AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

MARCH 1986 £1.20

FREE PCB AND PROJECTS GALORE TO USE IT FOR

PLUS

- RS232 TO CENTRONICS CONVERSION
- DISPLAY TECHNOLOGY SHOWS ITS COLOURS
- EXPERIMENT WITH PROGRAMMABLE LOGIC

YOUR FREE PCB WORTH OVER £2

AUDI... MUSIC.... RADIO.... ROBOT...

OMP POWER AMPLIFIER MODULES

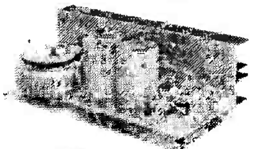
★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE S.A.E. 28p STAMP FOR CURRENT LIST

OMP POWER AMPLIFIER MODULES

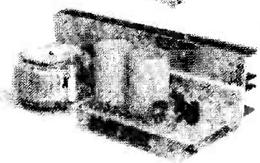
Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market, i.e. Industry, Leisure, Instrumental and Hi-Fi, etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B., and Drive circuits to power compatible Vu meter. Open and short circuit proof. **Supplied ready built and tested.**

OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115 × 65mm.
PRICE £33.99 + £3.00 P&P.

OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB, Size 300 × 123 × 60mm. PRICE
PRICE £39.99 + £3.00 P&P.

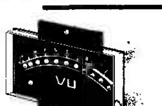


OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. —130dB, Size 300 × 150 × 100mm. PRICE
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE
PRICE £79.99 + £4.50 P&P.

NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV) If required, P.A. version (50KHz bandwidth & Input Sensitivity 775mV) Order — Standard or P.A.



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
PRICE £8.50 + 50p P&P.

BURGLAR ALARM

Better to be 'Alarmed' then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with inter-connection cable. **FULLY GUARANTEED.**

IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
Indoor alarm — Electronic swept freq. siren 104dB output.
Outdoor Alarm — Electronic swept freq. siren 98dB output. Housed in a tamper-proof heavy duty metal case.
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

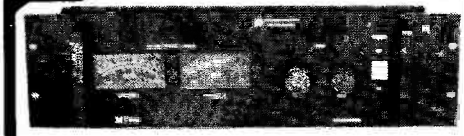
SAVE £138.00 Usual Price £228.85
BKE's PRICE £89.99 + £4.00 P&P
? Why buy a collection of self assembly boards!

OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full range 45Hz - 20KHz. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W. 1mtr. dB.

OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair.
Delivery Securicor £8.00 per pair

OMP 19" STEREO RACK AMPS



Professional 19" cased **Mos-Fet** stereo amps. Used the **World** over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4ohms). Input Sensitivity 775mV.

MF200 (100 + 100)W. £169.00 **Securicor**
MF400 (200 + 200)W. £228.85 **Delivery**
MF600 (300 + 300)W. £274.85 **£10.00**

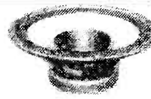
1 K-WATT SLIDE DIMMER

- ★ Control loads up to 1Kw
- ★ Compact Size $4\frac{3}{4}$" × 1" × $2\frac{1}{2}$"
- ★ Easy snap in fixing through panel cabinet cut out
- ★ Insulated plastic case
- ★ Full wave control using 8 amp triac
- ★ Conforms to BS800
- ★ Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £13.99 + 75p P&P

LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.

Cabinet Fixing in stock. Huge selection of **McKenzie Loudspeakers** available including Cabinet Plans. **Large** S.A.E. (28p) for free details.



POWER RANGE
8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. $1\frac{1}{2}$" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.
12" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 + £3.00 P&P ea.

McKENZIE
12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco.
2" ally voice coil. Ally centre dome. Res. Freq. 45Hz. Freq. Resp. to 6.5KHz. Sens. 98dB. PRICE £28.76 + £3.00 P&P ea.
12" 85 WATT R.M.S. C1285TC P.A./Disco 2" ally voice coil. Twin cone.
Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £29.80 + £3.00 P&P ea.
15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £54.99 + £4.00 P&P ea.
10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.
2" voice coil. Res. Freq. 75Hz. Freq. Resp. to 7.5KHz. Sens. 99dB. PRICE £19.15 + £2.00 P&P.
10" 200 WATT R.M.S. C10200GP Guitar, Keyboard, Disco.
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB. PRICE £51.00 + £3.00 P&P.
15" 200 WATT R.M.S. C15200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £59.45 + £4.00 P&P.
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £85.00 + £4.00 P&P.

WEM
5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £19.99 + £1.50 P&P ea.
8" 150 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £29.49 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
$1\frac{1}{2}$" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £33.49 + £2.00 P&P ea.
12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
$1\frac{1}{2}$" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £41.49 + £3.00 P&P ea.

SOUNDLAB (Full Range Twin Cone)
5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £9.99 + £1.00 P&P ea.
$6\frac{1}{2}$" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.
8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
$1\frac{1}{4}$" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
$1\frac{1}{4}$" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

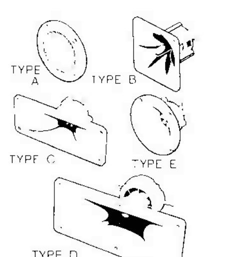
BSR P295 ELECTRONIC TURNTABLE

★ Electronic speed control 45 & $33\frac{1}{3}$ r.p.m. ★ Plus Minus variable pitch control ★ Belt driven ★ Aluminium platter with strobed rim ★ Cue lever ★ Anti-skate (bias device) ★ Adjustable counter balance ★ Manual arm ★ Standard $\frac{1}{2}$" cartrige fixings ★ Supplied complete with cut out template ★ D.C. Operation 9-14v D.C. 65mA
Price £36.99 — £3.00 P&P

ADC Q4 mag. cartridge for above. Price £4.99 ea. P&P 50p.

PIEZO ELECTRIC TWEETERS MOTOROLA

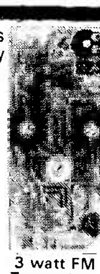
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £4.90 each + 40p P&P.
TYPE 'B' (KSN1005A) $3\frac{1}{2}$" super horn. For general purpose speakers, disco and P.A. systems etc. Price £5.99 each + 40p P&P.
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £6.99 each + 40p P&P.
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. Price £9.99 each + 40p P&P.
TYPE 'E' (KSN1038A) $3\frac{3}{4}$" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £5.99 each + 40p P&P.
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. Price £3.99 + 40p P&P.

PANTEC

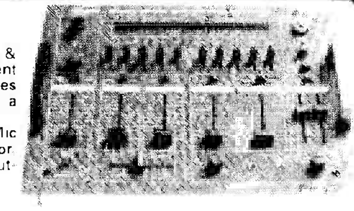
HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.



3 watt FM Transmitter

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt) **Price: £8.62 + 75p P&P.**
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) **Price: £14.49 + 75p P&P.**
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £17.82** Transmitter 80 × 50 × 15mm (9/12 volt). **Price: £11.29** P&P + 75p each. S.A.E. for complete list.

STEREO DISCO MIXER



STEREO DISCO MIXER with 2 × 5 band L. & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. Many outstanding features 5 Inputs with individual faders providing a useful combination of the following:— 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot. L. & R. Master Output controls. Output 775mV. Size 360 × 280 × 90mm
Price £134.99 — £3.00 P&P

VISA

POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME, SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED

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electronics today INTERNATIONAL

MARCH 1986 VOL 15 NO 2

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PUBLISHED BY:
Argus Specialist Publications Ltd.,
1 Golden Square, London W1R 3AB.
DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.,
12-18 Paul Street, London EC2A 4JS
(British Isles)
PRINTED BY:
The Garden City Press Ltd.
COVERS DESIGNED BY:
Argus Press Design.
COVERS PRINTED BY:
Alabaster Passmore.

ABC Member of the Audit Bureau of Circulation

Electronics Today is normally published on the first Friday in the month preceding cover date.

■ Subscription Rates. UK: £18.10. Overseas: £22.50. USA: $29.50. Airmail: £49.50.

EDITORIAL AND ADVERTISEMENT OFFICE
1 Golden Square, London W1R 3AB. Telephone 01-437 0626.
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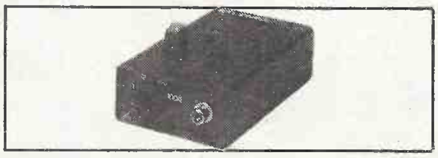
FEATURES

PROJECTS



ETCETERA

INFORMATION

SWITCHES
TOGGLE 2A 250V
SPST 35p DPDT 48p
SUB-MIN TOGGLE
SPST on off 58p
SPDT c over 64p
SPDT centre off 85p
SPDT biased both ways 105p
DPDT 6 tags 80p
DPDT centre off 88p
DPDT biased both ways 145p
DPDT 3 positions on on on 185p
4-pole 2 way 220p

SLIDE 250V:
DPDT 1A 14p
DPDT 1A c/off 15p
DPDT ½A 13p

PUSHBUTTON 6A
with 10mm Button
SPDT latching 150p
DPDT latching 200p
DPDT moment 200p

Mini Non Locking
Push to Make 15p
Push to Break 25p

DIGITAST Switch
Assorted Colours
75p each

ULTRASONIC TRANSDUCERS
40 Khz 475p

GAS/SMOKE DETECTORS
TGS812 or TGS813
£6 each
Holders for above 40p

DIP SWITCHES
(SPST) 4 way 65p; 6 way 80p; 8 way 85p; 10 way 125p (SPDT) 4 way 190p

ROTARY SWITCHES
(Adjustable Stop type)
1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way 48p

ROTARY: Mains DP 250V 4 Amp on/off 88p

ROTARY: (Make-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only 90p

WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 Way 65p
Mains DP 4A Switch to fit 45p
Spacers 4p. Screen 6p.

ROCKER SWITCHES
ROCKER: 5A/250V SPST 28p
ROCKER: 10A/250V SPDT 38p
ROCKER: 10A/250V DPDT c/off 95p
ROCKER: 10A/250V DPST with neon 85p

THUMBWHEEL Mini front mounting switches
Decade Switch Module 275p
B.C.D. Switch Module 298p
Mounting Cheeks (per pair) 75p

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
36 inches	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36

	20pin	26 pin	34 pin	40 pin
Single ended	160p	200p	260p	300p
Double ended	290p	370p	480p	525p

VEROBOARD 0.1in
2½ x 3¼ 95p
2½ x 5 110p
3¾ x 3¾ 110p
3¾ x 5 125p
3¾ x 17 420p
4¾ x 17 590p
VQ Board 195p
DIP Board 395p
Vero Strip 95p

VERO PINS per 100
Single ended 55p
Double ended 60p
Wire wrape S/E 155p
Wire wrape D/E 255p

VERO WIRING PEN
Pen + Spool 380p
Spare spool 75p
Combs 8p

Combs 8p
Pen + Spools + Combe 599p

PROTO DECs
Veroblock 480p
S-Dec 395p
Eurobreadboard 590p
Bimboard 1 575p
Superstrip SS2 1350p

VERO TOOLS
Spot face cutters 150p
Pin Insertion 185p

FERRIC CHLORIDE
1 lb bag Anhydrous 125p + 50p p&p

DALO ETCH RESIST PEN
Plus spare tip 100p

COPPER CLAD BOARDS

	Single-sided	Double sided
Fibre glass 6" x 6"	100p	125p
6" x 12"	175p	225p

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	20p
14 pin	10p	28p
16 pin	10p	40p
18 pin	16p	40p
20 pin	20p	58p
22 pin	22p	60p
24 pin	25p	68p
28 pin	28p	78p
40 pin	30p	89p

EDGE CONNECTORS

	.1"	.156"
2x6 way	—	75p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	175p	180p
2x22 way	200p	170p
2x23 way	150p	—
2x25 way	250p	245p
2x28 way	180p	—
2x30 way	280p	—
2x36 way	300p	—
2x40 way	320p	—
2x43 way	400p	—
2x75 way	600p	—

SIL SOCKET 0.1" Pitch 20 way 65p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	65p	65p	65p	100p
16 way	75p	75p	80p	—
20 way	90p	90p	95p	185p
26 way	105p	110p	115p	230p
34 way	115p	130p	135p	320p
40 way	140p	145p	150p	335p
50 way	165p	170p	175p	350p
60 way	195p	210p	225p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	125p	—	—	175p
DIN41612 2 x 32 A + B	200p	—	175p	185p
DIN41612 2 x 32 A + C	225p	—	185p	210p
DIN41612 3 x 32 A + B + C	280p	290p	295p	300p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	95p
16 pin	45p	100p
24 pin	85p	135p
28 pin	150p	200p
40 pin	200p	255p

ZIF TEXTOOL DIL SOCKETS
24 pin 550p
28 pin 650p
40 pin 800p

RIBBON CABLE
price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
28 way	55p	80p
34 way	60p	85p
40 way	70p	90p
50 way	100p	135p
64 way	120p	160p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	160p	250p
Female				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	260p	390p
PCB pins	100p	125p	195p	355p
Covers	75p	70p	70p	85p

IDC 25 way 'D' Plug 385p; Socket 450p

25 way 'D' CONNECTOR (RS232)
Jumper Lead Cable Assembly
18" long, Single end, Male 475p
18" long, Single end, Female 510p
36" long, Double Ended, M/M 995p
36" long, Double Ended, F/F £10
36" long, Double Ended, M/F 995p

AMPHENOL CONNECTORS

	IDC	SOLDER
24 way IEEE plug	465p	480p
24 way IEEE skt	485p	480p
36 way Centronics plug	375p	390p
36 way Centronics skt	480p	450p

PANEL METERS
FSD
60 x 46 x 35mm
0–50μA
0–100μA
0–500μA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0–1A
0–2A
0–25V
0–50V
0–300V AC 520p

CRYSTALS

32.768KHz	100
100KHz	400
200KHz	370
455KH	370
1MHz	265
1.008M	275
1.28MHz	450
1.6MHz	200
1.8MHz	545
1.8432M	2)0
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	95
3.6864M	300
4.0MHz	140
4.032MHz	290
4.19430M	150
4.433619M	100
4.608MHz	200
4.80MHz	150
5.0MHz	150
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	175
7.7328MHz	250
7.68MHz	200
8.0MHz	140
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	170
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	155
16.0MHz	200
18.0MHz	150
18.432M	150
19.968MHz	150
20.0MHz	150
24.0MHz	150
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295

RELAYS
Miniature, enclosed, PCB mount.

SINGLE POLE Changeover
RL-91 205R Coil; 12V DC (10V5 to 19.5V), 10A at 30V DC or 250VAC 195p

DOUBLE POLE Changeover, 6A 30V DC or 250V AC
RL-113 53R Coil, 6V DC (5V4 to 9V9) 190p
RL6-111 205R Coil, 12V DC (10V7 to 19V5) 195p
RL6-114 740R Coil, 24V DC (22V to 37V) 200p

ASTEC UHF MODULATORS
Standard 6MHz 375p
Wideband 8MHz 550p

BUZZERS
miniature, solid-state 6V; 9V & 12V 70p
PIEZO TRANSDUCERS PB2720 70p

LOUDSPEAKERS
Miniature, 0.3W- 8
2in, 3¼in, 2½in, 3in 80p
2½in 40Ω, 64Ω or 80Ω 80p
6" x 4" 8Ω 200p
7" x 5" 8Ω 225p
8" x 5" 8Ω 250p

MONITORS
- ZENITH — 12" Green, Hi-Resolution Popular £70
- MICROVITEC 1431. Standard Res. Colour RGB input 14" incl cable £179
- MICROVITEC 1451. 14" Medium resolution £229
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc £225 (car £7)
- KAGA 12". As above but Hi-Resolution £310 (car £7)
- Connecting Lead for KAGA £3

Carriage £7 Securicor

BT TELEPHONE CONNECTOR

LJU 1/4A	Mini Line Master	435p
LJU 1/6A	Mini Line Slave	295p
LJU 2/4A	Line Master	370p
LJU 2/6A	Line Slave	250p
LJU 3/4A	Flush Master	370p
LJU 3/6A	Flush Slave	240p
LJU 10/3A	Dual Splitter	550p
4 WAYBT Plug		65p

TRANSFORMERS
3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA 130p
PCB mounting, Miniature, Split bobbin
3VA: 2x6V/0.25A; 2x9V/0.15A; 2x12V/0.12A; 2x15V/0.2A 235p
6VA: 2x6V/0.5A; 2x9V/0.3A; 2x12V/0.25A; 2x15V/0.2A 280p
Standard Split Bobbin type:
6VA: 2x6V/0.5A; 2x9V/0.4A; 2x12V/0.3A; 2x15V/0.25A 250p
12VA: 2x4.5V/1A3; 2x5V-1A; 2x9V/0.6A; 2x12V/0.5A; 2x15V-0.4A; 2x20V/0.3A 345p (35p p&p)
24VA: 2x6V/1.5A; 2x9V/1.2A; 2x12V/1A; 2x15V/0.8A; 2x20V/0.6A 385p (60p p&p)
50VA: 2x6V/4A; 2x9V/2.5A; 2x12V/2A; 2x15V/1.5A; 2x20V/1.2A; 2x25V/1A; 2x30V/0.8A 520p (60p p&p)
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A 620p (60p p&p)
100VA: 2x12V/4A; 2x15V/3A; 2x20V/2.5A; 2x25V/2A, 2x30V/1.5A; 2x50V/1A 955p (75p)
P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS
1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	45p	7905	50p
12V	7812	45p	7908	50p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	45p	7918	50p
			7924	50p

100mA TO92 Plastic package

5V	78L05	30p	79L05	45p
6V	78L06	30p	—	—
8V	78L08	30p	—	—
12V	78L12	30p	79L12	45p
15V	78L15	50p	79L15	45p

ICL7660	245p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	TL497A	185p
LM309K	135p	78H05 + 5V/5V	550p
		78H12+12V/5A	695p
LM317K	250p		
LM317KP	450p	78HG+5V to +25V/5V 5A	550p
LM323K	450p		
LM337	175p	79HG-5V to-24V/5A	785p
LM723 Var	30p		
78S40	225p		

ANTEX SOLDERING IRONS

C15W	600p	CS17W	620p
C18W	620p	XS25W	650p
Spare Bits	85p	Elements	230p
Iron Stand	175p	Heat Shunt	30p

SOLDERCON PINS
Ideal for making SIL or DIL Sockets
100 pins 45p
500 pins 195p

ALUM BOXES

3 x 2 x 1"	85p
4 x 2½ x 2"	100p
4 x 2½ x 2½"	103p
4 x 4 x 2"	105p
4 x 4 x 2½"	120p
5 x 4 x 1½"	99p
5 x 4 x 2½"	120p
5 x 2¾ x 1½"	90p
5 x 2¾ x 2½"	130p
6 x 4 x 2"	120p
6 x 4 x 3"	150p
7 x 5 x 3"	180p
8 x 6 x 3"	210p
10 x 4 x 3"	240p
10 x 7 x 3"	275p
12 x 5 x 3"	280p
12 x 8 x 3"	295p

CMOS

4000	20
4001	20
4002	20
4006	70
4007	25
4008	60
4009	40
4010	40
4011	20
4012	20
4013	30
4014	50
4015	40
4016	25
4017	45
4018	55
4019	35
4020	50
4021	55
4022	60
4023	20
4024	35
4025	20
4026	90
4027	30
4028	40
4029	45
4030	20
4031	125
4032	65
4033	130
4034	145
4035	70
4036	250
4037	115
4038	75
4039	270
4040	45
4041	55
4042	45
4043	45
4044	50
4045	110
4046	60
4047	50
4048	50
4049	25
4050	25
4051	50
4052	50
4053	60
4054	70
4055	70
4056	85
4057	1000
4059	400
4060	70
4061	500
4062	986
4063	80
4066	25
4067	230
4068	20
4069	20
4070	25
4071	20
4072	20
4073	20

4075	25
4076	60
4077	25
4078	25
4081	20
4082	20
4085	60
4086	60
4089	120
4093	25
4094	70
4095	70
4096	100
4097	260
4098	70
4099	110
4160	95
4161	96
4162	96
4163	96
4174	96
4175	105
4194	105
4408	850
4409	850
4410	725
4411	750
4412	805
4415	590
4419	260
4422	770
4435	850
4440	900
4450	350
4451	350
4490	450
4500	395
4501	40
4502	90
4503	45
4504	100
4505	350
4506	100
4507	45
4508	130
4510	55
4511	55
4512	55
4513	150
4514	115
4515	115
4516	50
4517	275
4518	50
4519	35
4520	50
4521	110
4522	125
4526	70
4527	60
4528	45
4529	80
4530	90
4531	120
4532	65
4534	365
4536	250
4538	70
4539	80
4541	95

4543	65
4548	40
4549	390
4553	210
4554	180
4555	50
4556	50
4557	250
4558	120
4559	340
4560	110
4561	104
4562	350
4566	160
4568	250
4569	175
4572	45
4580	255
4581	125
4582	99
4583	100
4584	40
4585	65
4597	330
4599	155
40085	90
40097	45
40098	42
40100	215
40101	130
40102	140
40103	412
40104	120
40105	220
40106	40
40107	55
40108	325
40109	100
40110	235
40114	240
40161	194
40163	75
40173	100
40174	75
40175	75
40181	220
40182	80
40192	75
40193	90
40194	70
40195	75
40244	196
40245	196
40257	196
40373	220
40374	220
45106	588

OPTO

OCP71	120
ORP12	85
ORP61	88
BPX25	250
BPW21	320
TIL139	225

OPTO ELECTRONICS

LEDs with clips
TIL209 10
TIL211 GRN 14
TIL212 Yel. 14
TIL220 2" Red 12
2" Green, Yellow or Amber 14
0.2" Bi colour Red/Green 100p
Green/Yellow 115p
0.2" Tri colour Red/Green/Yellow 85
Hi-Brightness Red 58
High-Bri Green or Yel 68
Flashing red 0.2" red 55
Square LEDs. Red, Green, Yellow 30
Rectangle Stackable LEDs
Red, Green or Yellow 18
Triangular LEDs Red 18
Green or yellow 22
LD271 Infra Red 48
SFH205 Detector 118
TIL32 Infra Red 52
TIL78 Detector 55
TIL38 50
TIL100 75
BARGRAPH, Red 10 segments 275

ISOLATORS
IL74 75
ILD74 145
ILQ74 275
TIL111/2/4 70
ILCT6 Darlington 135
TIL117 125
4N33 Photo Darlington 136

7 Segment Displays
TIL312 .3" CA 120
TIL313 .3" CC 120
TIL321 .5" CA 140
TIL322 .5" CC 140
TIL729/730 140
DL704 .3" CC 125
DL707 .3" CA 125
FND357 Red 120
FND500 130
.3" Green CA 150
.6" Green CA 215
.3" ± 1 Red CA 150
.3" ± 1 Green CA 150
LCD 3½ Digits 496
LCD 4 Digits 530
LCD 6 Digits 625
Reflective Switch 225
SLOTTED Optical Switch similar to RS Comp's 295

TURNED PIN Low Profile
Professional DIL SOCKETS

8 pin	18p
14 pin	23p
16 pin	28p
18 pin	33p
20 pin	37p
22 pin	39p
24 pin	42p
28 pin	52p
40 pin	72p

SPECIAL OFFER

	1+	10+
2764-250nS	195p	185p
27128-250nS	295p	285p
6116LP-3	185p	150p
6264LP-150nS	395p	385p

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- EPSON FX80 Printer £265
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- EPSON LX80 Printer £210
- CENTRONICS (NLQ) Printer £99
- KAGA/TAXAN KP810 Printer £199
- KAGA/TAXAN KP910 Printer £335
- BROTHER HR15 Daisywheel £315

Cable for above printers to interface with BBC Micro £7

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(All Drives are supplied cased with Power Supply and Utilities Disc

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- **CD400** — Epson dual 400K, 40 track, Double sided £140
- **CD800S** — Mitsubishi dual 800K, Double sided 40/80 track switchable £179
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The only professional Disc Interface for the Spectrum Micro.

