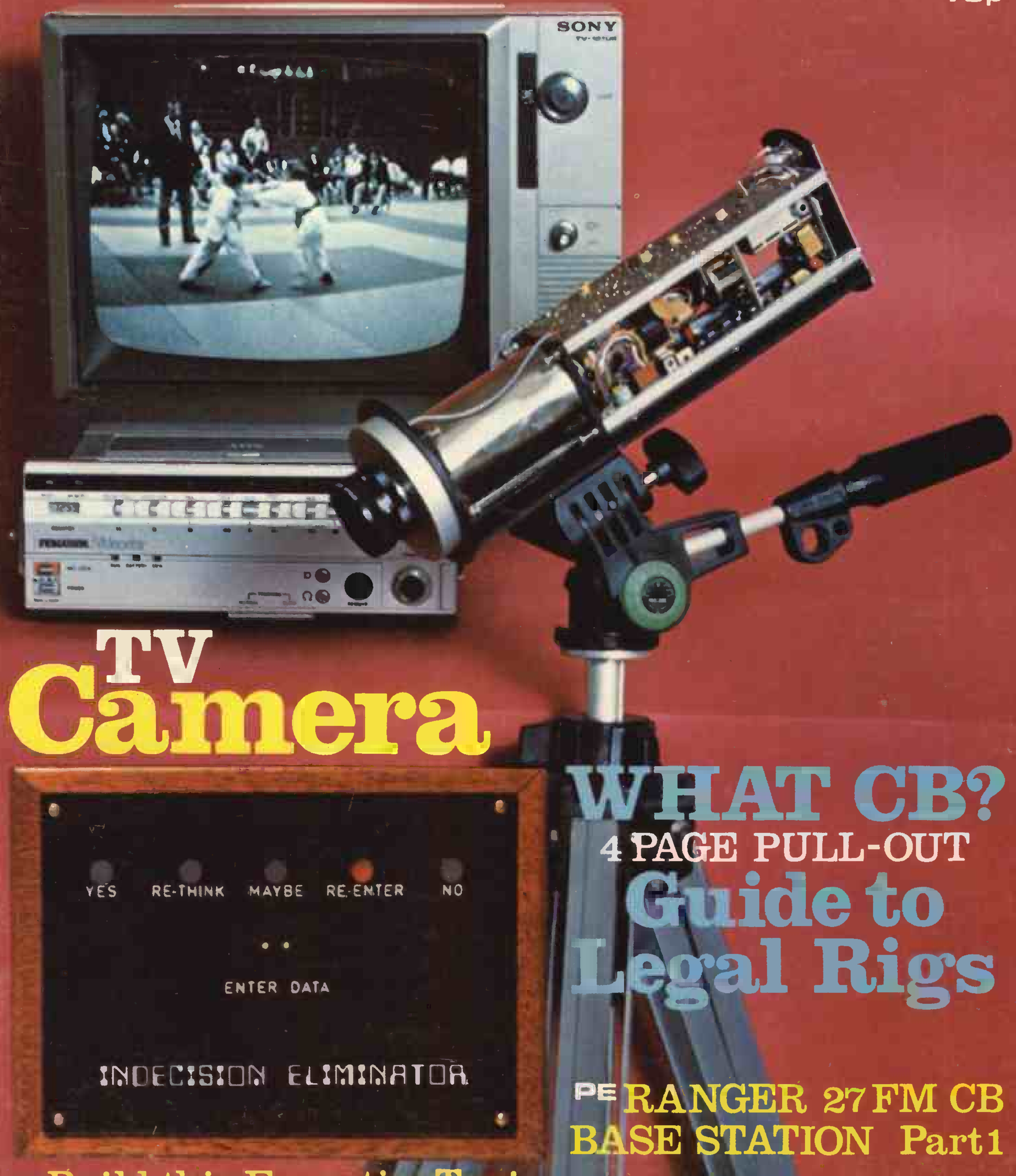
Australia $1.28 New Zealand $1.30 Malaysia $4.95 IR £1.07 (inc. VAT)

PRACTICAL

ELECTRONICS

JANUARY 1982

75p



TV Camera

WHAT CB?
4 PAGE PULL-OUT
Guide to Legal Rigs

PE RANGER 27 FM CB BASE STATION Part 1

Build this Executive Toy!

Much more than just kits quite simply the best way to make music . . .

WORLD LEADERS IN ELECTRONIC KITS

The smart contemporary styling of the 'black-boxes' contain the easy-to-build advanced electronics that produce everything from high grade amplifcation to complex lighting effects. These units are among the finest of their kind available and combine, as do all the Powertran kits, constructional ingenuity with high grade performance capability.

The finest materials and components are used throughout and the easy-to-follow fully illustrated and diagrammed manuals make building as pleasurable as operating.

Each unit can, of course, perform its independent function – but it is compatible with its fellows (same cabinet sizes and the same quality and professional finish) to enable you to assemble an impressive bank of wholly controllable power.

MPA 200 – a 100W amplifier with professional finish and performance at an exceptionally low price. Adaptable inputs mixer accepts a variety of sources. Straightforward construction – an excellent beginners kit. **COMPLETE KIT £49.90** (+ VAT)

CHROMATHEQUE 5000 – 5 channel lighting effect system. Sound to light, strobe to music level, random or sequential effects – each channel handles up to 500W yet minimal wiring is needed with our single-board design. **COMPLETE KIT £49.50** (+ VAT)

ETI VOCODER – 14 channel for maximum versatility and high intelligibility; each channel has independent level control. 2 input amplifiers – for speech/external excitation – each with level control and tone control. The Vocoder is a superb machine capable of infinite variety of operation. Contstruction with our easy to follow, comprehensive builders' manual – is challenging yet within the scope of most enthusiasts. **COMPLETE KIT £175** + VAT)

SP2 200 – 2 channel 100W amplifier. Two of the rugged, reliable and economic amplifiers from the MPA200 are fed by separate power supplies from a common toroidal transformer. Fully finished metalwork, fibreglass PCBs, controls, wire – everything you need to make this powerful unit. **COMPLETE KIT £64.90** + VAT)

DJ90 STEREOMIXER – a versatile new mixer with 2 stereo inputs for magnetic cartridges, a stereo auxiliary input and mike input. Auto planning for fast or slow, slider controls, multi-mixing, ducking, interrupt, input modulation – everything . . . yet still under £100! (Our console below shows the mixer neatly teamed with a Chromatheque and SP2 200) **COMPLETE KIT £97.50** + VAT)

PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until Feb. 28th, 1982, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.
EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.
U.K. ORDERS: Subject to 15% surcharge for VAT. No charge is made for carriage, or at current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit. FREE ON ORDERS OVER £100.
SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m.-12 noon, 1-4.30 p.m., Monday-Thursday.

MORE SUPERB KITS IN OUR CATALOGUE

BARCLAYCARD VISA

POWERTRAN ELECTRONICS, PORTWAY INDUSTRIAL ESTATE, ANDOVER, HAMPSHIRE SP10 3WN. Telephone Andover (0264) 64455

PRACTICAL
ELECTRONICS

VOLUME 18 No. 1 JANUARY 1982

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR FEBRUARY ISSUE WILL BE ON SALE FRIDAY, 8th JANUARY 1982
(for details of contents see page 31)

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

LIQUID CRYSTAL DISPLAYS

3½ digit	550
4 digit	750
6 digit	850

NEONS
Red or Amber Round or Square
30p each

OPTO SWITCH
TIL139 170

DIODES

AA119	15
BA100	15
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
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

BRIDGE RECTIFIERS
(plastic case)

1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	350
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ALUM.BOXES

3×2×1"	65
4×2½×2"	85
4×2¼×2¼"	103
4×4×2¼"	120
5×4×2	105
5×2¼×1½"	90
5×2¼×2¼"	130
5×4×1½"	99
5×4×2¼"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

ZENERS
Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V 1.3W 15p each

OPTO ELECTRONICS
LEDS including Clips

TIL209 Red 125"	13
TIL211 Green 125"	18
TIL212 Yellow	18
TIL220 ·2" Red	15
0·2" Yel, Grn, Amber	18
Red, Green and Yellow Rectangular LEDS.	29
Triangular LEDs R&G	18
0·2" Flashing LED Red	55
0·2" Bi colour Red/Green	65
Green/Yellow	65
0·2" Tri colour Red/Green/Yellow	85
0·2" Red High Bright	59
2N5777 45; OCP71	120
ORP12	86
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	91
TIL78 (detector)	54

7 Segment Displays

TIL100	90
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

VIC 20 Microcomputer

At last it is here, the long awaited Commodore's VIC 20 Microcomputer. Connects directly to any colour TV set. Sound reproduced through TV Speaker (Music, Language & other Sound effects). Has PET type Graphics. Standard PET Basic. Full size Keyboard, 5K memory expandable to 32K. Attractively cased.
Price: Only £165
Cassette Deck incl. Free 6 programme Cassette £34

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
36 pin	—	105p
40 pin	30p	99p

DIL PLUGS (Headers)

14 pin	44
16 pin	49
24 pin	88
40 pin	255

Ribbon Cable ft.
10 way 22p
20 way 40p

SPEAKING CLOCK
Full Kit of parts now available Only: £37.60

ZERO Insertion Force DIL Sockets
24 way 600p; 28 way 850p; 40 way 975p

WATFORD'S Ultimate Monitor IC.

A 4K Monitor Chip specially designed to produce the best from your: Superboard Series 1 & II, Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk In Practical Electronics, June 1981.
Price only £19.95 + 50p P&P.

EPSON MX Series PRINTERS
Now available from stock at very competitive prices.

- **MX80T** 10" Tractor Feed, 9×9 matrix, 80 column Speed 80 CPS bi-directional Centronics Interface, Baud rate 110-9600 (RS232) **£355**
- **MX80FT** Has Friction & Tractor Feed plus all the MX80T's facilities **£395**
- **MX80FT2** Has high resolution Graphics option plus all the MX80FT's facilities **£435**
- **MX100** 132 Column plus all the facilities of MX80FT2. Value for money. **£570**

SPECIAL OFFER

	1+	50+
741	14p	12p
NE555	16p	14p
2114-450n	90p	85p
2114L-3	99p	85p
2114L-2	130p	115p
2708	200p	185p
2532	525p	499p
2716	230p	199p
2732	455p	390p
4027	240p	215p
4116	85p	70p
4334-3	325p	290p
6116-3	855p	835p
7805 1A/5V	45p	35p

'D' CONNECTORS (Cannon type)

	Plugs	Sockets	Covers plastic
9 way	95p	125p	145p
15 way	135p	198p	150p
25 way	170p	250p	130p
37 way	290p	398p	185p

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA: 9-0-9V 75mA: 12-0-12V 75mA 98p
6VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A, 12V-·3A 12V-·3A; 15V-·25A 15V-·25A 220p
12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2, 6V-1·2A 12V-·5A 12V-·5A 275p (30p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A 320p (44p p&p)
50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A 395p (60p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A 920p (60p p&p)
(N.B. P&P charge to be added above our normal postal charge).

VEROBOARDS 0·1"

	Clad	Plain
2½×3¾"	73p	52p
2½×5"	83p	—
3¾×3¾"	83p	—
3¾×5"	95p	79p
3¾×17"	325p	211p
4¾×18"	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	1350

VARICAPS

MVAM2	165
MVAM115	158
BA102	30
BB105B	40
BB106	40

Noise Diode
Z5J 195

SCR's Thyristors

0·8A 100V	32
1A/200V	58
1A/400V	70
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/600V	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

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

DALO ETCH RESIST
Pen + Spare tip 90p

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

COPPER CLAD BOARDS

	Single-sided	Double-sided	SR8P
Fibre Glass			9·5"×8·5"
6"×6"	90p	110p	95p
6"×12"	150p	195p	

SOLDERCON PINS
100 pins 70p 500 pins 325p

ANTEX Soldering Irons

C15W	410
CX17W	425
CCN15W	425
X25W	440
Spare bits	50
Elements	200
Iron stands	160
Heat Shunt	25

Buy with


Just phone your order through, we do the rest.

GAS & SMOKE DETECTORS
TGS812 & 813 575
Sockets 40

ULTRASONIC Transducers
40KHz 395p pr.

25 WAY 'D' CONNECTOR
Jumper Lead Cable Assembly.

18" long, single end, Male	520
18" long, single end, Female	525
36" long, double ended M/M	1020
36" long, double ended F/F	1010
36" long, double ended M/F	1000

IC Test Clips DIL Gold plated contacts.

8 pin	600
14	370
16	390
18	815
20	945
22	1035
24	1130
28	1245
36	1630
40	1700

EDGE CONNECTORS double type

	·1	·156
2×10 way	—	135p
2×15 way	—	140p
2×18 way	180p	145p
2×22 way	199p	200p
2×25 way	225p	220p
2×30 way	245p	—
2×36 way	295p	—
2×40 way	315p	—
2×43 way	395p	—

JUMPER LEADS Ribbon Cable Assembly
Single ended DIP, 24" length Cable
14 pin 145p 16 pin 165p;
24 pin 240p; 40 pin 380p.
Double ended DIP

	14 pin	16 pin	24 pin	40 pin
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

COMPUTER CORNER

- **ETI/WATFORD'S MICRO EXPANSION SYSTEM.** This versatile economical Expansion System as published in ETI provides a Cheap but reliable Expansion possibility for most of the popular Micro-Computers. Send SAE for details.
- **VIC 20 MICROCOMPUTER** (see above SPECIAL OFFER section).
- **EPSON MX SERIES PRINTER:** see top right hand side of this advertisement.
- **SEIKOSHA GP80A** – Unihammer Printer, gives normal and double width characters as well as dot resolution graphics 8" Tractor feed. Parallel Interface standard. **£195**
- **SOFTY–2.** As reviewed in PE September 1981. 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 incl. encapsulated plug in power supply. **£169**
- **VIDEO MONITOR** 9" fully cased. B&W. Fully guaranteed. Excellent value for money at only **£69**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with integral 30 min. Electronic timer **£45**
- **Spare** 'UV lamp bulbs **£9**
- **5V/5A PSU** Ready built and tested **£25**
- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£26**
- **Extra 4K of RAM** (8 off 2114L-300nS) **£7.95**
- **Space Invaders** for Superboard **£6**
- **Full ASC11** coded keyboard type '756' **£39**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 Cassettes** in Library Cases **40p**
- **8½" Fan fold paper** (500 sheets) (no VAT) **£6**
- **9½" Fan fold paper** (500 sheets) (no VAT) **£6**
- **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	50p	7905	55p
12V	7812	50p	7912	55p
15V	7815	50p	7915	55p
18V	7818	50p	7918	55p
24V	7824	50p		
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

		LM309K	135
LM300H	170	LM309KP	99
LM304H	160	LM317H	280
LM305H	140	LM317K	350
78H05 5V/5A	550p	LM323K	500
78HG+5 to +24V 5A	599p	LM326N	240
		LM327N	270
79HG −2.25V to −24V 5A	785p	LM723	35
		T8A625B	75

SWITCHES

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

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

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

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 Biased 145
3 pole c/over 205

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 6p
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 56p
DIL Switches: (SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**; (SPDT) 4 way **190p**.

CRYSTALS

32·768KHz	200
100KHz	270
200KHz	295
455KHz	370
1MHz	295
1·28MHz	392
1·6MHz	323
1·8MHz	323
1·008M	290
1·8432M	220
2·0MHz	240
2·4576M	220
3·2768M	220
3·57954M	150
3·6864M	300
4·0MHz	200
4·032MHz	290
4·80MHz	200
4·194304M	200
4·433619M	120
5·0MHz	200
5·185MHz	300
5·24288M	390
6·0MHz	220
6·144MHz	240
6·5536MHz	200
7·0MHz	200
7·168MHz	250
7·68MHz	200
8·0MHz	200
8·867237M	240
9·00MHz	200
10·0MHz	200
10·7MHz	220
10·24MHz	200
12·0MHz	290
14·31818M	320
16·0MHz	275
18·0MHz	240
18·432M	240
19·968MHz	325
24·0MHz	200
26·69M	290
27·648M	330
27·145M	240
38·66667M	290
48·0MHz	270
100·0MHz	375
116·0MHz	300

ASTEC UHF Modulators
6MHz 280
8MHz Wide-bandwidth 450

WATFORD'S BOOKSHOP CORNER

	p
Texas TTL Data Book (Revised Edition)	680
TTL Cook-book	750
Motorola European CMOS Book (Revised)	695
Personal Computer Book	560
Illustrating BASIC	390
BASIC with Style	540
A Bit of BASIC	540
Basic Programme Primer	840
Programming in BASIC for Business	900
BASIC & the Personal Computer	1100
BASIC Handbook – 2e	1500
Advanced BASIC	840
BASIC Computer Games	590
More BASIC Computer Games	590
Some Common BASIC Programs	1150
Practical BASIC Programs	1250
6502 Software Design	900
6502 Application Book	1020
Programming the 6502 (C202)	1100
Programming & Interfacing the 6502	1200
6502 Assembly Language Programming	1350
6800 Assembly Language Programming	1250
6809 Assembly Language Programming	1390
Practical Intro to PASCAL	500
Using CP/M: A self teaching guide	780
8080A/8085 Assembly Lang. Programming	1250
Z80 Instruction Handbook	430
Z80/8080 Assembly Lang. Programming	700
Z80 Microcomputer Handbook	750
8080/Z80 Assembly Lang. Techniques	840
Programming the Z80 (C280)	1250
Z80 Assembly Language Programming	1350
Intro to TRS-80 Graphics	840
TRS80 BASIC – A self-teaching guide	750
32 BASIC Programs for PET Computer	1435
PET and the IEEE 488 Bus (GP1B)	1290
ZX81 Pocket Book	500
ZX81 Getting Acquainted (80 Programs)	550

Please add 55p P&P charge on books. (No VAT on Books.)

WATFORD ELECTRONICS
Tel. (0923) 40588 Telex. 8956095

DEVELOPMENT

EPROM-PROGRAMMER ROMULATOR

Softy 2

*£169 & VAT

2716
2732
2532
etc.

1. MONITOR or TV output (625 line UHF). Data contents of memory visible — A WINDOW IN THE CHIP.
2. 28-KEY, 2-LEVEL KEYPAD with HEX ENTRY and EDITING CAPABILITY. (BYTES and BLOCKS of code can be changed, inserted, deleted, shifted around etc.).
3. INPUT and OUTPUT: SERIAL (RS232) and PARALLEL (Centronics) routines provide ready interface with computer or printer.
4. EMULATION of PROGRAM MEMORY in-circuit is performed by plugging SOFTY into the ROM SOCKET. A lead with a 24 pin DIL PLUG is supplied.
5. CASSETTE INTERFACE.
6. EPROM-PROGRAMMER: an EPROM may be copied or reprogrammed at the press of a key.
7. PERSONALITY SWITCH selects 2716, 2532, 2732.

SOFTY is used as an EPROM-PROGRAMMER, a production ROM CHECKER and for the DEVELOPMENT and PRODUCTION of PRODUCTS which contain MICRO-PROCESSORS and use EPROM for program storage.

*Price is for a BUILT and TESTED SOFTY (No kits) including POWER SUPPLY, TV LEAD, ROMULATOR LEAD, 90 DAY WARRANTY and 14 day money-back guarantee.
£169.00 + £25.35 (VAT 15%) = £194.35.

DATAMAN DESIGNS,
Lombard House, Dorchester, Dorset DT1 1RX
Dorchester (0305) 68066 (UK Sales)
Maiden Newton (0300) 20700 (Export)

ILP TOROIDALS UNBEATABLE VALUE FOR MONEY!

New production capacity at Canterbury has increased our range, decreased our prices, improved our special customer design service. Choose from toroidal transformers in a range of 98 types.

Order using the FREEPOST coupon below.

Trade enquiries are welcome.

Supplied with rigid mounting kit with centre bolt, steel and neoprene washers GUARANTEED 5 YEARS

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE inc VAT	PRICE ex VAT
30 VA 70 x 30mm 0.45 Kg Regulation 18%	1X010	6 + 6	2.50	£5.28 + 0.87p P/P	£4.48 + 0.87p P/P
	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 x 35mm 0.9 Kg Regulation 13%	2X010	6 + 6	4.16	£5.83 + £1.10 P/P	£4.93 + £1.10 P/P
	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 x 30mm 1 Kg Regulation 12%	3X010	6 + 6	6.64	£6.51 + £1.43 P/P	£5.47 + £1.43 P/P
	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 x 40mm 1.2 Kg Regulation 11%	4X010	6 + 6	10.00	£7.55 + £1.43 P/P	£6.38 + £1.43 P/P
	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 x 40mm 1.8 Kg Regulation 8%	5X011	9 + 9	8.89	£9.92 + £1.43 P/P	£8.44 + £1.43 P/P
	5X012	12 + 12	6.66		
	5X013	15 + 15	5.33		
	5X014	18 x 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 inc VAT	PRICE ex VAT
225 VA 110 x 45mm 2.2 Kg Regulation 7%	6X012	12 + 12	9.38	£11.83 + £1.73 P/P	£10.06 + £1.73 P/P
	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 x 50mm 2.6 Kg Regulation 6%	7X013	15 + 15	10.00	£13.67 + £1.73 P/P	£11.66 + £1.73 P/P
	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 x 60mm 4 Kg Regulation 4%	8X016	25 + 25	10.00	£18.17 + £2.05 P/P	£15.53 + £2.05 P/P
	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 x 75mm 5 Kg Regulation 4%	9X017	30 + 30	10.41	£25.10 + £2.20 P/P	£21.54 + £2.20 P/P
	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.

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7¼ OCTAVE DOMESTIC MODEL

COMPONENT KIT £244

COMPLETE KIT £395.70

MANUFACTURED £675

Two Domestic Models are available including the 88-note full-size version.
Four intermixable Voice Controls may be used to obtain a wide variation of Piano tone, including Harpsichord.
Both Soft and Sustain Pedals are incorporated in the Design and internal Effects are provided in the form of Tremolo, Honky-Chorus, and Phase/Flanger.
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COMPONENT KIT £217

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Component Kits include Keyboard, Key-switch hardware, and all electronic components and may be purchased in four stages at no extra cost.
Complete Kits further contain Cabinets, wiring harness, Pedals and in the case of Domestic Models both Power Amplifier and Speaker.
The Six Octave Stage Piano has the same range of Voices and Effects and is designed for use with an External Amplifier and Speaker.

COMPLETE KIT £345

SIX OCTAVE STAGE MODEL

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Since 1972 Clef Products have consistently produced leading designs in the field of Electronic Musical Instruments, many of which have been published in technical magazines. With musical quality of paramount importance, new techniques have been evolved and the latest musically valid technology has been incorporated into projects which have been successfully completed by constructors over a wide range of technical capability. Back-up TELEPHONE advice to our customers is available from the Designer of all Kits advertised.

STRING ENSEMBLE

(As Published in conjunction with 'Practical Electronics')

A very popular Keyboard Synthesizer Kit, for Group or Home use, with a four octave compass and split Keyboard facility.
The instrument is fully polyphonic and has two rich Multi-String Voices plus Woodwind and Brass Effects for individual or Mixed use. Variable Attack and Sustain Controls give a good Orchestral Mix with the added concert hall reverberation effect produced by sustain coupled with phase modulation in the Chorus Unit.
The Component Kit includes Keyboard, Key-switch hardware, and all electronic components plus tone generator linking wire and Volume Pedal.
A copy of the P.E. project series can be supplied for £3.00 inc. post.

COMPONENT KIT £179.00

ROTOR-CHORUS

Comprehensive two speed organ rotor simulator plus a three phase chorus generator on a single 8" x 5" pcb. The kit includes all components for mains operation and a stereo headphone driver pcb. Easily integrated with existing organ/amplifier system.

COMPONENT KIT £89.00

KEYBOARDS

Our Square Front Keyboards are chosen for their superior feel to the discerning musician whilst giving adequate physical strength for the high impact playing present in the Piano application.

88 NOTE (A-C) £57.00
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FIVE OCTAVE £38.00
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EXPERIMENTERS

A number of our Sub-Kits are of interest to Electronic Music and COMPUTER Experimenters. These include the 6502 based MICRO-CONTROLLER and Music system kit used in the BAND-BOX, plus a 49 note four pitch diode Keyswitch system. See our lists for Sub-Kit prices.

PRICES INCLUDE VAT, UK CARRIAGE & INSURANCE (CARRIAGE EXTRA ON MFD PIANOS). Please send S.A.E. for our complete lists, or use our telephone VSA/ACCESS Service. Competitive quotations can be given for EXPORT orders – In Australia please contact JAYCAR in Sydney.

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The BAND-BOX provides an Electronic Backing Trio consisting of Drums, Bass, and a Chord Instrument (one of 16 Waveform/Enevelope combinations), with the capicity to store over 3,000 User Programmable Chord Changes on more than 120 different Chords. Using advanced Microprocessor technology, Playback of 50-100 Scores can be executed in any Key and at chosen Tempo. Complete Music Pad is electronically Indexed and stored on secondary battery back-up. Facility exists for composition of Intro, Repeat Chorus, and Coda sections including Multiple Score Sequences. Sockets are provided for Volume Pedal and Footswitch plus separate and mixed instrument Outputs. Total size 19" x 11" x 4¼" incorporating Master Rhythm.

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(As Published in conjunction with 'Practical Electronics')

EIGHT TRACK PROGRAMMING /TWENTY-FOUR PATTERNS/ TWELVE INSTRUMENTS SEQUENCE OPERATION.
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The Clef Master Rhythm is capable of storing 24 selectable rhythmic drum patterns, invented, modified, and entered by the Operator on to Eight Instrumentation tracks. A three position Instrumentation control expands the number of instruments available to twelve, grouped into sounds typical of playing with Drumsticks, Brushes, or Latin American Bongos and Claves.
Sequence operation allows two rhythm sections to be coupled with the second (B) section appearing at four, eight or sixteen Bar repetition. All drums can be adjusted for level and resonance on internal controls to suit individual taste, thus producing good musical sounds in a battery driven unit 8¼" x 5" x 2¼".

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The kit includes complete and finished cabinets, grille foam, wadding, drive units, crossovers, etc. – everything, in fact, to make a pair of excellent compact loudspeakers.

Suitable for amplifiers of 20 – 70 watts

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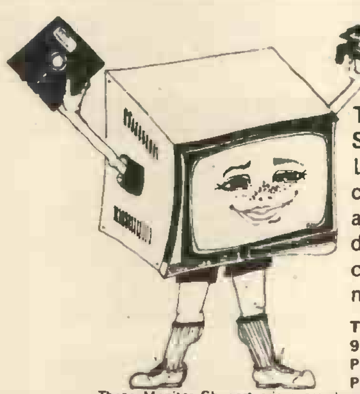

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No case, No Power Supply

SA 400	5¼"	S.S.S.D.	**£171.40**
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Load impedance, all models, 4 ohm — infinity. **Input impedance**, all models 100K ohm. **Input sensitivity**, all models, 500 mV. **Frequency response**, all models 15Hz-50kHz-3db.

BIPOLAR Standard, with heatsinks

Model No.	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D 50Hz/7kHz 4.1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex VAT
HY 30	15w/4-8Ω	0.015%	<0.006%	±18±20	76×68×40	240	£8 28	£7.29
HY 60	30w/4-8Ω	0.015%	<0.006%	±25±30	76×68×40	240	£9 58	£8.33
HY 120	60w/4-8Ω	0.01%	<0.006%	±35±40	120×78×40	410	£20.10	£17 48
HY 200	120w/4-8Ω	0 01%	<0.006%	±45±50	120×78×50	515	£24.39	£21.21
HY 400	240w/4Ω	0·01%	<0.006%	±45±50	120×78×100	1025	£36.60	£31 83

BIPOLAR Standard, without heatsinks

Model No.	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D 50Hz/7kHz 4.1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex VAT
HY 120P	60w/4-8Ω	0 01%	<0 006%	±35±40	120×26×40	215	£17 83	£15.50
HY 200P	120w/4-8Ω	0 01%	<0 006%	±45±50	120×26×40	215	£21 23	£18 46
HY 400P	240w/4Ω	0.01%	<0 006%	±45±50	120×26×70	375	£32.58	£28 33

Protection: Load line, momentary short circuit (typically 10 sec) Slew rate 15V/μs Rise time: 5μs. S/N ratio 100db. Frequency response (-3dB):15Hz-50kHz. Input sensitivity 500mV rms. Input impedance 100kΩ. Damping factor (8Ω/100Hz)>400.

ILP Electronics Ltd., Freepost 2, Graham Bell House, Roper Close, Canterbury CT2 7EP, Kent.

HEAVY DUTY with heatsinks

Model No.	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D. 50Hz/7kHz 4.1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc VAT	Price ex. VAT
HD 120	60w/4-8Ω	0.01%	<0.006%	±35±40	120×78×50	515	£25.85	£22·48
HD 200	120w/4-8Ω	0.01%	<0.006%	±45±50	120×78×60	620	£31.49	£27 38
HD 400	240w/4Ω	0 01%	<0.006%	±45±50	120×78×100	1025	£44 42	£38 63

HEAVY DUTY without heatsinks

Model No.	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D. 50Hz/7kHz 4.1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc VAT	Price ex. VAT
HD 120P	60w/4-8Ω	0 01%	<0.006%	±35±40	120×26×50	265	£22.82	£19.84
HD 200P	120w/4-8Ω	0 01%	<0.006%	±45±50	120×26×50	265	£27 17	£23.63
HD 400P	240w/4Ω	0 01%	<0 006%	±45±50	120×26×70	375	£39.42	£34.28

Protection: Load line, PERMANENT SHORT CIRCUIT (ideal for disco/group use should evidence of short circuit not be immediately apparent). The Heavy Duty range can claim additional output power devices and complementary protection circuitry with performance specs as for standard types.

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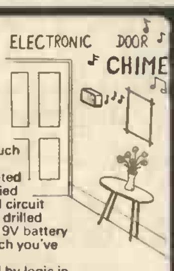


Fed up with your old doorbell? This KIT should cheer you up! Our latest kit gives you a pleasing three note harmonically related tone sequence (NOT a microprocessor controlled buzz) at a touch of a button. Based on a new integrated circuit, this KIT is supplied complete with a printed circuit board, loudspeaker and drilled box and requires only a 9V battery and a push-button, which you've probably already got. It may also be switched by logic in such applications as car alarms, clocks, toys, PA systems, etc. The unit produces a 150mW output and draws less than 1uA from a PP3 battery, when the tone ceases. Supplied complete with circuit and assembly instructions.

IDEAL PROJECT FOR BEGINNERS

ONLY £5.00 + V.A.T.

SOFTY 2

Plug SOFTY 2 into the EPROM socket of your favourite micro (Z80, 6800, 8035, etc.) prototype system, which will also contain input/output lines, RAM, keyboard, displays, etc. SOFTY 2 will operate as the ROM in your system but enable you to write data into any location, observe the memory contents on any black & white TV and store the program on a cassette recorder if required. Various editing facilities are also available to permit bytes or blocks of code to be changed, inserted, deleted, shifted, etc. enabling the programme to be developed and run on the host computer. When the program has been "debugged", SOFTY 2 may be used to turn it into an EPROM (2716 or 2732). Plug the Eprom into its socket and you have a dedicated microprocessor system.

You can also use it as an EPROM programmer and to copy EPROMs from a master or to/from tape.

The SOFTY 2 is housed in a black ABS case and comes complete with main supply, cable with 24-pin d.i.l. plug for connecting to your prototype system, and television lead. Fully built and tested.

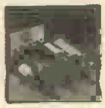
£169 + VAT. Send SAE for further details.

Also available is the new Z80 ASSEMBLER/MICRO CONTROLLER – MENTA. £115 + VAT

DISCO LIGHTING KITS

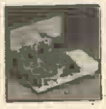
Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

DL1000K



This kit features a bi-direcitonal sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.60**

DLZ1000K



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

Optional Opto Input DLA1 **60p**

NOT JUST ANOTHER CLOCK

NEW

but a PROGRAMMABLE TIMER KIT which can run your central heating, burglar alarm, lighting, taperecorder/radio and lots more. Designed to control four mains outputs independently, switching these on and off on selected days and times in a seven day cycle.

Features include:

- ★ 0.5" LED 12 hr. display.
- ★ Day of week, am/pm and output status indicators.
- ★ Zero Voltage Switching 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 everyday 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.

To control your central heating, for example, (including different switching times at weekends), just connect it to your system, programme it, set it and forget it. The clock will do the rest. There has never been a clock capable of so much at this price. CT5000K Timer Kit (includes all components, assembly and programming instructions, and an attractive black case)

£45.00

DVM/THERMOMETER KIT

NEW DESIGN

Based on the ICL7126 (a low 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 + VAT

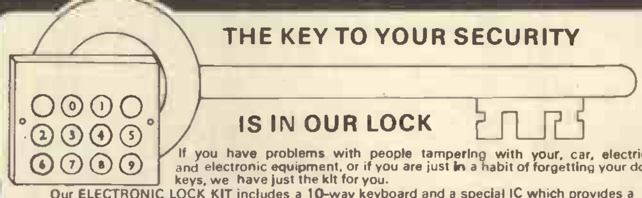
IF YOU CAN'T (REMOTE) CONTROL YOURSELF . . .

Remote control systems in magazines tend to be quite complex, requiring many difficult to get components and a well equipped lab to set them up. If this has put you off making your own system we have just the kits for you. Using infra-red, these KITS range from simple on/off controllers to coded transmitter/receivers with 16 on/off outputs or three analogue outputs for controlling TV or hi-fi systems, the kits are easy to build and simple to set up – and they are extremely versatile so you can use them for controlling anything from garage doors to room lighting just by adding the required output circuits, i.e. relays, triacs, etc.

If you can design your own system, we stock a wide range of remote control components at very competitive prices.

To help you decide, we have compiled a booklet on remote control, containing circuits, hints, data sheets and details of our remote control kits and components. So DON'T control yourself – send us 30p and an S.A.E. for your copy TODAY.

THE KEY TO YOUR SECURITY IS IN OUR LOCK



If you have problems with people tampering with your, car, electrical and electronic equipment, or if you are just in a habit of forgetting your door keys, we have just the kit for you.

Our ELECTRONIC LOCK KIT includes a 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 pre-wired 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!

LOCK I.C.s

LS7220 with SAVE memory	£2.75
LS7225 with latched and momentary outputs and a tamper output	£2.60
Electric Lock Mechanism	£12.50

Suitable for use with existing door locks and above electronic lock kit.

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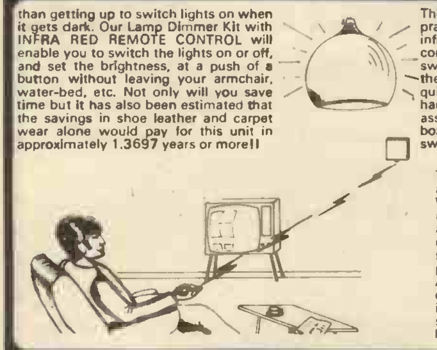

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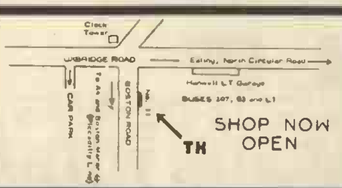

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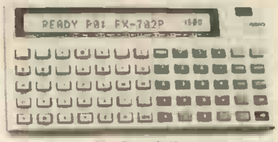

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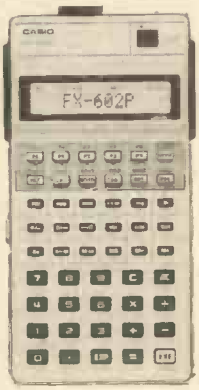

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HY 11	Mono mixer	Mixes five signals into one — with base/treble controls	10 mA	£8.11	£7.50
HY 68	Stereo mixer	Two channels, each mixing ten signals into one	20 mA	£9.14	£7.95
HY 74	Stereo mixer	Two channels, each mixing five signals into one — with treble and bass controls.	20 mA	£13.17	£11.45

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HY 13	Mono VU meter	Programmable gain/LED overload driver	10 mA	£6.84	£5.95
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HY 72	Voice operated stereo fader	Provides depth/delay effects.	20 mA	£15.07	£13.10
HY 73	Guitar pre-amp	Handles two guitars (bass and lead) and mic with separate volume/bass/treble and mix	20 mA	£14.09	£12.25
HY 76	Stereo switch matrix	Provides two channels, each switching one of four signals into one	20 mA	To be announced	
HY 77	Stereo VU meter driver	Programmable gain/LED overload driver.	20 mA	£10.64	£9.25

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B 6 mounting board for modules HY6 -HY13 £0.90 inc. VAT (0.78 ex. VAT.)
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PE VOLUME 18 No. 1 JANUARY 1982

COMING OF AGE!

