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ELECTRONICS

FEBRUARY 1979

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Complete with Monitor

The Sorcerer Computer is a completely assembled and tested computer system. Standard configuration includes 63-key typewriter-style keyboard and 16-key numeric pad, Z80 processor, dual cassette I/O with remote computer control at 300 and 1200 baud data rates, RS232 serial I/O for communications, parallel port for direct Centronics printer attachment, 4K ROM operating system, 8K ROM Microsoft BASIC in Rom PacTM cartridge, composite video of 64 char/line 30 line/screen, 128 upper/lower case ASCII set and 128 user-defined graphic symbols, operation manual, BASIC programming manual and cassette/video cables, connection for S-100 bus expansion.

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Brand new professional ASCII keyboards (USA)

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AND MANY OTHER APPLICATIONS

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Fully Assembled £35.90

The Teleplay Kit consists of a Professional Finished Inject Moulded Box Joystick Hand Controls — one cartridge which consists of 10 games — Football, Tennis, Solo Squash (1 & 2 players), Hockey, Basketball (1 & 2 players), Shoot etc. Mains Adaptor. All holes are pre-drilled — No Special equipment required. You'll be surprised how easy it is to assemble this professional kit! Instruction Manual supplied separately at 0.45p. TELEPLAY GIVES YOU TWICE THE FUN BUILDING AND PLAYING THE MOST PROFESSIONAL TV GAME KIT EVER OFFERED.

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Additional cartridges NOW available include:

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Cartridges come complete with printed case and easy to follow assembly instructions.

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All parts fully guaranteed

Electrical knowledge is not a necessity to assemble this project — just simple soldering.

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WITH EVERY NASCOM

Start now and don't get left behind THE NASCOM 1 is here Ex-stock with full technical services

Plus the opportunity to join the fastest moving club of personal computer users enabling you to get the most our of your computer. You can OBTAIN and EXCHANGE programs and other software — many now available.

The Powerful Z80 Microprocessor
Professional Keyboard
1 Kbyte Monitor in EPROM
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Plugs into your domestic TV
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Manuals seperately	2.95	Monitor quality improved	
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PIO Technical Manual	2.95	Power supply suitable for NASCOM	19.90
(All prices add 8% VAT)			

NASCOM AD ONS — Nascom improved monitor B Bug (2K) featuring — *Four times tape speed *Direct text entry without ASCII *Extended keyboard facility *Additional useful subroutines £23.00

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PRACTICAL
ELECTRONICS

VOLUME 15 No. 2 FEBRUARY 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR MARCH ISSUE WILL BE ON SALE FRIDAY, 9 FEBRUARY 1979
(for details of contents see page 67)

U.K. RETURN OF POST MAIL ORDER SERVICE *also* WORLDWIDE EXPORT SERVICE

BAKER LOUDSPEAKER, 12 INCH, 60 WATT.
GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER.
FULL RANGE PROFESSIONAL QUALITY.
RESPONSE 30-16,000 CPS
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Ideal for Groups Disco P.A. and Musical Instruments 4 inputs speech and music 4 way mixing.
Output 4/8/16 ohm. a.c. Mains 240V.
Separate treble and bass controls.
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Pick up and tape inputs. Recording output.
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All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer Input 200/240V a.c. Output voltages available 6 or 7.5 or 9 or 12V d.c. up to 100mA or less. Size 3 × 2½ × 1¼in. Please state voltage required
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Size 10½ × 8½ × 1/16in. Operating voltage 200/250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos
ONLY **40p** EACH (FOUR FOR £1·50)
ALL POST PAID—Discounts for quantity

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Complete kit of parts with R.C.S. printed circuit. Three 1000W channels. Will operate from 200mV signal source. CABINET extra £4. KIT = **£17.00**

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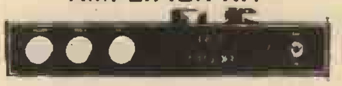
R.C.S. 10 WATT AMPLIFIER KIT



This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors. Both kits have printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s.
Input 100M.V. high imp. Size 9½ x 3 x 2in. A/C mains operated
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Easy to build. Full instructions supplied.

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3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£11·00
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9V 3 amp £2·75. 60V, 40V, 20V or 20-0-20V, 1A £3·50.
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Two for £15. Post 75p. **£7.95** Post 45p

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8/350V	22p	8+8/450V	50p	50+50/300V	50p
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32/500V	75p	16+16/450V	50p	100+100/275V	65p
50/350V	50p	32+32/350V	50p	150+200/275V	70p

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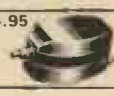
4 x 2 x 2in. 86p; 3 x 2 x 1in. 65p; 6 x 4 x 2in. 95p; 8 x 6 x 3in. £1.50; 9 x 4 x 4in. £1.70; 6 x 4 x 4in. £1.30.

THE "INSTANT" BULK TAPE ERASER £4.95
Suitable for cassettes, and all sizes of tape reels a.c. mains 200/240V. Leaflet S.A.E. Post 50p



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FERRANTI Semiconductors
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We can supply any Ferranti semiconductor device at the lowest prices. Send S.A.E. for our data sheet & price list.

ZNA116E	£3.75*	ZNA134J	£21.00*	BC415P	16p	ZTX109	12p
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TO CLEAR: P.C.B.'s for ZNA116 D.V.M. £1.00* the pair, while stocks last.

ORION amplifier
Complete set of semiconductors £9.75
Glass fibre PCB, printed with component locations £3.50

PHASE LOCKED STEREO DECODER KIT
Complete kit of parts to Motorola spec. only £2.95, including MC1310P all resistors & capacitors, gloss fibre p.c.b., L.E.D. & instructions. Suitable for most tuners. Dist. 0.3%, Separation 40db. 8–14 volts.

TONE BOOSTER (Everyday Electronics Sept. 1978)
The Tone Booster cuts out that dead, muddy sound and brings your guitar to life! Emphasises harmonics without reducing the low notes to give your guitar a clean penetrating tone. Complete kit of all parts as specified!........................£3.30*

PE TV SOUND SEPARATOR
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P & P 15p per order. Orders over £5 post free.
All devices are top grade, brand new and to full manufacturer's spec. We do not sell seconds or rejects. Send S.A.E. for our data sheet and price list.
Prices do not include VAT—add 8% to items marked*, and 12½% to all others.

DAVIAN ELECTRONICS (Mail order, callers by appointment only).
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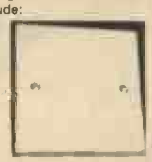
A Lightdimmer with NO knob. Dimming and on/off functions are controlled by touch. Features include:



★ No mains rewiring.
★ Easy to build – uses one MOS IC.
★ Switches on to preset brightness.
★ Can be switched and dimmed from many locations using TDE/K kit making 2-way switching easy.
★★ PRICE TD300K **£9.67**
TDE/K **£1.62**

TSD300K TOUCH-SWITCH & DIMMER combined. One touchplate for on/off. Small knob controls brightness. **£5.62**
TS300K TOUCHSWITCH. Two touchplates. ON/OFF **£4.64**
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400V Plastic Case

3A	64p
6.5A with trigger	86p
8A	80p
12A	90p
16A	113p
20A	178p
25A	205p
SCR (C106D) 5A/400V	54p
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COMPONENTS

0.2" L.E.D.s
Red 13p (£1.08/10)
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LCD .5" 4 digit	£8.75
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LM3911 temperature control/thermometer IC	£1.08
AY-5-1224	£3.81
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IN4148	5p
BC182L	11p
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DIGITAL VOLTMETER/THERMOMETER KIT

Based on the 7106 single IC 3½ digit D.V.M. the Kit contains a PCB, resistors, capacitors, presets, I.C. and 0.5" liquid crystal display. Components are also included to enable the basic D.V.M. kit to be modified to a Digital Thermometer using a single transistor as the sensor. Requires a 2mA 9V supply (PP3 battery).
ONLY £23.75

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Standard 240V mains primary
100mA secondary

6–0–6V	92p
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Switches any appliance of up to 1KW on and off at preset times once a day. KIT contains: AY–5–1230 Clock/Appliance Timer IC, 0.5" LEO display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full instructions. **£16.09**
White box (56 x 131 x 71mm) – drilled **£2.70**
– undrilled **£2.38**
Ready built **£24.30**

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Quantity discounts on request. Add 25p postage and packing. Mail order only to:

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ELECTROVALUE Buying Guide

Section 1

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Catalogue No. 9 now ready

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2N1304	52p
2N1305	52p
2N1306	56p
2N1307	56p
2N1308	60p
2N1309	60p
2N1599–SCR	88p
2N1613	23p
2N1711	22p
2N1893	35p
2N2218	24p
2N2218A	24p
2N2219	24p
2N2219A	24p
2N2270	75p
2N2369A	22p
2N2484	26p
2N2646	69p
2N2904	24p
2N2904A	24p
2N2905	24p
2N2905A	24p
2N2924*	25p
2N2925*	25p
2N2926*	25p
2N3053	26p
2N3054	73p
2N3055	70p
2N3391A*	41p
2N3405*	64p
2N3663*	52p
2N3702*	11p
2N3703*	10p
2N3704*	11p
2N3705*	10p
2N3706*	9p
2N3707*	12p
2N3708*	8p
2N3709*	12p
2N3710*	12p
2N3711*	12p
2N3794*	21p
2N3819*	22p
2N3820*	56p
2N3823E*	24p
2N3904*	24p
2N3906*	28p
2N4036	68p
2N4058*	12p
2N4059*	12p
2N4060*	12p
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2N4062*	12p
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2N4126*	27p
2N4286*	18p
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2N4291*	24p
2N4292*	21p
2N4303*	30p
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2N4443	£1.14
2N4444	£1.50
2N4906	£1.00
2N4915	£1.00
2N4991	80p
2N5062*–SCR	45p
2N5163*	24p

2N5192	85p
2N5195	99p
2N5457*	39p
2N5458*	39p
2N5459*	39p
6F40	£1.46
16F40	£1.65
40HF10	£1.64
40HF40	£2.28
40250	95p
40361	38p
40362	35p
40406	40p
40408	40p
40412	56p
40594	£1.18
40595	£1.50
40602	75p
40636	£1.80
40673	86p
A9903	44p
AA113	9p
AA116	9p
AA117	9p
AA118	10p
AA119	9p
AC126	30p
AC127	48p
AC128	28p
AC151R	56p
AC153	40p
AC153K	40p
AC176	58p
AC176K	40p
AC187K	70p
AC188K	70p
ACY17	92p
ACY18	91p
ACY19	99p
ACY20	70p
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AD142	90p
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AD162	96p
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AF116	30p
AF117	34p
AF124	25p
AF125	32p
AF126	25p
AF127	36p
AF139	32p
AF200U	10p
AF239	89p
AF279	30p
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AFY18D	£5.74
AFY18E	£6.15
AFY42	£3.07
AL102	£1.60
ASY26	£1.39
ASY27	£1.39
ASY28	£1.39
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BO140–SCR	35p
BO226–SCR	35p
BO240–SCR	40p
BO246–SCR	96p
BO680	10p
B1906	38p
B1912	38p

BA102	28p
BA127D	4p
BA133F	9p
BA138	20p
BA145	19p
BA156	14p
BA379	25p
BAX13	4p
BB103B	37p
BB103G	37p
BB104G*	53p
BB105B	28p
BB109G*	39p
BC107A	14p
BC107B	14p
BC108A	14p
BC108B	14p
BC108C	14p
BC109B	14p
BC109C	14p
BC121W	20p
BC122Y	61p
BC125*	20p
BC126*	20p
BC140	43p
BC147A*	21p
BC147B*	21p
BC148A*	21p
BC148B*	21p
BC148C*	21p
BC148C*	21p
BC149C*	21p
BC154*	16p
BC157A*	21p
BC157B*	21p
BC158B*	21p
BC159B*	21p
BC160	49p
BC167A*	8p
BC167B*	12p
BC168A*	8p
BC168B*	12p
BC168C*	8p
BC169B*	8p
BC169C*	12p
BC177A	18p
BC177B	20p
BC178A	16p
BC178B	17p
BC179B	20p
BC182L*	12p
BC182*	12p
BC183L*	12p
BC183*	12p
BC184L*	12p
BC184*	12p
BC202Y	75p
BC212L*	12p
BC212*	12p
BC213L*	12p
BC213*	12p
BC214L*	12p
BC214*	12p
BC238B*	8p
BC238C*	8p
BC239C*	12p
BC257A*	8p
BC257B*	8p
BC258A*	8p
BC258B*	8p
BC259B*	8p
BC267	16p
BC268C	17p
BC269C	18p
BC300	26p
BC301	24p
BC303	30p
BC327*	16p
BC328*	12p
BC337*	14p
BC338*	12p
BC447	29p
BCY31A	96p

BCY58	15p
BCY59	16p
BCY70	18p
BCY71	18p
BCY72	18p
BCY78	25p
BD130	45p
BD131	62p
BD132	77p
BD135*	38p
BD136*	42p
BD139*	41p
BD140*	46p
BDX18N	£1.10
BDY12	90p
BDY20	50p
BF115	38p
BF167	30p
BF173	34p
BF177	24p
BF178	24p
BF194*	18p
BF195*	17p
BF244B	30p
BF254*	14p
BF255*	14p
BF457*	36p
BF458*	37p
BF459*	40p
BFR39*	24p
BFR40*	24p
BFR41*	24p
BFR79*	24p
BFR80*	24p
BFR81*	24p
BFT66	£1.83
BFX29	24p
BFX84	24p
BFX85	24p
BFX87	24p
BFX88	24p
BFY50	24p
BFY51	24p
BFY52	24p
BFY90	£1.05
BR81WA	80p
BR92QA	£1.36
BRY39	60p
BSX20	22p
BSX46	45p
BSX63	£3.89
BT106	£1.47
BT107	£1.60
BU105	£2.50
BU208	£3.90
BUX28	£4.20
BY164	90p
BY238	8p
BYX38-300	65p
BYX38-300R	65p
C106D1	45p
CO326–SCR	£4.40N
CO340–SCR	£5.14N
C407*	17p
C1406	90p
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CS2925	20p
E99A40–Triac	£7.87N
E2506	£1.48
E2512	£1.74
MJ481	£1.48
MJ491	£1.63
MJ2955	78p
MJE340	78p
MJE2955	72p
MJE3055	68p
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MPF102*	44p
MPS6531*	24p
MPS6534*	25p
NAS206.S.5–SCR	81p

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NAS0654X5–Triac	80p
NAS0654W4–Triac	£1.04
NAS1001X5–Triac	60p
NAS1004W5–Triac	£1.10
NAS1004X5–Triac	£1.04
NKT211	20p
NKT212	20p
NKT213	20p
NKT274	20p
NKT275	20p
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OA90	6p
OA91	6p
OA95	8p
OA202	10p
OC28	£1.02
OC29	£1.07
OC35	£1.07
OC36	£1.02
OC45	£1.15
OC71	70p
OC72	70p
OC75	DIS
OC81	80p
OC83	70p
OC84	70p
PM7A2	£2.68
PN70*	5p
PN72*	5p
PN109*	5p
PN1613*	5p
PN2904*	5p
SI10M1	10p
T2700D	£1.55
T2800D–Triac	£1.04
TAG3-400–SCR	£1.00
TAG302-400–Triac	85p
TAG302-600–Triac	£1.05
TIP31A	45p
TIP32A	45p
TIP41A	60p
TIP41C	64p
TIP42A	60p
TIP42C	64p
TIS43*	35p
W02	25p
ZTX107*	12p
ZTX108*	11p
ZTX109*	12p
ZTX300*	12p
ZTX301*	16p
ZTX302*	14p
ZTX303*	18p
ZTX304*	21p
ZTX330*	8p
ZTX331*	19p
ZTX500*	12p

ZTX500*	15p
ZTX502*	17p
ZTX503*	19p
ZTX504*	22p
ZTX530*	12p
ZTX530*	8p

HEAT SINKS

Type	Drilled	
2PI	–	53p
2YT03	1 x T03	54p
2YT0661 x T066		57p
2.75R	–	£2.80
5.5R	–	£3.95
5F	T05 clip	10p
5F2	T05 clip	10p
6W1	–	£2.05
6W4	2 x T03	£2.25
10DNA	–	88p
10DNC	2 x T03	£1.14
17C2	2 x AD161	20p
18F	T018 clip	10p
18F2	T018 clip	10p
224F	T01 clip	10p
244F	D01 clip	10p
266F	D03 clip	10p
A1032	T01 clip	6p
A1053	2 x T01 clip	8p
A1058	1 x T03	22p
T0921	T092 clip	7p
T0922	2 x T092 clip	9p
TV2	T066	24p
TV3	T03	25p
TV4	BD131	21p
TV5	T0220	21P

ZENER DIODES

400mW 2.7–33V 9p
1.3W 3.3–200V 15p
1.5W 3.3–75V 55p
(1.5W are metal cased)
20W 7.5V–75V
£1.25 each

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Micro processor Evaluation Kit (for M.680 Microcomputer)

£175.87 + VAT (net)

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Section 3 – ***Opto-Electronics***
Section 4 – ***Resistors, Pots***
Section 5 – ***Hardware etc.***

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POLYESTER CAPACITORS: Axial lead type. (Values are in µF) 400V: 0.001, 0.0015, 0.0022, 0.0033 7p; 0.0047, 0.0068, 0.01, 0.015, 0.018 9p; 0.022, 0.033, 10p; 0.047, 0.068 14p; 0.10 15p; 0.15, 0.22 22p; 0.33, 0.47 39p; 0.68 45p. 160V: 0.39, 0.15, 0.22 11p; 0.33, 0.47 19p; 0.68, 1.0 22p; 1.5 29p; 2.2 32p. DUBILIER: 1000V: 0.01, 0.015 20p; 0.022 22p; 0.047 26p; 0.1 38p; 0.47 48p.

POLYESTER RADIAL LEAD (Values are in µF) 250V: 0-01, 0-015, 0-022, 0-027 5p; 0-033, 0-047, 0-068, 0-1 7p; 0-15 11p; 0-22, 0-33 13p; 0-47 15p; 0-68 18p; 1-0 24p; 1-5 27p; 2-2 31p.

FEED THROUGH CAPACITORS 100µF 350V 8p

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF) 500V: 10 40p; 47 68p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22 8p; 47, 32, 50 11p; 63, 100 27p; 50V: 1.0 7p; 50, 100, 220 25p; 470 50p; 1000 68p; 40V: 22, 33 7p; 100 12p; 2200, 3300 62p; 4700 64p; 35V: 10, 33 9p; 330, 470 32p; 1000 49p; 25V: 10, 22, 47 6p; 80, 100, 160 8p; 220, 250 13p; 470, 640 25p; 1000 27p; 1500 30p; 2200 41p; 3300 52p; 4700 54p; 16V: 10, 40, 47, 68 7p; 100, 125 8p; 330 14p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 4, 100 6p; 640 10p; 1000 14p.
70V: 2000 98p; 4700 121p; 50V: 10,000 255p; 40V: 2500 65p; 3300, 4700 70p; 15,000 450p; 25V: 4700 48p; 2200 37p; 325V: 200 + 100 + 50 + 100 190p.

TANTALUM BEAD CAPACITORS 35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2µF, 3.3, 4.7, 6.8; 25V: 1.5, 10; 20V: 1.5; 16V: 10µF 13p each. 47, 100 40p; 10V: 22µF, 33; 6V: 47, 68, 100; 3V: 68, 100µF 20p each.

MYLAR FILM CAPACITORS
100V: 0.001 0.002 0.005, 0.01µF 6p
0.015 0.02 0.04, 0.05, 0.056µF 7p
0.1µF 0.2 9p 50V: 0.47µF 11p

CERAMIC CAPACITORS: 50V
0.5pF to 10nF 3p each
15nF 22nF 33nF 47nF 4p each
0.1µF 6p

POLYSTYRENE CAPACITORS
10pF to 1nF 8p; 1.5nF to 47nF 10p.

SILVER MICA (Values in pF) 3.3, 4.7, 6.8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 9p each
250 300 330 360, 390, 600, 820 16p each
1000, 1800, 2000, 2200 20p each

MINIATURE TYPE TRIMMERS
2.5 6pF 3 10pF 10 40pF 22p
5 25pF 5 45pF 60pF 88pF 30p

COMPRESSION TRIMMERS
3 40pF, 10-80pF, 25-190pF 25p
100-500pF 45p

SOLDERCON PINS*
100 pins 50p; 1000 pins 395p

POTENTIOMETERS (AB or EGEN)
Carbon Track, ¼W Log & ½W Linear values
500Ω, 1K & 2K (lin only). Single 27p
5KΩ-2MΩ single gang 27p
5KΩ-2MΩ single gang D/P switch 60p
5KΩ 2MΩ dual gang stereo 70p

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 80p
Self Stick Graduated Bezels 22p

PRESET POTENTIOMETERS
Vertical & Horizontal
0 1W 50Ω- 5MΩ Miniature 8p
0 25W 100Ω—3-3MΩ Horiz 10p
0-25W 200Ω—4-7MΩ Vert 10p

RESISTORS - Erie make 5% Carbon Miniature High Stability Low noise

	RANGE	VAL	1-99	100
¼W	2·2Ω-4·7M	E24	1.5p	1p
½W	2·2Ω-4·7M	E12	2p	1.5p
1W	2·2Ω-10M	E12	5p	4p
2% Metal Film	10Ω-1MΩ		6p	4p
1% Metal Film	51Ω-1M		10p	8p

100 - price applies to Resistors of each type not mixed values

SPECIAL OFFER
IC741 (Texas) 17p*
NE555 (Texas) 22p*

OPTO ELECTRONICS★
LEDs plus clip
TIL209 Red 13
TIL211 Grn 18
TIL212 Yellow 22
·2" Red 15
·2" Yellow Green 19
Spare Clips 2
ORP12 63
2N5777 45
7 Seg Displays
LS400 255
TIL307 675
TIL312 C An 3" 105
TIL313 C Cth 3" 105
TIL321 C An 5" 115
TIL322 C Cth 5" 115
DL704 C Cth ·3" 99
DL707 C.A. ·3" 99
FND357 120
MAN3640 175
LCD 3½ digit 915

SWITCHES★
TOGGLE 2A 250V
SPST 28p
DPDT 38p
4 pole on/off 54p
SUB-MIN TOGGLE
SP changeover 59p
SPST on/off 54p
DPDT 6 tags 70p
DPDT Centre off 79p
DPDT Biased 115p
SLIDE 250V:
1A DPDT 14p
1A DP c/over 15p
½A DPDT 13p
4 pole c/over 24p
PUSH BUTTON
Spring loaded
SPST on/off 60p
SPDT c/over 65p
DPDT 6 Tag 85p

	JACK PLUGS		SOCKETS		
	Screened chrome	Plastic body	open metal	moulded with break contacts	in line couplers
2·5mm	12p	8p	8p		11p
3·5mm	15p	10p	8p		12p
MONO	23p	15p	13p	20p	18p
STEREO	31p	18p	15p	24p	22p

	PLUGS	SOCKETS	In Line
DIN 2 PIN Loudspeaker	11p	7p	18p
3, 4, 5 Pin Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours	9p	5p single / 8p double	16p
Metal Screened	12p	10p 3-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	7p	7p	—
WANDER 3mm	8p	8p	—

SWITCHES ★ Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER (white) 10A 250V
SP changeover centre off 30p
ROCKER: (black) on/off 10A 250V 23p
ROCKER: Illuminated (white)
Lights when on: 3A 240V 52p
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2-6W 3p/2-4W 4p/2-3W 41p
ROTARY: Mains 250V AC, 4 Amp 45p

DIL SOCKETS ★ (Low Profile – Texas)
8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 20p; 20 pin 27p; 24 pin 30p; 28 pin 42p; 40 pin 55p.

DIGITAL MULTIMETER

Announcing DM900 – The Digital Multimeter with a difference – It measures Capacitance too. *(as published in E.T.I. August 1978)*
Throw away your analogue meters, here's digital accuracy at only half the price of an equivalent commercial Multimeter.
The DM900 is a 3½ digit multimeter with an 0.5in L.C.D. display incorporating:
5 AC & DC Voltage ranges; 6 Resistance ranges.
5 AC & DC Current ranges; 4 Capacitance ranges.
The prototype accuracy is better than 1%.
This is a unique design using the latest MOS ICs and due to the minimal current drain, is powered by only one PP3 battery. There is also a battery check facility.
DM900 is an attractive hand-held lightweight device, built into a high impact case with carrying handle and has been ingeniously designed to simplify assembly.
Never before have all these features been offered to the electronics enthusiast in a single unit.

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Ready Built and tested units £78.50*
Including probes and carrying case
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Convert your TV into a VDU by using the new Thomson-CSF, TV-CRT controller chip SF.F 96364. 16 lines by 64 characters, text refreshment, cursor management on TV screen, line erasing, line end erasing. Compatible with any computing system.

SFF 96364E	£11.75*
AY-5-1013UART	£4.50*
71301 ROM SFC	£8.20*
SFS80102 RAM 1K	£2.05*
74LS163	£0.95*
MC1488	£0.85*
MC1489	£0.90*
SN75450	£1.20*
SN75451	£0.70*
SN75452	£0.70*
SN75454	£2.25*
2102 LF	£1.60*
2513	£5.95*
74LS132	£0.95*
81LS97	£1.09*
1 MHz crystal	£3.23*
14.31818 MHz	£2.70*
UHF Modulator	£2.50*

TTL 74★

7400	13	7494	78	74194	105	4056	134
7401	13	7495	65	74195	95	4057	2570
7402	14	7496	57	74196	99	4059	480
7403	14	7497	189	74197	85	4060	115
7404	14	74100	119	74198	150	4061	2380
7405	18	74105	62	75150	110	4062	999
7406	38	74107	29	75491	75	4063	110
7407	38	74109	54	75492	80	4066	58
7408	17	74110	54			4067	380
7409	17	74111	68	**CMOS★**		4068	22
7410	15	74112	88	4000	15	40698E	20
7411	20	74116	198	4001	17	4070	32
7412	17	74118	83	4002	17	4071	21
7413	30	74119	119	4006	105	4072	21
7414	51	74120	115	4007	18	4073	21
7416	30	74121	25	4008	87	4075	23
7417	30	74122	46	4009	50	4076	85
7420	16	74123	48	4010	50	4077	40
7421	29	74125	38	4011	18	4078	21
7422	24	74126	57	4012	18	4081	20
7423	27	74128	74	4013	42	4082	21
7425	27	74132	73	4014	86	4085	74
7426	36	74136	73	4015	89	4086	73
7427	27	74141	56	4016	45	4089	150
7428	35	74142	269	4017	89	4093	85
7430	17	74143	314	4018	89	4094	190
7432	25	74144	314	4019	48	4095	105
7433	40	74145	65	4020	99	4096	105
7437	30	74147	175	4021	91	4097	372
7438	33	74148	109	4022	88	4098	110
7440	17	74150	99	4023	20	4099	145
7441	74	74151	64	4024	66	4160	109
7442	68	74153	64	4025	19	4161	109
7443	115	74154	96	4026	180	4162	109
7444	112	74155	53	4027	45	4163	109
7445	94	74156	80	4028	81	4174	110
7446	94	74157	67	4029	99	4175	99
7447	82	74159	210	4030	50	4194	108
7448	56	74160	82	4031	205	4408	720
7450	17	74161	92	4032	100	4409	720
7451	17	74162	92	4033	145	4410	720
7453	17	74163	92	4034	196	4411	995
7454	17	74164	105	4035	111	4412F	1650
7460	17	74165	105	4036	325	4412F	1380
7470	28	74166	161	4037	100	4415F	795
7472	25	74167	198	4038	108	4415V	795
7473	32	74170	230	4039	320	4419	280
7474	27	74172	625	4040	105	4422	545
7475	38	74173	170	4041	80	4433	1180
7476	36	74174	87	4042	75	4435	825
7480	48	74175	87	4043	94	4440	1275
7481	86	74176	75	4044	88	4450	295
7482	69	74177	78	4045	145	4451	295
7483	72	74178	102	4046	128	4490F	695
7484	95	74180	85	4047	87	4490V	525
7485	106	74181	165	4048	58	4501	17
7486	31	74182	90	4049	48	4502	120
7489	210	74184	135	4050	48	4503	69
7490	33	74185	135	4051	72	4506	51
7491	75	74188	275	4052	72	4507	55
7492	38	74190	115	4053	72	4508	298
7493	32	74191	105	4054	110	4510	99
		74192	105	4055	128	4511	150
		74193	105			4512	98

LINEAR IC'S

702	75	MC1304P	260
709C 14 pin	35	MC1310	149
710★	43	MC1312P	195
723★	45	MC1488★	85
733★	99	MC1489★	90
741C★ 8 pin	22	MC1495★	395
747C★	70	MC1496	92
748C★	36	MC1710★	79
753	150	MC3401	69
810	159	MC3340P★	150
8038CC★	335	MC3360P	120
AY-1-0212	580	MFC4000B	85
AY-1-1313	660	MFC6040★	97
AY-1-1320	305	MK50398★	635
AY-1-5050	180	MK50362★	650
AY-1-5051	145	MM2112★	105
AY-1-6721/6	195	MM2112-2★	295
AY-3-8500★	385	MM57160★	620
AY-5-1224A★	260	NE518A★	210
AY-5-1230★	450	NE555★	29
AY-5-1315	560	NE556DB★	60
AY-5-1317A	630	NE560★	325
CA3011★	82	NE561★	395
CA3020	170	NE562★	410
CA3023	170	NE565A★	120
CA3028A★	80	NE566★	160
CA3035	240	NE567★	170
CA3043	190	NE571★	450
CA3046	71	RAM2102-2★	170
CA3048	200	RC4136D★	120
CA3075	175	ROM2513★	595
CA3080E★	70	SG3402	295
CA3081	190	SN76003N	175
CA3089E	210	SN76013N	140
CA3090AQ	375	SN76023N	140
CA3123E	200	SN76033N	175
CA3130★	85	SN76115N	215
CA3140★	70	SN76477★	225
ICL7106E★	752	SN76227	115
ICM7205★	1150	TAA621AX1	228
LD130★	452	TAA960	300
LM301A	30	TBA120S	70
LM304	240	TBA540Q	215
LM308	110	TBA550Q	330
LM318	195	TBA641BX11	250
LM324★	79	TBA651	180
LM339★	80	TBA800	90
LM348★	95	TBA810S	99
LM379★	375	TBA820	70
LM380	95	TBA920Q	260
LM381	145	TDA1022★	575
LM381AN	248	TDA2020	320
LM382	125	TL061CP★	48
LM1458★	50	TL064CN★	199
LM3900★	60	TL071CP★	76
LM3909N★	70	TL081CP★	48
LM3911★	125	TL082CP★	84
M252AA★	750	TL084CP★	130
M253AA★	795	UAA170	198
MC724★	175	ZN414	90
MC1303	88	ZN424	130
		ZN425E★	415

TRANSISTORS

AC117★	35	BC170	17	BF184★	30	OC41★	48	ZTX311	17	2N3563	20
AC125★	20	BC171	11	BF194	10	OC42★	32	ZTX314	24	2N3614★	169
AC126★	20	BC172	10	BF195	10	OC43★	55	ZTX326	40	2N3615★	135
AC127★	20	BC177★	17	BF196	10	OC44★	31	ZTX341	20	2N3663	24
AC128★	20	BC178★	17	BF197	10	OC45★	20	ZTX500	13	2N3702	10
AC141★	24	BC179★	17	BF198	18	OC46★	28	ZTX501	14	2N3703	11
AC141K★	38	BC182	9	BF200★	28	OC70★	19	ZTX502	19	2N3704	10
AC142★	24	BC182L	10	BF224A	18	OC71★	25	ZTX503	15	2N3705	11
AC142K★	38	BC183	9	BF244	24	OC72★	30	ZTX504	25	2N3706	10
AC176★	18	BC183L	10	BF256★	50	OC76★	36	ZTX531	25	2N3707	10
AC187★	20	BC184	9	BF257★	26	OC77★	76	ZTX550	25	2N3708	10
AC188★	20	BC184L	10	BF258★	30	OC79★	76	2N526★	58	2N3709	10
ACY17★	35	BC186	21	BF259★	32	OC81★	28	2N696★	35	2N3710	16
ACY18★	40	BC187★	28	BF394	22	OC82★	45	2N697★	21	2N3711	10
ACY19★	40	BC212	9	BF594	40	OC83★	48	2N698★	39	2N3715★	250
ACY20★	40	BC212L	10	BF595	38	OC84★	44	2N699★	39	2N3772★	170
ACY21★	35	BC213	9	BFR39	25	OC122★	48	2N706A★	19	2N3773★	288
ACY22★	40	BC213L	11	BFR40	25	OC123★	48	2N707★	50	2N3819	22
ACY28★	40	BC214	9	BFR79	28	OC139★	85	2N708★	19	2N3820	32
ACY39★	78	BC214L	10	BFR80	28	OC140★	85	2N914★	32	2N3823★	65
ACY40★	48	BC307B	14	BFX29★	26	OC141★	85	2N916★	27	2N3824★	70
ACY44★	39	BC308	13	BFX81★	130	OC170★	40	2N918★	30	2N3866★	90
AD140★	69	BC328	13	BFX84★	24	OC171★	40	2N920★	51	2N3903	16
AD149★	70	BC338	12	BFX85★	24	OC201★	75	2N930★	18	2N3904	18
AD161★	42	BC441★	30	BFX86★	28	OC202★	85	2N961★	61	2N3905	18
AD162★	42	BC461★	30	BFX87★	23	OC203★	85	2N1131★	22	2N3906	17
AF114★	25	BC477★	25	BFX88★	24	OC204★	85	2N1132★	22	2N4037★	52
AF115★	25	BC547	11	BFY18★	50	TIP29	43	2N1302★	35	2N4058	17
AF116★	25	BC548	11	BFY50★	20	TIP29A	44	2N1303★	50	2N4061	17
AF117★	25	BC549C	13	BFY51★	20	TIP29C	60	2N1304★	50	2N4064★	120
AF118★	55	BC557	13	BFY52★	20	TIP30	47	2N1305★	28	2N4236★	145
AF121★	48	BC558	12	BFY71★	20	TIP30A	47	2N1306★	35	2N4289	20
AF124★	55	BCY30★	57	BSX20★	18	TIP30B	64	2N1307★	50	2N4859	65
AF125★	35	BCY34★	75	BSY65★	30	TIP30C	65	2N1308★	46	2N5135	42
AF127★	35	BCY39★	80	BSY95★	25	TIP31★	40	2N1613★	23	2N5136	42
AF139★	35	BCY40★	78	BSY95A★	25	TIP31A★	40	2N1670★	150	2N5138	20
AF178★	70	BCY43	75	BU105	140	TIP31B★	40	2N1671B★	215	2N5179★	60
AF180★	70	BCY58★	22	BU205★	190	TIP31C★	66	2N1893★	28	2N5180★	60
AF186★	50	BCY59★	22	BU208★	228	TIP32★	45	2N1986★	60	2N5191★	65
AF239★	42	BCY70★	15	E5567	65	TIP32A★	49	2N2160★	350	2N5305★	24
ASY26★	40	BCY71★	17	MD8001★	158	TIP32B★	70	2N2217★	48	2N5457	32
ASY27★	45	BCY72★	17	ME4102	10	TIP32C★	70	2N2218A★	31	2N5458	32
BC107★	9	BCY78★	20	ME6002	14	TIP33★	80	2N2219A★	22	2N5459	32
BC107B★	10	BD115★	62	MJ400★	90	TIP33A★	80	2N2220A★	20	2N5485	32
BC108★	9	BD121★	95	MJ491★	190	TIP33B★	100	2N2221★	23	2N5777★	45
BC108B★	12	BD123★	98	MJ2955★	99	TIP33C★	105	2N2222★	20	2N6027	40
BC108C★	12	BD124★	115	MJE340★	50	TIP34★	85	2N2297	45	40311★	50
BC109★	9	BD131★	38	MJE370★	55	TIP34A★	85	2N2303★	45	40313★	125
BC109B★	12	BD132★	38	MJE371★	60	TIP34B★	110	2N2368★	21	40316★	85
BC109C★	12	BD133★	43	MJE520★	45	TIP34C★	110	2N2369★	15	40317★	52
BC113	17	BD135★	36	MJE521★	65	TIP35★	219	2N2476★	125	40324★	85
BC114	19	BD136★	37	MJE2955★	99	TIP35A★	225	2N2483★	28	40326★	52
BC115	19	BD137★	36	MJE3055★	70	TIP35C★	270	2N2484★	30	40327★	82
BC116	19	BD138★	36	MPF102	30	TIP36A★	265	2N2646★	48	40347★	80
BC117	15	BD139★	45	MPF103	36	TIP36C★	325	2N2784★	55	40348★	101
BC118	19	BD140★	50	MPF104	36	TIP41A★	63	2N2846★	140	40360★	43
BC119★	28	BD142★	59	MPF105	36	TIP41B★	73	2N2894★	30	40361★	45
BC134	19	BD145★	198	MPF106	50	TIP42A★	64	2N2904A★	22	40362★	48
BC135	20	BD222★	60	MPF107	50	TIP42B★	82	2N2905A★	20	40407★	50
BC136	18	BD695A★	75	MPSA05★	24	TIP2955★	63	2N2906★	18	40411★	289
BC137	20	BD696A★	75	MPSA06★	24	TIP3055★	60	2N2907★	20	40412★	63
BC140★	28	BDY17★	195	MPSA12	42	TIS43	36	2N2907A★	22	40467★	95
BC142★	25	BDY60★	110	MPSA55	24	TIS44	45	2N2926G	10	40576★	190
BC143★	25	BDY61★	165	MPSA56	24	TIS46	45	2N2926O	8	40594★	80
BC147	7	BF115★	22	MPSA70	34	TIS50	47	2N2926R	8	40595★	90
BC148	7	BF154★	25	MPSU02★	58	TIS60	45	2N2926Y	8	40603★	58
BC149	8	BF156★	29	MPSU05	48	TIS62	45	2N3011★	24	40636★	125
BC153	14	BF167	25	MPSU06	54	TIS74	47	2N3053★	20	40673★	68
BC154	14	BF173★	25	MPSU52★	65	TIS90	18	2N3054★	49		
BC157	10	BF177★	24	MPSU55★	53	TIS91	22	2N3055★	55		
BC158	11	BF178★	25	MPSU56★	56	ZTX107	11	2N3108	39		
BC159	11	BF179★	30	MPU131★	39	ZTX108	11	2N3121	40		
BC160	27	BF180★	30	OC25★	120	ZTX109	11	2N3133	43		
BC167A	11	BF181★	30	OC26★	150	ZTX300	13	2N3135	33		
BC168C	12	BF182★	30	OC28★	99	ZTX301	16	2N3250	30		
BC169C	10	BF183★	30	OC29★	160	ZTX302	18	2N3252	36		
				OC35★	80	ZTX303	21	2N3302	35		
				OC36★	99	ZTX304	24	2N3442★	131		

Diodes

IN4148	4
CR033★	148
Zeners 400mw 2.7-33v	9

KITS FOR SYNTHESISERS, SOUND EFFECTS

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHOTOCOPIES of P.E. texts for most of the kits are available—prices in our lists.

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET.

P.E. MINISONIC Mk. 2 SYNTHESISER
A portable mains-operated Miniature Sound Synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, mixer, power supply.

Set of basic component kits	from £61·00
Set of printed circuit boards	£8·99

P.E. SYNTHESISER (P.E. Feb. 73 to Feb. 74)
The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage. Details in our lists.

FORMANT SYNTHESISER (Elektor 1977/78)
Very sophisticated music synthesiser for the advanced constructor who puts performance before price. Details in our lists.

128-NOTE TUNE-PROGRAMMABLE SEQUENCER (P.E. Nov/Dec 77)
Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable. (Please use order codes quoted in brackets.)

Main Circuit (Nov) excl. sw's (KIT 76-1)	£18·03
Power Supply (KIT 76-3)	£4·72
Trigger Inverter and Alt. Output (KIT 76-2)	£1·15
LED Counter (KIT 76-4)	£2·10
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2·61
PCB for KITS 76-2 & 4 (PCB 76B)	£2·54

P.E. STRING ENSEMBLE (PE Mar-July 78)
The new keyboard string-instrument synthesiser.
Basic component sets:

Power Supply (KIT 77-1)	£8·77
Tone Generator (KIT 77-2)	£14·66
Diode Gates (KIT 77-3)	£18·81
Chorus Generator (KIT 77-4)	£19·08
Voicing System (KIT 77-5)	£7·38

Printed Circuit Boards:

Double-sided PCB for Power Supply, Tone Generator & Diode Gates with most of the Matrix wiring as printed tracking (PCB 77L/R)	£18.40
PCB for Chorus Generator (PCB 77C)	£2.65
PCB for Voicing System (PCB 77D)	£2.62

Fuller details of kits & PCBs are in our lists.

P.E. JOANNA PLUS ORGAN VOICING
The basic five octave electronic piano (P.E. May/Sept 75 and Sound Design) has switchable alternative voicings for Honky-Tonk, ordinary piano, and Harpsichord or a mixture of any of these three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The modification retains all the circuitry associated with the piano but in addition provides an organ-voice envelope facility with 5 switchable pitches, variable attack and sustain, phasing and vibrato.

Set of components (excl switches) for PSU, Frequency generator, Pitch and Note Divider, Envelope Shapers, Voicings, and Control circuitries. (Order as KIT 71-5)	£99·25
Set of PCBs (Order as PCB SET 71-6)	£29·18

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

Component set with special foot operated switches	£7·69
Alternative component set with panel switches	£5·05
Printed circuit board	£1·43

ELEKTOR ELECTRONIC PIANO (Elektor Sept 78)
A touch-sensitive, multiple-voicing 5 octave piano using the latest integrated-circuit techniques for the keying and envelope shaping and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos. Details in our lists.

DIGITAL REVERBERATION UNIT (Elektor May 78)
A very advanced unit using sophisticated i.c. techniques instead of mechanical spring-lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main component set (KIT 78-1)	£45·45
Extension component set (KIT 78-2)	£43·36
PCB for Kit 78-1 (PCB 78A)	£2·86
PCB for Kit 78-2 (PCB 78B)	£1·06

ANALOGUE REVERBERATION UNIT (Elektor Oct 78)
Using i.c.s instead of spring-lines, the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main component set (KIT 83-1)	£26·18
Additional Delay Set (KIT 83-2)	£18·25
PCB (as published) to hold both above kits (PCB 9973)	£4·31

RESONANCE FILTER (Elektor Oct 78)
This filter module has been designed to allow a synthesiser to produce a more realistic simulation of natural musical instruments.

Basic component set (KIT 82-1)	£15·10
PCB (as published) (PCB 9951)	£3·29

SYNTHESISER EXTERNAL INPUT INTERFACE (P.E. Oct 78)
This unit allows external inputs, such as guitars, microphones etc. to be processed by the circuits within a synthesiser.

Basic component set (incl PCB) (KIT 81-1)	£2·94

GUITAR MULTIPROCESSOR (P.E. Dec/Feb 78)
An extremely versatile sound processing unit capable of producing, for example, Flanging, Vibrato, Reverb, Fuzz and Tremolo as well as other fascinating sounds. May be used with most electronic instruments. Details in our lists.

RHYTHM GENERATOR KITS
Several available – details in our lists.

GUITAR FREQUENCY DOUBLER (P.E. Aug. 77)
A modified and extended version of the circuit published.

Component set and PCB	£4·52

GUITAR SUSTAIN (P.E. Oct 77)
Maintains the natural attack whilst extending note duration.

Component set, PCB and foot switches	£5·13
Component set, PCB and panel switches	£3·71

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds

Component set (incl. PCB)	£4·26

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

Component set using dual slider pot	£7·58
Component set using dual rotary pot	£6·89
Printed circuit board	£1·62

FUZZ UNIT
Simple Fuzz unit based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·05

TREMOLO UNIT
Based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·94

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component set (incl. PCB)	£2·51

WAVEFORM CONVERTER
Slightly modified from a circuit published in "Elektor". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and squarewave with an externally variable mark-space ratio.

Component set (incl. PCB but excl. sw/s)	£8·40

VOLTAGE CONTROLLED FILTER (P.E. Dec. 74)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers

Component set (incl. PCB) (Order as Kit 65-1)	£7·17

RING MODULATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers

Component set (incl. PCB) (Order as Kit 59-1)	£5·50

NOISE GENERATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 60-1)	£3·64

ENVELOPE SHAPER WITHOUT VCA (P.E. Oct. 75)
Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier

Component set (incl. PCB)	£4·77

ENVELOPE SHAPER WITH VCA (P.E. Apr. 76)
This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.

Component set (incl. PCB)	£6·68

TRANSIENT GENERATOR (P.E. Apr. 77)
An envelope shaper, without VCA, having the usual attack, decay, sustain and release functions, and in addition it also provides a "Repeat Effect" enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo

Component set	£4·87
Printed circuit board	£1·82

SOPHISTICATED PHASING AND VIBRATO UNIT
A slightly modified version of the circuit published in "Elektor", December 1976, and includes manual and automatic control over the rate of phasing and vibrato

Component set	£17·38
Printed circuit board	£2·33

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£3·20

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing

Component set (incl. PCB)	£4·74

WAH-WAH UNIT (P.E. Apr. 76)
The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component set (incl. PCB)	£3·63

AUTOWAH UNIT (P.E. Mar. 77)
Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.

Component set, PCB, special foot switches	£7·67
Component set and PCB, with panel switches	£4·83

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "talk-over"—particularly useful for Disco work or for home-movie shows.

Component set (incl. PCB)	£3·97

10% DISCOUNT VOUCHER (PE 72)

TERMS: Goods in current adverts & lists over £50 goods value (excl P&P & VAT). Correctly costed, C.W.O., U.K. orders only. This voucher must accompany order. Valid until end of month on cover of P.E.

ADD: POST & HANDLING
U.K. orders – Keyboards add £2·00 each plus VAT. Other goods: under £15 add 25p plus VAT, over £15 add 50p plus VAT. Recommended: optional insurance against postal mishaps, add 50p for cover up to £50, £1·00 for £100 cover, etc. pro-rata.
N.B. Eire, C.I., B.F.P.O. and other countries are subject to higher export postage rates.

ADD 12½% VAT
(or current rate if changed). Must be added to full total of goods, discount, post & handling, on all U.K. orders. Does not apply to Exports.

EXPORT ORDERS ARE WELCOME but to avoid delay we advise you to see our list for postage rates. All payments must be cash-with-order, in Sterling by International Money Order or through an English Bank. To obtain list – Europe send 20p, other countries send 50p.

PHONOSONICS · DEPT. PE72 · 22 HIGH STREET · SIDCUP · KENT DA14 6EH

TERMS: C.W.O., MAIL ORDER OR COLLECTION BY APPOINTMENT (TEL 01-302 6184)

AND OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list: Europe—send 20p: other countries—send 50p.

KIMBER-ALLEN KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes)	£25·50
4 Octave (49 notes)	£32·25
5 Octave (61 notes)	£39·75

Contact Assemblies (gold-clad wire) for use with the above KBDS (1 for each note):

Type GJ: Single-pole change-over	each 25½p
Type GA: 1 pair of contacts, normally open	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with most contacts (thus eliminating much interwiring) are available. Details in our lists.

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

Main component set (incl. PCB)	£14·93
Power supply set (incl. PCB)	£6·28

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl sw.)	£7·45

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)
A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

Component set	£24·05*
Printed circuit board	£3·03*

*This kit & PCB are at 8% VAT (all others are 12½%)

TAPE NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs

Standard tolerance set of components	£2·96
Superior tolerance set of components	£3·76
Regulated power supply (will drive 2 sets)	£4·69

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.

Component set (incl. PCB)	£4·58

DISCOSTROBE (P.E. Nov. 76)
4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation.

Basic component set	£18·19
Printed circuit board	£3·45

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)
Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Components set (incl. PCB)	£3·95
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6·69
Audio Amplifier Module Type PC7	£7·75

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.

SOPHISTICATED POWER SUPPLIES
A wide range of highly stabilised low noise power supply kits is available—details in our lists.

NEW PCB SERVICE

PCBS FOR ALL NEW P.E. & E.E. PROJECTS FOR WHICH PCB LAYOUTS HAVE BEEN PUBLISHED AND FOR WHICH FULL COPYRIGHT CLEARANCE IS AVAILABLE.

LIMITED QUANTITIES ONLY FOR AN EXPERIMENTAL PERIOD.

LET US KNOW YOUR NEEDS AND WE WILL ADVISE YOU OF AVAILABILITY AND PRICES.