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BBC model B Plus, Watford DDFS+ upgrade, Wordwise Rom, Twin 800K Mitsubishi drives in beige, Zenith 12" Hi-res. monitor (Green), Brother HR15 daisywheel printer, Database & Spreadsheet software, 10 Discs, 500 sheets fan-fold paper, 4 way mains trailing sockets, manuals, leads & a carrying for the BBC.

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DIGEST

Acorn Masters Some New Tricks

The continuing association between Acorn Computers Ltd and the BBC has been reinforced with the introduction of a new range of microcomputers called the Master Series.

Said to have been developed as a result of feedback from users of Acorn's BBC B microcomputer, the main machines in the new range are fully compatible with existing software and peripherals yet differ markedly from both the original BBC B and the recent B+ 128.

The foundation of the new range is the Master 128, an 8-bit, 65C12-based machine with 128K of RAM. It incorporates all the features of the BBC B plus a battery backed-up real time clock, improved graphics, and a suite of on-board software.

An internal expansion slot allows the Master 128 to be upgraded by the addition of a co-processor board. By adding a 65C102 processor board the 128 becomes the Master Turbo, an 8-bit machine which offers an extra 64K of memory and increased speed. Acorn say the Master Turbo beats all records for BASIC interpreting that they are aware of.

Adding an 80186 co-processor board to the Master 128 produces the Master 512, a sixteen bit machine with 512K of RAM which uses Digital Research's DOS-plus operating system to enable it to run MS-DOS software. This makes it compatible with a wide range of commercial and professional software. It also comes complete with an Acorn mouse and Digital Research's GEM software including Gem Desk Top, Gem paint and Gem Write.

The top machine in the range is the Master Scientific which uses a 32016 co-processor board running at 8MHz. This provides 32-bit processing with 1Mbyte of RAM and hardware floating point support. It can handle a wide range of languages used in the engineering and scientific fields including Fortran 77, C, ISO Pascal and many others as well as BASIC.

The final member of the new range is the Master Econet Terminal, a modified version of the Master 128 which includes an Econet interface and the new Advanced Network Filing System. It excludes some of the features of the 128 which are not required on an Econet system and therefore costs about £100.00 less. Those who require full facilities plus Econet working can add an Econet upgrade board to the Master 128.

The external styling of the Master series is similar to that of the BBC B but the case is about 125mm (5") wider and is stepped so that the keyboard is lower than the rest of the case. The BBC B keyboard layout has been retained complete with ten function keys but a 20-key numeric pad has been added to the right of the main keybaord and the BREAK key incorporates a screwdriver lock to prevent accidental operation.

Two sockets are provided which will accept Electron-style ROM cartridges of up to 256K and there are also three internal ROM expansion sockets, one of which takes 128K ROMS while the other two will accept 128K or 256K ROMs. In addition to the internal TUBE connection used for the upgrade boards there is also an external TUBE socket. This will allow the connection of second processors other than those on the upgrade boards, for example, one of the existing Z80 second processors. All of the other connections present on the BBC B and B+ are included and there is also a new audio output socket.

The suite of on-board software includes a VIEW-3 wordprocessor package, a VIEWSHEET spreadsheet and BASIC 4, an enhanced version of the BBC BASIC programming language. New graphics commands extend the range of facilities available on the BBC B to include colour mixing and allow easier and faster graphics development and manipulation. 50 bytes of battery backed-up CMOS RAM is also provided, allowing power-up default conditions to be defined in a rather more comprehensive fashion than was possible using the keyboard links on the BBC B.

The Master 128 is available now and costs £499.00 including VAT. The Econet upgrade board for the 128 is also available now and costs £49.99 inclusive. The Master Econet Terminal should be available by the time you read this at a cost of £399.00 along with the Master Turbo upgrade board which will cost £125.00, both prices inclusive of VAT. The Master 512 upgrade board and the Master Scientific upgrade board will both become available during the second quarter of 1986 at prices which have yet to be announced.

Acorn Computers Ltd, Cambridge Technopark, 645 Newmarket Road, Cambridge CB5 8PD, tel 0223-214411.

The Newrad Case

Those who have followed the saga of Newrad Intstrument Cases Ltd will be interested to learn that the Sheriff of the High Court has taken walking posession of the company's assets.

Whilst this does not mean that the company has gone into liquidation it does imply that Newrad will not be able to fulfil orders or make refunds in respect of orders already placed.

Under no circumstances should any further orders be placed with Newrad, nor should any money be sent to them for any other reason.

Unfortunately, it seems unlikely that those who have orders outstanding with Newrad will get either their goods or their money back. Readers who find themselves in this position are invited to contact us so that we can keep them informed should circumstances change.

Those who have ordered kits for the John Linsley Hood Audio Design amplifier from Newrad and have not received all of the parts may like to know that Hart Electronic Kits can supply the MOSFET transistors required. Their address is Penylan Mill, Oswestry, Shropshire SY10 9AF, tel 0691-652 894. None of the other components specified should prove difficult to obtain. The cases shown in the illustrations in the article were made by Newrad and are therefore no longer available, but cases with similar dimensions can be obtained from a number of suppliers and should prove an acceptable alternative.

The printed circuit boards for the amplifiers have hitherto been available only from Newrad but we will shortly be able to supply them through our own PCB Service. We hope to include prices next month. Meanwhile, the complete series of articles has been reprinted in the Winter, 1985/6, issue of Electronics Digest and the boards can be obtained from them.

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4164 200ns D RAMS 8 for **£14.95** **4116** 300 ns **£1.50** **2112** £10.00 **2114** £2.50 **2102** £2.00 **6116** £2.50 **EPROMS** 2716 £4.50 **2732** £3.00 **2764** £4.95 **27128** £5.50 **6800** £2.50 **6821** £1.00 **68A09** £8.00 **6809** £10.00 **8085** £5.50 **8086** £15.00 **8251** £7.00 **8748** £15.00.

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ON LINE NOW. CCITT, 8 bit word, no parity.
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PRINTER / TERMINAL SCOOP

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carriage on 5¼" drives **£5.50**
Brand **NEW** metal cases with internal PSU etc for above drives, below cost!!!
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8" Refurbished standard units.
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TWIN SUGART 851's in smart case, complete with PSU etc, £595.00
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Hard Disk Drives
DRE/DIABLO Series 30 2.5 Mb front load, **£525.00**, Exchangeable version £295.00
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Ex **BRITISH TELECOM** full spec, CCITT, ruggedised, bargain offers. Sold **TESTED** with data. Will work on any **MICRO** or system with **RS232** interface.
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DATEL 2412 Made by SE labs for BT this two part unit is for **synchronious** data links at 1200 or 2400 baud using **2780/3780** protocol etc. Many features include 2 or 4 wire working, self test, auto answer etc.
COST OVER £800 Our price **ONLY £199** + pp £8.00
DATEL 4800, RACAL MPS4800 baud modem, EX BT good working order, **ONLY £295.00** + pp £8.00
SUMMER OFFER
MODEM TG2393. Ex BT, Up to 1200 baud, full duplex over 4 wire or half duplex over 2 wire line. **ONLY £85.00 PER PAIR** + pp £10.00
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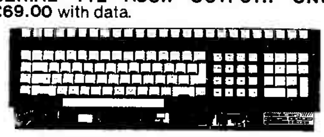


Carriage on all Keyboards £3.50

PLESSEY VUTEL

Manufactured by **PLESSEY** Ltd this compact unit, only slightly larger than a telephone, features an all in one **TELEPHONE**, 24 x 40 character CRT screen, **VIEWDATA – PRESTEL** modem, Keypad and electronics to run as a fully fledged **PRESTEL** terminal or telephone. Ready to plug direct into a BT 600 type jack socket and instantly connect you to **PRESTEL** etc. Many other features include Memory dialling, Recall button, Off line screen data storage, Picture expand, Standard Mullard **LUCY** chip set, Integral 5" JVC crt monitor, etc etc. Designed to sell to the **EXECUTIVE** at over £600!! But from **DISPLAY, BRAND NEW AND BOXED** at only £99.00 for **DTMF** tone dial or **£140.00** for standard **DIAL PULSE** version. Carr. £8.00.

COLOUR AND MONOCHROME MONITOR SPECIALS

'SYSTEM ALPHA' 14" COLOUR MULTI INPUT MONITOR
made in the UK by the famous **REDIFFUSION Co.** for their own professional computer system this monitor has all the features to suit your immediate and future monitor requirements. Two video inputs: **RGB** and **PAL** Composite Video, allow direct connection to the **BBC** and most other makes of micro computers and **VCR's**. An internal speaker and audio amplifier may be connected to your systems output or direct to a VCR machine, giving superior sound quality. Many other features included PIL tube, Matching **BBC** case colour, Major controls on front panel, Separate Contrast and Brightness – even in **RGB** mode, Two types of audio input, Separate Colour and audio controls for Composite Video input, **BNC** plug for composite input, 15 way 'D' plug for **RGB** input, modular construction etc etc.
This Must be **ONE OF THE YEAR'S BEST BUYS**
Supplied **BRAND NEW** and **BOXED**, complete with DATA and 90 day guarantee.
SUPPLIED BELOW ACTUAL COST – ONLY £149.00

DECCA 80 16" COLOUR monitor. RGB input.
Little or hardly used manufacturer's surplus enables us to offer this special converted **DECCA RGB** Colour Video TV Monitor at a super low price of only **£99.00**, a price for a colour monitor as yet unheard of!! Our own interface, safety modification and special 16" high definition **PIL** tube, coupled with the tried and tested **DECCA 80** series TV chassis gives 80 column definition and picture quality found only on monitors costing **3 TIMES OUR PRICE**. In fact, **WE GUARANTEE** you will be delighted with this product, the quality for the price, has to be seen to be believed. Supplied complete and ready to plug direct to a **BBC MICRO** computer or any other system with a **TTL RGB** output. Other features are: internal speaker, Modular construction, auto degaussing circuit, Attractive **TEAK CASE**, compact dimensions only 52cm W x 34 H x 24 D, 90 day guarantee. Although used, units are supplied in **EXCELLENT** condition, **ONLY £99.00** + Carr.
DECCA 80, 16" COLOUR monitor. Compositve video input. Same as above model but fitted with Composite Video input and audio amp for **COMPUTER**, VCR or **AUDIO VISUAL** use. **ONLY £99.00** + Carr.
REDIFFUSION MARK 3, 20" Colour monitor. Fitted with standard 75 ohm composite video input and sound amp. This large screen colour display is ideal for shops, schools, clubs and other **AUDIO VISUAL** applications. Supplied in AS NEW or little used condition **ONLY £145.00** + Carr.

BUDGET RANGE EX EQUIPMENT MONOCHROME video monitors.
All units are fully cased and set for 240v standard working with composite video inputs. Units are pre tested and set up for **80** column use on **BBC** micro etc. Even when **MINOR** screen burns exist – normal data displays are unaffected.
12" KGM 320-1 B/W high bandwidth input, will display up to 132 x 25 lines. **£32.95**
12" GREEN SCREEN version of **KGM 320-1** Only **£39.95**
9" KGM 324 GREEN SCREEN fully cased very compact unit Only **£55.00**
9" HITACHI VM-906E/K Black and White screen **£49.95**
Carriage and insurance on all monitors **£10.00**

D.C. POWER SUPPLY SPECIALS

GOULD OF443 enclosed, compact switch mode supply with DC regulated outputs of +5v @ 5.5a, +12v @ 0.5a, −12v @ 0.1a and −23v @ 0.02a. Dim 18 x 11 x 6 cm. 110 or 240v input. **BRAND NEW** only **£14.95**
GOULD G6-40A 5v 40 amp switch mode supply NEW £130.00
GREENDALE 19A-BOE Switch mode 60 watt open PCB with a fully regulated DC output of 5v @ 6 amps, and three semi regulated outputs of +12V, −12V +15V @ upto 1 amp. Dim only 11 cm x 20 cm x 5.5 cm. Similar to RS 591-994. 110 or 240v AC input. **TESTED** ex equipment. **Only £24.95**
AC-DC Linear **PSU** for **DISK** drive and **SYSTEM** applications. Constructed on a rugged ALLOY chassis to continuously supply fully regulated DC outputs of +5V @ 3 amps, −5V @ 0.6 amps and +24v @ 5 amps. Short circuit and overvoltage protected. 110 or 240 V AC input. Dim 28 x 12.5 x 7 cm **NEW £49.95.**
Carriage on PSU's £3.00

SPECIAL 300 BAUD MODEM OFFER

Another **GIGANTIC** purchase of these **EX BRITISH TELECOM, BRAND NEW** or little used 2B data modems allows US to make the **FINAL REDUCTION**, and for **YOU** to join the exciting world of data communications at an **UNHEARD OF PRICE OF ONLY £29.95**. Made to the highest **POST OFFICE APPROVED** spec at a cost of hundreds of pounds each, the 2B has all the standard requirements for data base, business or hobby communications. All this and more!!

- 300 baud full duplex
- Full remote control
- CCITT tone standards
- Supplied with full data
- Modular construction
- Direct isolated connection
- CALL, ANSWER and AUTO modes
- Standard RS232 serial interface
- Built in test switching
- 240v Mains operation
- 1 year full guarantee
- Just 2 wires to comms. line

NOW ONLY £29.95

BT 600 Jack plug and cable £2.25 Carriage and Ins. £10.00

VDU TERMINALS

Standard VDU data entry terminals at give away prices!!
QUME QVT108. Current product, state of the art terminal with detachable keyboard, 12" green screen, 2 page RAM, **TVI 925** emulation, 25 x 80, Clock, Swivel and tilt base, Printer port, Function keys etc. **BRAND NEW** and BOXED AT ALMOST **HALF PRICE** Only **£425.00**
AJ510 – EX RENTAL, Z80 controlled, 15" green screen 24 x 80 display, graphics, cursor addressing, printer port etc. Very good condition **TESTED** complete with manual only £225.00.
ADDS 520 – Dumb terminal, used, 12" b/w screen RS232 interface and printer port. **TESTED. ONLY £125.00**
Carriage on terminals £10.00
100's of other terminals in stock,
CALL for more details.

DISPLAY ELECTRONICS

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value ***£2.00.*** Minimum Credit Card order ***£10.00.*** Minimum BONA FIDE account orders from Government Depts., Schools, Universities and established companies ***£20.00.*** Where post and packing not indicated please ADD £1.00 + VAT. Warehouse open Mon-Fri 9.30-5.30. Sat 10.30-5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 894502 Data 01-679 1888

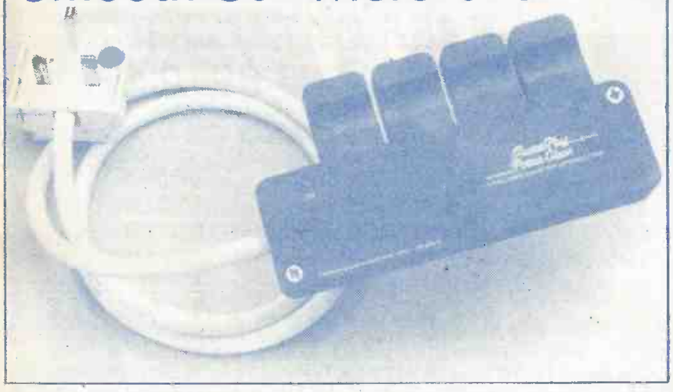
GrunDig For Victory

As part of the efforts by the new Grundig management to revive the company's flagging fortunes, a new range of video products has been announced.

The VS380 hi-fi stereo video recorder has reached the market after some delay. Like its smaller sister, the mono VS310, the 380 is a VHS machine offering 40 channels and up to ten pre-programmable events. The usual advanced features are included, and the 380 alkso offers 'long play' which doubles effective tape time to 8 hours. Both machines feature the new Auto Tape Time Select (ATTS) tape counter system which measures the exit and entry angles of the tape from and to its cassette and uses a microprocessor to calculate and display tape time used and remaining.

As if to demonstrate their firm committment to the VHS system, Grundig have also released their first VHS camcorder, the VS150, which uses standard cassettes and features autofocus, 6:1 motor zoom, electronic assemble editing and record review. The VS150 weighs 2.5kg, without its accumulator and sells for around £1350. The VS310 is priced at around £440 and the VS380 at around £650.

Smooth Con Merchants



A Welsh company, Conblock Electrical, are supplying a four outlet, domestic mains filter for use with home computer systems. The unit plugs into a standard 13A socket and is rated at 6A maximum.

Attractively styled in grey moulded polycarbonate, the Smoothline costs 'no more than a couple of computer games,' say Conblock, 'and allows the enthusiasts to almost totally eliminate system problems caused by interference transmitted via the mains supply.'

The unit is supplied complete with mains lead, mains plug and four miniature plugs for connections to a computer and various peripherals.

Contact: Conblock Electrical Ltd., Mochdre Industrial Estate, Newtown, Powys SY16 4LF (tel: 0686-27100).

EPSON-Line

Purchasers of new Epson computers and printers will receive free membership of EpsonLink, an electronic mail service run on Telecom Gold. EpsonLink promises next-day delivery anywhere in the UK or USA and also allows users to transmit to any Telex terminal in the World without Telex equipment. The system also allows users to receive information from several databases not subscribed to directly. It is aimed particularly at the users of portable computers, which Epson specialise in.

Not Disc-ontinued

Way back in our January 1986 issue (you know, the one that came out in December 1985) we offered a twin 3½in disc drive unit in conjunction with Watford Electronics at a special price.

Unfortunately, our February 1986 issue (which should come out in January but is printed in December to avoid the Christmas holidays) was distributed almost as soon as it was printed, appearing on some news-stands as early as the 19th December. As a result, the January issue (which comes out in December, remember) was on sale for less than two weeks and many people missed it (if all this sounds confusing to you, think how much worse it is for us as we sit here, in January, writing the March issue (which comes out in Feburary,) and planning the April issue).

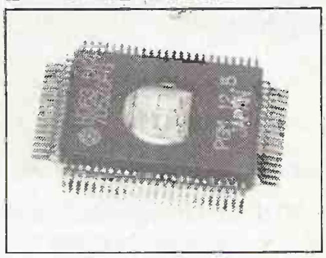
Because so many people missed the January issue, we have decided to extend the period for which the Watford disc drive offer is available.

The unit consists of two 3½" 80 track, double-sided, double density disc drives in a steel case which is coloured and styled to match the BBC microcomputer. The disc drives will work with other machines, of course, but they are provided with leads ready for direct connection to a BBC and come with a free utility disc containing a game for the BBC. The capacity of the drives is two megabytes total unformatted which represents 327K per side formatted.

The cost of the twin disc drive unit is £140.00 plus VAT, a total of £161.00. Postage and packing is included in this price. Cheques should be made payable to Watford Electronics and sent to us at the address on the contents page. Please mark envelopes ETI(DD) to ensure prompt attention.

Be A PAL

Copies of the latest edition of the Monolith Memories Programmable Logic Handbook are available free from MMI. The catalogue includes PAL and Programmable Logic Elements applications and data sheets and a number of technical articles that might be of interest. The catalogue can be obtained from Monolith Memories Ltd., Monolithic House, 1 Queens Road, Farnborough, Hants. GU14 6DJ (tel: 0252-517431).



SeePROM

The latest addition to Hitachi's growing range of CMOS microcomputer chips is a single-chip device including an 8-bit microprocessor, 8k of EPROM and an 8 channel by 8-bit ADC on board. Hitachi say that the HD63705Z also features a serial communications interface, 8 parallel I/O lines and 8 interrupt lines. The chip is supplied in an 80-pin flat-pack for surface mounting and, in one version, includes a window for UV erasing.

Further details from Hitachi Electronic Components (UK) Ltd., Hitec House, 221-225 Station Road, Harrow, Middlesex HA1 2XL (tel: 01-861 1414).

- *Caddis Systems have been appointed distributors for RETEX enclosures The range includes a variety of styles and sizes including the ABOX (ABS enclosure with sloping anodised aluminium front panel, taking standard Eurocards), the ELBOX (ABS with a steel sub-frame and slope-back feet) and SOLBOX-2 (steel enclosure with aluminium front panel, optional handled, louvred ventilation and slope-back feet). Caddis can be contained at 5 Keats Close, Maldon, Essex, CM9 6DB (tel: 0621 55116).*

- **Marco Trading have produced a component catalogue for 1986 which includes a reasonable range of items, some at notably low price. The catalogue comes complete with a six page special offer list and a 50p credit note. It costs £1.00 from Marco Trading, The Maltings, High Street, Wem, Shropsshire SY4 5EN (tel: 0939 32763).**

DIARY

Electronics In Oil and Gas — February 4-6th
Barbican, London. See November '85 ETI or contact Cahners at the address below.