This issue marks the start of a new year for PE—our 18th. Yes, even though we still think of ourselves as a "new" magazine, publication of PE started with the November 1964 issue. Hopefully many readers also continue to feel PE is "new", since this indicates we are keeping up with their needs and continuing to break new ground on projects and technology.

Before we forget it, let us take this opportunity of thanking you for your support over the years and wishing you seasonal greetings and a prosperous new year. We are planning some further steps forward for PE during 1982 and we hope you will all take them with us.

'81 CHANGES

We came some way in '81, 'though times have been difficult for many with the recession really biting. Unfortunately, it now seems that we will have to weather its ravages for the best part of next year as well. It is generally felt that even the "iron lady" will have to bend towards the end of the year so that things improve before the next election!

Another effect of the recession has been to attract more commercial companies into producing and marketing electronic projects as a means of keeping stock and financial turnover at a reasonable level. Thus there are probably more specialist professional engineers now working on projects for the "amateur" than ever before.

UK sales of PE have increased during the last six months and are higher now than they have been for 18 months, even though cover prices have had to rise and people's general wealth has fallen. Our overseas sale, which is in excess of 20,000 copies, is also very buoyant especially in the emerging nations.

One change, made earlier in the year, which readers may not have noticed was the introduction of a new front cover logo. This rather subtle increase in lettering size came in the July issue—check if you don't believe us! Thankfully, we have been able to continue to produce many "first time" projects; CB has come; we gave readers a Free Instrument Case, an I.C. Removal Tool and four suppliers' catalogues during the year. All of which were well received and we believe proved useful.

Our aim has been to make PE the best possible value for money and this will continue in '82. If we can be even better at this time next year everyone will be pleased. After all it's the "newness" of the mag. that keeps staff and readers interested and the whole thing on the boil. The quality, range and ingenuity of our projects is now better than ever.

CB

As we go to press we are hearing disturbing stories that European standard CB rigs and a.m./f.m. rigs are being sold as legal equipment with a CB 27/81 label on them. Readers should therefore be very careful when buying a rig to ensure that it is built to the British specification. Our rig review will assist with identification.

Mike Kenward

EDITOR

Mike Kenward

Gordon Godbold ASSISTANT EDITOR

Mike Abbott TECHNICAL EDITOR

David Shortland PROJECTS EDITOR

Jasper Scott PRODUCTION EDITOR

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John Pickering SEN. TECH. ILLUSTRATOR

Isabelle Greenaway TECH. ILLUSTRATOR

Colette McKenzie SECRETARY

Editorial Offices:
Practical Electronics,
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West Quay Road, Poole,
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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 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

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Binders

Binders for PE are available from the same address as back numbers at £4·30 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

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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 David Shortland & Jasper Scott

More Micros in Schools

Mr Kenneth Baker MP, Minister for Information Technology, recently announced an extension of the Department of Industry's Micros in Schools scheme to secondary schools which already have computer facilities.

Speaking at the launch of Information Technology '82 he said:

"The Micros in Schools scheme has proved a great success. Since the scheme was opened on June 1, almost 1900 applicants have been approved for 50% funding towards the cost of a microcomputer. Both maintained and independent schools in England, Wales, Scotland and Northern Ireland are participating.

"The Department of Industry estimated 2500–3000 secondary schools were without equipment and so we are well on the way to achieving my first objective of a micro in every secondary school by the end of 1982.

I am pleased to announce that, as from January 1, 1982, this scheme will be extended so those secondary schools already with equipment may take advantage of the grant.

With the back up teacher training provided for in the scheme, this initiative is a vital complement to the Microelectronics Programmes under way by the Education Departments. I hope teachers from all disciplines will be able to take advantage of these programmes so that an awareness of new technology is an integral part of all pupils' experience across the curriculum."

SECONDS AWAY!

The wonder of liquid crystal never ceases to amaze, and one of Casio's latest offerings uses the ubiquitous l.c.d. to take the "executive toy" to new heights.

Casio's BG15 is based on the now familiar clock/calculator format, with the usual added attraction of a game. But, instead of Alien Invaders, you have a boxing match, with excellent animated graphics and a realistic scoring system. Now you can beat the stuffing out of your opponent without sustaining a single bruise yourself!

The one criticism that could be levelled at the BG15 is that the instruction booklet is rather an epic work which takes a long time to get through—particularly the chapter on the game.

Anyone who has had a trying day and feels like inflicting a touch of GBH on their boss will find this machine a far less troublesome way of letting off steam. It is available at a discount price of £16·95 (inc VAT and p&p) from Tempus, Dept. PE, Freepost, 164–167 East Road, Cambridge, CB1 1DB. (0223 312866)

POINTS ARISING . . .

ULTRASONIC CLEANER (Jan. '80)
PE CONGRESS (April '80)

Wicca Electronic Systems Ltd, who supplied kits for the above projects have recently ceased trading. While components for the Congress should be available from other sources, we do not know of another supplier of certain parts for the Ultrasonic cleaner. However, a complete kit for a similar device is currently available from Heathkit. Further information is available from them on 0452 29451. Technical queries should be addressed to us.

DON'T!

Rodnay Zaks, computer scientist, author, and president of the publisher Sybex Inc., has been putting pen to paper (or perhaps finger to word processor) again. The latest book we have received is called:

Don't! (Or How To Care For Your Computer).

The front cover is striking, and with quotations of wisdom from Shakespeare's Macbeth through to Confucius leading you in to each chapter, it makes fulfilling reading. The book is openly "dedicated to the allegedly mythical trouble-free computer". It shows how most hardware problems are either directly or indirectly brought on by mishandling.

Make your hobby room comfy for humans and your home computer will like it too, says Mr. Zaks of temperature, vibration and dust considerations.

Among the often quite funny cartoons, photographs and diagrams you will find such "horror" stories as that recounted of the man who was unwittingly ruining discs by writing identity information on their sleeves with a hard ball-point pen, thereby embedding loose grit into the oxide.

You are also warned against smoking near disc drives. One picture shows the relative sizes of common pollutants. With the flying height of the head at 100μ, the cross section of a human hair shown adjacent looks something like a football next to the gap under the door. The *least* offensive, fingerprint oil, would be more than enough to swamp the gap! And that effluvium donated to the atmosphere so freely by our smoking companions looks as though it could cause havoc, comprising sticky particles of 300μ diameter.

The book's title, *Don't!*, applies to its *own* diagrams on page 157 if you are European, which illustrate typical NEMA receptacles and their mains wiring. In the USA there is no such thing as a brown "Live" wire, it's black, and it's "Hot" (probably pronounced "hut"). The book is written at a light-hearted level and makes enjoyable and informative reading.

You could say it is aimed at interfacing the *low event horizon user* to *leading edge technology practices*. Honestly, you could!

This soft-back is available through **Computer Bookshop,** 30 Lincoln Road, Olton, Birmingham, which is the UK outlet for Sybex. It costs £9·65 and consists of 213 pages measuring 150 x 230mm.

MARKET PLACE

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

Briefly...

To cope with the shortage of training aids in microwave engineering, the Microwave Products Division of Marconi Instruments, a GEC–Marconi Electronics company, have introduced a new low cost audio-visual course—"Understanding Microwave Equipment". It consists of six C90 cassettes held in a ring binder containing 175 supporting diagrams and photographs. This course can be used by anyone who has an interest in microwave equipment.

The six sessions cover a survey of microwave systems and devices, transmission lines and components, solid-state sources, tubes, low-noise receivers, antennas, radar, telecommunications and electronic warfare systems.

The cost of the course is £65. Further details are available from Harold Read, Marconi Instruments Ltd., Longacres, St Albans, Herts AL4 0JN (0727 59292)

● ● ● ●

The winner of our questionnaire competition was Mr Ray Causer of Wantage, whose estimate was 971. Mr Causer will receive a cheque for £50.

We would like to thank all our readers who took the trouble to fill in the questionnaire.

● ● ● ●

The new 12-page catalogue from Ace Mailtronix is now available price 30p. The catalogue covers a wide range of components and as always Ace will try and obtain any type component for constructors. For a quote by return of post please send a S.A.E.

Ace Mailtronix Ltd., 3A Commercial Street, Bately, West Yorkshire (0924 441129).

KEYBOARD TUTOR

Thousands of budding organists and pianists struggling through the first stages of learning to play will welcome a new electronic tutor developed by a Preston company.

Called Prelude, it gives an instant visual guide to more than 600 chords as well as all major and minor scales. It's a small, hand-held device with keys for the musical notes, chords and inversions, and a liquid crystal keyboard display.

The unit is designed to help tutored or self-taught students learn the basic 'alphabet' of music; to teach classically-trained musicians modern harmony and to help string or wind players to convert to keyboards.

Two professional organ teachers who helped in Prelude's design say that it is far easier and quicker to use than a printed tutor. Not only does it show notes making up the basic chord, but the user can add progressively more complex components, and show all the inversions—the different ways of playing it.

Prelude is priced at £19·95 including VAT, plus 40p p&p, and is available from Speedyplain Ltd., Freepost, Longton, Lancs PR4 5YL.

Countdown...

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below.

IDEA (Domestic appliances) Jan. 12–14. Birmingham. **B6**
OEM Assemblies Feb 2–4. Royal Hort. Halls London. **T**
BEX Bristol Feb. 3–4. **K**
BEX Bournemouth Feb. 17–18. **K**
Microsystems Feb. 24–26. West Centre Hotel London. **Z1**
Seminex Mar. 29–Apr. 2. Imperial College London. **H1**
CAD Mar. 30–Apr. 1. Metropole Brighton. **Z1**
Laboratory Edinburgh Mar. 30–31. Ass. Rooms. **E**
Test & Measurement Mar. 30–Apr. 1 Forum Wythenshawe. **T**
Sensors & Systems Mar. 30–Apr. 1 Forum Wythenshawe. **T**
Peripherals Mar. 31–Apr. 2. West Centre Hotel London. **Z1**
Laboratory Manchester Apr. 7–8. New Century Hall. **E**
All Electronics Show Apr. 19–21. Barbican London. **E**
BEX Brighton Apr. 28–29. **K**
Compec Europe May 4–6. Centre Int. Rogier. **Z1**
CETEX May 30–June 2. Earl's Court London. **B6**
BEX Leeds Jun. 9–10. **K**
Transducer/Tempcon Jun. 29–Jul. 1 Wemb. Conf. Cntr. **T**

B6 Andry Montgomery Ltd. ✆ 01-486 1951
E Evan Steadman, Saffron Walden ✆ 0799 22612
H1 Seminex Ltd., Tunbridge Wells ✆ 0892 39664
K Douglas Temple, Bournemouth ✆ 0202 20533
T Trident, Tavistock ✆ 0822 4671
Z1 IPC Exhibitions, Sutton ✆ 01-643 8040

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

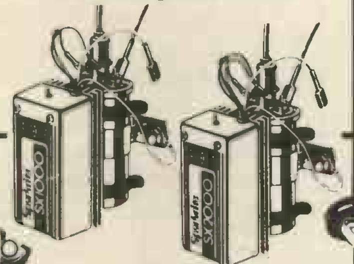
Sparkrite

BRANDLEADING ELECTRONICS

NOW AVAILABLE IN KIT FORM

SX1000
Electronic Ignition

- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



MAGIDICE
Electronic Dice

- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand over dice
- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
- Muting and Off switch on base
- Hours of continuous use from PP7 battery
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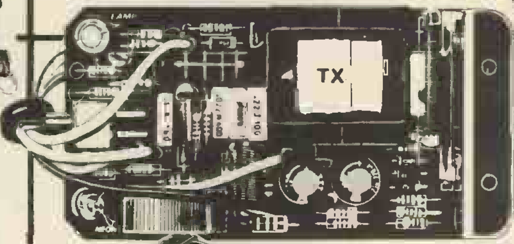
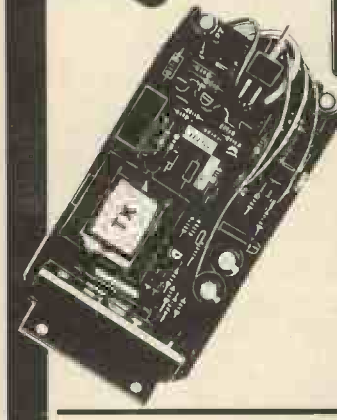
- Supplied in superb presentation gift box



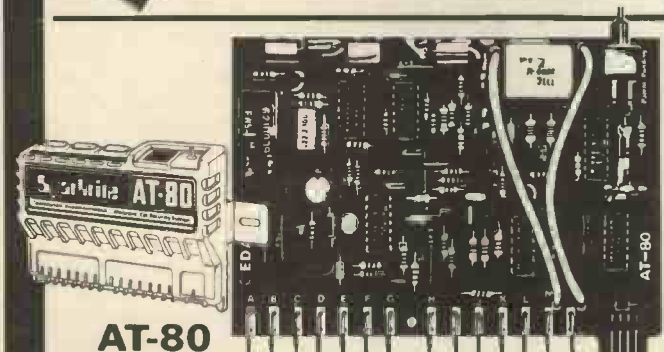
SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless. ● Three position switch with Auxiliary back-up inductive circuit. ● Reactive Discharge. Combined capacitive and inductive. ● Extended coil energy storage circuit. ● Magnetic contactless distributor trigger-head. ● Distributor triggerhead adaptors included. ● Can also be triggered by existing contact breakers. ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles. ● Over 150 components to assemble



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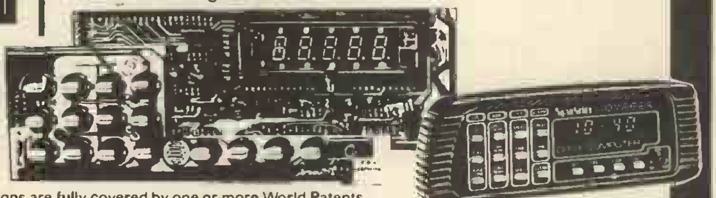
● A most sophisticated accessory. ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd. ● Affords 12 functions centred on Fuel, Speed, Distance and Time. ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on. ● Facility to operate LOG and TRIP functions independently or synchronously. ● Large 10mm high 400ft-L fluorescent display with auto intensity. ● Unique speed and fuel transducers giving a programmed accuracy of + or − 1%. ● Large LOG & TRIP memories. 2,000 miles. 180 gallons. 100 hours. ● Full Imperial and Metric calibrations. ● Over 300 components to assemble. A real challenge for the electronics enthusiast!

AT-80
Electronic Car Security System

- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen ● Fits all 12V neg earth vehicles
- Over 250 components to assemble



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EDA SPARKRITE LIMITED 82 Bath Street, Walsall, West Midlands, WS1 3DE England. Tel: (0922) 614791

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SX 1000	£12.75	£27.95
SX 2000	£19.95	£43.75
TX 2002	£29.95	£62.95
AT. 80	£24.95	£49.75
VOYAGER	£49.95	£84.75
MAGIDICE	£12.95	£19.95

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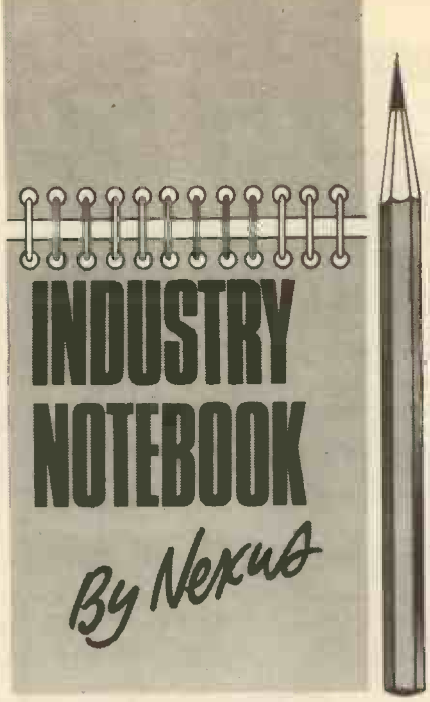
BRANDLEADING BRITISH ELECTRONICS

CUT OUT THE COUPON NOW!



Punch Drunk

I still feel slightly punch drunk after the autumn marathon of the political conference season. Hours and hours of waffle from the platform. Even more hours of pundits interpreting, analysing, what was said or, more sinister, what was not said. The acres of newsprint as a follow-up in the daily and weekly press.

It was all in the line of duty. Alas, my hopes of discovering just a small spark of inspiration in relation to industry and its problems were unrealised. The politicians had been wasting my time.

When the parties were not running down their opponents they were squabbling among themselves. But there was some consensus. All, in the face of facts, more or less agreed that British industry has been in decline for 20 years. If we accept this, as we must, we had the spectacle of those who assisted in the decline, indeed, probably accelerated it, putting themselves forward as the new messiahs. Yesterday's failures claiming they are tomorrow's saviours.

Dishonesty was the order of the day. But of course it is too much to expect public figures to even hint they had flopped in the past, or to admit they are powerless in the face of events over which they have no control.

Then there was the new alignment. The party labels are now confusing. Labour retains its name not its old character which is now re-born under the label Social Democratic, heavily loaded at the top with old-style Labourites. The Liberals, once proudly independent, after enjoying a brief moment of influence in the Lib-Lab pact have now found it expedient to enter an uneasy alliance with the SDP. The Tories are what they have always been except more so under Mrs Thatcher, but even there a shift is apparent.

Meantime, in the midst of political manoeuvre and intrigue, industry has to get on as best it can. It was a great pity that even the Tories, who are more honest than the others in presenting the brutal facts of life, did not ram home more forcefully the message that there is only one formula for industrial success—the right product at the right time at the right price. Only then can profits be generated to satisfy the social conscience in welfare and other benefits. The principle, simple as it is, applies right across the board from toilet rolls to jet aircraft. Government macroeconomics can help or hinder. But it is management and workers who produce the goods.

I can see no industrial future in the school of thought which recommends wholesale nationalisation, withdrawal from the EEC, import controls, currency controls, plus hostility to multinational operation which, in electronics, is the life-blood of all the larger companies including those which are British-based.

To institute central government control in place of free enterprise which stimulates technological advance and keeps prices down would certainly not benefit the elctronics industry. There is a real-life model on which I base this observation. It has the uninspiring title of the State Collective Electronic Communications Combine of the Soviet Union. Its products are also uninspiring. Could this be the fate, say, of GEC in 10 years time?

Turnround

Not that electronics has been universally successful. Few companies win all the time. ICL is running through a bad patch as I write and it is somewhat humiliating, even though common sense, that Japanese technology is being injected to boost sales. The same, of course, applies to BL with the Triumph (i.e. Honda) Acclaim. But in business you need to bend with the wind and seize every advantage.

Decca was on the skids. Now no longer so. How was this achieved?

When Racal moved in, paying £106 million at what was then thought to be a silly price, the new management made no secret of what they were after. It was capital goods in growth areas with electronic warfare in the lead. Racal knows electronic capital goods and its markets but didn't want to know music or domestic TV. These Decca activities were sold off to those who could make better use of them. Similarly, Racal saw no point in maintaining an imposing Thames-side headquarters in the middle of London. So Decca House on the Albert Embankment is being sold at a figure in the region of £6 million.

The Decca companies have been reorganised into eight major product or business areas, defence systems, marine radar, navigation etc. Each of the new Racal-Decca companies is expected to stand on its own feet and generate products or services, and profit. Marine radar is still losing money but is expected to get back in the black in the current financial year.

True, Decca is somewhat slimmer than before. But this is a small and necessary price to pay for ensuring jobs for the great majority now and in the future. Racal-Decca accounts for 30 percent of all Racal Electronics Group business and now, for the first time, Racal has joined the elite club of companies who can boast a world-wide turnover of a billion dollars .

One of Racal-Decca's real growth areas is in underwater exploration. It is strong in North Sea oil, and it was Racal-Decca Survey Ltd who supplied the know-how, the men and the equipment to locate the wreck of HMS Edinburgh, sunk in World War 2 in the Barents Sea, from which £45 million of gold bullion was recently salvaged.

Sugar-sweet

If you've got a product or service that people want to buy there is never a slump. On the general consumer front Marks and Spencer have turned in record results. A consistent high flyer with a value-for-money reputation.

In the more specialised field of consumer electronics, always a topic of gloom, we have Alan Sugar, heading up Amstrad, who took his company to the public in April 1980. His forecasts looked optimistic, if not downright rash, in the prospectus. But the public backed him to their own, and his, profit.

At the end of his first year of trading as a publicly quoted company, Sugar achieved 61 percent increase in turnover and 75 percent increase in profit. Not bad in a period of 'the greatest recession ever experienced'. Sugar is forecasting further gains in the current year and on his track record he should succeed.

Hooray for Russia!

Russian military aid to the third world countries is turning out to be good business for British electronics. Shifting political allegiance has left many countries with vintage Soviet defence hardware, out of date but in fair physical shape.

Modernising is not a new game but when you have fallen from grace with your benefactor you can hardly go back to him, and if you haven't native skills you must look elsewhere to those who have.

Thus, the prospect of over £500 million of work on modernising eight Russian-built destroyers in service with the Chinese navy. They will be fitted with new missile systems, new radars and other sensors, and new operations rooms. Contracts are reported to be near signing with British Aerospace as principal contractor for the missiles and electronics systems.

Elsewhere in the world there are hundreds of Russian tanks recently up-dated with British radio and gun-ranging equipment and Russian radar systems with new British signal processing and display systems.

Talking Exchange

Britain's 1,000 blind telephone operators will have the benefit of a speaking PABX exchange. GEC, British Telecom and the Royal National Institute for the Blind have devised a plug-in black box for the latest Monarch 120 PABX. This microprocessor-controlled exchange has a visual display. Any information displayed is automatically 'spoken' to the blind operator via a speech synthesizer.

EVERYONE must make decisions on a routine basis. The microelectronic revolution has provided us with hand held calculators to assist us in handling day-to-day number problems. Why not apply this same technology to day-to-day decision making?

This project has been developed after years of research into the decision making patterns of the man on the street. Operation has been made as simple and straightforward as possible. Gone are the days of feeding a computer with information for hours on end and spending the same amount of time deciphering what the computer's exact response was. Modern advances in microelectronic technology have enabled us to design and build one of the most sophisticated and powerful decision making aids in the world. It is as easy to operate as flipping a coin which can only provide an answer based on chance. This modern marvel of engineering ingenuity can not only provide instantaneous answers based on the information presented by the operator and its relationship with time and space but also eliminates the fatigue problem caused by flipping coins.

The basic model has been designed to offer the optimum responses to the widest range of questions that can be presented. The computer's basic responses are:

YES RE-THINK MAYBE RE-ENTER NO

ALTERNATIVES

There are many other response patterns that can be programmed into the computer. Some examples of these are shown:

Pilot's Collision Avoidance Computer
RIGHT LEFT PANIC UP DOWN

Navigator's Decision Computer
NORTH EAST PANIC SOUTH WEST

Diplomat's Decision Computer
PERHAPS MAYBE POSSIBLY CONCEIVABLY POTENTIALLY

Pay Rise Computer
NO CHANCE IMPOSSIBLE NO NEVER TRY NEXT YEAR

Idi Amin's Decision Computer
MAIM EXECUTE KILL MURDER VANISH

COMPONENTS

Resistors

R1–R20	10M (20 off)
R21	10k
R22–R24	1M (3 off)
R25	470k
R26	10

All 10% ¼W

Capacitors

C1–C3	4µ7 10V tantalum bead
C4	10n polyester

Integrated Circuits

IC1–IC2	4011B (2 off)
IC3	4022B
IC4	4049B

Miscellaneous

B1—9V battery, D1–D5—Red l.e.d. 0·2in.

All parts can be obtained from **Compu-Tech Systems,** Gaymer Way Industrial Estate, North Walsham, Norfolk NR28 0AN

Indecision Eliminator

W.C. DICKINSON

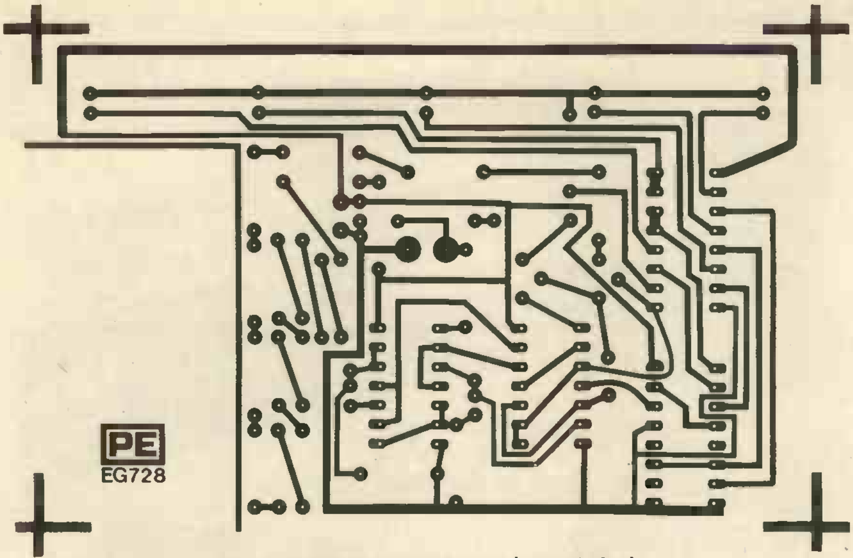


Fig. 1. Printed circuit layout (actual size)

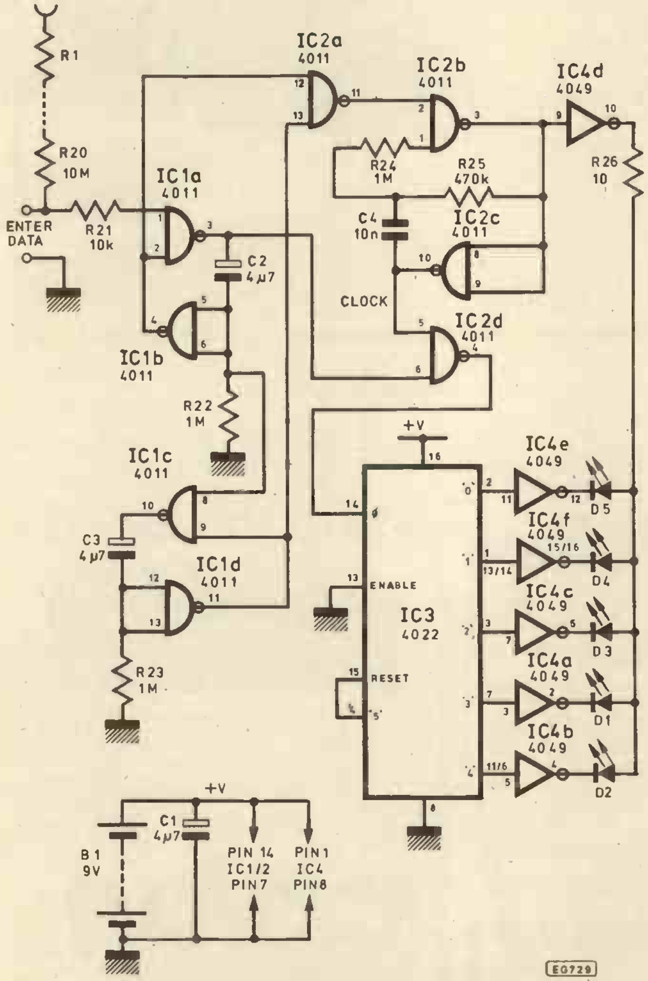


Fig. 2. Circuit of Indecision Eliminator

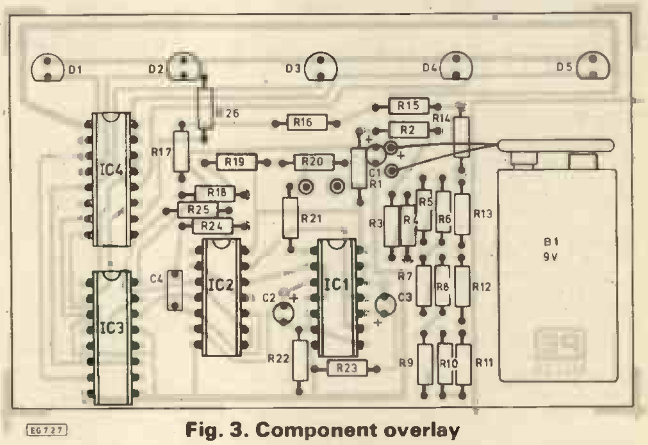
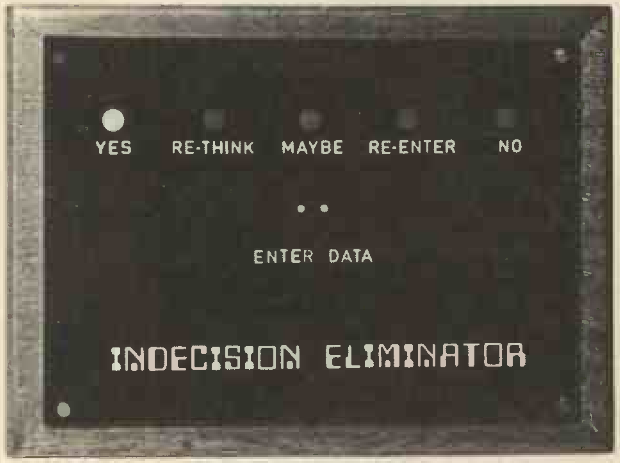


Fig. 3. Component overlay



Format of circuit box

OPERATION

The two touch contacts on the front panel are provided to accept data via direct contact with the operator. The operator's brainwaves are conducted into the unit and enter a brainwave to digital data converter. This data is instantly accepted and simultaneously locked to time and space vectors.

Upon acceptance of the information the five data output indicator l.e.d.s will begin to flicker, indicating that your input data is being processed. The unit is now searching for parity between time and space vectors and your question. Process time has been extended to approximately three seconds in order to ensure compatibility with the optic nerve.

After the data has been processed the scanning of the l.e.d.s will cease and one of the data output l.e.d.s will remain illuminated. If the 'RE-ENTER' l.e.d. illuminates parity did not exist between time and space vectors and your question. In other words you asked the question at the wrong time.

If the 'RE-THINK' l.e.d. illuminates the computer has found a fundamental error in the data presented to it. In other words you asked it a question that it could not answer.

The remaining three l.e.d.s are the computer's response to your question after an analysis of all data presented and the relevance of your question to the overall operation of the universe.

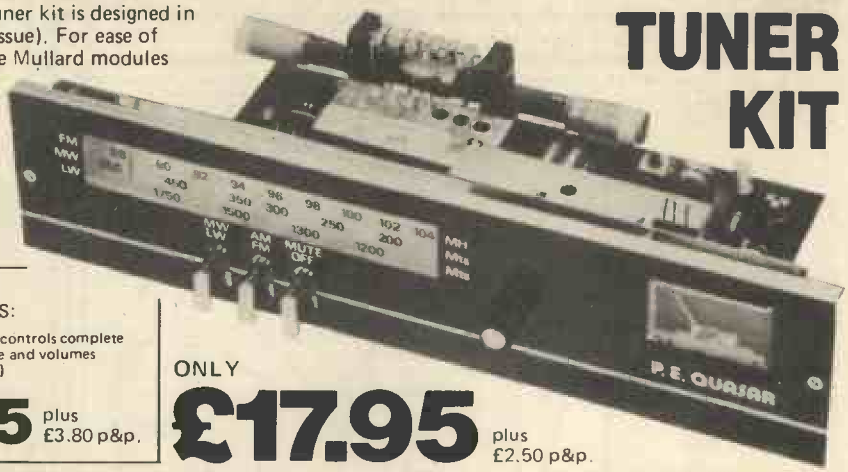
Once the computer has given a response the l.e.d. will remain illuminated for approximately three seconds and then return to the quiescent but ever alert state. In the power down state negligible current is drawn from the batteries thus eliminating the need for an on-off switch. ★

NEW

PRACTICAL ELECTRONICS - STEREO TUNER KIT

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size 10½"x 2½" approx. Complete with diagrams and instructions.

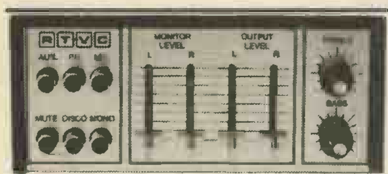


ONLY **£17.95** plus £2.50 p&p.

SPECIAL OFFER! TUNER KIT PLUS:

- Matching I.C. 10+10 Stereo Power amplifier kit (usually £3.95 + £1.15 p&p)
- Mullard LP1183 built preamp. suitable for ceramic and auxiliary inputs (usually £1.95 + 70p p&p)
- Matching power supply kit with transformer (usually £3.00 + £1.95 p&p)
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes (usually £1.70 + 80p p&p)

£21.95 plus £3.80 p&p.



STEREO AMPLIFIER KIT

- Featuring latest SGS/ATES TDA 2006 10 watt output IC's with in-built thermal and short circuit protection.
- Mullard Stereo Preamplifier Module.
- Attractive black vinyl finish cabinet, 9"x 8¼"x 3¾" (approx)
- 10+10 Stereo converts to a 20 watt Disco amplifier.

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs - tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amp assembly kit and mains power supply. Also features 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia with matching knobs and contrasting cabinet. Instructions available, price 50p. Supplied FREE with the kit.

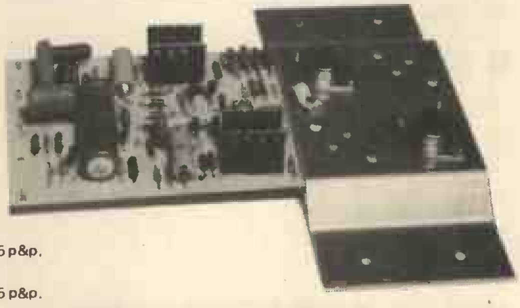
£14.95 Plus £2.90 p&p.

SPECIFICATIONS:	Suitable for 4 to 8 ohm speakers.
Frequency response	40Hz - 20KHz.
Input sensitivity	P.U. 150mV. Aux. 200mV. Mic. 1.5mV.
Tone controls	Bass ±12db @ 60Hz Treble ±12db @ 10KHz
Distortion	0.1% typically @ 8 watts
Mains supply	220 - 250 volts 50Hz.

STEREO MAGNETIC PRE-AMP CONVERSION KIT Includes FREE Magnetic cartridge with diamond styli. All components including p.c.b. to convert your ceramic input on the 10+10 to magnetic. Only available with 10+10 amp. £2.00 includes p&p.

8" SPEAKER KIT Two 8" twin cone domestic speakers. £4.75 per stereo pair plus £1.70 p&p. when purchased with amplifier. Available separately £6.75 plus £1.70 p&p.

HIGH POWER AMPLIFIER MODULES



READY BUILT OR IN KIT FORM

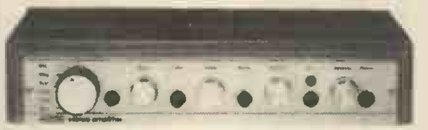
	KIT	BUILT
125 WATT MODEL	£10.50 Plus £1.15 p&p	£14.25 Plus £1.15 p&p.
200 WATT MODEL	£14.95 Plus £1.15 p&p	£18.95 Plus £1.15 p&p.