INTEGRATED CIRCUITS

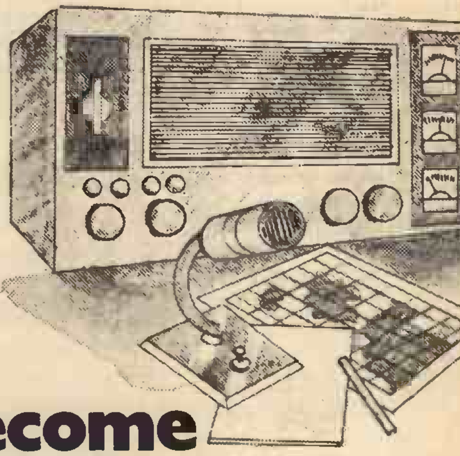
301	8-pin DIL	48p
318	8-pin DIL	220p
320-15	---	195p
324	14-pin DIL	87p
341-15	---	87p
709	8-pin DIL	48p
723	TO5	87p
723	14-pin DIL	51p
726	TO5	1005p
741	8-pin DIL	24p
748	8-pin DIL	57p
4007	14-pin DIL	17½p
4011	14-pin DIL	17½p
4024	14-pin DIL	46½p
4069	14-pin DIL	18p
4136	14-pin DIL	126p
AM2833	8-pin DIL	360p
AY10212	16-pin DIL	617p
AY16721/6		188p
CA3046	14-pin DIL	71p
CA3080	8-pin DIL	63p
CA3084	14-pin DIL	209p
FX209	16-pin DIL	729p
LM323	---	562p
M252	16-pin DIL	680p
MC3340	8-pin DIL	150p
MCM6810	24-pin DIL	670p
SG3402N	14-pin DIL	262p
STK025	---	595p
TDA1022	16-pin DIL	582p
XR2207	14-pin DIL	420p
ZN425E	16-pin DIL	375p

TRANSISTORS

AC128	32p
AC176	28p
BC107	13p
BC108	13p
BC109	15p
BC109C	16p
BC177	18p
BC184	11p
BC187	18p
BC204	10p
BC209C	13p
BC213	11p

PRICES ARE CORRECT AT TIME OF PRESS.
E. & O. E. DELIVERY SUBJECT TO AVAILABILITY.

PHONOSONICS



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7402	£0.09	7430	£0.08	7474	£0.22	74111	£0.55	74167	£2.00
7403	£0.09	7432	£0.20	7475	£0.27	74118	£0.75	74174	£0.60
7404	£0.09	7433	£0.28	7476	£0.22	74119	£1.10	74175	£0.60
7405	£0.09	7437	£0.20	7480	£0.40	74121	£0.22	74176	£0.55
7406	£0.22	7438	£0.20	7481	£0.80	74122	£0.35	74177	£0.55
7407	£0.22	7440	£0.10	7482	£0.65	74123	£0.38	74180	£0.80
7408	£0.12	7441	£0.45	7483	£0.55	74136	£0.50	74181	£1.25
7409	£0.12	7442	£0.38	7484	£0.82	74141	£0.50	74182	£0.55
7410	£0.09	7443	£0.68	7485	£0.65	74145	£0.54	74184	£1.00
7411	£0.15	7444	£0.68	7486	£0.22	74150	£0.65	74190	£0.68
7412	£0.14	7445	£0.64	7489	£1.60	74151	£0.45	74191	£0.68
7413	£0.22	7446	£0.60	7490	£0.30	74153	£0.45	74192	£0.65
7414	£0.45	7447	£0.45	7491	£0.60	74154	£0.80	74193	£0.60
7416	£0.22	7448	£0.52	7492	£0.32	74155	£0.48	74194	£0.55
7417	£0.22	7450	£0.09	7493	£0.28	74156	£0.48	74195	£0.55
7420	£0.09	7451	£0.09	7494	£0.70	74157	£0.48	74196	£0.60
7421	£0.19	7452	£0.09	7495	£0.45	74160	£0.55	74197	£0.58
7422	£0.15	7453	£0.09	7496	£0.48	74161	£0.60	74198	£1.00
7423	£0.20	7454	£0.09	74100	£0.80	74162	£0.60	74199	£1.00
7425	£0.18	7460	£0.09	74104	£0.35	74163	£0.60	74279	£1.00
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CD4002	£0.13	CD4019	£0.35	CD4037	£0.78	CD4069	£0.15
CD4006	£0.80	CD4020	£0.80	CD4040	£0.78	CD4070	£0.15
CD4007	£0.14	CD4021	£0.75	CD4041	£0.68	CD4071	£0.15
CD4008	£0.80	CD4022	£0.75	CD4042	£0.68	CD4072	£0.15
CD4009	£0.40	CD4023	£0.13	CD4043	£0.78	CD4081	£0.15
CD4010	£0.42	CD4024	£0.55	CD4044	£0.78	CD4082	£0.16
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Incorporating a short circuit protection and current limiting:

Voltage Regulation	2-30V
Regulated Current	0-2A
AC Input Maximum	25V

Eliminates the use of batteries and thus saves £'s-can be used time and time again ONLY £7.60 + V.A.T.

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ITT 923 Silicon Diodes 200mA 200v.

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Single-Sided Fibre Glass Board 12" x 3½" approx. 2 pcs £0.60

S143

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No. THY3A/50	3 Amp	50 volt	TO64	25p
No. THY3A/200	3 Amp	200 volt	TO64	32p
No. THY3A/400	3 Amp	400 volt	TO64	40p
No. THY5A/50	5 Amp	50 volt	TO66	25p
No. THY5A/400	5 Amp	400 volt	TO66	40p
No. THY5A/600	5 Amp	600 volt	TO66	50p
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S84 8 Amp 400 volt TO220 80p

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BR100	D32 each	12p

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All 3 at SPECIAL PRICE of £1.20•

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16163	21 Ceramic Caps	4700pF – 0.047µF

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Order No.		
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16214	60¼W.	1K – 8.2K
16215	60¼W.	10K – 82K
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16218	40½W.	1W – 8.2K
16219	40½W.	1K – 8.2K
16220	40½W.	100K – 820K

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No. MVR7812	µA7812	TO220	55p
No. MVR7815	µA7815	TO220	55p
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No. MVR7912	µA7912	TO220	75p
No. MVR7915	µA7915	TO220	75p
No. MVR7918	µA7918	TO220	75p
No. MVR7924	µA7924	TO220	75p

µA723C TO99 38p 72723 14 pin Dil 38p

LM309K TO3 £1.20

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No. S17	5 x Miniature Slide Switches	40p•
No. S18	4 x Standard Slide Switches	40p•
No. S19	4 x Miniature Push to Make single hole mounting	40p•
No. S20	3 x Miniature Push to Break single hole mounting	40p•
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S6	8 x 2 Pin Loudspeaker Plugs	50p•
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No. 16132	100 200mA Sil. diodes like OA200	40p
No. 16133	150 75mA Sil. Fast switching diode like IN4148	40p
No. 16134	50 750mA Sil. top hat Rects.	40p
No. 16135	20 3 amp Sil. stud Rect.	40p
No. 16136	50 400mw Zeners D.O.7 case	40p
No. 16137	30 NPN Plastic trans. like BC107/8	40p•
No. 16138	30 PNP Plastic trans. like BC177/8	40p•
No. 16139	25 NPN trans. like 2N697/ 2N1711 TO39	40p
No. 16140	25 PNP trans. like 2N2905 TO39	40p
No. 16141	30 NPN trans. like 2N706 TO18	40p
No. 16143	30 NPN Plastic trans. like 2N3906	40p•
No. 16144	30 PNP Plastic trans like 2N3905	40p•
No. 16145	30 PNP Germ. trans. like OC71	40p
No. 16147	10 NPN to 3 Power trans. like 2N3055	80p

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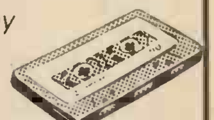

C90

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S24	6 x 1 K	LIN Single	40p*
S25	6 x 5 K	LIN Single	40p*
16193	6 x 22 K	LIN Single	40p*
16195	6 x 47 K	LOG Single	40p*
16194	6 x 47 K	LIN Single	40p*
S27	6 x 100 K	LIN Single	40p*
S28	6 x 100 K	LOG Single	40p*
S29	6 x 500 K	LOG Single	40p*
S32	6 x 50 K	LIN Single	40p*

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S30	6 x 2.5 K	LOG Single	40p*
S34	4 x 5 K	LOG Dual	40p*
S36	4 x 100 K	LOG Dual	40p*
S37	4 x 1.3 MEG	LOG Dual	40p*
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S132	2 x 24v Relays plastic case	£0.60*
S133	1 switch bank 5 way incl. silver knob	£0.75*
S134	2 x Magnets suitable for reed switches	£0.10
S135	.1 Veroboard pak 2 pcs 45 sq.ins. approx.	£0.80
S136	.15 Veroboard pak 2 pcs 60 sq. ins. appx.	£1.10
16199	.1 Veroboard pak pcs 30 sq. ins appx.	£0.50
16200	.15 Veroboard pak pcs 30 sq. ins. appx.	£0,50

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SUPER DUPER COMPONENT BOX

Min. 3lbs in weight consisting of a fantastic assortment of Electronic Components – Pots, Resistors, Condensers, Switches, Relays, Board – Semiconductors, wire, hardware, Etc., etc.,

This is a large box and is sent separate to your order £2.50 including p & p.
S140

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S141 0235 240v primary, 0-55v at 2 amps secondary. £4.50* + £1.00 p&p.

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STA25	25 watts per channel amplifier kit. Consists: 2xAL60–1xPA100–1xSPM120/45 1x2040 Transformer –1xreservoir cap 2xcoupling capacitors	£41.45 inc VAT + £1.16p p& p
STA35	35 watts per channel amplifier kit. consists: 2xAL80–1xPA100–1xSPM120–1x2041 transformer— 1 reservoir capacitor 2xcoupling capacitors	£48.45 inc VAT + £1.16p p & p
STA50	50 watts per channel amplifier kit. Consists: 2xAL120–1xPA200–1xSPM120/65 1x2041 transformer –1xreservoir capacitor 2xcoupling capacitors	£58.20 inc VAT + £1.10p p & p
STA125	125 watts per channel amplifier kit. Consists: 2xAL250–1xPA200 –2xSPM120/65 2x2041 transformers–1xreservoircapacitor 2xcouplingcapacitors	£72.85 inc VAT + £1.25p p & p

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BRAND NEW — FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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AC126	14p	BC178	12p	BF195	*9p	TIP328	35p	2N1711	15p
AC127	16p	BC179	12p	BF196	*12p	TIP32C	36p	2N1893	28p
AC128	16p	BC182	*9p	BF197	*12p	TIP41A	34p	2N2218	15p
AC128K	24p	BC182L	*9p	BF200	25p	TIP41B	35p	2N2218A	18p
AC176	16p	BC183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	BC183L	*9p	8FX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	BC184	*9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	8C184L	*9p	8FY51	12p	TIP42C	38p	2N2221A	16p
AC188	16p	BC212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	*10p			TIP3055	42p	2N2222A	16p
AD161		8C213	*10p	MPSA05	*22p	ZTX107	*6p	2N2369	10p
162MP	80p	BC213L	*10p	MPSA06	*22p	ZTX108	*6p	2N2904	14p
AF139	30p	8C214	*10p	MPSA55	*22p	ZTX109	*7p	2N2904A	15p
AF239	30p	8C214L	*10p	MPSA56	*22p	ZTX300	*7p	2N2905	14p
8C107	6p	8C251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
BC108	6p	8CY70	12p	OC45	12p	ZTX302	*9p	2N2906	12p
8C109	6p	8CY71	12p	OC71	9p	ZTX500	*8p	2N2906A	14p
8C118	*10p	8CY72	12p	OC72	12p	ZTX501	*10p	2N2907	12p
8C147	*8p	8D115	*40p	OC75	10p	ZTX502	*12p	2N2907A	13p
BC148	*8p	BD131	*35p	OC81	14p	2N696	10p	2N2926G	*8p
BC149	*8p	8D132	*37p			2N697	10p	2N2926Y	*7p
BC154	*16p	8F115	17p	TIP29A	35p	2N706	7p	2N3053	12p
8C157	*9p	8F167	19p	TIP29B	36p	2N706A	8p	2N3055	35p
8C158	*9p	8F173	20p	TIP29C	38p	2N708	8p	2N3702	*7p
8C159	*9p	BF180	25p	TIP30A	36p	2N1302	12p	2N3703	*7p
8C169C	*10p	BF181	25p	TIP30B	37p	2N1303	15p	2N3704	*6p
BC170	*6p	8F182	25p	TIP30C	38p	2N1304	15p	2N3903	*11p
8C171	*6p	8F183	25p	TIP31A	32p	2N1307	18p	2N3904	*11p
8C172	*6p	BF184	25p	TIP31B	33p	2N1308	22p	2N3905	*11p
8C173	*7p	8F185	25p	TIP31C	34p	2N1309	22p	2N3906	*11p

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	8AX16/		8YZ16	30p	OA85	7p	IS44	3p
AAZ13	4p	OA202	5p	8YZ17	28p	OA90	6p		
8A100	6p			8YZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	8YZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	*10p					IN5402	12p
8A148	10p	BYZ10	32p	OA47	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA70	5p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA79	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p	OA81	7p	IN4148	4p	IN5408	19p

LINEAR I.C.'s

TBA800	£0.75*	UA711	£0.25*	UA748	£0.28*
TBA810	£0.85*	UA703	£0.20*	72558	£0.45*
TBA820	£0.65*	741P	£0.18*	MC1310P	£1.25*
LM380	£0.80*	72741	£0.20*	76115	£1.25*
LM381	£1.25*	UA741C	£0.20	NE555	£0.22
72709	£0.20	72747	£0.55*	SL414A	£1.80*
UA709	£0.20	748P	£0.28*		

ZN 414 RADIO CHIP 75*

OPTOELECTRONICS

Displays

No. 1510 707 LED Display £0.70
No. 1511 747 LED Display £1.50
No. 1512 727 Dual LED Display £1.55

LED's

No. S120 .125	Bright Red	£0.09
No. S121 .2	Bright Red	£0.09
No. 1502 .125	Green	£0.12
No. 1505 .2	Green	£0.12
No. 1503 .125	Yellow	£0.12
No. 1506 .2	Yellow	£0.12
No. S82	Clear .2 illuminating Red	£0.10

2nd Quality Led Paks

No. 1507	10 Assorted Colours & Size	£0.75
No. S122	10 x .125 Red	£0.60
No. S123	10 x .2 Red	£0.60

LED Clips

No. 1508/.125	.125	5 for	£0.12
No. 1508/.2	.2	5 for	£0.15

No. S139 Infra Red Emitter Fairchild FPE100 **£0.50**

SPECIAL REDUCTIONS

No. 1514	NORP 12	each 45p
No. S76	OCP71	5 for £1.00
No. S83 5	NIXIE Tubes ITT 5870 ST (including Data)	£2.00
No. S77	Neon Indicator Lamps 230V A.C. State Colour (Red, Amber and Green.)	25p each

P.O. RELAYS

S85 – 2 Off Post Office relays 40p*

BATTERY HOLDERS

to take 6 x HP7's.
Order No. 202 each 10p

EX. G.P.O. | MICROSWITCHES

Order No. S51 4 for 50p

CABLE CLIPS

S65 – 50 2.5mm round single pin fixing 30p

POWER SUPPLY STABILIZER BOARD

Unused ex-equipment stabilizer board, Input 30V. D.C. Output 20V. Complete with circuit diagram.
Order No. S81 £1.25*

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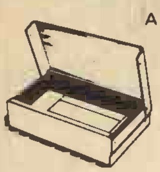
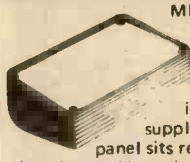
BIMENCLOSURES



ALL METAL BIMCASES

Red, Grey or Orange 14swg Aluminium removable top and bottom covers. 18 swg black mild steel chassis with fixing support brackets.

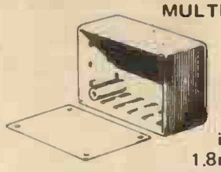
BIM 3000
(250x167.5x68.5mm)
£14.58



MINI DESK BIMCONSOLES

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.

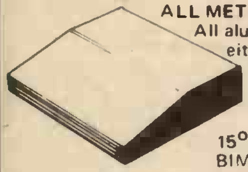
BIM 1005 (161 x 96 x 58mm) £2.18
BIM 1006 (215 x 130 x 75mm) £3.05



MULTI PURPOSE BIMBOXES

Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

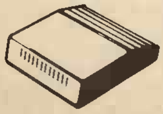
BIM 4003 (85x56x28.5mm) £1.18
BIM 4004 (111x71x41.5mm) £1.62
BIM 4005 (161x96x52.5mm) £2.19



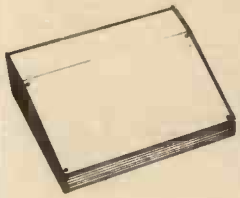
ALL METAL BIMCONSOLES

All aluminium, 2 piece desk consoles with either 15° or 30° sloping fronts, sit on 4 self-adhesive non-slip rubber feet. Ventilation slots in base and rear panel for excellent cooling.

Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold



15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£10.67
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£11.44
BIM7153 (165x216x51[28] mm)	BIM7303 (165x183x102[28] mm)	£12.61
BIM7154 (165x211x76[33] mm)	BIM7304 (254x140x76[28] mm)	£13.82
BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£15.36
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£16.67
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£17.58
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£18.55



LOW PROFILE BIMCONSOLES

Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

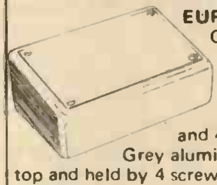
BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.37
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.08
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.12

ABS & DIECAST BIMBOXES

6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x60x31mm)	N/A		BIM5001/11	TBA	TBA
(100x50x25mm)	BIM2002/12	£0.96	BIM5002/12	£1.46	£1.19
(112x62x31mm)	BIM2003/13	£1.13	BIM5003/13	£1.78	£1.46
(120x65x40mm)	BIM2004/14	£1.35	BIM5004/14	£2.24	£1.82
(150x80x50mm)	BIM2005/15	£1.52	BIM5005/15	£2.84	£2.28
(190x110x60mm)	BIM2006/16	£2.37	BIM5006/16	£3.94	£3.33

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.00

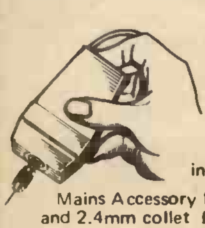


EUROCARD BIMCONSOLES

Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

BIM 8005 (169x127x70[45] mm) £4.12
BIM 8007 (to be announced shortly)

BIMTOOLS



MAINS BIMDRILLS

Small, powerful 240V hand drill complete with 2 metres of cable and 2 pin DIN plug. Accepts all tools with 1mm, 2mm or .125" dia. shanks. Drills brass, steel, aluminium and pcb's. Under 250g, off load speed 7500 rpm. Orange ABS, high impact, fully insulated body with spring return on/off switch £10.53

Mains Accessory Kit 1 includes 1mm, 2mm, .125" twist drills, 5 burrs and 2.4mm collet £2.48

Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £22.14

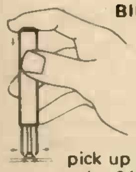
12 VOLT BIMDRILLS

2 small, powerful drills easily hand held or used with lathe/stand adaptor. Integral on/off switch and 1 metre cable.

Mini BIMDRILL with 3 collets up to 2.4mm dia £ 8.10
Major BIMDRILL with 4 collets up to 3mm dia £13.60

Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 – £15.12, Major Kit 1 – £19.44.
Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains 12V dc adaptor. Mini Kit 2 – £34.02, Major Kit 2 – £39.42.

Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 – £45.36, Major Kit 3 – £50.76.



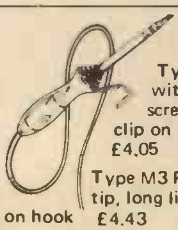
BIMDIPS

Rapidly inserts and withdraws any 4-18 pin, .3" pitch DIL package without beding the legs. Adjustable metal jaws for MOS type devices grip the bottom of the leg for minimum strain. Will pick up IC's from a bench, a carrier or a pcb. £13.77.

BIMSNIPS

Precision made side cutters, spring action, ground steel fine pointed blades for intricate work.

5¼" long £3.34

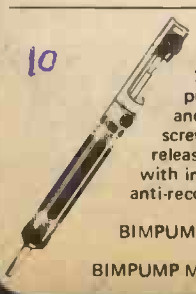


BIMIRONS

Type 30 General Purpose 27 watt iron with long life, rapid change element, screw on tip, stainless steel shaft and clip on hook. Styled handle with neon. £4.05

Type M3 Precision 17 watt iron, quick change tip, long life element, styled handle with clip on hook £4.43

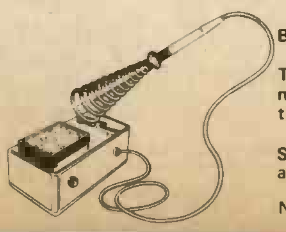
10



BIMPUMPS

2 all metal desoldering tools provide high suction power and have easily replaceable screw-in Teflon tips. Primed and released by thumb operation with in-built safety guard and anti-recoil system.

BIMPUMP Major (180mm long) £7.99
BIMPUMP Minor (150mm long) £6.80



BIMSTATION

Type PSU6 Soldering Iron Station complete with 6V, 6 Watt miniature iron having stainless steel shaft, quick change slide on tip and long life element.

Station contains 240V/6V transformer, neon, coiled iron support and sponge iron tip cleaning pad.

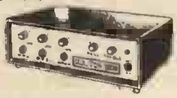
New product available shortly

SUPERSOUND 13 HI-FI MONO AMPLIFIER

A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high × 6in wide × 7½in deep. AC 200/250V.

PRICE £16·00 P. & P. £1·20.

HARVERSONIC MODEL P.A. TWO ZERO



An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp.). Input 1, 15mV into 47k. Input 2, 15mV into 47k (suitable for use with mic. or guitar etc.). Input 3, 200mV into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240 volts. Size approx. 12½in wide × 5in high × 7½in deep.

Special introductory price £28·00 + £2·50 carriage and packing.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER

Size 11¾in × 14 11/16in × 1 7/16in deep. Weight 19oz. Power handling 20W R.M.S. (40W peak). Impedance 8 ohm only. Response 40Hz-20KHz. Can be mounted on ceilings, walls, doors, under tables, etc. and used with or without baffle. Send S.A.E. for full details. Only £8·40 each + P. & P. (one 90p, two £1·10). Now available in either 8in round version or 4½ × 8½in rectangular. 10 watts R.M.S. 60Hz-20kHZ £5·25 + P. & P. (one 65p, two 75p.).

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER

200/240V Mains operated Solid State F.M. A.M. Stereo Tuner. Covering M.W. A.M. 540-1605KHz V.H.F. F.M. 88-108MHz. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on A.M. and F.M. Stereo Beacon Lamp Indicator. Built in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600mV R.M.S. into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8½in wide × 4in high × 9½in deep approx.

Limited number only at £28·00 + £1·50 P. & P.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up. 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p + S.A.E. (Free with parts). All parts sold separately. ONLY £15·50 P. & P. £1·40. Also available ready built and tested £20·00 P. & P. £1·40.

STEREO MAGNETIC PRE-AMP Sens. 3mV in for 100mV out. 15 to 35V neg. earth. Equ. ±1dB from 20Hz to 20KHz. Input impedance 47K. Size 1⅝in × 2⅜in × 5⅜in H. £2·60 + 20p. P & P.

Mullard LP1159 RF-IF module 470 kHz £2·25 + P. & P. 20p. Full specification and connection details supplied.

Pye VHF FM Tuner Head covering 88-108 MHz 10·7 MHz I.F. output. 7-8V + earth. Supplied pre-aligned, with full circuit diagram with precision-geared F.M. gang and 323PF + 323PF A.M. Tuning gang only £3·15 + P. & P. 35p.

SPECIAL OFFER

Slightly shop soiled radios by well-known manufacturer for AC Mains or battery use. MW and FM bands. Dynamic M/coil speakers, telescopic aerial and Internal ferrite aerial. Earpiece socket for personal listening. Finished in attractive simulated leatherette.

Size 7"H × 9½"W × 4"D approx. Fully guaranteed.

Bargain price of only £10·00 + £1·30 p&p.

MODEL FL4

Few only similar to above, but battery operation only. Twin speakers. Four wave bands. MW, FM and two VHF bands for reception of aircraft and some public services. ONLY £9·50 + £1·30 p&p.

MODEL MULTI 5

Specification as Model FL4 but with additional SW band.

Twin speakers. ONLY £11·00 + £1·30 p&p.

HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integral pre-amp with Bass, Treble and two Volume controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metalwork, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification. Power output 14 watts R.M.S. per channel into 5 ohms. Frequency response ±3dB 12-30,000Hz. Sensitivity better than 80mV into 1 MΩ. Full power bandwidth ±3dB 12-15,000Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1A.

Overall size 12in wide × 8in deep × 2½in high.

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT (Magnetic input components 33p extra)	£14·50 P. & P. 80p
POWER PACK KIT	£6·00 P. & P. 95p
CABINET	£6·00 P. & P. 95p

SPECIAL OFFER—only £25·00 if all 3 items ordered at one time plus £1·25 P. & P.

Full after sales service

Also available ready built and tested £31·25 P. & P. £1·50

HARVERSONIC STEREO 44

A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec play socket are mounted on the printed circuit panel. Size approx. 9½in × 2¼in × 1in max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically) at only £10·00 + 50p P & P. Mains transformer with an output of 17V a.c. at 500mA can be supplied at £2·00 + 40p P. & P. If required. Full connection details supplied.

STEREO DECODER

SIZE 2" · 3" · ½" ready built. Pre-aligned and tested for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6·00 plus 20p P. & P. Stereo beacon light if required 40p extra.

Open 9.30–5.30 Monday to Friday. 9.30–5 Saturday Closed Wednesday.

Prices and specifications correct at time of press. Subject to alteration without notice

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PIEZO HORNS

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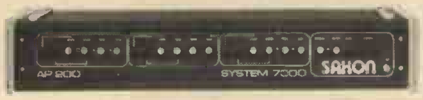

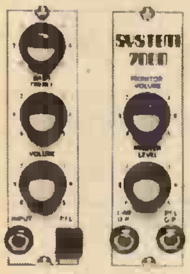

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PE VOLUME 15 No. 2 FEBRUARY 1979

MICRO MONEY

As we go to press the Government has announced a further £100 million investment in microelectronics. This makes the total investment something in the order of £400 million which exceeds the involvement of both the French and German governments. The extra money will be split with £60 million going to education and £40 million to encourage industry to employ microelectronics in products, in the automation of manufacturing equipment and in updating office equipment and practices.

The Prime Minister stated that the use of microelectronics would bring "some crucial job losses" but it was also pointed out that in the past the introduction of new technology had eventually given rise to an increase in jobs in particular industries. The Government Think Tank has also commented on "the contrast between the vehemence of those who claim that microelectronics will have a catastrophic effect on unemployment and the inadequacy of the analysis underlying the certainty of that prediction."

It is indeed heartening to hear such phrases as "dominant technology of the next decade" and to find ministers urging Britain to compete—fast and, what's more, putting our money where their mouth is!

The point that saddens us is that £15 million has to be spent in making direct presentations to industry to encourage the use of microelectronics. Perhaps we are too conservative to have believed any of the predictions made a few years ago, but surely more of them should have been investigated without companies having to be pushed.

It is often said that the car mechanic is the man slowing down the introduction of electronics to our every day transport, but he will have to accept the computer controlled engine eventually so let's get on with it. Training is what is needed—or retraining as the case may be—and the injection of money has been welcomed by both the CBI and TUC.

HOME COMPUTERS

One area where the microprocessor has found a ready market is in the home computer and now that a significant number of systems and peripherals are available we are taking another in-depth look at the subject. The interest being shown in the P.E. VDU System (published recently) and the P.E. Microprinter shows a demand for peripherals at the right price and both these projects meet that need admirably. We hope to bring you more projects like these in future. We are now finding a number of hobbyists and engineers that did not follow the microprocessor teach-ins the first time around and it is our intention to publish a simple microprocessor system and describe the first steps in programming in the near future. So all those that want to learn the subject, and it appears to be of growing importance in many areas, watch out for further announcements.

DON'T MISS OUT

Whilst looking at forthcoming subjects, we would urge you not to miss any issues and one way of ensuring your copy is to place a regular order with your newsagent. Often we find readers unable to get copies because of heavy demand and since our next issue will carry a 108-page Tandy catalogue (U.K. mainland sales only) and subsequent issues another catalogue and a free gift worth at least £1, demand is likely to be extra heavy—you have been warned.

Mike Kenward

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By MICHAEL TOOLEY B.A.
and DAVID WHITFIELD B.A.

PULSE GENERATOR

ELECTRONICS is a subject which is largely concerned with the generation and processing of a wide variety of electrical signals. While sine waves are still the most commonly generated waveforms, pulse waveforms are continuing to find ever-widening applications in communications and digital systems. The advent of cheap, readily available digital integrated circuits has brought with it the need for suitable test equipment which will allow the constructor to troubleshoot such digital systems under known conditions. This logic pulse generator is capable of providing waveforms of known characteristics over a wide range of frequencies and pulse widths and has the ability to slow down the operation of circuits to sub-Hertz frequencies to allow tests to be done at speeds low enough to enable functions to be verified with a conventional multimeter.

This instrument also features independent control over both pulse width and pulse frequency.

CIRCUIT DESCRIPTION

The wave generation system used in the pulse generator features an astable multivibrator to control the pulse repetition frequency and a monostable to determine the output pulse width. The complete circuit diagram of the pulse generator is shown in Fig. 1.

The control circuit uses a 555 timer (IC1), to produce a wavetrain of the required pulse repetition frequency. The actual frequency is determined by the values of the fixed resistors, R1/R2, the setting of the potentiometer, VR1, and the value of capacitor selected, C3 to C8. The resistors set the ratio of the maximum-to-minimum frequency coverage in the ranges, while the capacitor selected determines the actual frequency coverage. The circuit allows modest values of timing components to be used in generating very low frequency signals, without requiring values for the higher ranges which are so low as to make stray capacitances unduly significant. The performance of the astable is independent of supply voltage fluctuations and the output is a stable wavetrain with a well-defined repetition rate and an arbitrary pulse width.

The monostable circuit (IC2) uses a 74121 to set the output pulse width. The astable output drives the monostable active-high input, the active-low inputs being disabled. This configuration causes an output pulse to be produced each time a low-to-high transistion occurs at the input. The width of the pulse produced is determined by the timing components, VR2, R5 and C11 to C17. The circuit thus produces two complementary outputs whose repetition frequency is set by the astable and whose pulse width is set by the timing components of IC2. A single-shot facility is provided by using S3, to disable the output of the astable. The momentary switch action may then be used to generate a trigger pulse for the monostable whenever an output pulse is required.

The two monostable outputs are used directly to provide the normal and inverted TTL output signals. Each output will drive up to 10 normalised TTL loads. In addition, the inverted TTL output is used to produce the 0-10 volt variable output. The level translator, TR1, produces 180 degrees of phase shift and drives the emitter follower, TR2. The output signal is taken from a variable tapping on the emitter load resistance, VR3. The Zener diode, D1, serves to set the maximum output level and stabilise the collector potential of TR2.

Some typical operational waveforms are illustrated in the oscillograms in (Fig. 2, 3 and 4).

Front panel annotation

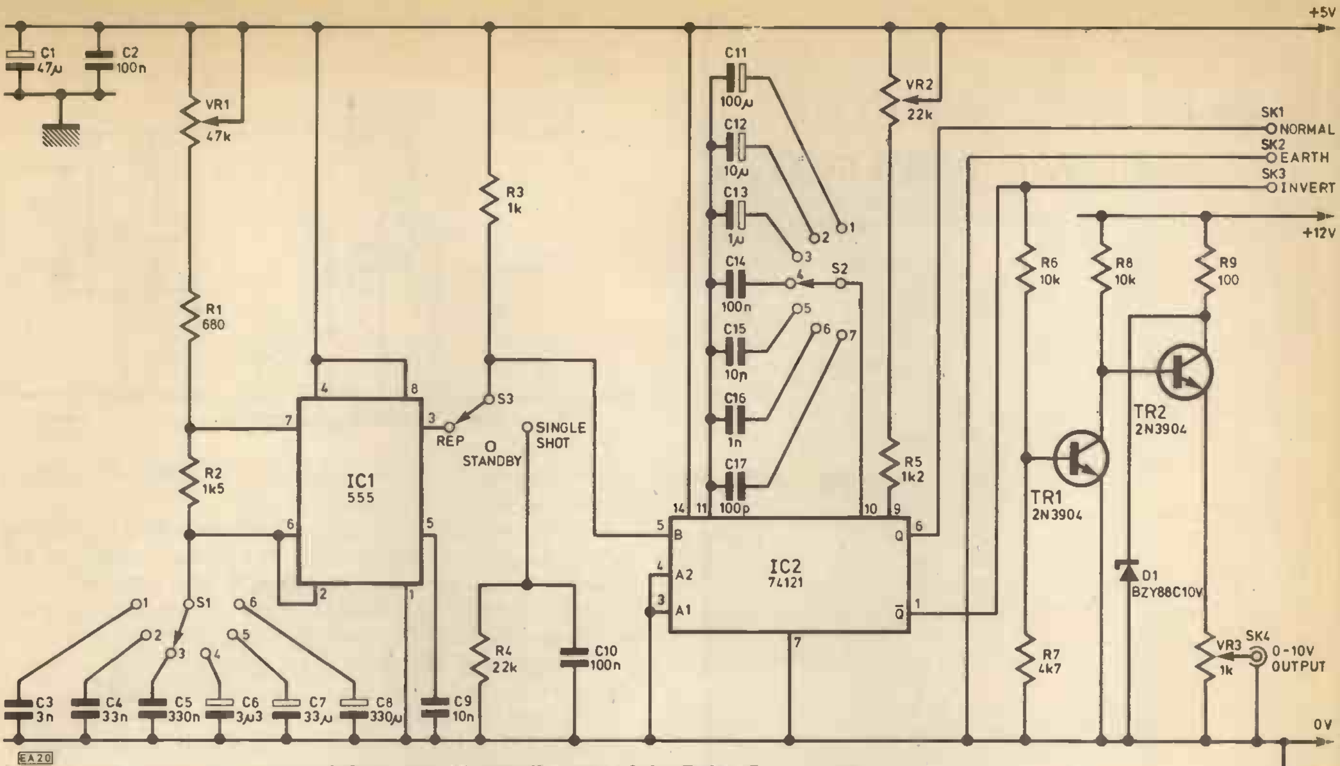


Fig. 1 Complete circuit diagram of the Pulse Generator

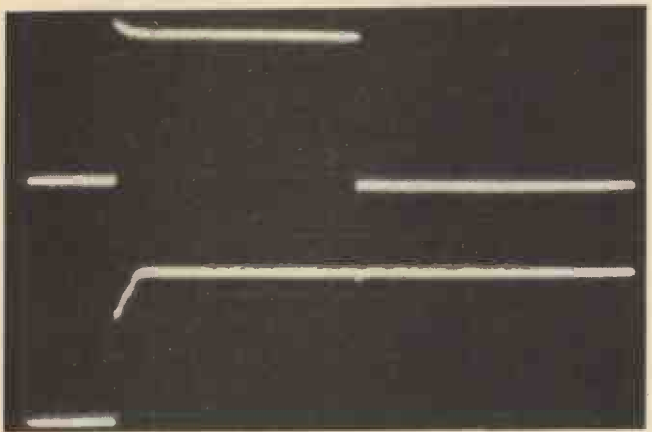


Fig. 2 Upper trace—Non inverted TTL output (IC2 pin 6)
Lower trace—Output from the astable (IC1 pin 3)
Oscilloscope setting 1µs/cm and 2V/cm

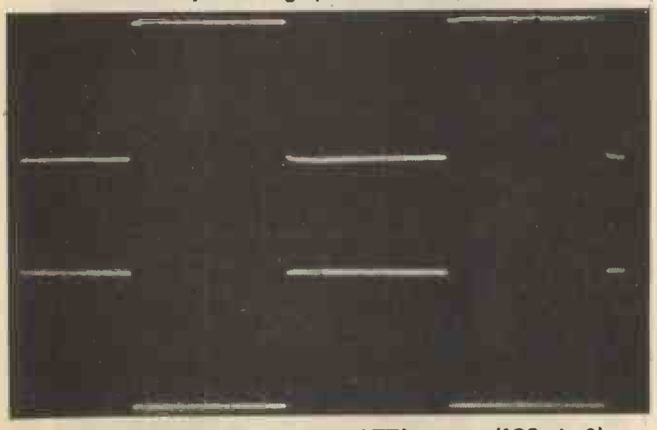


Fig. 3 Upper trace—Non inverted TTL output (IC2 pin 6)
Lower trace—Inverted TTL output (IC2 pin 1)
Oscilloscope setting 10µs/cm and 2V/cm. Pulse Generator set to 10kHz

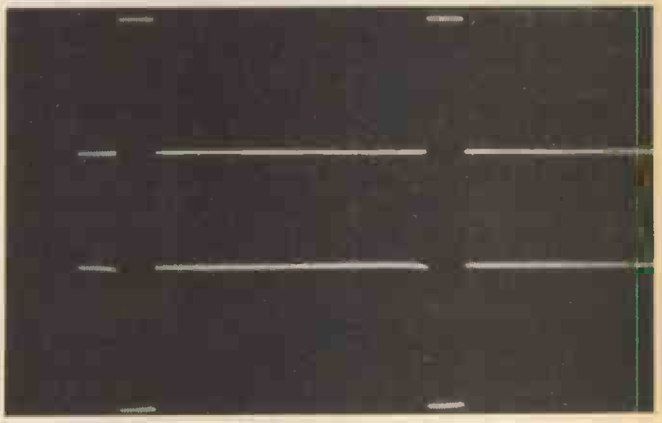


Fig. 4 Upper trace—Non inverted TTL output (IC2 pin 6)
Lower trace—Inverted TTL output (IC2 pin 1)
Oscilloscope setting 10µs/cm and 2V/cm (10:1 pulse at 10kHz)

WAVEFORM MONITORING CIRCUIT

When using any form of pulse generator featuring independent control over both pulse width and repetition frequency, it is usually possible to select combinations which, between them, represent an unrealistic waveform. In practical terms this means that, whatever the front panel controls may say, it is impossible to repeat a 1ms pulse at a frequency greater than 1kHz. Indeed, in order to produce a square wave at 1kHz, a pulse width of 500µs is required. In practical situations it was therefore felt that some form of advance warning of this condition would be a useful reminder to the user of the instrument, especially if it could be incorporated with little additional circuitry.

The circuit of Fig. 5 illuminates the l.e.d. when the duty cycle (the proportion of the cycle during which the normal output is "high") exceeds 50 per cent, a mark space ratio of 1:1. Thus, for a pulse repetition frequency of 1kHz, the l.e.d. will be illuminated when the pulse width exceeds 500µs.

SPECIFICATION

OUTPUTS

Non-inverted TTL	Output impedance ("high" level) =70 ohms
Inverted TTL	Output impedance ("low" level) = 12 ohms
	Each output will drive up to 10 normalised TTL loads, i.e. sink up to 16mA ("low") or source up to 400µA ("high").
	Rise and fall times better than 10ns unloaded.
High level output	Output impedance ⋞1 kilohms
	Output continuously variable from 0 to 10V peak.

RANGES

Pulse frequency	Pulse width
0·1Hz–1Hz	100ns–2µs
1Hz–10Hz	1µs–20µs
10Hz–100Hz	10µs–200µs
100Hz–1kHz	100µs–2ms
1kHz–10kHz	1ms–20ms
10kHz–100kHz	10ms–200ms
	100ms–2s

All ranges overlap by approximately 15 per cent of the maximum nominal range value at either end of the range in order to ensure both total coverage and simplicity of use.

The operational amplifier, IC3, acts as a low pass filter and comparator. The integrating components, R10 and C18, set the time constant of the filter and the mean level of the output from IC2 is compared with the potential at the junction

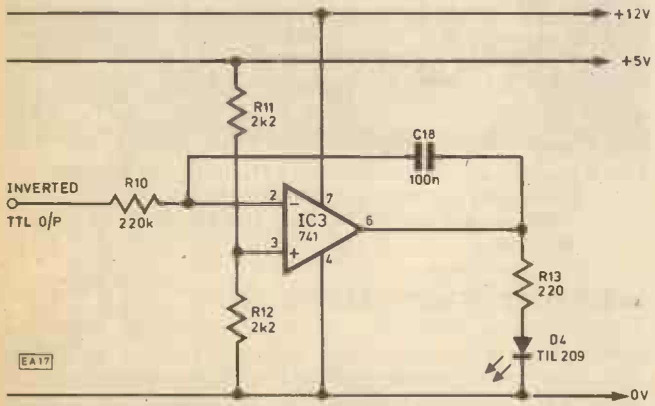


Fig. 5 Circuit diagram to illuminate the duty cycle l.e.d. when an unrealistic waveform has been selected

of R11 and R12. When the mean signal level exceeds this potential, the l.e.d. is illuminated. Making the values of R11 and R12 equal causes the l.e.d. to be illuminated at a duty cycle of 50 per cent. At very low frequencies the l.e.d. provides a direct visual indication of the waveform duty cycle.

POWER SUPPLY

The circuit of Fig. 6 provides the necessary supply voltages for operating the pulse generator from the mains supply. A centre-tapped transformer (T1), is used with a full-wave rectifier, D2 and D3, to build up a d.c. voltage across the reservoir capacitor, C19. This voltage is used directly to

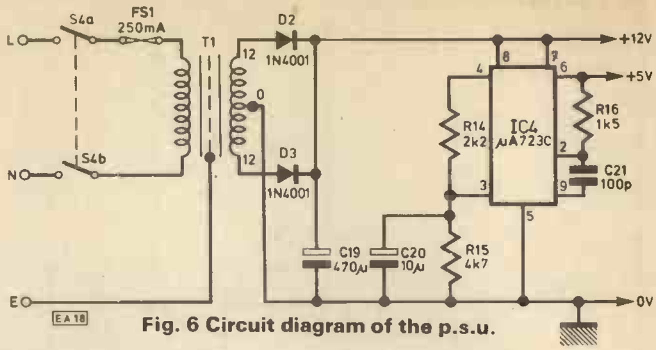


Fig. 6 Circuit diagram of the p.s.u.

provide the supply for the operational amplifier, IC3, and the variable-output buffer amplifier stages.

An integrated circuit regulator (IC4), is used to provide the 5V supply for the logic circuits. The output voltage of the regulator is set by the values of R14 and R15, with R16 selected to minimise temperature drift. The circuit has a line regulation of 0·5mV for a change of input voltage of 3V, and a load regulation of 1·5mV for a change in load current of 50mA. Frequency compensation is provided by C21.

For portable operation, the transformer and rectifier components may be omitted, and the d.c. supply (in the range 12 to 18 volts) connected across the reservoir capacitor, C19.

CONSTRUCTION

The unit was constructed on a p.c.b. the layout of which is shown in Fig. 7 with the component overlay shown in Fig. 8. A careful check should be made that the semiconductors and integrated circuits are correctly orientated. The use of

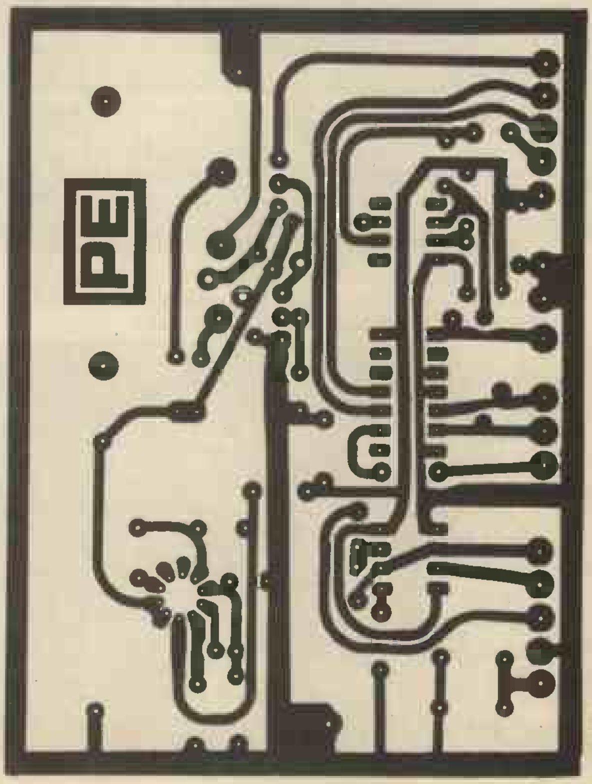


Fig. 7 P.c.b. layout for the Pulse Generator

COMPONENTS . . .

Resistors

R1	680
R2, R16	1k5 (2 off)
R3	1k
R4	22k
R5	1k2
R6, R8	10k (2 off)
R7, R15	4k7 (2 off)
R9	100
R10	220k
R11, R12, R14	2k2 (3 off)
R13	220

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

Capacitors

C1	47μ elect
C2, C10, C14, C18	100n (4 off)
C3	3n polystyrene
C4	33n polystyrene
C5	330n
C6	3μ3 elect
C7	33μ elect
C8	330μ elect
C9, C15	10n (2 off)
C11	100μ 10V elect
C12	10μ elect
C13	1μ elect
C16	1n polystyrene
C17, C21	100p polystyrene
C19	470μ 25V elect
C20	10μ 16V elect

Potentiometers

VR1	47k log
VR2	22k lin.
VR3	1k lin. with d.p.s.t. switch

Switches

S1	Rotary switch 2 pole 6 way
S2	Rotary switch 1 pole 12 way
S3	Sub min toggle switch, single pole c/o centre off, biased one way

Semiconductors

D1	BZY88 C10V 400mW Zener
D2, D3	1N4001 (2 off)
D4	TIL209 l.e.d.
TR1, TR2	2N3904 (2 off)
IC1	NE555
IC2	SN74121P
IC3	741P
IC4	μA723C

Miscellaneous

T1	12–0–12V 50mA transformer
FS1	250mA
SK1	B.N.C. round socket
SK2, 3, 4	RS type 444-703

Control knobs
Case

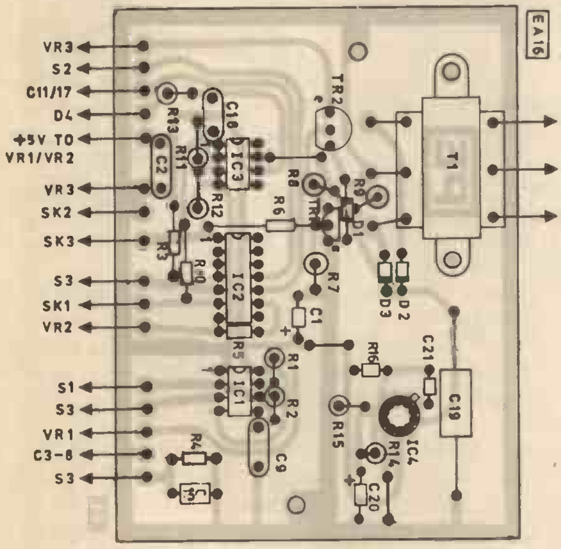


Fig. 8 Component overlay for p.c.b.