Intellectual Property and Patents — February 18th
Institute of Physics, London. One-day meeting. For details and registration forms contact The Meetings officer of the IoP at the address below.

Power UK '86 — March 4-6th
Kensington Exhibition Centre, London. Exhibition and conference devoted to power supplies and alternative power sources. Organised by the Power Supply Manufacturers Association. For details contact TCM Expositions Ltd, Exchange House, 33 Station Road, Liphook, Hampshire GU30 7DN, tel 0428-724 660.

Electronic Production Efficiency Exposition — March 11-13th
Olympia, London. See November '85 ETI or contact Cahners at the address below.

Electro-Optics/Laser International — March 18-20th
Metropole Convention Centre, Brighton. Exhibition and conference on optics and lasers which includes a special focus on fibre optics. For details contact Cahners at the address below.

Low Energy Ion Beams — April 7-10th
University of Sussex, Falmer, Brighton. Conference on the production and use of ion beams, covering such areas as semiconductor processing and machining and material modification in metals and insulators. There will also be an exhibition of related equipment. For details contact the Meetings Officer of the IoP at the address below.

Electrical Insulation Conference — May 19-22nd.
Brighton. International conference described by the organisers as the premier event in its field. For details contact the British Electrotechnical and Allied Manufacturers Association, Leicester House, 8 Leicester Street, London WC2H 7BN, tel 01-437 0678.

Advanced Infrared Detectors And Systems — June 3-5th
Institution of Electrical Engineers, London. Conference which aims to cover the developments in infrared detectors, systems and techniques and their relationship to developments in the field of millimetre waves. For details contact the IEE, Savoy Place, London WC2R 0BL, tel 01-240 1871.

Networks '86 — June 10-12th
Wembley Conference Centre, London. Exhibition and conference devoted to all aspects of data exchange networks. For details contact Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01-868 4466.

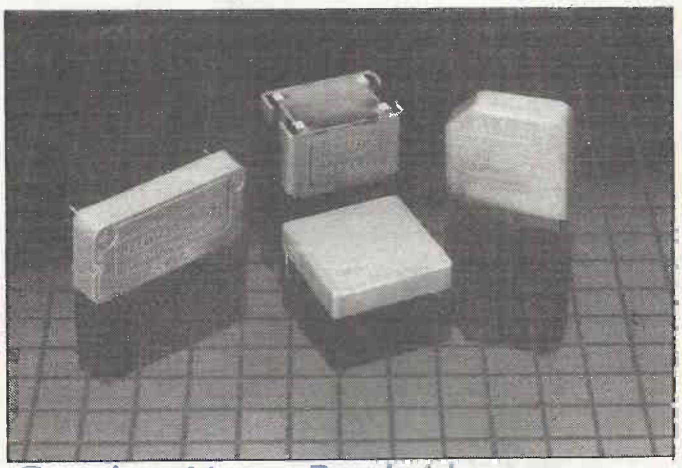
Northern Computer Show — June 24-26th
G-MEX Exhibition Centre, Manchester. Exhibition aimed at professional computer users, from professionals in user departments to computing specialists. For details contact Reed Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ, tel 01-643 8040.

KBS '86 — July 1-3rd
Wembley Conference Centre, London. Exhbition and conference devoted to knowledge based systems. Contact Online at the address below.

Voice Processing — July 1-3rd
Tara Hotel, London. Conference. For details contact Online at the address below.

Addresses:
Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01-891 5051.
Institute of Physics, 47 Belgrave Square, London SW1X 8QZ, tel 01-255 6111.
Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01-868 4466.

ETI



Getting Your Back Up

Battery backed-up memory is becoming increasingly important in microprocessor applications and can often be the most effective and efficient means of non-volatile data storage. Direct PCB mounting batteries are an attractive option where space is at a premium. A new range of batteries from the French company SAFT should meet most requirements.

The batteries are produced in upright or flat packs for either a small footprint or a low profile and the range includes rechargeable Ni-Cads and non-rechargeable lithium batteries with an operating life of up to 10 years.

The Ni-Cads are produced in versions with nominal voltages of 2.4 and 3.6 and capacities of either 40 mAH or 100 mAH. The smaller capacity batteries require a trickle-charging current of 2mA, while the larger capacity versions need 4mA. The upright Ni-Cads are only available at 3V6.

The SAFT lithium batteries are produced in both upright and low profile packages, but only in a 3V0, 200 mAH version.

The range is supplied by MS Components Ltd., Zephyr House, Waring Street, West Norwood, London SE27 9LH (tel: 01-670 4466).

● Mullard have announced a SECAM to PAL converter which distinguishes between SECAM and PAL signals, passing PAL directly to the chroma output but converting SECAM signals into PAL standard before output. The transcoder, as it is called, contains all necessary circuitry on a single chip, the TDA3592A, and operates by demodulating the SECAM signal and remodulating it in PAL format. The output is, therefore, a true PAL signal and the chip can be used with any PAL decoders in monitors, VCRs and video cameras as well as televisions.

Contact: Mullard Ltd., Mullard House, Torrington Place, London WC1E 7HD (tel: 01-580 663).

● **The new short form catalogue from British transistor manufacturers, Semelab, has been expanded to include devices distributed by the company as well as made by them. The catalogue also lists a range of USA replacement types and gives basic data and device characteristics. It is available free from Semelab Ltd., Coventry Road, Lutterworth, Leics. LE17 4JB (tel: 04555-56565).**

● **Pineapple Software have released a circuit-drawing program for the BBC micro. The program is called DIAGRAM and covers 39 screens in Mode 0 (high resolution). Individual screens operate as windows on this larger logical screen. The program supports printouts on most dot matrix printers in a variety of print sizes and can also be used to produced PCB layouts. DIAGRAM is supplied on 5¼ inch disc and costs £28.75 from Pineapple Software, 39 Brownlea Gardens, Seven Kings, Ilford, Essex IG3 9NL (tel: 01-599 1476).**

● *Halley's Comet disappears below the UK horizon on 31st March. Throughout March, it can be seen in Sagittarius having reappeared after its closest pass to the sun (perihelion) on 20th February before sunrise in the east at magnitude +3. Information from the European Space Research Unit, thanks to Oscar News, the magazine of AMSAT-UK, the Radio Amateur Satellite Organisation of the UK. Contact Ron Broadbent G3AAJ, 94 Herongate Road, Wanstead Park, London E12 5EQ (tel: 01-989 6741).*

ETI

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

ACORN COMPUTER SYSTEMS
BBC B PLUS with DFS .... £369 (a)
BBC B PLUS with 128K .... £389 (a)
BBC B PLUS Econet (No DFS) .. £360 (a)
BBC B PLUS Econet & DFS ..... £399 (a)
BBC Dust Cover .... £4.50 (d)

UPGRADE KITS
DFS Kit .... £80 (d)
Econet Kit .... £55 (d)
1770 DFS Upgrade for Model B £43.50 (d)
1.2 OS ROM .... £7.50 (d)
DNFS ROM .... £17.50 (d)
ADFS Rom (for B with 1770 DFS & B Plus .... £26 (d)
64K Upgrade Kit for B Plus .... £35 (d)

ACORN ADD-ON PRODUCTS
Z80 2nd Processor .... £299 (a)
6502 2nd Processor .... £169 (a)
Teltext Adaptor .... £125 (b)
IEEE Interface .... £278 (b)

Music 500 .... £160 (b)
ATPL Symphony Keyboard .... £86 (a)

COMMUNICATION ROM
Termulator .... £25 (d)
Communicator .... £49 (d)
Commstar .... £20 (d)
DATABEEB .... £22 (d)

BBC FIRMWARE
Basic II ROM .... £22.50 (d)
View 12.1 Word Processor ROM ... £41.00 (d)
Wordwise Plus .... £41.00 (d)
BCPL ROM/Disc .... £46.00 (b)
Viewsheet .... £41 (d)
Exmon II .... £22 (d)
Toolkit Plus .... £33 (d)
ISO-PASCAL .... £46 (a)
Acorn Micro-Prolog .... £69 (c)
Printmaster (FX80)/Graphics ...... £23 ea (d)
Oxford PASCAL/G-FORTH/LISP ROM .... £35 ea (c)
ACCELERATOR (BASIC Compiler) .... £48 (d)

TORCH UNICORN products including the IBM Compatible GRADUATE in stock
For detailed specification on any of the BBC Firmware/Peripherals listed here or information on our complete range please write to us.

PRINTERS

EPSON
RX80T .... £169 (a)
LX80 .... £209 (a)
FX80 (std) .... £245 (a)
FX80+ .... £299 (a)
NEW FX105+ Incl NLQ & IBM mode .... £449 (a)
JX80 5 colour printer .... £435 (a)
LQ1500 Printer .... £345 (a)

PLOTTERS
Epson H180: A4 4 colour Plotter .... £345 (a)
Hitachi 672: A3 4 colour Plotter ..... £475 (a)

TAXAN KAGA:
KP810 80 Col NLQ .... £299 (a)
KP910 156 Vol NLQ .... £339 (a)
JUKI 6100 Daisy Wheel .... £279 (a)
HR15LX (Serial) .... £310 (a)
HR15LX (Serial) £365 (a)

Paper:
2000 Sheets Fanfold:
9.5" x 11" .... £13 (b)
14.5" x 11" .... £18.50 (b)
Labels: (per 1000)
3.5" x 17/16" Single row .... £5.25 (d)
27/16" x 17/16" Triple row .... £5.00 (d)

ACCESSORIES

EPSON
FX plus sheet feeder .... £129.00 (b)
LX80 Sheet feeder .... £49.00 (b)
Paper Roll Holder .... £17.00 (d)
FX80 Tractor attachment .... £37.00 (c)
Interfaces: 8143 RS232 .... £28.00 (c)
8148 RS232 + 2K .... £57.00 (c)
8132 Apple II .... £60.00 (c)
8165 IEEE + cable .... £65.00 (c)
Serial & Parallel Interfaces with larger buffers available.
Ribbons: RX/FX/MX80 .... £5.00 (d)
RX/FX/MX100 .... £10.00 (d)
LX80 .... £6.00 (d)
Spare pens for H180 .... £7.50/set (d)
FX80 Tractor Attachment £37 (c)

KAGA TAXAN
RS232 Interface + 2K Buffer .... £85 (c)
Ribbon KP810/910 .... £6.00 (d)

JUKI:
RS232 Interface .... £65 (c)
Spare Daisy Wheel .... £14.00 (d)
Ribbon .... £2.50 (d)
Sheet Feeder .... £182 (a)
Tractor Feed Attachment .... £129 (a)

BROTHER HR15:
Sheet Feeder .... £189 (a)
Tractor Feeder .... £99 (a)
Ribbons Carbon or Nylon .... £4.50 (d)
Red Correction Ribbon .... £2.00 (d)

BBC Printer Lead:
Parallel (42") .... £7.00 (d)
Serial .... £7.00 (d)
Printer Leads can be supplied to any length.

MODEMS

— All modems listed below are BT approved

MIRACLE 3000:
A new range of microprocessor based modems offering of upto 2400 baud, full duplex. Features include 'HAYES' protocol compatibility, auto answer, auto dial, speed buffering, printer port, data security option etc. Mains powered.
WS3000 V2123 (V21 & V23) .... £295 (b)
WS3000 V22 (as above plus 1200 baud full duplex) .... £495 (b)
WS3000 V22bis2400 (as above plus 2400 baud full duplex) .... £650 (b)

MIRACLE 2000
A world standard modem covering V21, V23 (Bell 103/113/108 outside UK) and including 75, 300, 600, 1200 baud ratings. Optional Auto dial, auto answer cards, complete control from computer keyboard. WS2000 £125 (b)

Auto Dial Card .... £30 (d)
Auto Answere Card .... £30 (d)
SKI Software Control Kit .... £10 (d)

BUZZ BOX:
Pocket size, direct connect 300/300 half and full duplex with originate and answer modes .... £55 (c)

Data Cables for above modems available for most computers.

Serial Test Cable
Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end using a 10 way switch making it possible to produce almost any cable configuration on site.
Available as M/M or M/F £24.75 (d)

DISC DRIVES

These are fully cases and wired drives with slim line high quality mechanisms. Drives supplied with cables manuals and formatting disc suitable for the BBC computer. All 80 track drives are supplied with 40/80 track switching as standard. All drives can operate in single or dual density format.

With integral psu:
1 × 400K 40/80T DS: TS400 .... £99 (b)
PS400 with psu .... £120 (d)

Dual Drives: (with integral psu) Stacked Versions
PD200 2 x 100K 40TSS .... £195 (a)
PD800 2 x 400K 40/80T DS .... £199 (a)

3.5" Drives
TS35 1 x 400K 80T DS .... £99 (b)
TD35 2 x 400K 80T DS .... £172 (b)
5¼" 96 TPI double sided 1Mb unformatted DD .... £85 (b)
3.5" 96 TPI double sided 1Mb unformatted DD .... £88 (b)

3M FLOPPY DISCS

High quality discs that offer a reliable error free performance for life. Each disc is individually tested and guaranteed for life. Ten discs are supplied in a sturdy cardboard box.

5¼" DISCS
40 SS DD £13 (d)
80T SS DD £22 (d)
40T DS DD £18 (d)
80T SS DD £24 (d)

3½" DISCS
80T SS DD £30 (d)
80T DS DD £38 (d)

DISC ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives .... £14.50 (c)
Single Disc Cable .... £6 (d)
Dual Disc Cable .... £8.50 (d)
10 Disc Library Case .... £1.80 (c)
30 Disc Case .... £6 (c)
40 Disc Lockable Box .... £14 (c)
100 Disc Lockable Box .... £19 (c)

MICROVITEC

All 14" monitors now available in plastic or metal cases, please specify your requirement.

14" RGB
1431 Std Res .... £185 (a)
1451 Med Res .... £225 (a)
1441 Hi Res .... £385 (a)

14" RGB with PAL & Audio
1431 AP Std Res .... £199 (a)
1451 AP Med Res .... £275 (a)

Swivel Base for Plastic 14" Microvitecs .... £20 (c)

20" RGB with PAL & Audio
2030CS Std Res .... £380 (a)
2040CS Hi Res .... £685 (a)

KAGA TAXAN 12" RGB

VISION II 101Hi Res .... £210 (a)
VISION III Plus .... £330 (a)
SUPERVISION III Plus .... £330 (a)
MITSUBISHI 14" RGB Med Res IBM & BBC Compatible .... £229 (a)

MONOCHROME MONITORS:

SANYO DM8112CX Hi Res 12" Green Screen .... £86 (a)
KAGA KX1201G Hi Res 12" Etched Green Screen .... £92 (a)
KAGA KX1203A Hi Res 12" Etched Amber Screen .... £105 (a)
PHILIPS BM7502 12" Hi Res Green Screen .... £75 (a)
PHILIPS BM7522 12" Hi Res Amber Screen .... £79 (a)
Swivel Base for Kaga Monochrome fitted with Digital Clock .... £21 (c)

SPECIAL OFFER

2764-25 .... £2.00
27128-25 .... £3.00
6264LP-15 .... £4.00

ATTENTION

All prices in this double page advertisement are subject to change without notice.
ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

Serial Mini Patch Box
Allows an easy method to reconfigure pin functions without rewiring the cable assy.
Jumpers can be used and reused. £22 (d)

Serial Mini Test
Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
Connects in Line. £22.50 (d)

GANG OF EIGHT
INTELLIGENT FAST EPROM COPIER

Copies up to eight eproms at a time and accepts all single rail eproms up to 27256. Can reduce programming time by 80% by using manufacturer's suggested algorithms. Fixed Vpp of 21 & 25 volts and variable Vpp factory set at 12.5 volts. LCD display with alpha moving message. **£395(b).**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II .... £195 (b)
Adaptor for 2764/2564. **£25.00 (c)**

UV ERASERS

All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time .... £47 (c)
UV1T as above but with a timer .... £59 (c)
UV140 erases up to 14 eproms at a time. £71 (b)
UV141 as above but with a timer .... £88 (b)

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS
No of Ways

	9	15	25	37
MALE:				
Ang.Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang.pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw Lock	130	150	175	-

TEXTOOL ZIF
SOCKETS
24-pin £7.50
28-pin £9.00
40-pin £12

EDGE CONNECTORS

	0.1"	0.156"
2 × 6-way (commodore)	—	300p
2 × 10-way	150p	—
2 × 12-way (vic 20)	—	350p
2 × 18-way	—	140p
2 × 23-way (ZX81)	175p	220p
2 × 25-way	225p	220p
2 × 28-way (Spectrum)	200p	—
2 × 36-way	250p	—
1 × 43-way	260p	—
2 × 22-way	190p	—
2 × 43-way	395p	—
1 × 77-way	400p	500p
2 × 50-way (S100conn)	600p	—

EURO CONNECTORS

DIN 41612	Plug	Socket
2 × 32 way St Pin	230p	275p
2 × 32 way Ang Pin	275p	320p
3 × 32 way St Pin	260p	300p
3 × 32 way Ang Pin	375p	400p
IDC Skt A + B		400p
IDC Skt A + C		400p

For 2 × 32 way please specify spacing (A + B, A + C).

MISC CONNS
21 pin Scart Connector 200p
8 pin Video Connector 200p

AMPHENOL CONNECTORS

	Solder	ZDC
36 way plug	500p	475p
36 way skt	550p	500p
24 way plug IEEE	475p	475p
24 way skt IEEE	500p	500p

PCB Mtg Skt Ang Pin
24 way 700p 36way 750p

GENDER CHANGERS
25 way D type

Male to Male £10
Male to Female £10
Female to Female £10

RS 232 JUMPERS
(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female Female	£10.00
24" Male Male	£9.50
24" Male Female	£9.50

DIL SWITCHES
4-way 90p 6-way 105p
8-way 120p 10-way 150p

RIBBON
(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	-
20 pin	75p	-
24 pin	100p	150p
28 pin	160p	200p
40 pin	200p	225p

TECHNOLINE VIEWDATA SYSTEM

Using 'Prestel' type protocols for information and orders phone 01-450 9764. 24 hour service, 7 days a week.

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
7436A	60p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/	629/140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS244	80p
74LS245	110p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	60p
74LS290	80p
74LS292	900p
74LS293	80p
74LS295	140p
74LS297	£9
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS373	90p
74LS374	90p
74LS375	75p
74LS377	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	60p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
74LS783	£21

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	60p
74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	60p
74S37	60p
74S38	60p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S85	300p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	300p
74S132	100p
74S133	60p
74S138	180p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	200p
74S158	200p
74S163	300p
74S169	550p
74S174	300p
74S175	320p
74S188	180p
74S189	180p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S283	270p
74S287	225p
74S288	200p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	60p
4009	45p
4010	60p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	35p
4051	65p
4052	60p
4053	60p
4504	80p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	80p
4095	90p
4096	90p
4097	270p
4098	75p
4099	90p
4501	36p
4502	55p
4503	36p
4504	95p
4505	360p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	60p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	65p
4534	360p
4536	250p
4538	75p
4539	75p
4541	90p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14416	300p
14419	260p
14490	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	20p
40110	225p
40114	225p
40147	280p
40163	100p
40173/4067	120p
40174	100p
40175	100p
40192	100p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AM7910DC	£25
AN103	3200p
AY-1-5050	100p
AY-3-1350	380p
AY-3-8010	450p
AY-3-8912	500p
CA3019A	100p
CA3028A	110p
CA3046	70p
CA3059	325p
CA3080	50p
CA3080E	70p
CA3086	90p
CA3089E	210p
CA3090AQ	375p
CA3130E	90p
CA3130T	130p
CA3140E	45p
CA3140T	100p
CA3160E	90p
CA3161E	200p
CA3162E	800p
CA3189E	270p
CA3240E	150p
CA3280G	270p
D7002	£6
DAC1408-8	300p
DAC0800	300p
DAC0808	300p
DG308	300p
HA1366	190p
ICL7106	675p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	400p
ICM7216B	£22
ICM7217	750p
ICM7555	80p
ICM7556	140p
LC7120	300p
LC7130	300p
LC7137	350p
LF347	120p
LF351	80p
LF353	90p
LF355	90p
LF356N	110p
LF357	100p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	225p
LM311	80p
LM318	150p
LM319	180p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	160p
LM339	40p
LM348	60p
LM358P	50p
LM377	300p
LM380N-8	150p
LM380	150p
LM381AN	170p
LM382	200p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM389	180p
LM391	180p
LM392N	110p
LM393	385p
LM394CH	360p
LM709	35p
LM710	48p
LM711	100p
LM723	60p
LM725CN	300p
LM733	65p
LM741	22p
LM747	70p
LM748	20p
LM1011	400p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	550p
LM1889	450p
LM2917	300p
LM3302	90p
LM3900	60p
LM3909	100p
LM3911	180p
LM3914	390p
LM3915	340p
LM3916	340p
LM13600	150p
M51513L	230p
M51516L	450p
MB3712	200p
MC1310P	150p
MC1413	75p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	200p
MC3401	70p
MC3403	65p
MF10CN	300p
MK50240	800p
MK50398	790p
ML920	600p
ML922	400p
MM6221A	300p
NE531	120p
NE544	180p
NE555	22p
NE556	60p
NE564	400p
NE565	120p
NE566	150p
NE567	125p
NE570	400p
NE571	300p
NE592	80p
NE5532P	150p
NE5533P	180p
NE55334P	130p
NE5534AP	150p
OP-07EP	500p
PLL02A	500p
RC4136	58p
RC4151	200p
RC4558	55p
S566B	220p
SAA1900	£16
SFF96364	800p
SL490	300p
SN76033N	300p
SN76489	400p
SN76495	400p
SP0256AL2	700p
TA7120	120p
TA7130	140p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	90p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA940	175p
TDA1010	225p
TDA1022	400p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	190p
TDA2004	240p
TDA2006	320p
TDA2020	320p
TDA2030	250p
TDA2593	500p
TDA3810	750p
TDA7000	350p
TEA1002	700p
TL061CP	40p
TL062	60p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	35p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
UAA1003-3	935p
UA759	320p
UA2240	120p
UAA170	170p
UCN4801A	550p
ULN2003A	75p
ULN2004A	75p
ULN2068	290p
ULN2802	190p
ULN2803	180p
ULN2804	180p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	500p
XR210	400p
XR2206	400p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	190p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E8	225p
ZN447E	£9.50p
ZN449E	300p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	660p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

1A		+ve		−ve	
5V		7805	45p	7905	50p
6V		7806	50p	7906	50p
18V		7808	50p	7908	50p
12V		7812	45p	7912	50p
15V		7815	50p	7915	50p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
LM309K	1A 5V	140p
LM323K	3A 5V	350p
78H05KC	5A 5V	575p
78H12	5A 12V	640p
78P05	10A 5V	900p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T	3A+VAR	225p
LM350T	5A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	650
79HGKC	5A+VAR	675p
78GUIC	1A+VAR	225p
79GUIC	1A+VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

COMPUTER COMPONENTS

CPU

1802CE	650p
2650A	1050p
6502	450p
6502A	450p
65C02A	£15
6502B	800p
6800	250p
6802	300p
6803-2	£12
6809	650p
6809E	£8
68B09	£10
68B09E	£12
68000-LB	£36
8035	350p
8039	420p
80C39	700p
8080A	420p
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READ/WRITE

Social Consequences

Dear Sir,

I feel I must reply to Joseph Michael's letter (ETI, January 1986) concerning the inclusion in ETI of articles with political aspects. If I understand Mr. Michael's rather garbled argument correctly, he is presenting an attitude which is, in my opinion, untenable. In the interests of brevity, and in order not to appear too didactic, I will make three simple points.