SPECIFICATIONS:	125 W Model	200 W Model
Max. output power (RMS)	125 watts	200 watts
Operating voltage (DC)	50 - 80 max.	70 - 95 max.
Loads	4 - 16 ohms	4 - 16 ohms
Frequency response measured @ 100 watts	25Hz - 20KHz	25Hz - 20KHz
Sensitivity for 100 watts	400mV @ 47K	400mV @ 47K
Typical T.H.D. @ 50 watts, 4 ohms	0.1%	0.1%
Dimensions (both models)	205 x 90 and 190 x 36mm.	

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

ACCESSORIES:

Suitable LS coupling electrolytic for 125W model	£1.00 plus 25p p&p.
Suitable LS coupling electrolytic for 200W model	£1.25 plus 25p p&p.
Suitable mains power supply unit for 125W model	£7.50 plus £3.15 p&p.
Suitable Twin transformer power supply for 200W model	£13.95 plus £4.00 p&p.



30+30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet, silver finished rotary controls and pushbuttons with matching fascia, mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30+30 watts RMS, 60+60 watts peak. For use with 4 to 8 ohm speakers.
Size 14¾"x 10" approx.
BUILT AND TESTED.

£32.90 Plus £3.80 p&p.

MONO MIXER AMPLIFIERS

50 WATT Six individually mixed inputs for two pick ups (Cer. or Mag.), two moving coil microphones and two auxiliary for tape, tuner, organs, etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic and aux inputs. Size: 13¾"x 6½"x 3¾" app. Power output 50 watts R.M.S. (continuous) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

£39.95 Plus £3.70 p&p.

100 WATT

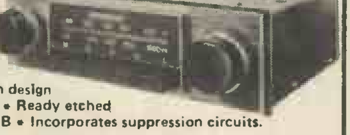
Brushed Aluminium fascia and rotary controls.
Size: approx. 14"x 4"x 10¼".

Five vertical slider controls, master volume, tape level, mic level, deck level, PLUS INTERDECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PFL) lets YOU hear the next disc before fading it in.
VU meter monitors output.
100w RMS output (200w peak).

£76.00 Plus £4.60 p&p.

PRACTICAL ELECTRONICS CAR RADIO KIT

SERIES II



2 WAVE BAND MW — LW

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

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Semiconductor UPDATE...

FEATURING RCA1804 WTV008

R.W. Coles

1802 UPGRADE

About the only thing good you can say about the RCA 1802 microprocessor is that it is a CMOS device and therefore uses very little power. That simple fact has assured it a place in the micro hall of fame, despite the fact that only masochists would choose to use it if they were not forced to by power supply limitations!

There are other CMOS devices of course, like the IM6100 which was an early competitor and even more ghastly than the 1802 in some respects, and the much newer NSC 800 which looks as though it will be a winner once National have learned how to make it in quantity and the price has dropped. For the moment however, if you want a cheap CMOS microprocessor with reasonable hardware and software support it has to be the cranky old 1802, which is why any improvements RCA can dream up are very welcome indeed.

RCA are selling 1802s at an ever increasing rate (over a million in 1980, according to their ads.) but they do realise that those unfortunate enough to be designing with the chip would happily change their allegiance if something better came along, and so they have been trying hard to make the 1802 more attractive by the addition of new family members with improved performance and extra features.

Already available at low cost is the 1802A which is directly compatible with the basic chip but made with an advanced CMOS process which has reduced the chip area and therefore increased both the speed of operation and the yield per wafer. At five volts the 1802A runs with a 3·2MHz clock as against 2·5MHz for the basic 1802, and some "tweaking" of the chip layout has improved the operation of functions such as Power On Reset to give a plug-in performance booster for new or existing 1802 circuits.

In the pipeline are two brand new members of the 1802 family which go much further than the 1802A in overcoming the limitations of their predecessor. First on the scene will be the 1804 which will run at 6·0MHz and has many enhancements to both the hardware facilities and instruction set of its parent. One of the big limitations of the 1802, the lack of explicit Jump-to-Subroutine and Return instructions, has been rectified with the 1804 to give a five times speed improvement when performing these functions. New instructions are also provided to allow the direct manipulation of 16 bit data, and to control a new on-chip timer function which can greatly simplify system design. Even more impressive is the ability of the 1804 processor to do the whole job single handed in many applications since it has a built-in 64 byte RAM array and a mask programmable 2Kbyte ROM to hold programs or data, in addition to its ability to address 64Kbytes off-chip. Add to this the fact that the 1804 is largely pin and instruction set compatible with the 1802 and it becomes a very attractive chip indeed.

Of course, not everyone needs the luxury of on-chip masked ROM programs, and so there is a companion device with all the other goodies but without the ROM, coded the 1805.

It looks as though RCA have managed to snuff out the "I Hate the 1802" movement before I even managed to get the badges made!

TALK CONTROL

Electronic speech synthesis is now a lost cost technique, and before long, all self-respecting vending machines and domestic appliances will be bending our ears with condescending announcements from their built-in speech chips and loudspeakers. Speech recognition, on the other hand, is a more difficult problem for the chip makers to solve, and it will be some time before the day dawns when we can expect to hold an intelligent conversation with our electric toaster about how we would like our toast done today (Thank goodness!).

Do not doubt for a minute, however, that this day will dawn eventually. Already the first terrifying steps have been taken on the slippery slope leading to smart Alec toasters and supercilious coffee machines with the introduction of a new device coded the WTV008 from a bunch of subversives called the Weitek Corporation of Santa Clara, California.

The WTV008 looks harmless enough in its demure 28-pin plastic package, but in fact it is the first of a long line of speech recognition chips which will make all our lives a misery if we don't act immediately to stamp out their proliferation. Oh, it seems innocuous all right, it only recognises eight words and then it only gets it right 90% of the time for 90% of the population, but this is only a beginning remember; before long the vacuum cleaner will be hanging on our every word, and no doubt reprimanding us when we swear at it.

If you really welcome this sort of thing, you may be pleased to know that the WTV008 has a unique output line for each word in its active vocabulary and a four line BCD output which gives a number code too. A strobe line shows that a valid output is present, and you can switch between two alternate eight word ROM based vocabularies by toggling the USEL input.

You have been warned!

THE BLUE LAMP

The possibility of a wall sized flat TV display unit based on l.e.d. lamps has now moved a step nearer with the introduction of a new semiconductor material which emits BLUE light when forward biased. RED and GREEN light emitting diodes based on gallium phosphide material are already with us of course, but the new devices based on silicon carbide complete the primary colour triad essential for the full colour spectrum of television reproduction.

The silicon carbide process has been developed by Sanyo in Japan, and rather than just offer a new colour for panel lamps the ingenious designers have recognised the potential for TV type applications and have mounted the new chip alongside red and green emitters in the same package. The four package pins allow independent control of brightness for each colour, but allowance has to be made for the different band gap voltages and efficiencies of the different materials. The silicon carbide l.e.d. produces about 2 millicandelas for a current of 20 milliamps at 3·5 volts, whereas the green chip gives 3 millicandelas for 10 milliamps at 2 volts, and the red chip gives 3 millicandelas for 5 milliamps at 1·9 volts.

If the prospect of buying and soldering in 25,000 l.e.d. lamps to make a TV display does not appeal to you, you can amaze your friends with just one of the little perishers used as a multi-coloured panel lamp!

TV CAMERA

PHILLIP GAFFNEY — **Part 1**

THIS is a monochrome television camera you can build yourself, which is ideal for closed circuit home video or security applications. This camera requires only a 24V/1A supply and may be wired using a single coax lead carrying both signal and power. The output is UHF modulated for direct "aerial socket" input to a standard television receiver.

POWER SUPPLY

The unit may be powered by a simple 24V PSU without semiconductor regulation circuits. That is to say, the standard "transformer-bridge-capacitor" configuration will do, although the line should be protected with a 1A quick-blow fuse.

Also, the supply line from wherever it may be derived, should include the filter circuit of Fig. 1.1 to allow the same wire to carry both signal and power.

24 volt power from point A is passed through L1 without hindrance, via the coaxial socket on the front panel, to the camera. The sheath of the coaxial cable is at earth potential, the core being at 24V. The d.c. is, however, blocked from going into the television set as C1 can be regarded as an open circuit to d.c. voltages. UHF received from the camera is blocked by the small inductor L1 preventing it from being dropped to ground by the low impedance of the power supply. Capacitor C1 has a very low reactance at UHF and allows the passage of the UHF signal to the television receiver.

Thus it can be seen that this simple circuit allows us to utilise the same coaxial cable to deliver power to the camera and convey signals from the camera to the television sets. When the unit has been fully assembled, and the voltage at point "A" checked, about 24V d.c. should be found at the centre pin of the coaxial socket on the front panel with respect to the case.

INVERTER AND HIGH VOLTAGE BOARDS

The *PE* (Seescan) camera is of modular construction, with the printed circuit boards connecting together with the coil assembly and back plates to form an extremely robust unit.

The inverter and high voltage power supply boards are used also as "cross-members" in the structure.

The inverter board steps up the low voltage camera supply to about 400V which is used to provide all the high voltages required to drive the pick-up tube (Vidicon in standard camera kit). The high voltage power supply board uses this 400V a.c. to produce several regulated d.c. outputs at the levels required by the picture tube. This board carries the three primary set-up adjustment presets for the pick-up tube, namely beam current, electrostatic focus, and target voltage. These three controls are easily accessible from the rear of the camera to make the final setting-up easy.

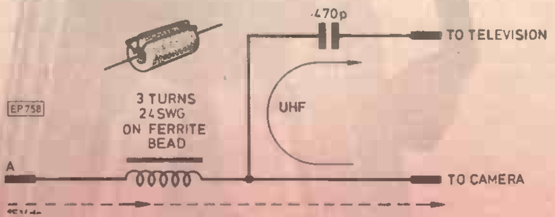
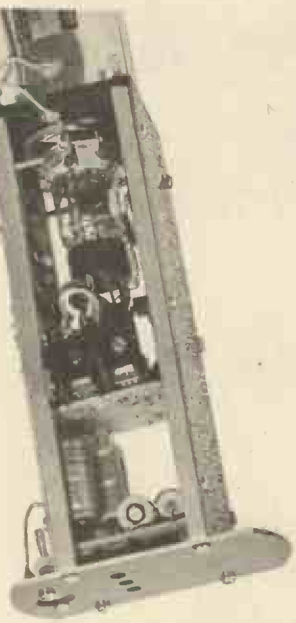
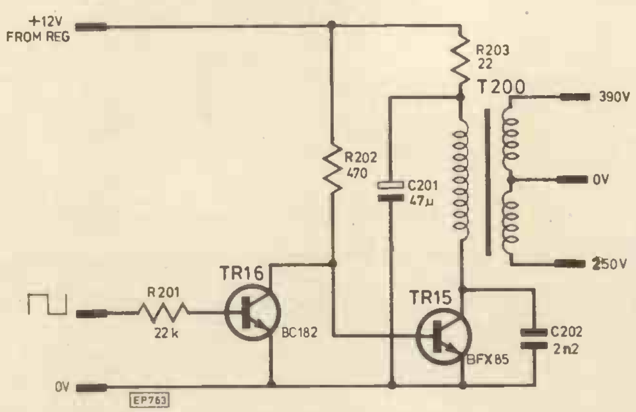


Fig. 1.1. PSU line filter arrangement. The L/C configuration separates VHF from the d.c. so that a single lead may service the camera

INVERTOR CIRCUIT DESCRIPTION

The invertor, a small p.c.b., mounted vertically in the camera, is used to step up the low voltage camera power supply rail to a high d.c. voltage suitable for driving the Vidicon pick-up tube. As can be seen from the circuit diagram, the invertor electronics are fairly straightforward. Line sync. pulse from the logic board are used to drive TR15 into saturation. Therefore, an inverted replica of the line sync pulse is developed across R202. This signal is used to drive T15 which acts as a switch, applying current pulses to the invertor transformer TR200. R203 and C201 decouple the output transformer from the main regulated 12V supply. C202 tunes the transformer to peak the large fly back pulse produced, thereby increasing efficiency. As all switching in the transformer takes place during line blanking there is no problem with any interference produced appearing on the camera picture.



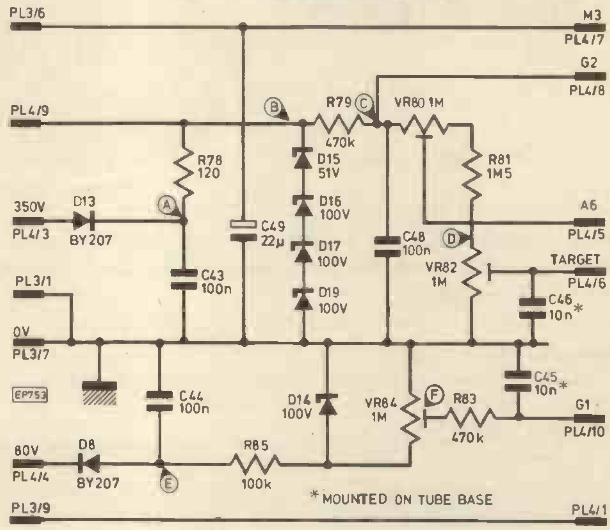


HIGH VOLTAGE POWER SUPPLY CIRCUIT

This small sub-board is used to rectify the high frequency a.c. from the inverter board and regulate the d.c. output to supply the necessary voltages for the pick-up tube. Both positive and negative voltages with respect to ground are required for the tube, and both are produced on this board. Rectifier diode D13, half-wave rectifies the 350V a.c. and the resulting d.c. is smoothed by C43. It should be noticed that D13 is a fast recovery diode, and it is important that the types specified should be used. If ordinary general purpose rectifiers are used, the efficiency will be lower, and sharp switching spikes will be generated in the inverter, which will appear as lines on the television picture. R78 and C49 further decouple the supply at high frequencies before being applied to D15–D19. These series connected Zener diodes crudely regulate the high voltage supply at about 350V, which is applied directly to the mesh of the Vidicon tube. R79, VR80, R81 and VR82 form a potential divider chain, voltages for the second grid, focusing anode and target, all being tapped at various points from this divider. C49 and C46 are used to decouple the grid and target respectively.

D8 is a fast recovery rectifier diode used as a half-wave rectifier, the d.c. from which is smoothed by C44. Diode D14 is used to stabilise the supply at round about −95V with respect to ground. Resistor VR84 allows a negative grid bias (Beam current) to be set between 0V and −95V. R83 and C45 effectively decouple the supply at high frequencies from G1.

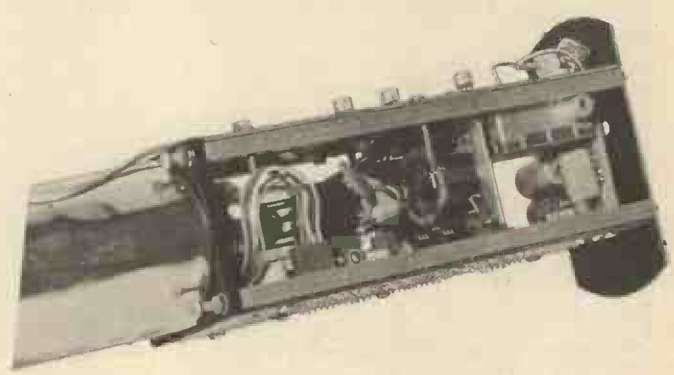
Fig. 1.3. High voltage board



Test voltages

A	380
B	350
C	280
D	100
E	−110
F	0 TO −100

All voltages are measured with respect to Ground and are measured with a meter having greater than 25K ohms per volt sensitivity. All voltages are measured with no light reaching the Vidicon target. The voltages at these test points should be within 5% of the stated values.



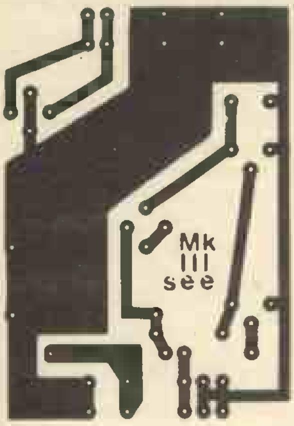


Fig. 1.4. Invertor board p.c.b. (actual size)

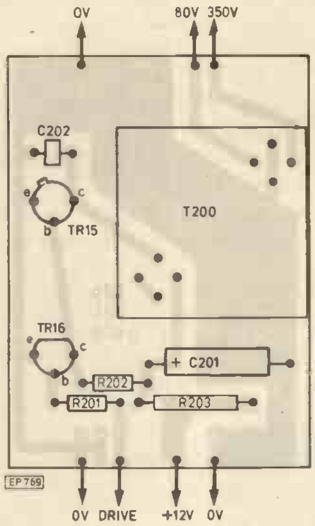


Fig. 1.5. Invertor board component layout

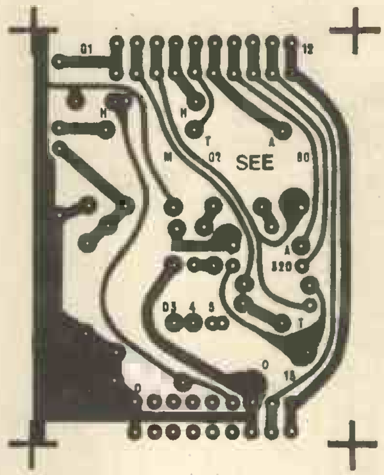


Fig. 1.6. High voltage board p.c.b. (actual size)

Note: The photographs of the prototype show the original invertor board, which has since been redesigned to use only one power transistor.

ACKNOWLEDGEMENT

We would like to thank the Bondi Judo Club of Poole for their assistance with our front cover photograph.

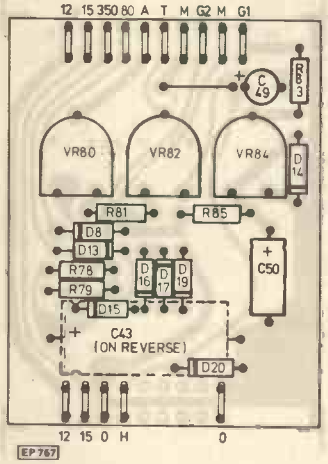


Fig. 1.7. High voltage board component overlay

COMPONENTS

Invertor and High Voltage Boards

Resistors

R78	120k
R79, R83	470k (2 off)
R81	1M5
R85	100k
R201	22k
R202	470
R203	22 1W

All resistors $\frac{1}{2}$W 5% unless otherwise specified

Potentiometers

VR80, VR82, VR84 — 1M Cermet preset (3 off)

Capacitors

C49	22µ
C43	100n
C44	100n/400V
C45, C46	10n/750V (2 off)
C48	100n
C201	47µ/16V
C202	2n2

Transistors and Diodes

TR15	BFX85
TR16	BC182
D8, D13	BY207 (2 off)
D14, D16, D17, D19	100V 1·3W Zener (4 off)
D15	51V 1·3W Zener

Miscellaneous

Inverter p.c.b.
High Voltage p.c.b.
Varelco connectors (for PL1–PL4)
Heatsink for TR15
Heatsink jointing compound
Screws, 6mm M3 (2 off)
Nuts, M3 (2 off)
Transformer T200 (special)

Constructor's Note

A complete kit of parts is available from **Marshall's** of Kingsgate House, Kingsgate Place, London NW6 4TA.

FRANK W. HYDE

IN RETROSPECT

In the matter of processed data, the presentation to the world at large varies a great deal as to time of release. Sometimes this is short and sometimes long. Usually the final release proves that science had profited. Such a situation arose in 1979. On August the 30th 1979 the Naval Laboratory coronagraph on board a spacecraft photographed a collision between a comet and the Sun. The reason for the delay in making this outstanding event public is that the data has only recently been analysed.

The coronagraph known as the Solwind, was designed to occult the disc of the Sun so that the corona is clearly visible—particularly the outer corona where there is much to be studied. In this special event a great deal of debris resulting from the encounter with the Sun was thrown out into this area. The spacecraft which carried the coronagraph is a Ball Aerospace vehicle which is similar to the NASA orbiting observatories. Because there were delays in releasing the data to the Naval Research Laboratories for analysis, the details have only just been discovered. It is thought that this comet may be one of a group of about eight comets which are known as Sun grazers. During the last three hundred years these eight comets have been observed from time to time. Because of the difficulty in making observations of any bodies close to the Sun and also the difficulty of recognising a body which when away from the Sun might be seen only by accident.

The images were to reveal that the tail of this comet going to its death was of the order of three million miles long. The closing speed was estimated to be about 645,000 miles an hour. The result of the impact threw the cometery debris millions of miles into space away from the solar surface. The comet was not actually reported as being seen from Earth even though the images returned show that it was as bright as Venus since the planet was in the frames of the photographs with the Sun itself. Doubtless more of such events will be observed and the secret of the comets with the mission to Halley's comet in 1986 should finally be within mankind's knowledge. Had there yet been any forecasts of dire events? Did August the 30th 1979 mark something or other?

SOVIET SPACE RELATIONS TAKE A NEW TREND

It is so often said of the old adage "It's an ill wind that blows nobody any good" that it is a way of excusing benefits in the face of sore distress. Originally there were wide and comprehensive hopes for the special combined missions to extract the maximum data and number of observations of Halley's comet. Much of the hope seemed to evaporate because of fiscal difficulties and part at least of the co-operative plans were delayed and then dropped. The Soviet Union offered a modification of one of their missions to Venus in an effort to maximise the failing situation.

It now seems that this has grown into a much wider possibility of joint effort. A joint planning meeting in Italy last September laid foundations for an international framework involving the Soviet Union, Italy, the European Space Agency, Japan and the United States. It is fortunate that these plans are now under way with greater momentum. If this pass of the comet inside the Earth's orbit were missed the opportunity would not come again until 2061.

The Soviet plan for two spacecraft is confirmed, the Japanese and the European Space agency have their programmes. Only the United States is yet uncommitted. However the American contribution at the moment will come through the involvement in the international Halley Watch. NASA has plans at the Jet Propulsion Laboratory and a proposal for a mission to collect samples from the comet. This however is not yet funded.

The Soviet dual mission is part of the separate plan to launch two spacecraft in December 1984 which will include a Venus pass in 1985 with comet encounter in 1986. The Venus study will be by two probes which will descend into the Venusian atmosphere and be deployed down to the surface. The spacecraft will then pass on to the Halley rendezvous. A drawback to this plan lies in the fact that the speed of the spacecraft will be higher than the comet during the encounter. Data transmission will be about 85 kilobits a second. Approximately 30 kilobits of this data will be devoted to the television cameras with wide and narrow angle facilities.

It was stated by an official of the Soviet group dealing with the mission that the camera system will be brought into the operational mode two days before the closest approach. At this time there will be general observations of the nucleus. Some three hours of observations will be made during the closest approach. The automatic operation of the system is set for the cameras to seek the brightest parts of the comet.

In addition to the imaging experiments there will be a three channel spectrometer, an infra-red spectrometer and a dust spectrometer. There will also be a dust particle counter with magnetometers and analysers of plasma waves at both high and low frequencies. Both the spacecraft will be through the same launch window late in December 1984. This will require accurate planning because it means two launches within a short period of a few days.

Japan's contribution will be the Planet-A spacecraft in August 1985. The launch vehicle will be an upgraded Mu launcher. The spacecraft will monitor the ultra-violet radiation from the comet and also measure the solar wind plasma near the comet. The two probes will be spin stabilised. The European Space Agency Giotto has already been described in a previous *Spacewatch* issue. The programme as it stands at the moment is for the launch by Ariane launch vehicle through a window available for fifteen days during July 1985. The encounter is planned for a date in March 1985. The actual encounter will be on March 12/13 1986. The planned sequence of manoeuvres will begin about 30 hours before the time of closest approach. During this period there will be a two hour rehearsal of the experiment and calibration checks. It is hoped that the encounter will last at least 4 hours. The expected time of this event is 3hrs 45min. before the closest point of approach. The visible corona will be entered at about 1hr before the closest approach point. It is hoped that it will be possible for this to occur in real time.

THE USSR AND FRENCH TECHNOLOGY

Since September a Soviet spacecraft, the Arcad satellite, has been undergoing tests and now it begins its programme. The joint payload vehicle is in an orbit 1,192 at apogee and 236 miles at perigee, inclined at 82·6 deg. It weighs 2,200lb. The French share of this project is four of the experiments with onboard programming and the telemetry unit.

The data programme is directed at the magnetosphere in the higher levels of the atmosphere, particularly at higher altitudes. The instrumentation is contained in a cylindrical body. The power is derived from eight solar panels spaced round the main body The cooperation was carried out with mixed personnel, and the facilities in both the USSR and France were used.

THE SHRINKING SUN AGAIN

A new paper in support of this experiment regarding the shrinking sun gives more information that the regular pulsation with a period of 76 years is confirmed and a new statement that the accepted radius of the Sun is greater than that hitherto used for the calculations.

SUBMILLIMETRE WAVELENGTHS

At a recent conference on submillimetre wavelengths in radio astronomy new important information was revealed. Using the special airborne observatory, which is able to fly above the blanket of absorbing water vapour in the atmosphere, revealed a neutral atomic gas cloud near the centre of the Galaxy. The gas was detected by its emission from neutral oxygen. 63·2 micrometres.

NEXT MONTH

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INFRA·RED REMOTE CONTROL

PRACTICAL

ELECTRONICS

FEBRUARY ISSUE ON SALE FRIDAY JANUARY 8th

PE RANGER BASE STATION

Michael Tooley B.A.
David Whitfield M.A. M.Sc.

PART ONE

IN COMMON with other hand-held transceivers, the PE Ranger in its most basic form is primarily intended for short-range portable communication and, although the operational range can be considerably extended by the use of an external supply and aerial, there may be many occasions when additional coverage is required. The Base and Mobile Adaptor unit described not only increases the r.f. output power from 0·5W to 4W (the maximum permitted) but also provides some additional r.f. amplification and selectivity on receive. The result is a three to four-fold increase in effective range when compared with the basic unit with the same antenna system. Furthermore, an audio power amplifier is also incorporated and this is particularly useful when the Ranger is to be used in a relatively noisy mobile environment. The Base and Mobile Adaptor operates from a nominal 12V d.c. supply and also provides power for the Ranger transceiver. A 240V a.c. supply may also be used by the addition of the optional mains power unit which is also described. Transmit/receive control switching is automatic and a meter is provided to indicate the strength of received signals and the relative power output. To comply with Home Office regulations a 10dB switched attenuator is incorporated within the equipment. Two l.e.d.s provide 'at a glance' status indication; an important consideration when the equipment is to be used mobile. The unit is housed in an identical size case to that used for the basic Ranger transceiver.

SYSTEM DESCRIPTION

The Base and Mobile Adaptor performs three basic functions:

(a) r.f. power amplification (Transmit)
(b) r.f. pre-amplification (Receive)
(c) a.f. power amplification (Receive)

The block schematic of Fig. 1.1 shows the basic arrangement of the unit and, as can be seen, the transmit and receive paths within the unit are quite separate. Switching is achieved by means of a relay and this provides a high degree of isolation between the two circuits.

On transmit the output signal of the Ranger is applied to a single stage power amplifier which provides a gain in excess of 10 dB. This implies that, when driven with a nominal 0·5W from the Ranger, the r.f. output power from this stage will be somewhat greater than 5W. The r.f. amplifier stage is followed by a band-pass filter which improves the spectral purity of the output signal by imposing a high rate of attenuation both below and above the design cut-off frequencies. Since the filter exhibits a loss of the order of 2dB, the actual r.f. output to the aerial will be approximately 4W. The precise value of r.f. output power can be adjusted by setting the r.f. output control within the Ranger transceiver itself.

The unit also incorporates a simple form of switched output attenuator which provides an approximate 10 dB reduction in output power when required by the terms of the Home Office licence.

On receive the incoming signal from the aerial is applied to a single stage r.f. pre-amplifier. This stage provides a modest value of gain which, although not strictly necessary, does help to improve the performance when receiving weak signals under quiet band conditions. A further advantage of this stage is that the additional tuned circuit provides further rejection of the image channel (910kHz below the wanted signal frequency) and this is all important in reducing interference from strong local signals operating in the illegal band around 26·9MHz. The gain of the r.f. stage is variable and offers a typical range of adjustment of some 40dB or more. At minimum gain settings the r.f. pre-amplifier stage effectively acts as an attenuator. This is beneficial in reducing the levels of strong signals and thus prevents overloading in the front-end stages of the Ranger.

The audio power amplifier operates in the receive mode only and increases the audio power when an external loudspeaker is used. The unit also incorporates a dual function meter which is used to indicate the strength of received signals in the receive mode and power output in the transmit mode. The S-meter signal is derived within the Ranger by means of an optional add-on module which consists of an amplifier/detector operating on the 455kHz i.f. signal. Connections to the Ranger and external power sources are shown in the block diagram of Fig. 1.2. Only two interconnecting cables are required; one to carry the control voltages, audio and S-meter signals and one to carry r.f.

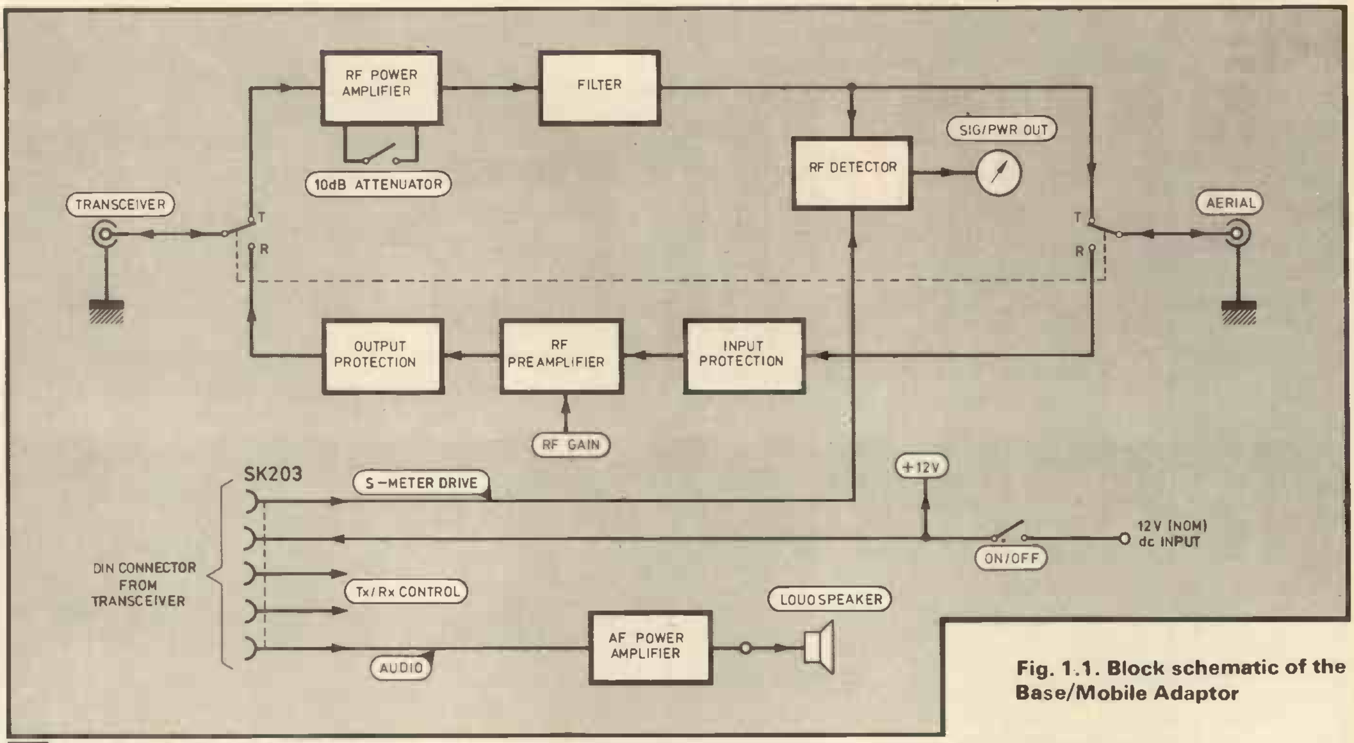


Fig. 1.1. Block schematic of the Base/Mobile Adaptor

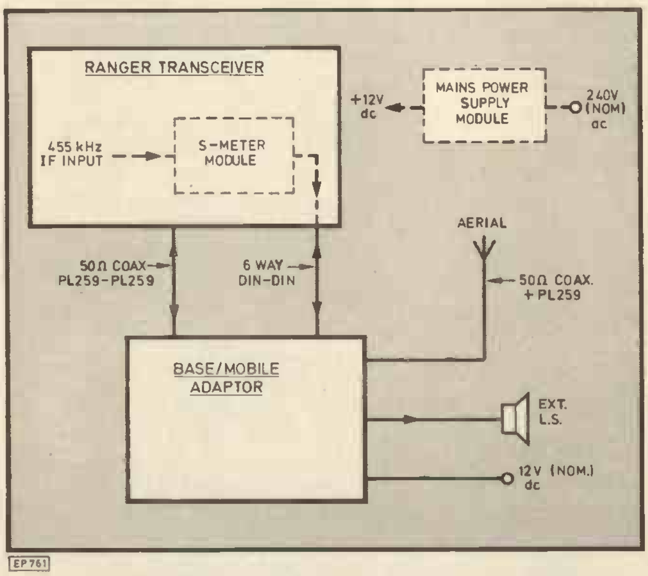


Fig. 1.2. Interconnection arrangement for the Base/Mobile Adaptor (N.B. Dotted lines indicate optional items)

CIRCUIT DESCRIPTION

The circuit diagram of the base station is shown in Fig.1.3. Red and green l.e.d.s, D1 and D2, provide status indication for 'transmit' and 'receive' respectively. The relay, RLA, operates whenever the transmit supply rail from the Ranger is enabled. The a.f. power amplifier, IC1, employs a conventional arrangement with voltage gain determined by R4 and R5. The supply voltage for the a.f. power amplifier is derived from the receive supply rail within the Ranger thus obviating the need for additional changeover contacts on the relay. The r.f. power amplifier, TR2, uses a silicon r.f. power transistor designed specifically for use in 27MHz CB equipment. The device is operated in common emitter mode under class-C conditions. Input matching to the base is provided by VC1, VC2, L3 and C11 while output matching from the collector is by means of L6, VC3 and VC4. The harmonic content of the output signal is reduced by two bandpass filter modules. The first of these removes the bulk of the spurii before the signal arrives at the changeover relay. The second is directly connected to the aerial socket and provides a 'last ditch' trap for unwanted harmonic signals. These two filters are required, as in the basic Ranger

SPECIFICATION

RF POWER AMPLIFIER	
Power output:	4W
Input/output impedance:	50Ω
Attenuator:	10dB (nominal)
Power gain:	10dB (nominal)
AF POWER AMPLIFIER	
Power output:	2W (into 4Ω)
Load impedance:	4Ω to 16Ω
Input impedance:	100kΩ
Voltage gain:	5
RF PRE-AMPLIFIER	
Voltage gain:	16dB
Input/output impedance:	50Ω
Gain variation:	40dB (approx.)
GENERAL	
Power supply:	11–14·5V d.c. negative ground 220–250V a.c. 50Hz with optional mains adaptor
Status indicators:	Transmit (red), receive (green)
Controls:	Power on/off r.f. gain Attenuator on/off
External connections:	Aerial and transceiver (S0239) Control and audio (6-pin d.i.n.) External d.c. input Loudspeaker
Meter:	Power output (transmit), signal strength (receive)
Dimensions:	200mm x 120mm x 40mm
Weight:	0·8kg

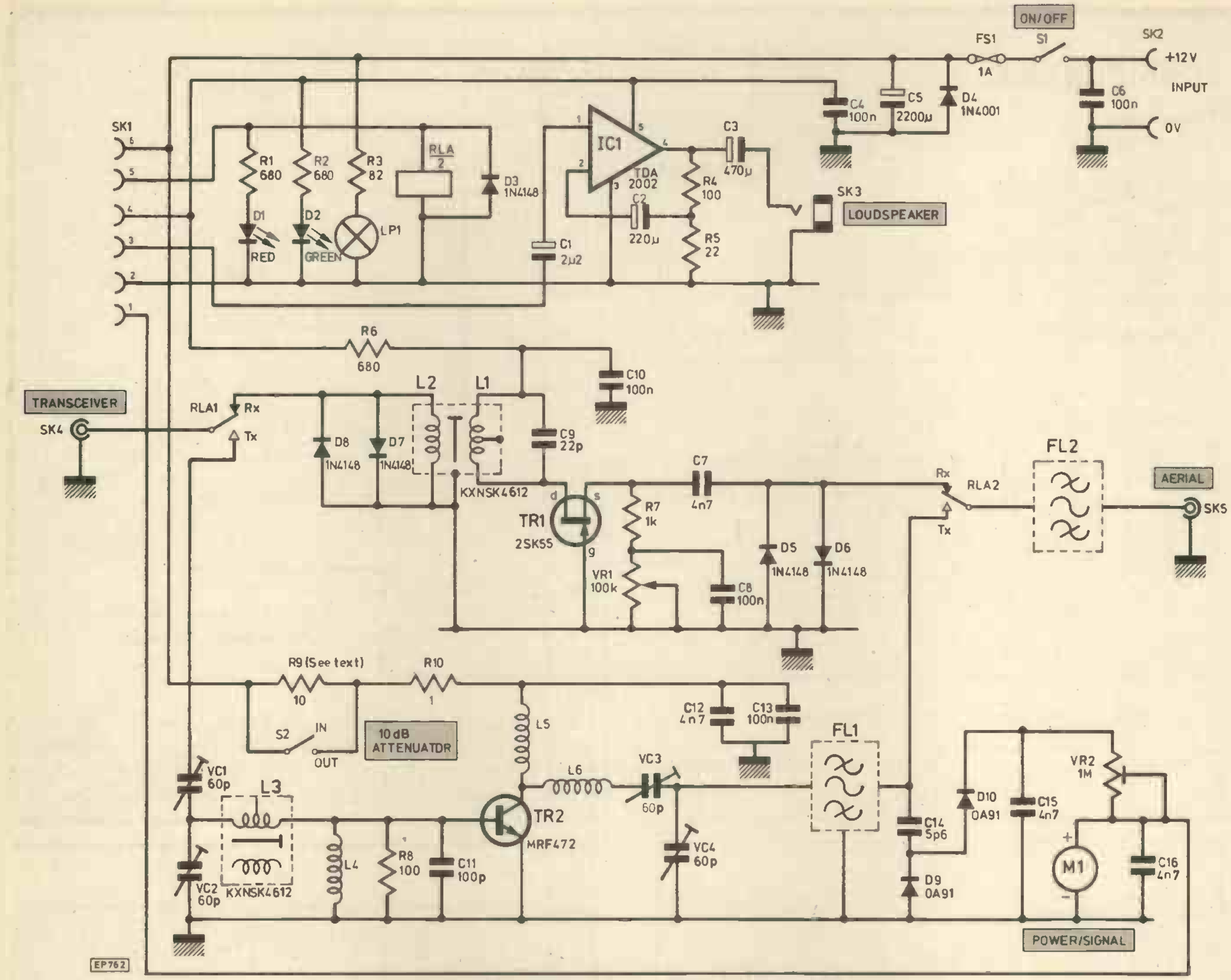
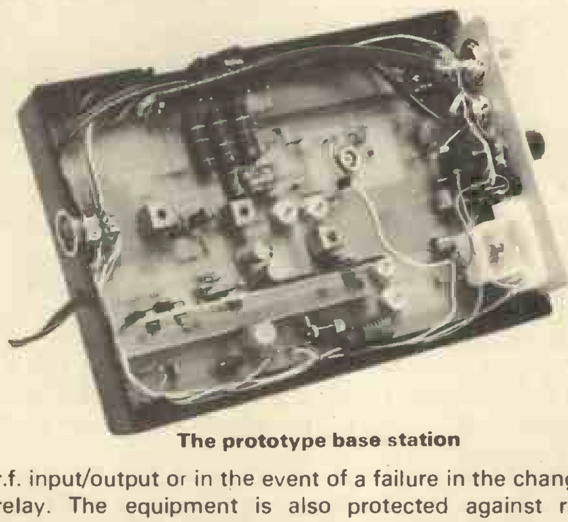


Fig. 1.3. Circuit diagram of the Base/Mobile Adaptor

transceiver, to ensure that the equipment meets the Home Office specifications concerning spurious emissions from CB equipment.