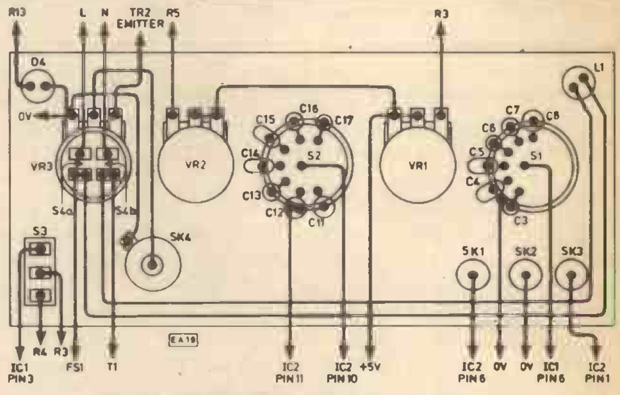


Fig. 9 Wiring diagram for front panel

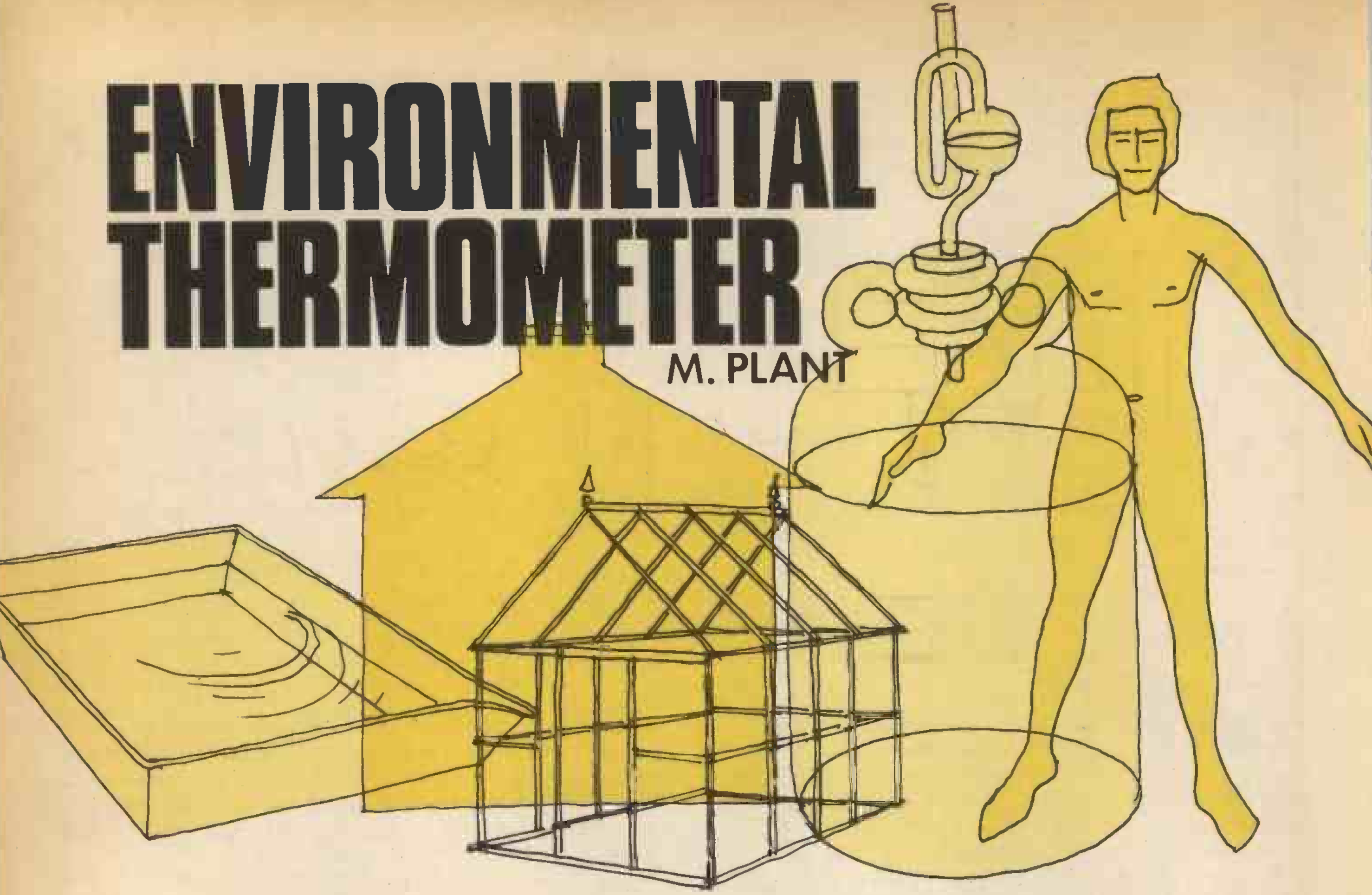
integrated circuit holders is also recommended.

The pulse generator is housed in a small aluminium case fitted with a detachable cover. The mains transformer is secured to the printed circuit board using two 4BA nuts and bolts and the board itself is supported by means of two pillars attached to the base of the case. Interconnecting wires, from the printed circuit board to the front panel, should be kept as short and as neat as possible. The use of colour coded wires is recommended as this further simplifies construction. The layout of the front panel is shown in the photograph with the corresponding internal wiring shown in Fig. 9. Capacitors C3 to C8 and C11 to C17 are mounted directly on S1 and S2 respectively. The common connection in each case consisting of a short length of 18 s.w.g. tinned copper wire formed into a circle of approximate diameter 22mm. The resulting capacitor assembly being self-supporting.

The front panel should be labelled using dry transfers and then given a light coating of clear protective lacquer. ★

ENVIRONMENTAL THERMOMETER

M. PLANT



THIS environmental thermometer which is capable of measuring temperatures from −15°C to 50°C uses a moving coil meter that can be switched over three ranges (−15°C to 10°C, 5°C to 30°C, 25°C to 50°C) to display the temperature reading.

The thermometer is easy to calibrate since the zero setting and range controls are independent of each other. This means that once the range is set for one scale, only one calibration point is required for each of the other ranges.

DESIGN CONSIDERATIONS

One of the problems to overcome when designing stable electronic circuits is the unwanted effect that changes in temperature have on the characteristics of the semiconductors being used. This effect is exploited in the thermistor although this is an unsuitable device for an electronic thermometer since the marked non-linearity of its resistance/temperature characteristics needs to be compensated for before a linear display on a meter can be obtained.

Since an ordinary silicon transistor is temperature sensitive, with the forward voltage drop of the pn junction varying linearly with the temperature (provided the current flowing through this semiconductor junction is maintained constant) it is ideal for use in a thermometer probe.

All three elements of the thermometer have linear characteristics, the pn junction temperature sensor produces a voltage which is directly proportional to temperature, the voltage amplifier has a linear transfer characteristic and the display element produces a visual reading which is proportional to the voltage fed to it from the amplifier.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Environmental Thermometer is shown in Fig. 1. There are two main aspects of this circuit. One is the constant current generator provided by IC2a and the other is the highly stabilised power supply provided by IC1. Once the latter is achieved, the former is automatically obtained. An integrated circuit regulator, IC1, is used for obtaining a split voltage stabilised supply for the operational amplifiers, IC2a and IC2b. The regulator i.c. is wired up to give a ±7V dual supply from a single ended input voltage in the range 18V to 27V. The current drawn by the circuit is only a few milliamps which the regulator can supply without the need for current buffer transistors. Thus two or three small PP3 batteries connected in series can operate the circuit for long periods. The advantage of relying on the internal reference diodes in the regulator i.c. is that they are internally temperature compensated.

The transducer pn junction (D3) may either be a silicon diode or the base-emitter junction of a silicon transistor. In the prototype probe a plastic packaged ZTX300 transistor was used to good effect since it is both small and resistant to the corrosive effects of any liquids into which it might be immersed.

In order to keep circuit interconnections as simple as possible, a dual op amp integrated circuit was used for IC2. Op amp IC2a is wired as a constant current generator with its non-inverting input placed at ground potential through R6. Due to the high gain of the op amp, the output voltage always moves sufficiently positive to maintain the inverting input at ground voltage as well. Thus the current through R5 is set at about 7V/120k or 60µA by the ground to −ve rail stabilised voltage. Since the current into pin 1 of the op amp is very small and can be neglected, all the constant current which flows through the pn junction is small enough not to cause self-heating of the junction.

The second op amp IC2b offsets the diode voltage to whatever range is selected and the second provides

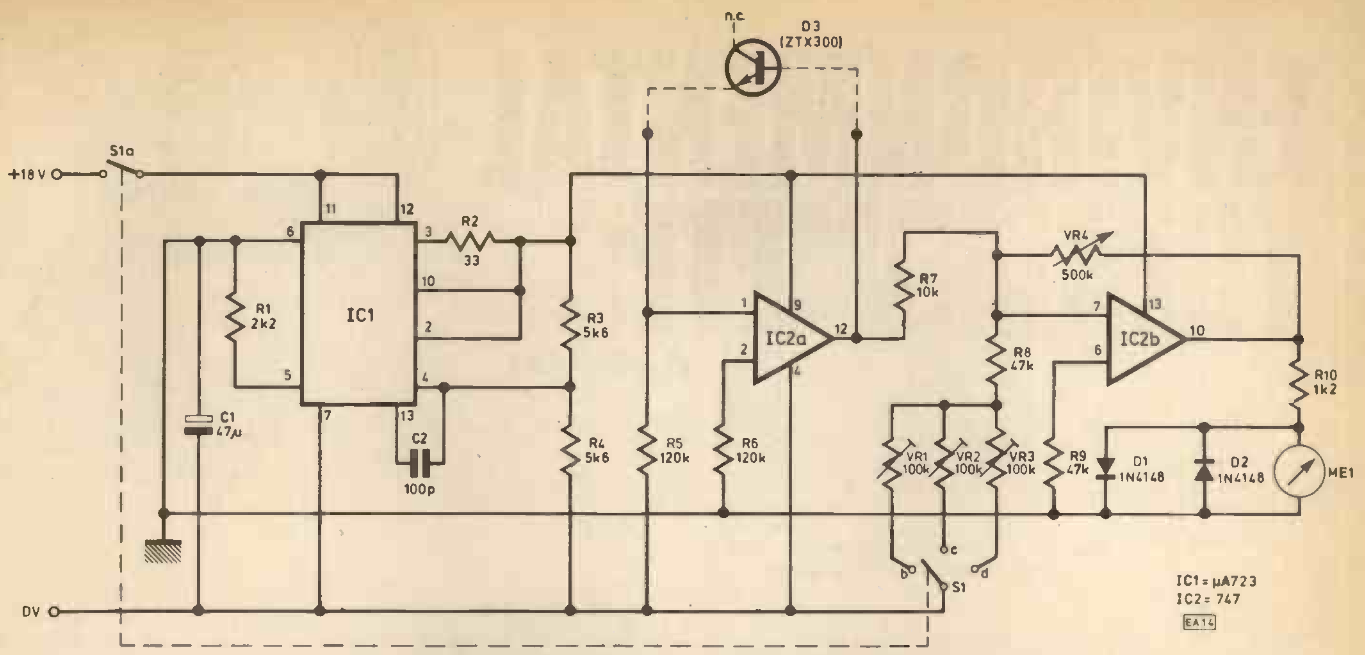


Fig. 1. Complete circuit diagram of the Environmental Thermometer

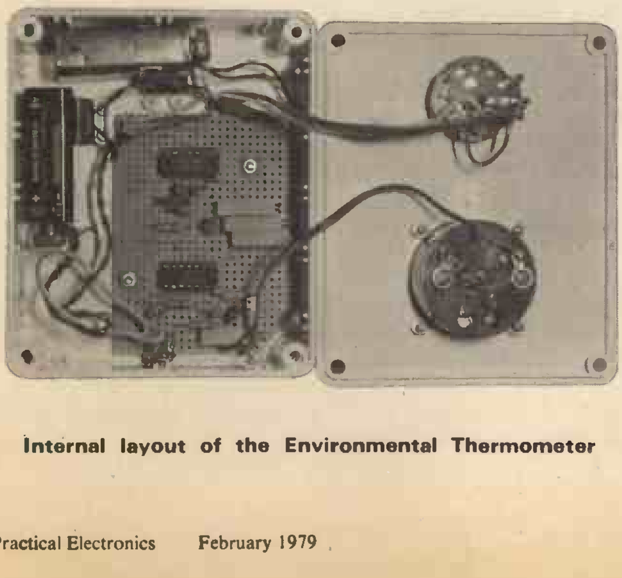
amplification of this voltage so that a deflection on the moving coil meter can be obtained. The offset is provided by the setting of the variable resistors VR1, VR2 and VR3 to give the three ranges as previously specified, and variable resistor VR4 sets the gain of the circuit to give the span of 25°C chosen for each range. The voltage gain is the ratio of VR4 to R7. Since the change of input voltage produced by the required range of 25°C is 25 x 2·2mV or 55mV, to produce an output voltage change of 2V requires a gain of 2V/55mV or about 37. This value of gain is within the ratio of 500k (max value of VR4) to R7, (i.e. 50.) Note that since the forward voltage across D3 falls with rising temperature, IC2b is connected as an inverting amplifier. The value of the series resistor R10 is chosen so that, with a maximum output at pin 10 of the op amp (i.e. 2V), only enough voltage is applied across the meter to produce full scale deflection. As the resistance and the full scale deflection current of the meter is known it is possible to work out the value of R10 using the equation

$$R10 = (2/I) - Rm\ (k\Omega)$$

where I is the f.s.d. current for the meter in milliamps and Rm is its resistance in ohms. The value of Rm can usually be neglected since it is small and the approximation R10 = (2/I) kΩ can be used. Note that the gain of the amplifier IC2b can be adjusted, so that the value of R10 is by no means critical. However, to avoid the possibility of saturating the amplifier, the maximum output voltage should be measured with a voltmeter so that it is in the range 2 to 4V.

Switch S1 is a three-pole four-way rotary switch wired so that one position is off and the other three positions select one of the three range resistors VR1, VR2 or VR3. Should more ranges be required this switch can be changed to a two-pole six-way version to accommodate two extra ranges (e.g. 45°C to 70°C and 65°C to 90°C).

Incidentally, if the current driving the meter is different from the setting of the range switch the movement of the meter could be damaged. Therefore, diodes D1 and D2 are connected back to back across the meter to provide protection (since the diodes only conduct when the full scale deflection voltage across the meter rises above 0·6V). Most meters will tolerate two or three times their f.s.d current.



Internal layout of the Environmental Thermometer

CONSTRUCTION

As Fig. 2 shows, all the components can be mounted on a piece of 0·1in. matrix Veroboard. Check that solder does not bridge between the tracks unintentionally and that the tracks are drilled cleanly at the points indicated. Use holders for the i.c.s since this will make replacement of faulty devices easier, and then check the layout carefully against the circuit diagram.

External connections are required to the switch S1, the meter, the sensor and the batteries. Note that in order to keep the wiring neat, the two common leads to the batteries are connected together via a spare track on the board. A miniature jack socket was used in the prototype for connecting the pn junction sensor to the circuit.

An aluminium battery clamp is used to hold the PP3 batteries firmly in the case. Once the Veroboard has been fitted to the base of the case and the leads taken to the switch and the meter, four small holes should be drilled carefully through the side of the box so that a screwdriver can reach the variable resistors VR1, VR2, VR3 and VR4 to set the gain and the zero offset of the ranges.

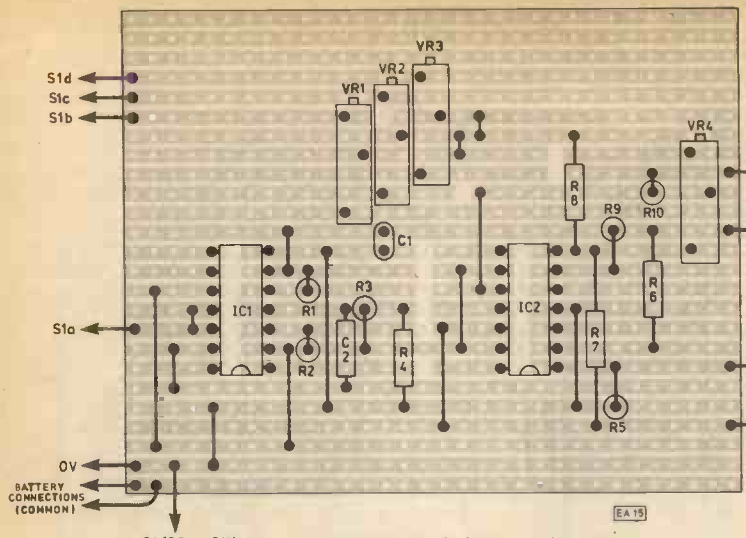


Fig. 2. Veroboard layout for the Environmental Thermometer

THE SENSOR

Carefully remove the collector lead from the ZTX300 transistor. Flexible insulated wire should be soldered to the base and emitter leads using sleeving to ensure that they cannot be shorted together. The wires should be passed down the body of a felt pen so that the transistor sits firmly in place at one end. The transistor should be sealed in place using Araldite to ensure that no water or other liquids can penetrate the probe.

COMPONENTS . . .

Resistors

R1	2k2
R2	33
R3, R4	5k6 (2 off)
R5, R6	120k (2 off)
R7	10k
R8, R9	47k (2 off)
R10	1k2

All $\frac{1}{2}$W 10% carbon

Potentiometers

VR1, VR2, VR3	100k 20 turn preset (3 off)
VR4	500k 20 turn preset

Capacitors

C1	47μ
C2	100p

Semiconductors

D1, D2	1N4148 (2 off)
D3	ZTX300
IC1	μA 723
IC2	747

Miscellaneous

S1	3 pole 4 way rotary switch
SK1	Min jack socket
PL1	Min jack plug
ME1	1mA meter
B1	PP3 battery (2 off)
Battery clips	(2 off)
Case	100 x 120 x 40mm
Veroboard	

CALIBRATION

This is fairly straightforward since the range and offset adjustments are independent of each other. The top range (25°C to 50°C) is best set first using two cups of water at these two temperatures. A helper is needed here to ensure that these two quantities of water are well stirred and with occasional topping up, are maintained at these temperatures. An accurate (±0·5°C) thermometer should be used. With the sensor at 25°C adjust VR1 to bring the meter to the (25°C) mark on the scale.

With the sensor at 50°C adjust VR4 to bring the reading to the upper end of the scale. Repeat these two adjustments until the needle swings between the upper and lower scale markings. The range is now set at 25°C and the lower point of one scale determined. Now switch the thermometer to the next lower scale (5°C to 30°C) and put the probe in the 25°C water. Adjust VR4 until the scale reading is 25°C which is four fifths of f.s.d. on the meter. This range is now set up, since the gain of the amplifier has already been determined in the first calibration, so that the lower end of this second scale corresponds to 5°C. Finally, for the lowest scale, stir some crushed ice in water and wait for the temperature to fall to 0°C. Adjust VR3 so that the needle reaches two fifths of f.s.d. The lower point of −15°C could be reached during a very cold spell in this country but check your deep freeze on this scale for starters.

SCALE READINGS

It should be obvious from the foregoing that the range chosen for the meter is entirely your own choice, subject to the gain of the op amp being sufficiently high. For example a range of 5°C not 25°C would require a gain of 5 x 37 or about 200. Since the maximum gain with the components shown in the circuit is about 50, four times this gain requires VR4 to have a value of about 2 megohms. To a large extent the range chosen is determined by the graduations on the meter (25 divisions in steps of 5 for the meter was used in the prototype.)

IMPROVED STABILITY

If greater stability against ambient temperature changes is required 748 op amps can be used in place of the 741's specified. However, these op amps require external frequency compensation by the connection of a 100p capacitor between pins 1 and 8. Otherwise the component values remain the same as in the circuit described. ★

Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by Alan Turpin and David Shortland

LOGIC ANALYSIS TEST KITS

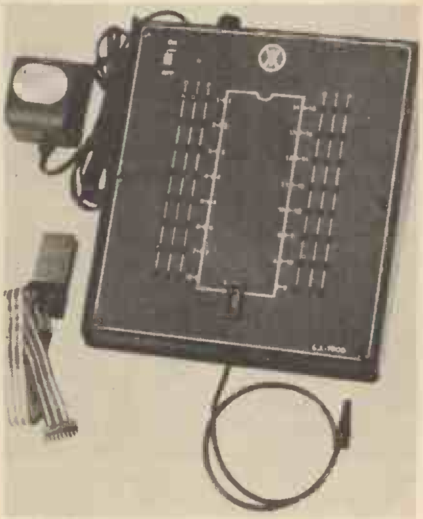
The 20 page professional products catalogue of Continental Specialties Corporation (CSC) has specifications on their following products: 550MHz Counter, 100MHz Counter, 50MHz Counter, 500MHz Prescaler; Function Generator, Pulse Generator; Digital Pulser, Logic Monitors, Logic Probes, Logical Analysis Test Kits; Breadboarding Equipment—Quick Test Sockets and Bus Strips, "Experimentor" Sockets and Bus Strips, Proto-Boards, Powered Proto-Boards, and i.c. Test Clips.

The Logical Analysis Test Kits comprise a Logic Probe, Digital Pulser, Logic Monitor, Probe Tips, Leads and Adapters, Manuals and Application Guides, all in rugged custom moulded cases. The kits are £127 and £143 plus VAT.

Catalogue, price list, order form from **CSC UK Ltd, Shire Hill Ind. Est., Saffron Walden, Essex CB11 3AQ (0799 21682).**

LOGIC INTERPRETER

Introduced by the United States manufacturer Kurz-Kasch Inc. the L1-1000 Logic Interpreter automatically displays static and dynamic states of digital i.c.s in circuit. Logic high, low and transitions are accurate to plus or minus five per cent. All logic levels are current is drawn from the board under test as a fully isolated, regulated power supply accompanies the interpreter.



Singer Products are the exclusive export representatives of Kurz-Kasch and further information can be obtained from—**Gil Williams, Electronic Division, Singer Products Company Inc., One World Trade Center, Suite 2365, New York, N.Y. 10048.**

DIGITAL PHOTO TACHOMETER

From Power Instruments of the USA is a touchless, digital photo tachometer, for measuring the r.p.m. of rotating objects from distances of between $\frac{1}{4}$in and 30in.

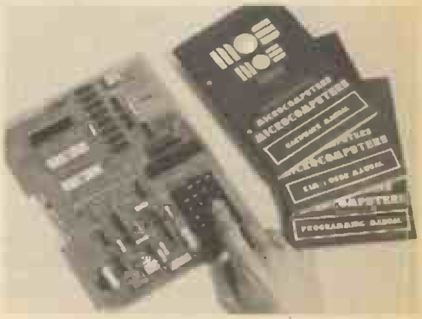
A piece of reflective tape is fixed on the surface of an object, and when the object is rotated a beam of light from the probe is focused on the tape path. A "target eye" lights up on the tachometer, showing when contact is made, and an r.p.m. readout is given on five $\frac{3}{8}$in l.e.d.s. A memory holds the reading indefinitely.

Being touchless, the tachometer can be used in places awkward to reach, and there is a 24in cord attached to the probe. The readout is quartz crystal controlled, with an accuracy of ± 1 digit up to 0·03 per cent. There is direct reading up to 30,000 r.p.m.

Powered by ordinary batteries, the model 1891 is provided with an aluminium carrying case, reflective tape and other accessories. It measures $8\frac{1}{2}$in × $4\frac{1}{4}$in × 2in and weighs $1\frac{1}{2}$lbs.

Optional extra accessories include measuring wheels, hand-held or permanent surface mounted to measure linear speed.

Price is £155, plus VAT and carriage, and it is available from the sole UK importers, **Electronic Brokers Ltd, 49/53 Pancras Road, London NW1 2QB (01-837 7781).**



Price of the KIM 1 single board microcomputer was reduced to £99·95 +VAT in December. Full details from GR Electronics Ltd., Fairoak House, Church Road, Newport, Gwent.

PRINTOUT CALCULATOR

A new hand-held calculator incorporating its own thermal printer has been introduced by Texas Instruments.

The TI-5025 operates from a rechargeable battery and has a large vacuum fluorescent display which can be used without the printer to conserve paper.

Functions provided are addition, subtraction, multiplication and division—plus percentage key and a 4-key memory.

It operates with the simple number-entry system used with other hand-held calculators in the Texas Instruments range.

The thermal printer is quiet in operation, has few moving parts and requires no ribbons; thermal-paper rolls are available in packs of three.

The TI-5025 measures 6·7 × 3·4 × 1·8in (170 × 86 × 46mm), and is supplied complete with a charger/adaptor, thermal paper and carrying case. VAT inclusive price is £64·95.

Details from **Texas Instruments Limited, European Consumer Division, Manton Lane, Bedford, MK41 7PA.**

CAR CLOCK

This car clock from Speedograph is connected through the ignition system and when the ignition is off the l.e.d. display is also off, thus preventing undue battery drain. The time keeping circuit remains on. The readout which automatically dims at night reads hours and minutes with a flashing second indicator.

The unit can be mounted using either an adjustable bracket or a self adhesive pad both of which are supplied.

The clock is priced at £27·55 plus VAT and is available from many accessory shops.

A-TO-D CONVERTORS

National Semiconductor has added two microprocessor-oriented analogue-to-digital convertor devices to its product range.

Available in both a $3\frac{1}{2}$ digit version designated ADC 3511, and in a $3\frac{3}{4}$ digit version designated ADC 3711, the new devices are complementary CMOS circuits that provide addressed binary coded decimal output for digital systems.

Operating from a single isolated 5V supply, the devices are designed to convert input voltages from −2·00 to +2·00V. The sign of the input voltage is automatically determined and indicated on the sign output pin, and overflow is indicated by a Hex EEEE output reading as well as by an overflow output pin. Unipolar input voltages do not require the use of isolated supplies.

The ADC 3511 and 3711 have their conversion rates set by an internal oscillator whose frequency may be determined by an external RC network, or can be driven from an external frequency source. The timing of conversions may be controlled and monitored via the Start Conversion input and Conversion Complete output which have been included on both devices.

STEREO MIXER

This portable four channel mic/line mixer by Soundex Limited was designed for stereo recording and features true PPM or VU metering, stereo gain control for a crossed pair of microphones and two "pan" controls for two spot microphones.

Frequency response is 20Hz to 20kHz, signal to noise ratio is 11db with 180µV from 150–600 ohms.

Optional variations are internal rechargeable cells, and XLR or jack connectors.

For further information contact **Tony Barnes, Bulgin Electronics Soundex Limited, Park Lane, Broxbourne, Hertfordshire EN10 7NQ (099 24 64455).**

ALL THE PROJECTS IN EPI

The Libraries and Arts Department of North Tyneside Metropolitan Borough Council have published an Electronics Projects Index (EPI). This descriptive guide covers over 2,500 projects published by (in alphabetical order) Electronics Today International, Elektor, Everyday Electronics, Practical Electronics, Practical Wireless, Radio and Electronics Constructor, Television, and Wireless World.

Most of the coverage is from January 72 to December 77, and all amendments to October 78 are included. Price is £1·50 inc. p&p. Postal Orders and cheques should be made payable to North Tyneside M.B.C.

Copies of the index are available from: **M. L. Scaife, Central Library, Northumberland Square, North Shields, Tyne & Wear NE30 1QU. Enquiries (08945 82811).**

FREQUENCY COUNTERS

Davis Electronics announce the introduction of their frequency counters. The basis of the design is an LSI chip which is a seven decade counter. This is extended to a full 8 digits by feeding the processed signal to a single decade counter, that is then decoded and fed to the least significant digit for display. The LSI then counts, decodes and feeds the digit drivers for the other seven digits. A further chip performs the functions of Xtal oscillator, gating dividers and driver, multiplexing signal generator, etc. Other discrete circuitry provides for signal conditioning, shaping, amplification and protection.

A pre-scaler and amplifier provide facilities for extending the 8 digit counter block to 600Mhz. This is switched in from the front panel. Also provided is switching for gate time and power. A "gate open" l.e.d. indicates when the count is active. A special Xtal in a proportionally controlled Xtal oven is also available.

Full specification and prices from distributors **Crael UK Ltd. 7 Hughendon Road, Hastings, Sussex TN34 3TG. (0424 428131).**

ARE YOU BEING CHARGED?

Coinciding with the change of name from Ever Ready (Special Batteries) Limited, Berec (Special Batteries) Limited introduce a range of rechargeable batteries and chargers for the consumer market.

equivalents of HP2, HP11, HP7 and PP3, and three chargers, two for specific batteries and one to take the three cylindrical batteries so that it is possible to charge different sizes at the same time. The chargers will recharge a fully discharged battery in 14–16 hours.

We are sorry to have to report a devastating fire at the Talk of The Town, Cambridge, 16 businesses were affected including that of Tempus. They are doing all they can to continue their normal service but apologise to anyone experiencing delay.

VERO ON VIEW

In the interests of their products being in first class condition when they reach the home constructor, Vero are skin packaging Veroboards, Veropins and other accessories.

The full range of newly designed packs can be seen on floor standing displays which will also contain a range of boxes. Component shops with little floor space are offered a simple wall stand with a limited range of Vero products.

All this, at no extra cost, say Vero.

MEMORIES THAT LAST

The latest scientific calculator from Casio has seven non-volatile memories which are powered by separate batteries that can hold stored figures when power is switched off—overnight, or for days or weeks at a time, even while exhausted main cells are being changed.

A powerful machine with 59 built-in functions, the FX-360 also offers a choice of power supplies: normal penlight batteries, rechargeable NiCad power pack, or a.c. mains via an adaptor.

Calculation capacity is 10 digits, plus two in the exponent. Trig functions and their inverses are handled in three types of measure, in degrees, radians or gradient. Statistical scope includes standard deviations, linear regression, or fitting logarithmic curves, exponential curves or power curves.

All the usual log, trig and hyperbolic functions are provided, plus permutations/combinations, rectangular/polar conversion, and factorials. The unit also handles fractions and many types of problems involving percentages. It copes with parentheses up to eight levels, and features a random number generator.

There is one independent accumulating memory plus six constant memories. Their contents are fully protected by two silver oxide batteries when main power is switched off.

The recommended retail price of the FX-360 is £59·95 including VAT. For further information contact **Casio Electronics Co Ltd, 28 Scrutton Street, London EC2A 4TY.**

Home Computers
...the Microprocessor Miracle!

PART ONE — R.W.COLES

FROM their barely noticed beginnings in the early seventies, microprocessors have mushroomed to become the number-one talking point among engineers and hobbyists alike. Industry is rapidly awakening to their power and capabilities, and many professional engineers are engaged in an undignified scramble to become conversant with this at first alien new technology. Meanwhile, most electronic hobbyists have been waiting on the sidelines for a convincing demonstration of how micros can help them; only a few have actually taken the plunge and built one of the simple "evaluation-card" systems which can be programmed in machine code.

Anyone who has purchased an evaluation card has probably learnt a great deal about microprocessors, but many will be disappointed by the problems involved in getting their system to do anything really useful. Persuading a micro to perform the functions of an ordinary calculator, for example, could take weeks of programming effort. A great chance to learn about computer arithmetic perhaps, but not really very practical. Using the microprocessor to replace random logic, to act as the controller of a domestic heating system for example, can, and is, being achieved with small evaluation cards. But how many hobbyists want to build logic systems of such complexity that the microprocessor becomes a viable alternative to say TTL or CMOS? Not very many.

ENTER THE HOME-COMPUTER

Paradoxically, the microprocessor is about to take the hobby market by storm, but it's not really the electronic hobbyist who is the main target. Armed with a high level language interpreter, surrounded by semiconductor memory, a typewriter keyboard and a television display unit, the microprocessor now forms the heart of a general purpose computer system which can be sold not only to electronic

The PET home computer together with its printer and second "external" cassette recorder

The Micros Z80 based system

enthusiasts, but to anyone who is prepared to spend a few days learning the rudiments of BASIC language. The home-computer has arrived!

Already small-business men, doctors, dentists, and hotel owners, computer programmers and of course, electronics enthusiasts, are rushing to buy one of the few systems already on the market, even though a home-computer system worth the name will cost £500 or more!

Five hundred pounds may seem like a great deal of money, but thanks to the microprocessor, you will get a computer which would have cost £10,000 and filled a fair sized room, ten years ago.

Not surprisingly, the home-computer concept originated in the United States, and its proliferation there has been extremely rapid, catching even the manufacturers off guard to begin with. In the United Kingdom, economic constraints will probably result in a slower build up, but already that build up has begun!

WHAT IS A HOME-COMPUTER?

A home-computer (also called micro-computer or personal-computer) has no universally accepted definition. Some manufacturers may wish you to believe that their small machine-code micro with a hexadecimal keyboard is a home computer, when in my view it certainly is not. I have also heard of avant garde computer hobbyists with old IBM systems installed in their garage, and this too falls outside my definition, which is as follows:

A home-computer is a small, low cost, general purpose digital computing system which uses an LSI microprocessor chip as its CPU (Central Processor Unit) and which is capable of storing and executing programs written in a high level language such as BASIC or PASCAL.

To get a clearer idea of what I mean, let's take as an example one of the more popular home-computers currently available, the Commodore PET (left). As you can see, the

The Tandy TRS 80 which is supplied complete with a video monitor, mains transformer and cassette recorder

PET is a fully integrated system which requires only a mains socket for instant use. Inputs are entered via a typewriter style keyboard, and outputs are displayed on a built-in 9in CRT screen which is arranged as 25 lines of 40 characters each. To the left of the keyboard is a built-in cassette recorder.

Using standard audio cassettes, programs or data entered via the keyboard may be recorded for later use, and commercial software such as business programs or games can be entered in cassette form without recourse to any tedious typing. Inside PET there lives a 6500 8 bit microprocessor surrounded by 8K bytes of RAM, 14K bytes of ROM, cassette, keyboard, and screen interface logic, and a bidirectional input/output port which can be used for a variety of external peripherals. The 8K of RAM forms a read/write memory area into which programs or data may be entered from the keyboard or cassette. Data is retained by this memory only while the power is "ON" of course, so it is normal for PET users to save any useful RAM data as a cassette tape data-file before the end of a programming session. The 14K of ROM appears to the microprocessor very much like the RAM, but in this case programs are stored in the mask programmed ROM chips during manufacture, programs which cannot be lost or modified and which form the all important firmware operating system and BASIC language interpreter. Putting all the system software in ROM is a technique pioneered by the PET and it confers several advantages over other machines which

The Research Machines 380Z system

The Apple II system

require these facilities to be loaded into RAM from a cassette or paper tape:

(1) ROM is cheaper than RAM. This means the economics are better because RAM is traded for ROM.
(2) No load-delay is incurred while cassettes or paper tape are read.
(3) The software is more reliable because ROMs, unlike cassette tapes, do not wear out. The main disadvantage is, of course, that you are stuck with the BASIC language which PET is born with, and if your fancy should later turn to PASCAL or Assembly language, there is not much you can do!

WHAT DO THEY DO?

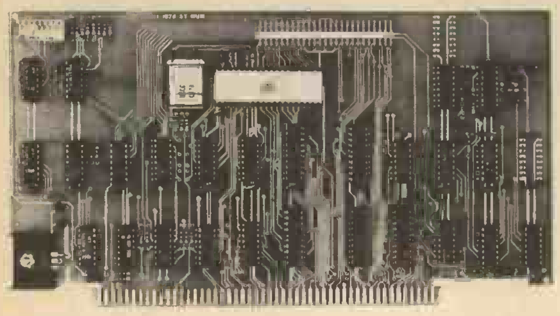
The PET then, is a typical home-computer, but there are many variations on the theme. Some home computers require a separate VDU and keyboard but display their outputs on an ordinary television via a UHF modulator; some provide a graphics, or picture-forming facility; still others have full-colour graphics, and so on. If there is one thing that they all have in common, it is their ability to run programs written in a high level language, usually BASIC.

BASIC

BASIC (Beginners All Purpose Symbolic Instruction Code) has been around for a long time and was originally conceived as an aid to teaching computer science and

The Nascom I is supplied in kit form and requires a power supply and VDU for operation

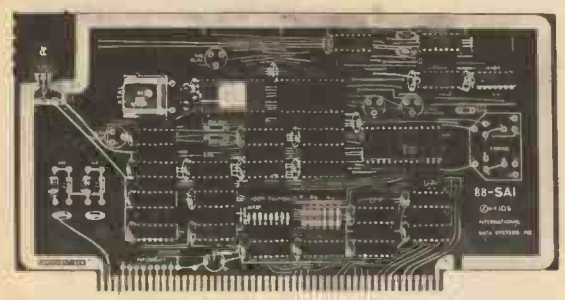
programming subjects. BASIC is an interpretive language, unlike for example FORTRAN which is compiled. Next month we will be examining home computer software in more detail and the distinction between interpreters and compilers will be discussed. For the moment all you need to remember is that interpretive languages are very easy to use, but quite slow in operation. In computer science terms this makes BASIC a less "powerful" language than say FORTRAN, but this is perhaps misleading because BASIC contains all the math, trig, and data handling functions you are likely to need, and most versions provide an arithmetic precision which is as good as, or better than, your trusty pocket calculator. For most home computer applications, the



S100 Bus board

slowness of BASIC programs is no real disadvantage, and anyway entering and debugging programs is actually much faster with BASIC because there is no wait while a compiler is used to process the newly entered program.

If you know anything at all about microprocessors and their instruction sets, just spend a few seconds considering the problem of producing a machine code program which will accept keyboard inputs, carry out decimal division, and print an answer. The keyboard input routine alone might take as many as 100 program lines, depending on the hardware, and a similar number might be needed to control a VDU or printer. The decimal arithmetic routine could be very tricky indeed and may need as many as 500 lines of code!



S100 Bus board

Now see how easy it is in BASIC. All you need to type in order to load the program is:

```
10 INPUT A, B
20 PRINT A/B
30 END
```

and to set it running you type:

```
RUN
```

followed by a pair of decimal numbers in response to the ? prompts printed by BASIC. Improving this simple program is easy. Adding another line:

```
5 PRINT "ENTER TWO DECIMAL NUMBERS A, B"
```

provides a better prompt, and changing line 20 to:

```
20 PRINT "A/B = "; A/B
```

gives an answer which is self explanatory. Changing line 30 to:

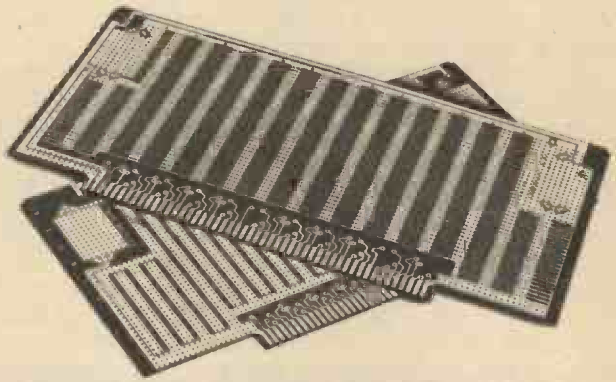
```
30 GOTO 5
```

removes the need to type RUN for each new pair of numbers, and of course, other enhancements can be added just as easily!

TRANSPARENT

In home-computers then, the microprocessor chip together with its registers and instruction set is more or less transparent to the programmer. I say "more or less" because most home computers will allow you to dabble in machine language programming if you really must, and in fact this facility is very useful for anyone who wishes to hook their computer up to gadgets in the outside world, as many electronics hobbyists undoubtedly will.

Using a high level language, doing useful or entertaining things with a microprocessor is easy. Within a few hours of picking up a BASIC manual, you will be able to write small programs which sort lists of numbers into ascending or descending order, write amusing messages on the VDU, or calculate the surface area of a sphere given its diameter. After a few weeks of practice you will be writing programs which plot graphs or balance the household accounts or play games such as NIM with you. If your home computer has an interface port or ports, you will be able to attach all sorts of



A Universal S100 prototyping board designed by Vero Electronics for breadboarding microprocessor systems

external hardware to your system and control it via a program. In most cases you can still use BASIC to talk to your hardware. Home computer BASIC interpreters often have facilities to link you with peripherals, either by direct reference to memory locations using instructions such as PEEK and POKE, or by the ability to call complete machine code subroutines which you can write yourself.

S100 BUS SYSTEM

Home-computers of the sort typified by PET are certainly the cheapest way into computing. You can learn and enjoy BASIC programming, make your system work for a living, and perhaps even connect it up to some of your own hardware. Unfortunately, there is a snag! After a few months or years, many users will want to squeeze more from their system than it can easily provide. At this point many people will wish that their system was a little more flexible and expandable, and this is where an extra investment at the start could pay dividends.

For a few hundred pounds more, it is possible to buy a home computer based on the S100 bus which will allow the later addition of all sorts of extra hardware and software so that one need never feel cramped. The S100 bus was actually introduced by the very first home-computer, the MITS Altair 8800 which appeared way back in 1975. Since then, many other home-computer designs have been introduced which use the S100 bus, and many firms (well over 100, world-wide) manufacture circuit boards using the S100 format. The S100 bus was designed around the 8080 microprocessor chip, but since its introduction several other microprocessors, including the Z80, the 6800 and the 6500 have been built into S100 systems. In addition to microprocessor CPU cards, it is also possible to buy a bewildering variety of static and dynamic read/write memory cards, serial and parallel interface cards, floppy disc controller cards, cassette interface cards, logic analyser cards, PROM programmer cards, floating point arithmetic cards, and even speech recogniser and synthesiser cards!

I am sure from the foregoing, you will agree that the S100 bus makes for a versatile home-computer, but what is the bus and why is it so versatile?

BUS ORGANISED

Many large computers are "bus organised" which means that all circuit cards connect to a comprehensive back-plane where all signal paths are common to each card. This means, for example, that pin 1 or pin N on one edge connector is connected to pin 1 or pin N on every other edge connector on the back-plane. The bus contains address, data, control and power lines and, in general, boards may be plugged into the bus in any slot, regardless of their function. In some ways this method of interconnection is very wasteful. Not all boards need all the facilities available on the bus; some need very few, and yet every board must connect to the bus via a multi-contact (and therefore expensive) edge connector. This inefficiency is more than made up for by the resulting versatility though, and bus organised systems are the norm for large computers.

The S100 bus (Fig. 1.1) is a very successful attempt to bring the large computer bus concept into the home-computer arena, and although there are one or two minor problems with it, its very popularity shows the vision and skill of the original MITS designers. Configured around a one hundred pin edge connector, the S100 bus has a 16 bit address bus, two unidirectional 8 bit data buses, 8 status lines, 5 control lines and a host of miscellaneous functions. Power is supplied to the bus in unregulated form so that individual board regulators can be used to reduce power line noise and distribute heat throughout the case.

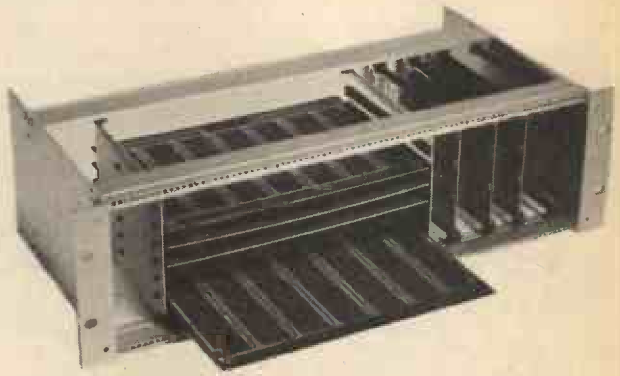
Fig. 1.1. The S100 Bus connections

pin 1	+8 Volts	pin 51	+8 Volts
pin 2	+16 Volts	pin 52	−16 Volts
pin 3	XRDY	pin 53	SSW DSB
pin 4	V10	pin 54	EXT CLR
pin 5	V11	pin 55	
pin 6	V12	pin 56	
pin 7	V13	pin 57	
pin 8	V14	pin 58	
pin 9	V15	pin 59	
pin 10	V16	pin 60	
pin 11	V17	pin 61	
pin 12		pin 62	
pin 13		pin 63	
pin 14		pin 64	
pin 15		pin 65	
pin 16		pin 66	
pin 17		pin 67	
pin 18	STATUS DSBL	pin 68	MWRITE
pin 19	C/C DSBL	pin 69	PS
pin 20	UNPROTECT	pin 70	PROTECT
pin 21	SS	pin 71	RUN
pin 22	ADDR DSBL	pin 72	PRDY
pin 23	DO DSBL	pin 73	PINT
pin 24	ϕ_2	pin 74	PHOLD
pin 25	ϕ_1	pin 75	PRESET
pin 26	PHLDA	pin 76	PSYNC
pin 27	PWAIT	pin 77	PWR
pin 28	PINTE	pin 78	PDBIN
pin 29	A5	pin 79	AØ
pin 30	A4	pin 80	A1
pin 31	A3	pin 81	A2
pin 32	A15	pin 82	A6
pin 33	A12	pin 83	A7
pin 34	A9	pin 84	A8
pin 35	DO1	pin 85	A13
pin 36	DOØ	pin 86	A14
pin 37	A1Ø	pin 87	A11
pin 38	DO4	pin 88	DO2
pin 39	DO5	pin 89	DO3
pin 40	DO6	pin 90	DO7
pin 41	D12	pin 91	D14
pin 42	D13	pin 92	D15
pin 43	D17	pin 93	D16
pin 44	SMI	pin 94	D11
pin 45	SOUT	pin 95	D1Ø
pin 46	SINP	pin 96	SINTA
pin 47	SMEMR	pin 97	SWO
pin 48	SHLTA	pin 98	SSTACK
pin 49	CLOCK	pin 99	POC
pin 50	GND	pin 100	GND

BUILDING A HOME-COMPUTER

Using the S100 bus concept, you can literally design and build your own home-computer system.

To get started you need (at least) an S100 back-plane, a CPU board, a memory board, and a terminal interface board. The CPU board usually has a ROM or PROM included which contains simple monitor software to allow you to enter, modify, and run machine code programs in hexadecimal, so this minimum system is on a par with the (much cheaper) evaluation cards. System expansion can begin with a cassette interface board. This provides the ability to save programs and also the ability to load commercial software such as BASIC. This four board system is at about the same level as a PET, but of course it is much more flexible. Unfortunately, when you add in the price of a power supply, a VDU, a cassette recorder and the necessary commercial software, it is also likely to be more expensive. It really depends on how much you make up yourself from kits. S100 memory board kits are particularly common, allowing electronics hobbyists to save some money and enjoy themselves at the same time! Power supplies can also be made up inexpensively by those who know how, unregulated supplies of plus 8, plus 16 and minus 16 volts are required, but beware—the current requirements of a large system can be a surprise!



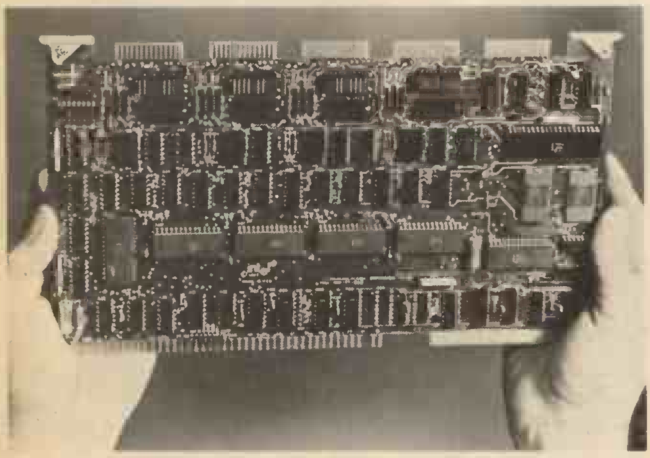
A suitable rack system for use with an S100 backplane. (Vero Electronics)

WINNER

The basic S100 system then, is only competitive with non-bus home computers under special circumstances, but from this point on, the S100 wins all the way. Want more RAM? Just plug in extra S100 boards up to the 64K maximum. Want to program PROMs? Plug in a Bytesaver board which provides sockets for, and programs, your 2708 PROMs. With a large RAM memory, you can use any software you like, BASIC, PASCAL, ASSEMBLER, all are possible. The cassette interface board probably handles more than one recorder anyway, so you can add the ability to copy tapes and sort files for only the cost of an extra cassette recorder. When it comes to serial or parallel interfaces for your "homemade" peripherals, there is a huge choice of S100 boards to help, and there are even S100 matrix boards so that you can wire up your own "special" interfaces and plug them into your system.

Finally, when you even outgrow all of these facilities, you can take the giant step and add a floppy disc controller and a drive or two to your system, and thus gain the ability to keep hundreds of kilobytes of data available for instant access. With floppy discs in your system you can swop from BASIC to ASSEMBLER in a few seconds, and keep all your programs and data in the form of easily edited, named files. We shall be returning to the subject of floppy discs later, but a final word on "buses" is now appropriate.

While the S100 bus is by far the most popular home computer bus, it is not the only one, and by being a "no compromise" design it is expensive. Another useful bus is championed by SWTPC (South West Technical Products Corporation) in their 6800 based system. The SWTPC bus has become known as the SS50, and it is inherently less expensive to use than the S100. Several firms in the U.S.A. now produce SS50 compatible boards. Other bus systems may be encountered occasionally. Intel have a very popular series of professional computer boards known as the SBC series for example, and these do turn up in the hobby market under the name of SBC-bus boards. No doubt there will be



A typical SBC board designed by Intel

many other contenders, for the rewards of becoming a "standard" are high. A European bus standard will be particularly useful, when it finally becomes established.

HOME-COMPUTER PERIPHERALS

A comprehensive list of possible home computer peripherals would be a very long one, but fortunately there is a short list of useful peripherals which have universal appeal, and a treatment of home-computers would not be complete without a look at these. In order of priority, these are as follows:

(1) ASCII keyboard
(2) VDU
(3) Cassette system
(4) Printer
(5) Floppy disc system.

A practical home computer system will normally have at least the first two items on this list.