Firstly, those of us who are scientists or technicians of some description have a responsibility to pay heed to the social consequences of our work, a point which Alfred Nobel realised. How can we do this if we are not kept informed of how science and technology is (allegedly) being used?

Secondly, although as Mr. Michael says, 'Many hours of politics are screened on television each day' it is devoid of hard technical data, aimed as it is at an audience most of whom would not understand such details. What better forum for these details than a technical publication like ETI?

Thirdly, these articles do not pose a threat to the conventional contents of the magazine, as Mr. Michael seems to imply. The Greenham piece took up only half a page in an isue of sixty-six pages! Anyone who wished to ignore it could do so with ease.

In conclusion, I look forward to many thought-provoking future articles about the wider implications of electronics.

Yours faithfully,
Malcolm Ray,
London NW6

Dear Sir,

On return from a trip abroad I welcomed the opportunity to peruse Dec. and Jan. issues of the magazine. After reading of Greenham Common and your reply to the letter from Sgt. R. Hailstones I have informed my newsagent to cancel my subscription.

I have no wish to encourage you to monitor any aspect of one of our defence establishments.

Yours faithfully,
C. H. Hargreaves,
Manchester.

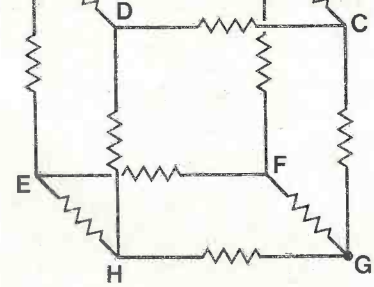
The idea that 'our defence establishments' are above monitoring, I find frankly appalling. They are, I believe,there to defend us and, what's more, they hold the power to destroy millions of us and millions of our fellow human beings. If any institutions should be monitored as a matter of course, surely it is them. Like it or not, ETI belongs to the family of the media and the responsible members of this family should represent the interests of concerned citizens. Electronics is a hobby or a career for just about all our readers, but it is also an instrument of warfare (or, if your prefer, defence). I think it absolutely right and proper that ETI and its readers should be aware of this. Incidentally, the abandonment of the dual-key policy with regard to cruise missiles means that the Greenham base can hardly be described as 'one of our defence establishments.' The decision to deploy the missiles sited there will, if that dreadful day ever comes, be entirely in the hands of the American Armed Forces. — Ed.

Alf — A Bet!

Dear Alf

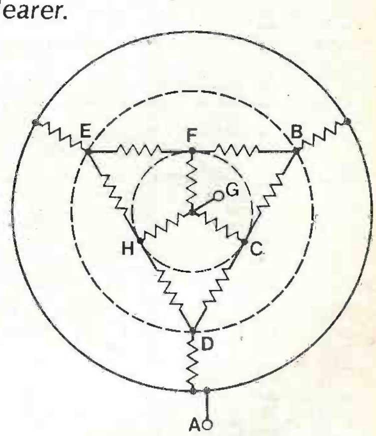
I spend a great deal of time doing puzzles of one sort or another, and enjoy yours very much. However, I think I've spotted a mistake in your solution in the January issue: the answer '(9R + 4R)// Alf' should read '9R + (4R// Alf)', with a similar amendment to the following line.

I wonder if you've ever come across the old favourite about the cube of one-ohm resistors? Twelve one-ohm resistors are wired together in the form of a cube and the problem is to determine the resistance between any two diagonally opposite corners; for



instance, between point A and G in Fig. 1. A solution by the usual series and parallel resistor calculations is possible, but there is a much easier way.

From the symmetry of the cube, it is easy to see that the voltages at points E, D and B will all be the same, no matter what signal may be applied to points A and G. A similar argument applies to the voltages at points H, F and C, which will also be equal to each other. If the symmetry is not obvious from Fig. 1, the same resistor network is shown rearranged in Fig. 2 to make it clearer.



If the voltages at any two points in a circuit are equal, it can make no difference at all to the operation of the circuit if the points are shorted together, since no current will flow through the link. Therefore, points E, D and B can be joined together, and so can points H, F and C, as shown by the dotted lines in Fig. 2. With these links in place, the resistance of the cube can easily be calculated: it is 1/3ohm + 1/6 ohm + 1/3 ohm = 5/6 ohm.

Yours sincerely,
Chris Finn,
Beverley.

Thank you for writing, it's not often I get a letter to myself, not being appreciated around here like I should. I can't speak about the brackets, not actually writing the puzzles myself, it's Auntie know-it-all Static to blame for that. She probably has a degree in brackets, I shouldn't be surprised. How would you like it if everytime you made a mistake, old smarty pants let the whole world know about it? The puzzles would be a darn sight better if I did write them, I could tell you a few things about

Auntie's rust spots and flea byte's wooden head. I hope they don't see this letter. Anyway, thanks again for the letter, and if you've got a puzzle that will really tie old smarty pants in knots, just send it along and then we'll see. — Alf.

P.S. Auntie Static writes: Any student of bracketology will realise that Chris is right. I blame the editor. — Auntie.

P.P.S. The Editor writes: That's enough about brackets (or parentheses, (for that matter)). — Ed.

Scope For Improvement

Dear Sir,

I am interested in building the ETI Oscilloscope (May-July, 1982, and February, 1983) and as informed in the February 1983 issue, I sent a PO for £2 to obtain the pot core (ET30) from Neosid. This PO was sent in early August. Up to now, I have not received the pot core. Please clarify. I have not got any sort of acknowledgement from Neosid.

It was mentioned that other pot cores may not work because a large inductance factor is needed. What is the inductance factor — perhaps Siemens or others may have one suitable? Please advise.

Finally, please note, I have written many times on previous occasions and have got no replies. Please break your habit in this case!

Yours faithfully
K. G. Vergis,
Malaysia.

Since the design was published, Neosid have become trade suppliers only. They will not supply individual orders for the ET30 but they should, of course, return your postal order. Unfortunately, we have no specifications for the pot core used in the design. All is not lost, however. We have received a number of queries like Mr. Vergis's and — as a result — the relevant parts of the circuit are being redesigned around a more readily available inductor. The revised design will be published towards the middle of this year. — Ed.

2001 Revisited

Dear Sir,

Reference ETI, September 1985, and the Cortex I/O article. Your circuit for the 74LS2001 has an error. Header pin 2 should be the output and pin 16 the input of IC2. By the way, if you have any info on the internals of the 74LS2001 or know where I can get info. on it, I would be grateful.

I built the header circuit (modified as above) and it works okay. I built mine a bit more compact than that suggested in your article — on a 20 pin DIL header (soldering the board directly on to pins 11 to 20 of the header and mounting IC2 about IC1)

Yours,
Mike Gallagher
Rugby.

Thanks for the correction, which will go straight into OOPS! As for the 2001 we can only suggest you get in touch with Richard Roberts at Microprocessor Engineering, 21 Hanley Road, Shirley, Southampton SO1 5AP (0703 780084). — Ed.

Cri De Constructor

Dear Mr. Editor, Sir!

I am writing to you in hope that you might be able to help me get some components for the Barry Porter Modular Preamplifier (ETI, December 1983, January and February, 1984). Your were able to help before when I was building the System A Power Amps — which are still going strong and love CDs.

I need two sets of parts for the disc amps (I received the PCs from you) and a friend in the UK has been unable to contact XL Audio Parts either by phone or letter. They may have moved again or folded. I would be grateful if you could help with an address.

Incidentally the headphone amp sounds great (with mods to PCB and using TIP41/42Cs).

If XL don't exist anymore, be so kind as to suggest someone else.

Thanks,
John Alderton,
Republic of South Africa

XL have proved to be elusive for a number of readers. NP Electronics, The Mill House, Watlington, Kings Lynn, Norfolk PE38 9DW (tel: 0553 — 810 096) have offered to supply kits of the non-polarised electrolytic capacitors and none of the other components should present many problems. By the way, 'Mr. Editor, Sir' strikes just about the right note. Keep it up. — Ed.

Dear Sir,

In your July and August, 1984, editions of your magazine you featured a printer buffer kit. In Zimbabwe we do not have ready suppliers of electronic components and I would like to make up two of the above buffers, is there any supplier that you know of who could assist in making up the kits and at the same time give me some advice on connections, firstly to a Commodore which has only an RS232 interface and secondly to a Nascom 2. The printer in both cases has a Centronics interface. Will I require an additional adaptor for the Commodore to accept the Centronics interface?

Your assistance is appreciated.

Yours faithfully
P. Squair,
Zimbabwe.

I presume you are talking about a Commodore 64, in which case the answer to that query is that you will definitely require a lead to connect the 64 user port to the printer Centronics input. You may also require some software, although most commercial programs include the routines as standard and, in any case, the routines are not complicated if you know how to handle the 64 user port. For further information and advice, contact the PCB and EPROM supplier, Tronik Designs, 68A Broomfield Avenue, Palmers Green, London N13 4JP. Cables and software for the 64 can be obtained from 64 Supplies Company, PO Box 19, Whitstable, Kent CT5 1TJ. — Ed.

Dear Sir or Madam,

I wish to construct a Digital Cassette Deck such as is described in your issue of ETI for September 1984, page 27, for computer use.

Could you please inform me where I can obtain the Tanashin Electric TN-3600 cassette deck required for this project.

As there is no mention of the renewal of your PCB service in your issue of ETI for this December I must assume it is not yet functioning. If you are not yet in a position to supply the PCB I require for this project, perhaps you would be so kind as to let me have a good foil pattern so that I can etch a board myself.

Yours sincerely
D. Van Beirendonck
Flint,
Clwyd

The PCB Service is now back and raring to go. The Digital Cassette Deck PCB costs £10.25 and you will find details of how to order towards the end of the magazine. The deck itself is obtainable from Cirkit, Park Lane, Broxbourne, Herts. Stock number is 72-03600, price £43.95. — Ed.

ETI

AUNTIE STATIC'S PROBLEM CORNER

Dear Auntie,
I have been following ETI's Sound Sampler project with great interest, but despite my degree in electronics I often find myself getting in deep water. For one thing, I have never heard of 'switched capacitor' filters. Will you please explain what they are and how they work? I am sure other readers would be interested.
W. Richards,
Chatham,
Kent.

A popular circuit for implementing standard filter configurations is the 'Universal State Variable' filter, shown in Fig. 1. The circuit gives high pass, band pass and low pass outputs, and with the addition of an extra op-amp will also give a band reject, or notch, output. In addition, with suitable choice of component values, the circuit can be made to conform to any of the classical filter responses: Bessel, Cauer, Chebyshev, Butterworth, and so on. You can't get much more universal than that!

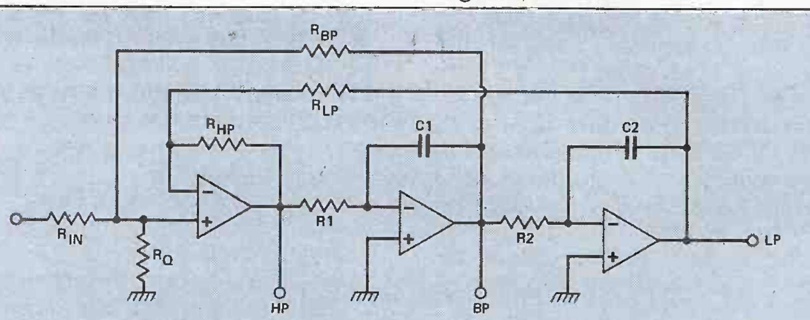


Fig. 1 The Universal State Variable Filter

Unfortunately, the circuit has a number of disadvantages, not the least of which is that the design equations are complicated enough to make you consider abandoning electronics and devoting your life to stamp collecting. Apart from that, if the response of the circuit is to be at all satisfactory, precision low-drift capacitors are needed. These tend to be rather expensive.

The switched capacitor filter offers all the advantages of the state variable filter with far fewer shortcomings. The design equations are simple, there are no external capacitors, and the turnover frequency is accurately determined by the frequency of the applied clock signal.

If you look again at Fig. 1, you will see that the filter consists, in essence, of an op-amp followed by two integrators. The resonant frequency of the filter will be determined by the time constants of the two integrators, R_1C_2 and R_2C_2 (and also by the ratio of R_{HP} to R_{LP}, incidentally).

Using sampled data techniues, the resistor in each integrator can be replaced by a capacitor and two switches, as shown in Fig. 2. The two switches are closed alternately. With SW1 closed and SW2 open, C_1 will charge up to V_{in}. With S_1 open and SW2 closed, C_1 is discharged into the virtual earth at the inverting input of the op-amp. Each time SW2 closes, a charge of $C_1 V_{in}$ is transferred, and if the switches are opened and closed by a clock of frequency, f, with one operation of both switches every clock cycle, the average current will be V_{in}/R, so the capacitor and switches have an 'equivalent resistance' of $1/fC_1$ and the time constant of the integrator will be C_2/fC_1.

Now, if the idea is to build a filter from discrete components, this has just compounded the problem. Instead of one precision capacitor for each integrator, we now need two! In the case of an IC, however, although it is still quite tricky to fabricate accurate capacitor values, it is relatively simple to maintain the *ratio* of two capacitors within very precise tolerances. For instance, if the IC designer intended C_1 to be 10_pF and C_2 to be 50_pF, variations in the production process may lead to their values being 10% higher than intended (say), but as both capacitors are subject to the same processes they will both be higher by 10%, and the ratio (11_pF to 55_pF) will still be 1:5.

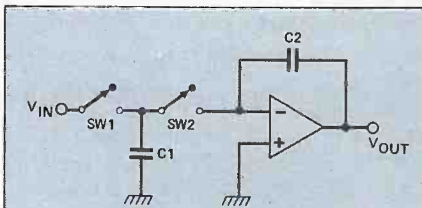
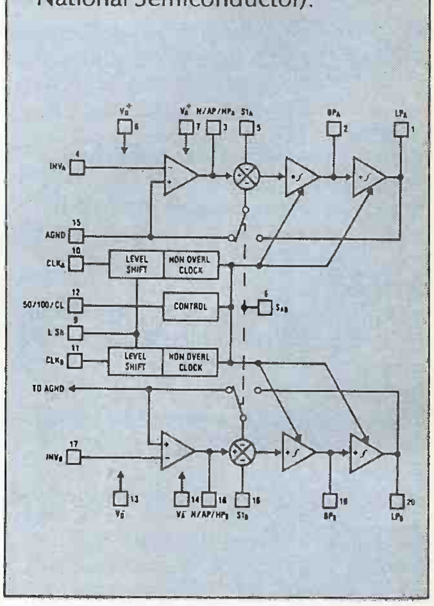


Fig. 2 A Switched Capacitor Integrator.

The term involving time constants in the equation for the resonant frequency of the filter of Fig. 1 is $1/\sqrt{T_1 T_2}$, where T_1 and T_2 are the time constants for the two integrators. If all other component values are held constant, the frequency will be directly proportional to the value of this term. Using the time constant of 1/kf for each switched capacitor integrator (k is C_1/C_2 - a constant detemined by the IC manufacturer, as already explained), this term becomes $\sqrt{k^2f^2}$, or kf, so not only is the resonant frequency dependent on the clock frequency, it is directly proportional to it! In the case of the MF10 IC, circuit parameters have been chosen by the manufacturer to make the ratio between the clock frequency and turnover frequency 50:1 or 100:1 (selectable), so the calculation could hardly be easier!

The complete diagram of the MF10 is shown in Fig. 3 It has various additional facilities to make the circuit more versatile, but still consists essentially of an op-amp and two integrators. There are two identical second order filters in each IC, which makes the circuit look more complicated than it actually is.

Fig. 3 Block diagram of the MF10 switched capacitor filter (courtesy National Semiconductor).



Other members of the MF10 family are: the MF4 — a fourth-order Butterworth low pass filter in an 8-pin package, needing no external components at all, the MF5, which is just half of the MF10, that is to say just a single second-order filter, and finally the MF6, a sixth-order Butterworth low pass filter which doesn't even need an external clock.

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Well, Almost. Actually, it isn't quite that powerful and it is a little bit bigger than a pinhead, but even so we think the ETI Matchbox Amplifier is going to be hard to . . . well, match. It's a good bit smaller than the average matchbox, delivers up to 50 watts RMS and uses a standard power-amp IC in either a single-ended or bridging configuration. Even with a power supply and generous heatsinking attached, it should still be possible to produce a strikingly small amplifier system using this board. Get your magnifying glasses ready now!

Battery-Operated PA Amplifier

Continuing with the audio theme, we present a John Linsley Hood amplifier design which offers 50 watts of high quality audio and can be operated from a car battery or other 12V DC supply. Unlike some designs in which the amplifier stages operate directly from the low-voltage supply, this project employs a switch-mode power supply which generates a 55V DC rail, reducing the need for compromises in the design of the amplifier itself. The first article describes the design and construction of the PSU, a self-contained unit which can be used with this and with other amplifier units or in any application where a 55V DC 2A supply must be obtained from a 12V DC input.

Constant Current Sources

Graham Nalty takes a look at the various types of constant current generator circuits in use and discusses their strengths and the weaknesses and the uses to which they are put. Taking up the audio theme which runs through this issue, he considers the use of constant current sources in audio amplifiers and describes the effect of introducing modified constant current arrangements into a proprietary hi-fi amplifier, raising some potentially controversial issues in the process.

Plus

Projects, features, Tech Tips, News Digest, Circuit Solutions, Read/Write, Reviews and a SPECIAL OFFER — a digital multimeter module which we are offering at a knock-down price, complete with some suggested circuits to help you make maximum use of it.

AND . . .

Three more projects to build on your free PCB — a frequency meter module, a touch switch and a Coldbathwaterometer!

THE AUDIBLY-SUPERIOR APRIL 1986 ISSUE OF ETI, ON SALE MARCH 7th. HAVE YOU HEARD HOW GOOD IT IS?

Articles described here are at an advanced stage of preparation but circumstances beyond our control may dictate changes to the final list of contents.

MICRO-EXPANSION

Why upgrade when you can expand? Do you really need Megabyte power, or can your micro do the job with a little ingenuity and a home-built add-on? Mike Barwise cuts through the jargon jungle to rescue the good old 8-bit from the inflated claims of the supermicros.

The mushroom growth of the home computer industry has injected an almost maniacal sense of urgency into marketing strategy. No sooner is one model in the shops than the next is under development, in the hope that the public will buy and buy again.

This has had a significant influence on the design of the home micro. Short development times coupled with the need for obvious advantages in the next model has led the industry to provide micros which are in essence cut down versions of the previous generation of business computers. But design concepts which have validity in high performance business computer systems can easily degenerate into mere buzz words when pared down and applied to the design and marketing of the low cost home micro.

Emotive descriptions of processor power, speed and memory capacity capture the imagination, frequently clouding understanding of the concepts involved and their currency. These descriptions often prove to be no more than sales pitch, having little relevance to the real performance of the home micro.

Megabytes: Who Needs Them?

As microchip design progresses it becomes possible to cram more and more microscopic hardware into a smaller and smaller space. Larger scale integration can run faster due to improvements in design, and costs less per function, since expenditure on die development is not directly proportional to gate count.

On the other hand, skilled technician time stays as expensive as always and various high level compilers are now almost universally used to speed up commercial software development. These produce bulky and slow code, but increase the productivity of software developers by up to 100 times, when compared to the output of programmers using assembler.

Faster and more highly integrated hardware systems running massive software at considerably less than maximum efficiency have become the order of the day in business computing. Since the tasks generally required for business applications are not excessively demanding, performance can be very high, but the high speed and enormous memory requirements of such implementations have created user expectations which are not really applicable to the 8-bit micro.

To keep the price down, the home micro uses much simpler hardware than its business brother, with an 8-bit data and a 16-bit address bus remaining the norm. The average business-oriented micro, with a 20-bit or 32-bit address bus, has an address map in excess of 1Mbyte, whereas the home micro usually has 64Kbytes maximum. Ironically, home micro users are likely to demand a much wider variety of applications of their less complex and slower hardware.

There is nothing, however, to prevent the expansion of almost any 8-bit home micro into quite an advanced, fast and complex system. The first step is to appreciate some of the most significant machine-level design principles.

Micro Memory

The small micro address map may generally be divided into four more or less functionally distinct areas: systems, program and data memory, and I/O space. As most recent micros have almost every available space already dedicated, it is important to take the maximum advantage of any 'user area' available.

Systems memory is that portion allocated to the hidden 'housekeeping' tasks of the micro, including the I/O drivers, the system control code, the variable and pointer stacks and the scratchpad areas. Different systems make widely differing demands on memory, but in general, the higher 'level' the micro, the more systems memory it requires. As a user of a ready-built machine, you normally have little control over the allocation of systems memory.

Program memory is the area set aside for user applications software. Strictly speaking high level language interpreters and compilers are situated in the program memory as well, although some micros will not allow the user to access the areas set aside for them when they are absent.

The way in which applications software is written largely defines program memory usage, so it is reasonably easy to adapt and make use of extensions if you are writing your own software. However, few efficiently written 8-bit micro applications should require in excess of 28-32K of program memory, so you shouldn't go mad.