As with all r.f power amplifiers careful consideration has to be given to supply rail de-coupling and this is provided by R10, C12 and C13. These components ensure that the supply rail exhibits a negligible impedance over a very wide range of frequencies. D9 and D10 sample the r.f. output level and provide a signal for the power output meter. When an attenuated output is required to comply with the Home Office regulations concerning elevated aerial systems, R9 is switched into the r.f. power amplifier's supply rail by means of S2. This series resistor reduces the d.c. input power to the stage and consequently reduces the r.f. output power. The result is an approximate 10dB reduction in output from the amplifier stage.

The receive pre-amplifier, TR1, employs a junction gate f.e.t. operated in common gate configuration. This provides a high value of power gain coupled with a low input and high output impedance. Noise performance is of comparatively little concern at 27MHz due to the residual level of co-channel signals and thus no attempt has been made to optimise the stage for low noise performance. The r.f. gain is made adjustable by varying the static drain-source current whilst silicon diodes, D5, D6, and D7, D8, provide input and output protection for the pre-amplifier. This protection is important in the case of an inadvertent misconnection of the r.f. input/output or in the event of a failure in the changeover relay. The equipment is also protected against reverse polarity supply connection. When the supply is wrongly connected D4 conducts and this causes the fuse to rupture. This may appear to be somewhat crude but it is highly effective and can prevent extensive and costly damage to the rest of the circuit.



The prototype base station

NEXT MONTH: Construction and alignment of the Base and Mobile Adaptor plus details of the S-meter module.

COMPONENTS . . .

Resistors

R1, R2, R6	680 (3 off)
R3	82 $\frac{1}{2}$W
R4, R8	100 (2 off)
R5	22
R7	1k
R9	10 2W (see text)
R10	1 2·5W (Wirewound)

All resistors are $\frac{1}{4}$W carbon unless otherwise stated

Potentiometers

VR1	100k lin
VR2	1M preset

Capacitors

C1	2µ2 16V elect
C2	220µ 16V elect
C3	470µ 16V elect
C4, C6, C8, C10, C13	100n ceramic (5 off)
C5	2200µ 25V elect
C7, C12, C15, C16	4n7 ceramic (4 off)
C9	22p ceramic
C11	100p ceramic
C14	5p6 ceramic

All electrolytic capacitors are vertical p.c.b. mounting types

Variable capacitors

VC1–VC4	60p min solid dielectric (4 off)

Inductors

L1/L2, L3	KXNSK 4612 (2 off)
L4–L6	see text

Semiconductors

D1	red l.e.d.
D2	green l.e.d.
D3, D5, D6, D7, D8	IN4148 (5 off)
D4	IN4001
D9, D10	OA91 (2 off)
IC1	TDA 2002
TR1	2SK55, 2N3819 or a T1S588A
TR2	MRF472

Miscellaneous

RL1	Relay type 221 D012 p.c.b. mounting 12V 2p c/o
M1	200µA meter 'Signal strength/Power output'
S1, S2	s.p.s.t. min. toggle (2 off)
SK1	6-way d.i.n. socket
SK2	Non-reversible chassis plug
SK3	2·5 jack socket
SK4, SK5	Round SO239 socket (2 off)
FL1	Bandpass filter module (see text)
FL2	Bandpass filter module (see text)

Case with front panel
P.c.b.
Knob
12V d.c. lead fitted with non-reversible socket

Constructor's Note

A complete kit of parts for the base station is available from Autumn Products Ltd, Park Drive, Baldock SG7 6EW

PE BAND-BOX

PART 3 A.J. BOOTHMAN

TO complete assembly of the Band-Box, the Display board requires to be joined to the System board and various interconnecting leads prepared. A seven pin DIN socket is also required to be fitted to the Master Rhythm to provide the necessary control pulses and drum audio to the Band-Box.

CONSTRUCTION OF THE SYSTEM BOARD

Fig. 9 shows the track layout and component overlay for the p.c.b. and it is advisable to closely inspect this before proceeding. All components apart from the composition keyswitches and power l.e.d. are mounted from the side containing least tracks, and should be carried out in the order of resistors, diodes, track pins, i.c. sockets, capacitors, output sockets and switches.

It should be noted that a number of resistors require soldering on both sides of the p.c.b. and that the orientation of the keyswitches is important as indicated by the flat portion.

All rotary switches, apart from the key selector, require to be set to operate on the first four positions before insertion into the board. This is achieved by first turning the switch fully anti-clockwise to position one and then removing the mounting nut and washer. A metal ring, concentric with the shaft, will be seen when the washer is removed and it contains a small tab which will be pushed in one of the holes in the plastic body. The ring should be removed and repositioned such that it enters the hole between the numbers 4 and 5 marked on the plastic. The ring is retained in position when the washer and fixing nut are replaced. To obtain the twelve position action required by the key selector the metal ring should be discarded.

After mounting the switches on the p.c.b. bare metal links can be used to connect the switch tags, with an insulated conductor to the centre tag or tags. Before inserting i.c.s it is well worth the additional quarter of an hour required to check for shorts between adjacent tracks using a meter.

CONSTRUCTION OF THE DISPLAY BOARD

The Display board contains displays, input keyswitches with caps, and mounting positions for potentiometers. Track layouts and the component overlay are shown in Fig.10. The two diodes are mounted on the back of the board, and it should be noted that the 24 pin sockets have spare pins beyond the outer edge of each display pair when inserted.

JOINING THE BOARDS

Twenty-six solid wire links are required to join the System board to the Display board and will provide sufficient mechanical support during initial testing provided that reasonably careful handling is given to the system. When mounted in the case the boards will be approximately 1–2mm apart so that a small amount of adjustment slack should be covered by giving the links a comfortable radius.

The links are shown in Fig. 11, as are all remaining interconnections within the Band-Box. When the links have been fitted, the three Level potentiometers should be wired to the corresponding pins on the System board using twin core screened wire. Note that the lead orientation for each set of terminals is different. A mounting hole is provided for a P-clip which will help retain the relatively heavy screened cable in a comfortable position. The required lead lengths are shown in the diagram against each relevant potentiometer.

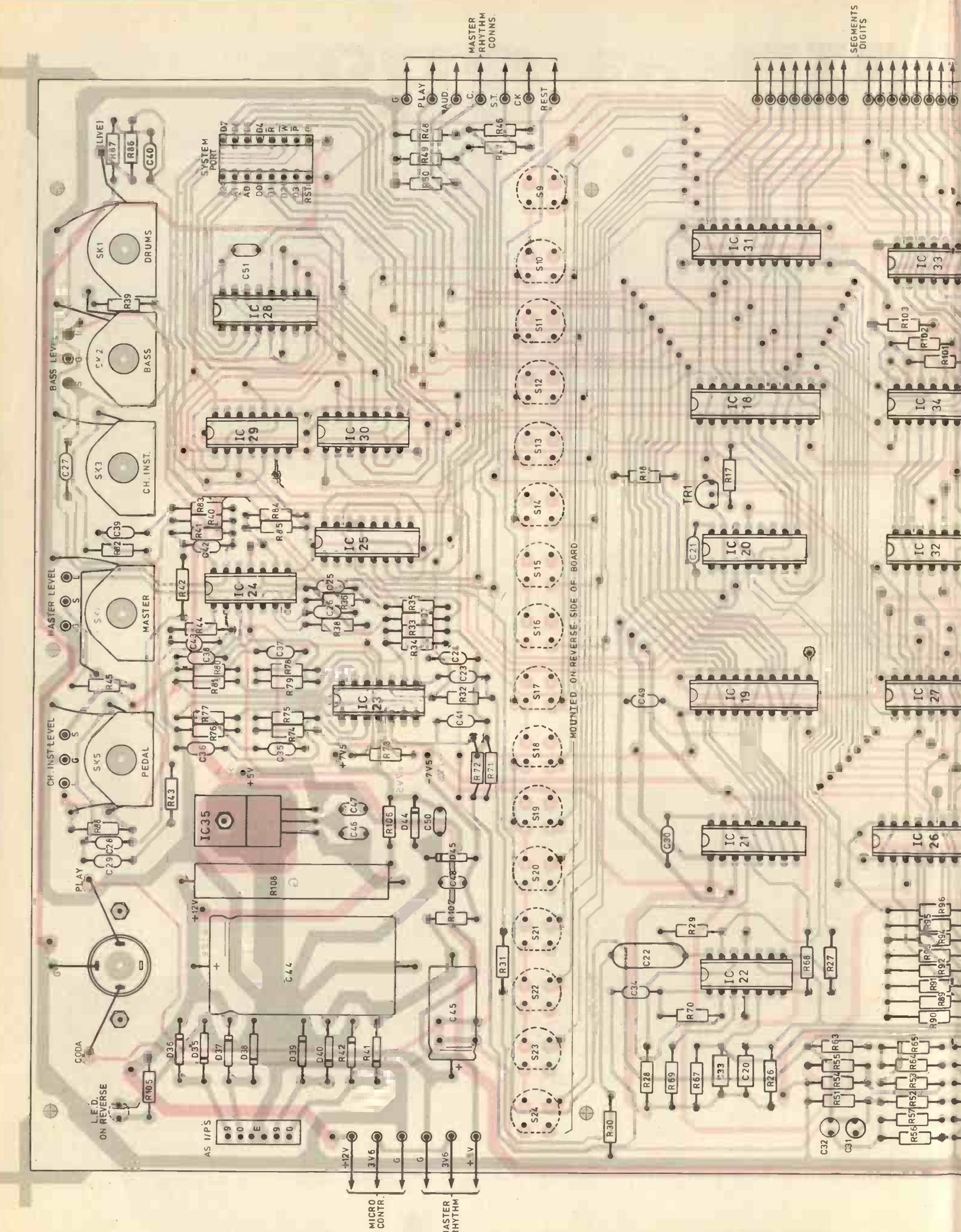
MASTER RHYTHM LINK

Twelve inch leads should be prepared to connect between the System board and the seven pin DIN plug used for the Master Rhythm link. A screened cable is used to carry the audio into the Band-Box and its screen makes the ground connection between board and plug. The connections are shown in Fig. 11 and represent the view from the back of the plug showing the actual solder points.

MICROCONTROLLER LINKS

Power for the Microcontroller is provided from the pins on the left-hand side of the System board and terminates in a three pin connector which plugs into the Microcontroller board. The Molex connector tags can be crimped to the end of the wires using pliers, and if the special tool is not available a small amount of solder can be used to ensure that a good joint is made. Only +12V and ground are required to power the Microcontroller, the third (3V6) connection is provided to supply the System board with the secondary battery back-up voltage which may then be routed to the Master Rhythm if required as discussed later.

A 16 pin double ended jumper is used to link the Microcontroller signals to the System board mating with standard DIL sockets. This type of jumper is very convenient when splitting the system, but contacts can be a danger and



MASTER RHYTHM CONNS.
G
PLAY
AUD.
L.C.
S.T.
CK
REST
SEGMENTS
DIGITS
SYSTEM PORT
LIVE
DRUMS
BASS
BASS LEVEL
CH. INST.
MASTER
MASTER LEVEL
PEDAL
CH. INST LEVEL
PLAY
CODA
L.E.D. ON REVERSE
AS I/P'S
MOUNTED ON REVERSE SIDE OF BOARD
+12V
+5V
+7V5
-7V5
+12V
3V6
G
G
3V6
+V
MICRO CONTR.
MASTER RHYTHM

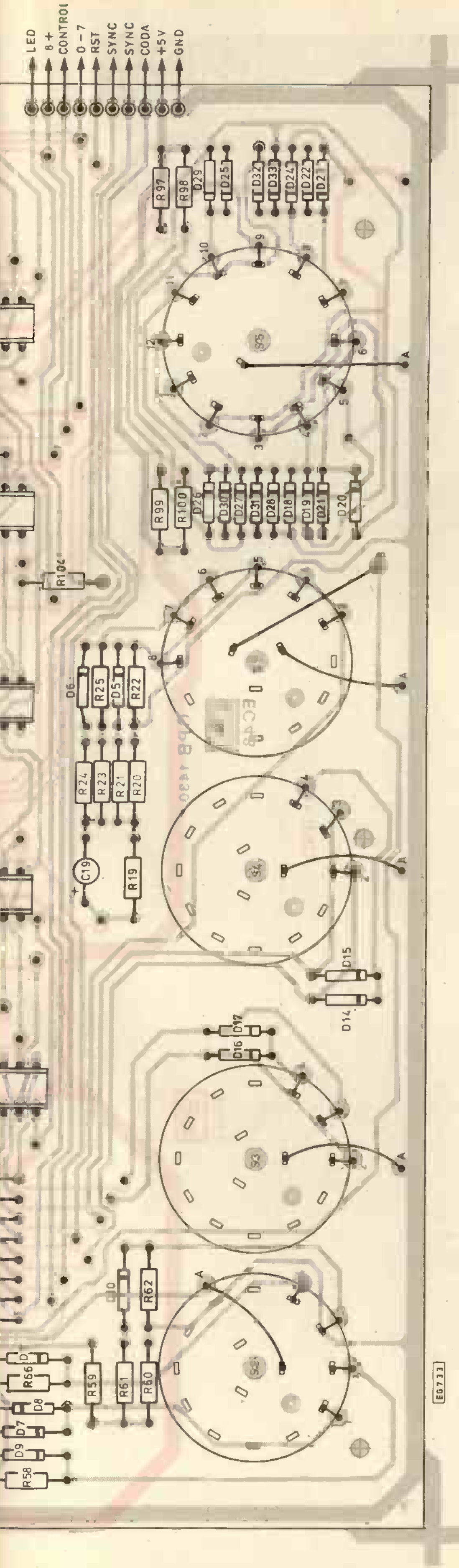


Fig. 9. Track layout and component overlay for the System board

it is recommended that the pins are very slightly bent inwards with the fingers before the first insertion into the socket. The jumper plugs are marked with pin numbers and orientation should be carefully checked.

MAINS CONNECTION

All mains components are mounted in the lower half of the case. The mains lead enters at the side, protected by a plastic grommet, and terminates with live to the fuse, neutral to the switch, and earth to a tag in the case. A P-clip clamps the cable to the base. A link is made between the fuse holder and switch, and the two transformer input wires soldered to the switch. The top two tags on the switch should be used for neutral in and out, whilst the bottom (hidden) tags should be used for live connections.

A Molex connector is used to transmit the two 9 volt a.c. windings and the earth to the System board.

MASTER RHYTHM SOCKET

A seven pin DIN socket requires to be fitted to the front of the Master Rhythm box in order to provide the connections shown in Fig. 12. The connections are shown on the rear of the socket in the actual solder tag positions. Play and Rest switch connections are taken from the live side of each switch and a common connection from the ground track below the switches. The clock pulse is obtained from the track at pin 11 of IC2 and is a 5–6 volt positive pulse occurring at one per measure in the Master Rhythm. The Start signal is taken from pin 1 of IC3 and is at ground when the Master Rhythm is at Rest, rising to 5–6 volts when playing. This signal level ensures that the Band-Box knows when to play and also resets the Band-Box to the beginning of a score when the Master Rhythm stops. The connection to the Long Cymbal pin on the Control board provides rhythm pulses for the Chord Instrument in the Band-Box and replaces the connection to the Master Rhythm instrument board. If the constructor prefers to use one of the other instrument triggers in the Master Rhythm to provide this facility they are all identical in terms of the pulses required. The audio can be obtained by a screened lead soldered to the output jack socket. The screen should be connected at the jack end but not at the DIN socket.

This modification does not affect normal operation of the Master Rhythm which may still be removed from the Band-Box and used on its own. The new connections provided allow for Play/Rest footswitch connections and also give all the signals required for external sequencer operation.

MECHANICAL ASSEMBLY

A photograph was shown on page 39 of the November issue which indicated the mechanical mounting of the System board, Display board, and Master Rhythm. The latter is fixed to brackets, which suspend from the upper half of the case, using self-tapping screws, whilst the two boards are fixed with 6BA screws at various mounting points. In order to obtain the correct distance from the front panel a screw is first inserted through the case, then a $\frac{1}{4}$in plastic spacer is placed over the thread and retained with a 6BA half nut. The boards should slide onto the mounting points and are retained with a further set of nuts.

Since little clearance exists between the body of the seven pin DIN plug and the Display board it is useful to clip protruding display socket pins close to the board. This point should also be taken into account when fixing the position of the Master Rhythm socket.

The Microcontroller is fixed to the lower half of the case with a spacing from the base of two full nuts.

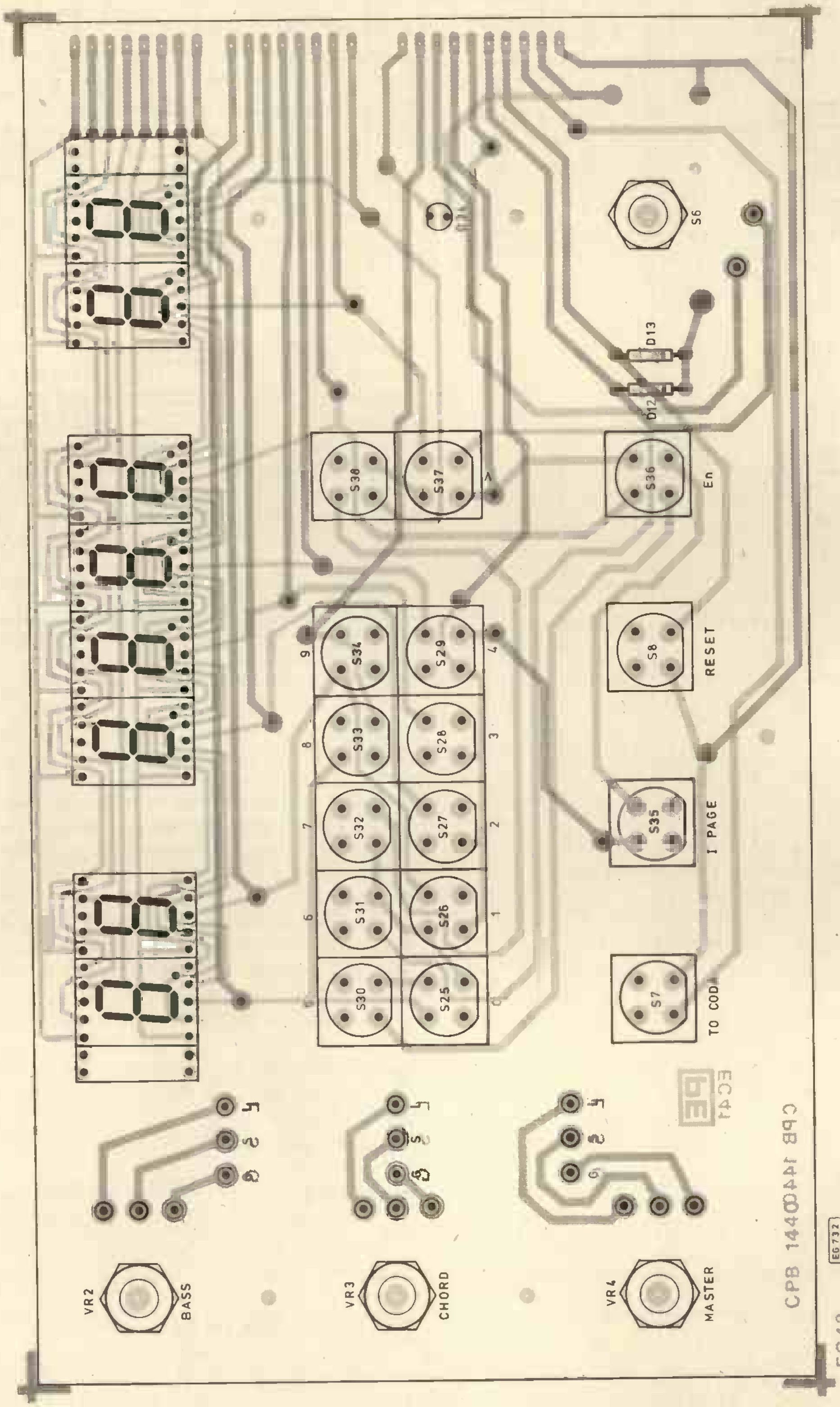


Fig. 10. Track and component overlay for Display board

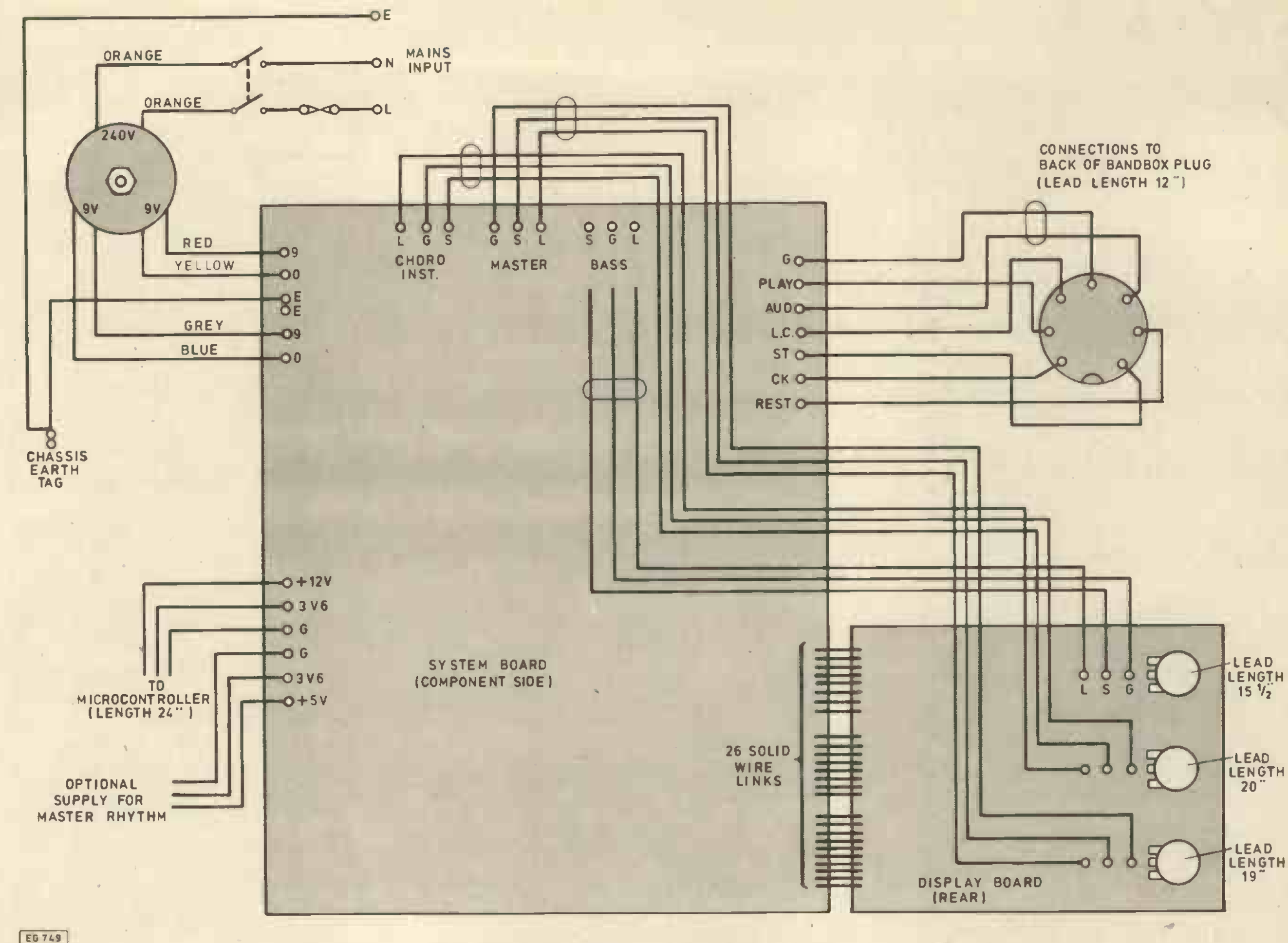


Fig. 11. Interwiring the Band-Box system

Assembly of the two halves of the case requires some care due to their relative shapes. The right-hand end is first slid into position and then the case moved to the left. This operation should not be carried out with mains connected to the unit.

POWER OPTION FOR MASTER RHYTHM

Three connections have been incorporated into the System board which can supply power to the Master Rhythm if required; however, a number of options are open to the constructor on how to make use of the facility.

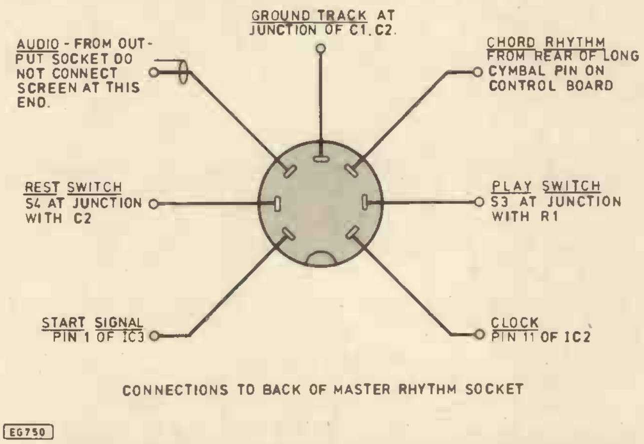


Fig. 12. The socket should be mounted below the Play button on the front panel at a height which just clears the inside lip of the lower half

The simplest option is to leave the Master Rhythm as a battery-operated unit which will ensure that it always retains its rhythm pattern information independent of the Band-Box. The disadvantage involved is remembering to switch the Master Rhythm off when the Band-Box is not in use.

The second option is permanent connection of the +5 volt, 3V6 and ground rails to the Master Rhythm, discarding the battery. If this is chosen, the link to the Microcontroller, which contains the secondary battery for storage, should never be broken and soldering used in preference to connectors.

A third option is shown in Fig. 13, and gives the dual possibility of battery/mains operation. With this system it is still essential to be careful to ensure that battery power is available from the Microcontroller when the power socket is connected to the Master Rhythm.

It is recommended that all testing of the complete Band-Box is carried out with a normal configuration Master Rhythm with 4 X HP7 batteries, and possible power conversions considered when the full system is operating satisfactorily.

THE BAND-BOX IN OPERATION

As promised at the beginning of the series, a detailed step by step operating procedure is now given for the Band-Box. The earlier warning is repeated that the procedures are more difficult to describe than execute, but it is hoped that the information in Figs. 14 to 17 will assist the operator in the early stages.

Next Month. Completion of the series.

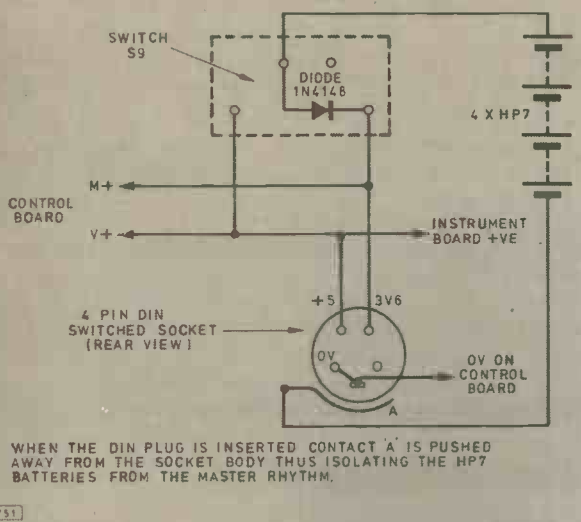


Fig. 13. Optional power supply to the Master Rhythm for battery/mains operation

Playback procedure

1.	Switch on mains	
2.	Display reads	01 CLEF En.
3.	If not press Reset	
4.	Now press Enter	
5.	Display reads	En. PAGE No.
6.	Key page number (e.g. 03)	
7.	Display reads	En. PAGE 03
8.	Press Enter	
9.	Display reads	En. LINE No.
10.	Key line number (e.g. 15)	
11.	Display reads	En. LINE 15
12.	Press Enter	
13.	Display reads	03 —GO—15
14.	Press Play on Master Rhythm	
15.	Score plays and display is blank	
16.	*Press Rest on Master Rhythm	
17.	Display reads	03 —GO—15
18.	If score is not required again press Reset	

*Rest will not normally be used to stop playback. The coda key allows the score to continue to its natural end at which automatic stop will occur. Coda is pressed to indicate that a further repeat chorus is not required and subsequent actions will depend on the programme in the score store as explained later.

Fig. 14. Summary actions for the playback procedure

Number	Description	Format
1a	Chord type—1–14 plus Tacet (Silent)	1–15 En. 1–8 >
1b	Chord duration—measured in beats (8 maximum)	
2	Change chord group to 0, 1, 2, ------11	0 En. 0–11 >
3	Start repeat here—Segno abbreviated S	0 En. S. >
4	Repeat from Segno—Dal Segno abbreviated d	0 En. d. >
5	Spare instruction—Labelled J	0 En. J. >
6	Finish—Fin abbreviated F	0 En. F. >

Fig. 15. Instructions recognised by the score store

Composition procedure

1.	Press Reset	
2.	Display reads	01 CLEF En.
3.	Press > which indicates that the composition mode is required	
4.	Display reads	En. PAGE No.
5.	Key page number (e.g. 03)	
6.	Display reads	En. PAGE 03
7.	Press Enter	
8.	Display reads	En. LINE No.
9.	Key line number (e.g. 15)	
10.	Display reads	En. LINE 15
11.	Press Enter	
12.	Display reads	RE SET !!
	This is the automatic lock which deters unauthorised meddling. If Reset is pressed the machine reverts to the start of the normal playback procedure	
13.	To unlock—Key "9", then "0" Any other combination will return to the playback procedure	
14.	After correct unlocking procedure Display reads	En. Chrd. GP
15.	Key first chord group required (e.g. 1)	
16.	Display reads	En. Chrd. G1
17.	Press Enter	
18.	Display reads	15 1 'X Y
	This displays the Instruction X, Y stored at Page 3, Line 15 of the score together with the current chord group (1)	
19.	Either > or < keys may now be used to inspect the contents of the next (16) or previous (14) line without alteration to the contents of the store. See text for score modification procedures	

Fig. 16. Summary actions for the composition procedure

Intro	‖ CM///	F6///	CM///	G7///	D.S.
Chorus	‖: CM/Am/	Dm7/G7/	CM/G7S/	FM7/G7/	:‖ Fin.
Coda	CM///	F6///	G7///	CM//–	‖

Score Symbol	Contents of display			Comments
	Score Line	Chord Group	Instruction Format	
CM (4)	00	0	1 En. 4 >	4 beats CM
F6 (4)	01	0	4 En. 4 >	4 beats F6
CM (4)	02	0	1 En. 4 >	4 beats CM
G7 (4)	03	0	5 En. 4 >	4 beats G7
SEG.	04	0	0 En. S. >	Set repeat from next line
CM (2)	05	0	1 En. 2 >	2 beats CM
Am (2)	06	0	6 En. 2 >	2 beats Am
Dm7 (2)	07	0	2 En. 2 >	2 beats Dm7
G7 (2)	08	0	5 En. 2 >	2 beats G7
CM (2)	09	0	1 En. 2 >	2 beats CM
G7S (2)	10	0	d. En. 2 >	2 beats G7 susp 4th
GP.5	11	0	0 En. 5 >	Change to chord group 5
FM7 (2)	12	5	J En. 2 >	2 beats FM7 (major 7th)
GP. 0	13	5	0 En. 0 >	Change to chord group 0
G7 (2)	14	0	5 En. 2 >	2 beats G7
D.S.	15	0	0 En. d. >	Repeat from SEG
CM (4)	16	0	1 En. 4 >	4 beats CM
F6 (4)	17	0	4 En. 4 >	4 beats F6
G7 (4)	18	0	5 En. 4 >	4 beats G7
CM (3)	19	0	1 En. 3 >	3 beats CM
FIN	20	0	0 En. F. >	End

Fig. 17. Keying procedure for an example chord sequence. The two control keys used in composition are shown next to the instruction format and do not appear in the display

Digital Design Techniques...