KEYBOARDS

An ASCII keyboard is the minimum input device needed for a home computer because high level languages depend on the use of the full ASCII alphabet with punctuation and control characters (Fig. 1.2). ASCII keyboards, in the form of a full set of keys mounted on a printed circuit card, along with an encoder chip and debounce circuitry, are widely available at low cost. These keyboards usually produce a parallel 8 bit code (7 bit ASCII + 1 parity bit), and this data format can be interfaced directly with a parallel

LSD \ MSD		0 000	1 001	2 010	3 011	4 100	5 101	6 110	7 111
0	0000	NUL	DLE	SP	0	@	P	\	p
1	0001	SOH	DC1	!	1	A	Q	a	q
2	0010	STX	DC2	"	2	B	R	b	r
3	0011	ETX	DC3	#	3	C	S	c	s
4	0100	EOT	DC4	$	4	D	T	d	t
5	0101	ENG	NAK	%	5	E	U	e	u
6	0110	ACK	SYN	&	6	F	V	f	v
7	0111	BEL	ETB	'	7	G	W	g	w
8	1000	BS	CAN	(	8	H	X	h	x
9	1001	HT	EM	)	9	I	Y	i	y
A	1010	LF	SUB	*	:	J	Z	j	z
B	1011	VT	ESC	+	;	K	[	k	{
C	1100	FF	FS	,	<	L	\	l	1
D	1101	CR	GS	—	=	M	]	m	}
E	1110	SO	RS	●	>	N	↑	n	~
F	1111	SI	VS	/	?	□	←	o	DEL

Fig. 1.2. Full ASCII alphabet with punctuation and control characters

microprocessor port if you write your own (simple) driver software. Most home computer operating systems already have driver software for a serial interface, and to make the cheap keyboards interface to this, it will be necessary to add a UART (Universal, Asynchronous, Receiver, Transmitter)

Keyboard layout

chip to the basic keyboard encoder. Home computer serial interface ports are typically of the RS232/V24 type, an international standard based on a 25 way D type connector which represents a logic one as −12 volts, and a logic zero as +12 volts. S100 serial interface cards can be programmed to operate at a range of speeds from about 10 characters per second, up to about 960 characters per second, to suit the peripheral to which they are to be connected. Fig. 1.3 shows the range of standard serial interface speeds, along with their associated "baud rates".

For a keyboard alone, there is no point in using anything faster than 110 baud, because you can't type any faster, but

BAUD SPEED	CHARACTERS/ SECOND
110	10
300	30
600	60
1,200	120
2,400	240
4,800	480
9,600	960
19,200	1,920

Fig. 1.3. Standard serial interface speeds and their associated "baud rates"

keyboards are nearly always used with a printer or a VDU, and in the case of the VDU anyway, the higher baud rates can be useful.

VDU SYSTEMS

VDU systems are the cheapest way to display home computer generated outputs, and it is possible to buy, for around £500 or less, a complete "glass-teletype" which has a keyboard and a display screen. "Glass teletypes" such as the Lyme 4000 series, are ideal for use with home computers of the S100 type. They can operate over a wide range of baud speeds, and are easily hooked up to any RS232/V24 serial port to provide full two-way communication facilities. An even cheaper alternative is to

A Lyme 4000 VDU system

use a simple ASCII keyboard for input, and use a standard TV set or monitor for output. In this case the home computer itself has to provide the screen refresh memory and character generator functions and, of course, there are S100 boards which can do just that. Using a TV as a VDU is also a popular ploy for the cheaper home-computer designs because it saves the cost of a special display monitor and does away with the need for UARTS and serial interface cards. Some designs have been published which describe the production of television based VDUs for less than £100, such as the PE VDU, but in general these have been parallel-load, non-keyboard designs which are only to be recommended to those who can produce their own driver software and interface arrangements.

CASSETTE SYSTEMS

While you run your home computer programs you keep them in RAM, but when you hit the OFF switch, they're gone for good unless you can save them on some permanent storage medium. By changing your RAM data into serial form, and sending out one audio tone for a logic "zero" and another for a logic "one", you can store all those precious data and programs on an audio cassette recorder, and load them back into RAM whenever you choose. There is no need to modify the cassette recorder, and the interface circuitry is fairly simple, so simple in fact that many cassette recording standards have appeared which are unfortunately not compatible. The closest thing yet to a universal cassette recording protocol is the 300 baud "Kansas City" or C.U.T.S. standard which uses 2·4kHz for a logic "one" and 1·2kHz for a logic "zero". This has proved to be usable with a wide range of cassette recorders and has shown itself to be very reliable. By no means everyone uses this standard, however, and it is unwise to buy software in cassette form without making sure it is in a format compatible with one's own system!

The use of two cassette recorders is a great improvement to any system because it allows cassette copying and file sorting. It is, for example, possible to add a second (external) cassette unit to the PET, and most S100 cassette interface cards can control more than one as supplied. If you build up your own S100 home-computer, a cassette interface will allow you to buy and use BASIC interpreters, assemblers, and other software from the wide range now advertised in cassette form.

PRINTERS

Although I would recommend the use of a VDU rather than a bulky, noisy and unreliable teletypewriter for use with a home computer, there are always occasions when the ability to print-out a program or graph is very desirable. You can of course use a teletypewriter to provide this function, but a neater solution is to use a small stand-alone printer of the type which is now becoming available at low cost, and to only turn it on when you really need a printed copy. These

The Tandy TRS 80 printer uses 4in wide electrostatic paper

small new printers can be purchased with either a parallel interface (which is cheaper), or with a standard RS232/V24 serial interface (which will plug straight in to most systems). The printers use a variety of print-head designs, but to me the type which use electro-sensitive aluminiumised paper shows the most promise. Often containing a microprocessor of their own, these useful peripherals can operate much faster than a traditional teletype and some can also be used as a plotter for graphics output. The PET also has its own special add-on printer, known as the 2020, which plugs straight in to the parallel port provided.

Next month: Software.

PE MICROPRINTER
PART 2

MARK SIMON

PART 1 covered the principle of electrosensitive printing, character formation, and gave the circuit diagram with a description of how the interface works.

In this part the driver circuits and power supply are described, along with the software necessary to run the printer with a microcomputer system.

ELECTRODE DRIVER

To melt the aluminium coating and produce a dot on the paper will, as you can imagine, take a fair amount of current, albeit for a short space of time. The driver circuit shown in Fig. 2.1 amplifies the output from the character generator chip sufficiently to achieve this. It operates in the following way.

When an output from the character generator chip pulses active low the BC212 level changing transistor is turned on, supplying base drive current to the BD189.

When the BD189 turns on it throws 24V across the electrode which burns the dot on the paper. *Obviously not a circuit to leave with its input stuck low!*

THE MOTOR DRIVER

The motor driver has a similar "front end" (Fig. 2.2). The motor flip-flop $\overline{Q}$ going active low, turns on the BC212. This causes a positive voltage to be switched to the bases of the complementary power transistors. The 2N3053 turns on, supplying power to the motor, which will hopefully run.

When the motor flip-flop $\overline{Q}$ output returns high and the BC212 is turned off, the power transistor bases will revert to a large negative voltage. The 2N3053 will turn off and the motor will develop a large back e.m.f. This will turn on the 2N4037 which dissipates the stored energy.

POWER SUPPLIES

The voltages required for the system are, +5V, −12V and −24V. The +5 volts is required for the interface logic. As this is all MOS, the current requirement is low (typically 70mA) and so the host microcomputer system should have the capacity to supply this. The printer motor and electrodes work off a −24V rail and require quite high values of current for short durations of time. This seems to average out at around 130mA during printing. A good transformer preferably screened, of 5VA minimum and an output of 25V or greater will be required (see Fig. 2.3). The −12V supply is required solely to produce a bias voltage (Vgg) to the character generator chip. The tolerance here is not particularly tight, so a Zener diode is used to pick the requisite voltage from the −24V rail. The actual circuit was built up on Veroboard and mounted on the transformer (Fig. 2.4).

To avoid component damage the supplies must be switched in the following sequence:

on—First +5V, and −12V, then −24V

off—First −24V, and then −12V and +5V

This action can be realised by a 4-pole 3-way lever switch (PO 1000 type), or rotary wafer switch, the wiring of which is shown in Fig. 2.5.

CIRCUIT LAYOUT

With relatively large current pulses and motor starter currents so prevalent in this circuit, protecting noise prone logic circuitry is very important. Circuit layout is obviously crucial (see Figs. 2.5 and 2.6).

The first requirement is that the larger current carrying elements of the circuit, be grouped together and kept away from the more noise prone logic devices. Inputs and outputs must be kept separate. On the layout diagram the pickup coil, reed, and other inputs enter on one side of the circuit board. Whilst the motor driver output and electrode driver outputs leave at the other end of the board. The separation of these parts of the circuit even extends to supplies. The 5V line is brought in, via capacitors, to the logic at one end of the board. The 5V supply for the drivers, comes via another wire and enters the circuit at the driver end of the board. The 0V line is also separated; in fact a low value resistor, R (10 Ohms), is inserted between the logic and driver 0V lines to enhance noise immunity.

The final anti-noise measure is to place 100n capacitors across the 0V and 5V lines about the circuit. These are shown on Fig. 2.6, which gives pin-out information for all the integrated circuits and transistors used.

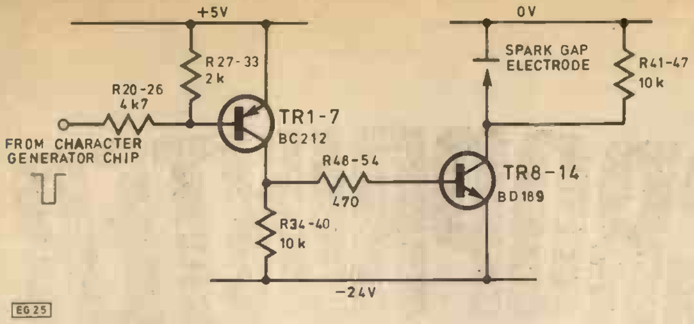


Fig. 2.1. Print electrode/head drivers

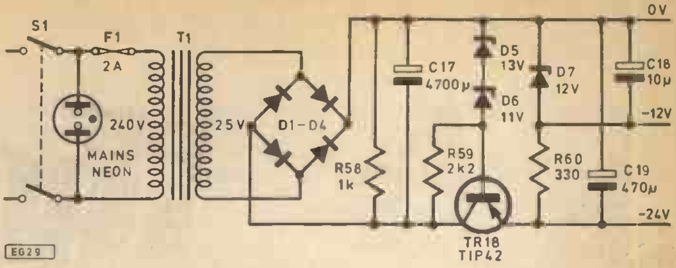


Fig. 2.3. Power supply circuit, −12V and −24V. Mains earth should connect to the transformer screen and the metal case

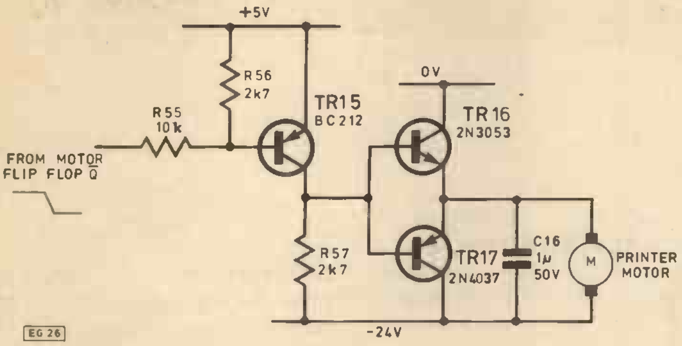
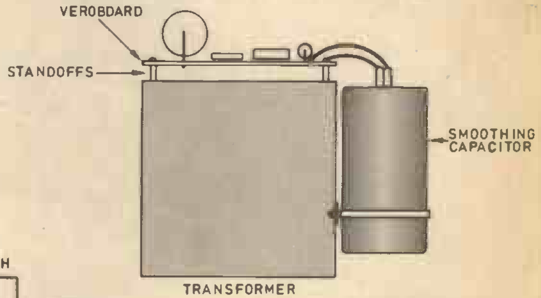


Fig. 2.2. Motor driver (−24 volt motor)

Fig. 2.4. Power supply construction. A stripboard can be mounted on top of the transformer using standoff pillars, and the capacitor strapped to the side



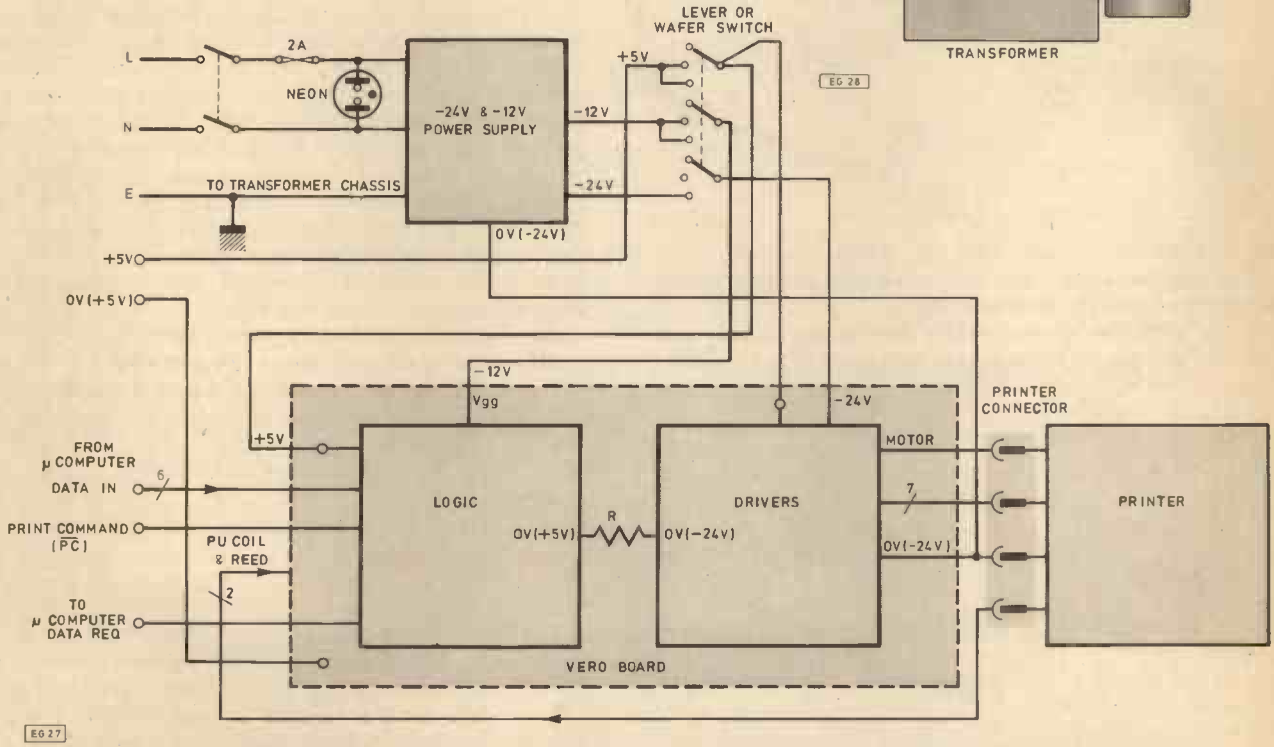


Fig. 2.5. System wiring. The supply line to which the 0V relates is shown in brackets. The two 0V systems are linked by a low value resistor

BOXING

The main box used to house the prototype was chosen primarily because it happened to be lying about at the time of building! The circuit board was fixed to one side leaving the majority of the space free for the power supply and the cable runs. (Fig. 2.7 shows dimensions and internal layout.) The printer, its connector and its paper holder were mounted on top of the box (see Fig. 2.8).

During development lengthy printing runs were achieved using no paper holder at all. Long lengths of printing paper were simply pulled off the roll and allowed to run through the printer. Although this worked well, it was thought that a more business-like approach was needed. Therefore the paper roll was placed on a mandrel with grooves notched at each end (Fig. 2.9). This assembly then sits in the roll holder which is screwed to the top of the box behind the printer. The paper roll holder was made from 16 gauge brass strip.

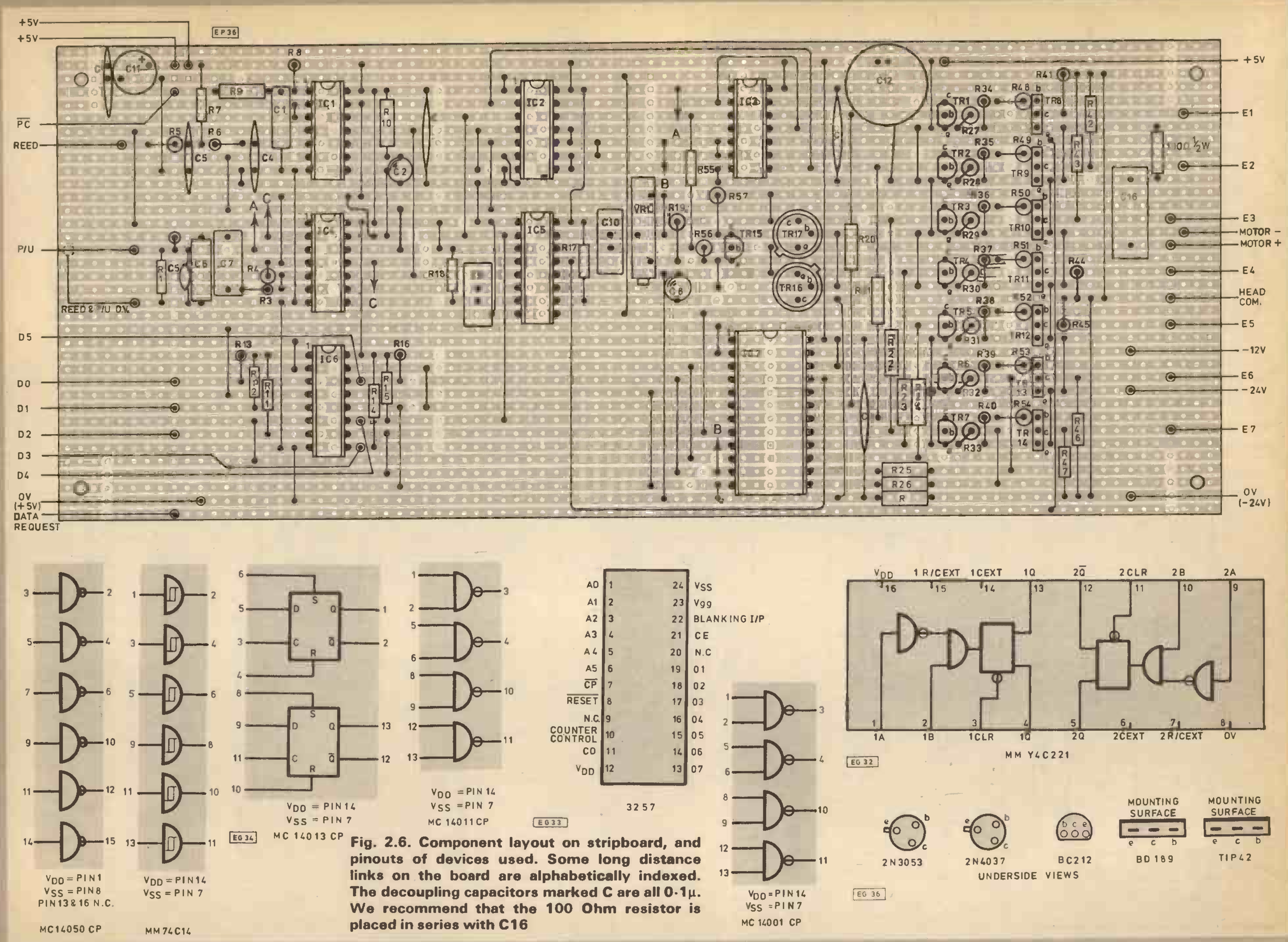


Fig. 2.6. Component layout on stripboard, and pinouts of devices used. Some long distance links on the board are alphabetically indexed. The decoupling capacitors marked C are all 0·1μ. We recommend that the 100 Ohm resistor is placed in series with C16

CONSTRUCTORS NOTE

The Matsushita electrosensitive printer is available from **Datac Ltd., Tudor Road, Broadheath, Altrincham, Cheshire, WA14 5TN. (Telephone 061-941 2361).** Although type 245/L/40 is specified, type 245/L/20 may be supplied, preset for 40 columns.

An alternative supplier for this and most other components is **Technomatic Ltd.**

It was not mentioned in Part 1 that construction requires the use of a 15-way edge connector to link the Matsushita printer to the main control unit. This is Amphenol type 143-015-01, available from Celdis for £2·74 inclusive of handling charge. **Celdis Ltd, 37/39 Loverock Road, Reading, Berks, RG3 1ED.**

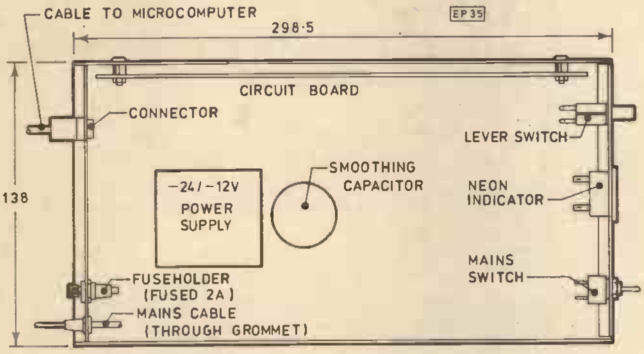


Fig. 2.7. Internal layout

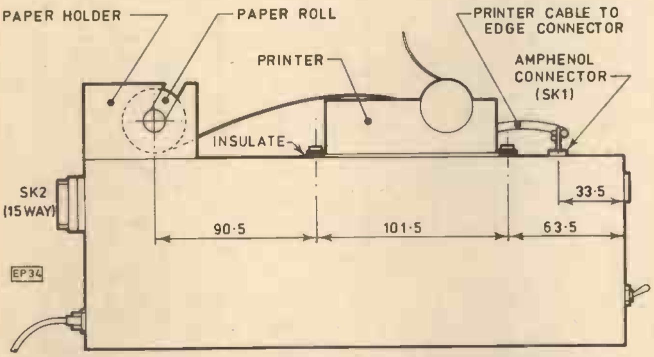


Fig. 2.8. Printer mounting. Fig. 1.1. last month showed the paper at −24V and the electrode energised at 0V. The reverse is of course true, otherwise the printer casing would need to be insulated from the control box cabinet. However, some mechanical insulation from vibration is still advisable, and this can be done by sleeving the printer mounting lugs with rubber grommets

PRINTER TO MAIN UNIT CONNECTIONS

Pin No.	Signal
A	Reed
B	Pick-up coil
C	OV for P/U coil & Reed
D	Motor +
E	Motor −
F	Head & Pinch Roller Common
H	N.C.
J	1st Dot
K	2nd Dot
L	3rd Dot
M	4th Dot
N	5th Dot
P	6th Dot
R	7th Dot
S	N.C.

EXTERNAL CONNECTOR TO μCOMPUTER

Pin No.	Signal
A	DO
B	D1
C	D2
D	D3
E	D4
F	D5
H	Print command ($\overline{PC}$)
J	Data Request
W & X	+5V supply
M	OV

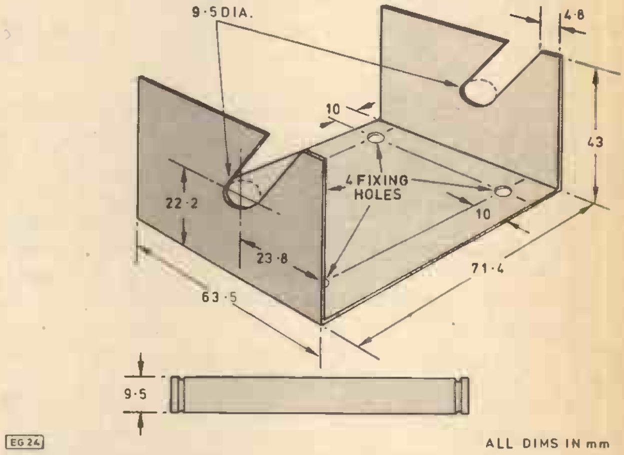


Fig. 2.9. Paper roll holder. The holder can be made of alloy sheeting. In the prototype the bobbin was made from brass rod, but a simpler solution would be to use wooden dowel, and insert screws in each end to key into the roller slots

SOFTWARE

The purpose of the software is to present data to the interface for conversion to printing pulses, whilst monitoring the status of the printer. The DUMP routine will also allow the printing of memory contents along with address information.

Although the system only uses six of the seven bits used in the Standard ASCII code, it will print all capital letters, numbers and symbols from the character set.

The only control characters required are Carriage Return, and End of Text, both of which are recognised by the software. For Carriage Return the ASCII code ODH is retained. For the End of Text character a non-standard code is used, FFH. In fact the software will terminate printing if it encounters any character byte with bit 7 set. Therefore it is important to remember that if printing text, the byte after the last character should contain FFH.

The software for the prototype is written in Z80 assembler code and the peripheral chip used is the Z80 PIO. Conversion to other microprocessor instruction sets and peripheral chips should not present too much difficulty, especially as fairly detailed flow charts are included in the article.

INPUT OUTPUT REQUIREMENTS

The I/O requirements of the system are as follows:

5 outputs, latched, for DO–D5
1 output, latched, for PRINT COMMAND ($\overline{PC}$)
1 input, unlatched, for DATA REQUEST (DATA REQ)

In the prototype system the PIO was programmed to operate in Mode 3, the bit mode. Bit 0 to bit 6 were programmed as outputs and Bit 7 was programmed as an input (see Fig. 2.10). It may be cheaper in some cases to use two separate ports, one for input and one for output. A latched I/O device such as the Intel 8212 could be used for the outputs, and a separate simple tristate buffer part could be used for the DATA REQ input. This would require only slight alteration to the software.

SYSTEM SOFTWARE

The majority of the software is involved with the DUMP routine. The actual PRINT routine itself is relatively small. We shall look at this routine first and then see how it fits into the DUMP programme.

PRINT

The PRINT routine's function is to set the printer in motion and to sequentially present data to the interface at the required time. It also detects the carriage return and end of text codes and actually performs these control functions.

There are only 2 rules for its use:

(a) The Start address of the text buffer must be in the HL register pair on entry.

(b) That the end of text code (FFH) must be in the first memory location, after the text to be printed.

For example, say we want to print the word "HELLO", the ASCII code of which starts at memory location 2000H. Before entry to the print routine HL must be set to 2000H, and the text buffer should appear as in Fig. 2.12.

The flowchart for the PRINT routine is as Fig. 2.11 and its operation is as follows:

The peripheral chip (if used) is programmed. A down-counter (the character per line counter) is preset. This enables the processor to determine when it has filled the line.

The system activates the printer by generating a "low" to $\overline{PC}$. It waits for DATA REQ to go active then moves the first character byte to the accumulator. Before outputting the character, bit 7 is tested. If set it is interpreted as an end of text character. If not set, it is then compared with 0DH to check if it is a carriage return. If not, then the routine decides it is a valid character and outputs it for printing. The character per line counter is decremented and checked for 0 at this time to see if a line has been filled. After printing, the text buffer pointer (HL), is incremented to point to the next character and the process is repeated.

If a carriage return code is detected the routine calls the subroutine SPACES, which repeatedly outputs the SPACE code to the interface until the end of the current line. (When the character per line counter = 0.) A delay routine is then called to give the print-head time to return to the beginning of the next line, the routine then proceeds as before.

When the end of text character is detected the subroutine SPACES is again called, but after its completion a return code is loaded into the accumulator and PRINT is exited.

The subroutines used by PRINT are detailed in Figs. 2.13 and 2.14.

The printer system will run with the PRINT routine alone, for printing text and program listings. All the rest of the system software is used for the memory DUMP function, PRINT is called by the DUMP program as a subroutine. PRINT and its subroutines appear towards the end of the system software listing. It actually starts on line 143.

	7	6	5	4	3	2	1	0
	I/P DATA REQ	O/P $\overline{PC}$	O/P D5	O/P D4	O/P D3	O/P D2	O/P D1	O/P D0

Fig. 2.10. PIO allocation

DUMP

As previously mentioned the DUMP routine enables the user to print out the contents of areas of memory.

Firstly the hexadecimal memory address is printed, then the contents of that location and the following seven locations are printed, also in hexadecimal. The next line begins with the start address +8, followed by the contents of the next eight locations, and so on until the specified finish address is reached. Carriage return and end of text control characters are inserted automatically by the software.

The organisation of the software is as Fig. 2.15. DUMP is the controlling routine, which calls the conversion routine, the compare routine and the print line routine. This in turn calls PRINT and its associated routines, which have already been described.

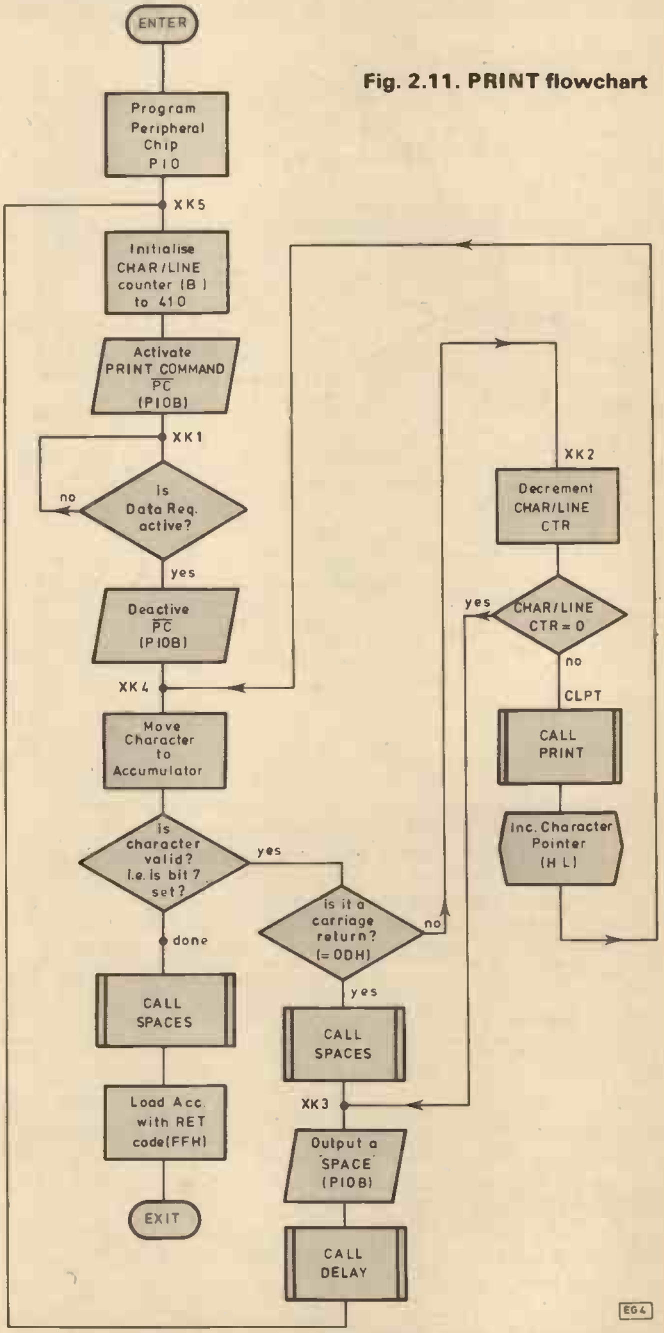


Fig. 2.11. PRINT flowchart

location	2000	2001	2002	2003	2004	2005
HEX contents	08 H	05 E	0A L	0A L	0F O	FF EOT

Fig. 2.12. Text buffer example

Fig. 2.13. PRNT flowchart (PRINT subroutine)

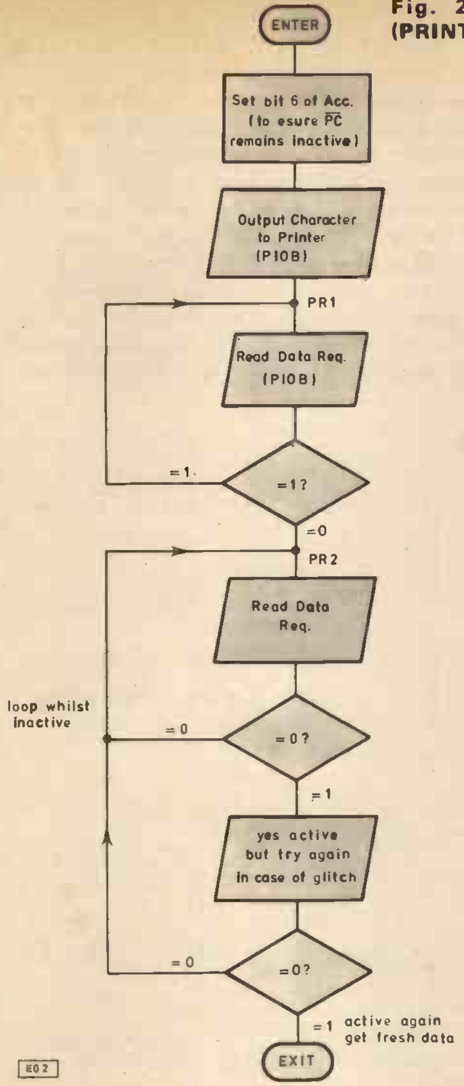
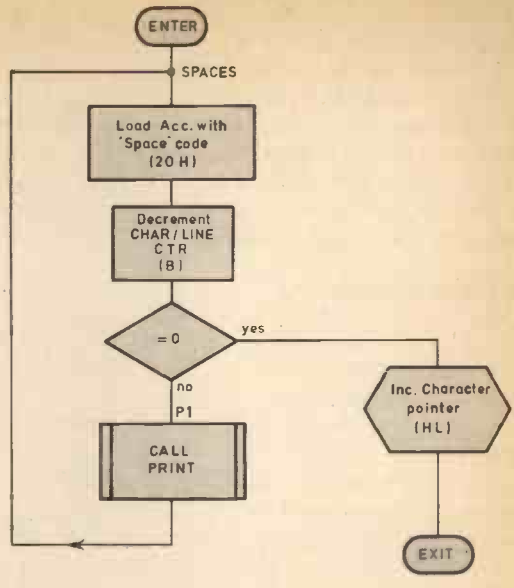


Fig. 2.14. SPACES flowchart (PRINT subroutine)



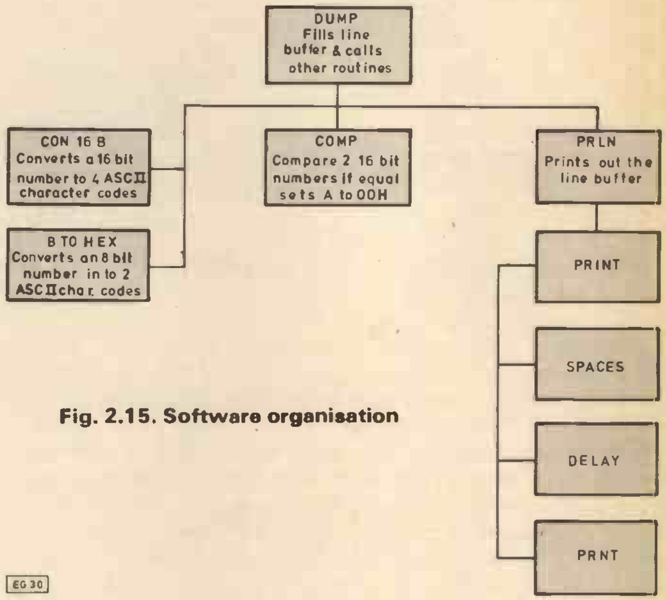
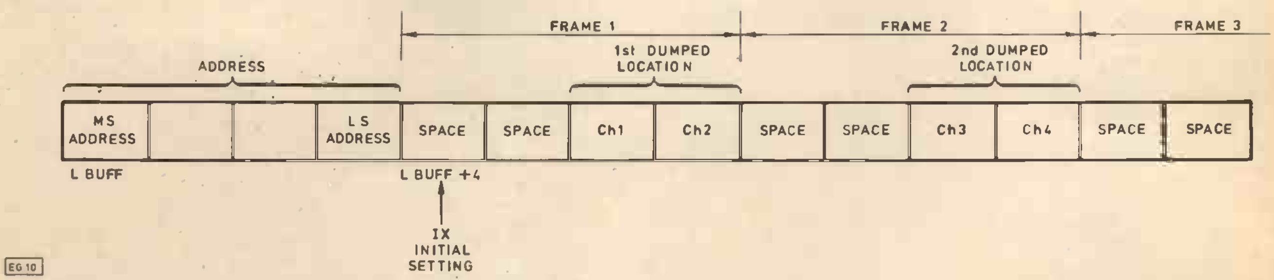


Fig. 2.15. Software organisation

Fig. 2.16. Line buffer organisation



OPERATION

DUMP operates by creating a line buffer in RAM, where it inserts the address, the spaces and the contents of the eight locations (see Fig. 2.16).

It then calls the PRINT routine to print that line. Each location and its spaces are referred to as a "frame" of four bytes. The line buffer consists of four address bytes and eight frames. It is filled in the following way:

The Start address is loaded into HL to serve as an indirect pointer (see Fig. 2.17). It is also loaded into DE where the subroutine CON16B converts it to hexadecimal and then to ASCII. The resulting four ASCII characters are placed at the beginning of the line buffer by CON16B. The line buffer pointer (IX) and the frame counter (B) are initialised. IX and C are used to place the first two spaces into the line buffer (see Fig. 2.16).

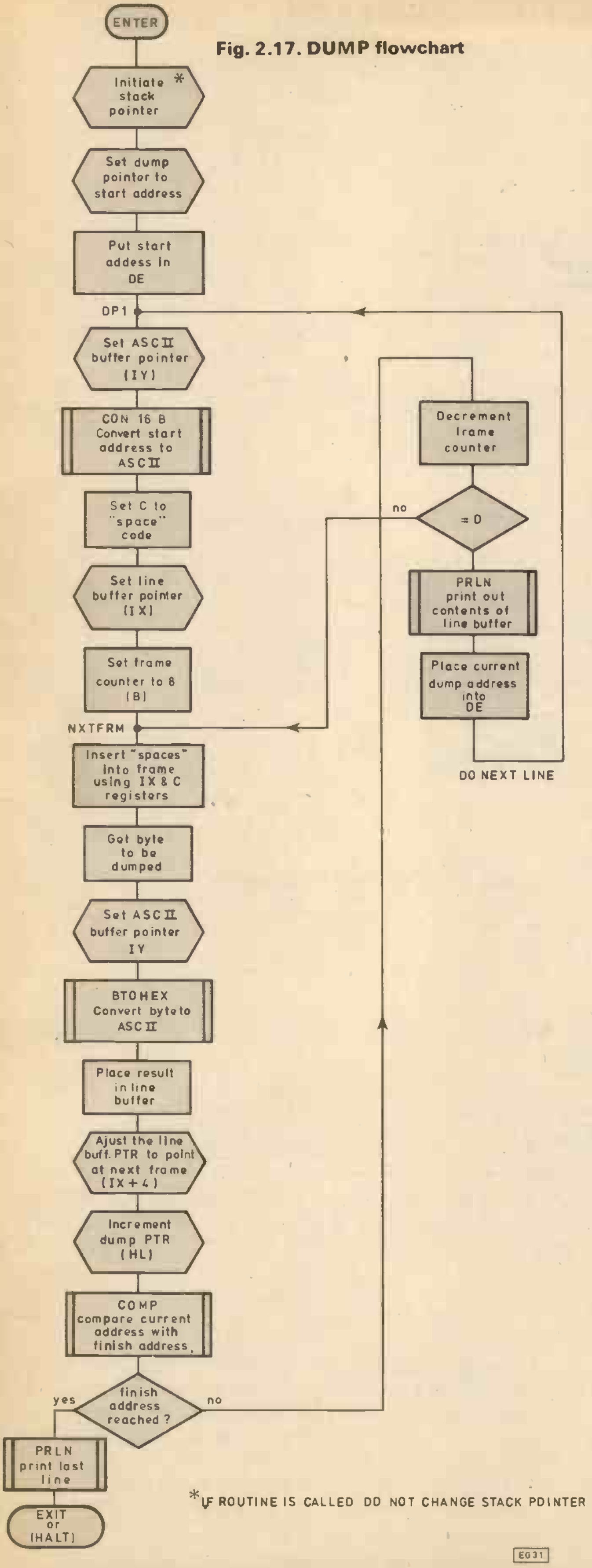


Fig. 2.17. DUMP flowchart

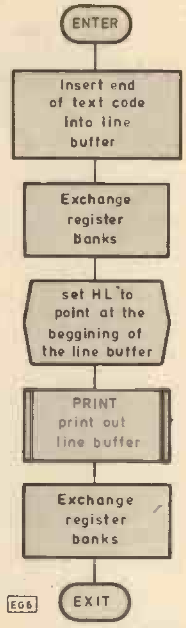


Fig. 2.18. PRLN flowchart

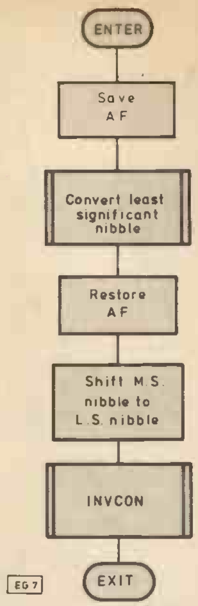


Fig. 2.19. BROHEX flowchart

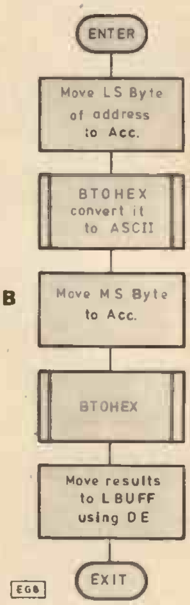


Fig. 2.20. CON16B flowchart

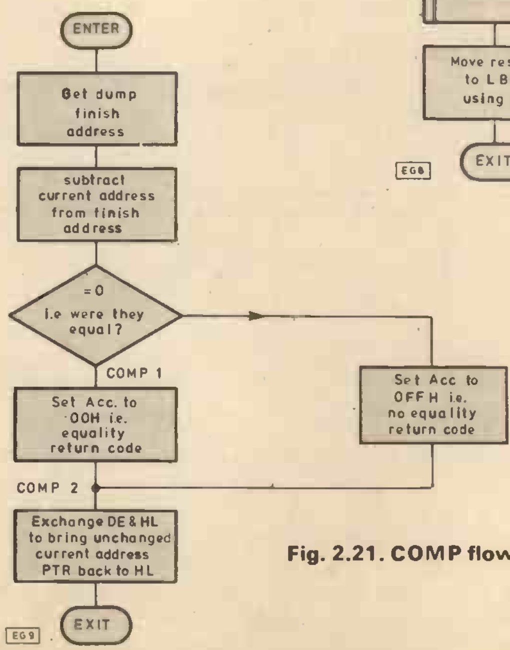


Fig. 2.21. COMP flowchart

SOFTWARE LISTING FOR Z80 WORKING

```
                          DX2    LISTING                       PAGE.  0001
LOC   OBJ CODE   STMT SOURCE STATEMENT

                 ; DUMP IS THE CONTROL ROUTINE FOR A MEMORY
                 ; DUMP TO A MATSUSHITA PRINTER.
                 ;
1750                           ORG    1750H      ;
1750  310035                   LD     SP,3500H   ;*** DELETE IF CALLED
1753  2A2821                   LD     HL,(DPST)  ;SET DUMP PTR
1756  ED5B2821                 LD     DE,(DPST)  ;READY FOR CONVERSION
175A  FD212F21   DP1:          LD     IY,ASCIB+3 ;SET ASCIB PTR
175E  CDC717                   CALL   CON16B     ;DPST TO ASCII
                 ;
                 ;
1761  0E20                     LD     C,20H      ;ASCII 'SPACE' CODE
1763  DD210421                 LD     IX,LBUFF+4 ;SET LBUFF PTR
1767  0608                     LD     B,8        ;SET FRAME CTR
1769  DD7100     NXTFRM:       LD     (IX+0),C   ;INSERT SPACES INTO
176C  DD7101                   LD     (IX+1),C   ;  LINE BUFFER
                 ;
                 ;
176F  7E                       LD     A,(HL)     ;GET DUMP BYTE
1770  FD212D21                 LD     IY,ASCIB+1 ;SET ASCIB PTR
1774  CDAA17                   CALL   BTOHEX     ;CONVERT TO ASCII
1777  ED5B2C21                 LD     DE,(ASCIB) ;RESULT TO DE
177B  DD7302                   LD     (IX+2),E   ;& THEN TO
177E  DD7203                   LD     (IX+3),D   ;LBUFF
                 ;
                 ; THE ASCII CONVERSIONS OF THE DUMP BYTE ARE
                 ; NOW IN THE LINE BUFFER.
                 ;
1781  110400                   LD     DE,4       ;ADJUST LBUFF PTR TO
1784  DD19                     ADD    IX,DE      ;POINT AT NEXT FRAME.
1786  23                       INC    HL         ;INC DPPTR
1787  CDE017                   CALL   COMP       ;COMPARE WITH DPFIN
178A  A7                       AND    A          ;TEST RET CODE
178B  2809                     JR     Z,FINISH-$ ;IF=0, JUMP OUT
178D  10DA                     DJNZ   NXTFRM-$   ;DO NEXT FRAME
                 ;
                 ;
                 ; PRINT OUT THE CONTENTS OF THE LINE BUFFER.
                 ;
                 ;
178F  CD9A17                   CALL   PRLN
                 ;
1792  E5                       PUSH   HL         ;COPY HL TO DE
1793  D1                       POP    DE         ;
1794  18C4                     JR     DP1-$      ;DO NEXT LINE
                 ;
                 ;
                 ;
1796  CD9A17     FINISH:       CALL   PRLN       ;
                 ;
1799  76                       HALT              ;***PUT RET IF CALLED
                 ;
                 ;
                 ;
179A  3EFF       PRLN:         LD     A,0FFH     ;INSERT FINISH CODE
179C  DD7700                   LD     (IX+0),A   ;
                 ;
179F  08                       EX     AF,AF'     ;
17A0  D9                       EXX               ;
17A1  210021                   LD     HL,LBUFF   ;SET PTR
17A4  CDF117                   CALL   PRINT      ;PRINT OUT LBUFFER
17A7  D9                       EXX               ;
17A8  08                       EX     AF,AF'     ;
17A9  C9                       RET               ;
                 ;
                 ;
                 ;BTOHEX CONVERTS THE CONTENTS OF A INTO 2 ASCI
                 ;CHARACTERS.
                 ;
                 BTOHEX:
17AA  F5                       PUSH   AF         ;SAVE AF
17AB  CDB717                   CALL   INVCON     ;CONVERT LS4 BITS
17AE  F1                       POP    AF         ;RESTORE
17AF  1F                       RRA               ;
17B0  1F                       RRA               ;
17B1  1F                       RRA               ;
17B2  1F                       RRA               ;MS4BITS TO LS4BITS
17B3  CDB717                   CALL   INVCON     ;CONVERT
17B6  C9                       RET               ;
                 ;
                 ;
17B7  E60F       INVCON:       AND    0FH        ;MASK OUT MS 4BITS
17B9  FE0A                     CP     10         ;0 - 9 ?
17BB  3802                     JR     C,INV1-$   ;IF YES JUMP
17BD  C607                     ADD    A,7        ;ADJUST FOR A - F
17BF  C630       INV1:         ADD    A,30H      ;CON TO ASCII
17C1  FD7700                   LD     (IY+0),A   ;STORE IN ASCIBUFF
17C4  FD2B                     DEC    IY         ;ADJUST POINTER
17C6  C9                       RET               ;
                 *E
                 ;
                 ;
                 ;   SUB ROUTINES
                 ;
                 ;
                 ;CON16B CONVERTS THE NUMBER IN DE TO 4 ASCII
                 ;CHARACTERS.
                 ;
                 CON16B:
17C7  7B                       LD     A,E        ;LSBYTE TO A
17C8  CDAA17                   CALL   BTOHEX     ;CONVERT
17CB  7A                       LD     A,D        ;MSBYTE TO A
17CC  CDAA17                   CALL   BTOHEX     ;CONVERT

17CF  ED5B2C21                 LD     DE,(ASCIB) ;MOVE RESULTS TO LBUFF
17D3  ED530021                 LD     (LBUFF),DE ;
17D7  ED5B2E21                 LD     DE,(ASCIB+2);
17DB  ED530221                 LD     (LBUFF+2),DE;
17DF  C9                       RET               ;
```

```
                              DX2    LISTING
LOC   OBJ CODE   STMT SOURCE STATEMENT

                 ;
                 ;
                 ; COMP, THIS ROUTINE LOOKS FOR EQUALITY BETWEEN
                 ; THE DUMP POINTER DPPTR, AND THE END OF DUMP
                 ; ADDRESS DPFIN.
                 ;
                 ;
                 COMP:
17E0  ED5B2A21                 LD     DE,(DPFIN) ;GET FINISH ADDRESS
17E4  EB                       EX     DE,HL      ;
17E5  AF                       XOR    A          ;CLEAR CARRY
17E6  ED52                     SBC    HL,DE      ;DPFIN-DPPTR
17E8  2804                     JR     Z,COMP1-$  ;JUMP IF DPFIN=DPPTR
17EA  3EFF                     LD     A,0FFH     ;NO EQUALITY RET CODE
17EC  1801                     JR     COMP2-$    ;
17EE  AF         COMP1:        XOR    A          ;A=0. EQUALITY RET CODE
17EF  EB         COMP2:        EX     DE,HL      ;DPPTR BACK TO HL
17F0  C9                       RET               ;
                 ;
                 ;
                 ;
                 *E
                 ;PRINT IS THE ROUTINE THAT ACTUALLY CONTROLS
                 ;THE MATSUSHITA PRINTER.
                 ;THE I/O HARDWARE USED IS THE Z80 PROGRAMMABLE
                 ;INTERFACE CICUIT, THE P.I.O., THE FIST SECTION
                 ;OF CODE DEALS WITH PROGRAMMING THIS DEVICE.
                 ;

                 ;
                 ; PROG PIO. MODE 3, B0-B5=DATA O/PS,B6=PRINT COMM
                 ; B7=DATA REQUEST I/P.
                 ;
17F1  3EFF       PRINT:        LD     A,0FFH     ;MD 3
17F3  D303                     OUT    (PIOBC),A  ;
17F5  3E80                     LD     A,80H      ;I/O CONTROL
17F7  D303                     OUT    (PIOBC),A  ;
17F9  3E03                     LD     A,03H      ;DISABLE PIO INTERRUPTS
17FB  D303                     OUT    (PIOBC),A  ;
17FD  3EE0                     LD     A,0E0H     ;INIT'SE O/PS, PC=1
17FF  D301                     OUT    (PIOB),A   ;D0-D5 = 20H = SPACE.
                 ;
                 ;
1801  0629       XK5:          LD     B,41D      ;CHAR/LINE COUNTER
1803  3EA0                     LD     A,0A0H     ;ACTIVATE P.C.
1805  D301                     OUT    (PIOB),A   ;
1807  DB01       XK1:          IN     A,(PIOB)   ;IS DATA REQ ACTIVE?
1809  CB7F                     BIT    7,A        ;
180B  28FA                     JR     Z,XK1-$    ;NO, JUMP BACK
180D  CBF7                     SET    6,A        ;YES, DEACTIVATE P.C.
180F  D301                     OUT    (PIOB),A   ;
                 ;
                 ;
1811  7E         XK4:          LD     A,(HL)     ;CHAR TO ACC
1812  CB7F                     BIT    7,A        ;VALID CHAR?
1814  201A                     JR     NZ,DONE-$  ;NO, MSB SET JP OUT
1816  FE0D                     CP     0DH        ;IS CHAR CR?
1818  2005                     JR     NZ,XK2-$   ;JP IF NOT CR
181A  CD3618                   CALL   SPACES     ;IF CR, FILL UP LINE
181D  1802                     JR     XK3-$      ;
181F  1009       XK2:          DJNZ   CLPT-$     ;IF NOT 0 CALL PRINT
1821  3EE0       XK3:          LD     A,0E0H     ;OUTPUT A SPACE
1823  D301                     OUT    (PIOB),A   ;
                 ;
1825  CD5B18                   CALL   DELAY      ;IF 0 DELAY
1828  18D7                     JR     XK5-$      ;DO NEXT LINE
                 ;
                 ;
182A  CD4418     CLPT:         CALL   PRNT       ;PRINT CHAR
182D  23                       INC    HL         ;
182E  18E1                     JR     XK4-$      ;GET NEXT CHAR
                 ;
                 ;
1830  CD3618     DONE:         CALL   SPACES     ;FILL UP LINE
1833  3EFF                     LD     A,0FFH     ;RETURN CODE
1835  C9                       RET               ;EXIT
                 ;
                 ;
1836  3E20       SPACES:       LD     A,20H      ;ASCII SPACE
1838  1005                     DJNZ   P1-$       ;
183A  23                       INC    HL         ;INC TEXT PTR
183B  CD5B18                   CALL   DELAY      ;
183E  C9                       RET               ;
183F  CD4418     P1:           CALL   PRNT       ;
1842  18F2                     JR     SPACES-$   ;
                 ;
                 ;
1844  CBF7       PRNT:         SET    6,A        ;ENSURE P.C. STAYS=1
1846  D301                     OUT    (PIOB),A   ;O/P DATA
1848  DB01       PR1:          IN     A,(PIOB)   ;READ DATA REQ
184A  CB7F                     BIT    7,A        ;
184C  20FA                     JR     NZ,PR1-$   ;IF DATA REQ=1 LOOP
184E  DB01       PR2:          IN     A,(PIOB)   ;DATA REQ INACTIVE
1850  CB7F                     BIT    7,A        ;
1852  28FA                     JR     Z,PR2-$    ;LOOP WHILST INACTIVE
1854  DB01                     IN     A,(PIOB)   ;ACTIVE BUT RECHECK
1856  CB7F                     BIT    7,A        ;IN CASE OF GLITCH
1858  28F4                     JR     Z,PR2-$    ;IF GLITCH JP BACK
185A  C9                       RET               ;GET FRESH DATA
                 ;
                 ;
185B  1640       DELAY:        LD     D,40H      ;DELAY APPROX 60MS
185D  1E7D       LP2:          LD     E,125      ;
185F  1D         LP1:          DEC    E          ;
1860  20FD                     JR     NZ,LP1-$   ;
1862  15                       DEC    D          ;
1863  20F8                     JR     NZ,LP2-$
1865  C9                       RET               ;
                 ;
                 ;
```