Data memory is the real crunch when it comes to the small address map of the home micro. It is often

1V=1n

not delineated from program memory, there being a tendency to store data in array structures appended to the program. This is not necessarily the best answer. Depending on your application, you may need anything from a few bytes to a Megabyte or more. When data memory is separate from program memory, it is the easiest of all memory areas to adapt. Various approaches to unmapped and semi-mapped storage can extend it theoretically almost without limit.

I/O space is the easiest area to start from when post-implementing expansion on your micro. Almost all adequate micros have one or more (usually small) undedicated 'user' expansion areas. The trick is to cram as much as possible into these spaces.

Commercial Micro Expansion

Paged memory units, RAM-disk, files, second processors and buffers are optional add-ons available for an increasing number of home micros in an attempt to overcome capacity and speed restrictions. Unfortunately, it is rare to find add-ons from different sources which are compatible, and it is difficult to select the one which will perform best in a specific user-defined application. All of them have to be fairly general in their application, or else be dedicated to accompanying software packages, in order to cover an adequate market. The principles of these gizmos are nevertheless remarkably simple, and with a little ingenuity they may even be improved upon by the enthusiast.

RAM Disk

RAM disk is really a misnomer. The system is actually a type of buffer ported to look at high level like a disk interface. Without the disk drive emulation software, a similar buffer concept can be used with increased versatility, as long as the user keeps track of data structures. Such buffers are more suited to data than to program storage, but can also be used in interfaces to secondary or slave processors in multiprocessor systems. The design of ported buffers will figure later in this series.

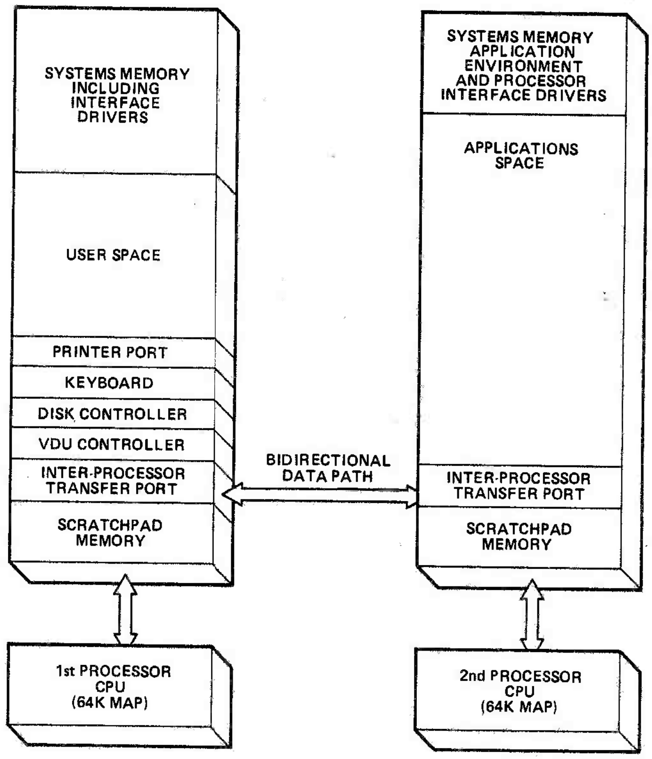

Fig. 2 Second processor configuration.

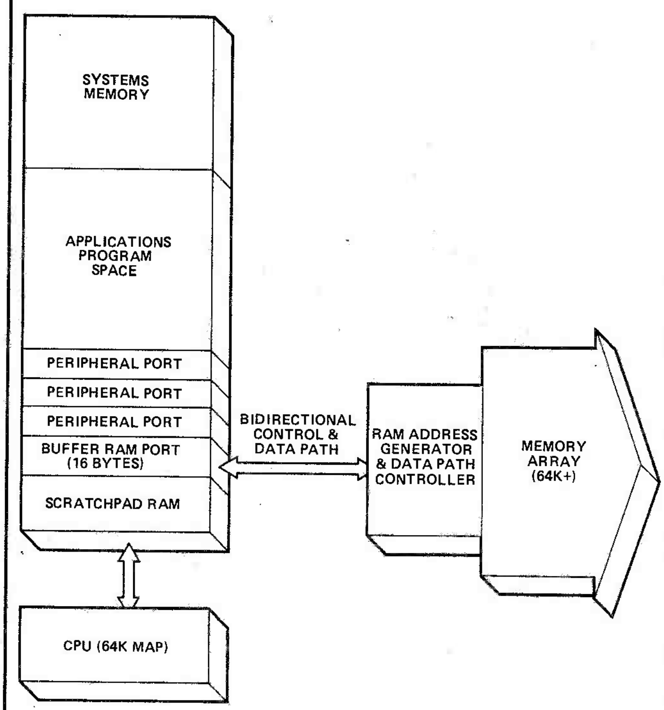

Fig. 1 Ported buffer configuration.

Second Processors

The second processor (Fig. 2) is essentially a special case of the multi-processor concept. Its aim is twofold: to increase the effective program and/or data memory of a limited map CPU, and to allow the running of non-native applications code.

Either or both these aims may be fulfilled in any given installation. The principle is that the second processor takes over the running of the application, while the primary processor performs the relatively simple but time-consuming tasks associated with I/O: keyboard input, printer output, disk storage, and so on. This not only relieves the second processor of interruptions and delays, but in addition releases for other uses the memory areas that would otherwise have to contain the I/O drivers and associated housekeeping code. A good example of this is the running of CP/M on the Z80 second processor with the BBC micro.

The idea is not a bad one in principle, but it has a few drawbacks for post-implementation. In order to install a second processor of this type, the original host (primary) processor has to be working in a software environment which was created with a second processor in mind. Also, to write applications software which makes full use of the facilities available takes a great deal of systems knowledge. Both these cautions are due to the very general nature of the tasks being performed by both processors.

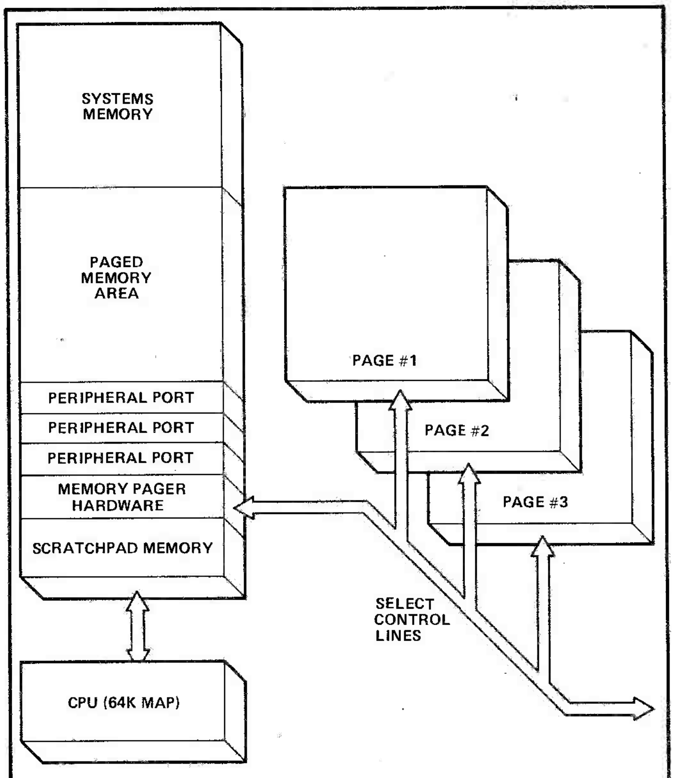

Fig. 3 Paged memory configuration.

As a generalised system, the second processor will not necessarily perform specific tasks at optimum efficiency compared with dedicated multi-processors, but on the whole it is probably a great deal better than nothing. Several DIY second processors have featured recently in ETI, and it is well worth a look back at the concepts embodied in them. (See, in particular, 'Second Processor For The Electron', June and July, 1985).

Paged Memory

Paged memory (Fig. 3) allows whole large areas of the procesor map to be replaced at will by others effectively wired in parallel. Whole or part applications can be rapidly exchanged for others during a program run. A high degree of consistency is required in the structure of software to be used in paged virtual memory systems, but the control overhead can be remarkably small. The BBC micro paged ROM system is an excellent example of the job done well. Commands included in different ROMs can be executed in succession, creating an effective program storage many times larger than the available real program memory.

Multiprocessors

The aim of a multiprocessor system (Fig. 4) is to enhance overall system performance by allowing dedicated sub-systems to handle specialised tasks concurrently and independently.

Significant losses of system efficiency occur when data has to be transmitted to and from the real world. The majority of I/O is painfully slow by CPU standards, due to its reliance on mechanical devices, with all their attendant problems of inertia, wear and tear and bits of carpet fluff. Some really complex maths problems can, if implemented in software, tie up the arithmetic logic unit and its associated areas for long periods, leaving the remainder of the system idle. It may also be necessary to acquire and/or transmit information asynchronously with a primary task, or in such volume that the memory constraints of the primary processor cannot accommodate it.

These problems can frequently be eliminated by the efficient linking together of single function subsys-

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There is nothing to prevent the expansion of almost any 8-bit home micro into . . . an advanced, fast and complex system . . .

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tems whcih can perform the time-wasting or otherwise impossible operations concurrently with, and independently of, other primary processor operations.

An excellent everyday example of this is the printer buffer (see ETI, July and August, 1985). The dedicated system emulates a printer port as far as the primary processor is concerned, but can accept data as fast as it can be sent, rather than at the mere 100 or so characters per second of the mechanical printer.

A floppy disk controller chip is also a single function sub-system, although this is less obvious at first sight. In this case it normally shares the primary processor memory (either by primary processor intervention or by direct memory access — DMA), but the principle is the same. Without the FDC, the micro's CPU would have to send all the drive head stepping pulses with their associated timing, load and unload the heads, test the index pulses and write protect signal, identify the track and sector ID references and compute the CRCs. Some additional means of parallel/serial conversion and back would also be needed. This is altogether a massive task, which would take a great deal of the primary CPU time to perform without an FDC.

Multi-User and Multi-Tasking

These are two increasingly common buzz phrases, primarily of interest in the office environment, where they improve throughput and assist the efficient use of expensive peripherals such as Winchester disks and high speed printers. Either several workstations or terminals (multi-user) or several independent tasks on one micro (multi-tasking) are performed concurrently by multiplexing so that most of the hardware is active most of the time.

The principles are quite simple, but the adaptation of small systems to work in this way is probably too much effort for the return from a system not designed with multiplexed operation in mind.

Home micro users should consider enhancement of their systems primarily from the hardware standpoint. Adaptation of the operating system, apart from being frowned upon in the current contentious atmosphere surrounding the copyright situation, is really a very difficult job. The level of familiarity required to do it properly would enable the user to make a start on their own independent OS, and if you could do that, you would be unlikely to be reading this article!

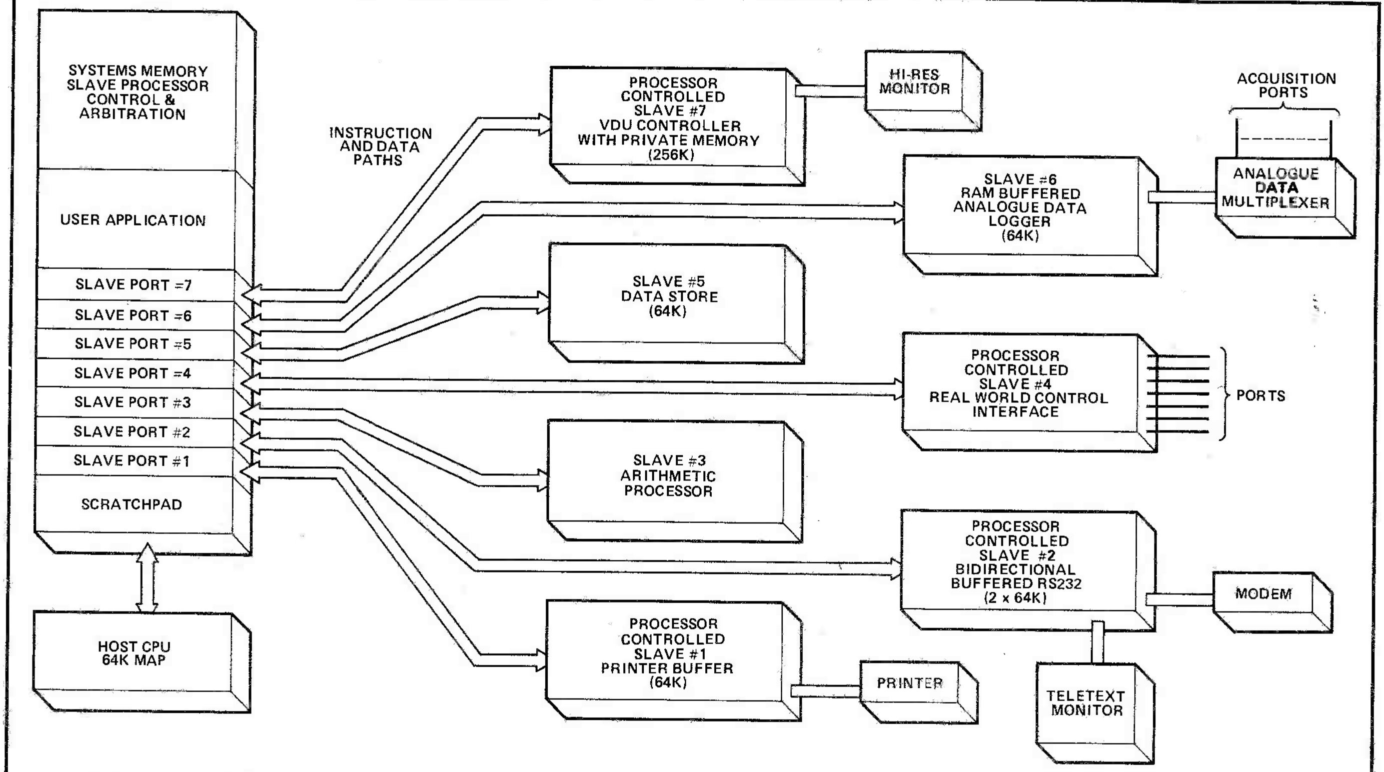


Fig. 4 Typical multi-processor system configuration.

The host (primary processor) software required to drive any extensions should be minimal, so we are really left with the addition of dedicated single function (possibly processor-controlled) sub-systems, allowing concurrency of independent tasks, controlled ideally by no more than short instruction sequences from the primary processor. Interdependent tasks performed in this way require more careful control in the time domain, but the problems are by no means insuperable.

Key Functions

The key to optimisation is to identify those functions of the overall system which are invariable or could advantageously be operating concurrently with other tasks. These will normally include:

1. Data file I/O operations via mechanical devices which constrain the processor system to low fixed transfer rates, frequently asynchronous with the system timing.
2. Protracted arithmetic on volume data (for example, encryption/decryption) where long delays can occur between provision of data and obtaining a valid 'answer', and where hardware arithmetic can substantially improve throughput.
3. Real world data interfaces such as analogue data logging where data may be presented unexpectedly or at high asynchronous rates, and are lost if the interface is not serviced in time.
4. Control interfaces to motors and experimental rigs where the control consists of the sending of one or two mode instructions followed by long sequences of, say, serial pulse trains which could be readily generated by simple hardware.

In the forthcoming parts of this series I will be discussing ideas for systems building blocks suitable for these and similar tasks. Design notes will cover inter-systems ports, buffer memory, hardware handshaking.

The 6500 series processor will be used as a model when specific details are called upon, as these processors are about the simplest in structure, but operate in a manner typical of the majority of 8-bit CPUs used in home micros.

Next month I will be concentrating on efficiency, reliability and dynamic investigation of microsystems, systems watchdogs and guidelines for a DIY logic analyser.

In the meantime, get out your micro technical manual and familiarise yourself with the address map.

Home micro users should consider enhancement of their systems primarily from the hardware standpoint . . .

Make notes first on the locations of designed-in 'user areas' dedicated to both RAM and I/O, and then on functions which you would like to see enhanced. For example, if you need a fast A-to-D interface (around 50kHz acquisition rate) it is worth considering exchanging it for the slow one built into your micro already.

Once you have a general idea of the address map which is free for post-expansion, the best approach can be defined. If your list is very short, the only answer is really to add intelligent peripherals, and finish up with a multi-processor system. Even if your list is quite long, this is, in my opinion, still the most exciting alternative.

ETI

THE SHOW MUST GO ON

Display technology is such a fast moving field that we felt it worthwhile to get up to date with some very recent developments. Keith Brindley was at the latest trade show in the cause of further enlightenment.

It's only right that we should give priority to age, and the CRT is certainly getting on a bit. It has been around for a hundred years or so in one form or other, although only as a display device in televisions since about 1930.

The resolution of a CRT display is dependent primarily on the distance between the phosphor spots produced by the electron beam as it forms the picture. In a colour CRT, the resolution depends on the distance between triads of primary colour spots, which in turn is dependent on the accuracy of the shadow mask used to direct the three beams to their respective colour phosphors. CRTs with spot distances (known as pitch sizes) of as small as 0.2mm have been made, but typical television CRT displays have pitch sizes of about 0.6mm. In terms of resolution, the CRT has a way yet to develop, but we can expect television pictures of tremendous clarity from high resolution CRTs.

The problems associated with CRTs are not to do with picture clarity. They are large, ungainly and heavy; their depth is often as big as or greater than the screen size. They consume a lot of power — up to 200 watts or so. They are fairly easily damaged. None of this is any great disadvantage for mains-powered, fixed-site equipment, as long as you don't mind your television taking up all of the corner of the living room, or your computer taking up most of the room on your desk. If lightness, durability, and power consumption are important, then the conventional CRT will not do.

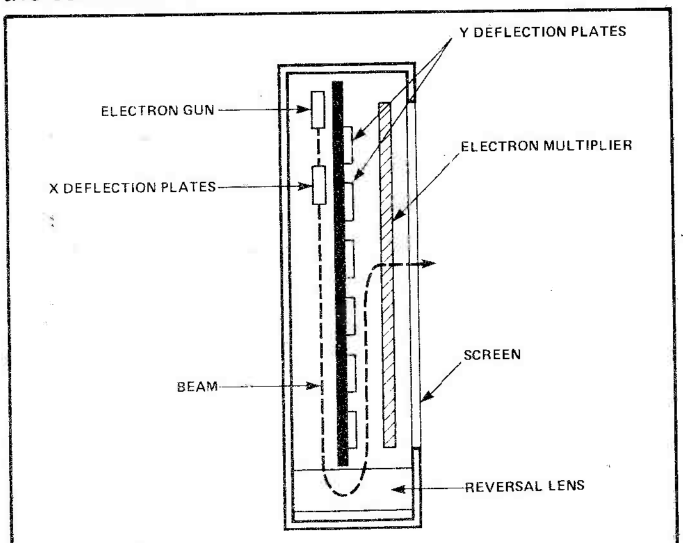
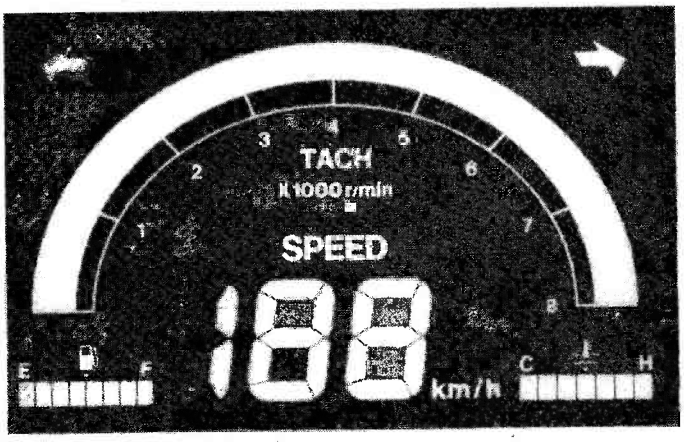


Fig. 1 Philips flat-screen CRT (simplified).



The latest from Epson — the high-contrast 'Black Shutter'.

Sinclair's flat-screen CRT is one development of a traditional technology. As it stands, however, the device — though ingenious — is monochrome, difficult to view and constrained by its very ingenuity to remain small. Philips is one company developing a flat-screen colour CRT. While similar to the Sinclair device in that the electron beam is side-projected, it is totally different in other respects (Fig. 1). The Sinclair tube uses a familiar electron gun bent through 90°. To engineer such a tube for the accuracy required of colour television would be very difficult. Philips use a single electron beam — like Sinclair but it scans at three times the normal rate, so it can cover all three spots in a colour triad. It also has an unusual approach to deflection. After reversal of the beam, frame plates bend it to the required spot on the screen. Before hitting the screen the beam passes through an electron multiplier, increasing the number of electrons and so making a brighter spot. ITT and Siemens are the other two companies working on the developments of flat-screen colour CRTs.

The Liquid Crystal Ball

Apart from dabbling at new developments in CRTs (Sony's Trinitron CRT — a single electron beam device — and Toshiba's flatter, squarer tube) the Japanese appear to be leaving major CRT developments such as flat-screen devices well alone. Instead they are concentrating afforts towards *flat-panel* displays which do not use electron beam at all.

The main force of their work so far has been in the devel̀opment of LCD devices, but other technologies will probably form the display devices of the future.

There are a number types of LCDs, but the principle is the same in all of them (Fig. 2). A layer of liquid crystals is sandwiched between two transparent electrodes. The molecules of the liquid crystals are generally aligned in one direction and so light from behind the device can pass through. When a potential is applied across the electrodes, however, the molecules of the crystals all became polarised into another alignment, which prevents light from passing through the layer, making the layer appear dark.

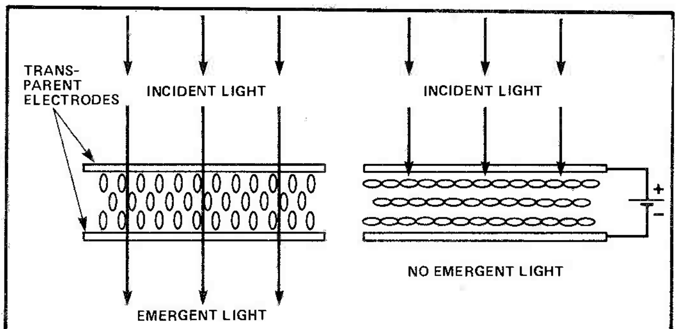


Fig. 2 LCD operation.