Tom Gaskell B.A.(HONS) ELEC. ENG.

Part 6 Numerical Systems

IN the series so far we have touched briefly on codes and numbers; decimal, binary and 7-segment. This month we are going to look in more depth at numerical representation and manipulation within logic circuits.

BASICS

The logic systems that we have been discussing are all based on a 'binary' concept; 'binary' meaning two-level. All normal conditions in a logic circuit can be represented by a logic 0 or a logic 1. 0's and 1's can be used to represent any two-state condition: On or off, open or closed, in or out, high voltage or low voltage, etc. Combinations of 0's and 1's can also be used to represent numbers. To see how this is done we must first look at our 'conventional' decimal numbering system.

Consider the number three thousand five hundred and twenty one:

THOUSANDS	HUNDREDS	TENS	UNITS
3	5	2	1

You will probably remember the units, tens, hundreds and thousands columns from schooldays! The number is made up by taking one from the units column, two from the tens column, five from the hundreds column, and three from the thousands column, then adding them all together:

$1 + 20 + 500 + 3{,}000 = 3{,}521$

This numerical system is based on tens; the columns are 'powers' of 10:

$1 = 10^0$ (any number to the power 0 = 1)

$10 = 10^1$

$100 = 10^2$

$1000 = 10^3$

So, our original 3,521 number can be drawn in columns marked as shown:

10^3	10^2	10^1	10^0
3	5	2	1

Obviously, as you move further to the left in the sequence of columns, the powers go higher; to the left of 10^3 comes 10^4, then 10^5 etc., as the number becomes larger. To change the 'base' of 10 to binary, which has a base of 2, simply replace all the tens by twos:

etc., etc., 2^3 | 2^2 | 2^1 | 2^0 ($2^0 = 1$, $2^1 = 2$, $2^2 = 4$, $2^3 = 8$, etc.)

The least significant digit (column 2^0) is in units, the next digit (2^1) is in twos, the next is in fours, the next is in eights, and so on in multiples of two. In each column there can only be a 0 or a 1, NOT a two; that would be a 1 in the next column to the left. So the binary number:

2^3	2^2	2^1	2^0
1	0	1	1

is equal to the decimal number eleven: One one, plus one two, plus no fours, plus one eight; total, eleven. The first sixteen numbers (including zero) of this binary code are shown in Table 1.

The binary table, of course, is one that we've come across before. You will remember that binary (and decimal) counters and dividers are readily available in CMOS and TTL integrated circuits. Binary, and as we shall see shortly 'BCD' code inputs and outputs from i.c.s are frequently labelled QA, QB, QC and QD, or even just A, B, C and D. A or QA is the least significant bit, i.e. 'units', and D or QD is the most significant bit, i.e. 'eights'.

DECIMAL	BINARY				GRAY			
	D	C	B	A	D	C	B	A
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	1	0
5	0	1	0	1	0	1	1	1
6	0	1	1	0	0	1	0	1
7	0	1	1	1	0	1	0	0
8	1	0	0	0	1	1	0	0
9	1	0	0	1	1	1	0	1
10	1	0	1	0	1	1	1	1
11	1	0	1	1	1	1	1	0
12	1	1	0	0	1	0	1	0
13	1	1	0	1	1	0	1	1
14	1	1	1	0	1	0	0	1
15	1	1	1	1	1	0	0	0

TABLE 1 The binary code

Note that each vertical column of Table 1 changes state regularly as we count through the table. The 1's column changes alternately between 0 and 1, i.e. it changes every one step. The 2's column changes every two steps, the 4's column every 4, and the 8's column every eight. If this principle is remembered, it becomes very easy to draw up binary tables of any size, or any number of bits, when required; the starting point is always zero, since all binary bits are 0 for a count of zero.

BCD

You may have noticed that there is a slight anomaly in this table, in the decimal column; it changes part way down the column from being a single digit number to being a two digit number (9 to 10). This can cause problems in circuit design. If three binary counters are being used to represent a three digit decimal number, for example, then each one should represent the numbers 0 to 9. This corresponds to binary numbers 0000 to 1001. After binary number 1001 has been reached, the next count should cause that counter to start again at 0000, and the next counter in the chain should then increase by one; in other words, a 'carry one' operation.

Self-resetting circuitry can be added to implement this return-to-zero effect, but in most cases it is easier to use an i.c. with the circuitry already built in. This is known as a 'BCD' device, which stands for Binary Coded Decimal. Each BCD number is a direct equivalent to a single digit decimal number. The maximum count for a BCD counter is 1001. There are no BCD numbers higher than this; they would be invalid, and have no meaning.

HEXADECIMAL

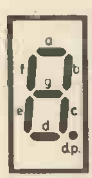
To represent the decimal numbers 0 to 9, four bits of binary information are needed, as can be seen from Table 1. Imagine a circuit used to route, store and control these four bit numbers. There would have to be four bit latches, groups of four flip-flops, four bit registers, groups of four gates, etc., for each decimal number to be represented. Unfortunately, there is a great inefficiency in our system, because we are only using ten combinations of 0's and 1's, whereas there are a possible sixteen! We are 'Not Allowed' to use binary numbers:

1010
1011
1100
1101
1110
1111

because they all correspond to a two digit decimal number, and the second digit must be represented by a different four bits of binary information. So, these six extra codes are wasted.

To optimise the use of the circuitry, a new code must be introduced which allows the use of these extra six numbers. This code is known as "HEXADECIMAL", coming from Hex (six) plus decimal (ten), i.e. a numerical system with a base of 16, rather than 10 or 2. To represent 'Hex' (as it is shortened to) numbers in a fairly familiar way, we use decimal numbers for the first 10 states, then letters A to F for the last six. A is equivalent to ten, B to eleven, C to twelve, etc. The full table of decimal, binary BCD, and Hex numbers is shown in Table 2.

	BINARY				B,C,D,					7-SEGMENT BARS
DECIMAL	D	C	B	A	D	C	B	A	HEX.	LIT (SEE LATER)
0	0	0	0	0	0	0	0	0	0	a,b,c,d,e,f
1	0	0	0	1	0	0	0	1	1	b,c
2	0	0	1	0	0	0	1	0	2	a,b,d,e,g
3	0	0	1	1	0	0	1	1	3	a,b,c,d,g
4	0	1	0	0	0	1	0	0	4	b,c,f,g
5	0	1	0	1	0	1	0	1	5	a,c,d,f,g
6	0	1	1	0	0	1	1	0	6	a,c,d,e,f,g
7	0	1	1	1	0	1	1	1	7	a,b,c
8	1	0	0	0	1	0	0	0	8	a,b,c,d,e,f,g
9	1	0	0	1	1	0	0	1	9	a,b,c,d,f,g
10	1	0	1	0	–	–	–	–	A	a,b,c,e,f,g
11	1	0	1	1	–	–	–	–	B	c,d,e,f,g
12	1	1	0	0	–	–	–	–	C	a,d,e,f
13	1	1	0	1	–	–	–	–	D	b,c,d,e,g
14	1	1	1	0	–	–	–	–	E	a,d,e,f,g
15	1	1	1	1	–	–	–	–	F	a,e,f,g



7 SEGMENT DISPLAY BARS

TABLE 2 Comparison of numerical systems and the 7-segment display

It should be remembered that Hex is only a notation for 4 bit binary numbers. It does not have patterns of 0's and 1's exclusive to itself, but merely represents binary numbers in a 'short hand' way. There are other similar systems (the 'Octal' code represents 3-bit binary numbers, for example) but the 4 bit binary numbers of Hex are the most useful to represent, since groups of 4 bits, and groups containing multiples of 4 bits, occur very frequently in logic circuits and systems.

The Hex system can consist of multi-digit numbers of course, in the same way that binary and decimal systems can, and again these are arranged in powers of 16. Comparing Hex with decimal:

3A is equivalent to $(3 \times 16) + (10 \times 1) = 58$
B9 is equivalent to $(11 \times 16) + (9 \times 1) = 185$
2AF is equivalent to $(2 \times 16^2) + (10 \times 16) + (15 \times 1) = 687$

Hex numbers are most usually seen these days in computer programs. When writing programs, it is ridiculous to use long lists of 0's and 1's to represent data and instructions, so the simplest abbreviation of this is to represent 8 bit binary numbers by 2 digit Hex numbers. (Most modern microcomputer systems use 8 bit logic circuitry). Conveniently, an 8 bit binary code can represent 256 different numbers; exactly the same as a 2 digit Hex code can! These 2 digit Hex numbers are known in computer jargon as 'object code', and so this explains the reason for those long lists of numbers such as 3A, 0E, 3F, A2, B2, 23, 23, 47, etc., etc., that you may have seen written down in computer program listings.

7-SEGMENT DISPLAYS

The principles of the 7-segment display are quite straightforward and were covered earlier in the series. Briefly, seven bars of light can be used to represent all the numbers 0 to 9, and many stylised letters of the alphabet, including the letters A, b, C, d, E and F, with upper and lower cases as shown. (This is convenient for Hex number representation.) The 7 segments of the display are lettered a,b,c,d,e,f and g (there is usually a decimal point, 'd.p.', provided too,) and are arranged in the layout shown in Table 2. The segments lit for each code number are also shown in Table 2.

Integrated circuits are readily available to convert binary codes into 7-segment codes. Usually, these i.c.s have extra functions built into them, such as latches, or output driver stages to directly drive the display segments without extra buffers or amplifiers. The Dual-Digi-Dice 'mini-project' this month uses two of these i.c.s built into them, while the other i.c.s are able to drive several displays, in a multi-digit arrangement, simultaneously. We shall look closer at display driving techniques, and alternative display technologies, next month.

THE GRAY CODE

Although binary, BCD, Hex and 7-segment are the most regularly used electronic codes, there are many others of which the majority are very specialised indeed. The 'Gray Code' is one of the more widely used of these alternative codes. To be completely accurate, the term Gray code, sometimes known as a 'reflected' code, can encompass a range of different codes, but we shall only look at the most common one.

The Gray code is primarily used in positional encoders. These are electromechanical devices which convert a physical movement or rotation into an electronic code which has a value proportional to that movement or rotation. In essence, they are multi-way switches giving a coded output, and are used to feed positional information from machinery or instruments, into logic circuits. The switching action can be by electrical contacts, or by optical means using marked discs passing between light sources and detectors.

Binary codes could be used in these applications, but would suffer from race hazards; if the shaft was just on the point of changing from one binary number to another, it may be that some bits had changed state, while others were about to change. This would give a completely false binary number. For example, if 0111 was to count by one to 1000, the three least significant bits may change state fractionally before the most significant bit does. The sequence would then go: 0111, 0000, 1000. If the shaft was resting in the 0000 position, this would be a completely false and erroneous reading: in fact, it should read 'half way' between 0111 and 1000!

To get round this problem, the Gray code only changes one bit at a time, so each count only differs from the previous and succeeding counts by the change of state of one bit. By this means, the greatest uncertainty of value that there can ever be is plus or minus $\frac{1}{2}$. The complete code, with binary shown alongside for reference, is given in Table 3. Although the Gray code might look rather complex, it is

DECIMAL NUMBER	4 BIT BINARY NUMBERS			
	8's	4's	2's	1's
	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
	Changes Every 8	Changes Every 4	Changes Every 2	Changes Every 1

TABLE 3 The Gray Code

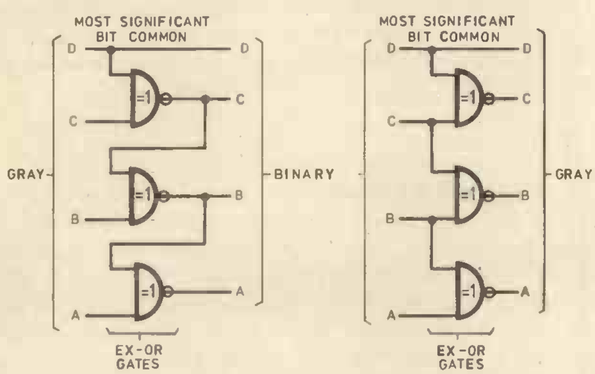


Fig. 6.1. Gray to/from binary conversion

very easy to convert from binary to Gray, and vice versa. The circuits to do this are shown in Fig. 6.1, and can be expanded for any number of bits from one upwards! In each case, the most significant bit is common to both codes, and the other bits follow the interconnection pattern shown.

OTHER CODES

The only other code that you will be likely to come across regularly is the ASCII code: the American Standard Code for Information Interchange. This is a fairly universal code used for representing symbols, characters and control signals, and has wide application in the field of computing. ASCII is a 7 bit binary code, and is used in association with large keyboard assemblies to provide coding for upper and lower case letters of the alphabet, numerals, punctuation, and control functions such as reset, backspace, carriage return, etc. The same codes are also used for character generation: when fed into suitable 'character generator' i.c.s they cause a specifically encoded signal to be produced which is then suitably modulated and displayed on a video monitor or domestic television. In these instances, most of the keyboard control functions are replaced by fairly complex graphic symbols which allow the programmer greater flexibility in the symbols that he can write up onto the screen.

Since there are 128 different ASCII codes, we shall not list them all here; they are easily accessed via character generator, microcomputer, or keyboard encoder i.c. data sheets. The generation of these 7-bit codes from the contacts of the keyboard switches, together with contact debouncing and other basic timing and control functions, is normally carried out by i.c.s on the actual keyboard p.c.b. itself.

It should be noted that code converters can be easily designed using Boolean algebra, as discussed in the first part of the series. Each digit (or bit) of the 'new' code has its own Karnaugh/Veitch map, drawn up from all the digits (or bits) of the 'old' code. In most cases, of course, there are readily available i.c.s to perform the complete conversion so these techniques need only be employed for very specialised code conversions.

BINARY ARITHMETIC

All digital calculators, microprocessors and (of course) computers, at their most fundamental level, use binary codes for their numerical representation. On these codes must be performed arithmetic operations, mostly additions, subtraction, multiplication and division. To see how this is done in practice it is first necessary to determine the rules of binary arithmetic, which follow 'conventional' arithmetic techniques to a large extent.

ADDITION

This works in a very straightforward way, the only difference between binary and decimal addition being that we 'carryone' to the next most significant digit when the sum exceeds 9 in decimal, whereas in binary we carry one when the sum exceeds 1. So we can see that:

0 + 0 = 0
0 + 1 = 1
(Similarly, 1 + 0 = 1)
1 + 1 = 0 carry 1

Examples:	a)	b)	c)
	11010	0100	100101
	plus 00010	plus 0001	plus 001101
	equals 11100	equals 0101	equals 110010
	carry 1		carry 1

SUBTRACTION

This is a rather more complicated procedure than addition, due to the requirement to 'borrow' digits. The way that most systems overcome this difficulty is to complement one number, then add the other number to this complement. 'Complementing' simply means turning a negative number into a positive one, or vice versa; i.e. in terms of decimal numbers,

16 − 4 = 12

is the same as,

16 + (−4) = 12

Using this method, we can use the same circuits as for the addition process, with only an extra complementing circuit needed. There are a number of different ways of deriving a negative binary number from a positive one. We shall look at the most common system, known as 'Two's Complement':

To form the two's complement of a number (i.e. turn a positive binary number into a negative one), perform the following steps:

1) add an extra 0 on the left of the number (i.e. the most significant bit)
2) invert all the bits (1 becomes 0, 0 becomes 1)
3) add 1 to the resulting number.

Example: a) Turn 17 into −17

17 in binary is:	10001
add 0 to the left:	010001
invert all the bits:	101110
add 1:	000001
Result:	101111

Hence, 101111 is the two's complement representation of −17.

Example: b) Turn 3 into −3

3 in binary is:	11
add 0 to the left:	011
invert all the bits:	100
add 1:	001
Result:	101

Hence, 101 is the two's complement representation of −3.

In both these examples it is necessary to know that two's complement arithmetic is being used, and hence the left band bit is an 'extra' one; in the latter case, for example, we know that the result 101 is not 5 in decimal because the original number was a 2 bit number, and our 2's complement method results in a 3 bit number.

When building subtraction systems, circuitry to perform the two's complementing of one number is followed by addition circuits, to add the result of the two's complement process to the other number. The final result is a subtraction! Note that if a positive and a negative number are added and if the most significant bit of the result 'carries by one', i.e. the result is one bit larger than either of the two original numbers, then this most significant bit can be discarded, i.e. ignored.

For example, take

+3 − 3 = 0
−3 in binary = 101
+3 in binary = 011

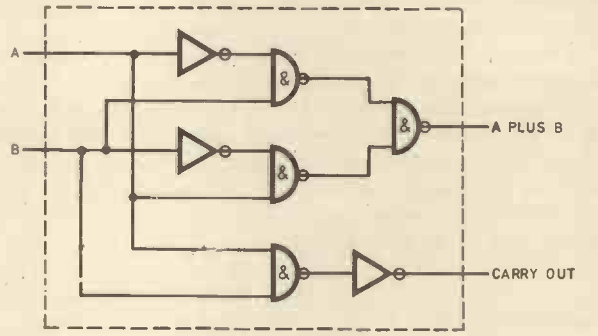
Adding together, the RESULT = 1000
↑ Discard

Hence, the result = 000 (zero)

HALF AND FULL ADDERS

Combinational circuitry is used to implement binary addition. The most basic addition circuit is known as a 'half adder', since it is used when two bits only are to be added; it has no 'carry in' facility. See Fig. 6.2. To include carry in requires two half adders to be connected together with an extra gate, as shown in Fig. 6.3. Note that in Fig. 6.2 and 6.3 the circuits are based on the use of NAND and NOR gates, since these are most usually found in discrete circuitry. To simplify the circuits still further, EX-OR gates are often used in place of several gate combinations.

A 4-bit CMOS full adder i.c. is readily available, the 4008, which has extra circuitry provided to give a 'fast' carry out signal. If this extra circuitry was not provided, the carry out



EG746 **Fig. 6.2. The half adder**

EG747 **Fig. 6.3. Block diagram of the full adder**

signal would have to ripple through the adder stages, incurring considerable delay and potentially giving rise to hazards in the operation of the following circuitry. The majority of adder circuits today are, of course, buried deep within microprocessor and calculator i.c.s. The principles outlined here still apply, nonetheless. The circuitry for binary subtraction need not be shown, since it is merely a set of inverters with an extra half adder to add one to the complemented binary number, followed by a set of full adders as detailed above.

MULTIPLICATION AND DIVISION

There are three different approaches which can be adopted when designing multiplication and division circuits. The first is to use a fairly complex but fast arrangement of full adders and control circuitry to perform 'long multiplication' and 'long division':

For example, multiply 01101 by 1010:

MULTIPLY: 01101 (13 in decimal)
BY: 1010 (10 in decimal)

00000
01101
00000
01101

'Multiply the top number (01101) by each digit of the bottom number one at a time and each time shifting the answer left by one position.

TOTAL: 10000010 (Adding all four multiplications together)
Carry 1

The result is 10000010, or 130 in decimal.

Since the process was simply a 'shift-and-add' routine, this is obviously implemented by using a large number of full adders, suitably interconnected, with inputs gated on and off by the bits of the second number (1010). Division is carried out by a similar process.

In many calculators and microprocessors, the rather complex and specialised circuitry needed for these operations is unnecessary; a far simpler, though slower, method can be used. It is analogous to the way a supermarket check-out operator totals up many identical purchases:

6 items, at 7 pence each, total: 7 + 7 + 7 + 7 + 7 + 7 = 42 pence.

So, in the above case of 13 multiplied by ten, the result is obtained by adding 13 to 13, then adding the result to 13, then adding that result to 13, and so on, for the required number of times. The speed of circuit operation is sufficient to obtain a result from this apparently clumsy multiplication process in only a few microseconds! Divison, of course, is a very similar process.

The final method of multiplication and division is actually rather a cheat! If the number that you are multiplying by or dividing by is an integer (a whole number) power of 2 i.e. 2, 4, 8, 16, 32, 64, etc., then no addition steps are necessary. The original number to be multiplied or divided is merely 'shifted' left or right respectively by the power of 2 concerned, filling in 0's where necessary. The best way to illustrate this is to show some examples:

Example 1:

	1011	(eleven in decimal)
multiplied by	100	(four in decimal)
i.e.	1011	multiplied by 2^2
therefore, move	1011	left by two positions, and fill in the gaps with 0's
the result is	$1011\underbrace{00}_{\text{2 extra 0's added}}$	(i.e. 44 in decimal)

Example 2:

	11001	(twenty five in decimal)
multiplied by	1000	(eight in decimal)
i.e.	11001	multiplied by 2^3
therefore, move	11001	left by three positions, etc.
the result is	$11001\underbrace{000}_{\text{3 extra 0's added}}$	(i.e. 200 in decimal)

In the case of division, as many bits must be discarded as the number of places being shifted to the right:

Example 3:

	10100	(twenty in decimal)
divided by	00100	(four in decimal)
i.e.	10100	divided by 2^2
therefore, move	10100	right by two positions
the result is	$00101\underbrace{00}_{\text{discard these two bits.}}$	i.e. the result is 00101 (five in decimal)

This shifting procedure is tailor-made for the shift register! If the number that you are to multiply or divide by is an integer power of two (this is surprisingly a regular occurrance) then the shifting technique is by far and away the easiest way to implement this arithmetic operation.

THE ARITHMETIC LOGIC UNIT

When several full adders and some control logic are added together in one circuit, in combination with some external parallel in-parallel out registers, we end up with a very flexible and versatile multi-function unit capable of performing a number of arithmetic and logic operations on sets of binary information. This is known as the ALU (Arithmetic Logic Unit) and is at the heart of every computer, microprocessor and most calculators. The ALU is normally treated as a 'black box'; it's detailed internal operation need not be known, it is merely a block of circuitry capable of addition, subtraction, complementing, multiplications, division (these two functions sometimes requiring the use of extra external registers), logical operations such as AND-ing and OR-ing of binary numbers, and other similar operations.

To achieve this flexibility and versatility of operation, the interconnections between the various registers, control logic, full adders, etc., must be fairly complex. In order to vastly simplify these interconnections and to give some semblance of order to the internal structuring of microprocessor and calculator circuitry, the 'BUS' system is used.

THE BUS

A bus is a set of common parallel interconnections between many different devices and circuit subsections in a system. It has a certain 'width' measured in binary bits, which usually corresponds to the maximum number of bits in the binary numbers to be manipulated within the equipment. The 8 bit bus is very common these days, so this bus physically consists of eight separate tracks on the p.c.b., or inside the i.c. chip. Sometimes extra bits for control purposes are added to the bus; the most regularly seen types being known as 'flags', which are used for control signalling between parts of the circuitry.

Some devices feed their outputs onto the bus, others take their inputs from the bus, and some even do both! Not all this happens simultaneously, though. Device A might feed onto the bus while device B takes it's input from the bus, in which case the output of A is fed to the input of B. These two then stop using the bus, while device C feeds onto the bus, and device D takes it's input from the bus; the output of C then feeds into the input of D, without affecting either A or B. The bus is often known as a 'data highway' with devices

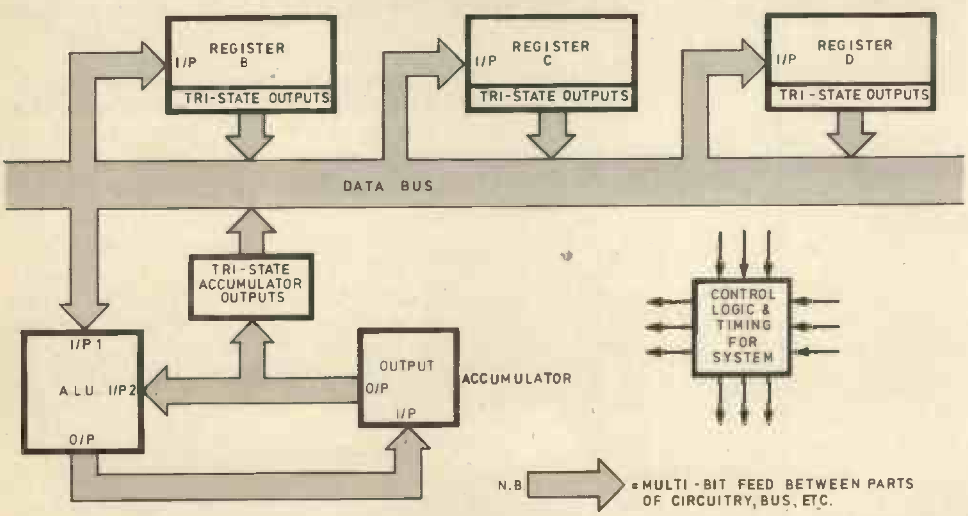


Fig. 6.4. Simplified block diagram of bus-orientated ALU system

EG 748

and circuit sections taking it in turn, two or more at a time, to be connected with each other via it.

To achieve all this without excessive loading or shorting out of gate outputs, a 'tri-state' (three state) logic system is employed on all device outputs feeding onto the bus. When the tri-state outputs are turned on, they can be at either logic 0 or logic 1 levels, as used in the rest of the system, but when the tri-state outputs are turned off they become very high impedence points, capable of floating in voltage, with negligible loading of other circuitry feeding the bus. Hence, only the device selected at any time by the controlling logic can feed onto the bus. Inputs to devices are enabled by the control logic in a fairly conventional way. The bus can therefore be considered 'bidirectional'; binary information flows up and down it in rapid succession as different parts of the circuit use it to perform their various interconnections.

It is usual for complex digital systems to have more than one bus. The other bus or buses can carry information to different areas, or carry other forms of information, for example 'addresses'. The address is a binary number which defines a particular place in the memory system of the device, rather like the use of Ordnance Survey grid reference numbers to define a particular place in the country. (We'll look at memories in more detail next month). A typical arrangement is to have an 8 bit data bus and a 16 bit address bus run adjacently in the circuit.

A simplified bus arrangement is shown in Fig. 6.4. The 'accumulator' is a register, similar to the B, C, and D registers, but dedicated to the ALU. It's input is always fed from the ALU, while its output always goes to one of the two main ALU inputs, and can also feed, via tri-state enable gates, onto the bus. By careful internal timing of the system, binary numbers can be fed out of any of the B, C or D registers into the ALU, mathematically processed with the output of the accumulator, and the accumulator can latch into itself the result of this mathematical process, which can then be fed onto the bus and either back into the ALU again, or into one of the registers. For example, the sequence of events to add the contents of register B to those of register C, and put the result in register D, would be:

1) Reset accumulator (output equals zero).
2) Feed output of register B onto the bus, and enable inputs to the ALU.
3) Add ALU input 1 (i.e. the number in register B) to input 2 (zero).
4) Latch the output of the ALU into the accumulator.
5) Feed the output of register C onto the bus, and enable the inputs to the ALU.
6) Add ALU input 1 (the contents of register C) to input 2 (the number which originally came from register B).
7) Latch the output of the ALU into the accumulator.
8) Feed the output of the accumulator, via the tri-state enable gates, onto the bus and enable the inputs to register D.

Although this sounds a complex procedure most computers, calculators or microprocessors can carry out this series of steps in no more than a few microseconds; many in considerably less time than this! We're now starting to get an insight into the internal operation of microprocessor and computer central processing units, or 'CPUs'. We'll cover the subject more fully in the final article of the series. Before that, however, in next month's article we shall look at the use of analogue techniques within digital logic circuitry. This includes complex display driving, analogue transmission gates, conversion between analogue and digital signals, and (of course) those all-important memories!

DUAL-DIGI-DICE

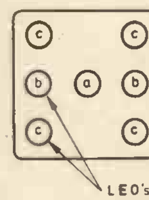
This project accurately simulates the rolling of a pair of dice, with fairly authentic l.e.d. dice face patterns. When the 'ROLL' switch is pressed, both dice faces start changing and flickering rapidly, then gradually slow down and stop at a final result. The changes are completely random; they do not simply 'count up' numerically. Approximately 10 seconds after the final result has been obtained, the two l.e.d. dice displays switch off to conserve battery power.

PRINCIPLES

The circuit design is based upon the fact that dice face patterns change in a way that is approximately a binary count. Referring to the pattern of l.e.d.s, we can compare the dice face l.e.d.s lit with a sequence of binary numbers, as shown in Fig. 6.5. There is obviously a direct correlation between the l.e.d.s lit and the binary count; the 'A' l.e.d. is lit by the least significant binary digit, the 'B' l.e.d.s by the middle digit and the 'C' l.e.d.s by the most significant digit. Hence a binary counter can be used to provide the correct code for the dice face, as long as the invalid 0 and 7 states, which never occur on a dice, can be avoided.

NUMBER	DICE FACE LED's LIT	BINARY CODE
0	INVALID (NONE LIT)	0 0 0
1	a	0 0 1
2	b	0 1 0
3	a & b	0 1 1
4	c	1 0 0
5	a & c	1 0 1
6	b & c	1 1 0
7	INVALID (NONE LIT)	1 1 1

MOST SIGNIFICANT DIGIT — LEAST SIGNIFICANT DIGIT



EG722

Fig. 6.5. Dice face l.e.d. patterns

CIRCUIT DESCRIPTION

IC4 is a dual binary counter; two separate synchronous counters in one i.c. package. The 'C' output of the first counter is used to clock the second counter, so the two halves are 'cascaded' asynchronously. The slight race between the two counter halves is unimportant in this case; any static hazards caused are irrelevant, as the counters are clocked randomly by a noise source anyway! The output of each counter is fed into a Quad D-type latch, the Q outputs of which drive the l.e.d.s via conventional transistor buffers. (Note that the 'B' and 'C' l.e.d.s are arranged in series pairs to cut down current consumption, although it would be unwise to put all four 'C' l.e.d.s in series since the total voltage drop across them could be as high as 10 volts, which would not allow for sufficient variation of power supply voltage.) TR3, TR4, R16 and R17, and TR5, TR6, R15 and R18 form Darlington driver configurations, each to supply current to all the l.e.d.s in a dice face display. These configurations are fed in turn from IC7a. The inputs of IC7a are connected to a very long time period pulse stretcher — D4, C8 and R14. When S3 is pressed and released, IC7a pins 1 and 2 are held at logic 1 for approximately 15 seconds, causing the output pin 3 to go to logic 0, turning on the two Darlington drivers and hence the displays. After the time period of 15 seconds has ended, pin 3 goes high again and the Darlington drivers turn off, so the l.e.d. displays also turn off, conserving valuable battery power! This time period can obviously be varied by charging R14 or C8. S2 is provided to permanently switch off the 'A' dice display when only one dice is being used.

The random changes of dice face display are obtained by

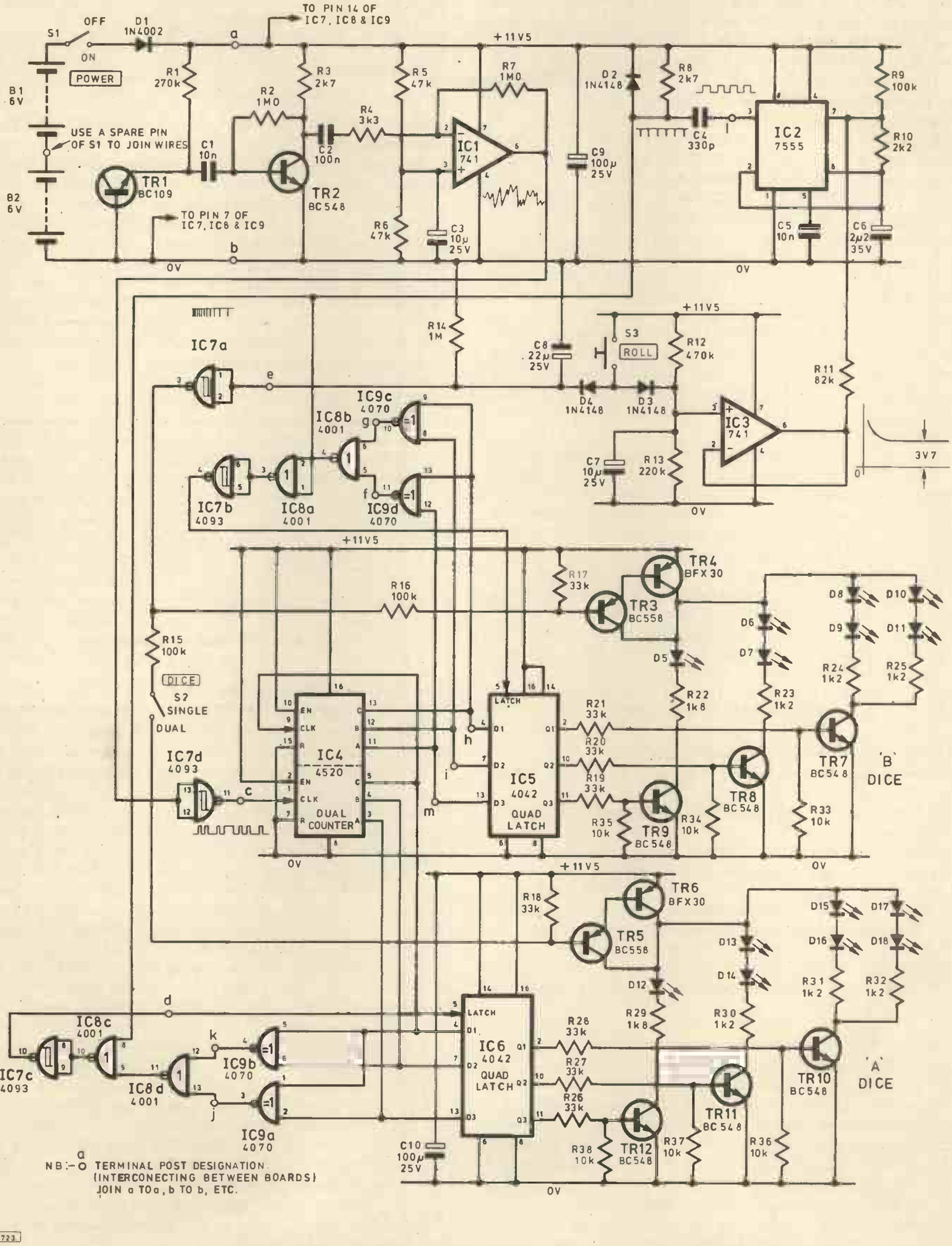


Fig. 6.6. Circuit diagram of the Dual-Digi-Dice

using a random noise source to clock the counters, then latching the counter outputs in IC5 and IC6 as frequently as required to give the effect of the dice rolling. The clocking of the counter occurs very rapidly and the latching fairly slowly, so for each latch pulse, IC4 will have counted through its entire range of numbers many times. Each successive dice face shown, therefore, will be chosen completely at random.

The noise source is formed by reverse biasing the base-emitter junction of TR1, with the collector left disconnected. This is buffered and amplified by TR2 (with R2, R3 and C1) then amplified again by IC1. R4 and R7 set the gain of IC1, while R5, R6 and C3 set the non-inverting input to a reference point of approximately +5·8 volts. The noise output of IC1 swings almost to each supply rail, and needs only to be fed through a Schmitt trigger gate, IC7d, to clean up the waveform into correct logic levels, before feeding into the clock input of the counter, IC4 pin 1. Note that a high battery voltage for the unit is needed (12 volts) in order that a satisfactory noise voltage can be obtained from the reverse biasing of the TR1 junction. Although a 9V battery could be used, it would require special selection of TR1 to find a transistor with a particularly high noise voltage. Diode D1 is provided to protect the unit against accidental reverse connection of the batteries with C9 and C10 decoupling the power supply rails.