CONTINUED

```
                                  DX2     LISTING
 LOC    OBJ CODE    STMT SOURCE STATEMENT

                    0220 ; RESEVED RAM LOCATIONS
2100                0221             ORG    2100H
2100                0222 LBUFF:      DEFS   40          ;LINE BUFFER
2128                0223 DPST:       DEFS   2           ;DUMP START ADDRESS
212A                0224 DPFIN:      DEFS   2           ;DUMP FINISH ADDRESS
212C                0225 ASCIB:      DEFS   4           ;CONVERSION BUFFER
                    0226 ;
                    0227 PIOB:       EQU    01H         ;PORT ADDRESS
                    0228 PIOBC:      EQU    PIOB+2      ;CONTROL ADDRESS
                    0229 ;
                    0230 ;
                    0231             END

 CROSS REFERENCE                 DX2     LISTING
 SYMBOL  VAL DEFN REFS

 ASCIB   212C 0225 0008 0020 0022 0105 0107
 BTOHEX  17AA 0070 0021 0101 0103
 CLPT    182A 0178 0170
 COMP    17E0 0117 0032
 COMP1   17EE 0125 0122
 COMP2   17EF 0126 0124
 CON16B  17C7 0099 0009
 DELAY   185B 0211 0174 0191
 DONE    1830 0183 0165
 DP1     175A 0008 0045
 DPFIN   212A 0224 0118
 DPST    2128 0223 0006 0007
 FINISH  1796 0049 0034
 INV1    17BF 0086 0084
 INVCON  17B7 0082 0072 0073
 LBUFF   2100 0222 0013 0060 0106 0108
 LP1     185F 0213 0214
 LP2     185D 0212 0216
 NXTFRM  1769 0015 0035
 P1      183F 0193 0189
 PIOB    0001 0227 0150 0155 0156 0160 0172 0198 0199 0202 0205 0228
 PIOBC   0003 0228 0144 0146 0148
 PR1     1848 0199 0201
 PR2     184E 0202 0204 0207
 PRINT   17F1 0143 0061
 PRLN    179A 0055 0041 0049
 PRNT    1844 0197 0178 0193
 SPACES  1836 0188 0168 0183 0194
 XK1     1807 0156 0158
 XK2     181F 0170 0167
 XK3     1821 0171 0169
 XK4     1811 0163 0180
 XK5     1801 0153 0175
        17F1 0138
```

The first DUMP byte is then "fetched" from the start address by use of HL. It is then converted to ASCII characters using BTOHEX and placed in the line buffer using DE and IX. The first frame is now complete.

HL is now incremented to point at the next DUMP byte, but before being used it is compared with the DUMP finish address using the COMP routine. On returning from COMP the Accumulator is tested for the equality code OOH, if A = FFH there is no equality and the routine loops back to fill the next frame.

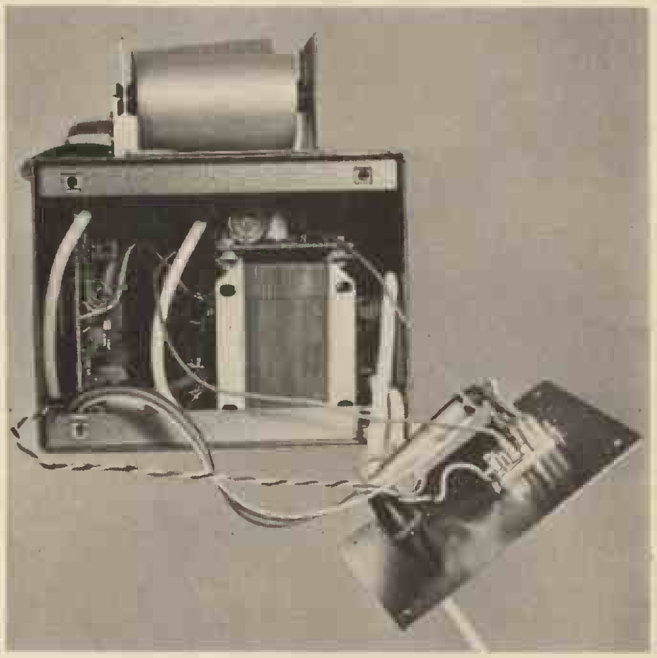
When all eight frames have been filled and the frame counter is at zero, the routine PRLN is called. PRLN inserts the end of text code at the end of the line buffer and causes the Processor to exchange register banks. It then calls the previously described PRINT routine to print the line buffer contents.

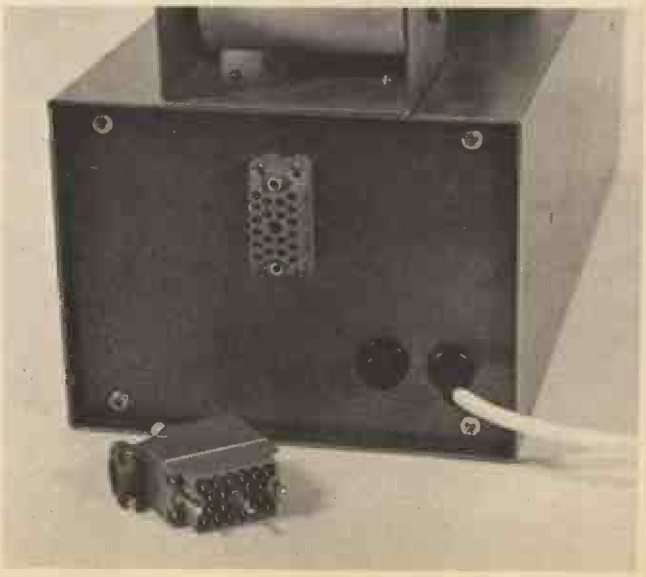
On returning from PRLN the next DUMP address is copied from HL to DE. The routine then loops back and starts converting the new address in DE and creating a new line of data.

DUMP is exited only when the current DUMP address held in HL and the DUMP finish address are found to be equal by the COMP routine. On return from COMP the accumulator contains OOH (equality code), when this is detected PRLN is called to print out the last line after which the program is exited (or halted).

The flowchart of subroutines PRLN, BTOHEX, CON16B and COMP are described in Figs. 2.18, 2.19, 2.20, 2.21, respectively. The full system software is listed.

This software section completes the description of the system. All that is now required are a few pointers along the stoney path of testing, and a few do's and don'ts about the printer itself. These will appear in Part 3 next month.





FRANK W. HYDE

HEAO-2

The second High Energy Astronomical Observatory was successfully launched on November 13 1978. Its primary task is to investigate X-ray sources. This is a wide area for it includes stellar objects such as Pulsars, Quasars, Super Novae and Radio galaxies. The large glancing incidence X-ray telescope is the largest telescope that has so far orbited the Earth.

HEAO-1 which was launched in August 1977 was designed to be operational for six months. This period has been exceeded by many months and it is still active. During the time up to the launch of HEAO-2 it had added upwards of a thousand more X-ray sources to the 200 or so known at that date.

It must be remembered that the pioneer work on X-ray sources have been done by Ariel-1 and Ariel-5 and the teams working in the British Isles were responsible for this important branch of astronomy getting into the "big time".

The progress that follows such pioneer work does appear sometimes to overshadow what has gone before. The benefits however are the best tribute to the right thinking of the pioneers. HEAO-2 is to add to the extensive search; the sensitivity of the experiments means that it will be possible to look still deeper into space for data to help solve some of the problems facing astrophysicists.

One of the problems of HEAO-2 is that it is necessary to lock on to an object for a long period in order to obtain positive results, consequently the attitude control has had to be improved. The gas jet system has been supplemented with reaction wheels. This will give a pointing accuracy of about one arc-second.

The mirrors employed vary in diameter from 30mm to 560mm. There are three star dissectors used as star trackers which update the gyros during the pointing action. The total length of the telescope is 4·7 metres. A high resolution imager digitally records the central field of the telescope which is about 25 arc-minutes at the central portion. This operates on the photo-multiplier principle. An incident X-ray photon triggers the emission of an electron and after successive impinging on other plates, its charge is detected. The detected result provides information as to position and features of the object. It is arranged that the imager can work in conjunction with two types of spectrometer.

PROPORTIONAL COUNTER

Another experiment is a proportional counter. This is co-aligned with the telescope but independent of it. The counter covers a wider range of energies received from X-ray sources. In this case the range is 0·2 to 20keV and the instrument will scan much the same area as the main telescope.

There are three other focal plane experiments. One of these, the crystal spectrometer, will be used to provide spacial as well as spectral information about extended X-ray sources. In this category would come supernovae remnants. The mode of operation can be controlled to variable resolution. Four different apertures can be used and this instrument has its own proportional counters. It is possible with this instrument to obtain information on the chemical composition of the source.

WIDE FIELD IMAGER

Another instrument is the wide field imager using a pair of counters. Each counter is divided into small regions which observe a portion of the source. The final image resolution is about one arc-minute. There is a further instrument which is a solid state spectrometer. This is capable of observing the whole spectrum over a range of 0·4 to 4KeV. The important part of this instrument is the silicon-germanium crystal. This is cooled by solid methane and ammonia.

The Telescope is orbiting at 537km with an inclination of 23·5 degrees. The vehicle is 6·7m long and 2·4m in diameter with a weight of 3,175kg. The designed life is for 12 months, though no doubt it will follow previous histories and be operational for much longer. To keep up the continuity of observations another vehicle HEAO-3 is planned.

ANOTHER GOONHILLY

Goonhilly 4 is the first part of the United Kingdom's contribution to Eutelsat. In 1977 the U.K. became a participant in the 17 country Eutelsat. The system is based on the 11/14GHz communication satellite which is called ECS. At present there is a test satellite in orbit which is called OTS2. Since May 1978 it has been in a geo-stationary orbit at 10 degrees above Gabon. The degree is a line of longitude passing near Oslo through middle Europe by Hamburg, Lake Constance, Milan, Sardinia and Tunis.

The terminal is a joint venture of the Post Office, The Department of Industry and Marconi Communication Systems Ltd. The station was designed and built by Marconi's at a cost of some 3·5m and has already been in operation sending 14GHz signals to the satellite and receiving them back at 11GHz.

The aerial is a 19 metre dish with a Cassegrain feed a gain of 66dB at 14·14GHz and a gain of 65dB at a frequency of 10·95 to 11·8GHz. A special feature of the aerial system is that it allows identical frequencies to be transmitted at the same time one polarised horizontally and the other polarised vertically. There is therefore a saving of spectrum space. Part of the preliminary tests are to discover if meteorological conditions will adversely affect performance of those two modes.

The 14GHz transmitter is installed in a building below the dish and feeds the aerial through a waveguide system and horn. The r.f. amplifier consists of a five cavity klystron and gives a power of 1·6kW with a gain of 32dB at a bandwidth of 90MHz. This is fed from 14GHz signals. The convertor can operate on two modes 140MHz which can carry 120Mbits of digital information or 70MHz carrying 60Mbits of digital or f.m. video information.

In addition to dual polarisation further economies are to be obtained by means of digital speech interpolation. This equipment has been designed by Cambridge Consultants. It is a distributed microprocessor system which employs seven Texas Instruments TMS9900S devices. This was such an advanced design that a special simulator had to be built to test it. Simulation of activity in speech is equivalent to 240 terrestrial channels.

The EUTELSAT system is developing to handle European telephony and television programmes during the decade of 1980/90.

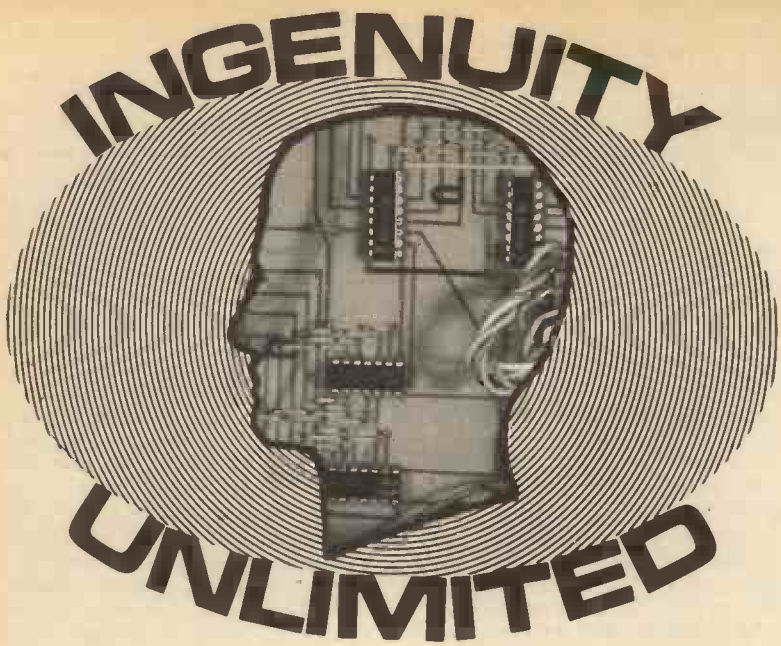
GENERAL DESIGN

The general design of the satellite will be similar to the OTS2. The main differences are that ECS will have twelve 80MHz transponders instead of six different band widths. It will not have attitude control. It will therefore be seen from Earth moving daily in a figure of eight path between 3·5 degrees north and 3·5 degrees south. It will have three spot beam aerials instead of the five on OTS2 and is designed for a 7 year life. The satellite will carry sufficient batteries to power five transponders during an eclipse and is now expected to be launched by the ARIANE launcher instead of the U.S. Thor Delta.

The twelve transponders are accommodated within the frequency band of 500MHz. Six of these are vertically polarised and six are horizontally polarised. The output of the solar panels is capable of powering 9 of the transponders. Each of these transponders terminates in a travelling-wave-tube amplifier output of 20 watts. By the mid 80's it is expected that 15 earth stations will be operational.

ICE SHEETS SLOW UP MOON

Christopher Doake of the British Antarctic Survey suggests that the ice sheets floating in the Arctic are resposible for slowing down the Moon and thus cause it to recede. The bending of the ice sheets by about one metre must dissipate something like 2×10^{12} watts over the 26,000 km "hinge line" where the ice is 500 metres thick. Doake says that extensive glaciation occurs in the periods that precede turning points, that is, when the Earth increases its spin velocity.



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

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

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

VERSATILE TIMER

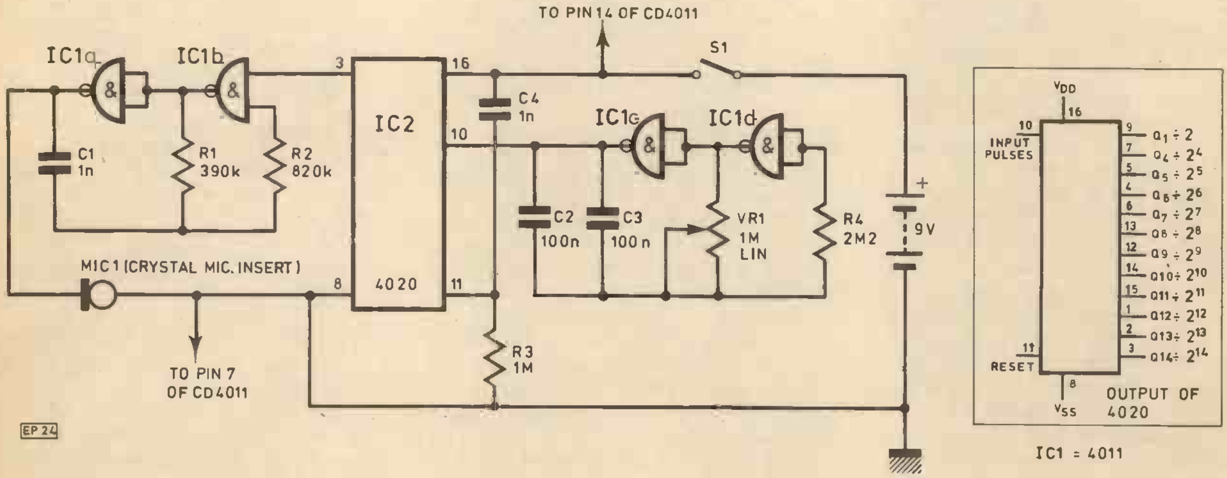
THIS timer was designed for a full scale range of 60 minutes but by using an output of a lower order than 2^{14}, of the divider, a shorter time can be more accurately achieved. Alternately C1 could be changed for a different range altogether.

IC1c and IC1d form a timing oscillator feeding a fourteen stage binary divider IC2. The output of the divider gates a 1kHz oscillator, IC1a and IC1b, which in turn powers a crystal mike insert as a bleeper. With the VR1 potentiometer of the timing oscillator on maximum and output Q14 of the IC2 feeding the 1kHz oscillator, the bleeper comes on 60 minutes after closing the switch (R3 and C4 form an initialising circuit resetting the divider at the instant of turn on).

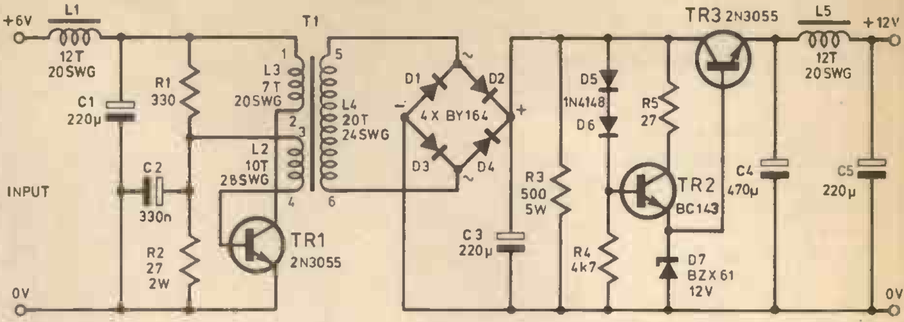
The current consumption is in the order of 500µA when timing and 1mA when bleeping.

VR1 should be calibrated to suit the timing range chosen. Comparing the inset with the full scale time, it can be seen that if Q14 is chosen the maximum time is 60 minutes, if Q13 is chosen the maximum time is 30 minutes and if Q12 is chosen the maximum time is 15 minutes etc. By changing C2/C3 to suit the application, the timer has many uses. Examples are as a parking meter, egg timer etc.

D. P. Burton,
Warrington,
Cheshire.



6-12V CONVERTOR



MANY imported cars used to have a 6 volt electrical system. Unfortunately, most British car accessories, notably, radio/cassette recorders, require a 12 volt power supply, which makes it impossible to use them in one of the older imported vehicles.

The unit described overcomes this problem by producing a 12 volt supply from a 6 volt battery, at an output current rating of about 0·5 amps, which should be adequate for most car accessories.

The complete circuit diagram. It consists of two main parts—an oscillator which drives a step-up transformer, then a rectifier and regulator circuit.

Transistor TR1 and its associated components form and audio frequency oscillator which operates at about 15kHz, although the exact frequency depends upon the load current. Resistor R1 provides d.c. bias to the transistor base and oscillation is achieved by positive feedback derived from winding L2 on the transformer. The output waveform is almost a square wave, which is stepped up to about 32 volts peak-to-peak in the transformer secondary before being rectified by diodes D1-D4. This produces a voltage of about 15 volts d.c. before the regulator circuit, with less than 0·1 volt peak-to-peak ripple. The transformer inductors should be pile wound on an FX2243 bobbin and enclosed in the pot core.

A simple series regulator circuit is all that is required to produce a constant 12 volt output. The base voltage of the series transistor TR3 is controlled by the 12 volt Zener diode D7. Transistor TR3 base current and the Zener current are supplied from transistor TR2, which together with D5, D6, R4 and R5 form a constant current source. This was used in place of the conventional resistor in this position since it prevents the Zener current from rising excessively in the "no load" condition. It also allows a smaller rating Zener diode to be used. The inclusion of R3 limits the rectifier output to about 35 volts when the regulator is not supplying any current.

Inductors L1 and L5 eliminate r.f. interference from the 6 and 12 volt supplies and should be wound on ferrite rod.

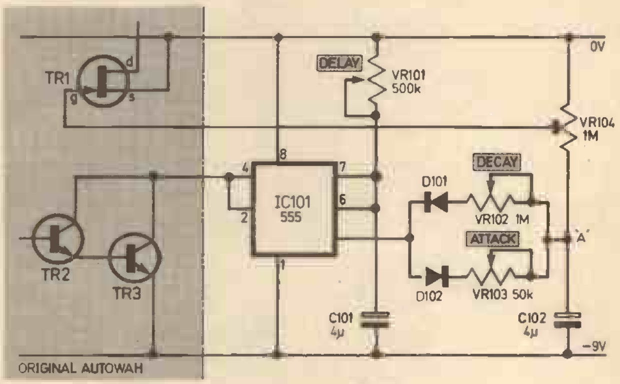
The connections shown are for a car with a 6 volt, negative earth system. The diecast box can be bolted directly onto the chassis and the internal connection made between the box and the 6 volt negative supply. If a + 12 volt supply is required, the negative output lead may also be connected directly to chassis.

For a 6 volt positive earth system, the only change is that the internal chassis connection must be connected to the 6 volt positive supply.

Because the output is electrically isolated from the input, either one of the output leads may be connected to chassis so providing either a positive or negative 12 volt supply.

D. Turner,
Plymouth,
Devon.

ENVELOPE SHAPER



A simple modification to the Autowah circuit (PE March '77) will add an envelope shaping facility and a more interesting Wah-Wah sound. This requires the replacement of the ramp generator (C7, VR2, VR3, R9 and R10) with a trapezoid waveform generator.

A pulse at the base of TR2, due to a signal at the input, causes TR3 to conduct and the voltage at pins 4 and 2 of the 555 to fall to the –ve rail. This resets and re-triggers the 555 monostable. The output of the 555—pin 3—goes high—toward 0V—and C102 charges through D102 and VR103 at a rate dependent on the setting of VR103.

After a period of time, dependent on VR101, pin 3 goes low—and C102 discharges through D101 and VR102 at a rate dependent on VR102.

Thus at the beginning of each note a trapezoid waveform will appear at point "A" with attack, delay and decay lines fully controllable. This voltage controls the VCA/VCF built around IC11 via VR104 and TR1.

VR104 should be adjusted for flat compromise between no signal at the output when the control voltage is low (–ve rail) and maximum signal when the control voltage is high—with the circuit in the VCA mode. D101 and D102 can be any g.p. silicon diodes.

The timing components (C101, VR101, VR102, VR103, C102) can be altered for those used in the prototype if desired. If the control pulse breaks through onto the output this can be cured with 0·22µF capacitor across the output. Finally, a piece of advice about usage; the delay period must be long enough to allow the attack phase to occur, otherwise no control voltage will be generated.

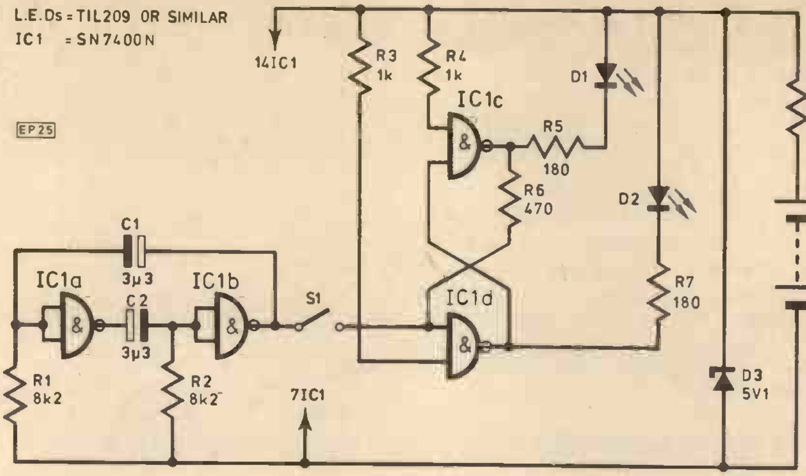
A. N. Oliver,
Brentwood,
Essex.

HEADS OR TAILS?

THIS is a variation on "heads or tails". By using l.e.d.s instead of small bulbs, the whole circuit can be constructed from a single integrated circuit, without the need for a separate transistor clock.

The circuit is shown where IC1a and IC1b form an astable or free-running multivibrator, which clocks the bistable or memory made up of IC1c and IC1d. When S1 is closed, the coin is in the "spinning" mode, in which the square wave output from the multivibrator switches the bistable, and hence the two l.e.d.s, alternately. When S1 is opened, the coin has "landed" and the bistable remains in the state it was last in, and the corresponding l.e.d. will light up indicating the visible side of the coin (heads or tails).

The whole can be constructed inside a tin, provided that a small enough battery is used (PP3 or similar), the "Spin" switch being a miniature push-to-make switch.



D. J. Taylor,
Maidenhead,
Berks.

NOVELTY DOOR-BELL

THIS simple novelty doorbell produces an adjustable range of sounds which will surprise even the most travelled doorbell ringer.

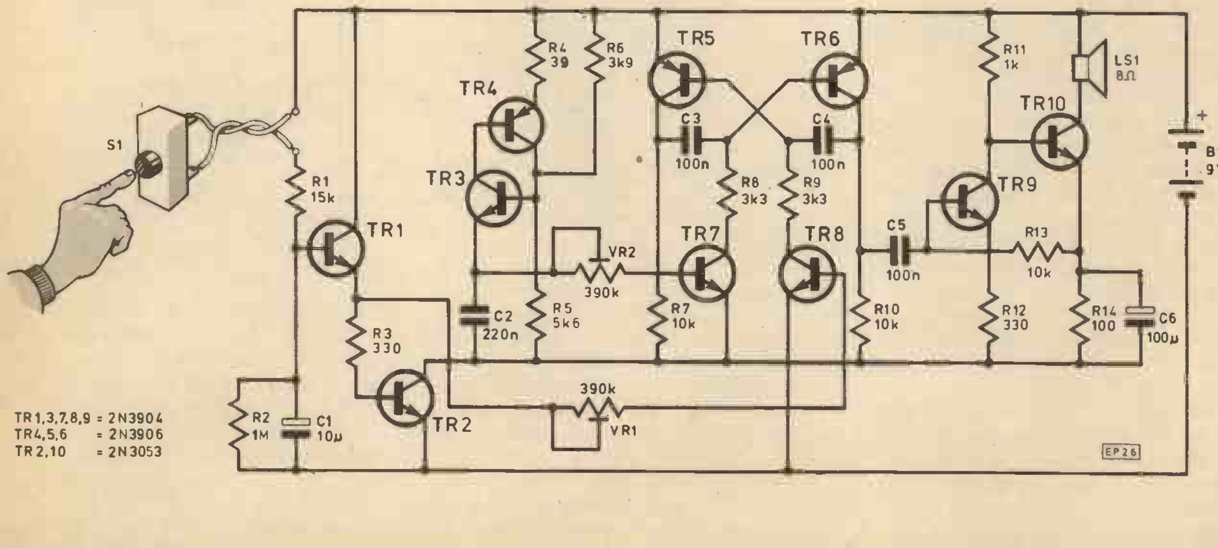
The circuit shown below comprises a number of distinct sections: TR2 forms the on/off controller; TR3 and TR4 form a ramp generator; TR5 to TR8 form a voltage controlled oscillator (VCO) and TR9 and TR10 form an audio amplifier.

When the pushbutton S1 is pressed, C1 charges via R1. The voltage across C1 is followed by the emitter of TR1. As this voltage rises, TR2 turns on which energises the remainder of the circuit. The ramp generator, running at about 20Hz modulates the VCO on one input, while the voltage on TR1 emitter controls the other input. The VCO output is amplified and passed to the loudspeaker.

When S1 is released, the circuit remains active for a few seconds while C1 discharges through R2. VR2 adjusts the ramp modulation, while VR1 adjusts the rise and fall of frequency as the button is pressed and released. The range of frequencies produced is quite wide, hence the sound of the bell is difficult to mask (or ignore).

The standby current is infinitely small, and with normal use a PP9 battery will last several years.

P. R. Williams,
Stevenage,
Herts.



Semiconductor UPDATE...

FEATURING :MC68488, MC3448, ICL8211, ICL8212 — R.W. Coles

ON THE BUSES

Wouldn't it be nice to gather together an ad hoc collection of test equipment such as voltmeters, counters and signal generators, to connect them all together, daisy-chain fashion, and then be able to control the whole collection with the aid of, say, a microcomputer so that the result is a tightly controlled measuring *system.*

Imagine it, to test a radio receiver, the microcomputer sends out commands to set the frequency and output level of the signal generator, the voltage range of the voltmeter, and the timebase of the counter. While moving automatically through a measuring sequence, the microcomputer accepts output data from the measuring instruments and prints it out in the form of a fully formatted test report. Pipe dream? No, if you like you can do all of this right now, provided that your test instruments are fitted with IEEE488 bus interfaces.

The IEEE488 bus started life at Hewlett Packard as the HP-IB, and it turned out to be such a sound, well engineered design that it has now become accepted as an *international* standard, adopted by many instrument makers.

In essence the IEEE488 bus consists of an 8 bit wide bi-directional data bus and a further 8 bits of control and handshake data. Instruments connected to the bus are allocated individual addresses, and they may act as "talkers" or "listeners" as determined by the bus controller which could be a programmable calculator or a microcomputer.

Data transfer on the bus can be from any device activated as a talker to any (reasonable) number of devices activated as listeners, and data can be moved at up to two megabytes per second!

Individual instruments can act as talkers *and* listeners (to receive range commands and transmit measured data for example) and the bus controller can carry out "polling" operations to determine which devices need service.

Not that the bus is restricted only to sophisticated measuring systems, you can connect together a voltmeter talker and a printer listener to form a simple and controllerless system, and if further proof of the usefulness of the IEEE488 is necessary, the Commodore PET microcomputer comes equipped with an interface as a standard feature.

BUS CHIP

Now, to get to the point of my story, Motorola have introduced an IEEE488 bus interface in a single 40 pin package, coded **MC68488.**

The new chip is a version of the GPIA (General Purpose Interface Adapter), and is a member of the MC6800 microprocessor family.

One side of the interface hooks up to the microprocessor data bus and control lines such as R/W and RESET, and the other side drives the IEEE488 bus via bi-directional Tri-state drivers such as the **MC3448** (which is designed for the job).

The MC68488 handles many of the complex bus protocol functions automatically, but some others do require extra effort from the microprocessor, under software control.

With a little imagination, you can use the MC68488 with other microprocessors, so come on, if you want to transfer data at a rapid rate, send it by bus!

MICRO-POWER

No, not another microprocessor news item (sighs of relief!), but a pair of new low consumption voltage regulator building blocks which are optimised for use at very low voltages and/or currents where their fixed voltage (e.g. LM309) cousins fear to tread.

The new devices are made by Intersil and are coded **ICL8211** and **ICL8212.** Both are bipolar monolithic integrated circuits in 8 pin mini-d.i.p. packages, and both can be used in some interesting and diverse applications such as positive and negative voltage regulators, constant current sources, overvoltage crowbar circuits and power failure detectors.

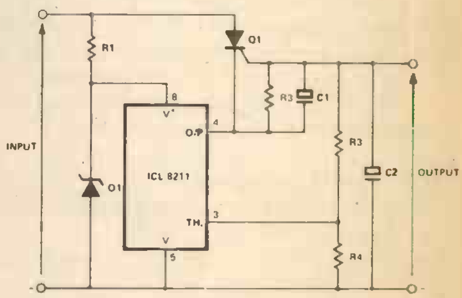
The ICL8211 contains a low voltage (1·15 Volt) reference circuit, a differential error amplifier with a feedback reference input, a current limited common emitter output amplifier, and p.n.p. hysteresis transistor.

The ICL8212 is similar except that the common emitter stage is not current limited.

The new devices are really intended for the unusual, rather than the run-of-the mill, applications, particularly those where low consumption is essential.

APPLICATIONS

One application which caught my eye was the use of the ICL8212 as a programmable "Zener". This circuit uses two resistors and a capacitor in addition to the i.c., but by varying the ratio of the resistors, any "Zener" voltage from 2 to 30V can be selected. and a particular advantage is the extremely low "knee" current of less than 300 micro-amps.



POSITIVE REGULATOR — THYRISTOR BOOST

Another application using an 8211, and shown here, is interesting for its use of an external thyristor as an n.p.n.-p.n.p. transistor structure, operating in a linear mode and providing increased output current in a positive voltage regulator circuit.

A unique feature of this circuit is that the cathode of the thyristor is acting as the control terminal, and the gate as the output terminal!

The only problem with this circuit is that manufacturers' data sheets for thyristors do not cover this strange mode of operation, and no gain figures will be given for the p.n.p. portion of the structure which is utilised here. This of course, need not hinder the experimenter!

GUITAR SOUND MULTIPROCESSOR

Part 3

Mark A. Sawicki M.Sc.(Eng.) **Alex. Kowalewski**

IN part two we dealt with the clock system and the input and output filters. In this the VU driver, power supply board and the pushbutton switch control module will be described together with chassis design details and enclosure.

PUSHBUTTON CONTROL MODULE

In the stacked pushbutton control module there are three boards, the top being the input filter, the second is the clock board, and the third is the output filter (see photos Part 2). The boards are separated from each other by means of eight 2·5cm p.v.c. spacers and from the bottom plate by four 1cm p.v.c. spacers. The whole module is fastened to the bottom plate by means of four 85mm steel wires threaded for 6BA self-locking nuts. The front panel is fastened to the bottom plate by the necks of the five jack sockets.

The centres of the pushbuttons are about 30mm apart in both horizontal and vertical directions.

OPTIONAL VU DRIVER

Fig. 14 shows the complete VU driver circuit. The 748 is an op-amp packaged into a TO99 round metal can, with leads bent into an 8 pin d.i.l. configuration. C75 is provided to damp the movement of the meter.

The 748 is a similar device to the 741 op-amp except it has external frequency compensation for improved high frequency gain.

The power for this circuit is taken from the 0 and +15V d.c. rails only. Input is taken directly from the output of the first low pass filter.

Calibration is achieved by means of VR11.

Due to the simplicity of this optional unit it was constructed on a piece of 0·1in matrix Veroboard (45mm x 25mm) and fastened to the main board as can be seen in the photograph (page 1251—Part One).

LED STATUS INDICATOR SYSTEM

Fig. 15 shows the complete circuit diagram of the l.e.d. status indicator system. The spare connections on the main front panel slider switches are used for this purpose. Note that the l.e.d. status indicators are independent of the remote control.

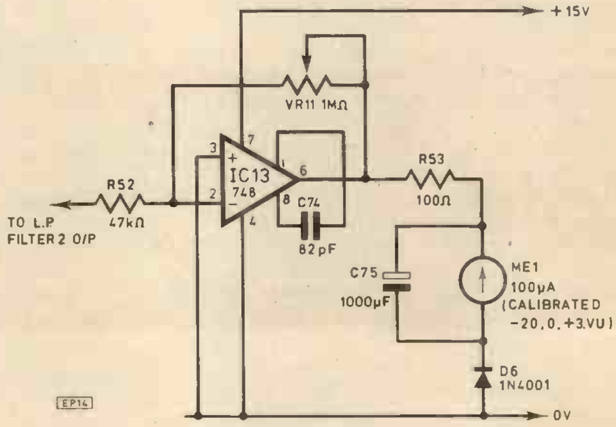
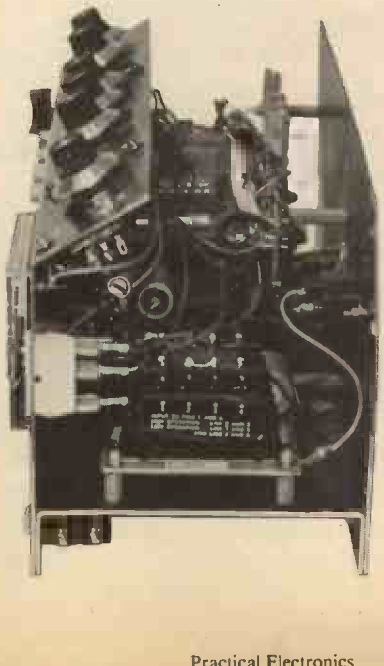


Fig. 14. VU driver circuit



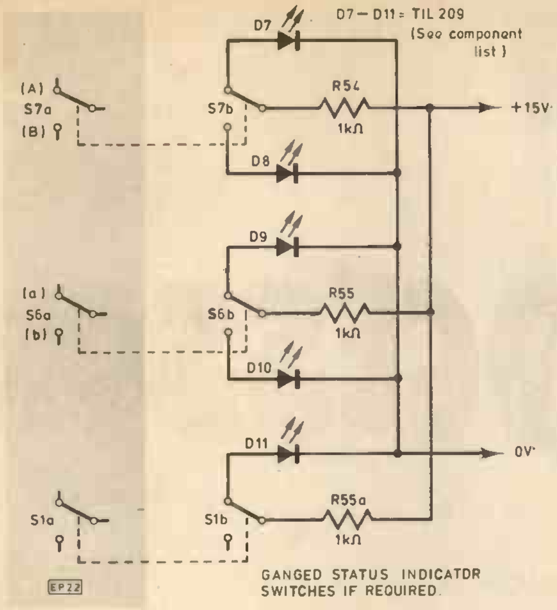


Fig. 15. L.e.d. status indicator

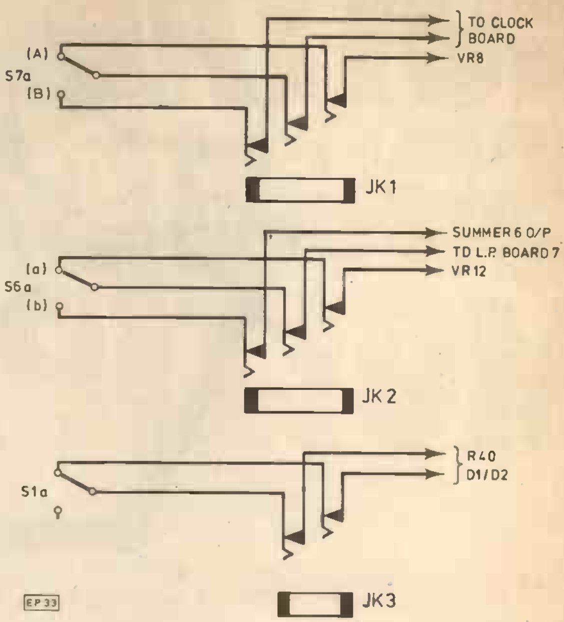
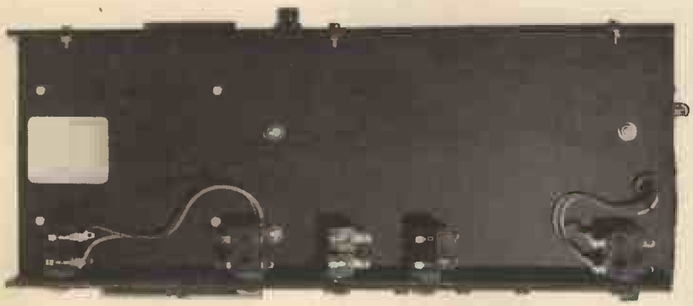


Fig. 16. Wiring for optional remote control jacks



The l.e.d.s are very useful if the processor is used in a live performance situation where the ambient light is often very low. Here the upper switch positions are denoted by green and the bottom by red l.e.d.s. The fuzz effect however has a yellow l.e.d. for the on position.

REMOTE CONTROL

Fig. 16 shows a complete circuit diagram of the remote control system. It employs three, two and three pole chassis mounting $\frac{1}{4}$in jack sockets. Consequently when a jack plug is inserted into the socket it automatically bypasses the slider switch on the front panel, thus preparing the unit for optional footswitch operation.

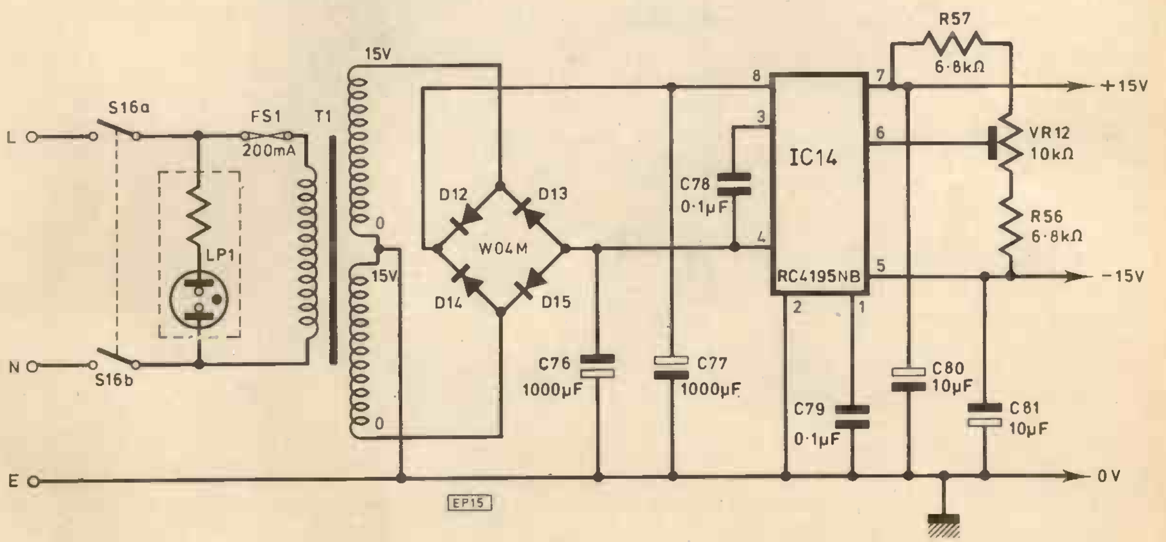


Fig. 17. Circuit of power supply unit

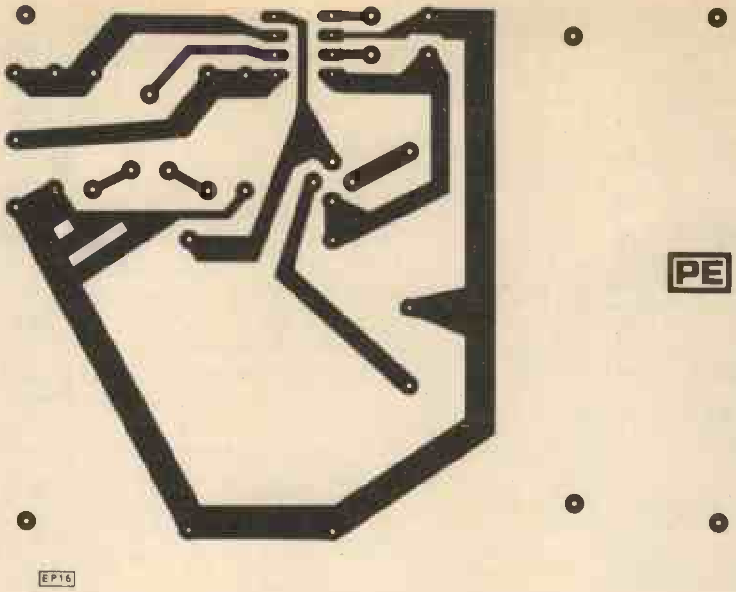


Fig. 18. P.s.u. printed circuit board

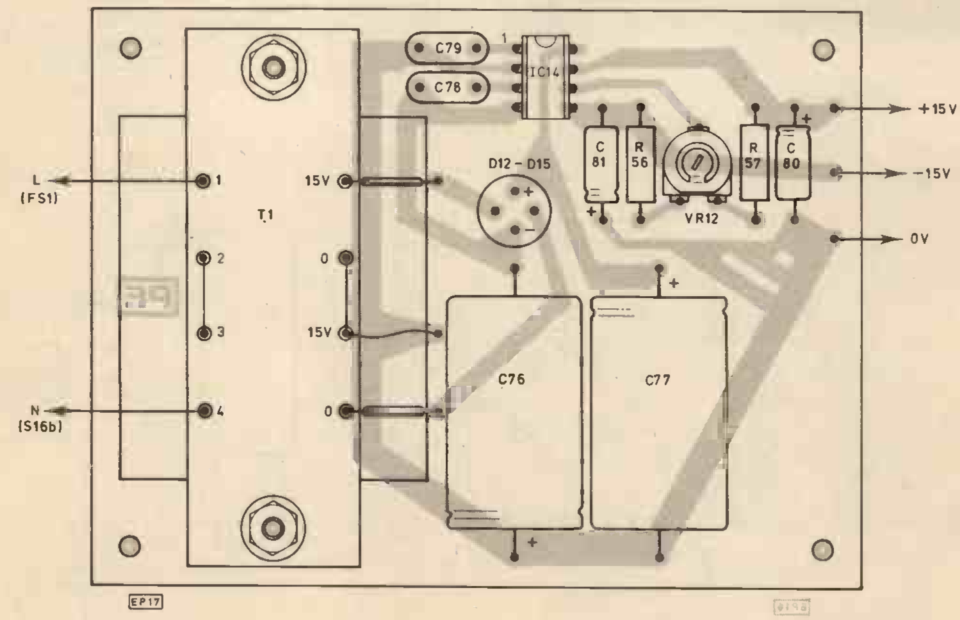


Fig. 19. P.s.u. board layout

Prototype board based entirely on RS components

This feature will prove to be essential for guitar work. These footswitches are available from:

Re-An Products Ltd.,
Burnham Road,
Dartford,
Kent, DA1 5BN.