Three main varieties of liquid crystal are used to make LCDs: nematic, cholestric and smectic (Fig. 3). The major difference is in how the molecules are aligned, and this produces greatly different LCDs.

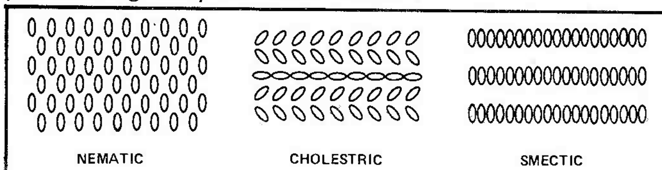


Fig. 3 Temperature dependent structures in liquid crystal.

Nematic liquid crystals are more commonly called 'twisted nematic' crystals, because the crystals sandwiched between the transparent electrodes are twisted through 90° between one electrode and the other when no potential is applied. Polarising sheets (at 90° to each other) are applied at the front and back of the device, so that light entering the LCD is polarised in one plane by the first polarising sheet, passes through the liquid crystal where it is twisted through 90° by the twisted nematic struture, then leaves the device through

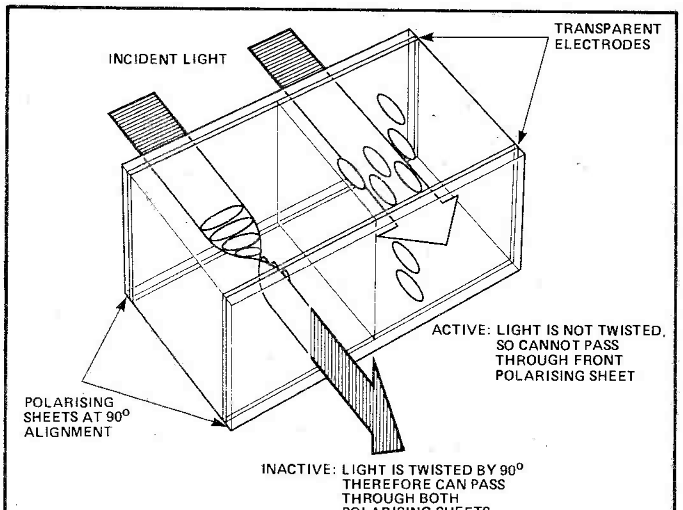


Fig. 4 Twisted nematic LCD.

the second polarising sheet (Fig. 4). Typically the LCD wouldn't normally be used like this, but a reflecting surface would direct the emergent light back through the set-up, so that an observer on the same side as the incident light would see a 'transparent' area.

When a potential is applied across the electrodes, the crystal becomes active, and the molecules are all aligned in one direction. The incident light, which is polarised by the first sheet, now passes through the liquid crystal without beng twisted. It cannot pass through the rear polarising sheet, cannot be reflected, and therefore cannot be seen by the observer. An opaque area is produced.

Cholestric crystals do not need polarising sheets since a dye is added to the liquid crystal to absorb the incident light. LCDs using this principle are sometimes known as 'guest-host' devices. Dichroic dyes, which produce a different colour depending on which way their cells are aligned, are the 'guests' in the liquid crystal 'host'.

In an inactive state, incident light passing through the liquid crystal is polarised by the natural twist in the structure, and because of the dye the emergent light appears coloured (Fig. 5). As with twisted nematic LCDs, when the activating potential is removed the structure reverts back to its inactive, though this time coloured, state.

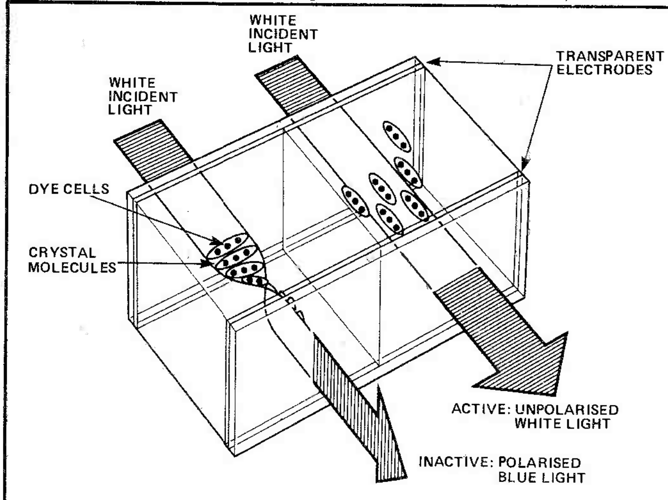


Fig. 5 Cholestric LCD.

Heat Waves

All liquid crystals have several temperature dependent phases, in which the ordering properties of the molecules change. Three phases: isotropic, nematic and smectic are used in smectic liquid crystal devices to create a different type of LCD. Smectic LCDs rely on three phonomena to do their job:

1. In the smectic phase, the molecular arrangement of the liquid crystals cannot be changed by an applied electric field.
2. When liquid crystals are heated to the isotropic phase then cooled to the smectic phase with no applied electric field, they become strongly disordered.
3. When heated to nematic phase, then cooled with an applied electric field to the smectic phase, the orientation of the molecules will be as in the nematic phase.

To exploit these phenomena, smectic LCDs use a matrix of electrical lines so that each display element in the display can be addressed and heated electrically.

By heating the liquid crystals to the isotropic phase, then cooling them to the smectic phase, incident light is prevented from passing (Fig. 6). By heating the crystals to the nematic phase, applying an electric field to align the molecules, then cooling to the smectic phase, incident light is allowed to pass.

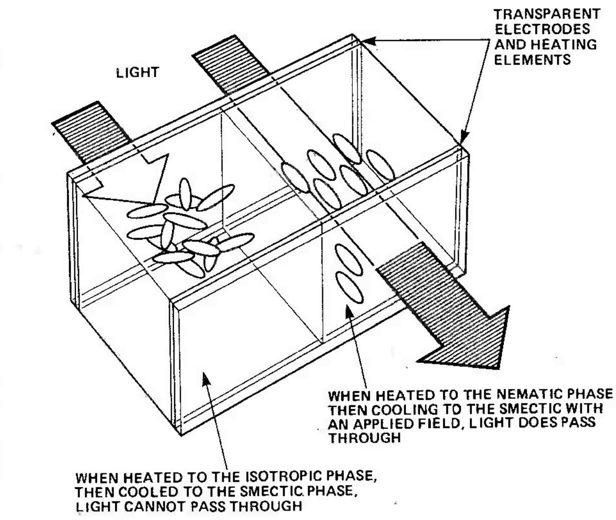


Fig. 6 Smectic LCD.

The really clever bit is that by maintaining the temperature so that the liquid crystal is held in the smectic phase after it has cooled from an isotropic or nematic phase the crystal molecule arrangement remains fixed at what it was, prior to cooling. Smectic LCDs have a memory facility so that removing the 'addressing' potential has no effect. To change the molecuar arrangement requires a further addressing, heating, and cooling procedure.

Most of the work currently being undertaken into computer-type LCDs is along the smectic lines. One of the latest LCD developments is STL's smectic-A 760 x 420 pixel prototype display which, it is hoped, will be on the market soon.

Colour LCDs

The LCD techniques we've looked at so far have been for dot-matrix displays — ideal for computers but not so good for televisions. There are three reasons for this. First, the displays are monochromatic — and who wants a black-and-white television? (Well, Sir Clive?) Second, the display type is dot-matrix — each dot can only be on or off, unlike CRT screen spots which are graduated in brightness. Most important is the response time of these devices (the time it takes for the device to switch between active and inactive states). Common response times are around 300ms — great for computer or alphanumeric displays, but certainly not fast enough for television where each spot on the CRT screen is addressed by the electron beam every 40ms.

Two of these problems, colour and response time, are being tackled by a number of Japanese manufacturers with LCD devices which use thin-film transistors (TFTs) mounted directly on the glass which forms the casing to contain the liquid crystal. The transistors are thus in direct contact with the crystal itself (Fig. 7).

The use of TFTs dramatically reduces the LCD response time, down to a level approaching that required to display television pictures. By making an LCD element so small that it can be considered as a spot,

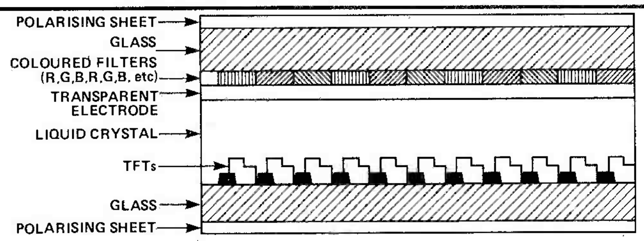


Fig. 7 Thin film transistors speed up response time.

and by grouping three spots into triads, coloured filters can be placed over the individual spots so that the triads can be addressed much like the triads of a conventional CRT. And, hey presto, we have an LCD colour television display device.

A number of Japanese manufacturers, notably Sanyo, Casio, and Citizen, have recently shown prototypes of colour television using this method. Sanyo's, the largest, is a 4 inch display. The Epson Elf, a colour television with a 2 inch display, was the first to be produced and has been on sale abroad for a year or so already.

The resolution of these displays is limited by the number of liquid crystal triads which can be produced in the device. At present the resolution doesn't even approach that of typical low-grade television CRTs, but it is only a matter of time — and research money.

Size is probably the colour LCD's greatest enemy. The quality of the colour display is limited by the constancy of the thickness of the layers in the device. The larger the device, the more difficult it becomes to maintain constant thickness. So, no wall-sized flat-panel television screens using LCDs yet, I'm afraid.

Flat Contender

A contender in the race to beat the CRT as the only viable television display device is the electroluminescent (EL) flat-panel. Electroluminescence occurs when certain phosphorescent materials are influenced by an electric field.

Figure 8 shows a cross-section of an EL display, with criss-crossed electrodes allowing each point where two electrodes overlap to be addressed. The material sandwiched between the layers of electrodes is typically zinc sulphide, which emits a bright yellow-orange colour when an electric field is generated through it, but red, green and blue emitting materials have recently been isolated.

EL displays are of four main types: DC thick-film, AC thick-film, DC thin-film, AC thin-film. Thin-film varieties have proved to be the most successful so far, in terms of reliability and power requirements. In these, a layer of powder phosphor, typically around 30μm thick is deposited onto a sheet of transparent oxide which forms the front electrode. This layer is then covered by a vacuum evaporated aluminium rear electrode. After

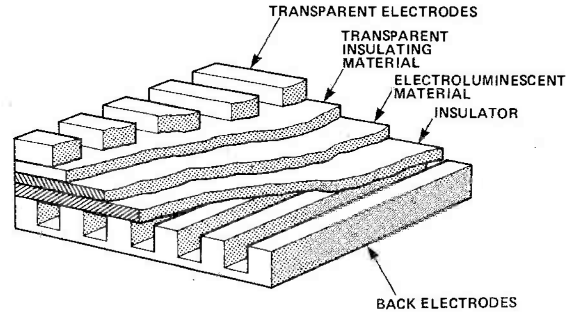


Fig. 8 Structure of electroluminescent display.

etching horizontal and vertical rows and columns into the front and rear electrodes, the device is more or less usable.

Such displays are of monochromatic dot-matrix form suitable for alphanumeric computer displays and graphics. By overlaying thin-films of red, blue and green emitting phosphide layers, there is hope that EL displays suitable for reproduction of coloured television pictures can be made. Their availablity on a commercial basis is many years off yet.

EL displays generally need quite a high operating voltage (over 100V) and considerable current, so they are probably not the display to be used in portable equipment, but for flat-panel home or office use their potential is great.

Plasma Gas Discharge

Plasma gas discharge of inert gases under a strong electric field is the basis of another type of flat-panel display — the plasma display panel (PDP). The gas breaks down into a plasma and gives off light. Neon indicators work in the same way.

The two main varieties of PDP differ in the applied voltages. In the DC plasma display the criss-crossed electrodes are in direct contact with the gas. In the AC plasma display, the electrodes are close to the gas but electrically isolated from it (Fig. 9).

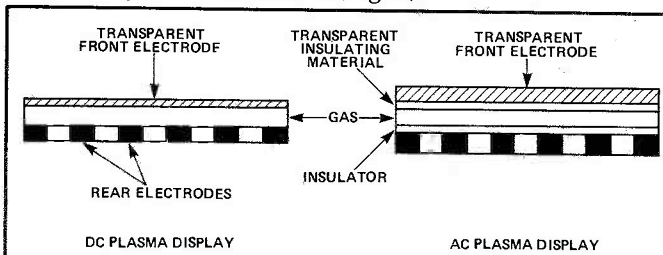
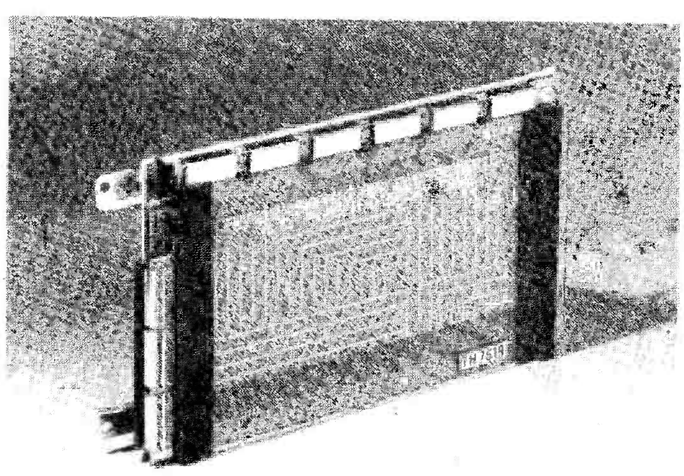


Fig. 9 DC and AC plasma displays.

Large sized PDPs have been developed, initially for military use, and now available on a commercial basis and used in many computers. Thomson-CSF, for example, has recently produced a 1024 x 1024 dot-matrix PDP display, whose resolution is not far short of a CRT.

PDP displays still have many disadvantages. Operating voltages are quite high (typically around 80V),



Thompson-CSF compact 96 x 200 dot graphic AC plasma display.

they're not solid-state devices and can't be as rugged as LCD or EL displays. Colour dispays suitable for television use are going to be difficult, if not impossible, to make.

ECDs

One new form of display device, just now reaching the market, looks as though it might topple the CRT in years to come. The electrochromic display (ECD) uses the fact that an electrochromic material changes its colour reversibly by redox reaction.

For example, amorphous tungsten trioxide (a-WO_3) turns reversibly from transparent to blue by reacting with lithium ions in an electrolyte, following the formula:

$$WO_3 + Li^+ + e^- \upsilon LiWO_3$$

A simple display is illustrated in Fig. 10.

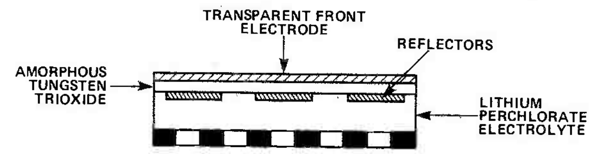


Fig. 10 A simplified electrochromic display.

This display is much simpler in operation than an LCD, and would be much cheaper to make. It does, however, have significant disadvantages, not the least of which is its response times (over half a second to change from white to blue, and over two seconds to change from blue to white!) Significant development work is underway, and it's probably true to say that ECDs are only at the stage which LCDs were at 15 years ago (nowhere). Given a few years and some hard research and development...

Old And New

The problem for manufacturers is not just one of research and development because other factors, mainly financial, are also involved. CRTs are an old technology. They've been made for many, many years by experienced manufacturers. They are used mainly as a television display device, but they're also used in test equipment — oscilloscopes, spectrum analysers, logic analysers and frequency response analysers — as well as in computers. Because of the numbers involved and because of tried and tested manufacturing techniques, they are very cheap.

Flat-panel displays, on the other hand, are new. They're relatively difficult to make and therefore expensive. So, manfacturers are going to be very careful to analyse the situation before they decide on any one other display technology which they think can fit the bill. No one display technology is yet capable of being better than the CRT in *all* applications. LCDs use much less power, but they have a very restricted viewing angle, low contrast, and can't be viewed in the dark (they are a non-emissive technology); EL displays are much thinner and are an emissive technology, but their power requirements are not much less than those of the CRT. ECDs are thin, have a wide viewing angle and high contrast, but they still have an unacceptably long response time.

At present, CRTs are unbeatable because technology rides on the back of its own success. New developments such as flat-sceen, low-powered, high resolution colour CRTs will be along soon. But time is the CRT's own worst enemy. Given a few years, easier manufacturing techniques and lower manufacturing costs, flat-panel displays must surely beat and CRT. The questions are: which flat-panel device will do it — and when? **ETI**

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BETTER BY DESIGN

Even professionals make mistakes, and Andy Armstrong is not afraid to point out some of the commonest. If you're thinking of designing a circuit, the best place to start is here. . .

After inspecting many designs at the draft stage, it is clear that there are some misunderstandings and design errors which crop up again and again. Some aspects of circuit design, for reasons unknown, seem to be ignored or glossed over by even the most seasoned practitioners.

Most of the problems fall into the category of 'things which will work most of the time or work with certain samples of the components used'.

A typical example was faced by a friend of mine, in a vacation job after his second year at college, and involved unijunction transistors. Someone had designed (by dint of sheer building) a control unit, incorporating a unijunction, for an electric arc welder. The first production batch of welders worked very well, but none in the second batch worked at all.

It turned out that the circuit had been optimised, by trial and error, to work with a batch of unijunctions which were at the edge of the specification. The next batch purchased had more typical characteristics, and the circuit could not cope. The configuration of the circuit was not designed to take account of the tolerances of unijunctions but a change of component values centred the circuit on the typical operating parameters. Subsequently only one component value had to be changed if a batch of unijunctions was too far from typical.

Design Posts

Nobody expects magazine projects to be designed to industrial standards, (*although we prefer it if they are — Ed.*). This would be uneconomic, because of the very large amount of time required to design even a simple circuit to production standard, and because of the need to make more than one prototype to double check a design. These limitations notwithstanding, a project design needs to be as close in standard to an industrial design as possible, and should, in particular, avoid problems connected with variations in the electrical and mechanical characteristics of components.

Of course, there are differences in emphasis. For example, a circuit may rely on a particular component characteristic, perhaps requiring that two diodes have a similar voltage drop at a certain current. The home constructor could happily select the components but, in an industrial design, the cost of paying someone to grade components would mean that the real price of a 5p diode would be a lot more than 5p!

On the other hand, if too much decision-making on the part of the constructor is necessary to make a project work, then some of the people who build it will simply never succeed.

Family Characteristics

Many of the marginal designs I have encountered have used CMOS, so this is the place to start.

The 4000 range of CMOS is designed to work over a wide range of power supply voltages. Different manufacturers specify slightly different operating characteristics at different voltages, but here I shall refer to the Mullard/Signetics HEF4000B range. Some of the family specifications are reproduced here for reference.

Logic

CMOS: HEF4000B family book 4 part 4

Family Specification
D.C. characteristics V_{ss} = 0 V; for all devices unless otherwise specified

parameter	V_{DD}	symbol	T_{amb} (°C) −40 min.	−40 max.	+25 min.	+25 max.	+85 min.	+85 max.	unit	conditions	
Quiescent device current											
gates	5	I_{DD}	—	1,0	—	1,0	—	7,5	μA		
	10		—	2,0	—	2,0	—	15,0	μA		
	15		—	4,0	—	4,0	—	30,0	μA		
buffers, flip-flops	5	I_{DD}	—	4,0	—	4,0	—	30	μA		
	10		—	8,0	—	8,0	—	60	μA		
	15		—	16,0	—	16,0	—	120	μA	all valid input combinations:	
MSI	5	I_{DD}	—	20	—	20	—	150	μA	$V_I = V_{SS}$ or V_{DD}	
	10		—	40	—	40	—	300	μA		
	15		—	80	—	80	—	600	μA		
LSI	5	I_{DD}	—	50	—	50	—	375	μA		
	10		—	100	—	100	—	750	μA		
	15		—	200	—	200	—	1500	μA		
Output voltage LOW	5	V_{OL}	—	0,05	—	0,05	—	0,05	V		
	10		—	0,05	—	0,05	—	0,05	V	$V_I = V_{SS}$ or V_{DD}	(1)
	15		—	0,05	—	0,05	—	0,05	V		
Output voltage HIGH	5	V_{OH}	4,95	—	4,95	—	4,95	—	V		
	10		9,95	—	9,95	—	9,95	—	V	$V_I = V_{SS}$ or V_{DD}	(1)
	15		14,95	—	14,95	—	14,95	—	V		
Input voltage LOW (buffered stages only)	5	V_{IL}	—	1,5	—	1,5	—	1,5	V	V_O = 0,5V or 4,5V	
	10		—	3,0	—	3,0	—	3,0	V	V_O = 1,0V or 9,0V	(1)
	15		—	4,0	—	4,0	—	4,0	V	V_O = 1.5V or 13.5V	
Input voltage HIGH (buffered stages only	5	V_{IH}	3,5	—	3,5	—	3,5	—	V	V_O = 0,5V or 4,5V	
	10		7,0	—	7,0	—	7,0	—	V	V_O = 1,0V or 9,0V	(1)
	15		11.0	—	11,0	—	11,0	—	V	V_O = 1,5V or 13,5V	
Input voltage LOW (unbuffered stages only)	5	V_{IL}	—	1	—	1	—	1	V	V_O = 0,5V or 4,5V	
	10		—	2	—	2	—	2	V	V_O = 1,0V or 9,0V	(1)
	15		—	2,5	—	2,5	—	2,5	V	V_O = 1.5V or 13.5V	
Input voltage HIGH (unbuffered stages only)	5	V_{IH}	4	—	4	—	4	—	V	V_O = 0,5V or 4,5V	
	10		8	—	8	—	8	—	V	V_O = 1,0V or 9,0V	(1)
	15		12,5	—	12,5	—	12,5	—	V	V_O = 1,5V or 13,5V	
Output (sink) current LOW	5	I_{OL}	0,52	—	0,44	—	0,36	—	mA	V_O = 0,4V: V_I = 0 or 5V	
	10		1,3	—	1,1	—	0,9	—	mA	V_O = 0,5V: V_I = 0 or 10V	
	15		3,6	—	3,0	—	2,4	—	mA	V_O = 1,5V: V_I = 0 or 15V	
Output (source) current HIGH	5	$-I_{OH}$	0,52	—	0,44	—	0,36	—	mA	V_O = 4,6V: V_I = 0 or 5V	
	10		1,3	—	1,1	—	0,9	—	mA	V_O = 9,5V: V_I = 0 or 10V	
	15		3,6	—	3,0	—	2,4	—	mA	V_O = 13,5V: V_I = 0 or 15V	
Output (source) current HIGH	5	$-I_{OH}$	1,7	—	1,4	—	1,1	—	mA	V_O = 2,5V: V_I = 0 or 5V	
Input leakage current	15	$\pm I_{IN}$	—	0,3	—	0,3	—	1,0	μA	V_I = 0 or 15V	
3-state output leakage current: HIGH	15	I_{OZH}	—	1,6	—	1,6	—	12,0	μA	output returned to V_{DD}	
3-state output leakage current: LOW	15	$-I_{OZL}$	—	1,6	—	1,6	—	12,0	μA	output returned to V_{SS}	

Note: (1) = $|I_O| < 1 \mu A$

66

Family specification of HEF4000B devices(with thanks to Mullard).