IC2 and IC3 are used to generate the latch pulses, starting off with very rapidly occurring latch pulses, then slowing down to a final halt. CMOS timer IC2 is connected as a fairly conventional oscillator, but with an extra resistor R11 taken to the output of IC3. This op-amp is connected as a voltage follower; the voltage on pin 6 will be exactly the same as that on non-inverting input pin 3, but at a very low impedance. When S3 is pressed, C7 charges up to +11 volts via D3, hence the output pin 6 of IC3 also goes to +11 volts and IC2 oscillates at a relatively high frequency. As soon as S3 is released, C7 begins to discharge in a manner defined by R12 and R13, to a final voltage of approximately 3·7 volts. The output of IC3, via R11, then causes the oscillations of IC2 to decrease in frequency and finally stop. (Note that pin 5 of a 555 timer i.c. would normally be used to alter frequency, but in this case it was unsuitable as the oscillations could not be completely stopped.)

The output of IC2, pin 3, has short pulses derived from it by C4, D2 and R8. These are then used to latch IC5 via IC7b and IC8a, and IC6 via IC7c and IC8c. The invalid conditions of the counter IC4, 000 and 111 (as shown in Fig. 6.5.) are prevented from occurring by IC9c, IC9d and IC8b (for the 'B' dice) and IC9a, IC9b and IC8d (for the 'A' dice). In each of these networks, the outputs of the two EX-OR gates are both at logic 0 if their respective binary counts are 000 or 111. This, via the following NOR gate, disables any latch pulses passing to IC5 or IC6 (as appropriate), thereby preventing an invalid code from ever being latched and displayed.

CONSTRUCTION

The matchboards should be built up as shown in Fig. 6.7, leaving the l.e.d.s OFF the boards for the moment and fitting the wire links on each board after all the components have been added. The l.e.d.s are then soldered to the REVERSE side of the board (i.e. the copper foil side) with their tops protruding approximately 10mm above the surface of the p.c.b. Note that the 'a' (centre) l.e.d. has to have its leads bent outwards to fit the holes in the board. Ensure that these bends are made well away from the l.e.d. body.

The case can then be drilled to take the switches and the two match-boards' support pillars, and rectangular cutouts should be made to allow viewing of the l.e.d. displays; these cutouts can then have a piece of red tinted transparent perspex or plastic glued behind them to improve visibility and contrast of the l.e.d.s. The interwiring between boards, and to the switches, can now be added in flexible (multistrand) wire, and the boards can be screwed to the front panel of the case using suitable spacers: ½ inch x 6 BA

COMPONENTS . . .

Resistors

R1	270k
R2, R7, R14	1M (3 off)
R3, R8	2k7 (2 off)
R4	3k3
R5, R6	47k (2 off)
R9, R15, R16	100k (3 off)
R10	2k2
R11	82k
R12	470k
R13	220k
R17, R18, R19, R20, R21, R26, R27, R28	33k (8 off)
R22, R29	1k8 (2 off)
R23, R24, R25, R30, R31, R32	1k2 (6 off)
R33, R34, R35, R36, R37, R38	10k (6 off)

All resistors ⅓ or ½W 5% carbon

Capacitors

C1, C5	10n polyester (2 off)
C2	100n polyester
C3, C7	10μ 25V elect. (2 off)
C4	330p ceramic plate
C6	2μ2 35V tant.
C8	22μ 25V elect.
C9, C10	100μ 25V elect. (2 off)

Semiconductors

D1	1N4002
D2, D3, D4	1N4148 (3 off)
D5 to D18	red l.e.d. (14 off)
TR1	BC109
TR2, TR7 to TR12	BC548 (7 off)
TR3, TR5	BC558 (2 off)
TR4, TR6	BFX30 (2 off)
IC1, IC3	741 8 pin i.c. (2 off)
IC2	ICM 7555 CMOS timer
IC4	4520 CMOS Dual binary counter
IC5, IC6	4042 CMOS Quad latch
IC7	4093 CMOS Quad Schmitt NAND gate
IC8	4001 CMOS Quad NOR gate
IC9	4070 (or 4030) CMOS Quad EX-OR gate

Miscellaneous

2 off	Matchboard Exp-300PC Global Specialties
S1	Double pole miniature toggle switch
S2	Single pole or double pole miniature toggle switch
S3	Momentary push button switch
2 off	Battery holders, with connecting leads (each 4 x HP7)
1 off	Design Mate Case DMC2, Global Specialties
8 off	½in. x 6BA threaded spacer

6BA screws and wire to suit

2 small pieces of red gelatine, perspex, etc (see text)

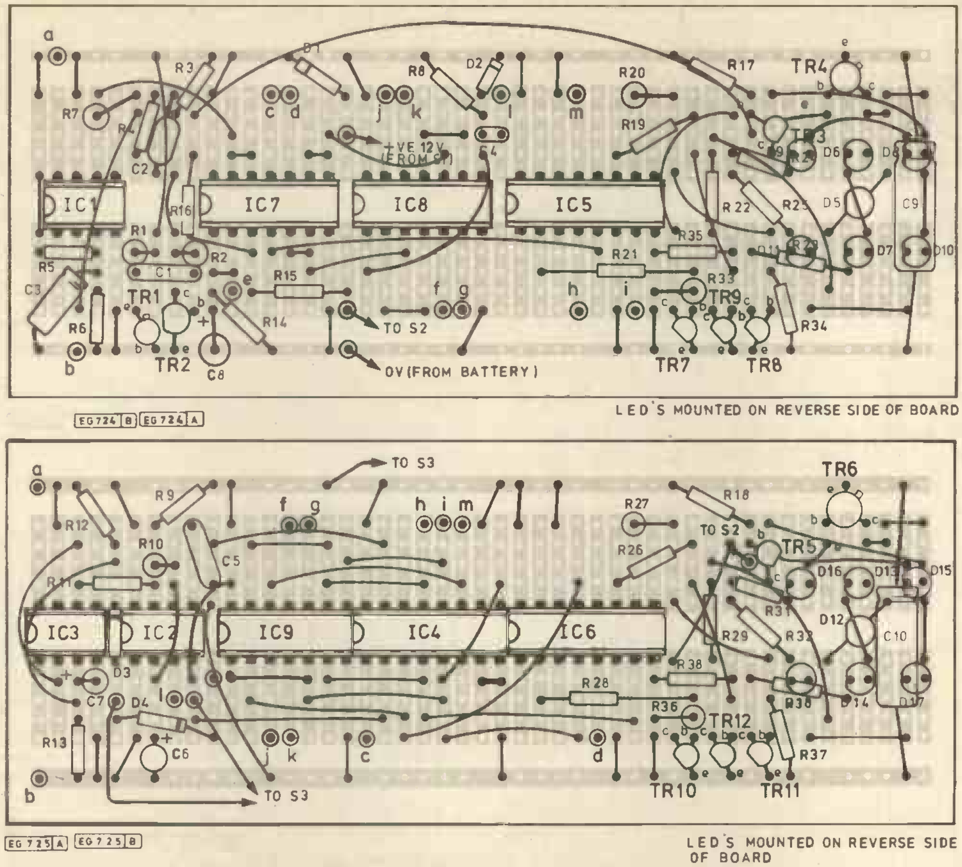
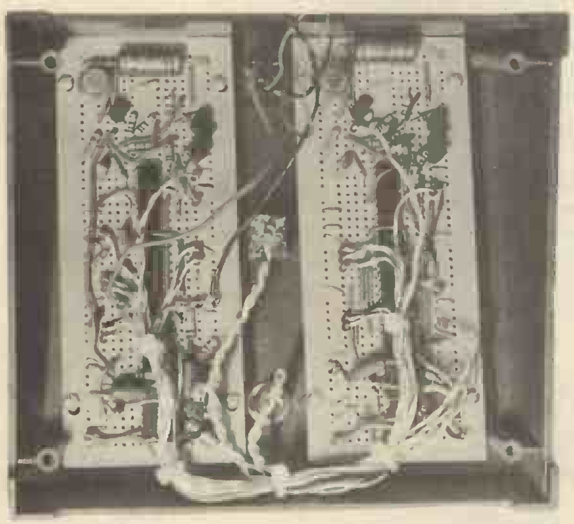


Fig. 6.7. Matchboard layout for the Dual-Digi-Dice

tapped pillars are ideal. The battery holders can be fixed to the case baseplate using 'sticky fixers', and the batteries should then be added.

The project is now finished! If it seems that the noise source is not operational (no logic changes at IC7d pin 11) try changing TR1, or lowering the value of R4 to 1kΩ, and make sure that the supply voltage is high enough. The rate at which the dice face displays slow down their changes can be varied by altering the values of R11, R12 and R13, but note that too slow a 'slowing down' may result in the dice face never actually finally stopping before the displays switch themselves off! For testing purposes, removing C2 and C4



Internal view

will enable you to use a logic pulser (on IC7d pin 11 and IC8a pin 1), to simulate the action of both the random noise generator and the latching pulse generator, and thereby debug any faults that there might be. Finally, there is plenty of room in the case to add a simple mains power supply if preferred, as shown in Part 2 of this series; any voltage from 12 to 15V will work very well indeed.

NEXT MONTH

Multiplexing of displays, complex displays (liquid crystal, gas discharge and similar). Analogue switches, transmission gates etc, A to D and D to A converters.

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CMOS

4000	14	4016	30	4031	170	4053	60	4077	25	40175	100	4527	90
★4001	13	★4017	45	4034	170	4054	110	4081	18	40193	120	4528	75
4002	14	4018	60	4036	285	4055	115	4082	20	4502	70	4529	150
4006	65	4019	35	4039	295	4059	480	4085	65	4503	50	★4532	95
4007	17	4020	60	★4040	55	4060	85	4086	65	4507	38	4534	495
4008	58	4021	65	4041	75	4063	90	4089	140	4508	200	4538	110
4009	30	4022	70	4042	55	★4066	35	★4093	38	4510	65	4543	110
4010	35	4023	18	4043	60	4067	395	4094	140	★4511	50	4549	380
★4011	14	★4024	40	4044	85	4068	18	4095	90	4512	70	4553	295
4012	17	4025	18	4046	70	4069	18	4097	340	4514	180	4555	45
★4013	30	★4026	96	4047	70	4070	18	4098	85	4515	180	4556	48
4014	60	4027	30	4048	55	4071	18	4099	95	4516	75	★4559	390
4015	60	4028	55	★4049	28	4072	18	★40106	50	★4518	45	4560	180
		4029	75	★4050	28	4073	20	40109	100	4520	70	4584	45
		4030	35	4051	60	4075	20	40163	100	4521	200	4585	99
				4052	70	4076	20	40173	100	4526	80	4724	140

LINEAR

709	40	CA3160E	100	LM358	50	LM2917	200	NE566	150	★TDA1022	560
★741	14	CA3162E	450	LM377	150	LM3900	50	NE567	150	TDA1024	125
748	35	CA3189E	290	LM380	80	LM3909	70	NE571	425	TL071	45
AY-1-0212	680	★ICL7106	700	LM381	120	★LM3914	200	RC4136	90	TL072	75
AY-1-1313	670	ICL8038	320	LM382	120	★LM3915	200	SN76013	170	★TL081	30
AY-3-1270	840	ICM7555	80	LM386	80	LM13600	120	SN76018	150	TL082	70
AY-3-8910	700	LF351	45	LM387	120	MC1310	150	★SN76477	150	TL084	90
★AY-3-8912	625	LF353	85	LM393	100	MC3302	150	TBA641B11	250	★XR2206	300
CA3046	60	LF356	90	LM709	40	MC3340	135	TBA800	80	ZN414	100
CA3080	70	LM10	395	LM710	50	NE515	270	TBA810	95	ZN423	195
CA3089	215	LM301A	25	LM725	350	NE529	225	TBA820	80	ZN424	135
CA3090AQ	375	LM311	70	LM733	75	NE531	150	TBA950	290	ZN425E	390
CA3130E	90	LM318	85	LM741	14	NE544	185	TCA940	170	ZN426E	330
★CA3140E	45	★LM324	40	LM747	75	★NE555	17	TDA1004	300	ZN427E	650
		LM339	50	LM748	35	NE556	55	TDA1008	320	ZN428E	480
		LM348	90	LM1458	40	★NE565	120	TDA1010	225	ZN1034E	200

TRANSISTORS

AC125	35	BC147	8	BC212L	10	BD139	35	TIP33A	50	★2N3704	6
AC126	25	BC148	8	BC213L	10	BD140	35	TIP34A	60	2N3705	9
AC127	25	BC149	9	★BC214L	8	BFX29	25	TIP41A	60	★2N3819	15
AC128	25	BC157	10	BC477	30	BFX84	25	TIP42A	60	2N3904	10
AD149	80	BC158	10	BC478	30	BFX88	25	TIP2955	60	2N3905	6
AD161	40	BC159	10	BC547	10	BFY50	23	TIP3055	55	2N3906	10
AD162	40	BC177	18	BC548	10	BFY51	23	ZTX107	12	2N5459	30
BC107	10	BC178	18	BC549	10	BFY52	23	ZTX108	12		
BC108	10	BC179	18	BC558	10	★BF244B	18	ZTX300	14		
BC108C	12	★BC182L	8	BCY70	18	MJ2955	100	ZTX302	15		
BC109	10	BC183L	10	BCY71	18	TIP29A	40	ZTX500	15		
BC109C	12	★BC184L	7	BCY72	18	TIP30A	40	2N2369	17		
				★BD131	35	TIP31A	45	2N2646	45		
				BD132	35	TIP32A	45	★2N3702	6		

DIODES

1N4002	5
1N4006	6
★1N4148	2
★400mW zeners	6

COMPONENT KITS

¼W Resistor Kit. Contains 10 of each value from 4.7Ω to 1M all 5% types (total of 650 resistors) **480p each**
Ceramic Capacitor Kit. Contains 5 of each value from 22pF to 0.01μF (total 135 caps.) **370p each**
Polyester Capacitor Kit. Contains 5 of each value from 0.01μF to 1μF (total 65 caps.) **575p each**

CAPACITORS

Polyester. Radial leads. 250V C280 type. 0.01, 0.015, 0.022, 0.033, **6p**; 0.047, 0.068, 0.1, **7p**; 0.22, **9p**; 0.33, **13p**; 0.47, **13p**; 0.68, **20p**; 1.0μF, **23p**.
Electrolytic. Radial or axial. Please specify type. 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, **20p**; 1000/25V, **30p**.
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**.
Polystyrene. 5% tolerance. 10p-1000p **6p**; 1500p-4700p **8p**; 6800p-0.012μF **10p**.
Siemens Miniature Polyester. PCB mounting. 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**.

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3mm red	7p	★★★★★ 3 or 5 mm clips 3p each.
3mm green	14p	
3mm yellow	14p	
5mm red	9p	
5mm green	14p	
5mm yellow	14p	

Dual colour red/green 60p.
Rectangular LEDs
Red 16p, Green 17p, Yell 17p.

FND500	90p	FND507	90p
DL704	95p	DL707	95p
2N5777	45p	ORP12	85p

SOCKETS

★8 pin	7p	22 pin	20p
★14 pin	9p	24 pin	22p
★16 pin	10p	28 pin	26p
18 pin	15p	40 pin	32p
20 pin	18p		

Soldercon pins 60p/100.

REGULATORS

78L05	30	79L05	65
★78L12	25	★7905	50
78L15	30	★7912	45
★7805	45	LM723	40
7812	50	LM317T	180
7815	50	★LM323K	350

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2.5 x 1" 22p 3.75 x 5" 95p
Veropins per 100
Single sided 50p
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¼W 1% Metal film. E24 series 10Ω-1M **6p each**.

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DIN	Plug	Socket	Jack	Plug	Socket
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	10p	9p
5 pin	13p	11p	Std.	16p	20p
Phono	10p	12p	Stereo	24p	25p

SWITCHES

Submin. toggle
SPST 55p; SPDT 60p; DPDT 75p.
Miniature toggle
SPDT 80p; SPDT centre off 90p. DPDT 90p; DPDT centre off 100p.
Standard toggle
SPST 35p; DPDT 48p.
Miniature DPDT slide 14p.
Push to make 15p. Push to break 22p.
Rotary type adjustable stop
1P12W, 2P6W, 3P4W, 4P3W, 55p each.

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2112	3.40
2114/2	1.49
4027	5.78
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8 x 0.3"	12p	22 x 0.3"	20p
14 x 0.3"	13p	22 x 0.4"	20p
16 x 0.3"	13p	24 x 0.6"	22p
18 x 0.3"	18p	28 x 0.6"	25p
20 x 0.3"	19p	40 x 0.6"	35p
20 x 0.4"	19p	42 x 0.6"	38p

VOLTAGE REGULATORS

78XX1A TO-220 pos	0.58
79XX1A TO-220 neg	0.60
78G 1A TO-220 adj pos	1.10
78G 1A TO-3 adj pos	3.95
78H5A TO-3 5v pos	4.25
78H5A TO-3 12v pos	5.45
78HG5A TO-3 adj pos	7.45
79HG5A TO-3 adj neg	7.45
LM317.5A adj pos	1.30
LM337.5A adj neg	1.75
78S401.5A adj pos sw reg	1.20

DISCRETES

BC237	8p	BC556	12p		
BC238	8p	BC550	12p	2SK168	35p
ZTX238	9p	BC560	12p	J310	69p
BC239	8p	BC639	22p	J176	65p
BC307	8p	BC640	23p	40823	65p
BC308	8p	2SC1775A	22p	3SK45	49p
BC309	8p	2SA872A	18p	3SK51	54p
BC413	10p	2SD666A	30p	3SK60	58p
BC414	11p	2SB646A	30p	3SK88	99p
BC415	10p	2SD668A	30p	MEM680	75p
BC416	11p	2SB648A	40p	BF960	99p
BC546	12p	BF256	38p	BF961	70p
		2SK55	28p	BF963	99p

XTALS

1MHz	3.00
3.2768MHz	2.00
4MHz	1.70
4.194MHz	1.70
4.43MHz	1.25
5MHz	2.00
6.5536MHz	2.00
7MHz	2.00
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PE Car Computer...

P. McFarlane — Part 2

FITTING the flow and speed sensors, installation, calibration and a description of the program controlling the computer.

There is the option of a combination lock facility which could be used to operate an ignition cutout or alarm. The combination consists of three digits and can be changed up to seven times without erasing the PROM.

FITTING THE FLOW SENSOR

Because of the wide variety of fuel systems, precise instructions cannot be given to cover every make of car, but fitting the flow sensor is in fact an easier job than many would imagine, providing the following guide lines are observed.

The flow sensor is fitted in the petrol pipeline between pump and carburettor, and after the fuel filter. The arrow on the side must point in the direction of flow as seen in Fig. 11.

The fuel line, which may be of metal, plastic, rubber or a combination of all three, must be cut or otherwise parted in order to insert the flow meter. In the case of a flexible hose, it is simply necessary to slacken the hose clamp, preferably at the fuel pump end (assuming it is a mechanical engine driven pump), pull off the hose and join the flow meter to the pump outlet pipe by means of the polyurethane pipe supplied. In the case of a metal fuel line, it is better to remove the pipe from the engine before cutting, to enable the ends to be satisfactorily deburred and avoid swarf entering the fuel system.

The usual plastic fuel line is made of nylon and is best cut with a sharp knife. It is normally rigid enough to accept a flexible pipe and clamp without collapsing.

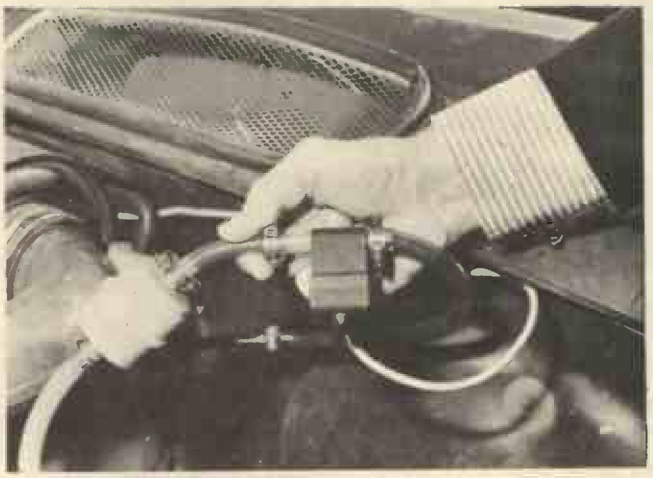
The flow sensor is not normally affected by vibration and because of its light weight, it may be mounted so that it is suspended in the fuel line. It should however not be positioned so that it is subjected to direct radiant heat from the exhaust manifold. If close proximity (less than 6in) is unavoidable, a metal heat shield should be fitted between.

It should ideally be mounted vertically, but if it has to be mounted horizontally or close to the horizontal, it should be fitted with the fuel passage above the detector housing. It is not susceptible to electrical interference but it is advisable to avoid close proximity to high tension leads.

If no filter is present, we recommend that a standard type of in-line paper element fuel filter be fitted just ahead of the flow sensor, taking care to note the direction of flow.

So far so good. Now for the snags. Some of you might have a car in which the fuel is not only pumped up to the carburettor, but is pumped back to the tank as well; in fact it hurtles around the fuel system at a much faster rate than your engine could ever use it. Obviously, if you stick your flow sensor in line with that lot, the answer is going to be rather wrong.

The presence of a second fuel pipe connected to the carburettor, which disappears back to the fuel tank means that you have a recirculating fuel system. It is standard on the Range Rover, Rover 3500 (pre SD1), Fiat, Audi and many other types. If you are in any doubt, your local agent will enlighten you.



Showing an in-line fuel filter and the flow sensor

This little problem is easily overcome by fitting the T-junction supplied with each kit into the fuel line between the pump and the flow meter. Make sure that the return to the tank is fitted to the leg of the tee, since this contains the restricting orifice which limits the return flow.

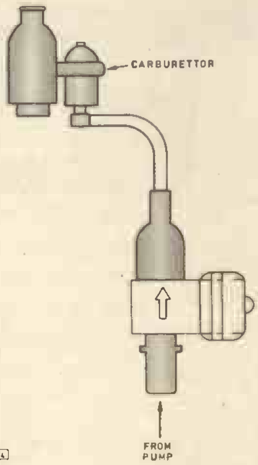


Fig. 11 The flow sensor fitted

On some cars, a T-junction is already fitted between pump and carburettor, in which case the flow meter and filter should be fitted after the T-junction.

It is important to check all fuel lines and joints for leaks immediately the engine is first started and again after a short running interval. The possibility of fuel spillage will be reduced if the fuel tank is reasonably empty before the fuel line is disconnected or cut.

The present flow measuring system cannot be used with a fuel injection engine, since the fuel may not be diverted or shut off.

FITTING THE SPEED SENSOR

Locate a suitable part of the speedometer cable to fit the sensor, probably fairly near the bulkhead in the engine compartment, and draw four lines on it as in Fig. 12. Detach the cable from the back of the speedometer and withdraw the inner cable. Using a hacksaw cut the outer cable at the two inner lines and throw away the section. Slide a jubilee clip along each part of the outer cable.

Refit the inner cable and re-connect to the speedometer, leaving the inner cable hanging from the cut end of the outer.

Push the inner cable through the sensor, the side of the sensor with the screw heads being nearer the speedometer.

This will take a certain amount of force as there is a friction grip on the cable.

Keep feeding the cable through until the outer cable is entering the slotted end tube of the sensor, pulling the inner cable at this point rather than pushing the outer. Allow the outer cable to enter the tube until the drawn line is level with the end of the tube, then release the inner cable and pull back the outer cable about 0·5mm/0·02in. Drop the jubilee clip over the slotted tube and do it up to clamp the cable.

Check that the inner cable is free to rotate when pushed towards the sensor and pulled from it. Thread the inner cable through the rest of the outer, feeding the outer cable so that its line is level with the end of its slotted tube. Fit the jubilee clip as before.

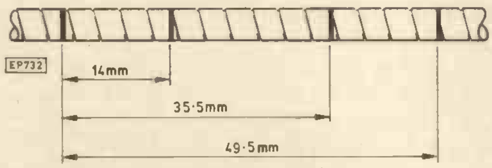


Fig. 12 Speedometer cable marking

Showing the speed sensor

MAIN UNIT

Fit the main unit in a suitable position. If screws are to pass through the plastic box make sure that they will not foul anything inside. Double sided adhesive pads can be used to mount the flat side of the box to a flat surface or to a bracket, and these hold well. Thread the cable to a suitable point and connect up as follows. This is for −ve earth vehicles.

Black wire —Terminal block 1, also to chassis.
Red wire —Unswitched battery power (+ 12 volts).
Yellow wire —Power switched by ignition switch (or auxiliary).
Orange wire —Power switched by light switch (e.g. a panel light).
Brown wire —Terminal block 2 (+5 volts).
Violet wire —Terminal block 3 (Speed signal).
Green wire —Terminal block 4 (Flow signal).

Connect to the sensors as follows.

Terminal block 1—Blue wires from both sensors.
Terminal block 2—Brown wires from both sensors.
Terminal block 3—Green/Yellow wire from speed sensor.
Terminal block 4—Green/Yellow wire from flow sensor.

CALIBRATION

The flow sensor will be supplied with two numbers, one for litres, one for gallons. This number is the number of pulses per litre or gallon divided by 256.

With the unit installed in the car and the ignition switched on, press 'Enter', 'F.Cal', the number, 'End'. Note that if this number is greater than 128, fuel use will read distance/fuel (i.e. miles per gallon), if less than 128 it will read 100 × fuel/distance (i.e. litres per 100 kilometres).

The distance calibration is calculated in a similar manner. It will be about 25 for miles, 16 for kilometres; the exact number depends on gear ratio and wheel sizes. Calibration is achieved by entering an approximate number (25 or 16), driving a known distance, pressing 'Reset' at the beginning of the distance and 'Hold' at the end. The true calibration number is obtained by multiplying the entered calibration number by the recorded distance and dividing by the actual distance.

The marker posts on motorways are exactly 100 metres apart (100 yards on some of the older ones) and can be used for calibration as follows. Press 'Enter', 'D.Cal', 1, 6, 'End', 'Distance'. Drive along the motorway and as a post is passed press 'Reset'. Count 20 posts (2 kilometres) and press 'Hold'. The kilometre calibration figure is 16 × reading /2. The calibration for miles is obtained by multiplying the kilometre calibration by 1·61. For greater accuracy travel a greater distance.

When reading speed it is likely that the computer reading will be considerably different from the car speedometer, and the distance could also be different. It is the car's own speedometer that is wrong, usually reading high. This makes the car appear to be faster and do more miles per gallon than is actually the case, so be prepared for a disappointment.

It is possible to calibrate the flow sensor for optimum accuracy in the same manner as for the speed sensor, by filling the tank up, driving a distance then refilling the tank. It is easy to trap air in the tank or spill a small amount of petrol, so this should be done over at least 10 gallons. Garage petrol pumps are usually very accurate.

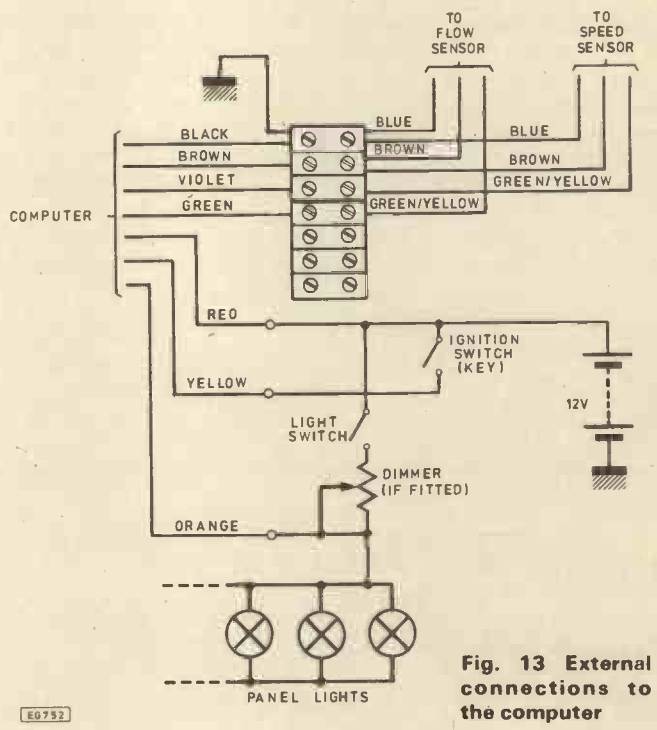


Fig. 13 External connections to the computer

The new calibration constant is:

$$\text{Old calibration constant} \times \frac{\text{Computer reading}}{\text{Actual quantity}}$$

The reading for the display is obtained by dividing the number of pulses counted by (256 × calibration constant). The litres figure is 0·219 × the gallons figure. The fuel could therefore be expressed in any form, for example cost, giving a readout of pounds, miles per pound and so on. The totals are not affected by changes in the calibration number.

The calibration numbers, entered numbers, entered start and stop values and totals will be held in the unit's memory until changed from the keyboard as long as the unit is connected to power. If the battery is disconnected or allowed to go flat the calibration numbers will have to be re-entered. The 1000µ capacitor, C9, will hold the power for a very short while.

The unit is intended to work on negative earth vehicles, but can be adapted for positive earth by connecting the light return wire to the +ve supply wire and constructing a simple transistor invertor for the ignition wire as shown in Fig. 14.

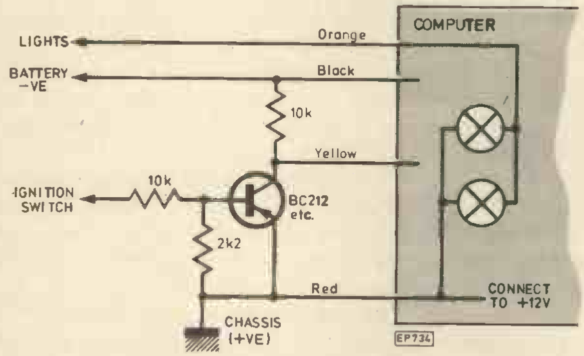


Fig. 14 Transistor invertor for the ignition wire

COMBINATION LOCK

Pin 35 of IC1 is an output of a combination lock facility incorporated in the computer. This could be used to operate an alarm or ignition cutout, and the operation is as follows. If 'Enter', 'Average/Low' is pressed, the display will show an 'L' in the function digit and blank the rest of the display. If the ignition is now switched off, when it comes on again pin 35 of IC1 will be high. To cause it to go low again a three digit combination must be entered, then 'End' pressed. The number is held in the 2716 program memory, and will normally be supplied with a random number, though a specific number could be supplied.

The signal on pin 35 will not go from low to high (locked) with the ignition switched on. This is needed with an ignition cutout as a safety measure as otherwise it could switch off the engine going along, but in addition to this, some sort of 'fail safe' circuit should be used, such as that shown in Fig. 15. R1 should be mounted inside the box, the other components outside. The reason for this is to keep interference noise out of the unit. The relay disables the ignition by shorting out the contact breakers, or inductive or photocell pick up. If the wire to the computer is cut with this circuit, the ignition will be disabled.

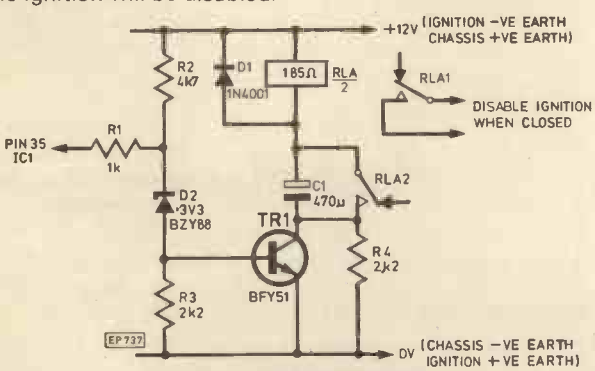


Fig. 15 Ignition disable circuit

CHANGING THE COMBINATION

The three digit combination number is held in the 2716 program memory and can be changed up to seven times without erasing the PROM, making use of the fact that individual memory locations in a 2716 can be programmed. The initial number is held in locations 7FE and 7FF (hex), but the unit will search for a number from locations 7F0 upwards (in pairs), and use the first that it finds that is not FF. The first new number can thus be entered by programming into locations 7FC and 7FD, the next to 7FA and 7FB and so on. The low order location contains the two low digits of the combination, the high order location a hex 'D' (Binary 1101) and the high order digit of the combination.

So to change the number to 123, location 7FC is programmed with 23 hex and 7FD with D1 hex. To change again to 456, program location 7FA with 56 and location 7FB with D4.

PROGRAM

The operation of the car computer is controlled by the program contained in IC2. It is not practical to describe in full this program, or even to list it, but what follows is a brief description of how it operates.

The various sections of the program are:

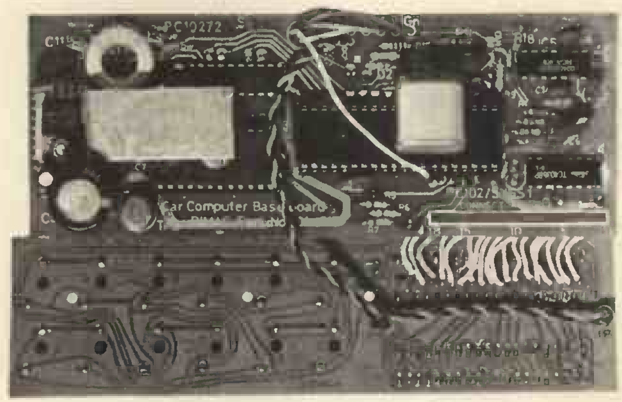
Interrupt—Every 500µs approximately, the program receives a time interrupt.

Keyboard—When a key has been pressed, this routine carries out the appropriate action.

Calculation—This routine takes the information from the appropriate stores, under the control of the function selected, and performs the necessary arithmetic on it, for feeding to the display.

Sample—Every second, or eighth of a second, this routine updates the instantaneous stores.

Start-Stop—If the start-stop mode is active, this routine compares the result from the calculation routine with the start stop information and carries out a reset, or sets the hold condition as required.



The two board component assembly

INTERRUPT

The interrupt routine (a) updates the timebase and time store (b) samples the speed and flow inputs (c) every fourth interrupt it samples the keyboard, and advances the strobe and multiplexed data output.

The main stores for holding total time, fuel and distance are each three bytes long. The low order time byte is also the high order timebase byte, the timebase being two bytes long, and each interrupt the combined 4 byte store is incremented.

The speed and flow inputs are compared with their states at the previous interrupt. If one is now high and was low, the corresponding total store is incremented. A separate one byte store used for the instantaneous signal is also incremented, and the timebase copied to a start store if this is the first count in a sample, or to a stop store otherwise. This is done to improve resolution as there could be only a small number of counts in a sample.

Every fourth interrupt the keyboard lines are sampled. If one is high, the line and timebase information is copied into a current key store. The strobe lines are all made low, the data lines set to the next digit and the new strobe information sent, derived from the timebase.

Note that the timebase information that was copied into the current key store corresponded to the next strobe line. This is why the keyboard is scanned one strobe early. At the end of four strobes the current key store is compared with a previous key store, then copied to that. If the two were different, then a new key has been pressed and a flag is set to instruct the keyboard routine to action the key.

KEYBOARD

If the new key flag is set, it is cleared, and the keyboard routine run. The key is first checked for nothing—releasing a key also sets the new key flag. There is a main flag with eight states which controls the keyboard.