POWER SUPPLY

The complete circuit diagram of the power supply board is shown in Fig. 17. This employs a RS transformer, and monolithic voltage regulator. The prototype multiprocessor included an RS board; however an alternative p.c. layout is given in Fig. 18 with component and wiring details in Fig. 19.

The power supply is stabilised and regulated providing +15V, 0V, −15V d.c. The whole p.c.b. is mounted on four 1cm p.v.c. spacers on the right-hand side of the base plate as can be seen. The mains is switched on and off by means of an illuminated rocker switch.

Power is fed to the unit via a Euroconnector and then a 200mA fuse, both auxiliary devices are mounted on the rear panel.

CHASSIS AND CASE CONSTRUCTION

Fig. 20 shows the dimensions of the individual metal plates required to construct the chassis unit for the guitar sound multiprocessor. All the aluminium used was 1·5mm thick. Basically all that is required is the main base plate (C), rear panel (B) and front panel (A) which has been bent to cater for the sloping front panel design. All the metal surfaces were sprayed with gloss paint and the artwork was carried out in Letraset which was later sprayed with lacquer in order to protect it.

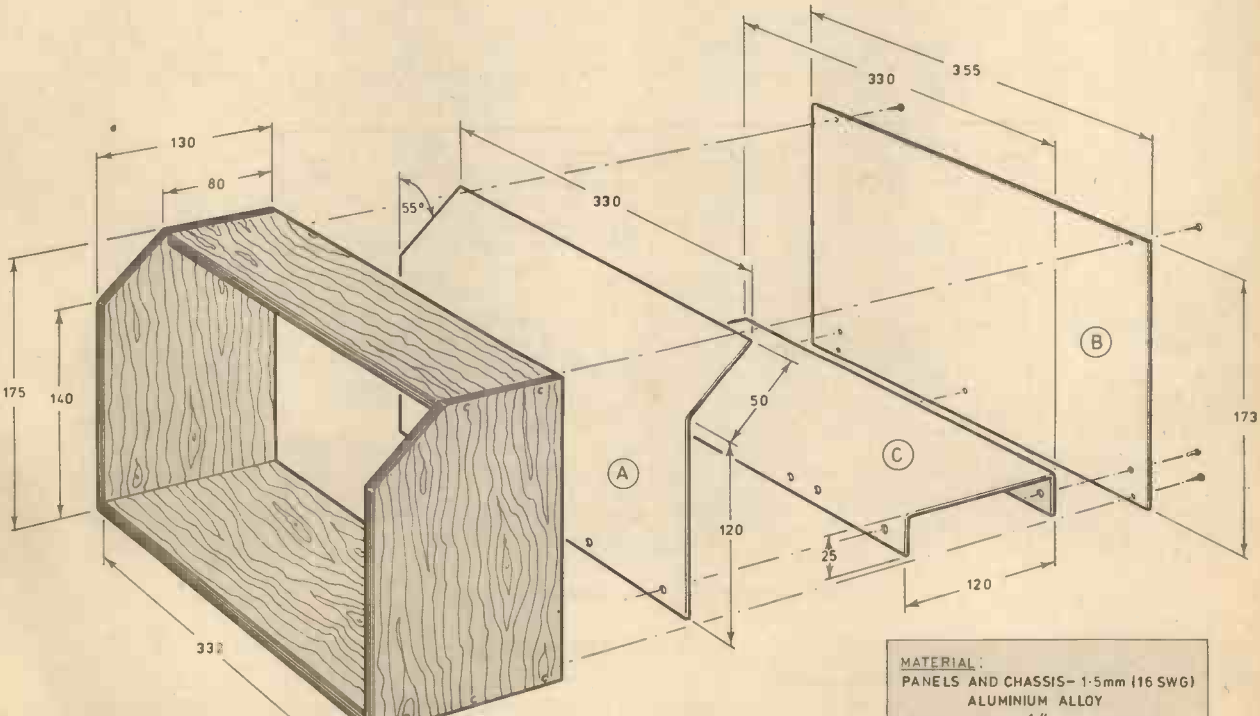


Fig. 20. Exploded diagram of chassis and case

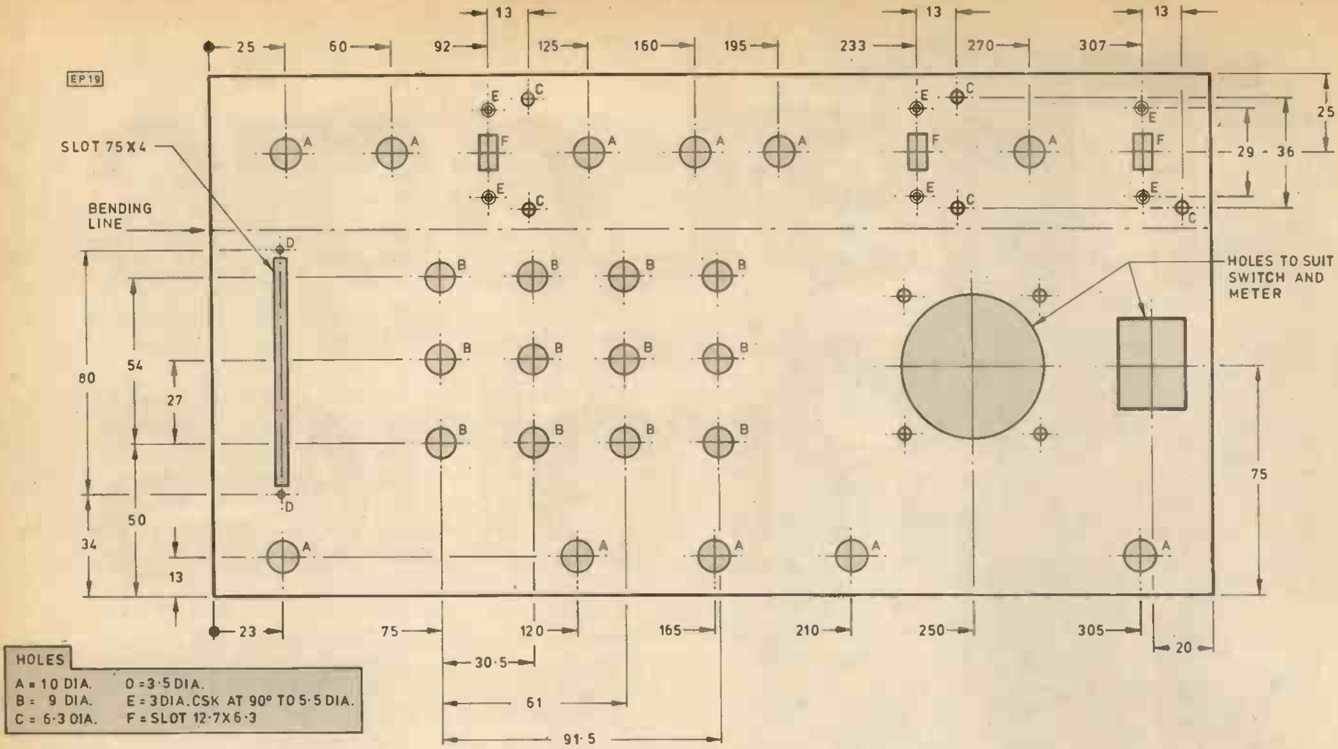


Fig. 21. Cutting details of front panel

Switch positions and o'clock settings of potentiometers for sounds indicated

Control	Rotary	Fuzz	Flanging	Phaser/Vibrato	Reverb	Computer Voice	Repeat Echo	Vibrato/Reverb
1	9	Min	9	Min	Min	9	10	9
2	5	Min	1	Min	6	Min	Min	Min
3	Down	Down	Up	Up	Down	Up	Up	Min
4	12	Min	Min	Min	11.30	12	Min	12
5	12 (delay 4mS)	Min (delay 4mS)	12 (delay 4mS)	12 (delay 4mS)	Min (delay 43mS)	12 (delay 9mS)	9 (delay 43mS)	4 (delay 4mS)
6	9	Min	10	6	Min	5.30	9	9
7	Down	Down	Down	Up	Down	Up	Up	Up
8	Min	5.30	Min	Min	Min	12	Min	Min
9	Up	Down	Up	Up	Up	Up	Up	Up

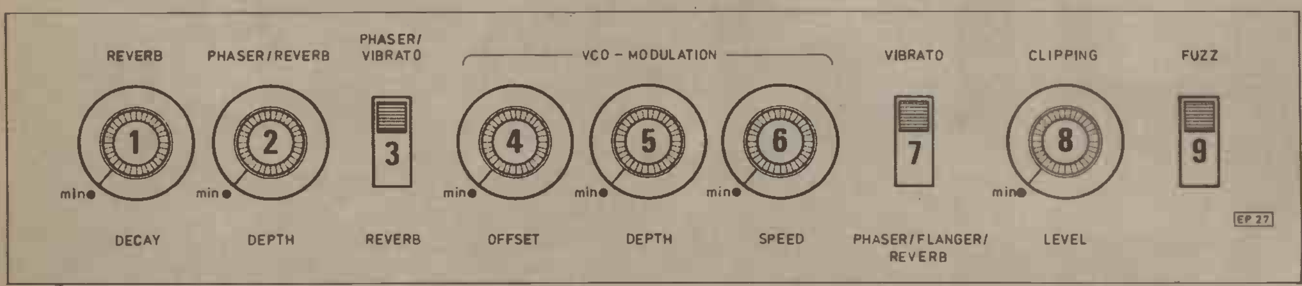


Table 2 and numbered related controls

Drilling details for the front panel are given in Fig. 21 but these should be modified as component sizes dictate.

Fig. 20 shows the dimensions of the case components which were comprised of $\frac{1}{2}$in plywood covered in plastic Vinyl Rexine. When gluing on the plastic use "Evostick" because it allows you to move the plastic into position before it sets.

It's a good idea to attach a carrying handle to the case for safety and ease in transportation.

SETTING UP

This instrument is experimental in nature so when using it let your imagination be your guide. However, Table 2 gives you a rough idea of what can be achieved with the processor.

Some component changes have been made and are correct as shown in the circuit diagrams.

★

INDUSTRY NOTEBOOK

By Nexus

International

Electronics has always been an international industry. But never on such a vast scale as we are witnessing today or over such a variety of electronic products. Countries who had little or no capability in electronics are now becoming substantial producers.

At first, these "backward" countries were being used as low-cost labour areas for assembly work. They are now climbing the learning curve. Soon they, too, will be designing.

The process is being accelerated by technology transfer, especially in defence electronics. Few countries today, when procuring defence equipment, are content to let an overseas supplier provide everything. They want a share of the work themselves.

If they need, say, 1,000 military radios they will take the first 100 from the supplying country and set up a local assembly plant to build the balance of 900 radios, largely from kits but embodying as much as possible that can be built or acquired locally. This is very true of the Middle East.

But for commercial or other reasons it is also happening in the advanced electronics countries. Who could have imagined only a few years ago that one day the chairman of a substantial UK operation would be a Mr. Kenichero Hiyama, overseeing the production of radio and TV equipment carrying famous brand names such as Bush and Murphy. Mr. Hiyama is the Japanese chairman of Rank-Toshiba, the first joint Anglo-Japanese company of which 70 per cent is owned by the Rank Organisation, 30 per cent by Toshiba.

The company will plough in an extra £3 million investment to strengthen the existing Rank plants at Plymouth and Redruth with the target of a production rate of 350,000 colour sets and 100,000 monochromes a year.

We can expect further Japanese penetration in the years ahead. The advantage of a joint company is clear. At least, from the British viewpoint, production is maintained, even increased, in the UK and products will be exported under the Toshiba brand name to other European countries.

Thorn Consumer Electronics is expressing a willingness to learn from others. Half a dozen union men and four senior managers have been to Japan to see for themselves the conditions and work methods of their main competitors.

Technology Transfer

Technology transfer has also been in the news. The biggest single new outlet for UK expertise looks like being China. At the time of writing no substantial new orders had been announced as definite but there were high hopes of substantial contracts for defence and other equipment. It is almost certain that China will want to build, for example, Harrier jump-jets and aero engines under a technology transfer agreement. Defence electronics will follow.

Nearer home, Racal has done a deal with Spain in which the Spaniards will build Racal-designed VHF military manpack radios in a factory near Madrid. A condition of tender was that bulk manufacture would take place in Spain. Refusal means no business. Acceptance of the condition still brings in Racal some £6 million, well worth having and, as there was plenty of competition for the contract, if Racal didn't win someone else would.

Discussing this type of deal with industry leaders I was told that high technology companies are confident they have the inventive muscle to stay ahead of the game. That by the time a technologically retarded country had mastered the present generation of equipment the advanced companies would already be in production of the next generation. As for example, in the giant Togliattigrad car assembly plant in the Soviet Union, designed by Italian Fiat but behind in technolgoy compared with Fiat's present developments at Turin, or the production of ITT connectors in Poland which are technologically a generation behind those produced by ITT in Western Europe or the United States.

Nonetheless, the gap is bound to narrow and there are plenty of examples of intelligent pupils who have outclassed their masters, prime example being the Japanese who were non-starters in many fields a short 30 years ago but are now fearsome competitors, not least in electronics.

Single Chip

The single-chip revolution is now well under way. I have quoted several examples in recent months and almost daily some complicated function or other is revealed as not only technically feasible on a single piece of silicon but with production samples available.

I remember the mixed feelings I had when I looked into the guts of the first Racal 99 Series frequency counters, based on a Ferranti chip, when they appeared some three years ago. There was the box with practically nothing in it. Of course they worked beautifully but when you are laying out a few hundred pounds you expect to see something substantial inside for your hard-earned cash.

I was reminded of this early experience, almost shocked disbelief, when Hewlett-Packard announced their new 100MHz 5315A countertimer which includes computing facilities from a microprocessor.

Only nine years ago the equivalent H-P product of that era had a dozen p.c.b.s packed with TTL circuits to perform the logic functions alone. The same work is now done by a couple of chips. In all, the new instrument contains just nine i.c.s. The 5315A, selling at about £500 and a low-cost sister instrument at about £230 have been introduced to meet fierce competition in the counter market.

Look to Philips, too, for intensification of competition in the instrument market. Philips was anything but a leader even five years ago.

Since catching the instrument bug Philips has made considerable inroads, especially with oscilloscopes. The 1978 sales of instrument products in the UK were 50 per cent higher than in 1977 and in the instrument business this is indeed fast growth.

Prestel

The Post Office Prestel viewdata service is proving an exciting prospect for overseas administrations as well as at home. It could be a big export hit. West Germany, the Netherlands, Hong Kong and the USA (in agreement with a US company) have already signed, or are in process of doing so. The seventeenth country in which live demonstrations have been given is the Soviet Union with a presentation in Moscow.

Post Office researchers are now busy devising new ways of getting viewdata on the screen in different alphabets such as Arabic, Greek, Hebrew and the phonetic Japanese script known as Katakana.

There are great hopes that the British system will be adopted as the world standard, thus enhancing further export prospects.

GEC/Fairchild

The GEC/Fairchild joint venture in the UK for the production of VLSI circuits appears to be on schedule with production still forecast for 1980. INMOS, a possible competitor backed by the National Enterprise Board, will pose no threat according to Fairchild chairman Wilf Corrigan who has gone so far as to forecast INMOS as "doomed" and "too late".

Well, time will tell, but as regular readers will remember I tend to agree that INMOS chances are slim if only because it has no established marketing outlets and no previous track record of its own.

PATENTS REVIEW...

Copies of Patents can be obtained from :
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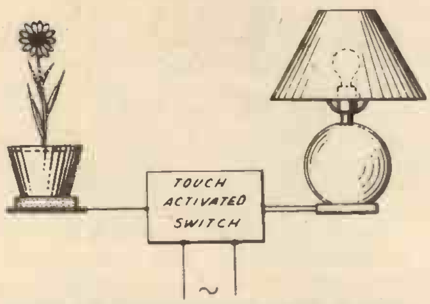
ORGANIC TOUCH SWITCH

BP 1 520 625, from Harold Barkan of New York, describes a simple idea in lengthy prose which is characteristic of patents originating from the USA. The interest value of the simple idea does however justify the effort of cutting through the verbiage. The object is to modify a touch control switch so that it is actuated by touching a living plant!

Barkan has made the simple, but apparently novel, observation that if the touch sensitive element of an electrical touch switch (e.g. of the type used to control domestic lighting) is electrically connected to the roots of a pot plant, then the plant itself will serve as the touch sensitive element.



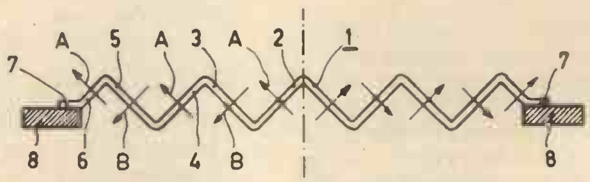
Bearing in mind the high fluid content of a living plant, this is readily understandable. Barkan maintains that even cut flowers or fruit and vegetables in a bowl are sufficiently electrically conductive to function in the same manner.

The simplest approach recommended is merely to extend the touch sensitive element of an off-the-shelf touch sensitive switch. A length of wire connects with an electrode buried under the earth in which the plant grows. According to the inventor, a light or other load connected to the switch terminals can then be switched on and off merely by gently stroking the plant leaves or flowers.

PIEZOELECTRIC TRANSDUCER

Audio designers are turning towards piezo-electric powered loudspeakers and several modern high fidelity speakers now incorporate piezo horns as their HF units or "tweeters". In BP1 489 351, Philips patent a loudspeaker which is based on a diaphragm formed entirely from piezo-electric material and, in principle, appears adaptable to larger and wider bandwidth units than previously.

Fig.1



The Philips transducer has a circular diaphragm formed from a foil of polyvinylidene fluoride, a material which has piezo-electric properties. The diaphragm foil has metal electrodes vacuum deposited on each major surface and is circularly corrugated, so that its surface is covered with concentric rings of V-shaped cross-section. The opposite walls or flanks of each ring are oppositely polarised. Thus in Fig. 1 the flanks 2, 4 and 6 are polarised in one direction (arrows A) and the flanks 3 and 5 are polarised in the opposite direction (arrows B). In Fig. 2 the flanks 20, 22 and 24 are polarised in the direction of the arrows P and flanks 21 and 23 in the direction of arrows Q. The diaphragm is polarised by electrodes 30 and 31 of the polarising device (Fig. 3).

When an alternating voltage audio signal is applied to the surface electrodes (not shown in the diagrams), all the flanks of the diaphragm behave in characteristic piezo-electric manner and change in length. But as the flank pairs are oppositely polarised the action of all the flanks is concerted, and the diaphragm as a whole moves in an axial direction. It thus behaves in the manner of a conventional loudspeaker cone driven electromagnetically by a moving coil. So, the applied audio signal is converted directly into mechanical energy. This suggests that the unit will have high efficiency in terms of sound level transduced from audio signal input.

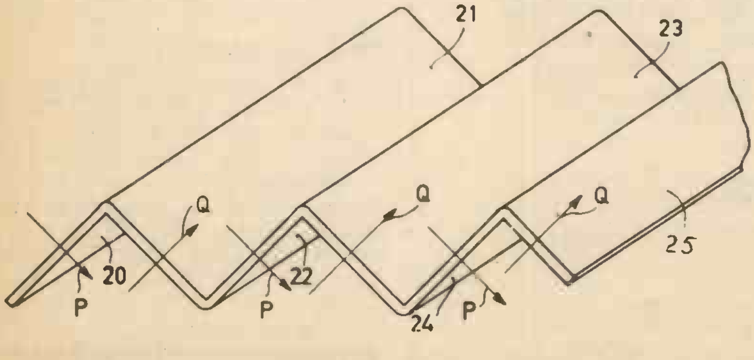


Fig.2

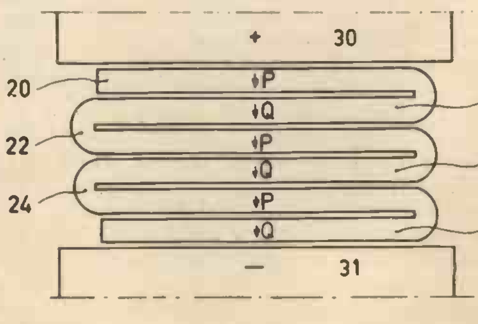


Fig.3

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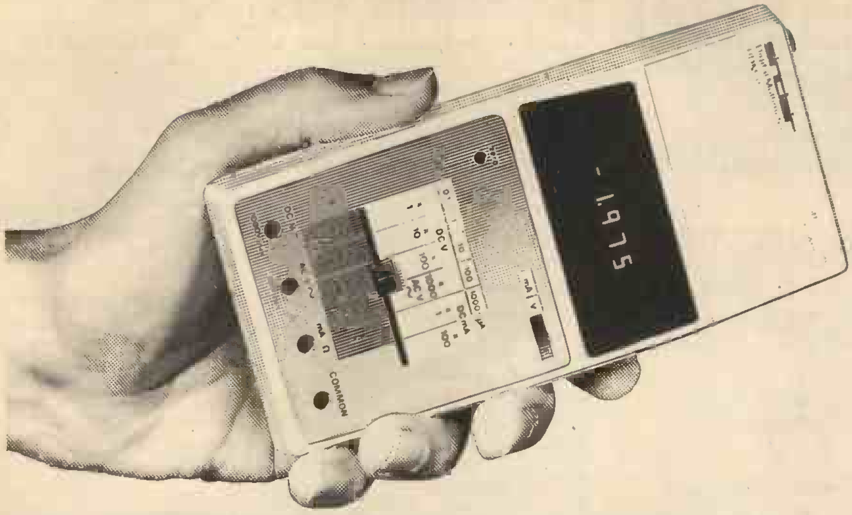

Technical specification

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Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
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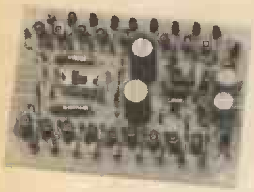
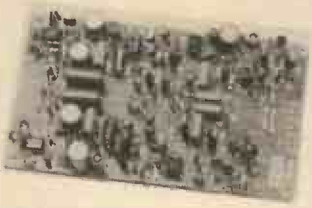


CPR 1



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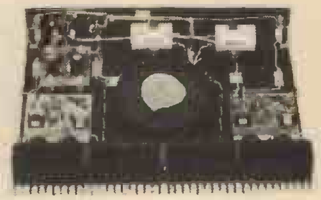

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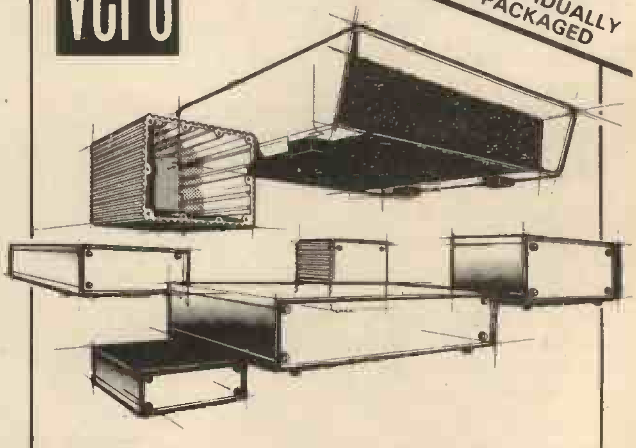

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ADDING TO SC/MP INSTRUCTION SET

THE CIRCUIT to be described takes advantage of unassigned op-codes in the SC/MP instruction set and uses them to provide 16 one-byte subroutine calls so that effectively 16 one-byte user-defined instructions are added to the instruction set. This feature is especially useful for SC/MP systems since normally seven bytes are needed to set up a subroutine call and this overhead tends to discourage their liberal use.

The existing SC/MP instruction set is shown in Table 1; the first hex digit of each instruction appears down the left-hand edge of the table, and the second hex digit along the top. The circuit, shown in Fig. 1, takes advantage of the fact that the whole of row 2 is blank. When one of these codes is encountered as an instruction the circuit generates an interrupt; an interrupt service routine then determines which of the codes caused the interrupt and jumps to a different section of program for each one.

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0	HALT	XAE	CCL	SCL	DINT	IEN	CSA	CAS	NOP								
1										SIO			SR	SRL	RR	RRL	
2																	
3	XPAL 0	1	2	3	XPAH 0	1	2	3					XPPC 0	1	2	3	ONE BYTE
4	LDE																
5	ANE																
6	XRE																
7	ADE																
8																DLY	
9	JMP 0	1	2	3	JP 0	1	2	3	JZ 0	1	2	3	JNZ 0	1	2	3	
A									ILD 0	1	2	3					
B									DLD 0	1	2	3					TWO BYTE
C	LD 0	1	2	3	LDI	LD@ 1	2	3	ST 0	1	2	3		ST@ 1	2	3	
D	AND 0	1	2	3	ANI	AND @ 1	2	3	OR 0	1	2	3	ORI	OR @ 1	2	3	
E	XOR 0	1	2	3	XRI	XOR @ 1	2	3	DAD 0	1	2	3	DAI	DAD @ 1	2	3	
F	ADD 0	1	2	3	ADI	ADD @ 1	2	3	CAD 0	1	2	3	CAI	CAD @ 1	2	3	

Table 1. Assignment of the 256 possible codes to instructions in the SC/MP instruction set

CIRCUIT DESCRIPTION

Operation of the circuit is as follows: the SC/MP micro signals when an instruction will be on the data bus by preceding it with a high level on DB5 during the NADS signal. This status signal, called IFLAG, is latched into the D-type latch whose Q output consequently goes high. If during the following instruction-fetch an instruction X'20—X'2F appears on the data bus, the upper four data lines DB7–DB4 will be at '0010' and the output of the 8-input NAND gate will go low.

This output will thus go low when an instruction X'20–X'2F occurs, and not if one of these bytes occurs as an operand to another instruction. This low signal is clocked into a second D-type latch by the NRDS pulse, thus taking SC/MP's SENSE-A input high. Provided that interrupts are enabled in the micro this will generate an interrupt before the next instruction. The net effect of this circuit is that all the op-codes X'20–X'2F behave as if they were the XPPC 3 instruction (X'3F). With more complicated decoding circuitry other gaps in the instruction-set table could be utilized for user-defined instructions.

The circuit was used with a Science of Cambridge MK14; the earlier MK14 kits do not disable the ROMs during NADS so there is a conflict between the contents of the ROMs and status signals such as IFLAG. Fortunately the remedy is simple, and can be implemented using two spare gates in the circuit. It involves breaking a track on the underside of the MK14 circuit board, as shown in Fig. 2(a), and inserting the circuit shown in Fig. 2(b) between the points labelled A and B. MK14 boards which are issue III or later incorporate this modification. In the prototype the circuit, which comprises four packages, was built on a small square of veroboard connected to the underside of the MK14 circuit board by a length of ribbon cable.

NEW INSTRUCTION PROGRAM

Obviously the assignment of operations to the new op-codes depends on the user's particular application. The program of Fig. 3 shows how the codes can be assigned to different functions: X'20 changes the state of the three flag outputs and X'21 writes a segment pattern to the display, where P1 is assumed to point to the display; the segment pattern to be

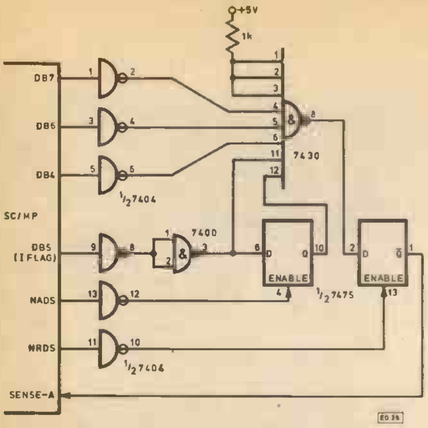


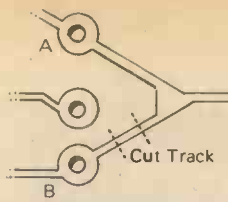
Fig. 1. Circuit which generates an interrupt when one of the codes X'20–X'F occurs as an instruction

displayed is taken from the subsequent byte. The remaining codes, X'22–X'2F, are undefined in this example and they behave as NOPs.

The program operates as follows: the address of the user's program minus one is stored at OF1E (high byte) and OF1F (low byte). Instead of starting execution at the beginning of the user's program, one enters at SETUP. This then points P3 to the user's program, enables interrupts, and jumps to the user's program with an XPPC 3. When one of the codes X'20–X'2F is encountered in the user's program an interrupt is generated and this causes a jump to the interrupt service routine, ISR, with the address of the code saved in P3. Thus the value of the code that caused the interrupt can be discovered by loading it using P3-relative addressing. In this example X'20 causes a jump to SRO which inverts the three flag outputs. The code X'21 picks up the second byte and stores it using P1-relative auto-indexed addressing. The user's program at OF80 demonstrates the use of the two new op-codes. It loops around loading P1 with the display address, displaying 'HO' in the rightmost two display positions with two X'21 instructions, and toggling the flags with an X'20 instruction.

```
                ; ADD USER-DEFINED INSTRUCTIONS TO
                ; SC/MP INSTRUCTION SET.
                ;
0000                    .=OF1D
OF1D            ASAVE:  .=.+1                   ;FOR A-REGISTER
OF1E OF7F       P3:     .DBYTE  UPROG-1         ;FOR JUMP
                ;
OF20 COFD       SETUP:  LD      P3              ;GET ADDRESS OF
OF22 37                 XPAH    3               ;  USER'S PROGRAM.
OF23 COFB               LD      P3+1
OF25 33                 XPAL    3
OF26 COF6       RETURN: LD      ASAVE           ;RESTORE A-REG.
OF28 05                 IEN                     ;ENABLE INTERRUPTS
OF29 3F                 XPPC    3               ;JUMP TO USER'S PROG.
OF2A C8F2       ISR:    ST      ASAVE           ;SAVE A-REG
OF2C C300               LD      (3)             ;GET 'OP-CODE'
OF2E E420               XRI     X'20            ;IS IT 20?
OF30 9806               JZ      SRO
OF32 E401               XRI     X'01            ;IS IT 21?
OF34 9808               JZ      SR1
OF36 90EE               JMP     RETURN          ;IGNORE OTHERS
                ;
                ; X'20 CHANGES FLAGS
OF38 06         SRO:    CSA
OF39 E407               XRI     7               ;INVERT FLAG BITS
OF3B 07                 CAS
OF3C 90E8               JMP     RETURN
                ;
                ; X'21 DISPLAYS SEGMENT CODE IN NEXT BYTE
OF3E C701       SR1:    LD      @1(3)           ;BUMP P3
OF40 C300               LD      (3)             ;GET SEGMENT CODE
OF42 CD01               ST      @1(1)           ;DISPLAY IT
OF44 90D4               JMP     RETURN
                ;
                ; TEST PROGRAM TO ILLUSTRATE USE
                ;
     0D00       DISP    =       0D00            ;DISPLAY ADDRESS
OF46                    .=OF80
OF80 C40D       UPROG:  LDI     H(DISP)         ;POINT P1 TO
OF82 35                 XPAH    1               ;  DISPLAY ADDRESS.
OF83 C400               LDI     L(DISP)
OF85 31                 XPAL    1
OF86 213F               .BYTE   X'21,X'3F       ;DISPLAY 'O'
OF88 2176               .BYTE   X'21,X'76       ;DISPLAY 'H'
OF8A 20                 .BYTE   X'20            ;TOGGLE FLAGS
OF8B 90F3               JMP     UPROG           ;LOOP AROUND
                ;
     0000               .END
```

Fig. 3. Program for SC/MP which with the circuit of Fig. 1 extends the instruction set



(a) The track lying between IC8 and IC3 on the underside of the board should be cut as shown

SC/MP XPAL O INSTRUCTION

A program in the *Micro-Bus August 1978* demonstrated how a computed goto could be achieved with the M6800 by making use of the great variety of branch-on-condition instructions provided. The following letter, received from *N. Feilden* of Suffolk, shows how to take advantage of an undocumented SC/MP instruction to achieve a similar effect.

"Hands up all those SC/MP users who have used the instruction XPAL O (X'30). For those who have not, it exchanges the accumulator value with the lower half of the program counter. It thus effects a jump to the location AC+1 with the address from which it came in the accumulator. A subroutine call is thus available anywhere within a 256-byte page without having to set up one of the other pointers. XPAL O can also be used to achieve a computed goto, which makes up for not being able to use the extension register as a displacement in jump instructions. Of course all sorts of wonderful things can be done by writing programs which rewrite themselves, but not in ROM."

The program segment in Fig. 4 shows how a computed goto can be implemented; it jumps to one of four possible addresses for values in the accumulator of 0 to 3.

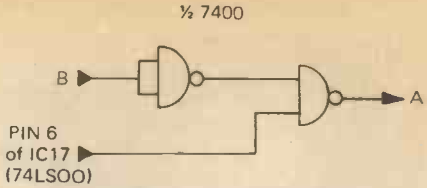
The corresponding higher-byte instruction XPAH O (X'34) also works but is less useful for obvious reasons. In a larger system it might be useful as a page selector.

```
                ; COMPUTED GO TO
                ; INDEX IN ACCUMULATOR
                ;
OF34 01                 XAE
OF35 02                 CCL
OF36 40                 LDE
OF37 70                 ADE                     ;DOUBLE INDEX
OF38 F43A               ADI     L(HERE)         ;ADD TO PC
OF3A 30         HERE:   XPAL    0               ;PUT IN PC
OF3B 900C               JMP     L0
OF3D 901A               JMP     L1
OF3F 9028               JMP     L2
OF41            L4:                             ;ROUTINES
```

Fig. 4. Program segment for SC/MP jumps to one of four different labels depending on the value in the accumulator

ANALOGUE INFORMATION

If the properties of our environment such as temperature, pressure, light intensity, sound level, frequency, and position, are to be made accessible to a microprocessor system, they must first be converted into the digital form it understands. A new multi-input Analogue-to-Digital (or A/D) conversion chip known as the Data Acquisition System has recently become available, and its incorporation into a microprocessor system would make possible such applications as temperature sensing for household and industrial heating control, interfacing to joysticks for micro-based games and simulations, digitisation of speech waveforms for computer speech recognition and reproduction, and, in general, many machine control and interface applications.



(b) Two gates should be wired between the points shown

Fig. 2 (above). Modification needed to MK14 kits

ADC0817 DATA ACQUISITION SYSTEM

National Semiconductor's ADC0817 Data Acquisition System or DAS is a single 40-pin chip incorporating an 8-bit successive approximation A/D converter and a 16-channel analogue multiplexer. It is thus ideal for applications where information must be coordinated from a number of different analogue sources. It was originally designed for the automotive market and is currently being used in the instrument panel circuitry of General Motors' latest Cadillac. The ADC0817 has an accuracy of ± 1 bit; the ADC0816 is a prime version of the same part with an accuracy of $\pm \frac{1}{2}$ bit. The multiplexer section is separate from the A/D conversion stage so that it is possible to insert circuitry, such as sample-and-hold, between the two. The ADC0817 is available from Marshall's for £15·63 (inc. VAT).

INTERFACE CIRCUIT

The DAS can be interfaced directly to an M6800 microprocessor system bus as shown in Fig. 5; it is addressed as a single memory location ($4 000 in this case) and selected by the $\overline{\text{SELECT}}$ input. The required input channel is chosen by writing the channel number to the DAS; the lower four data lines are latched into the multiplexer on the rising edge of the $\overline{\text{WRITE}}$ pulse at the ALE (Address Latch Enable) input. The conversion is begun when the rising edge of the WRITE pulse occurs at the START input. When the conversion is complete EOC is taken high by the DAS and this generates an interrupt on the M6800's $\overline{\text{IRQ}}$ line. Note that EOC is also high for 1–8 clock periods after the rising edge of the START pulse, but this will be ignored. If there are other peripherals generating interrupts in the microprocessor system the EOC flag will have to be taken to the data bus via a tri-state buffer, enabled by a separate address from the DAS, so that it can be interrogated by the micro to determine the source of the interrupt.

The data outputs from the DAS are normally in a high-impedance state, but reading from the DAS takes TSC (Tri-State Control) high and puts the result of the A/D conversion on to the micro's data bus. The DAS is clocked by the M6800's $\varnothing_2$ signal; the maximum clock rate permitted is 1·2MHz, giving a conversion time of about 60 microseconds. The circuit should work equally well with micros such as SC/MP and the 8080 which provide NRDS and NWDS signals; these should be inverted to give the READ and WRITE signals in the circuit of Fig. 5.

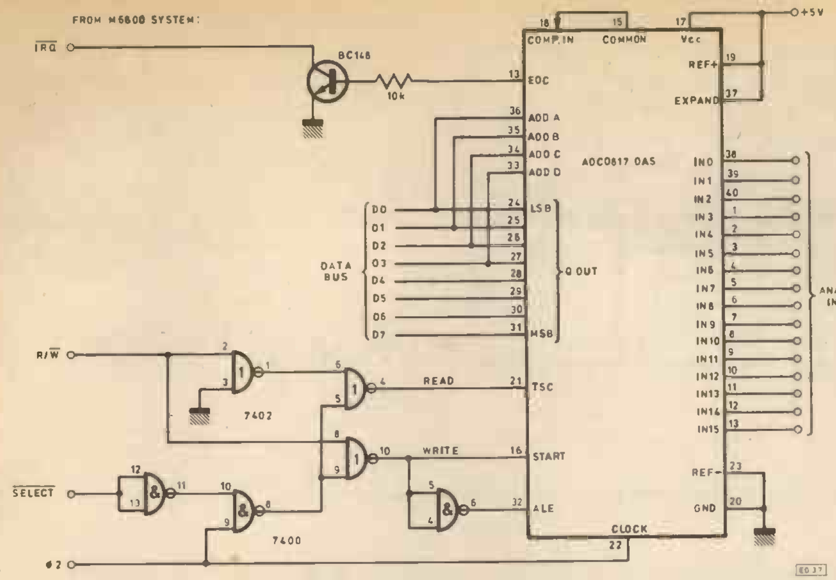


Fig. 5. Interface between a Data Acquisition System chip and an M6800 system

```
                  NAM    DAS
            *
            * DATA ACQUISITION SYSTEM CHIP INTEAFACE
            *
     4000   DAS    EQU    $4000
     0000   INPUT  EQU    0        INPUT CHANNEL (0 - F)
            * IN D2 KIT MONITOR:
     A000   IRQVEC EQU    $A000    INTERRUPT VECTOR
     E0FE   DISPLA EQU    $E0FE    DISPLAY ROUTINE
     E31C   REGST5 EQU    $E31C    CONVERT HEX TO 2 DIGITS
     A00C   DISBUF EQU    $A00C    DISPLAY BUFFER
            *
            * INITIALISE DAS FOR FIRST CONVERSION
            *
0000                  ORG    0
0000 CE 0010 MAIN     LDX    £ISR
0003 FF A000          STX    IRQVEC
0006 86 00            LDA A  £INPUT
0008 B7 4000          STA A  DAS      SELECT INPUT
000B 0E               CLI
000C 7E E0FE          JMP    DISPLA   WAIT FOR INTERRUPT
            *
            * DISPLAY INPUT IN HEX (00 - FF)
            *
0010                  ORG    $0010
0010 B6 4000 ISR      LDA A  DAS
0013 BD E31C          JSR    REGST5
0016 86 00            LDA A  £INPUT
0018 B7 4000          STA A  DAS      START NEW CONVEASION
001B 3B               RTI
```

Fig. 6. Program using interrupts to give a continuous display determined by the voltage at one input of the Data Acquisition System chip

DAS PROGRAMS

A complete program for the M6800 to drive the DAS circuit just described is given in Fig. 6. The program was developed on a Motorola D2 kit, and gives continuously-updated hexadecimal display of the conversion value, reading from 00 to FF for input voltages of from 0V to +5V. The program makes use of two display routines in the D2 kit's JBUG monitor and these will have to be provided if the program is to be used with other systems. The first part of the program from $0000 to $000E puts the address of the interrupt service routine ISR at $A000; on interrupts the monitor uses this as a jump address. The first conversion is started by writing the required channel number, O in this case, to the DAS; the program then jumps to the display loop in the monitor. This continuously displays the contents of the display buffer $A00C—$A011. On interrupts the ISR changes the contents of this buffer so that the latest A/D conversion result is displayed.

The interrupt service routine in Fig. 6 picks up the result of the conversion in accumulator A and the jumps to the subroutine REGST5 in the monitor which separates this into two 4-bit nibbles and puts them into the display buffer for display.

News Briefs

'78 AUDIO WRITER IS PE CONTRIBUTOR

THE 1978 Audio Writer Award, sponsored by BASF United Kingdom, has been made to Barry Fox who writes under the pen name of Adrian Hope. Barry's pen name may be known to regular readers but if we tell you that since March 1974 Barry has regularly contributed to P.E. with his column *Patents Review*, he will then be known to all. We have also published a number of special features by him and our next issue carries his article *Binaural Stereo Patents*.

The presentation of a silver tuning fork on mahogany base and a cheque for £300 was made by Charles Mackerras the international conductor. We are sure readers will join us in thanking Barry for his valuable contributions; he is shown below with the award, flanked by Henry Pattinson of BASF (left) and Charles Mackerras.

NEW OLDE MAGAZINE

IF THE days when you could buy little "lozenge" tins containing cat's whiskers and crystals does more for your imagination than today's conductive foam packs containing l.s.i. chips, then this is the journal for you.

For the first time a magazine is to be launched exclusively for the vintage enthusiast. *Sounds Vintage* will be published bi-monthly, to cater for those interested in a wide field of subjects relating to the sounds of yesterday.

Among the areas covered will be vintage wireless equipment, gramophones and cylinder machines, records and cylinders, vintage amplifiers, pre-war literature. There will also be stories of the pioneers and of companies involved in the manufacture of the hardware and software since the early days.

Other reader attractions will include practical hints on the care, maintenance and restoration of vintage equipment, news from the major auction rooms, news of clubs and societies, reviews of books associated with vintage sound, readers letters and wants, reproduction of vintage advertisements, and *anything* which will be of value or interest to the collector, dealer or casual enthusiasts of the various aspects of sound reproduction in the days before it became too "electronic".

Sounds Vintage will start off as a 32-page A4 presentation, and will be available on subscription only. Top names are lined up for many leading articles and features.

No. 1 was scheduled for publication in mid-January 1979. The annual subscription will be £5·80 inland, £6·80 overseas, postage paid. A special offer is being made for No.1 only, a sample copy at 65p post paid. An illustrated subscription form is available from: Sounds Vintage, 28 Chestwood Close, Billericay, Essex.

STEREO MIXER

J. P. MACAULAY

Will mix line and dynamic microphone inputs for a stereo image

MANY readers must possess a hi-fi cassette or reel to reel tape recorder which is not used to it's full creative capacity for want of a good mixer. With a mixer one can produce one's own jingles or mix the output from several microphones to better capture the sound of a live performance. Alternatively announcements can be recorded onto a music tape without the tell tale clicks and pops that result from the microphone being plugged in and out.

CIRCUIT

The circuit of a simple but effective mixer is shown in Fig. 1. Here the input signals are fed into a virtual earth amplifier which will accept both line and dynamic microphone inputs.

Line inputs enter the circuit via the resistors R1, R2 and R3. These form an attenuator with the input pots, VR1, VR2 and VR3.

Microphone inputs are fed directly to the "live" ends of the input pots and the sensitivity here for full output is some 3·5mV. The signals at the slider of the pots is fed to the virtual earth via the resistors R4, R5 and R6.

C1 both isolates the virtual earth amplifier from any d.c. present at the input and defines the −3dB point in the bass region at 10Hz. The virtual earth amplifier employs two transistors in what might be, to some readers, a novel circuit.

TR1 operates in the common emitter mode with a low collector current of about 100µA to minimise noise. The collector of load resistor R9 however is bootstrapped to the emitter of TR2, a *p.n.p.* device. Due to this bootstrapping the voltage gain open loop is around 1,000 times and independent of line variations.

Minimum noise is produced when the base of TR1 sees an input impedance of 600 ohms. This can be conveniently arranged by judicious selection of feedback resistor, R7, so that the virtual earth impedance between the base of TR1 and earth approaches that figure.

R7 and R8 provide overall feedback at both a.c. and d.c. and of course the bias current required by TR1. The gain of this stage has purposely been kept down to 20dB to provide the low noise conditions already described and a reasonable input impedance. In consequence further amplification is required to bring the signal up to a usable level, 350mV.

SECOND STAGE

This is done by the next stage built around TR3. Again the virtual earth mode is used to define the gain of the stage.

Feedback is applied, and base bias, by the potential divider R12, R13. The gain is defined by the ratio of R12 to R11. C4 blocks the d.c. from the emitter of TR2.

To maintain stability hefty decoupling is applied to both stages by R15, R16, C3 and C5.

The signal from the collector of TR3 is fed to the master volume control VR4 and from thence to the record input of the tape recorder, via R20. Headphone monitoring is provided on a large number of tape recorders although one can only listen to the actual recording as it is being made on three head machines.

Those that do provide a headphone monitoring facility are usually of inadequate volume to properly hear all the nuances of the recording. This is the reason for the inclusion of such a facility in this mixer. A separate board is used for this part of the circuit and those who would rather rely on the built-in monitoring provided by their recorders can omit this altogether without detriment to the performance of the mixer.

POWER OUTPUT STAGE

A dual audio amplifier i.c. is used, National Semiconductor's LM377. In this application a heatsink is not required, a relief to anybody that has struggled to solder small pieces of tinplate to the pins of the i.c. whilst praying that the device is not overheating!

Reference to Fig. 1 will show that this stage is again operated in the virtual earth mode. The signal being applied to the inverting input via the d.c. blocking capacitor C8 and R17. Overall feedback is provided by R18.

The bias pin of the i.c. is connected to the non inverting inputs and tied to a.c. earth by C7. (The numbers in brackets refer to the corresponding pins on the other channel.)

Specification

S/N Ratio −76dB unweighted. 350mV output at master volume control.

Max. output before clipping, 3·6V r.m.s.

Harmonic distortion—none audible up to max. output.

Frequency response −3dB 10Hz–30kHz.

Line sensitivity 100mV.