A number of circuits use a CMOS gate output to switch a transistor, which is used to control a relay, lamp, etc. Normally, a small signal transistor such as a BC182 is used to drive the load and, in order to work well, the transistor must be switched on hard. This requires adequate base current — a rule of thumb is to use a base current of 0.1 times the required collector load current. This can exceed the current which the gate is guaranteed to supply, though in fact most gates manage well over the minimum specified current.

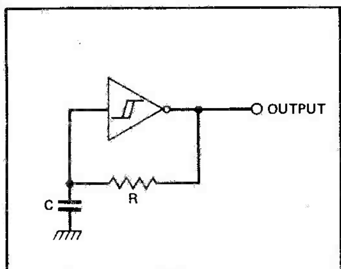
It is not a good idea to rely on your good fortune in selecting a gate. Back on the industrial front, I recently had to investigate a rash of mysterious board failures, and discovered that one of the CMOS gates was beings asked to deliver about twice its guaranteed output current. After a while, most gates from one batch failed, though the design had been produced without problems for several years beforehand. Presumably this batch of gates was unable to exceed its specification without damage.

To avoid this sort of problem in home projects, a CMOS gate sourcing current should have a load resistance of at least 1kΩ per volt of power supply. If this means that the transistor it is feeding receives insufficient base drive to switch properly, then the answer is to use a Darlington transistor, or two transistors connected as a Darlington pair.

Most of the problems fall into the category of 'things which will work most of the time or work with certain examples of components used'. . . .

Alternatively, you could use a power FET suitable for the desired load current. A power FET capable of switching several amps may be driven directly by a CMOS gate. The switching speed may be low, because of the limited rate at which the CMOS output can charge or discharge the FET gate capacitance. The heavy load presented to the CMOS gate output by this capacitance is of short enough duration not to risk damaging the CMOS chip unless a high frequency switching signal is used.

There is one exception to these stern warnings about overloading CMOS outputs. When powered from a 5V supply, most CMOS chips are designed to be 'short circuit proof'. The practice of driving an LED from the output of a CMOS gate should not be harmful at this supply voltage, though the output will not provide a proper logic level when used in this manner. My recommendation is that this practice be confined to 'novelty' circuits, such as the infamous Thing.



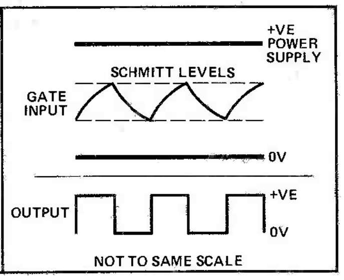


Fig. 1 Simple Schmitt oscillator. Fig. 2 Waveform diagram.

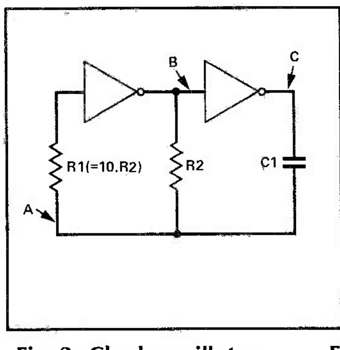
Clock Oscillators

Many projects incorporate some sort of oscillator, which may be needed to clock a counter, or to generate an audible tone. Figure 1 illustrates a simple oscillator circuit, using a Schmitt trigger IC. As shown in the waveform diagram, Fig. 2, the capacitor charges through the feedback resistor until the voltage on it reaches the positive threshold of the Schmitt trigger gate. The output of the gate then switches to logic 0 and the capacitor starts to discharge until it reaches the lower Schmitt threshold.

There are two drawbacks to this circuit. The Schmitt levels may vary widely from batch to batch of the chip, and the output frequency of the circuit is directly dependent on these levels. Also, the threshold levels are not symmetrical with respect to the power supply (the characteristic of Schmitts known as hysteresis), so the mark-to-space ratio of the output wave is not unity. If the mark-to-space ratio is not important, the circuit may be made more acceptable by the addition of a potentiometer to fine tune frequency.

Some aspects of circuit design seem to be ignored or glossed over by even the most seasoned practitioners. . .

A more consistent circuit is shown in Fig. 3, and its waveform diagram in Fig. 4. The junction point of R2 and C1 alternately takes up voltages outside the power supply rails, and then charges or discharges to approximately half the power supply voltage. Because the voltage range over which the capacitor works is large, small differences in switching level between different samples of chip do not have much effect on the frequency or the mark-to-space ratio. The frequency is approximately 1/(2.2 x R2 x C 1).



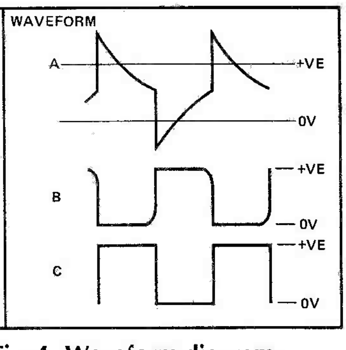


Fig. 3 Clock oscillator. Fig. 4 Waveform diagram.

Many project designers omit the resistor R1. If this component is omitted, then the junction of R2 and C1 is prevented from taking up a voltage outside the supply rails by the input protection diodes of the CMOS gate. The frequency is approximately three times the frequency given if R1 is included (and if R1 is, as specified, ten times R2). Variations in switching levels or gain between samples of chip now have a more significant effect, so the net effect is to decrease the predictability of the circuit's performance.

If very high value resistors are used in the circuit, then high frequency noise pickup on the input connected to R1 may be a problem. In this case, rather than lower R1 and make the operation less predictable, a capacitor of a few hundred picofarads may be added in parallel with R1. Practice has shown that this always solves the problem without any detectable effect on the correct operation of the circuit.

In some project designs, NOR or NAND gates are used instead of inverters. The 'spare' inputs may be used to gate the oscillator and turn it on or off in response to a logic signal. A logic 0 signal will stop a NAND gate oscillator, while a logic 1 will stop a NOR gate oscillator. If it is necessary to start to clock a counter immediately the oscillator is started, then the rest of the oscillator should be considered. For example, if the signal is generated by pressing a switch, the response should be immediate or the user may begin to wonder if it is working.

Data books never claim that a circuit will work precisely as well under all circumstances. . .

The circuit shown in Fig. 5 will generate a positive edge on its output immediately a logic 0 is applied to its control input. By its nature, the circuit in its inhibited state will always charge its capacitor in such a way that it ready to switch as soon as it is allowed to do so.

Op-Amps

The correct use of op-amps is another area which seems to be difficult for some project designers. There are several aspects which cause problems.

First of all, some designers simply fail to take account of the input bias and offset current. If a bipolar op-amp is used, the bias resistors should be of a low enough value that the voltage drop in them is small. I recall seeing a reader's circuit in one electronics magazine, showing a 741 connected with all the bias current for the negative input flowing through a 4M7 resistor.

A good rule is to make the bias resistors as low as the rest of the circuit design allows, and to make the total DC resistance connected to each input the same. In this way, the difference in voltage between the two inputs (the offset) is determined by the difference in bias current between the two inputs (the input offset current) rather than the total bias current. If the offset is still too large, then a FET input amplifier should be used.

The open loop gain of an op-amp also seems to confuse some people. The text of the reader's circuit mentioned above stated, 'the maximum gain of a 741 is quoted as 20,000, but in this circuit it is wired to provide a gain of 47,000'. This mistake arises from a misunderstanding about the way the op-amp's gain is determined. The gain is determined by the ratio of the two feed back resistors in the circuit. You can use any ratio you please, but you cannot make the op-amp give more than its maximum open loop gain.

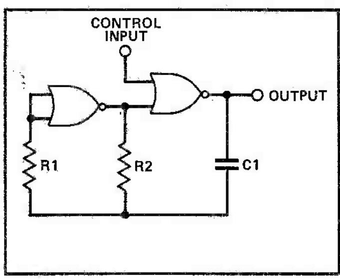


Fig. 5 An instant turn-on.

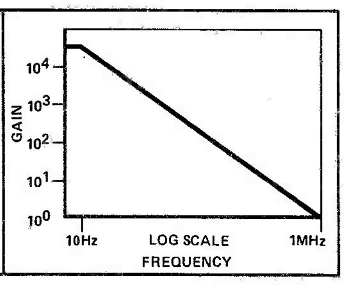


Fig. 6 Typical frequency response of an op-amp.

A typical op-amp frequency response is shown in Fig. 6. There are two relevant and related factors, the open loop gain and the gain-bandwidth product. The open loop gain defines the maximum low frequency gain the op-amp can produce under any circumstances, and the gain-bandwidth product indicates the increase in gain with decreasing frequency.

An op-amp having a gain-bandwidth product of 1MHz, for example, will have an open loop gain of unity at a frequency of 1MHz. As the frequency is decreased, this gain will rise until the maximum open loop gain is reached, often at a frequency of about 10Hz.

Totally Slewed

The effects of output slew rate limiting and of power supply variations on op-amp characteristics are clearly illustrated by a mistake of mine, made when 741s were the normal choice of op-amp for any task. In a car project, I used a 741 to clock a CMOS counter. According to the data books, the slew rate of the output of a 741 is inadequate to clock the CMOS counter reliably, but still the circuit seemed to work — at least some of the time. After a little experimenting, I found that the car battery voltage affected the circuit. It all worked well when the engine was running and the lights were turned off, but couldn't be relied on when the battery was being drained and its voltage dipped.

It seems that the op-amp's slew rate was slightly higher when the voltage was higher. This was just enough to make the counter clock on.

The moral of this is that the slew rate of the op-amp can be crucial, and that you should not assume that a characteristic which is specified to be just good enough with, say, +/- 15V power supplies will still be alright at lower voltages. This is true even though the op-amp may be specified to work at much lower voltages. Data books never claim that a circuit will work precisely as well under all circumstances.

Passive Components

There are two common areas of misunderstanding which I have noticed in the use of passive components. The problem with resistors is very simple: ordinary quarter-Watt resistors have too low a voltage rating to be connected to the mains. Resistors rated ½ Watt and greater have a higher voltage rating and are therefore generally okay to connect to the mains. The voltage rating of a resistor can limit the maximum power that can be fed into it to less than its nominal wattage rating.

The other point of misunderstanding is in the use of non-polarised capacitors on AC, specifically when connected to the mains. Most people realise that a capacitor to be used on AC should have a DC rating equal to the peak of the AC waveform, but the problem does not stop there.

At any significant frequency, above a few Hertz, the voltage which the capacitor can withstand is reduced, because the chemical bonds in the dielectric material are stressed first one way then the other by an AC waveform, and in this process power is dissipated. Weak spots in the dielectric can become hot spots if subjected to AC waveforms, and can subsequently break down. Dielectric materials with higher levels of AC power dissipation suffer from this problem more severely. Generally, polypropylene capacitors are much better than polyester, while ceramics come in widely varying qualities.

One type of polyester capacitor, for example, is rated at 400VDC, 150VAC at 50Hz. A high quality polypropylene capacitor in the same catalogue is rated at 1000VDC, 350VAC at up to 5kHz. Some mica capacitors are rated to handle substantial RF signals. **ETI**

CAPACITANCE METER MODULE

This free PCB project gives your multimeter extra capacity.

A multimeter is an essential item for anyone with an interest in electronics, but it has its limitations. Few will measure anything more than voltage, current and resistance, but there is no reason why this range should not be extended by the addition of a little extra circuitry. The module described in this project produces an output voltage proportional to the value of a capacitor connected to its terminals, and can be connected to a multimeter on a low voltage range to give direct capacitance readings. The accuracy is surprisingly good for such a simple circuit and you can have just as much confidence in the capacitance readings as you would in the meter's own resistance ranges.

Methods

Two common methods of measuring capacitance are the bridge method, which you can read about in the RCL bridge project (ETI August, 1985), and the monostable method. The bridge method is notionally capable of great accuracy, since its readings are independent of the accuracy of the meter movement, but the full potential is rarely realised in any but the most expensive instruments. Precision components must be used since the bridge effectively compares a known value and the unknown one at the terminals. The most awkward point, from a home construction point of view, is the need to construct an accurate scale for the balancing pot. If unlimited numbers of precision components are available, the scale can be calibrated directly. Otherwise the constructor is faced with the problem of trying to interpolate a highly non-linear scale between the readings that can be made. Unpredictable non-linearities in the pot itself make matters worse.

An attractive idea is to measure some circuit parameter which is related to capacitance, and thus derive a direct reading. A common method is shown in Fig. 1.

The monostable is triggered at regular intervals by a pulse from an oscillator. The monostable is designed to have a timing period proportional to the value of the timing capacitor, which is the unknown capacitor. Assuming the oscillator runs at a fixed frequency and the monostable output pulses are of constant amplitude, the mark-to-space ratio of the monostable output, and hence the average voltage across C1, will be proportional to the value of the unknown capacitor. R1 and C1 are chosen to give a reasonable compromise between ripple and settling time.

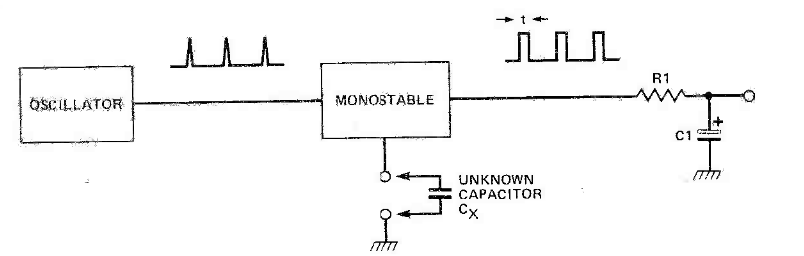


Fig. 1 Monostable capacitance meter.

This type of circuit can work well or not so well, according to the care taken over the design. One point to note, however, is that there are three circuit parameters which must be accurately controlled: the oscillator frequency, the output amplitude of the monostable, and the linear relationship between the unknown capacitor value and the monostable period. Drift in any of these will cause a proportional change in the output voltage. If the number of critical areas can be reduced, it seems reasonable to expect a corresponding improvement in the accuracy of the meter.

Without increasing circuit complexity, another arrangement is possible (Fig. 2a). The oscillator produces an output of constant frequency and amplitude which is applied via R1 to the unknown capacitor. When the oscillator output is low, Cx will discharge via D1. When the oscillator output rises, charge is transferred from Cx via D2 to C1. (R1 is just a current limiting resistor.) Assuming that the rise in voltage across C1 is negligible, the amount of charge transferred is easily calculated: it will be V.Cx, where V is the high output voltage of the oscillator. This charge transfer will take place f times a second, where f is the oscillator frequency, so the total charge transferred every second (in other words, the average current) will be f.V.Cx amps. The average voltage across R2 will therefore be R2.f.V.Cx volts. As R2, V and f are constant, the voltage across R2 will be proportional to Cx ... or will it?

The assumption I slipped in earlier on, that the rise in voltage across C1 should be negligible,

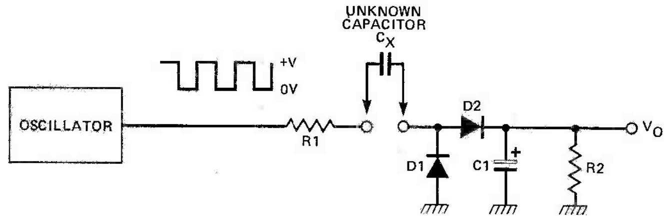


Fig. 2a Charge pump capacitance meter.

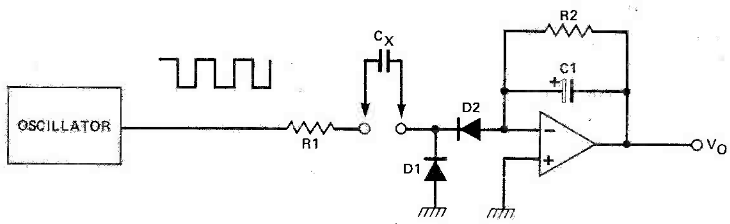


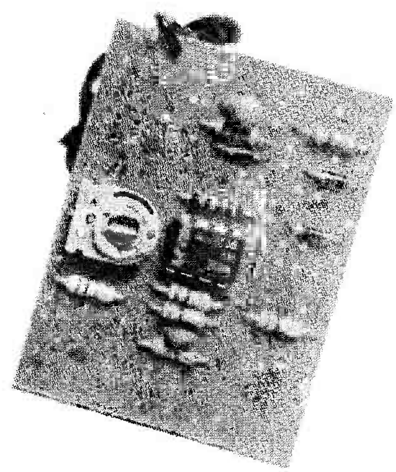
Fig. 2b Linear charge pump capacitance meter.

imposes an unfortunate restriction since this is the voltage used as an output. As it rises, it reduces the voltage available to pump charge through Cx and so, as the value of Cx rises, the corresponding increase in the output voltage gets progressively smaller. In other words, the relationship between capacitance and output voltage is not really linear at all. Reasonable results can be achieved by limiting the output to a low voltage (0 to 100mV, say) but to make the circuit truly linear Cx should transfer charge into a constant voltage.

In the diagram of Fig 2b, a virtual earth current to voltage converter has been added to provide a constant voltage point for the charge transfer, as in this project. The diodes have been reversed so that an increase in capacitance will still give an increase in output voltage. As the average current flowing from the virtual earth via D2 will equal the average current through R2, the output voltage is still equal to R2.f.V.Cx. C1 is chosen to give a reasonable settling time without excessive ripple and R1 is chosen so that R1.Cx is very small in relation to the oscillator period for the largest value of Cx to be measured, while limiting the peak current to a value that the oscillator output can cope with.

Circuit

The final circuit is shown in Fig. 3. IC1a forms the oscillator and IC1b the virtual earth current to voltage converter. The component values shown are for measurement of small capacitance values; RV1 is adjusted for an output of 1V per 100p, so on a 10V meter range you can make readings up to about 800p (remembering that the output voltage of the module is limited by the battery voltage) or readings of 0 to 100pF on a 1V meter range. As the output is linear, a reading of 2V2 would mean 220p, 4V7 will be 470p, and so on.



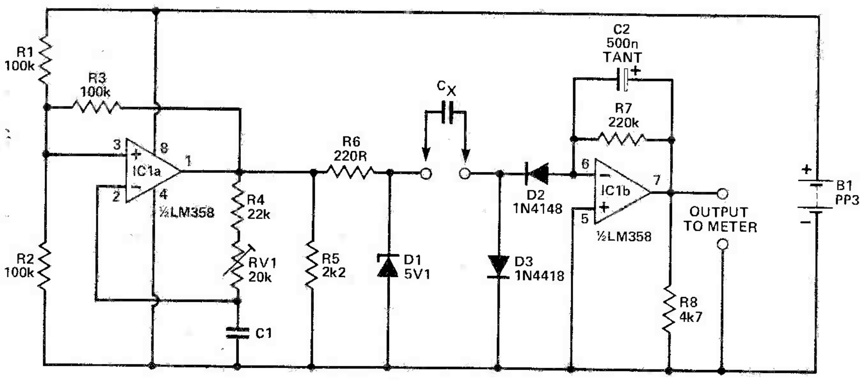


Fig. 3 Capacitance meter circuit diagram.

HOW IT WORKS

IC1a and the components around it form an oscillator which produces a square wave output at about 8KHz, adjustable by RV1. One of the features of the LM358 is that its output is quite happy to go down to the negative supply rail without disturbing the operation of the feedback. Unfortunately, the IC won't pull the output down quite that far of its own accord — an external resistor (R5) is necessary. R6 performs two functions: it is the equivalent of R1 in Fig 2b, and it is also the ballast resistor for the zener, D1.

D1 clips the output of IC1a at about 5V, giving a square wave of fixed amplitude. D3 holds the 'right hand' plate of C_x at the negative supply voltage during high outputs from IC1a; D2 allows C_x to draw current from the virtual earth at IC1 pin 6 when IC1a output goes low.

The current to voltage converter around IC1b makes use of another useful characteristic of the LM358: it remains in linear mode when one or both of its inputs are at the negative supply voltage. This means that pin 5 can be taken directly to the negative supply, giving a circuit with very few passive components.

R7 produces a voltage at the output of IC1b proportional to the current drawn from pin 6. C2 smoothes out the fluctuations so that the voltage across R7 is proportional to the average current. R8 is once again included to pull the output of IC1b to the negative supply so that the meter will give a zero reading when no capacitor is connected.