If the key is 'End' the flag is set to zero. In this state with the key 1 to 5, the function store is set to the key number and the average/low and remainder flags are cleared.

When the key is 6, the average/low flag is set. Depressing 7, the total stores are set to zero. If the start-stop mode is active, then the Start flag is set. With 8, the hold flag is set and the start-stop flags cleared. At 9, the hold flag is cleared. If the start-stop request flag is set, the start-stop active flag is set, the start number subtracted from the stop number and the sign of the result copied to the start-stop direction flag.

With 0 keyed, the keyboard flag is set to 1. If the key is 'Enter', the keyboard flag is set to 3.

If the keyboard flag is 1 then if the key is 1 to 5 it is copied to the function store and to a remainder function store. The flag is set to 2 and the remainder flag set. Any other key, the keyboard flag is set to 0 and the key handled as for a flag of 0.

If the keyboard flag is 2 and if the key is 1 to 3 it is copied to the remainder function store. The keyboard flag is set to 0. any other key, the keyboard flag is set to zero and the key handled as for a keyboard flag of 0.

If the keyboard flag is 3 and if the key is 6 then the lock routine is executed. If 8 the start-stop request flag is set. If 4, 5 or . it is ignored. Otherwise the key is copied to a destination store, the keyboard flag is set to 4 and the contents addressed by the destination store are sent to the display.

If the keyboard flag is 4 then the results digits are cleared, the key added to the display store and this copied to the address pointed to by the destination store.

If the keyboard flag is set to 5 then as before except that the results digits are not cleared. Whenever the keyboard flag is set to a number other than zero, a countdown flag is set to 7.

CALCULATION

There are five basic calculations, as follows

Total—function 1 to 3
Instantaneous—function 4 or 5
Average—function 4 or 5
Remaining total—function 1 to 3
Remaining average—function 4 or 5

The total is calculated by taking the contents of the total store addressed by the function store and dividing by the corresponding calibration number. The calibration number for time is generated internally. If the low flag is set, this is now divided by ·001 (the same as multiplying by 1000). If this causes an overflow, the low flag is cleared.

Instantaneous functions are obtained by taking the instantaneous distance divided by its calibration and dividing this by either instantaneous time (a constant) for speed, or instantaneous fuel for fuel use, again divided by its calibration number. If fuel use and the calibration number is less than 128 then 100 is divided by the result obtained (for litres per 100 kilometres).

Average functions are the same except that totals rather than instantaneous quantities are used.

It starts to get complicated for remaining totals. In the description following total function refers to the total addressed by the function store, entered remainder refers to the entered quantity addressed by the remaining function store, and so on.

The total remainder is divided by its calibration, copied to a temporary store then divided by the total function divided by its calibration. The result is stored in a second temporary location. The contents of the first temporary location are now subtracted from the entered remainder, and this divided by the contents of the second temporary store to give the result.

Remaining averages are obtained as for averages except that the difference between the entered stores and the totals are used rather than the total stores.

SAMPLE

When the timebase low byte becomes zero in the interrupt routine, the sample routine is entered. This is approximately eight times per second. If the lower three bits of the timebase high byte are also zero, i.e. every second, then the countdown flag is decremented. If it is now zero, the keyboard flag is set to zero. The main sample routine is entered. If the lower three bits are not zero, then if the start-stop active flag is not set, the sample routine is skipped. If either the flow or distance counts (instantaneous) is less than 2 the sample routine is skipped, otherwise the main sample routine is executed, as follows.

The instantaneous count for flow is divided by the difference between the start and stop numbers, the result being instantaneous flow. This is repeated for distance. The instantaneous counts are cleared. The input signals are thus measured for both frequency and period giving good resolution even at low frequencies.

START-STOP

There are three flags controlling start-stop operation, start-stop request/started, start-stop active and start-stop direction. The latter is set if the start number is greater than the stop number. The request flag is set when 'Enter', 'Stop' is entered from the keyboard and the active flag when 'Run' is pressed and the request flag is set.

If the active flag is clear, the start-stop routine is ignored.

If the request/started flag is set then the start store is used for the following comparison, otherwise the stop store.

The result is subtracted from the start or stop store and the sign of the result exclusive ORed with the start-stop direction flag. If the result of this is a '1' no further action is taken, otherwise:

If the request/started flag is set, it is cleared and the main totals reset to zero. The timebase and instantaneous counts are also reset.

If the request/started flag was clear, the hold flag is set and all start-stop flags are cleared. ★

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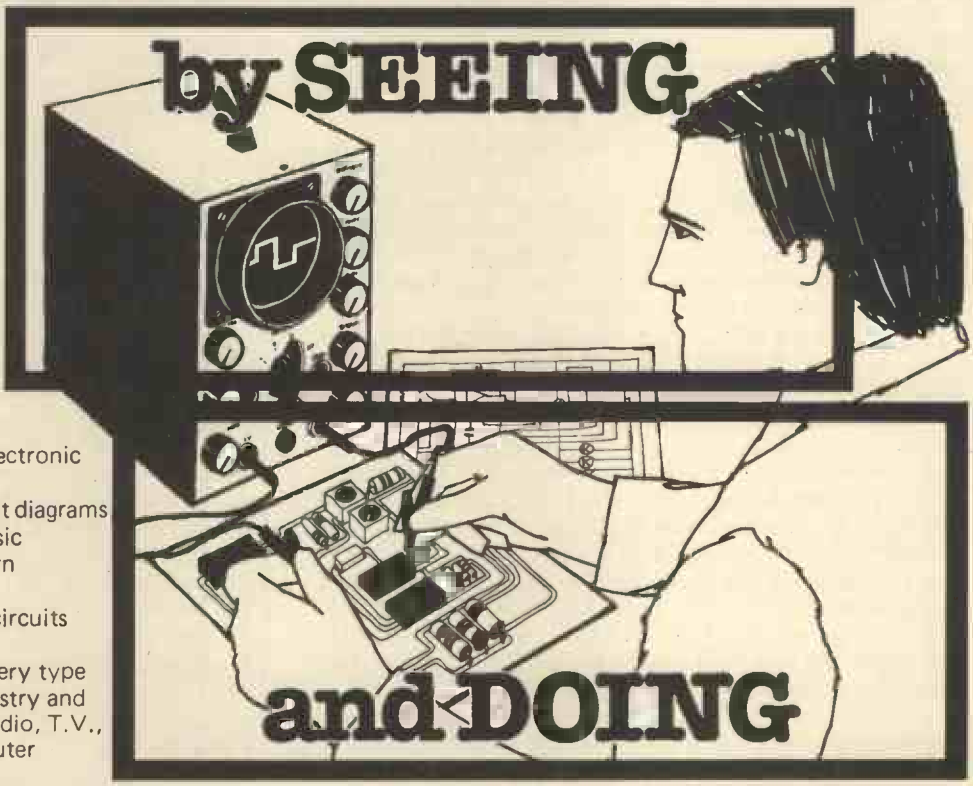

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LESLIE SIMULATION

CBS of New York has filed a string of European patent applications (under number 0 031 692) on an electronic circuit for simulating the sound of a Leslie loudspeaker, as often used to reproduce the sound of an electronic organ.

Figure 1 shows a loudspeaker of the Leslie type. The drive unit 10 rotates about a vertical axis while reproducing the sound. In the speaker position shown in Figure 1, no direct sound reaches the listener L; only sound reflected from the walls of the cabinet. As the speaker rotates towards position 2, the reproduced sound rises in pitch due to Doppler effect. At the same time direct sound starts to reach the listener so there is an increase in amplitude along with increase in perceived frequency. This continues up to a maximum at position 3. Further rotation away from position 3 towards position 4 produces a perceived decrease in frequency and amplitude. The term "pulsato" conveniently describes the combination of tremulo and vibrato which is heard. Conventionally there is a switched choice between slow pulsato, at 0·7Hz, and fast pulsato, at 7Hz.

Figure 2 shows the CBS electronic equivalent to this well known mechanical arrangement. A musical tone at input 20 is fed to variable delay device 22, which can be a bucket brigade delay line. The delay is driven by clock 24 which is under the control of a sine wave generator. This is adjustable between 1Hz and 7Hz for slow and fast operation. The control waveform is shown at Figure 3A.

The output of delay 22 is filtered at 28, to remove any clock pulses impressed on the signal, and the filtered output is shown at Figure 3B. As the delay 22 is modulated by the clock signal it causes the phase of the musical tone to advance and retard, making it sharp or flat with respect to the input. This mimics the Doppler effect created by a rotary speaker.

The frequency modulated signal (B) at the output of filter 28 is applied to the input of amplitude modulator 40. This is also controlled by sine wave oscillator 26. Modulator 40 provides 80% amplitude modulation of the frequency modulated signal B to produce a composite signal. As shown at Figure 3C the amplitude of this composite signal is maximum at the transitions from sharp to flat pitch and minimum at the transitions from flat to sharp pitch. The modulator 40 inverts the phase of the signal, and high frequency components are removed by filter 42. The filtered, amplitude-modulated signal (C) is summed at 46 with the constant amplitude, frequency-modulated signal B. Capacitor 54 transmits only the high frequencies of signal B for summing at 46 with the phase inverted signal C. So only high frequencies are amplitude modulated in summing circuit 46 by the AM, FM signals from modulator 40. This produces a composite envelope as shown in Figure 3D. Amplitude modulation of the higher frequencies is in opposite phase relative to that of the lower frequencies, and the percentage of modulation varies with frequency. This complex, amplitude-modulated, AM signal is reproduced by stationary speaker 50 and the less complex, FM signal is reproduced by stationary speaker 34. The overall effect, with acoustic summing of the two sound signals, is said to resemble that produced by a rotary Leslie system.

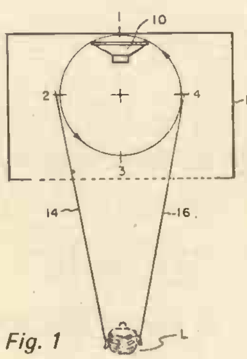


Fig. 1

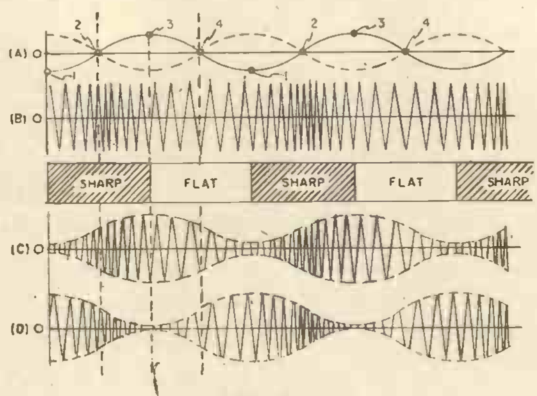


Fig. 3

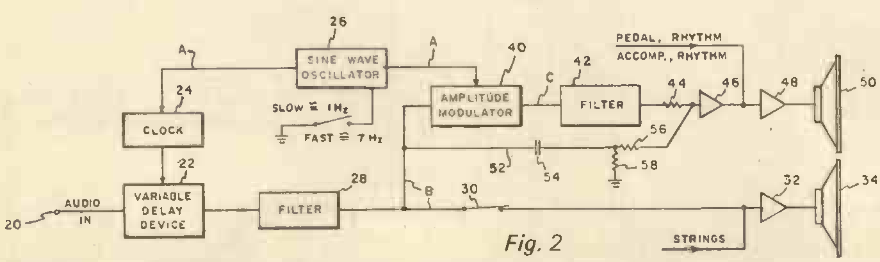
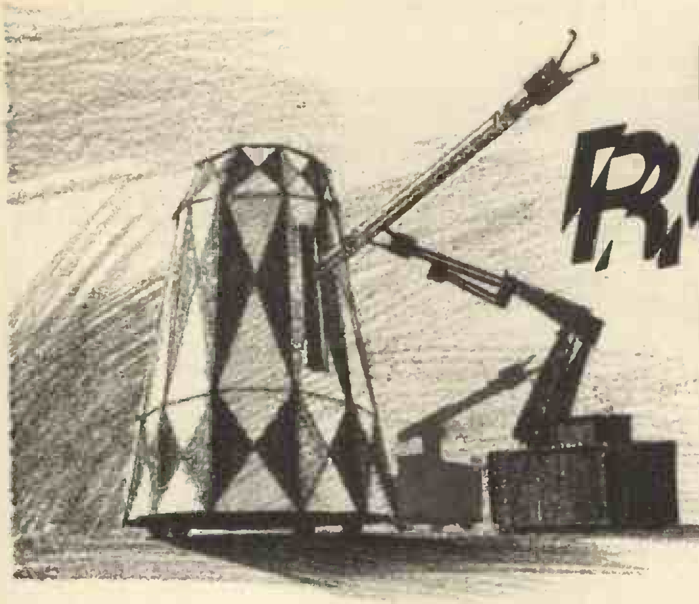


Fig. 2

BUY BRITISH!

The Director of Leeds Library reminds us that British, American, European and PCT patents can be inspected free of charge at public libraries in Birmingham, Glasgow, Leeds, Liverpool, Manchester and Newcastle, as well as in the libraries attached to the London Patent Office. This reminder follows our warning that it can be very expensive to purchase a copy of a lengthy foreign application: up to £20 each in the case of the two very bulky PCT patents applications on Robert Carver's power amplifier and sonic holography circuits. There is also another way of avoiding the high cost of purchasing foreign applications.

When the British equivalent application to a foreign patent is published it is of course possible to obtain a full copy of the British version for the standard price of just £1.45. The trick is to wait for the British version of lengthy foreigns. Take for instance the example of PCT 80/02219, the Robert Carver patent on sonic holography. The equivalent British patent application has now been published as no. 2 058 524. Although the British document is only a single printed page synopsis which cross references with the lengthy PCT case, the British Patent Office is obliged to provide a full photocopy of the PCT case for the all-in price of £1.45, instead of the £20 or so it would cost to obtain the same patent by ordering it under the PCT number!



PE ROBOTS

PART 3

RICHARD BECKER · TIM ORR

THE MOTOR control boards which fit on the wheel base of the M101, control the two 1/10 h.p. 12 V motors which provide its motive power. The controls implemented by these boards are forward, reverse, stop and variable speed. .

DISPLAY BOARD

This gives a visual indication of the microprocessor's control mode and an audible indication of incoming data.

POSITION DETECTOR BOARD

This is the only electronics inside the bases of the Genesis S101, P101 robots. It is used to suppress mains hum and generally improve the signal from the position detector coils sending it at low impedance to the interface board.

MANUAL CONTROL KEYBOARD

All the position control and programming switches fit to this unit. Information from it is either by infra-red link for the M101 or by wire link for the S101 and P101.

RECEIVER

This detects the infra-red transmissions sent to the M101 mobile machine.

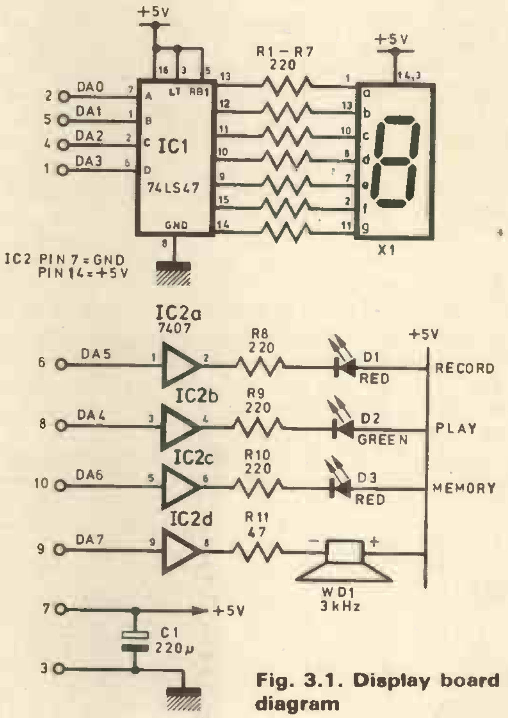


Fig. 3.1. Display board circuit diagram

CONTROL LOGIC		
A	B	FUNCTION
0	0	FORWARD
0	1	REVERSE
1	0	STOP
1	1	STOP

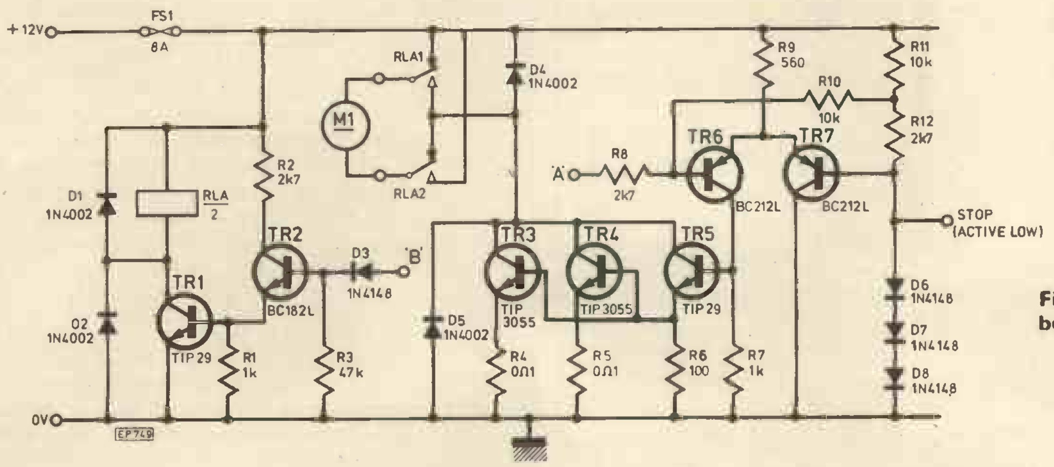


Fig. 3.2. Motor driver board circuit diagram

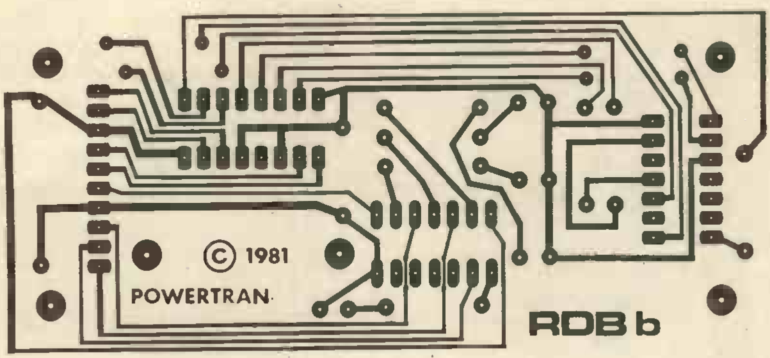


Fig. 3.3. Display board p.c.b. (actual size)

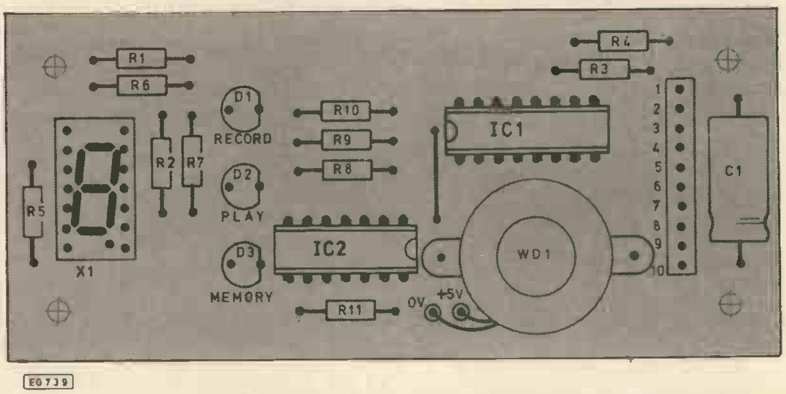


Fig. 3.4. Display board component layout

BOARD PIN No.	10 WAY MOLEX NUMBER	SIGNAL NAME	WIRE	COLOUR
1	M5–9	DA3	7/0.2	WHITE
2	M5–3	DA0	7/0.2	ORANGE
3	M5–10	GND	7/0.2	BLACK
4	M5–7	DA2	7/0.2	MAUVE
5	M5–5	DA1	7/0.2	GREEN
6	M5–6	DA5	7/0.2	BLUE
7	M5–1	+5V	7/0.2	BROWN
8	M5–8	DA4	7/0.2	GREY
9	M5–2	DA7	7/0.2	RED
10	M5–4	DA6	7/0.2	YELLOW

* CABLE LENGTH 12". USE 6mm SLEEVING

DISPLAY BOARD

Refer to Fig. 3.1. The seven segment display which indicates the memory page number (0 to 7) is driven by decoder IC1. An open collector TTL buffer drives l.e.d.s indicating such functions as RECORD, PLAY, MEMORY ($\frac{3}{4}$ full) and motor control. The bleeper announces the arrival of data.

MOTOR CONTROL

Refer to Fig 3.2. The wheel base is driven by two independently operated 1/10 h.p. motors equipped with special shafts in direct contact with the rubber wheels. The gearing is by virtue of the difference in diameter of the shaft and the wheel. Steering is accomplished by operating the motors at different rates. The castors are not driven and are for stabilisation of the wheel base only.

There is one control board per motor, which is a 12V d.c. 90 watt device. When the motor is turned on, the initial current is 15 amps, falling to 7·5 amps after 0·3 seconds. This hefty current is handled by power transistors TR3 and TR4. On/off control is a TTL signal (A). Motor reversal is produced with a changeover relay, again under TTL control (B). The motor speed is controlled using mark/space modulation with a period of about 40ms. The control box has two motor controls. One is forward-stop-reverse, and the other is steering. Both controls are specified with a three bit code. The software decodes these two parameters and generates the appropriate B signals and mark/space modulated A signals. When no control data is received by the interface board a stop signal is generated which turns off both motors. This prevents the mobile unit travelling beyond its reception range.

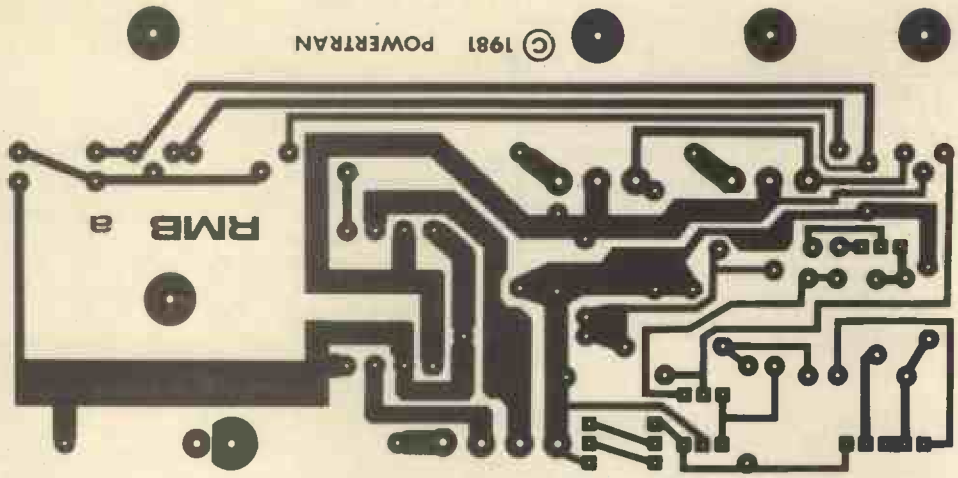


Fig. 3.5. Motor Control board p.c.b. (actual size)

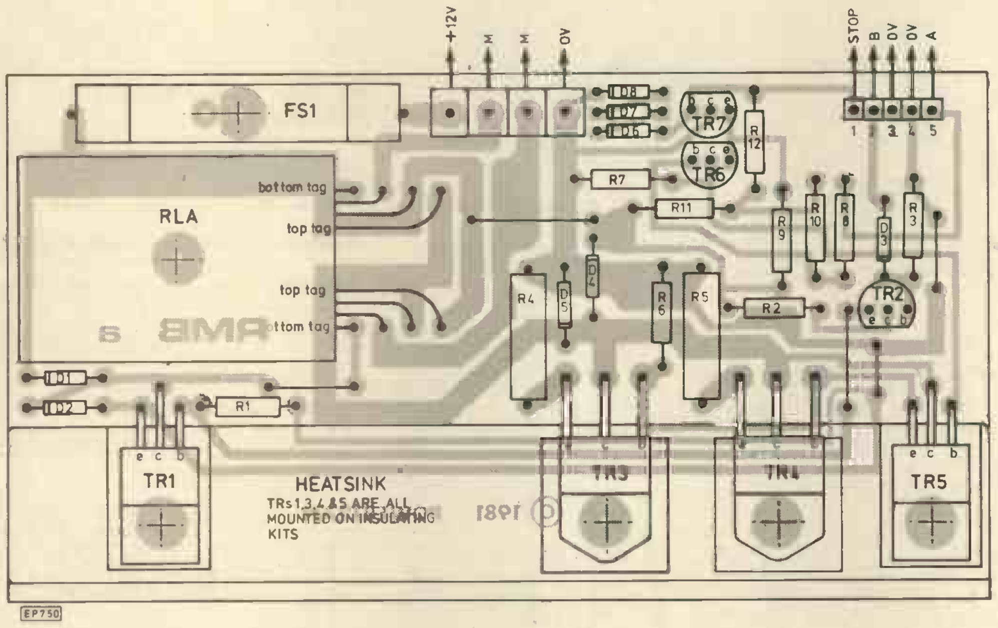
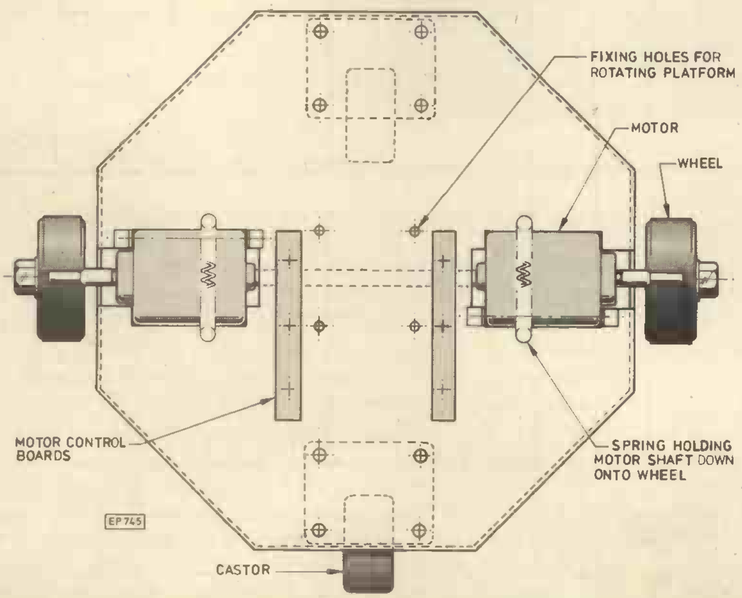


Fig. 3.6. Motor Control board component layout



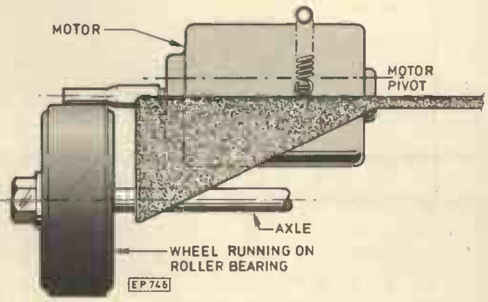


Fig. 3.7. Two views of the motorised wheel base of the M101

COMPONENTS . . .

MOTOR CONTROL (2 off on mobile unit only)

Resistors
R1, R7 1k (2 off)
R2, R8, R122k7 (3 off)
R3 47k
R4, R5 100m 2W (2 off)
R6 100
R9 560
R10, R1110k (2 off)

Transistors and Diodes
D1, D2, D4, D51N4002 (4 off)
D3, D6–81N4148 (4 off)
TR1, TR5TIP29 (2 off)
TR2 BC182L
TR3, TR4TIP 3055 (2 off)
TR6, TR7BC212L (2 off)

Miscellaneous
Printed circuit board RMBa
p.c.b. mounting fuse holder
8A fuse
4-way screw terminal
Relay 2p-2w, 10A contacts
5-way Molex p.c. terminals
Heatsink bar (special product)
6BA pan head $\frac{1}{2}$in. plus nut (4 off)
Insulating kit for TIP 3055 (2 off)
Insulating kit for TIP29 (2 off)

DISPLAY BOARD

Resistors
R1–10 220 (10 off)
R11 47

Capacitors
C1 220μ/10V

Diodes and Displays
D1, D3 Red l.e.d. 0·2in. (2 off)
D2 Green l.e.d. 0·2in.
X1 Common anode 7-segment

Integrated Circuits
IC1 74LS47
IC2 7407

Miscellaneous
Printed circuit board
WD 1 audible warning device PB2130
10-way lead (10 x 7/0·2)
10-way Molex shell 6471-10
Crimp terminals 4809TL
7/0·2 wires
6mm p.v.c. sleeving

	← ON
S4 NORMAL	TEST E19–TRISTATE T
S3 NORMAL	TEST E20–TRISTATE T
S2 NORMAL T S+SOLENOIDS ON	T S+SOLENOIDS OFF
S1 NORMAL T S– SOLENOIDS ON	T S– SOLENOIDS OFF

Fig. 3.8. Signal and axis directory

AXIS No. DRIVE COIL	0 DC0	1 DC1	2 DC2	3 DC3	4 DC4	5
DETECTOR COIL Molex M8 connection	D0 M8–8	D1 M8–5	D2 M8–4	D3 M8–10	D4 M8–1	
MUX PIN (E25)	13	14	15	12	1	
M101 MOBILE – AXIS	ROTATE * LEFT	RETRACT *	DOWN *	WRIST * CCW	HAND OPEN	NONE
M101 MOBILE + AXIS	ROTATE * RIGHT	EXTEND *	UP *	WRIST * CW	HAND CLOSED	NONE
S101 STATIC – AXIS	ROTATE * LEFT	RETRACT *	DOWN *	WRIST * CCW	HAND OPEN	NONE
S101 STATIC + AXIS	ROTATE * RIGHT	EXTEND *	UP *	WRIST * CW	HAND CLOSED	NONE
P101 STATIC – AXIS	ROTATE * LEFT	SHOULDER * ↓	ELBOW * ↓	WRIST * ↓	WRIST * CCW	HAND OPEN
P101 STATIC + AXIS	ROTATE * RIGHT	SHOULDER * ↑	ELBOW * ↑	WRIST * ↑	WRIST * CW	HAND CLOSED
SOLENOID + DRIVE MOLEX No.	S0+ M3–8	S1+ M3–10	S2+ M2–8	S3+ M2–1	S4+ M2–3	S5+ M2–5
SOLENOID – DRIVE MOLEX No.	S0– M3–9	S1– M2–7	S2– M2–9	S3– M2–2	S4– M2–4	S5– M2–6

* Indicates position feedback

POSITION DETECTOR BOARD

The first stage of the position detector electronics provides a signal gain of 20dB (times 10). The second stage is a 100Hz high pass filter that suppresses any picked-up mains hum (50Hz) by 12dB (a factor of 4) relative to the 100Hz feedback signal. The output signal is typically a sinewave that varies in amplitude from 160mV p.p. to 1·6V p.p. as the hydraulic actuators move over their full range. This signal is then fed to the interface board where it is turned into a d.c. voltage. See Figs. 3.9, 3.10 and 3.12.

MANUAL CONTROL KEYBOARD

This hand-held controller provides up to 27 push-button commands plus two analogue channels for use with the mobile M101 to which data is transmitted by infra-red whilst the S101 and P101 use a 4-core cable link. See Figs. 3.13 and 3.14.

E10 is an oscillator set to run at 2KHz. E4 divides this frequency by two and generates complementary squarewave outputs. These are differentiated and then squared up by the Schmitt triggers E5 thus producing complementary marker and data pulses. The data pluses drive a binary counter E3, which then drives row and column multiplexers (E2 and E1). This causes the keyboard switches to be sequentially scanned. When a key is pressed data pertaining to that key will appear at E2 pin 3. The timing diagram shows that there are 64 data pulses per complete scan of the unit. The first 40 are reserved for push buttons (only 27 are used), next come two blocks of 8 that are used for analogue to digital conversion and the last block of 8 is a sync period. The ADC units operate by comparing a ramp waveform with the d.c. voltage that is to be digitized. When the ramp voltage exceeds the d.c. voltage the output of the comparator E8 goes high and appears at the $\bar{Q}$ output of E9 on the next marker clock pulse. As the d.c. voltage is varied the ADC will produce zero to 8 data pulses in its respective time slot. E6 and E7 combine the keyboard and ADC data with the marker pulses and the sync period. The M101 unit uses infra red diodes to transmit the data. The diodes need current pulses of about 1 to 2 amps and so a Darlington transistor pair had been used (TR1, TR2).

Two component layouts are given (next month), one for the M101 unit and one for the S101 and P101 units neither of which have ADCs or an infra-red link.