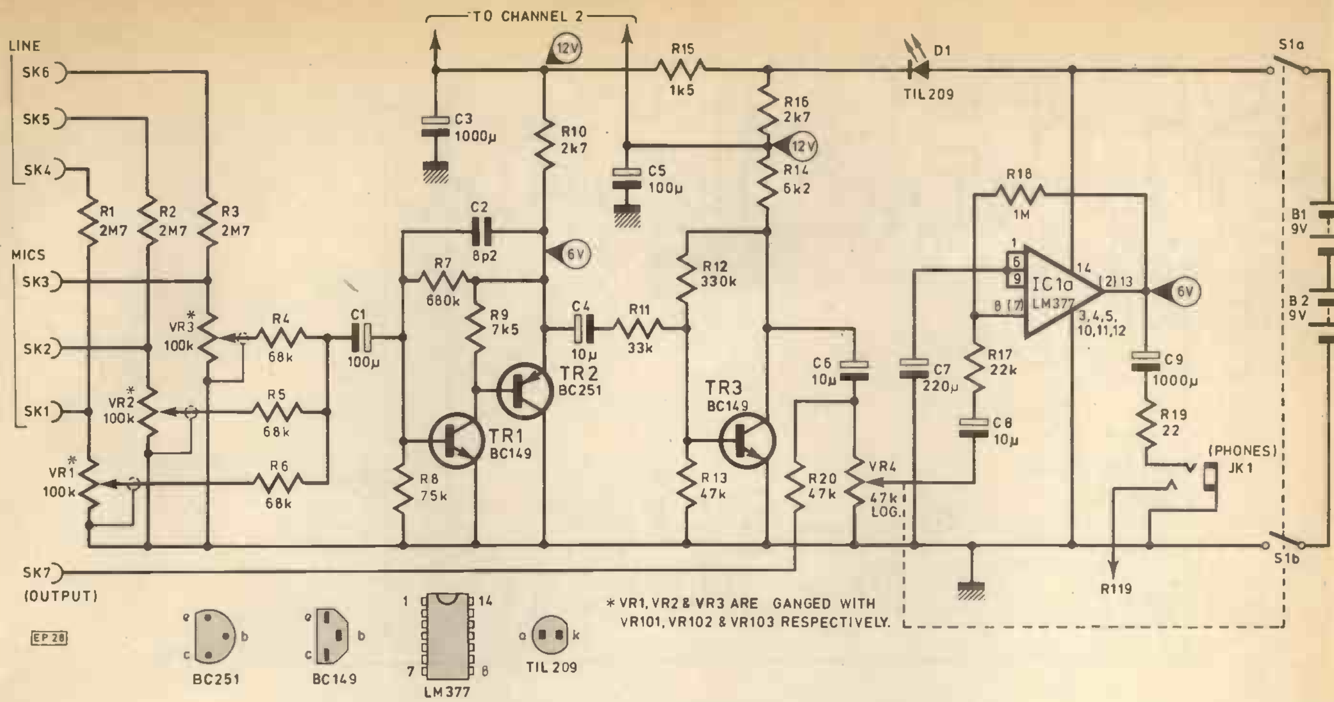


Fig. 1. Circuit of one channel of mixer

The output signal is fed to the headphones by both C9 and R19. One of the design considerations was portability. To enable the unit to be used in difficult locations, that is when only one mains socket is available, the unit is battery operated. This is no hardship however since the current consumption is quite low, the prototype takes only 12mA under quiescent conditions and around 30mA when the headphones are being driven hard. Two PP9s provide many hours of continuous use. Larger capacity batteries can be easily accommodated in the chassis space available.

CONSTRUCTION

Construction begins with the wiring of the boards. The layout of both is shown (Figs. 2-3). Little comment is required on this although care must be exercised to ensure that the semiconductors and electrolytics are correctly orientated.

The boards are lifted clear of the case by means of 6BA screws and nuts and the constructor must ensure that the breaks in the Veroboard tracks near these are properly made or the circuit will not function.

COMPONENTS

Resistors (2 required except where asterisked)

R1, R101	2M7
R2, R102	2M7
R3, R103	2M7
R4, R104	68k
R5, R105	68k
R6, R106	68k
R7, R107	680k
R8, R108	75k
R9, R109	7k5
R10, R110	2k7
R11, R111	33k
R12, R112	330k
R13, R113	47k
R14, R114	6k2
*R15	1k5
*R16	2k7
R17, R117	22k
R18, R118	1M
R19, R119	22
R20, R120	47k

All ½W carbon 10%

Potentiometers

VR1, VR101	100k lin. dual gang
VR2, VR102	100k lin. dual gang
VR3, VR103	100k lin. dual gang
VR4, VR104	47k log. + d.p. switch

Semiconductors

TR1, TR101	BC149
TR2, TR102	BC251
TR3, TR103	BC149
*IC1	LM377
*D1	TIL209

Capacitors

C1, C101	100µ elect. 10V
C2, C102	8p2 silver mica
C3, C103	1,000µ elect. 25V
C4, C104	10µ elect. 25V
C5, C105	100µ elect. 16V
C6, C106	10µ elect. 16V
C7, C107	220µ elect. 16V
C8, C108	10µ elect. 16V
C9, C109	1,000µ 25V

Miscellaneous

Stereo headphone jack socket, 14 phone sockets
Aluminium case 11 × 7½ × 3½in
4 knobs, 5 × 2½in Veroboard, 1¾ × 2in Veroboard

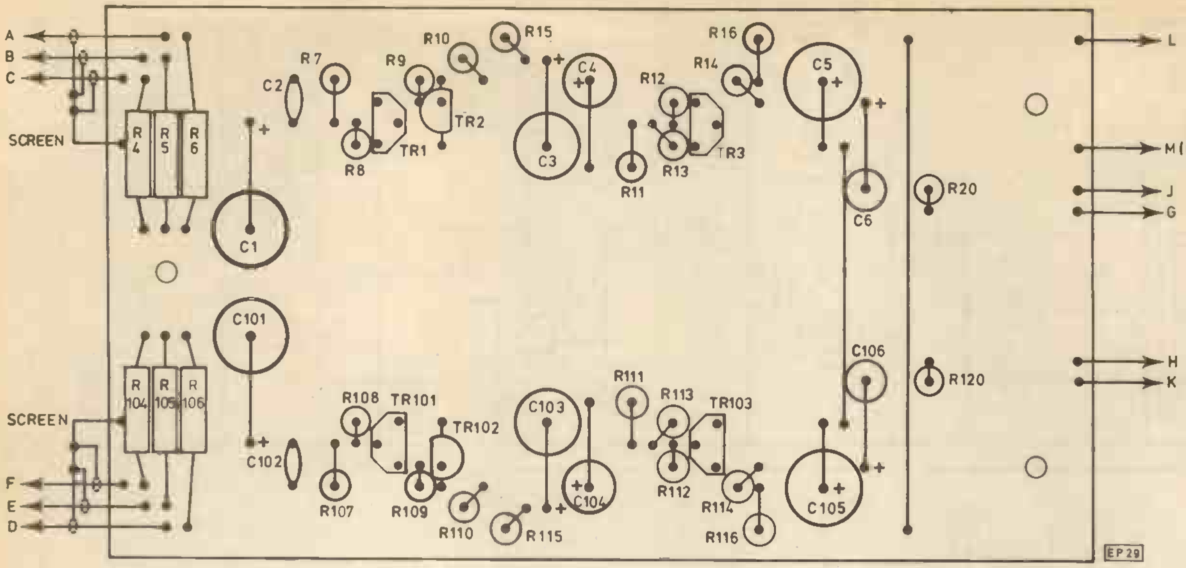
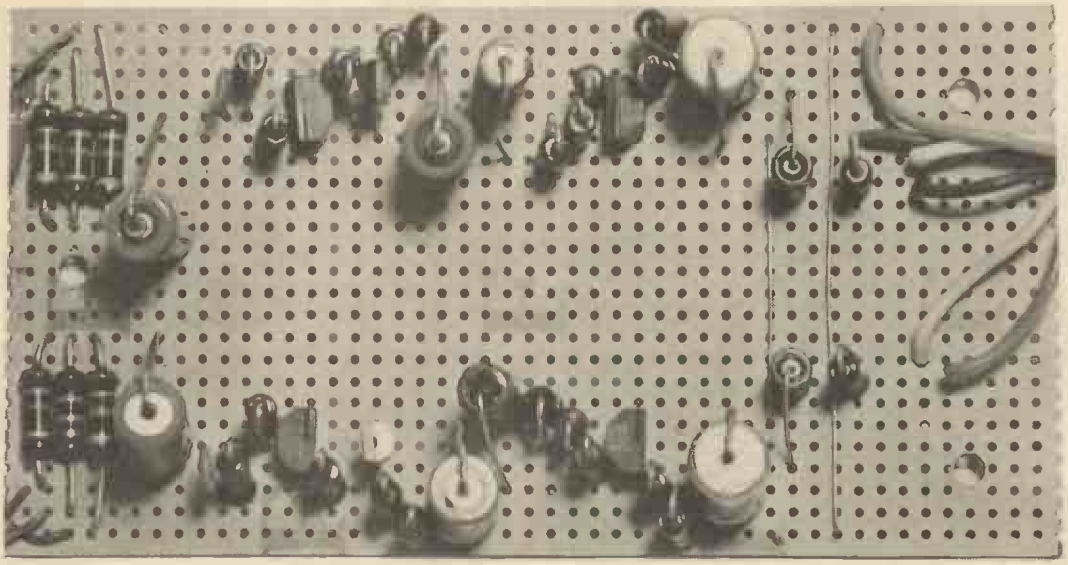


Fig. 2. Main board showing two channel transistor assembly



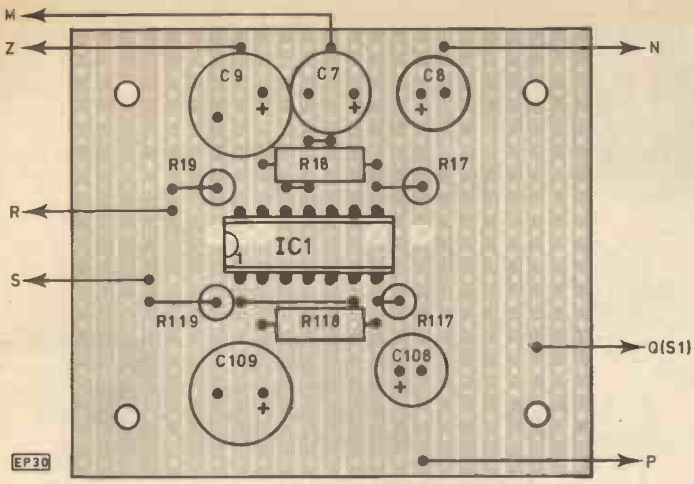
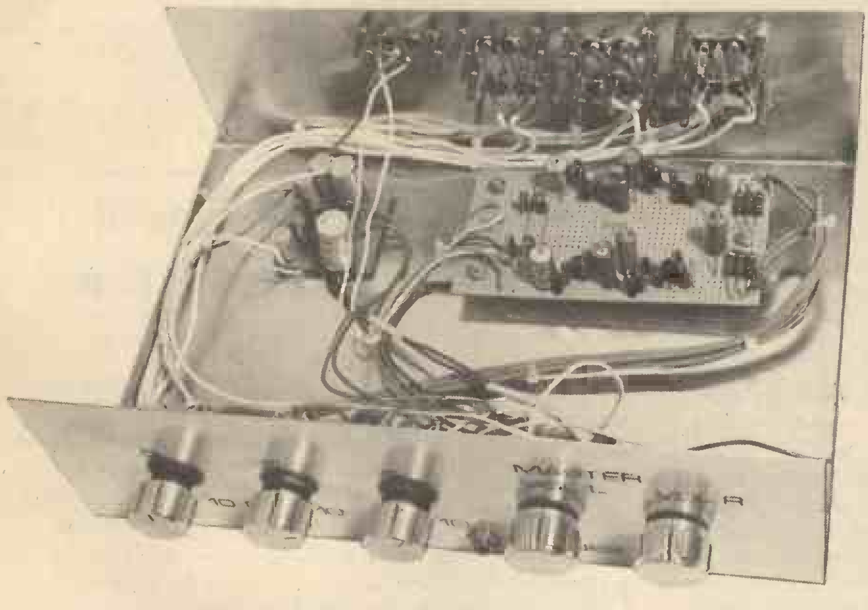
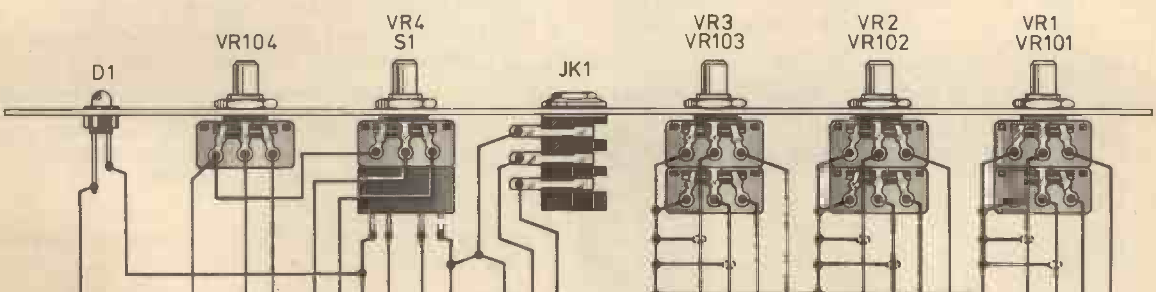
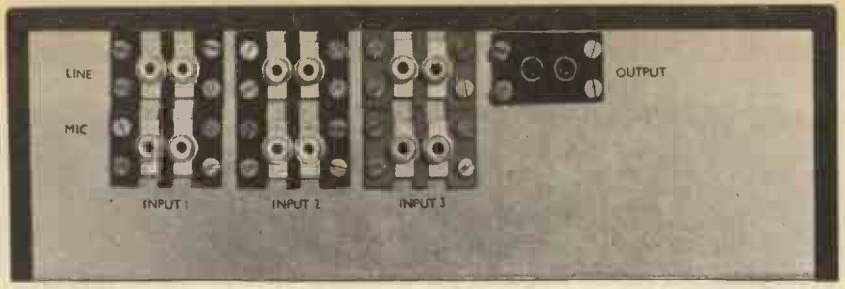


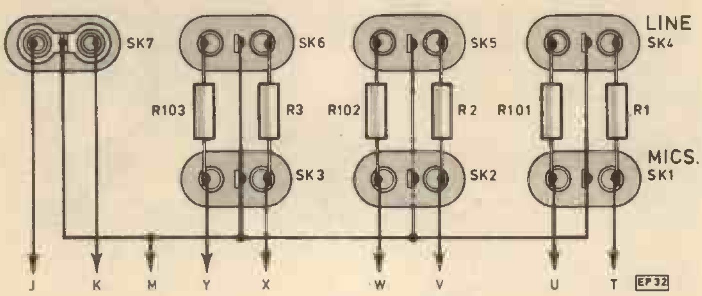
Fig. 3. I.c. power stage



(Left). Chassis interior showing board placement (Below). Wiring to control panel components. All lettered flying leads refer to the main board and the headphone amplifier board







Showing phono socket assembly at rear panel for line and microphone inputs and mixer output. Note that the attenuator resistors are wired directly at the input sockets for all channels

CASE

No case drilling details are shown as photographs make this quite straight forward. Readers will notice that rotary pots are used instead of the more usual slide types. The reason for this is that the latter tend to be more prone to the ingress of dirt and in consequence become sticky and noisy in use.

Needless to say, dual slide pots could be used but the layout of the case must be altered to suit. In practise, rotary controls are as simple and accurate as the linear slide type.

Linear pots are used at the input because they are better matched than logarithmic types, usually to within 1dB. Due to the inherently close tolerance between tracks of the input pots, overall balance is obtained by the manipulation of the master volume controls.

LEGENDS

Legends are applied to the case with Letraset "magic lettering". These are clearly indicated for the front and rear panels in the photographs.

This should be fixed with either a proprietary varnish spray or alternatively clear nail varnish. The choice of control knob is, of course, a matter of personal choice although experience shows that a knob with a large diameter, say 1in, with a pointer is best. Push on types are less bothersome than the grub screw fitting types, and tend to be les expensive.

Once the case has been drilled the boards should have the necessary flying leads soldered in place and then mounted in their respective positions. The pots, l.e.d. and sockets are then mounted. Finally the flying leads are connected to their destinations. At this point the wiring should be thoroughly checked. When satisfied that all is well connect the batteries, headphones and signal sources. Switch on and check the action of the controls. A final check that the voltages shown in Fig. 1 are present ± 1V and the mixer is ready for use. ★

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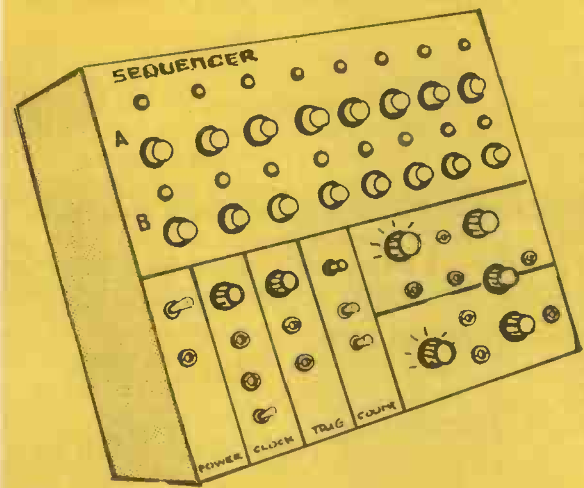
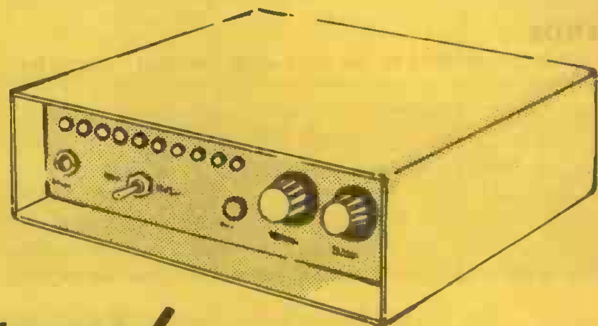


16 NOTE SEQUENCER

Enables the user of a synthesiser to program in voltage patterns to provide repeated melodies, rhythm accompaniments etc., which can be manipulated for speed and key change.

LOGISCOPE

In addition to indicating whether a test point is at logic 1, logic 0, floating or pulsing this tester will provide information about the mark space ratio and the frequency of the input signal.



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BOOK REVIEWS

MICROPROCESSOR PROGRAMMING FOR COMPUTER HOBBYISTS
By Neill Graham
Published by Tab Books
Available from W. Foulsham, 837 Yeovil Rd., Slough, Bucks.
378 pages. Price £6·50

THE problem with books about microprocessors is that the author either concentrates on one specific device and loses readers not interested in it, or else, as in many books on the subject currently available, devotes part of the book to a discussion of different devices being manufactured; this usually turns out to be a very expensive way of buying the manufacturers' data.

In this book Mr Graham overcomes this problem by giving programming examples in a high-level language, namely PL/M, and one section is devoted to describing its features. The routines given to illustrate the techniques presented in the remainder of the book can thus be converted from PL/M to any specific assembly language.

The subjects covered include: floating-point arithmetic, input, and output; pseudo-random number generators; manipulation and use of data structures including arrays, strings, stacks, queues, deques, chains, and trees; and finally, searching, hashing, indexing, and sorting methods. Within these sections the book covers the topics clearly, if a little briefly, and the use of data structures is illustrated with a number of clear diagrams.

Though prior familiarity with a high-level language like PL/1, on which PL/M is based, might be an advantage in understanding the examples, the book should be a valuable source for the microprocessor programmer.

D.J.D.

COMPETITION

THE free entry competition we ran at Breadboard attracted a large entry and guesses at the number of projects published in P.E. from the December 1976 issue to December 1978 inclusive ranged from 2 to 2,000. The correct answer was 94. No one guessed this figure correctly but we had many with 93 and 95.

The winner eventually selected was Mr B Wallington of Chatham. He receives a P.E. VDU System (presented by Technomatic), and a year's supply of P.E.

The ten runners up were: A. C. Walkland (Liverpool), J. Green (London W.14), J. D. Parker (Buckhurst Hill), M. Davis (Nuneaton), P. D. Bond (South Godstone), J. Jones (Birmingham), Yan Lee (Tipton), M. Browne (Fleet), M. W. Keen (Bridgend), J. N. Jones (Basingstoke), each will receive a year's supply of P.E.

Two extra runners up prizes have been awarded to Mr. C Wysocki (London W9) and Dr. R. D. Bailey for their original "slogans". These were: "I think P.E. is to electronics magazines what St Michael is to underwear", and "I think P.E. is worth your trouble and my money". Well Dr. Bailey you can save your money for the next year, your copies will be sent by us. Our thanks to all those who participated, especially the staff of other magazines for their constructive comments!

BREADBOARD EXHIBITION

TO all our readers who visited our stand at Breadboard, we are sorry that our technical staff were prevented from being there to demonstrate equipment and answer queries. This was due to an N.U.J. dispute within the I.P.C. Magazines Group. Thankfully the dispute has not affected P.E.s publication dates and is now over.

POINTS ARISING

R.C. MOTOR CONTROL *(DECEMBER 1978)*

The left hand side of Link-2 shown on the component overlay should connect to the junction of R13 and D5. This requires an extra p.c.b. pad at R13, and a longer link to clear the track running underneath.

readout

... a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Of Bees And Keys

Sir—Congratulations to you and the authors on the CHAMP project. This ranks as perhaps the most exciting project to have been published in "Practical Electronics" for years. I have just had a very absorbing time in programming CHAMP to play the "Flight Of The Bumble Bee" (over 800 notes) using less than 512 program instructions, and look forward to other equally challenging problems.

The only criticism I have is that the authors use a keyboard which is apparently not readily obtainable. Readers may be interested to know that a good, robust, cheap hex keyboard can be obtained from Chiltmead Ltd, Arthur Rd, Reading. It is, however, somewhat too large to fit into the space allocated, but can nevertheless be accommodated by repositioning a few of the switches. The keyboard encoder and digit drivers can be mounted on a piece of Veroboard under the sloping panel at its top. The ground and 5V leads can then run to the terminals at the front, and the ribbon cable to the main board need only be 16 wires, which is more convenient than 18. This cable can run through a rectangular hole in the chassis symmetrically placed with respect to the other cable hole. This arrangement seems to me to be neater than that described in the original article.

W. Gough
Cardiff.

EMI SPEAKER BARGAIN

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7 watts speech and music.
Tape Sensitivity Playback 400mV/30K OHM for max output Record 200mV/50K output available from 25KHz. (150mV/100K) deviation
FM signal Frequency Range (Audio) 50Hz to 17KHz within ± 1dB
Radio FM sensitivity for 3dB below limiting better than 10 uV
AM sensitivity for 20dB S/N MW 350 uV/Metre LW 1mV/Metre
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1 PACK 1. 2 x LP1173 10w. RMS output power audio amp modules, + 1 LP1182/2 Stereo pre amp for ceramic and auxiliary input.
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Suitable power supply parts including mains transformer, rectifier, smoothing and output capacitors. £1.00 p+p **£1.95**

Recommended set of rotary stereo controls comprising BASS, TREBLE, VOLUME and BALANCE. p+p 50p **95p**

FOR PERSONAL SHOPPERS ONLY

GARRARD BARGAIN

LIST PRICE ~~£90.08~~

OUR PRICE **£39.95**

86 SB MKII. Belt drive, 2 speed turntable module with plinth and cover.

20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in teak finished cabinet. Silver fascia with aluminium rotary controls/pushbuttons, red mains indicator and stereo jack socket. Functions switch for mic. magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features two mains outlets DIN speaker and input sockets plus fuse 20x20 watts RMS 40x40 watts peak. For use with 8 to 15 ohm speakers. **£29.90** + £2.50 p&p

SPECIAL OFFER
FOR PERSONAL SHOPPERS ONLY

FREE. 4 dimensional stereo sound adaptor, when purchasing the 20x20 Viscount amplifier.

30x30 WATT AMPLIFIER IN KIT FORM

For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output, 60x60 watts peak. For use with 4-15 ohms speakers. £23.00 without cabinet. £29.00 complete with cabinet. p&p £2.50 in each case.

£23.00 + £2.50 p&p without cabinet. (NOTE Cabinet not available separately.) **£29.00** + p&p £2.50 complete with cabinet.

SPECIAL OFFER Complete with Case
30x30 WATT AMPLIFIER IN KIT WITH SPEAKERS

2 Goodman compact 12" bass woofers with cropped size 14,000 Gauss magnet. 30 watt RMS handling + 3¼" approx. tweeters and crossovers. **£49.00** + p&p £4.00

BUILT AND READY TO PLAY 39.00

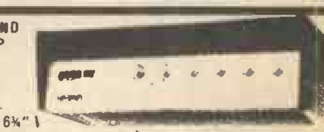
30x30 Viscount. Available fully built and tested. + p&p £2.50

RTVC

323 EDGWARE ROAD, LONDON W2
21D HIGH STREET, ACTON W3 6NG

ALL PRICES INCLUDE VAT AT 12½%

All items subject to availability. Price correct at 1.12.78 and subject to change without notice.

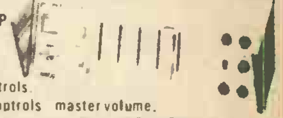


50 WATT MONO DISCO AMP

£29.95 P&P £2.50
Size approx. 13⅜" x 5¼" x 6¾"

50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.
SPECIAL OFFER. The above 50 watt amp plus 4 Goodmans Type 8P. 8" speakers. Package price £45.00 + £4.00 P&P.

70 & 100 WATT MONO DISCO AMP



Size approx. 14" x 4" x 10½"
Brushed aluminium fascia and rotary controls.
Five vertical slide controls master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

70 watt 140 watt peak **£57** p & p £4.00
100 watt **£65**

STEREO CASSETTE TAPE DECK ASSEMBLY

Consisting of ready built tape transport system/mechanism, mated to the electronics Unit is ready built for installing into cabinet of own choice. Features include pause control, solenoid assisted auto-stop, 3 digit tape counter, belt driven balanced fly wheel by DC motor with electronic speed control, twin VU meters. Specification Power Output, more than 0.5v, mic -65dB 10KΩ, DIN -47dB 100KΩ. Track-2 channel stereo record play-back, Tape speed 4.8cm/sec Freq. response 50-1200 Hz signal to noise ratio 42dB Recording system AC bias Erasing system AC erase Bias freq. 57KHz. Compatible for both normal and chrome dioxide tapes. Size of mechanism only 4½" x 6¾" x 11¼" approx., included a moulded top-plate as illustrated 13¾" x 9¼" approx. with circuit diagram. **£25.00** P&P £2.50

Opt. extras: Mains transformer to suite £2.50 + £1 p & p.

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A. Marshall (London) Ltd., Dept: PE. Head Office mail order: Kingsgate House, Kingsgate Place, NW6 4TA. Tel: 01-624 0805
Retail Sales London: 40-42 Cricklewood Broadway, NW2 3ET. Tel: 01-452 0161/2. Telex: 21492. London: 325 Edgware Road, W2. Tel: 01-723 4242.
Glasgow: 85 West Regent Street, G2 2QD. Tel: 041-332 4133. Bristol: 1 Straits Parade, Fishponds Road, B516 2LX. Tel: 0272 654201.

TRANSISTORS

2N696	0.39	2N2219	0.38	2N3397	0.19	2N4062	0.20	2N5247	0.44	40410	0.82		
2N697	0.31	2N2219A	0.39	2N3438	0.85	2N4064	1.35	2N5248	0.44	40411	3.10		
2N698	0.49	2N2220	0.39	2N3440	0.75	2N4074	2.65	2N5294	0.44	40594	0.87	BC147	0.13
2N699	0.58	2N2221	0.25	2N3441	0.92	2N4121	0.27	2N5295	0.44	40595	0.98	BC147B	0.13
2N706	0.30	2N2221A	0.25	2N3442	1.45	2N4122	0.27	2N5296	0.44	40673	0.80	BC148	0.13
2N706A	0.30	2N2222	0.25	2N3638	0.17	2N4123	0.19	2N5298	0.44	40669	1.30	BC148B	0.13
2N708	0.30	2N2222A	0.25	2N3638A	0.17	2N4124	0.19	2N5447	0.16	AC126	0.48	BC148C	0.13
2N718	0.30	2N2369	0.27	2N3702	0.14	2N4125	0.19	2N5448	0.16	AC127	0.48	BC149	0.15
2N718A	0.54	2N2369A	0.27	2N3703	0.14	2N4126	0.19	2N5449	0.20	AC128	0.48	BC149C	0.15
2N720A	0.85	2N2646	0.80	2N3704	0.14	2N4284	0.38	2N5457	0.38	AC151	0.43	BC157A	0.15
2N722	0.45	2N2647	1.55	2N3705	0.14	2N4286	0.22	2N5458	0.35	AC152	0.54	BC158A	0.15
2N727	0.50	2N2903	1.60	2N3706	0.14	2N4287	0.22	2N5459	0.32	AC153	0.59	BC158B	0.15
2N914	0.38	2N2904	0.31	2N3707	0.14	2N4288	0.22	2N5460	0.65	AC153K	0.59	BC159A	0.17
2N916	0.33	2N2904A	0.31	2N3708	0.12	2N4289	0.22	2N5484	0.37	AC176K	0.70	BC159B	0.17
2N917	0.38	2N2905	0.31	2N3709	0.12	2N4347	2.20	2N5485	0.40	AC176	0.54	BC160	0.38
2N918	0.45	2N2905A	0.31	2N3771	2.16	2N4348	2.85	2N5486	0.40	AC187	0.59	BC161	0.38
2N929	0.37	2N2906	0.25	2N3772	2.20	2N4918	0.85	2N5490	0.64	AC187K	0.65	BC167	0.13
2N929A	0.37	2N2906A	0.25	2N3773	3.15	2N4919	0.70	2N5492	0.64	AC188	0.54	BC167B	0.13
2N930	0.37	2N2907	0.25	2N3819	0.36	2N4920	0.83	2N5494	0.65	AC188K	0.65	BC168A	0.13
2N930A	0.95	2N2907A	0.25	2N3820	0.39	2N4921	0.54	2N5496	0.67	AD161	1.00	BC168B	0.13
2N1711	0.30	2N2923	0.17	2N3821	0.96	2N4922	0.60	2N6027	0.64	AD162	1.00	BC168C	0.13
2N1889	0.30	2N2924	0.17	2N3900	0.28	2N4923	0.75	2N6107	0.45	AF106	0.60	BC169B	0.13
2N1890	0.30	2N2926	0.19	2N3901	0.30	2N4924	1.15	2N6108	0.55	AF109	0.52	BC169C	0.13
2N1893	0.30	2N2928	0.17	2N3903	0.20	2N5086	0.30	2N6109	0.55	BC107	0.16	BC177	0.22
2N2102	0.50	2N3053	0.25	2N3904	0.18	2N5087	0.30	2N6111	0.49	BC107A	0.16	BC177A	0.22
2N2192	0.58	2N3054	0.72	2N3905	0.18	2N5088	0.30	2N6121	0.41	BC107B	0.16	BC177B	0.25
2N2193	0.50	2N3055	0.75	2N3906	0.18	2N5089	0.30	2N6122	0.44	BC108	0.18	BC178	0.22
2N2193A	0.52	2N3390	0.50	2N4031	0.55	2N5190	0.65	2N6123	0.48	BC108A	0.16	BC178A	0.25
2N2194	0.42	2N3391	0.40	2N4032	0.65	2N5191	0.75	2N6124	0.45	BC108B	0.16	BC178B	0.35
2N2194A	0.45	2N3391A	0.45	2N4036	0.72	2N5192	0.80	2N6125	0.47	BC108C	0.17	BC179	0.25
2N2195	0.40	2N3392	0.17	2N4037	0.60	2N5193	0.75	40361	0.55	BC109	0.16	BC179A	0.25
2N2195A	0.40	2N3393	0.17	2N4058	0.22	2N5194	0.80	40362	0.55	BC109B	0.17	BC179B	0.25
2N2217	0.56	2N3394	0.17	2N4059	0.17	2N5195	0.97	40363	1.45	BC109C	0.18	BC179C	0.26
2N2218	0.35	2N3395	0.19	2N4060	0.22	2N5245	0.37	40408	0.82	BC140	0.30	BC182	0.12
2N2218A	0.38	2N3396	0.19	2N4061	0.19	2N5246	0.38	40409	0.82	BC141	0.32	BC182A	0.12

		BC214B	0.17	BC549B	0.14	BD244A	0.70	BF182	0.37	BFX89	1.37	MJE520	0.50
		BC214C	0.17	BC549C	0.15	BD244C	0.87	BF183	0.44	BFY50	0.27	MJE521	0.70
BC182B	0.13	BC214L	0.18	BC557	0.14	BD245A	0.69	BF184	0.41	BFY51	0.27	MJE2955	1.65
BC182L	0.15	BC214LB	0.18	BC558	0.13	BD245C	0.85	BF185	0.37	BFY52	0.27	MPF3055	1.05
BC182LA	0.15	BC214LC	0.18	BC559	0.15	BD246A	0.72	BF194	0.16	BFY90	1.35	MPF102	0.33
BC182LB	0.15	BC237B	0.15	BCY70	0.21	BD246C	0.93	BF195	0.16	BR101	0.55	MPF103	0.44
BC183	0.12	BC238A	0.13	BCY71	0.26	BD433	0.44	BF196	0.16	BRY39	0.55	MPF104	0.44
BC183A	0.12	BC238B	0.13	BCY72	0.18	BD434	0.46	BF197	0.18	BSX19	0.35	MPS105	0.44
BC183B	0.13	BC238C	0.13	BD115	0.88	BD435	0.46	BF198	0.19	BSX20	0.35	MPSA05	0.27
BC183C	0.13	BC239B	0.16	BD131	0.55	BD436	0.46	BF199	0.19	BSX21	0.35	MPSA06	0.27
BC183L	0.15	BC239C	0.17	BD132	0.75	BD437	0.55	BF224J	0.22	BU104	1.80	MPSA12	0.44
BC183LA	0.15	BC257A	0.18	BD135	0.40	BD438	0.55	BF225J	0.27	BU105	1.55	MPSA14	0.33
BC183LB	0.15	BC258B	0.19	BD136	0.40	BD529	0.48	BF244A	0.38	BU126	1.08	MPSA55	0.27
BC183LC	0.15	BC259B	0.19	BD137	0.41	BD530	0.55	BF244B	0.33	BU204	2.20	MPSA56	0.27
BC184	0.12	BC300	0.43	BD138	0.41	BD535	0.70	BF245A	0.44	BU205	2.40	R2008B	2.45
BC184B	0.13	BC301	0.43	BD139	0.43	BD536	0.70	BF245B	0.44	BU206	2.70	R2010B	2.15
BC184C	0.13	BC302	0.37	BD140	0.43	BD537	0.74	BF257	0.35	BU208	2.70	TIP29A	0.49
BC184L	0.15	BC303	0.54	BD181	1.80	BD538	0.77	BF258	0.35	ME0401	0.22	TIP29C	0.65
BC184LB	0.15	BC307	0.18	BD182	2.20	BD539	0.80	BF259	0.35	ME0402	0.22	TIP30A	0.54
BC184LC	0.15	BC307A	0.16	BD183	2.35	BD540	0.80	BF336	0.42	ME0404	0.17	TIP30C	0.70
BC212	0.15	BC307B	0.16	BD187	0.95	BDX14	1.32	BF337	0.49	ME0412	0.22	TIP31A	0.54
BC212A	0.15	BC308	0.16	BD235	0.46	BDX18	1.90	BF338	0.52	ME0414	0.22	TIP31C	0.72
BC212B	0.15	BC308B	0.16	BD236	0.44	BDY20	1.10	BFR39	0.30	ME4001	0.16	TIP32A	0.59
BC212L	0.18	BC309A	0.18	BD237	0.44	BDY55	1.90	BFR40	0.29	ME4002	0.16	TIP32C	0.82
BC212LA	0.18	BC309B	0.16	BD238	0.44	BDY56	2.10	BFR41	0.30	ME4003	0.16	TIP41A	0.76
BC212LB	0.18	BC309C	0.16	BD239A	0.44	BF115	0.39	BFR79	0.30	ME4101	0.11	TIP41C	0.97
BC213	0.15	BC327	0.22	BD239C	0.59	BF160	0.33	BFR80	0.30	ME4102	0.11	TIP42A	0.86
BC213A	0.15	BC328	0.20	BD240A	0.49	BF161	0.65	BFR81	0.30	ME4103	0.11	TIP42C	1.08
BC213B	0.15	BC337	0.20	BD240C	0.59	BF167	0.37	BFX29	0.34	ME4104	0.11	TIP2955	0.70
BC213C	0.15	BC338	0.23	BD241A	0.49	BF173	0.37	BFX30	0.34	ME6101	0.22	TIP3055	0.59
BC213L	0.17	BC547	0.13	BD241C	0.65	BF177	0.27	BFX84	0.30	ME6102	0.22	TIS34	1.05
BC213LA	0.17	BC547A	0.13	BD242A	0.55	BF178	0.27	BFX85	0.38	MJ2955	1.35	TIS42	0.50
BC213LB	0.17	BC547B	0.13	BD242C	0.62	BF179	0.33	BFX86	0.30	MJE340	0.62	TIS43	0.47
BC213LC	0.17	BC548	0.13	BD243A	0.65	BF180	0.37	BFX87	0.35	MJE370	0.62	TIS90	0.22
BC214	0.17	BC549	0.14	BD243C	0.87	BF181	0.37	BFX88	0.30	MJE371	0.86	TIS91	0.27

LINEAR CIRCUITS

CA3018	0.75	LM379S	4.25	LM7815K	1.75	TAD100	2.00
CA3018A	1.10	LM380N8	0.96	LM7824K	1.75	TBA120	0.80
CA3020	2.20	LM380N14		LM78L05CZ		TBA500	2.24
CA3020A	2.50		1.08		0.30	TBA500Q	2.34
CA3028A	0.90	LM381AN	2.70	LM78L12CZ		TBA510	2.35
CA3028B	1.25	LM381N	1.69		0.30	TBA510Q	2.48
CA3030	1.50	LM382N	1.32	LM78L15CZ		TBA520	2.60
CA3030A	2.20	LM384N	1.65		0.30	TBA520Q	2.70
CA3038	2.90	LM386N	0.88	MM5314	4.60	TBA530	2.35
CA3038A	4.10	LM387N	1.10	MM5316	4.60	TBA530Q	2.45
CA3045	1.55	LM388N	1.00	NE555	0.33	TBA540	2.60
CA3046	0.77	LM389N	1.00	NE556	0.85	TBA540Q	2.70
CA3048	2.45	LM702C	0.81	NE558N	1.98	TBA550	3.60
CA3052	1.78	LM709	0.70	NE560	4.50	TBA550Q	3.80
CA3080	0.85	LM7098	0.50	NE561	4.50	TBA560CQ	3.00
CA3080A	2.10	LM70914	0.49	NE562	4.50	TBA570	2.10
CA3086	0.50	LM710	0.67	NE565	1.39	TBA570Q	2.20
CA3088B	1.87	LM71014	0.64	NE566	1.75	TBA700Q	2.20
CA3089B	2.90	LM711CN	0.72	NE567	1.90	TBA720AQ	2.06
CA3090Q	4.40	LM723C	0.75	NE571N	4.95	TBA750	2.36
CA3130	1.06	LM723C14	0.45	SAS580	2.70	TBA750Q	2.45
CA3140	1.04	LM741C	0.70	SAS570	2.70	TBA800	1.30
LM301	0.30	LM741C8	0.30	SAJ110	2.10	TBA810S	1.30
LM307N	0.50	LM741C14	0.30	S041P	1.35	TBA820	0.80
LM308N	0.95	LM747CN	0.99	S042P	1.35	TBA920	2.99
LM309KC	1.95	LM7488	0.50	SN76001N		TCA160C	2.36
LM317K	3.35	LM74814	0.90		1.30	TCA160B	2.55
LM318N	2.45	LM1303N	1.15	SN76003N		TCA270	2.99
LM320TS	2.15	LM1304N	1.52		2.38	TCA730	4.50
LM320T12	2.15	LM1305N	1.52	SN76013N		TCA740	4.50
LM320T15	2.15	LM1307N	1.22		1.50	TCA750	3.00
LM320T24	2.15	LM1310N	2.10	SN76023N		TCA760	2.00
LM320P5	1.15	LM1351N	1.30		1.50	TCA105	1.49
LM320P12	1.15	LM1458N	0.45	SN76033N		TCA440	1.65
LM320P15	1.15	LM1496N	0.97		2.35	TDA1022	7.50
LM320P24	1.15	LM1808N	2.10	TAA263	1.35	TDA1024	1.24
LM323K	6.95	LM1812N	6.20	TAA300	3.70	TDA1034	4.75
LM339N	0.60	LM1820N	1.16	TAA320A	1.15	TDA2020AD	
LM340T5	0.88	LM1828N	1.90	TAA350A	3.00		4.50
LM340T15	0.88	LM1830N	1.90	TAA521	1.10	UAA170	2.15
LM340T24	0.88	LM1841N	1.90	TAA522	2.10	UAA180	2.15
LM341P5	0.80	LM1845N	1.50	TAA550	0.48	TL080CP	1.20
LM341P12	0.80	LM1848N	1.98	TAA560	2.10	TL081CP	0.90
LM341P15	0.80	LM1850N	1.90	TAA570	2.20	TL082CP	1.10
LM341P24	0.80	LM1889N	4.90	TAA370A	5.46	TL083CN	1.40
LM348N	0.95	LM3301N	0.60	TAA630	2.40	TL084CN	1.45
LM358N	0.60	LM3302N	0.55	TAA960	3.90	LF355N	0.80
LM360N	3.00	LM3401N	0.55	TAA970	2.40	LF356N	0.80
LM370N	3.30	LM3900N	0.68	TAA611B	2.50	LF357N	0.80
LM371H	2.35	LM3905N	1.15	TAA621	2.50	LF13201N	3.00
LM350K	6.45	LM3909N	0.78	TAA661A	1.65	LF13331N	3.00
LM373N	3.35	LM3911N	1.10	TAA861B	1.45	LF13741H	0.80
LM374N	3.36	LM7805K	1.76	TAA700	4.50	LF13741N	0.55
LM377N	1.80	LM7812K	1.75	TAA930A	1.45		
LM378N	2.40	LM324	0.75	TAA930B	1.45		

CMOS

4000	0.22	4016	0.52					4068	0.27	4086	0.89
4001B	0.22	4017B	1.05	4030	0.84	4050B	0.85	4069B	0.24	4089B	2.10
4002	0.22	4018B	1.05	4031B	2.25	4051B	0.85	4070B	0.85	4093B	1.00
4006	1.25	4019B	0.52	4035B	1.30	4052B	0.86	4071B	0.24	4094	2.30
4007	0.22	4020B	1.15	4037	1.20	4053B	0.98	4072	0.27	4095	1.30
4008B	0.99	4021	1.05	4041B	0.85	4054	1.48	4073B	0.24	4096	1.30
4009	0.58	4022B	1.00	4042B	0.86	4055	1.65	4075B	0.24	4097	4.65
4010	0.58	4023B	0.22	4043	1.05	4056	1.65	4076B	0.99	4098	1.00
4011B	0.22	4024B	0.76	4044	1.00	4059	6.00	4077	0.70	4510B	1.20
4012	0.22	4025B	0.22	4045	1.75	4060B	1.15	4078	0.27	4511	1.75
4013B	0.52	4027B	0.55	4046B	1.50	4063	1.35	4081B	0.24	4516	2.10
4014	1.00	4028B	0.92	4047B	0.96	4066B	0.75	4082	0.27	4518B	1.20
4015	1.05	4029B	1.10	4049	0.96	4067	4.85	4085	0.89		

TTL

74LS00N	0.26	74LS162N	1.43	7400N	0.17	7490AN	0.45
74LS01N	0.26	74LS164N	1.43	7401N	0.17	7491AN	0.85
74LS02N	0.26	74LS168N	2.43	7402N	0.17	7492N	0.45
74LS03N	0.26	74LS169N	2.43	7403N	0.17	7493N	0.45
74LS04N	0.29	74LS174N	1.33	7404N	0.17	7494N	0.90
74LS10N	0.26	74LS175N	1.26	7405N	0.22	7495N	0.76
74LS12N	0.26	74LS181N	3.95	7406N	0.56	7496N	0.70
74LS13N	0.58	74LS189N	3.74	7407N	0.55	7497N	1.95
74LS14N	1.43	74LS190N	1.00	7408N	0.22	74100N	1.40
74LS20N	0.26	74LS191N	1.00	7409N	0.22	74107N	0.35
74LS26N	0.39	74LS192N	1.98	7410N	0.20	74118N	0.95
74LS27N	0.50	74LS193N	1.98	7411N	0.26	74119N	1.40
74LS28N	0.42	74LS196N	1.28	7412N	0.20	74121N	0.28
74LS30N	0.26	74C00N	0.24	7413N	0.36	74122N	0.55
74LS37N	0.32	74C02N	0.24	7414N	0.60	74123N	0.55
74LS38N	0.32	74C04N	0.24	7416N	0.36	74125N	0.45
74LS40N	0.29	74C08N	0.24	7417N	0.36	74141N	0.86
74LS42N	1.07	74C10N	0.24	7420N	0.22	74148N	1.35
74LS47N	1.09	74C14N	1.41	7423N	0.30	74145N	0.86
74LS48N	1.09	74C20N	0.24	7425N	0.32	74150N	1.20
74LS49N	1.09	74C30N	0.24	7427N	0.32	74151N	0.76
74LS51N	0.26	74C32N	0.24	7430N	0.22	74153N	0.76
74LS54N	0.26	74C42N	0.92	7432N	0.30	74154N	1.20
74LS73N	0.42	74C48N	1.38	7437N	0.35	74155N	0.70
74LS76N	0.42	74C73N	0.54	7438N	0.32	74157N	0.78
74LS78N	0.42	74C74N	0.56	7440N	0.20	74160AN	1.10
74LS83AN	1.20	74C76N	0.54	7441AN	0.84	74161AN	1.10
74LS85N	1.10	74C83N	1.30	7442N	0.76	74162AN	1.10
74LS90N	1.10	74C85N	1.30	7445N	1.40	74163AN	1.10
74LS91N	1.20	74C86N	0.64	7446AN	0.90	74164N	1.36
74LS92N	0.86	74C89N	4.39	7447AN	0.80	74165N	1.36
74LS93N	1.10	74C90N	0.85	7448N	0.80	74167N	2.50
74LS95AN	1.10	74C93N	0.85	7450N	0.22	74174N	1.60
74LS96N	1.36	74C95N	1.04	7451N	0.22	74175N	1.00
74LS107N	0.42	74C107N	1.22	7453N	0.22	74176N	0.90
74LS109N	0.42	74C150N	4.14	7454N	0.22	74177N	0.90
74LS122N	0.80	74C151N	2.47	7460N	0.22	74180N	1.00
74LS123N	0.83	74C154N	3.68	7470N	0.46	74181N	2.00
74LS124N	2.70	74C157N	2.21	7472N	0.30	74182N	0.80
74LS125N	0.50	74C160N	1.11	7473N	0.44	74184N	1.50
74LS126N	0.50	74C161N	1.11	7474N	0.32	74185AN	1.50
74LS136N	0.44	74C162N	1.11	7475N	0.80	74188AN	3.25
74LS145N	1.30	74C163N	1.11	7476N	0.45	74189N	2.60
74LS151N	1.07	74C164N	1.04	7480N	0.60	74190N	1.40
74LS153N	0.58	74C165N	1.04	7481N	0.90	74191N	1.20
74LS154N	1.45	74C173N	0.90	7482N	0.90	74192N	1.20
74LS155N	1.20	74C174N	0.90	7483N	1.05	74193N	1.20
74LS156N	1.20	74C175N	0.90	7484N	1.05	74196N	1.20
74LS158N	0.65	74C192N	1.11	7485N	1.36	74197N	1.00
74LS160N	1.43	74C193N	1.11	7486N	0.36	74198N	2.00
74LS161N	0.85	74C195N	1.04	7489N	2.45	74199N	2.00

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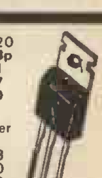

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		BC108A	0.07	BC177B	0.12	BC348A	0.15	BD508	0.50	BFX43	0.70	OC71	0.09	2N2188	0.20
AC107	0.23	BC108	0.07	BC178B	0.12	BC350A	0.17	BD518	0.50	BFX84	0.20	OC74	0.10	2N2218A	0.22
AC125	0.17	BC109	0.06	BC179	0.12	BC441	0.20	BD537	1.02	BFX85	0.20	OC75	0.10	2N2222	0.18
AC126	0.17	BC109B	0.07	BC182A	0.09	BC461	0.24	BD587	1.40	BFX88	0.20	OC82	0.48	2N2222A	0.20
AC127	0.16	BC109C	0.07	BC182B	0.09	BC546	0.10	BDX32	1.90	BFY18	0.50	OC139	0.50	2N2270	0.39
AC127K	0.23	BC113	0.12	BC183A	0.09	BC547	0.11	BDY16	0.50	BFY19	0.50	OC203	2.50	2N2368	0.10
AC128	0.14	BC114	0.15	BC183LA	0.09	BC547A	0.11	BDY20	0.50	BFY33	0.50	OC207	2.70	2N2484	0.18
AC128K	0.25	BC116	0.13	BC183LB	0.10	BC547B	0.11	BF115	0.35	BFY34	0.50	OC1072	2.50	2N2904	0.18
AC128/176	0.42	BC117	0.15	BC184	0.08	BC547C	0.11	BF121	0.20	BFY46	0.50	OC1074	2.50	2N2906	0.18
AC142	0.18	BC118	0.12	BC184L	0.09	BC548A	0.11	BF123	0.20	BFY51	0.12	R2008B	2.10	2N3053	0.15
AC153	0.65	BC119	0.25	BC184LB	0.10	BC548B	0.11	BF125	0.20	BFY52	0.12	TIP30	0.35	2N3117	1.00
AC158	0.50	BC125	0.15	BC186	0.19	BC548C	0.11	BF127	0.20	BFY81	4.00	TIP31	0.45	2N3440	0.70
AC176	0.16	BC125B	0.16	BC187	0.19	BC549A	0.11	BF137	0.21	BRY39	0.35	TIP31A	0.45	2N3638	0.15
AC187	0.50	BC126	0.15	BC204	0.08	BC549B	0.11	BF152	0.15	BSX20	0.18	TIP32	0.45	2N3638A	0.16
AC187K	0.55	BC136	0.15	BC204B	0.09	BC550	0.11	BF154	0.15	BSX52	0.33	TIP33	0.60	2N3643	0.24
AC188K	0.55	BC137	0.15	BC206	0.10	BC557	0.11	BF157	0.37	BSY20	0.21	TIP42	0.60	2N3692	0.24
ACY20	1.02	BC138	0.30	BC206B	0.11	BC557A	0.11	BF158	0.15	BSY25	0.30	TIP2955	0.65	2N3705	0.06
ACY22	1.02	BC140	0.27	BC207	0.10	BC557B	0.11	BF167	0.25	BSY26	0.30	TIS90	0.18	2N3706	0.06
AD142	0.87	BC141	0.29	BC209B	0.09	BC557C	0.11	BF173	0.20	BSY27	0.30	2N344B	0.30	2N3707	0.06
AD143	0.87	BC142	0.20	BC212A	0.10	BC558	0.11	BF174	0.20	BSY29	0.54	2N404	0.45	2N3711	0.06
AD149	0.65	BC147	0.06	BC213L	0.10	BC558A	0.11	BF177	0.25	BSY39	0.15	2N524	0.48	2N3819	0.20
AD161	0.35	BC147B	0.07	BC214L	0.10	BC558B	0.11	BF178	0.25	BSY52	0.33	2N526	0.48	2N3899	3.00
AD161/162	0.70	BC148	0.06	BC237	0.15	BC559B	0.11	BF179	0.25	BSY54	0.39	2N527	0.48	2N3904	0.06
AD162	0.35	BC148A	0.07	BC237A	0.16	BCY42	0.55	BF180	0.20	BSY56	0.36	2N685	3.50	2N3905	0.06
AD262	0.36	BC148B	0.07	BC237C	0.21	BCY58	0.20	BF181	0.20	BSY60	0.36	2N705	0.10	2N3906	0.06
AD263	0.36	BC149	0.06	BC238	0.15	BCY71	0.13	BF182	0.20	BSY84	0.30	2N706	0.10	2N4037	0.25
ADY26	4.74	BC157	0.06	BC238B	0.16	BCY72	0.13	BF183	0.20	BU105	1.08	2N706A	0.11	2N4058	0.10
ADZ11	4.05	BC157A	0.07	BC238C	0.18	BD115	0.30	BF184	0.20	BU105-04	1.08	2N708	0.12	2N4222A	0.65
AF106	0.45	BC158	0.07	BC251A	0.15	BD116	0.30	BF185	0.20	BU108	1.80	2N1039	0.15	2N4348	2.00
AF109R	0.36	BC158A	0.08	BC251B	0.17	BD123	0.60	BF194	0.06	BU126	1.00	2N1059	0.15	2N4448	1.50
AF124	0.25	BC158V1	0.09	BC252A	0.15	BD128	1.02	BF194A	0.07	BU133	1.75	2N1101	0.15	2N4914	3.50
AF125	0.25	BC159	0.06	BC252B	0.17	BD131	0.35	BF195	0.06	BU204	1.30	2N1102	0.15	2N5172	0.25
AF126	0.25	BC159A	0.07	BC252C	0.20	BD133	0.40	BF195D	0.07	BU205	1.30	2N1132	0.20	2N5245	0.30
AF127	0.25	BC159B	0.07	BC258	0.20	BD135	0.30	BF195G	0.07	BU208	1.50	2N1304	0.50	2N5296	0.40
AF139	0.32	BC161	0.25	BC261A	0.10	BD136	0.30	BF196	0.06	BU208-02	1.75	2N1305	0.50	2N5458	0.25
AF178	0.30	BC167	0.06	BC262	0.20	BD137	0.30	BF197	0.06	BU406	3.60	2N1307	0.50	2N5496	0.60
AF179	0.30	BC168	0.06	BC267A	0.21	BD138	0.30	BF198	0.06	BUY69A	6.75	2N1309	0.50	2N5670	0.65
AF200	0.36	BC169	0.06	BC267B	0.22	BD139	0.30	BF224	0.18	BUY69B	2.00	2N1613	0.18	2N5926	0.55
AF201	0.39	BC170B	0.07	BC268	0.21	BD140	0.30	BF253	0.18	BUY69C	7.00	2N1671	1.10	2N6123	0.65
ASY73	0.30	BC170C	0.07	BC304	0.25	BD144	0.30	BF254	0.18	BUY70A	5.00	2N1671B	2.20	2SC03	0.75
ASZ15	0.60	BC171	0.06	BC307	0.15	BD168	0.50	BF255	0.18	BUY71	4.50	2N1711	0.20	2S303	0.90
ASZ16	0.60	BC171A	0.07	BC307A	0.15	BD178	0.72	BF257	0.16	MPS6517	0.48	2N1893	0.25	2S304	0.90
ASZ17	0.60	BC171B	0.07	BC307B	0.15	BD181	1.32	BF258	0.28	MPS6523	0.27	2N1905	0.25	2S305	0.90
AU103	0.90	B172	0.06	BC308	0.15	BD183	1.50	BF259	0.28	MPSA06	0.90	2N1990	0.25	2S323	1.00
AU107	1.00	BC172A	0.07	BC309A	0.15	BD232	0.60	BF324	0.20	MV5053	0.72	2N2060	1.00	2S732	1.00
AU110	0.90	BC172B	0.07	BC317B	0.15	BD233	0.60	BF335	0.25	NKT214	0.25				
AU210	0.90	BC172C	0.07	BC322	0.10	BD234	0.60	BF338	0.45	NKT224	0.25				
BC107	0.06	BC173	0.06	BC327	0.16	BD235	0.40	BF457	0.60	OC22	1.40				
BC107A	0.07	BC173B	0.07	BC328	0.16	BD236	0.40	BF523	0.22	OC26	1.40				
BC107B	0.07	BC174B	0.07	BC337	0.16	BD237	0.40	BF594	0.10	OC29	0.85				
BC108	0.06	BC177A	0.12	BC338	0.16	BD238	0.40	BFR91	5.00	OC36	1.00				
						BD434	0.40	BFT43	0.54	OC44	0.12				
						BD507	0.50	BFX29	0.20	OC45	0.12				

TTL / CMOS

TTL						CMOS			
7400	.12	7476	.13	74161	.80	4000	.15	4073	.20
7401	.12	7483	.75	74163	.80	4001	.15	4075	.20
7402	.12	7484	.90	74164	.90	4002	.20	4076	1.10
7403	.12	7485	.90	74165	.90	4006	.95	4078	.20
7404	.13	7486	.26	74166	1.00	4007	.20	4081	.20
7405	.13	7489	2.00	74167	2.70	4008	.94	4082	.20
7406	.29	7490	.35	74170	1.70	4009	.46	4502	.90
7407	.29	7491	.65	74172	4.00	4010	.50	4507	.52
7408	.14	7492	.45	74173	1.20	4011	.15	4508	2.30
7409	.14	7493	.36	74174	.90	4012	.15	4510	1.10
7410	.13	7494	.80	74175	.70	4013	.35	4511	.70
7411	.18	7495	.55	74176	.90	4014	.85	4512	.95
7412	.21	7496	.62	74177	.90	4015	.80	4516	.70
7413	.25	7497	2.40	74178	1.20	4016	.45	4518	.65
7414	.54	74100	.95	74179	1.10	4017	.55	4520	1.10
7416	.27	74105	.40	74180	.70	4018	.90		
7417	.27	74107	.28	74181	1.95	4019	.45		
7420	.13	74109	.45	74182	.75	4020	.60		
7421	.28	74110	.46	74184	1.20	4021	.85		
7423	.25	74111	.70	74185	1.20	4022	.85		
7425	.22	74116	1.60	74186	7.20	4023	.20		
7426	.25	74118	.82	74188	5.40	4024	.68		
7427	.25	74119	1.30	74190	1.10	4025	.20		
7428	.34	74120	.82	74191	1.00	4026	1.35		
7430	.13	74121	.26	74192	1.00	4027	.35		
7432	.24	74122	.40	74193	1.10	4028	.70		
7433	.32	74123	.55	74194	.92	4029	.90		
7437	.24	74125	.45	74195	.85	4030	.50		
7438	.24	74126	.46	74196	.92	4033	1.40		
7440	.13	74128	.62	74197	.92	4035	1.10		
7441	.52	74132	.70	74198	1.60	4040	.90		
7442	.55	74141	.58	74199	1.50	4041	.80		
7444	.90	74142	2.02			4042	.75		
7445	.70	74143	2.02			4043	.85		
7446	.70	74144	2.02			4044	.85		
7447	.66	74145	.65			4049	.28		
7448	.60	74147	1.35			4050	.45		
7450	.13	74148	1.20			4051	.88		
7451	.13	74150	1.00			4052	.88		
7452	.13	74151	.60			4053	.88		
7454	.13	74153	.60			4055	1.00		
7460	.13	74154	1.06			4060	1.00		
7470	.28	74155	.63			4066	.35		
7472	.22	74156	.63			4068	.20		
7473	.26	74157	.63			4069	.20		
7474	.20	74158	1.70			4070	.20		
7475	.28	74160	.80			4072	.20		

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Prices 10R to 5K0 1.61 each.
10K & 20K 1.82 each.

1.5W Convergence preset potentiometer. Values available 5R0, 7R0, 10R, 15R, 20R, 100R, 500R.
Price 0.50 each.

2W 10 Turn potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K.
Price 7.34 each.

DIODES

AA119	0.17	BB105G	0.35	BY201-3	0.40	ITT210	1.35	OA202	0.07
AA121	0.11	BB110G	0.45	BY201-4	0.45	ITT827	2.35	ST2	0.14
AA129	0.08	BB142	1.25	BY201-5	0.56	ITT921	0.20	1N4001	0.04
AA143	0.15	BR100	0.20	BY201-6	0.56	ITT923	0.35	1N4002	0.05
AA144	0.09	BR101	0.30	BY203-12	0.60	ITT1075	0.25	1N4003	0.05
BA102	0.30	BY100	0.20	BY203-16	0.65	ITT2001	0.25	1N4004	0.06
BA111	0.98	BY103	0.35	BY203-20	1.00	ITT2002	0.20	1N4005	0.06
BA115	0.25	BY118	1.45	BY204-4	0.45	MR502	0.75	1N4006	0.07
BA145	0.15	BY126	0.15	BY204-8	0.65	MR813	0.90	1N4007	0.08
BA148	0.12	BY127	0.10	BY204-10	0.75	MR854	1.80	1N4148	0.04
BA154	0.10	BY130	0.15	BY206	0.30	MR856	2.10	1N4150	0.45
BA155	0.12	BY133	0.10	BY210-400	0.48	MR992A	1.56	1N4448	0.25
BA156	0.12	BY134	0.45	BY210-600	0.50	MV2203	1.80	1N5401	0.12
BA157	0.46	BY142	0.45	BY210-800	0.55	MV5460	0.85	1N5402	0.15
BA158	0.65	BY164	0.50	BYX10	0.35	OA47	0.07	1N5403	0.15
BA159	0.75	BY176	3.45	BYX55-350	0.45	OA70	0.07	1N5404	0.16
BA182	0.46	BY179	0.90	BYX55-600	0.55	OA71	0.35	1N5405	0.25
BA201	0.15	BY182	1.85	BYX71-350	0.90	OA81	0.12	1N5406	0.20
BA243	0.85	BY184	0.70	BYX71-600	1.15	DA85	0.12	1N5407	0.19
BAX13	0.06	BY187	1.30	BZX61 series	0.18	OA86	0.20	1N5408	0.20
BAK16	0.07	BY198	0.75	BZY88 series	0.08	OA90	0.07	1N5450A	6.75
BAX17	0.10	BY199	0.56	DK13	0.45	OA91	0.08	1N5761	0.60
BB105B	0.35	BY201-2	0.40	ITT44	0.10	OA95	0.06		

CAPACITORS

Tantalum Bead		
6.3V	47uF	0.32 each
	100uF	0.50 each
16V	10uF	0.24 each
	22uF	0.30 each
	47uF	0.50 each
25V	22uF	0.41 each
35V	0.1uF	0.22 each
	0.22uF	0.22 each
	0.47uF	0.22 each
	1.0uF	0.22 each
	2.2uF	0.22 each
	4.7uF	0.24 each
Disc Ceramic		
8kV	150pF	0.27 each
	180pF	0.27 each
	200pF	0.27 each
	220pF	0.27 each
	250pF	0.40 each
	270pF	0.40 each
	300pF	0.40 each
Mixed Dielectric		
600V	1uF	1.01 each
1kV	0.01uF	0.26 each
	0.033uF	0.32 each
	0.047uF	0.35 each
	0.1uF	0.39 each
	0.22uF	0.58 each
	0.47uF	0.89 each
1.25kV	0.1uF	0.50 each
1.5kV	0.001uF	0.24 each
	0.0022uF	0.24 each
	0.0047uF	0.24 each
	0.22uF	0.28 each
Single Ended Electrolytic		
16V	10uF	0.11 each
	22uF	0.11 each
	47uF	0.11 each
	100uF	0.11 each
	220uF	0.14 each
	470uF	0.28 each
	1000uF	0.32 each
63V	1uF	0.11 each
	2.2uF	0.11 each
	4.7uF	0.11 each
	10uF	0.13 each
	22uF	0.16 each
	47uF	0.22 each
	100uF	0.32 each
	220uF	0.46 each
Double Ended Electrolytic		
10V	22uF	0.14 each
	100uF	0.14 each
	220uF	0.17 each
	470uF	0.38 each
	1000uF	0.40 each
25V	10uF	0.14 each
	22uF	0.14 each
	47uF	0.17 each
	100uF	0.17 each
	220uF	0.36 each
	470uF	0.47 each
	1000uF	0.72 each
63V	1uF	0.14 each
	2.2uF	0.14 each
	4.7uF	0.14 each
	10uF	0.17 each
	22uF	0.17 each
	47uF	0.29 each
	100uF	0.40 each
	220uF	0.65 each
	470uF	0.66 each
	1000uF	1.01 each
	2200uF	1.44 each
100V	10uF	0.20 each
	22uF	0.25 each
	47uF	0.36 each
	100uF	0.61 each
	220uF	0.68 each
450V	1uF	0.27 each
	4.7uF	0.45 each
	10uF	0.53 each
	22uF	1.07 each
	33uF	1.22 each
Silvered Mica		
500V	3.3pF	0.18 each
	5pF	0.18 each
	10pF	0.18 each
	39pF	0.18 each
	100pF	0.18 each
	150pF	0.18 each
	180pF	0.18 each
	220pF	0.18 each
	330pF	0.36 each
	470pF	0.36 each
	680pF	0.36 each
	820pF	0.36 each
	1000pF	0.42 each
	2200pF	0.50 each
	8200pF	1.58 each
	10000pF	1.62 each
Multi-sectional Electrolytic		
30V	2500/2500uF	1.94 each
70V	2500/2500uF	2.70 each
300V	150/150/100uF	2.81 each
350V	200/300uF	2.46 each
	200/200/100/32uF	3.89 each
	150/100/100/100/150uF	4.75 each
	400/400uF	4.75 each
	300/300/150/100/50uF	5.18 each

LINEAR INTEGRATED CIRCUITS

CA3020	1.75	SC9504P	2.00	TAA300	3.75	TBA400	2.26	TBA750Q	2.60
CA3046	0.80	SL414A	4.85	TAA310	3.15	TBA510	2.40	TBA800	0.80
CA3048	2.50	SL415A	6.30	TAA320	2.80	TBA510Q	2.80	TBA800Q	2.06
CA3065	1.58	SL901B	8.60	TAA350A	3.00	TBA520	2.80	TBA810A	3.40
CA3089E	7.00	SL917B	10.70	TAA435	3.40	TBA520Q	2.60	TBA810S	1.10
CA3080Q	4.60	SL1310	5.85	TAA550	0.60	TBA530	2.60	TBA820	0.80
ETT6016	4.96	SL1327	2.75	TAA550B	0.40	TBA530Q	2.50	TBA915	7.35
ETTR6016	4.96	SL3046	2.60	TAA570	2.85	TBA540	2.60	TBA920	3.00
MC1303L	1.50	SN76003N	2.50	TAA621	6.95	TBA540Q	2.25	TBA920Q	3.60
MC1304P	2.00	SN76003ND	2.15	TAA630	8.66	TBA550	3.80	TBA950-2	5.40
MC1305	5.15	SN76013N	1.60	TAA630S	5.10	TBA550Q	3.80	TBA950-2X	6.04
MC1307P	2.05	SN70613ND	2.15	TAA661A	1.70	TBA560	6.46	TBA990	4.95
MC1310P	1.00	SN76023N	1.60	TAA661B	1.80	TBA560C	4.60	TBA990Q	3.75
MC1327P	2.75	SN76023ND	2.15	TAA700	3.60	TBA560Q	7.35	TCA160	5.10
MC1327PQ	2.60	SN76033N	2.40	TAA840	4.60	TBA560CQ	3.00	TCA270	3.00
MC1330P	1.26	SN76110N	1.50	TAD100	1.35	TBA570	2.00	TCA270B	3.80
MC1339P	3.06	SN76131N	2.00	TBA120A	3.06	TBA570Q	2.00	TCA270Q	3.80
MC1349	3.35	SN76226N	3.15	TBA120AS	1.60	TBA641A12	6.20	TCA270S	2.25
MC1351P	1.26	SN76226ND	3.15	TBA120S	2.70	TBA641B11	5.66	TCA270SQ	3.40
MC1352P	1.46	SN76227N	2.50	TBA120SB	1.60	TBA673	5.00	TCA800	5.40
MC1358PQ	3.86	SN76532N	3.15	TBA120SQ	1.80	TBA700	3.96	TCA800Q	12.40
SAA570	4.20	SN76533N	2.70	TBA281	4.70	TBA700Q	2.25	TCA830	3.10
SAA700B	10.15	SN76544N	1.80	TBA350A	3.00	TBA720	5.10	TDA440	6.75
SAS560	2.75	SN76550N	1.80	TBA396	1.80	TBA720A	5.10	TDA1327	2.85
SAS570	2.75	SN76660N	0.80	TBA440	3.60	TBA720AQ	2.10	TDA1327B	2.86
SBA750B	6.75	SN76666N	1.60	TBA4406	3.96	TBA750	2.40	TDA1330	1.60
SC9503P	2.00			TBA480Q	2.60			741	0.25

BRIDGE RECTIFIERS

CURRENT	VOLTAGE	ORDER CODE	PRICE
1A	50V	B1/50	0.25
1A	100V	B1/100	0.26
1A	200V	B1/200	0.28
1A	400V	B1/400	0.30
1A	800V	B1/800	0.34
2A	50V	B2/50	0.40
2A	100V	B2/100	0.46
2A	200V	B2/200	0.55
2A	400V	B2/400	0.65
2A	800V	B2/800	0.70
3A	200V	B3/200	0.70
3A	600V	B3/600	0.80
4A	100V	B4/100	0.90
4A	400V	B4/400	0.96
6A	50V	B6/50	0.95
6A	200V	B6/200	1.10
6A	400V	B6/400	1.20
10A	400V	B10/400	2.80
25A	50V	B25/50	4.00
25A	200V	B25/200	4.20
25A	400V	B25/400	4.30

I. C. SOCKETS

NO. OF PINS	ORDER CODE	PRICE
8	D8	0.10
14	D14	0.11
16	D16	0.13
20	D20	0.30
22	D22	0.35
24	D24	0.40
28	D28	0.45
40	D40	0.60

PANEL METERS

Size 2" x 2" x 1⅜", requires 1¾ cut-out.

F.S.D.	ORDER CODE	PRICE
1mA	M1	5.50
500mA	M500	5.50

THYRISTORS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
80mA	30V	TO18	S08/30	0.22
80mA	60V	TO18	S08/60	0.24
80mA	200V	TO18	S08/200	0.25
1A	50V	TO220	S1/50	0.25
1A	100V	TO220	S1/100	0.26
1A	200V	TO220	S1/200	0.28
1A	400V	TO220	S1/400	0.35
3A	50V	TO220	S3/50	0.25
3A	100V	TO220	S3/100	0.28
3A	200V	TO220	S3/200	0.30
3A	400V	TO220	S3/400	0.40
4A	50V	TO220	S4/50	0.35
4A	100V	TO220	S4/100	0.40
4A	200V	TO220	S4/200	0.60
4A	400V	TO220	S4/400	0.65
5A	400V	TO220	S5/400	0.65
7A	50V	TO220	S7/50	0.45
7A	100V	TO220	S7/100	0.50
7A	200V	TO220	S7/200	0.65
7A	400V	TO220	S7/400	0.80
8A	400V	TO220	S8/400	0.70

TRIACS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
3A	100V	TO220	T3/100	0.75
3A	200V	TO220	T3/200	0.80
3A	400V	TO220	T3/400	0.85
6A	200V	TO220	T6/200	1.00
6A	400V	TO220	T6/400	1.05
8A	400V	TO220	T8/400	1.35
10A	400V	TO220	T10/400	1.40
15A	400V	TO220	T15/400	2.00

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	£p		£p		£p		£p		£p
AA119	0·10	BCY70	0·15	*MPSA56	0·26	*ZTX550	0·16	7405	0·16
AAY30	0·27	BCY71	0·17	*MPSU01	0·36	1N914	0·05	7406	0·40
AAY32	0·42	BCY72	0·13	*MPSU06	0·46	1N916	0·07	7407	0·40
AAZ13	0·18	BCZ11	1·50	*MPSU56	0·49	1N4001	0·06	7408	0·20
AAZ15	0·34	BD115	0·45	NE555	0·45	1N4002	0·06	7409	0·20
AAZ17	0·27	BD121	1.20	NKT401	2·00	1N4003	0·07	7410	0·16
AC107	0·60	BD123	1·20	NKT403	1·73	1N4004	0·07	7412	0·26
AC125	0·20	BD124	1·30	NKT404	1·73	1N4005	0·08	7413	0·32
AC126	0·20	BD131	0·35	OA5	0·95	1N4006	0·08	7416	0·32
AC127	0·20	BD132	0·38	OA7	0·55	1N4007	0·09	7417	0·32
AC128	0·20	BD135	0·34	OA10	0·60	1N4009	0·06	7420	0·17
AC141	0·25	BD136	0·34	OA47	0·14	1N4148	0·06	7422	0·20
AC141K	0·35	BD137	0·35	OA70	0·30	1N5400	0·13	7423	0·32
AC142	0·20	BD138	0·40	OA79	0·30	1N5401	0·13	7425	0·30
AC142K	0·30	BD139	0·43	OA81	0·30	1S44	0·04	7427	0·30
AC176	0·20	BD140	0·44	OA85	0·30	1S920	0·07	7428	0·43
AC187	0·20	BD144	2·00	OA90	0·08	1S921	0·07	7430	0·17
AC188	0·20	BD181	1·10	OA91	0·08	2G301	1·00	7432	0·30
ACY17	0·85	BD182	1·18	OA95	0·08	2G302	1·00	7433	0·36
ACY18	0·80	BD237	0·40	OA200	0·09	2G306	1·10	7437	0·32
ACY19	0·75	BD238	0·55	OA202	0·09	2N404	1·00	7438	0·32
ACY20	0·70	BDX10	0·91	OA211	1·00	2N696	0·25	7440	0·18
ACY21	0·75	BDX32	2·00	OAZ200	1·00	2N697	0·25	7441AN	0·85
ACY39	1·50	BDY20	1·25	OAZ201	1·00	2N698	0·30	7442	0·72
AD149	0·70	BDY60	1·50	OAZ206	1·00	2N705	1·20	7447AN	0·90
AD161	0·45	BF115	0·25	OAZ207	1·00	2N706	0·15	7450	0·18
AD162	0·45	BF152	0·18	OC16	2·00	2N708	0·20	7451	0·18
AF106	0·45	BF153	0·20	OC20	2·50	2N930	0·20	7453	0·18
AF114	0·35	BF154	0·17	OC22	2·50	2N1131	0·26	7454	0·18
AF115	0·35	BF159	0·23	OC23	2·75	2N1132	0·26	7460	0·18
AF116	0·35	BF160	0·16	OC24	3·00	2N1302	0·35	7470	0·35
AF117	0·35	BF167	0·20	OC25	0·90	2N1303	0·35	7472	0·33
AF139	0·40	BF173	0·20	OC26	0·90	2N1304	0·45	7473	0·36
AF186	1·20	BF177	0·24	OC28	2·00	2N1305	0·45	7474	0·40
AF239	0·45	BF178	0·24	OC29	2·00	2N1306	0·50	7475	0·54
AFZ11	2·75	BF179	0·25	OC35	1·50	2N1307	0·50	7476.	0·40
AFZ12	2.75	BF180	0·30	OC36	1·50	2N1308	0·55	7480	0·55
ASY26	0·40	BF181	0·30	OC41	0·80	2N1309	0·55	7482	0·75
ASY27	0·40	BF182	0·30	OC42	0·75	2N1613	0·25	7483	0·90
ASZ15	1·25	BF183	0·25	OC43	2·25	2N1671	1·50	7484	1·00
ASZ16	1·25	BF184	0·25	OC44	0·60	2N1893	0·25	7486	0·35
ASZ17	1·25	BF185	0·25	OC45	0·55	2N2147	1·75	7490	0·52
ASZ20	1·50	*BF194	0·09	OC71	0·55	2N2148	1·65	7491AN	0·80
ASZ21	2·00	*BF195	0·09	OC72	0·55	2N2218	0·25	7492	0·60
*AU110	1·70	*BF196	0·10	OC73	1·00	2N2219	0·24	7493	0·60
*AU113	1·70	*BF197	0·12	OC74	0·65	2N2220	0·18	7494	0·80
*AUY10	1·70	BF200	0·27	OC75	0·65	2N2221	0·18	7495	0·72
*BA145	0·13	*BF224	0·20	OC76	0·55	2N2222	0·18	7496	0·80
*BA148	0·13	BF244	0·28	OC77	1·20	2N2223	2·75	7497	3·00
BA154	0·09	BF257	0·24	OC81	0·65	2N2368	0·17	74100	1·50
BA155	0·10	BF258	0·26	OC81Z	1·20	2N2369A	0·21	74107	0·45
BA156	0·09	BF259	0·32	OC82	0·65	2N2484	0·20	74109	0·70
BAW62	0·05	BF336	0·30	OC83	0·65	2N2646	0·55	74110	0·50
BAX13	0·06	BF337	0·30	OC84	0·65	2N2904	0·25	74111	0·70
BAX16	0·09	BF338	0·31	OC122	1·50	2N2905	0·25	74116	1·75
BC107	0·12	BFS21	3·96	OC123	1·75	2N2906	0·21	74118	1·00
BC108	0·12	BFS28	2·23	OC139	2·25	2N2907	0·21	74119	1·50
BC109	0·13	*BFS61	0·20	OC140	2·75	*2N2924	0·21	74120	0·83
*BC113	0·12	*BFS98	0·20	OC141	3·25	*2N2925	0·22	74121	0·40
*BC114	0·13	BFW10	0·65	OC170	1·00	*2N2926	0·14	74122	0·60
*BC115	0·14	BFW11	0·65	OC171	1·00	2N3053	0·25	74123	1·00
*BC116	0·15	BFX84	0·22	OC200	1·50	2N3054	0·50	74125	0·55
*BC117	0·17	BFX85	0·23	OC201	1·75	2N3055	0·70	74126	0·55
*BC118	0·10	BFX87	0·21	OC202	1·75	2N3440	0·60	74128	0·60
BC125	0·16	BFX88	0·21	OC203	1·75	2N3441	0·80	74132	0·70
*BC126	0·20	BFY50	0·26	OC204	2·50	2N3442	1·10	74136	0·55
*BC135	0·14	BFY51	0·26	OC205	2·50	2N3525	0·80	74141	0·80
*BC136	0·15	BFY52	0·26	OC206	2·50	2N3614	1·50	74142	2·30
*BC137	0·15	BFY64	0·26	OC207	1·75	*2N3702	0·11	74143	2·50
*BC147	0·09	BFY90	1·25	OCP71	1·25	*2N3703	0·13	74144	2·50
BC148	0·08	BSX19	0·21	ORP12	0·75	*2N3704	0·13	74145	0·90
*BC149	0·09	BSX20	0·20	*R2008B	1·75	*2N3705	0·13	74147	2·00
*BC157	0·09	BSX21	0·20	*R2009	2·25	*2N3706	0·13	74148	1·75
*BC158	0·08	BT106	1·25	*R2010B	1·75	*2N3707	0·13	74150	1·60
*BC159	0·10	BTY79/4	3·19	T1C44	0·30	2N3708	0·10	74151	0·85
*BC167	0·12	*BU205	1·75	T1C226D	1·20	2N3709	0·13	74154	1·75
BC170	0·11	*BU206	2·25	T1L209	0·20	2N3710	0·10	74155	0·85
BC171	0·10	*BU208	2·00	*T1P29A	0·41	2N3711	0·10	74156	0·85
BC172	0·10	BY100	0·45	*T1P30A	0·44	2N3771	1·75	74157	0·75
BC173	0·12	BY126	0·14	T1P31A	0·45	2N3772	2·00	74159	2·10
BC177	0·15	BY127	0·15	T1P32A	0·48	2N3773	3·00	74170	2·30
BC178	0·14	BZX61	0·18	T1P33A	0·69	2N3819	0·36	74172	4·40
BC179	0·16	Series		T1P34A	0·73	2N3820	0·45	74173	1·40
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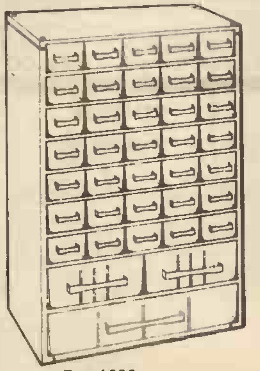

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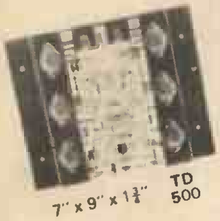

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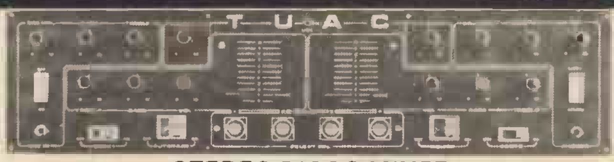

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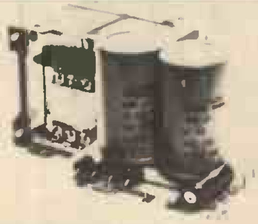

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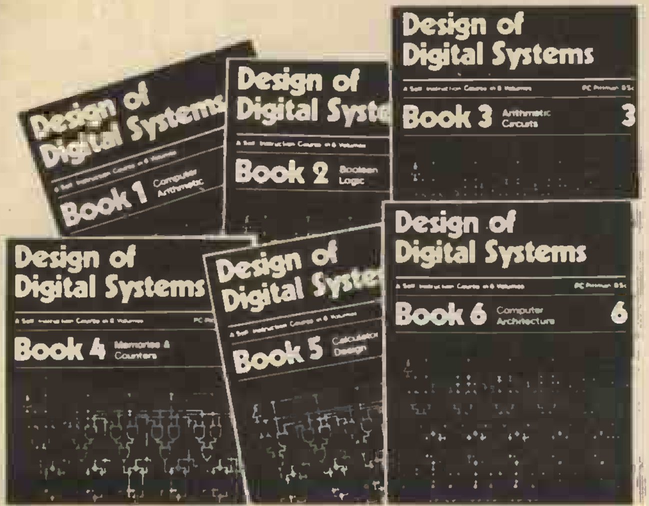

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74150	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	140p
74167	200p
74170	240p
74172	720p
74173	120p
74174	93p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	200p
74182	90p
74184A	150p
74185	150p
74186	700p
74190	100p
74191	100p
74192	100p
74193	100p
74194	100p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74200	1000p
74221	160p
74C221	150p
74251	140p
74259	250p
74265	90p
74278	290p
74279	140p
74283	190p
74284	400p
74285	400p
74290p	150p
74293	150p
74294	200p
74298	200p
74365	150p
74366	150p
74367	120p
74368	150p
74390	200p
74393	200p
74490	225p

74LS SERIES

74LS00	14p
74LS02	14p
74LS04	16p
74LS08	25p
74LS10	20p
74LS11	40p
74LS13	45p
74LS14	72p
74LS20	20p
74LS21	40p
74LS22	28p
74LS27	38p
74LS30	20p
74LS32	27p
74LS42	70p
74LS47	90p
74LS55	30p
74LS73	50p
74LS74	40p
74LS75	45p
74LS83	110p
74LS85	100p
74LS86	40p
74LS90	60p
74LS93	60p
74LS107	45p
74LS112	100p
74LS123	70p
74LS124	180p
74LS132	95p
74LS133	60p
74LS138	60p
74LS139	60p
74LS151	100p
74LS153	60p
74LS157	60p
74LS158	120p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	110p
74LS164	120p
74LS165	180p
74LS166	180p
74LS173	110p
74LS174	90p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	140p
74LS193	140p
74LS195	140p
74LS196	120p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	170p
74LS245	170p
74LS251	140p
74LS253	140p
74LS257	120p
74LS259	160p
74LS266	100p
74LS273	130p
74LS279	90p
74LS298	249p
74LS324	200p
74LS373	180p
74LS374	195p
74LS378	200p

4000 SERIES

4000	15p
4001	17p
4002	17p
4006	95p
4007	18p
4008	60p
4009	40p
4010	50p
4011	17p
4012	18p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	22p
4024	50
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	32p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
s4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	33p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4093	80p
4094	250p
4098	107p
4411	1100p
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
4520	100p
4528	100p
4543	180p
4553	450p
4560	250p
4583	90p
4584	90p
40014	90p
40085	200p
40097	90p
14411	1100p
14412	1100p
14433	1100p

INTERFACE ICs

MC1488	100p
MC1489	100p
75107	160p
74182	230p
75324	375p
74325	375p
75451	72p
75491/2	96p
8T26	250p
8T28	300p
8T95	160p
8T97	160p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9601	110p
9602	220p
9603	160p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
8311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	225p
9368	200p
9370	200p
9374	200p

VEROBOARD

	0.1	0.15
(copper clad)		
2½ x 3½	41p	33p
2½ x 5	49p	45p
3¾ x 3½	49p	45p
3¾ x 5	56p	60p
2½ x 17	152p	121p
3¾ x 17	195p	163p
4¾ x 17	252p	—

Pkt of 35 pins 30p
Spot face cutter 85p
Pin insertion tool 99p

VERO WIRING PEN

Plus spool 325p
Spare spool (wire) 80p
Combes 7p each

BUCKET BRIGADE*

SAD1024 1800p

LINEAR I.Cs

*AY1-0212	600p
*AY1-1313	668p
*AY1-1320	320p
*AY1-5050	211p
*AY5-1315	600p
*AY5-1317	636p
*CA3019	80p
*CA3046	70p
*CA3048	225p
CA3080E	72p
*CA3089E	225p
*CA3090AQ	375p
CA3130S	100p
CA31140E	70p
CA3160E	100p
FX209	750p
ICL7106	850p
ICL8038	340p
LM301A	30p
LM311	120p
LM318	200p
LM324	70p
LM339	75p
LM348	95p
*LM377	175p
*LM380	75p
*LM381AN	160p
*LM389N	140p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	20p
LM747	70p
LM748	35p
LM3900	70p
LM3911	130p
LM4136	120p
*MC1310P	150p
MC1458	55p
MC1495L	350p
*MC1496	100p
*MC3340P	120p
*MC3360P	120p
*MFC4000B	120p
MK50398	750p
NE531	110p
*NE540L	200p
NE543K	225p
NE555	25p
NE556	70p
NE561B	425p
NE5628	425p
NE565	130p
NE566	155p
NE567	175p
NE571	425p
RC4151	400p
SFF96364	1150p
*SN76003N	175p
*SN76013N	140p
*SN76013ND	120p
*SN76023N	140p
*SN76023ND	120p
*SN76033N	175p
SN76477	250p
*SP8515	750p
*TAA621	275p
*TBA641B11	225p
*TBA651	200p
*TBA800	90p
*TBA810	100p
*TBA820	90p
*TCA940	175p
*TDA1004	300p
*TDA1022	600p
*TDA2020	320p
TL084	130p
TL170	50p
XR2206	400p
XR2207	400p
XR2211	600p
*XR2216	675p
XR2240	400p
*ZN414	90p
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		-ve	
5V	7805	90p	7905	100p
12V	7812	90p	7912	100p
15V	7815	90p	7915	100p
18V	7818	90p	7918	100p
24V	7824	90p	7924	100p
100mA	TO-92			
5V	78L05	35p	79L05	80p
12V	78L12	35p	79L12	80p
15V	78L15	35p	79L15	80p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
LM317T	200p	TL430	65p
LM323K	625p	78HO5KC	675p
LM723	37p	778MGT2C	135p

OPTO-ELECTRONICS

2N5777	45p	OCP71	130p
ORP12	90p	ORP60	90p
ORP61	90p	TIL78	70p

LEDS

0.125"		0.2"	
TIL32 I.R.	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	FND500	120p
DL704	140p	FND507	120p
DL707 Red	140p	MAN3640	175p
707 Gr	140p	TIL311	600p
DL747 Red	225p	TIL312/3	110p
747 Gr	225p	TIL321/2	130p
FND357	120p	TIL330	140p

DRIVERS

9368	200p
9370	200p

"PE" MICROPRINTER
SEND S.A.E. FOR DETAILS

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116/7	30p
AD149	70p
AD161/2	45p
BC107/8	11p
BC109	11p
*BC117	20p
*BC147/8	9p
*BC149	10p
*BC157/8	10p
*BC159	11p
*BC169C	12p
*BC172	12p
BC177/8	17p
BC179	18p
*BC182/3	10p
*BC184	11p
BC187	30p
*BC212/3	11p
*BC214	12p
BC461	36p
BC477/8	30p
*BC516/7	50p
*BC547B	16p
*BC549C	18p
*BC557B	16p
*BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
BD242	70p
BDY56	200p
BF200	32p
*BF2448	35p
*BF256B	70p
BF257/8	32p
BF259	36p
*BFR39	30p
*BFR40	30p
*BFR41	30p
*BFR79	30p
*BFR80	30p
*BFR81	30p
BFX29	30p
BFX30	34p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	22p
BFY51/2	22p
BFY56	33p
BFY90	90p
BLY83	700p
BRY39	45p
BSX19/20	20p
BU104	225p
*BU105	190p
*BU108	250p
BU109	225p
*BU205	200p
*BU208	200p
*BU406	145p
BJ481	175p
MJ491	200p
MJ2501	225p
MJ2955	100p
MJ3001	225p
*MJE340	65p
MJE2955	100p
MJE3055	70p
*MPF102	45p
*MPF103/4	40p
*MPF105/6	40p
MPSA06	30p
*MPSA12	50p
*MPSA56	32p
*MPSU06	63p
MPSU65	78p
OC28	130p
OC35	130p
*R2008B	200p
*R2010B	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
*TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP2955	78p
TIP4055	70p
*TIS43	34p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N940	18p
2N1131/2	20p
2N1613	25p
N1711	25p
2N2102	60p
2N2160	300p
2N2219A	22p
2N2222A	22p
2N2369A	16p
2N2484	30p
2N2646	50p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	20p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3663	20p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	14p
*2N3708/9	12p
*2N3773	300p
*2N3819	25p
*2N3820	50p
2N3823	70p
2N3866	90p
*2N3903/4	18p
*2N3905/6	20p
2N4037	65p
2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	22p
*2N4125/6	22p
*2N4289	20p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	85p
40410	85p
40411	300p
40594	97p
40595	105p
40673	75p
40841	90p
40871/2	90p

DIODES

*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
*15920	9p

*ZENEERS

2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

HEAT SINKS

For TO220 Voltage Regs. and Transistors 22p
For TO5 12p

THYRISTORS

1A 50V	40p
1A 400V	65p
1A 600V	70p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
*MCR101	36p
2N3525	120p
2N4444	140p
*2N5060	34p
*2N5064	40p

BRIDGE RECTIFIERS

*1A 50V	21p
*1A 100V	22p
*1A 400V	30p
*1A 600V	35p
*2A 50V	30p
*2A 100V	35p
*2A 400V	45p
*3A 200V	60p
*3A 600V	72p
*4A 100V	95p
*4A 400V	100p
6A 50V	90p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

LOUD-SPEAKERS

Size		
2½"	64R	70p
2½"	8R	70p
2"	8R	75p
1½"	8R	75p

MEMORIES

2102	100p
2102-2	120p
2102L-4	140p
2107B	600p
2111-1	225p
2112-2	300p
2114	1000p
5101	510p
6810	350p

ROM/PROMs

74S188	225p
74S287	400p
74S387	400p
93427	400p
93436	650p
93446	650p
93448	1000p

CPUs

4040a	670p
6502	1200p
6800	900p
6801	TBA
8080A	550p

EPROMS

1702A	600p
2708	900p
2716	2500p
4702	900p

TRANSFORMERS

(prim 220-240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
12-0-12	100mA	95p
0-12 0-12	500mA	280p+
0-25V (5VA)		250p
9-0-9	1A	270p*
12V	2A	350p*
0-12-15		
20-24-30	1A	340p*
15-0-15	1A	265p*

(Please add 50p p&p charge to all marked * above our normal p&p charge)

DATA BOOKS

TTLs, CMOs, Linears, Memories, etc. by Mfrs stocked.

Please send S.A.E. for details.

UART

AY-3-1015P	500p
AY-5-1013	400p
TMS6011NC	400p

CHARACTER GENERATOR

3257ADC	990p
MCM6576	750p
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	550p
SN74S262AN	1360p

OTHER

3245	400p
4201	390p
4289	970p
4801	500p
6820	600p
6850	700p
8205	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
8259	1400p
AY5-2376	1000p
MC14411	1100p

SUBMINIATURE SWITCHES

Toggle	
SPST	51p
SPDT	53p
DPDT	55p
DPDT (Centre-off)	85p
Push to make (Red, Green, Yel., Blue)	15p
Push to break (Black only)	25p

CRYSTALS

100KHz	300p
1MHz	370p
3.2768MHz	350p
10.7MHz	350p
18MHz	300p
27.135MHz	300p

EDGEBOARD CONNECTORS

0.156" Solder Tail

2 x 10 way	85p
2 x 15 way	100p
2 x 18 way	120p
2 x 22 way	135p
2 x 25 way	160p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	11p	18 pin	25p	24 pin	33p
14 pin	12p	20 pin	28p	28 pin	42p
16 pin	13p	22 pin	30p	40 pin	51p

WIRE WRAP SOCKETS

8 pin	30p	24 pin	80p
14 pin	40p	28 pin	100p
16 pin	55p	40 pin	120p

EDGE CONNECTOR

31 Way Plug 105p
31 Way Skt. 110p
(0.1" Pitch)

PE VDU SYSTEM

A low-cost memory-mapped system designed to interface with all micro-computer systems.

Designer Approved Suppliers

Complete Kit	**£49**
Ready-built tested module	**£69**

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***RESISTORS** High Stab Carbon Film 5% Tol E12 Series
¼W 10R-1M **1p 90p**/100 each valve
½W 10R-10M **1.5p 120p**/100 each valve

***MINIATURE PRESETS,** Horz/Vert
100R-1M: **10p**

***CARBON TRACK POTENTIOMETERS**
¼W LOG or LIN

Single 5K-2M	26p
Single with DP Switch 5K-2M	55p
Dual 5K-2M	66p

CAPACITORS

Low Voltage Electrolytic, Polyester, Tantalum Disc Ceramic available

VEROBOARDS IC BREADBOARD

(20 x 14 pin DIL ICs or 16 x 16 pin DIL ICs) 4.15" x 6.15" 270p

VQ BOARD

Specially designed for DIL ICs – No track cutting 5.82" x 2.9" 105p

ANTEX SOLDERING IRONS

Model C 15W	360p
CX 17W	360p
X25	360p
CCN	380p
Spare Bits	
C/CX/CCN	46p
X25	50p

VAT RATE: All items at 8% except where marked* where 12½% applies.

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15-240 WATTS!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropiate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack: multi-function equalisation: low noise: low distortion: high overload: two simply combined for stereo.
APPLICATIONS: hi-fi: mixers: disco: guitar and organ: public address.
SPECIFICATION: Inputs-magnetic pick-up 3mV: ceramic pick-up 30mV: tuner 100mV: microphone 10mV: auxiliary 3–100mV. Input impedance 47kΩ at 1kHz. Outputs—tape 100mV: main output 500mV R.M.S. Active Tone Controls—treble ±12dB at 10kHz: bass ±12dB at 100Hz. Distortion—0·1% at 1kHz: signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage—±16–50V.

Price £6·27 + 78p VAT. P. & P. free
HY5 mounting board B.1. 48p + 6p VAT. P. & P. free

HY30
15W into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit: low distortion: short, open and thermal protection: easy to build.
APPLICATIONS: updating audio equipment: guitar practice amplifier: test amplifier: audio oscillator.
SPECIFICATION: Output Power—15W R.M.S. into 8Ω. Distortion—0·1% at 15W. Input Sensitivity—500mV. Frequency Response—10Hz-16kHz −3dB.

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HY50
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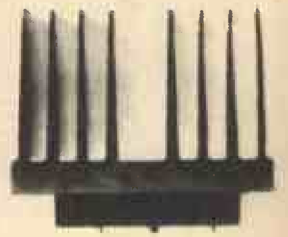
FEATURES: low distortion: integral heatsink: only five connections: 7 amp output transistors: no external components.
APPLICATIONS: medium power hi-fi systems: low power disco: guitar amplifier.
SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·04% at 25W at 1kHz. Signal/Noise Ratio—75dB. Frequency Response—10Hz-45kHz −3dB. Supply Voltage—±25V. Size—105 × 50 × 25mm.

Price £8·18 + £1·02 VAT. P. & P. free

HY120
60W into 8Ω



The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion: integral heatsink. load line protection: thermal protection: five connections: no external components.
APPLICATIONS: hi-fi. high quality disco. public address. monitor amplifier: guitar and organ.
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HY200
120W into 8Ω

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown: very low distortion: load line protection. integral heatsink: no external components.
APPLICATIONS: hi-fi: disco: monitor. power slave: industrial: public address.
SPECIFICATION: Input Sensitivity—500mV. Output Power—120W R.M.S. into 8Ω. Load Impedance—4–16Ω. Distortion—0·05% at 100W at 1kHz. Signal/Noise Ratio—96dB. Frequency Response—10Hz-45kHz −3dB. Supply Voltage—±45V. Size—114 × 50 × 85mm.

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HY400
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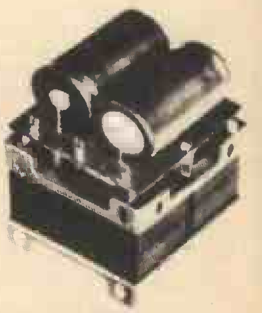

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: thermal shutdown: very low distortion: load line protection: no external components.
APPLICATIONS: public address: disco: power slave: industrial.
SPECIFICATION: Output Power—240W R.M.S. into 4Ω. Load Impedance—4–16Ω. Distortion—0·1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz-45kHz −3dB. Supply Voltage—±45V. Input Sensitivity—500mV. Size—114 × 100 × 85mm.

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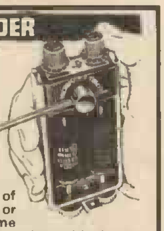

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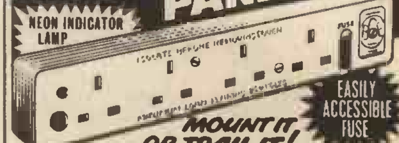

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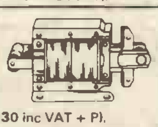

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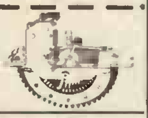

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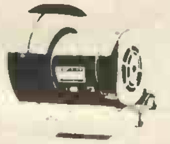

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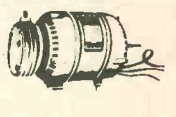

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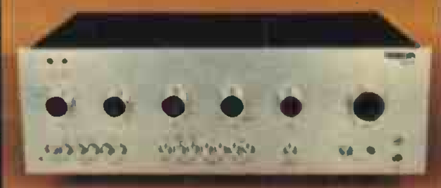

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