HAVE A BISCUIT

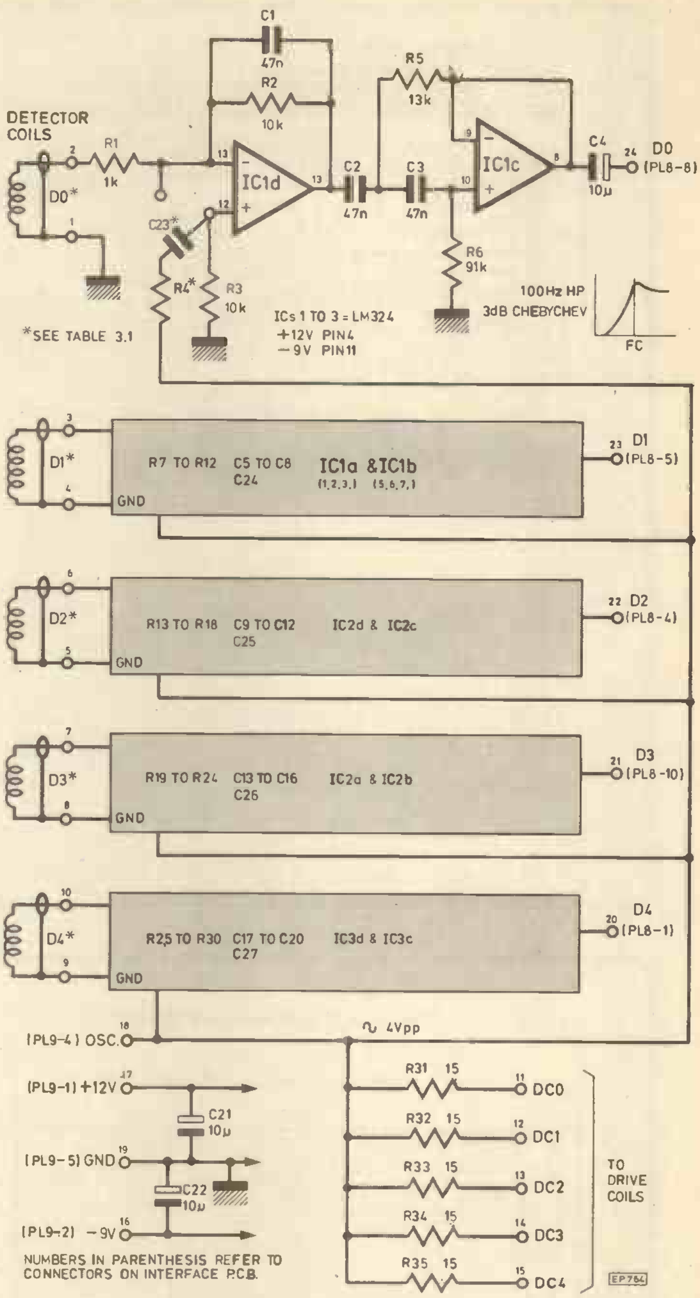
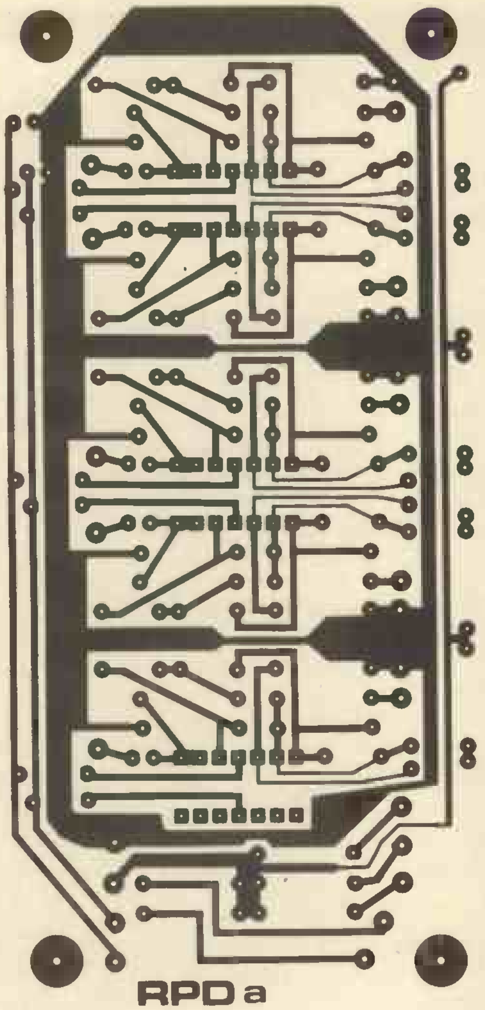


Fig. 3.9. Position Detector board circuit diagram

Fig. 3.10. Component values for Position Detector board

Axis	M101, S101	P101
D0	C23 = 3n3 R4 = 220k	C23 = 3n3 R4 = 220k
D1	C24 = 4n7 R10 = 220k	C24 = 3n3 R10 = 130k
D2	C25 = 2n2 R16 = 220k	C25 = 3n3 R16 = 130k
D3	C26 = 1n5 R22 = 220k	C26 = 1n5 P22 = 220k
D4		C27 = 1n5 R28 = 220k



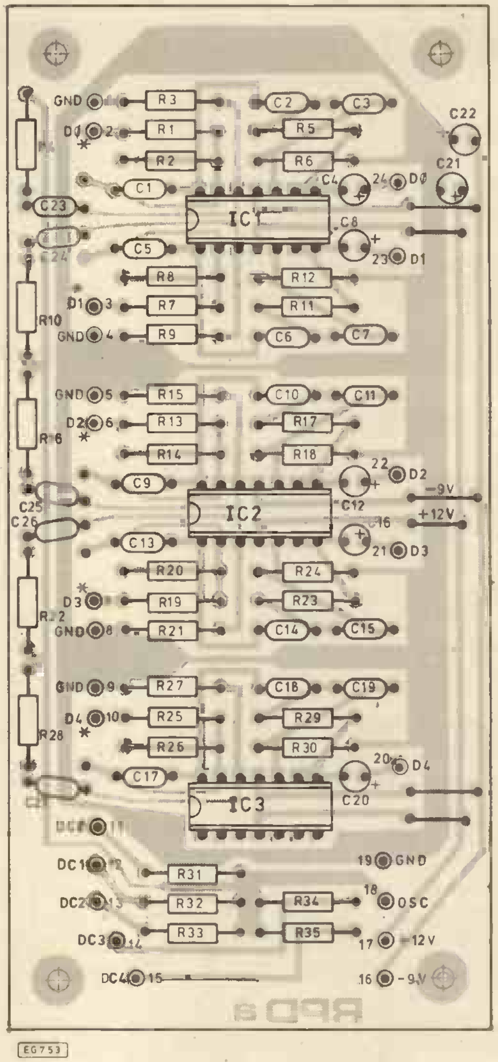
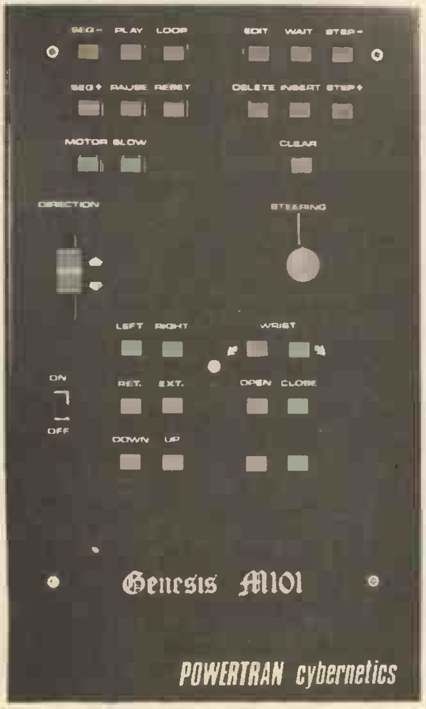
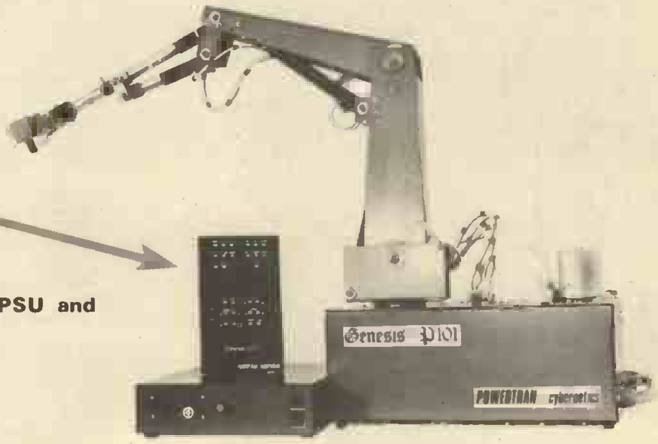


Fig. 3.11. (top left) Position Detector board p.c.b. (actual size)

Fig. 3.12. (top right) Position Detector board component layout





The P101 with its PSU and controller

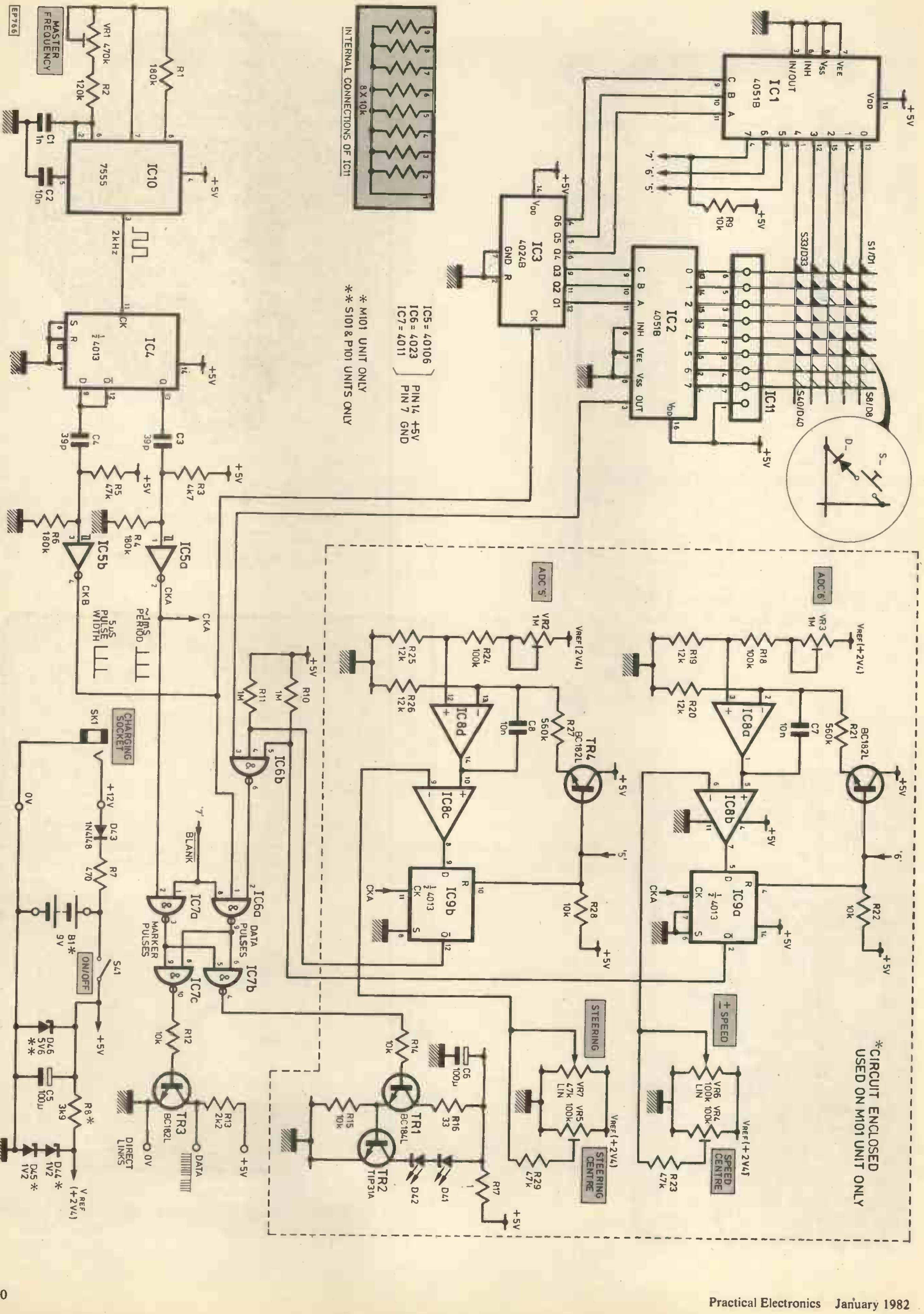


Fig. 3.13. Manual control keyboard

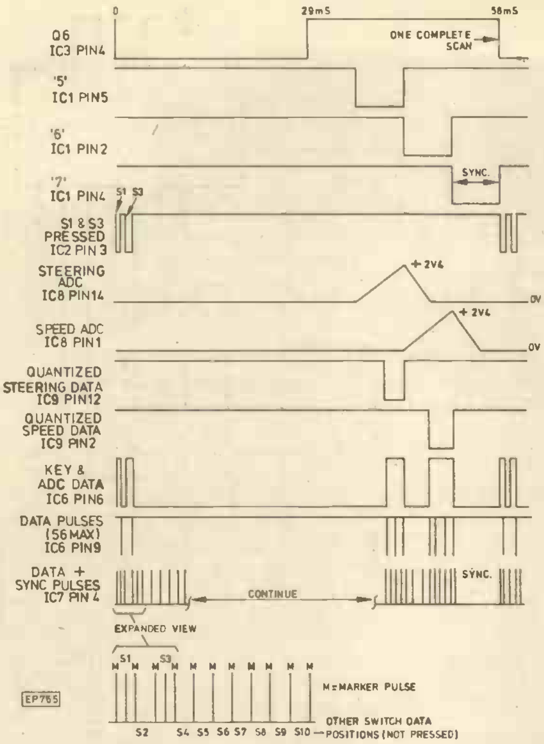
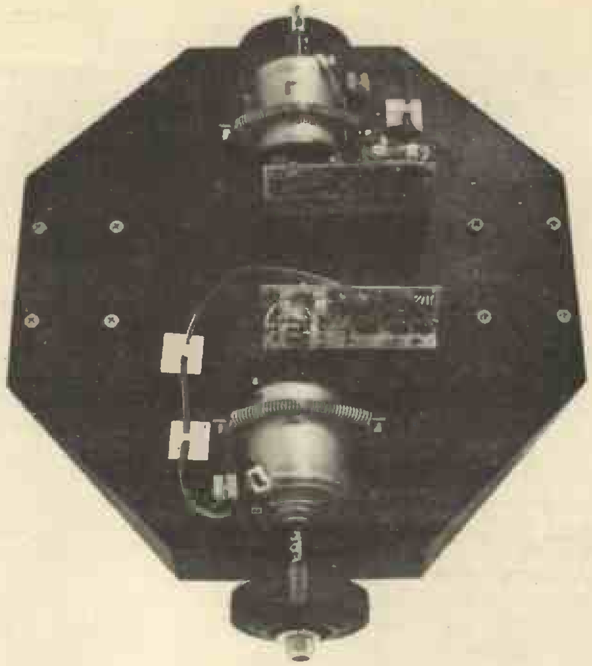


Fig. 3.14. Timing diagram for manual control keyboard



To clear a sequence, enter reset mode (if not already in this mode), and select the required sequence number. Hold down the CLEAR button; whilst holding this button down, momentarily press the EDIT button, then release the CLEAR button. The unit responds by bleeping and flashing the display.

DIRECT SOLENOID CONTROLLER

It is possible to control the robots directly without any electronics by use of this board. Switches S1–S12 are used to turn on the Darlington drivers E1–E4 which supply the power to the solenoid operated valves.

INFRA-RED RECEIVER (next month)

The infra-red pulses are detected by two reverse biased diodes (D3, D4). The signal from these diodes is amplified by E1, and level shifted by the first part of E2. The second part of E2 is a voltage comparator which is used to recover the original pulses from somewhat noisy infra-red signal. The data is then sent to the decoding section on the interface board. TR4 and TR5 turn on the l.e.d. (D5) when data is being received.

MICROPROCESSOR SECTION: HOW THE CONTROLS WORK (next month)

On power up the bleeper sounds five times, the play and record l.e.d.s go off, and the sequence number indicates zero. The controller is now in reset mode. Only from this mode can the sequence number be changed or can the current sequence be cleared.

Reset mode can always be reached by pressing the RESET button.

CHANGING THE SEQUENCE NUMBER (RESET MODE ONLY)

Pressing the SEQ+ button will advance the indicated sequence number (up to 7). Pressing the SEQ– button will decrement the indicated sequence number (down to Ø).

For correct functioning of a new unit (or one in which the CMOS memory had been powered down) it is necessary to clear each sequence memory before you attempt to record a sequence.

COMPONENTS . . .

POSITION DETECTOR BOARD

Resistors

R1,R7,R13,R19,R25	1k (5 off)
R2,R3,R8,R9,R14,R15,R20,R21,R26,R27	10k (10 off)
R5,R11,R17,R23,R29	13k (5 off)
R6,R12,R18,R24,R30	91k (5 off)
R31–35	15 (5 off)

For R4,R10,R16,R22 and R28 see Fig. 3.10
All resistors ¼W 5%

Capacitors

C1–C3, C5–C7, C9–C11, C13–C15, C17–19	47n (15 off) (Siemens B32560 type)
C4,C8,C12,C16,C20 C21,C22	10u elect. (7 off)

For C23–27 see Fig. 3.10 (should be Siemens B32560)

Integrated circuits

IC1–3	LM324 (3 off)

Miscellaneous

Printed circuit board RPD
14 pin sockets for i.c.s (3 off)

NEXT MONTH: Manual control and manual control board electronics

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.

IN THIS month's Micro-Bus the emphasis is on graphics. Two novel hardware modifications for the Acorn Atom provide noise-free graphics, with virtually no loss in speed, and a previously inaccessible eight-colour graphics mode. Also featured are two graphics programs for the ZX81.

NOISE-FREE ATOM GRAPHICS

When the Atom's 6502 processor accesses the video memory, screen interference is produced in the form of white specks. The following simple hardware modification completely removes this problem, producing interference-free video-RAM access. It was discovered by *Chris Dunning* of Bristol who writes:

"The 6502 processor used in the Acorn Atom only accesses memory when its Ø0 clock is high, so if the video output circuit is arranged so that it only accesses memory when Ø0 is low the micro and the video controller will never clash for memory access and no interference will be produced on the screen.

"To achieve this on the Atom carry out the following modifications, shown in Fig. 1:

1) Solder a wire link across C10.
2) Remove that 4MHz crystal.
3) Connect a wire from pin 8 to IC9, the inverted 3·58MHz clock used by the 6847 CRT controller.
4) Connect the other end of this wire to the hole left by removing the crystal, which is connected to pin 3 of IC45.

The effect of these modifications can be shown most strikingly by the following test. Before making them, assemble and execute the following machine code in the screen memory by typing:

```
P = #8000
[JMP P
LINK P-3
```

The text will become completely masked by screen noise produced by accessing the graphics memory. Repeating the test after having made the modifications gives a perfectly clear screen, with no noise.

"Since the micro's Ø0 clock is now 0·895MHz instead of the previous 1MHz the cassette interface is no longer CUTS standard; this is presumably why the Atom uses independent crystals for the display and the processor. You could of course re-record all your programs at the new frequency, or the modification can be made switchable. The best way to do this is probably to cut the track to pin 13 of IC44 and connect this via a changeover switch to pin 2 of IC45 (with C10 and the crystal still in place) and pin 8 of IC9; see Fig. 2. The switch can now be used to change the clock to 1MHz for reading tapes or 0·895MHz for clean graphics. Note, however, that you should always hold down the break key when operating the switch or the contents of memory may become corrupted."

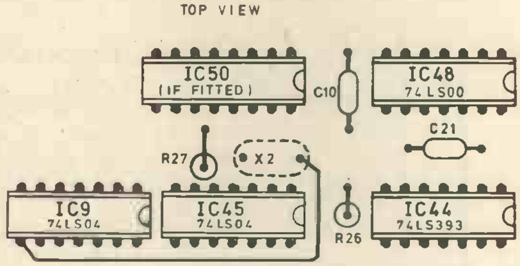


Fig. 1. Modifications to the Acorn Atom give noise-free graphics

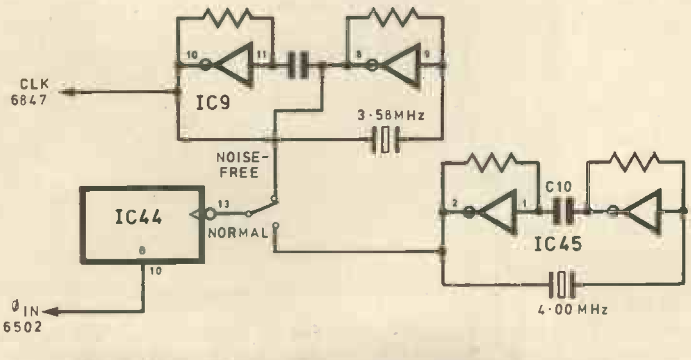


Fig. 2. Modification to the Atom switches between noise-free graphics and full-speed operation

NEW ATOM GRAPHICS MODE

The second of this month's hardware modifications to the Acorn Atom computer shows how to plot in an eight-colour graphics mode. This mode is provided by the 6847 Video Display Generator chip, and is called the "Semigraphics Four" mode; it is not directly accessible on the Atom, but can be obtained with two simple circuit modifications.

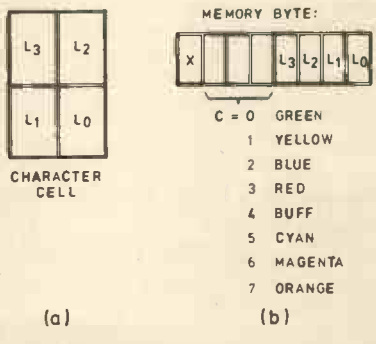


Fig. 3. Eight-colour graphics mode: (a) character-cell pixel arrangement; and (b) corresponding memory byte

The mode, which will be referred to as "0a", uses the same arrangement of character cells as the text mode. The character cell is divided into four elements, as in Fig. 3(a), and each of the four elements can be "on" or "off", as determined by the states of the lower four bits of the corresponding byte in memory. The next three bits determine the colour of the elements that are "on", as shown in Fig. 3(b). All the elements in one character cell have to be the same colour, or black, and with this restriction mode 0a provides nine-colour graphics (counting black) with a resolution of 64 x 32.

HARDWARE MODIFICATION

To access the eight-colour graphics mode the following modifications should be made to the Atom circuit board:

1) Remove the 6847, IC31, from its socket.

2) If the i.c. socket gives access to the printed circuit board beneath it, locate the track which links pins 31 and 34 to pin 2 (on the component side of the board). Make two cuts in this track, as close as possible to pins 31 and 34, to isolate these pins from the circuit. Replace IC31.

3) Alternatively, bend pins 31 and 34 of the 6847 outwards, and replace the i.c. into its socket with these pins sticking out sideways.

4) Connect a wire from pin 31 if the i.c. (INT/EXT) to pin 1 (earth).

5) Connect a wire from pin 34 of the i.c. (A/S) to pin 39 (CSS)

The normal switch-on mode will be text, as before; to obtain the new graphics mode type:
? # B002 = 8
This takes pin 34 on the 6847 VDG high and gives the new mode. The low-resolution graphcs characters are now not accessible; however, if required, a switch could be inserted to give a choice of either mode.

PLOTTING POINTS

A BASIC routine 'p' to plot points in mode 0a is shown in Fig. 4, lines 100 to 110. The coordinates are passed to the routine in variables X and Y, where X = 0, Y = 0 corresponds to the bottom left-hand corner of the screen, and X = 63, Y = 31 is the top right-hand corner of the screen. The value of C determines the colour in which the point is plotted, and this can have the values 0 to 7 as shown in Fig. 3(b). Note that plotting a point of one colour in the same character cell as another point will set both points to the last colour.

```
 10 DIM(W3)
 20 !W=#4080102
 30 CLEAR 0; ?#B002=8 .
 40 FOR U=-31 TO 31; FOR V=-15 TO 15
 50 C=((U*U+V*V)/80)&7; X=U+31; Y=V+15
 60 GOSUB p; NEXT; NEXT; DO UNTIL 0
100pP=X/2+(31-Y)/2*32+#8000; ?P=(?P&#F)+C*16
110 ?P=?P|W?(X&1+Y&1*2); RETURN
```

Fig. 4. Atom program plots circles in the eight-colour graphics mode

To clear to mode 0a the statements:
CLEAR 0; ? # B002 = 8
can be used. Note that pressing escape will not reset the graphics mode to the text mode; to do this it is necessary either to type:
? # B002 = 0
or to press **BREAK** followed by typing OLD to retrieve the program.

The **BASIC** plotting routine could be converted into machine-code and patched into the Atom's graphics to give fast line drawing in the new mode.

COLOURED CIRCLES

As an example of the use of this routine the program in Fig. 4, lines 40 to 60, draws a series of concentric coloured circles. The equation in line 50 gives a number whose value depends on the distance from the centre of the screen; this value is then used to select the colour for plotting. The resulting display, shown in Fig. 5, is very colourful, although the black-and-white photograph does not really do justice to it.

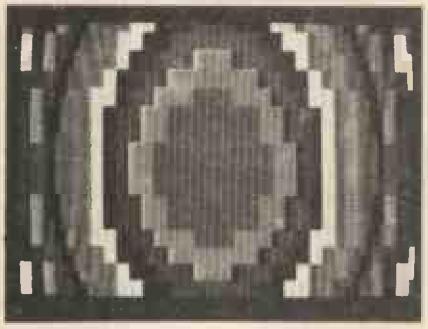


Fig. 5. Display produced by the program of Fig. 4

LINES ON ZX81

Drawing a straight line between any two points is one of the fundamental graphics operations. The subroutine of Fig. 6 devised by *S. J. Duggins* of Birmingham performs this operation in just seven statements, improving over the routine given in the ZX81 manual (on page 121) which takes 26 statements.

```
9000 LET L=INT(0.5+(SQR(ABS(X2-X
1)**2+ABS(Y2-Y1)**2)))
9005 FOR A=0 TO L
9010 LET X=(X2-X1)*A/L
9020 LET Y=(Y2-Y1)*A/L
9030 PLOT X1+X,Y1+Y
9040 NEXT A
9050 RETURN
```

Fig. 6. ZX81 routine plots a line between X1, Y1 and X2, Y2

The two points between which the line is to be drawn are supplied to the program as variables X1, Y1 and X2, Y2, where X1>= 0, X2<= 63, Y1>= 0 and Y2<= 43. The number of plotting points between the end-points is first calculated as L (line 9000). To plot the points two separate linear equations are used, one for the X direction and one for the Y direction.

ZX81 ETCH-A-SKETCH

The program shown in Fig. 7 was submitted by *G. Wheaton* of Bolton, and turns the 1K ZX81 into an etch-a-sketch machine so that designs can be drawn using the cursor-movement keys 5, 6, 7 and 8. Mistakes can be rectified by pressing the 0 (rubout) key, and plotting resumed by pressing the 1 key. Diagonal lines are possible by careful use of the 0 and 1 keys between plotting.

```
 10 LET N=10
 20 LET X=0
 30 PLOT N,X
 40 IF INKEY$="8" THEN LET N=N+1
 50 IF INKEY$="5" THEN LET N=N-1
 60 IF INKEY$="6" THEN LET X=X-1
 70 IF INKEY$="7" THEN LET X=X+1
 71 IF INKEY$="0" THEN GO TO 90
 72 IF N>30 THEN LET N=30
 74 IF N<0 THEN LET N=0
 76 IF X>30 THEN LET X=30
 78 IF X<0 THEN LET X=0
 79 UNPLOT N,X
 80 GO TO 30
 90 PLOT N,X
 95 UNPLOT N,X
100 IF INKEY$="1" THEN GO TO 30
110 IF INKEY$="8" THEN LET N=N+1
120 IF INKEY$="5" THEN LET N=N-1
130 IF INKEY$="6" THEN LET X=X-1
140 IF INKEY$="7" THEN LET X=X+1
150 GO TO 90
```

Fig. 7. Etch-a-sketch program for the ZX81 uses the cursor controls to draw pictures

The program should be fairly self-explanatory. Plotting is performed by lines 30 to 80, and unplotting by lines 90 to 150. When unplotting the cursor flashes (lines 90 and 95) to indicate its position.

HORSE-RACE ADDENDA

"The Horse-Race program for the Mk14 VDU in August's Micro-Bus is excellent, once it works!" writes *W. R. Osborne* of Tyne and Wear, who has pointed out some misprints. Three jump offsets are incorrect, and should be altered as follows:
AD2 should read E1 not D1
AD8 should read 0D not 0C
ADE should read 07 not 0C

Also, the XPPC 3 at the end of the program does not return to the monitor, since P3 is altered in the program. The code shown in Fig. 8, added to the end of the program, overcomes this problem and also displays the number of the winning horse; hitting any key (except ABORT) then runs the game again. To run the modified game GO to 0B4B.

```
0B39 C4 0F 36 C4 00 32 C4
0B40 01 37 C4 3F 33 40 CA 0D
0B48 3F 08 08 C4 00 36 C4 0F
0B50 36 32 C4 00 CE 01 32 9C
0B58 F8 C4 0A 35 C4 A0 31 3D
```

Fig. 8. Addition to the Mk14 Horse-Race game displays the number of the winning horse

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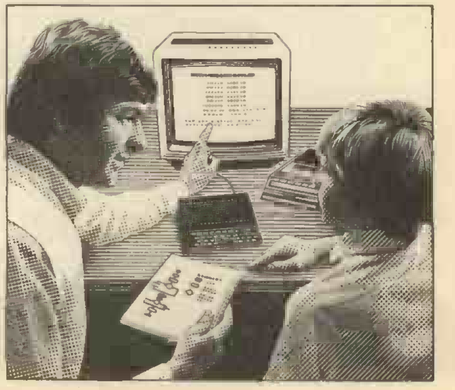

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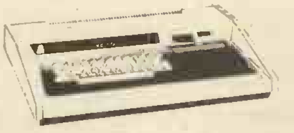
Expansion box without/with RS232 **£179/£209**. Disk drive **£205**. 16K-32K ram board **£93/£128**. Colourboard **£34.95**. Parallel printer interface **£32**. Write for free software list.



SINCLAIR PRODUCTS
SC110 Oscilloscope **£139**. PFM200 **£49**. PDM35 **£32.95**. DM235 **£53**. DM350 **£72**. DM450 **£116**. Microvision TV **£69**.
BATTERY ELIMINATORS*
3-way type 6/7, 5/8V 300ma **£3.50**. 100ma radio types with press studs **9V £4.95**. **9+9V £6.25. Car convertor 12V input, output 3/4, 5/6/7, 5/9V 800ma £3.04.**
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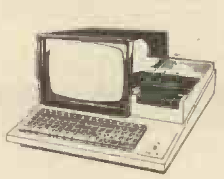
TV GAMES*
AY-3-8600 + kit **£12.98**. AY-3-8550 + kit **£9.26.**
SHARP COMPUTERS
MZ80K 20K **£380**, 36K **£394**, 48K £4.08, PC1211 **£82**.



PRINTERS

Buy any of the below and get a free interface kit and work processor program for UK101 or Superboard:– Eprom MX70 **£259**. Epson MX80F/T2 **£449**. Epson MX200 **£575**. OKI Microline 80 **£295**. OKI Microline 82A **£399**. OKI Microline 83A **£699**. Centronics 737 **£365**. Seikosha GP80A **£199**.

BI-PAK AUDIO MODULES*
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VIC 20 COMPUTER
£173 with free cables to suit normal cassette recorders.

SWANLEY ELECTRONICS,
Dept. PE, 32 Goldsel Rd.,
Swanley, Kent BR8 8EZ.
Tel. Swanley (0322) 64851.

*Postage £3.50 on computers, £4.50 on printers and 45p on other orders. Lists 27p post free. Please add VAT to all prices except those sections marked with a * which already include it. Overseas and official credit orders welcome.*

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MAPLIN for ATARI

ATARI

AUTHORISED DEALER

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Maplin Electronic Supplies Ltd PE/1/82
P.O. Box 3, Rayleigh, Essex.
Tel: Southend (0702) 552911/554155

Note: Order codes shown in brackets.
All prices include VAT & shipment by datapost.
(Errors excluded).

What CB?

Guide to Legal Rigs

This guide covers all the currently available legal rigs we could find. Please note that the prices quoted are only intended as a guide and will vary depending upon the supplier.

The DNT range of rigs which are marketed by Radiotechnic Ltd., Bel Royal, St Lawrence, Jersey C.I. include the B40 FM (top left), the F40 FM (top right), the HF13/40 (bottom left) and the HF12/3 (bottom right)

The Cybernet Beta 1000, 2000, 3000. Goodmans Loudspeakers Ltd., Downley Road, Havant, Hants

The Radiomobile 201 and 202. Radiomobile Ltd., Goodwood Works, North Circular Road, London NW2 7JS

The M2 mobile and the Diplomat 40 base station. John Woolfe Racing, Electronics Division, Woolfe House, Norse Road, Bedford

What CB?

Guide to Legal Rigs

The CB900 and CB901. Amstrad Consumer Electronics Ltd., 1–7 Garman Road, Tottenham, London

The Reftec 934 is a 20 channel for 934 MHz. RF Technology Ltd., Leyton Avenue Industrial Estate, Mildenhall, Suffolk

The Realistic TRC-2000

The JCB 863 from York which is marketed by Sulkin (UK) Ltd., 73 Grosvenor Street, London W1X 9DD

The Realistic TRC-1001

The Midland 2001 (top), the 3001 (left), and the 4001. Midland Telecom, 133 Flaxley Road, Stechford, Birmingham B33 9HQ

The Realistic TRC-2001. The Realistic range of rigs is available from all Tandy stores

NAME	MODEL	PRICE	FREQUENCY (MHz)	No. OF CHANNELS	SQUELCH	DIS/LOC SWITCH	HIGH-LOW SWITCH	CHANNEL FREE LED	S/RF POWER LED	Tx LED	Rx LED	PA FACILITY	TONE CONTROL	CHANNEL 9 SWITCH	RF GAIN CONTROL	S/RF POWER METER	Ex SPEAKER SOCKET	MIC GAIN
AMSTRAD	CB 900	79·95	27	40	•				•	•	•		•		•		•	
	CB 901	89·95	27	40	•				•	•	•	•	•	•	•		•	
BINATONE	LONG RANGER 6	59·95	27	6	•		•					•				•	•	
	LONG RANGER 12	69·95	27	12	•		•					•				•	•	
	SPEEDWAY	79·95	27	40	•											•	•	
	ROUTE 66	89·95	27	40	•		•			•	•	•				•	•	
	5-STAR	99·95	27	40	•		•					•	•	•	•	•	•	•
	BREAKER PHONE	109·95	27	40	•		•			•	•	•					•	•
CYBERNET	BETA 1000	70·00	27	40	•				•								•	
	BETA 2000	80·00	27	40	•	•			•	•	•	•	•				•	
	BETA 3000	95·00	27	40	•	•			•	•	•	•	•	•	•		•	
DNT	HF 12/3 FM	41·50	27	3	•													
	HF 13/40 FM	70·50	27	40	•					•						•		
	M40 FM	85·50	27	40	•	•	•	•		•						•	•	
	B40 FM	95·50	27	40	•	•	•	•		•						•	•	
FIDELITY	CB 1000 FM	69·00	27	40	•											•	•	
	CB 2000 FM	89·00	27	40	•							•	•	•	•	•	•	•
GRANDSTAND	BUZZING BEE	64·95	27	40	•		•			•	•				•	•	•	
	HAWK	74·95	27	40	•		•			•	•				•	•		
	BLUE BIRD	89·95	27	40	•		•		•					•				
	GEMINI	122·95	27	40	•		•		•	•		•			•			
	BASE STATION	249·95	27	40	•		•			•		•	•		•	•		
HARRIER	CB	79·99	27	40	•					•						•	•	
	CBX	109·99	27	40	•					•	•	•	•	•	•	•	•	•
	CB-HQ	149·99	27	40	•					•	•		•	•	•	•		
JWR	M2	74·95	27	40	•		•			•		•				•	•	
	DIPLOMAT 40	165·00	27	40	•		•	•					•	•	•	•	•	
MIDLAND	75-720	59·95	27	3	•					•								
	77-810	72·95	27	40	•					•								
	2001	69·95	27	40	•					•		•				•	•	
	3001	79·95	27	40	•	•						•			•	•	•	
	4001	89·95	27	40	•	•				•		•			•	•	•	•
	79-200	149·95	27	40	•		•									•	•	
MODUS	PE RANGER	59·95	27	6	•					•							•	
RADIO-MOBILE	CB 201	90·00	27	40	•			•									•	
	CB 202	120·00	27	40	•				•	•	•	•	•	•	•		•	
REFTEC	MTR 934-1	200·00	934	20	•					•	•						•	
TANDY	TRC-1001	119·95	27	40	•		•									•	•	
	TRC-2000	99·95	27	40	•					•		•			•	•	•	•
	TRC-2001	79·95	27	40	•					•		•				•	•	
TRANSCOM	GBX 2000	69·95	27	40	•											•	•	
	GBX 4000	89·95	27	40	•					•	•	•	•	•	•	•	•	
VOXSON	TENVOX	97·00	27	40	•		•		•	•	•			•				
YORK	JCB 861	69·95	27	40	•								•				•	
	JCB 863	89·95	27	40	•					•	•	•	•	•	•	•	•	•

EG751

What CB?

Guide to Legal Rigs

The Grandstand base station. Beeware Ltd., Ripon Way, Harrogate, North Yorkshire

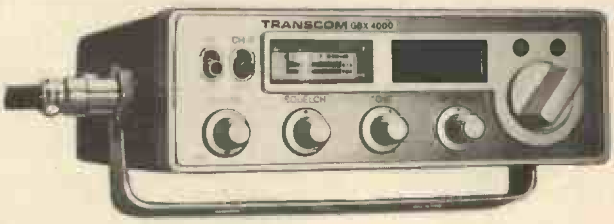
The Harrier CBX from Dixons, Dept. DS33, Camera House, Cartwright Road, Stevenage

The Binatone Phone Breaker (top) and the 5-star. Binatone House, Beresford Avenue, Wembley, Middlesex

The Voxson Tenvox. Voxson Audio Ltd., Nuffield Way, Abingdon, Oxfordshire

The CB1000. Fidelity Radio, Victoria Road, London

The Grandstand Buzzing Bee



The Transcom GBX 2000 (top) and the GBX 4000. Transcom International, 1–12 Market Street, Bracknell, Berks