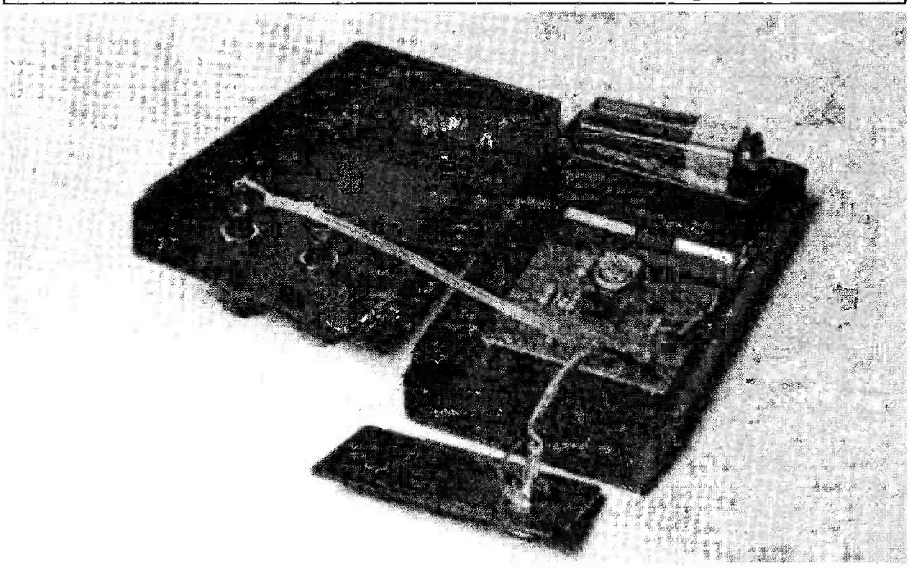
For different ranges, all that is necessary is to change the value of C1, as shown in Table 1. Although there is no room for the additional components on the PCB, the circuit can be adapted without difficulty to give a multi-range instrument, as shown in Fig. 4. The additional capacitors and presets could be mounted on a small piece of veroboard, or could even be soldered directly to the switch. The values from Table 1 should be followed, so C1a would be 1n (for the 1V per 100p range), C1b is 10n, and so on. To make the best use of the higher ranges, it would be a good idea to increase the value of C2 to 10u.

Calibration

The component layout for the project is shown in Fig. 5. It is a good idea to check component positions carefully, since the locations are not all used and mistakes are easily made. To calibrate the instrument, you will need a 1% tolerance capacitor for each range. For best results, set your multi-meter to the 10V range and use a capacitor which will give a half-scale deflection. For instance, on the 1V per 100p range, use a 500p capacitor and adjust RV1 for a meter reading of 5V.

C1	1n	10n	100n	1μ	10μ
Range	1V=100p	1V=1n	1V=10n	1V=100n	1V=1μ

Table 1 Values of C1 required for various ranges.



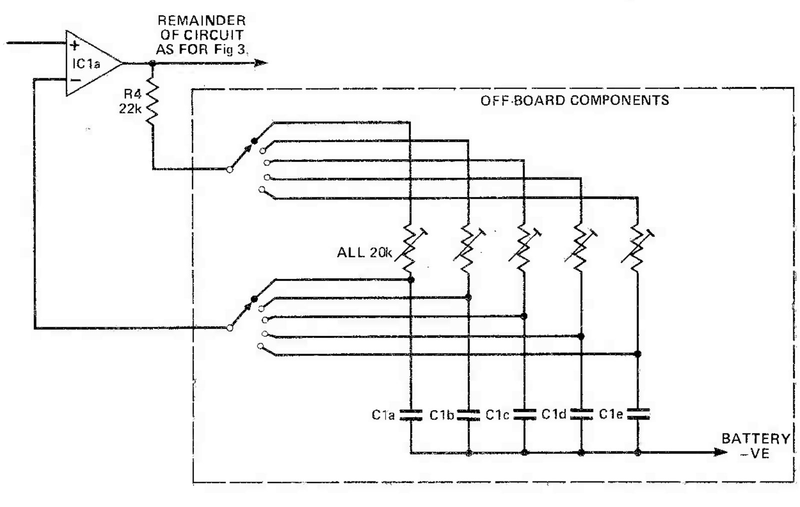


Fig. 4 Switching arrangement for a multi-range meter.

PARTS LIST

RESISTORS (all 1/4W 5%)

R1	100k
R2	100k
R3	100k
R4	22k
R5	2k2
R6	220R
R7	220k
R8	4k7

RV1 20k miniature horizontal preset

CAPACITORS

C1	1n
C2	500n 10V tantalum

SEMICONDUCTORS

IC1	LM358
D1	4V7 or 5V1 zener
D2, 3	1N4148

MISCELLANEOUS

PP3 battery clip, PP3 battery, BC3 box with battery compartment.

BUYLINES

None of the components used in this project should present the slightest difficulty. However, you may be interested to know that the LM358 ICs are available to ETI readers at the special price of 5 for £2, inclusive, from: Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. A box with a PP3 battery compartment to house the project is available for £2.80 from the same address. Spare printed circuit boards can be obtained by sending £1 and a stamped, self-addressed envelope to: ASP Readers Services, PO Box 35, Wolsey Road, Hemel Hempstead, Herts. HP2 4SS.

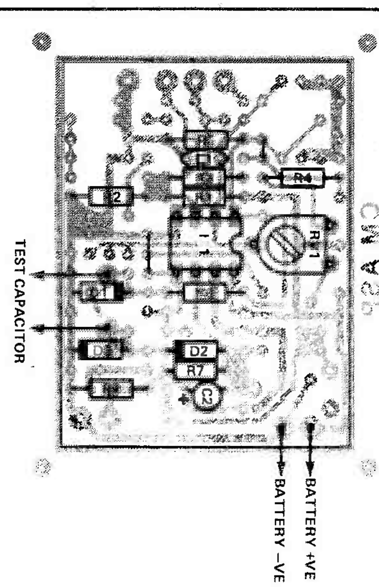


Fig. 5 Component overlay for capacitance meter.

ETI

MEMO MINDER

In a phrase, a lighthouse on a board. Amazing, but true! ETI's free PCB shows that it's more than just a flash-in-the-pan. Not much . . . .

'What ETI really needs,' ruminated Alf, absentmindedly syringing his ears with a solder sucker, 'is something completely different.' The wind howled around ETI Towers and rain lashed the windows of as Flea-byte drew his chair closer to the solitary candle which spluttered fitfully, as solitary candles will, in the centre of the floor. 'What did you have in mind?,' he asked. 'Well, I can't remember the last time we had a project,' said Alf thoughtfully, 'to flash an LED.'

Flea-byte resisted the temptation to put the solder sucker to better use and Auntie Static reverted to her background program. This would be a bad winter for her diodes, she sensed it in her sprockets, and having to listen to Alf's blathering didn't help matters in the least.

Alf, realising that his genius would once again go unrecognised, stomped off to make adjustments to an oscillator. Outside, it was raining cats and dogs, speckled geese and the occasional marmoset. It was that kind of day. A lone police car, searching for a mate, wailed plaintively from the Soho wilderness. Suddenly, Auntie's photocells began to twinkle. A half forgotten mini-flopperama diskette, an unwise purchase from Carnaby Street in the late Sixties, had engaged in her disk drive and was infusing her with vital statistics. 'Gather round, my friends,' she said, 'I think I've got the answer.'

The Auntie's Tale

Auntie quickly outlined the story of the two itinerant coal porters who had patented a device for minding buildings when the owners were away. Their invention was a light which would be illuminated as long as the building remained in place, but would go out if it was stolen, so that anyone could see at a glance whether the house was still there or not. Theft of darkhouses, as they were called at the time, was rife, but since the invention of the 'houseminder' security light, very few of these seaside homes have been moved.

The next stage of development had to await the arrival of a child to the Kunn family, who had an astonishing degree of foresight in naming their offspring after the light he would one day invent. Belisha B. Kunn it was who adapted the lighthouse principle to produce a 'roadminder' to preserve small sanctuaries of whiteness on an otherwise black road surface. These areas are now great tourist attractions; indeed the more popular ones are so crowded that it is hard to stop and admire the handiwork of the artist who painted them on.

Further reference to the invention can be found in the diaries of Arthur Daley ....'And that,' concluded Auntie, 'is the story of the minder. Why don't we do a miniature version for looking after memos?'

'Sounds OK to me,' said Alf, 'but what are we going to write about it?' 'Oh, I think we could get away with just a Parts List and a "How It Works",' said Auntie. 'After all, nobody ever reads the rest of the article anyway.'

HOW IT WORKS

IC1 contains an infra red LED and phototransistor. When the LED is illuminated the beam will normally fall on the phototransistor, allowing it to conduct and pull the inverting input of IC2a low. If the beam is interrupted by a memo being placed in the slot between the LED and detector, the phototransistor will cease to conduct and the inverting input of IC2a will go high. IC2b and the components around it form an oscillator to flash the LED once a second. When the output of IC2a is low, it has no effect on the oscillator since D1 will be reverse biased. If IC2a output goes high, the oscillator capacitor will be kept at full charge, since R5 is much smaller than R8; IC2b will cease to oscillate and the LED will be extinguished.

The result of all this is that when a memo is held in the slot of IC1, the LED will flash to attract attention to it.

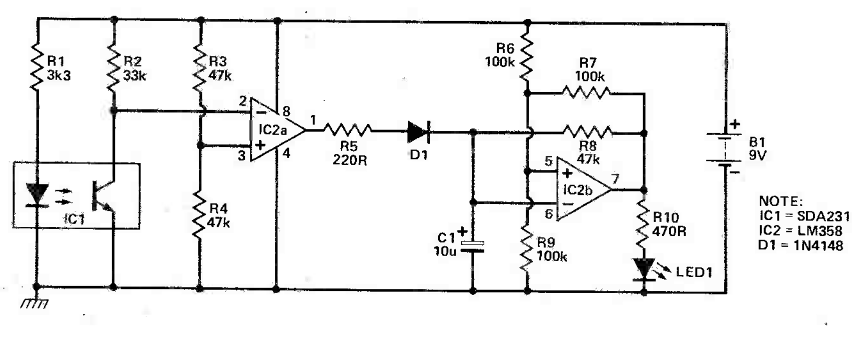


Fig. 1a Circuit of memo minder.

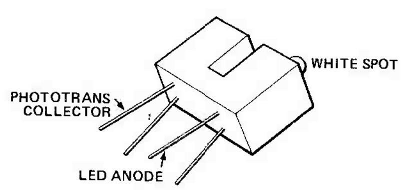


Fig 1b Pin-out of the SDA 231.

PARTS LIST

RESISTORS (all ¼W 5%)

R1	3k3
R2	33k
R3	
R4	47k
R5	220R
R6	100k
R7	100k
R8	47k
R9	100k
R10	470R

CAPACITORS

C1	10μ 10v tant.

SEMICONDUCTORS

IC1	SDA231
IC2	LM358
D1	1N4148

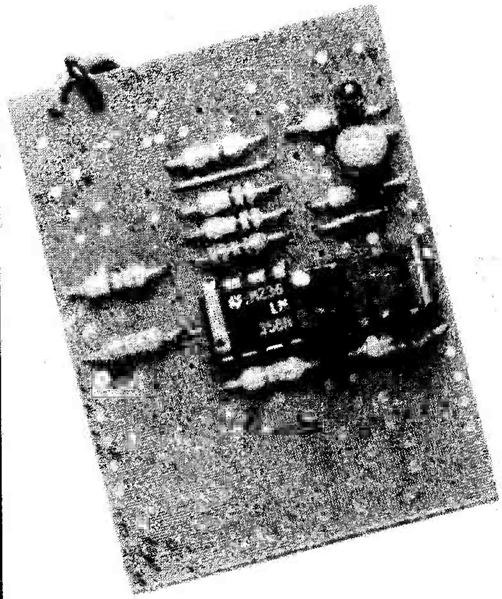
LED1 3mm LED, the colour of your choice.

MISCELLANEOUS

PP3 battery connector,
PP3 battery.

BUYLINES

The SDA 231 slotted opto switch is available from Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. Price 80p. They will supply the LM358 ICs to ETI readers at the special price of 5 for £2. Extra printed circuit boards can be obtained by sending £1 and a stamped, self-addressed envelope to: ASP Readers Services, PO Box 35, Wolsey Road, Hemel Hempstead, Herts. HP2 4S.



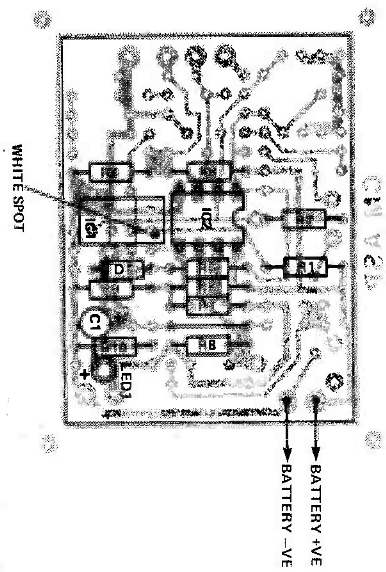


Fig. 2 Component overlay for memo minder.

RIAA AND NAB EQUALISATION STAGES

The free PCB demonstrates that it has an ear for a good tune. Start here for the ultimate in low-cost stereo.

A stereo pre-amplifier which can give either RIAA magnetic pickup equalisation, or NAB standard tape equalisation, is the final offering for this month. Used with the 'matchbox amplifier' to be featured next month, a low cost, powerful sound system can be assembled in no time!

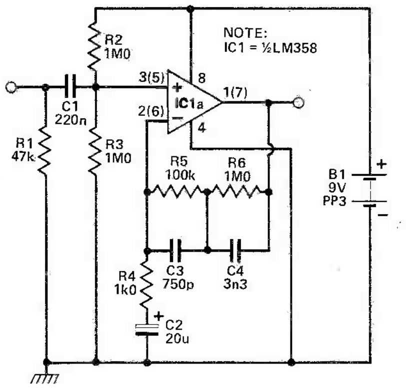


Fig. 1 Circuit of the pre-amp, with RIAA equalisation.

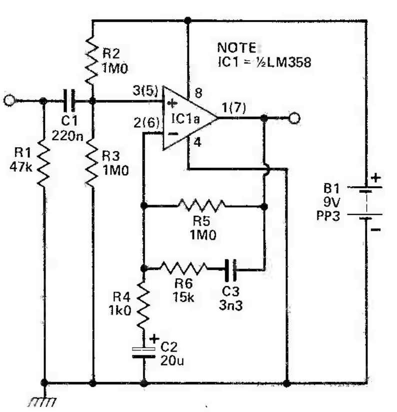


Fig. 2 Circuit of the pre-amp, with NAB equalisation

HOW IT WORKS

The LM358 is connected as a shunt feedback amplifier with some additional components in the feedback network to tailor the frequency response. The NAB equalisation standard requires a roll-off of 6dB per octave to begin at 50Hz and continue to 3180Hz, at which point it levels off again. In Fig. 2, if the effect of C2 are ignored, the low frequency gain of the circuit will be determined by R5 and R4, and will be 1000. By 50Hz, the impedance of C3 has dropped sufficiently for it to have a significant effect on the gain of the circuit, which will be reduced by about 30% at this frequency, giving the first -3dB point.

The gain continues to drop until the impedance of C3 is comparable with the resistance of R6, at which point any further drop in its impedance will have less and less effect on the gain. At high frequencies, therefore, the gain levels out and is determined by R6 and R4. It will be about 15.

The RIAA circuit operates in a similar way, with the addition of another turnover point introduced by C4.

BUYLINES

The LM358 ICs are available to ETI readers at the special price of 5 for £2 from: Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. Extra printed circuit boards can be obtained by sending £1 and a stamped, self-addressed envelope to: ASP Readers Services, PO Box 35, Hemel Hempstead, Herts. HP2 4SS.

COMPETITION

Why not use your own ingenuity to design a circuit for our free PCB? The sender of the winning entry will receive £40 and the two runners up will win £20 each. We will publish the winning circuits later in the year. The circuit should fit neatly onto the board, without components soldered to the back, and we will be looking for original, well presented and elegant designs.

Entries should include a circuit diagram, component layout, a parts list and a description of the circuit (typed, please, and not more than 750 words in length.) If you are not the kind of person who has circuits published, have a go anyway. You may find out that you are!

Send your entries to: ETI (FP), 1 Golden Square, London W1R 3AB. Please enclose a stamped, self-addressed envelope if you want your entry returned and, please, no submissions after 2 May, 1986.

PARTS LIST

RIAA

RESISTORS (all ¼W, 5%)

R1, 101	47k
R2, 102	1M
R3, 103	1M
R4, 104	1k
R5, 105	100k
R6, 106	1M

CAPACITORS

C1, 101	220n
C2, 102	20µ 10V tant.
C3, 103	750p
C4, 104	3n3

SEMICONDUCTORS

IC1	LM358

MISCELLANEOUS

PP3 battery connector,
PP3 battery.

NAB

RESISTORS (all ¼W, 5%)

R1, 101	47k
R2, 102	1M
R3, 103	1M
R4, 104	1k
R5, 105	1M
R6, 106	15k

CAPACITORS

C1, 101	220n
C2, 102	20µ 10V tant.
C3, 103	3n3

SEMICONDUCTORS

IC1	LM358

MISCELLANEOUS

PP3 battery connector,
PP3 battery.

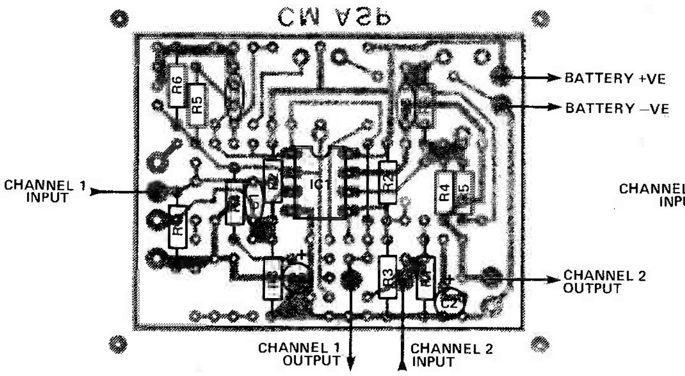


Fig. 3 Component overlay for the RIAA circuit — duplicated components are distinguished in Parts List.

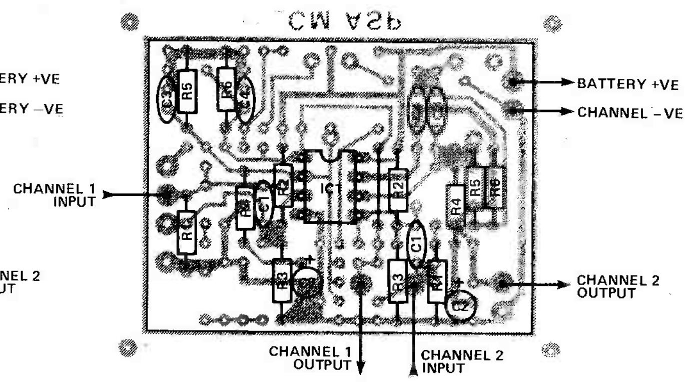
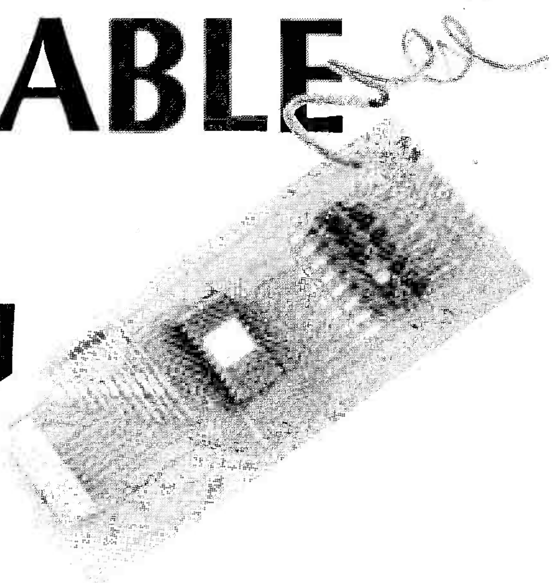


Fig. 4 Component overlay for the NAB circuit — duplicated components are distinguished in Parts List.

ETI

PROGRAMMABLE LOGIC EVALUATION BOARD



In a follow-up to his article on programmable logic in last month's issue, Mike Bedford describes a simple evaluation board which will allow readers to experiment for themselves.

In last month's Digital Superglue article, the whole realm of custom, semi-custom and programmable logic devices was investigated. It is quite out of the question for the amateur electronics enthusiast to make use of custom or semi-custom chip technology but the use of programmable logic, on the other hand is quite feasible.

It was shown that programmable logic devices are divided into three categories, namely PALs, FPLAs and PROMs. Of these, PALs and FPLAs are the most flexible but, for reasons mentioned in the article, are also the most difficult to program. It would not be impossible for the amateur to design and build a PAL programmer, but whilst this would prove interesting it would also be extremely ambitious.

PROMs, on the other hand, although less flexibile are more easily programmed. EPROMs in particular would make an ideal programmable logic device for home electronics use since many people now have EPROM programmers operating in conjunction with home computers. The theory of using EPROMs in programmable logic arrangements is identical to the concept of using PROMs and was fully covered last month. The purpose of this article is to present both a BASIC program and an experimentation board to allow the amateur to investigate this technology in a practical way.

BUYLINES

The PCB is available as usual from the ETI PCB service. The other components are quite standard and should be easily obtainable from any other source. If a 12 way DIL switch proves to be a problem then two or more smaller DIL switches could be stacked end to end.

Basic Program

To recap a little on what was said in the feature article, a PROM (or EPROM) is an example of an AND/OR array. This is an arrangement which allows any Boolean sum-of-products function to be implemented, dependent only on there being sufficient inputs and outputs. Since any Boolean transfer function may be expressed in this form, it follows that any such functions could be programmed into an EPROM. As in all custom, semi-custom and programmable chip design, computer assistance is required for all but the simplest of cases. The purpose of the BASIC program presented here is to convert Boolean equations entered by the user into a hex dump of the data required to program into the EPROM. Alternatively, the program will write the data to a block of memory where it may be accessed by an EPROM programmer.

The design software listing (Listing 1) is written in BASIC but not specifically for one machine. Instead of using a particular dialect and hence special features which may only be applicable to one computer, the program has been written in standard Microsoft BASIC. It should prove a simple task to get it running on any machine. The only areas which may prove to be a problem on some computers are the long IF statements, such as that at line 490. If the version of BASIC in use does not support sufficient continuation lines, it will have to be split into a number of separate IF statements.

The following is a brief description of the way the program works. Lines 300-700 prompt the user for the number of inputs and outputs to be used followed by the Boolean equations, one for each output in use. Within this loop, lines 430-570 carry out syntax checking of the equations, print an error message, indicate the offending character and re-prompt where necessary. Also in this input loop, lines 500-690 add brackets to the equations in order to prioritise the operators such that ANDs are carried out before ORs. The main loop of the program, lines 710-1000, then executes for each memory location used within the EPROM which in turn is equal to 2 to the power of the number of inputs used. For each location the elements of D%() are set to the binary bits of the address. These values are then 'plugged in' to

```
100   REM ***************************************
110   REM *                                     *
120   REM *  PROGRAM : PROM                     *
130   REM *  AUTHOR  : MIKE BEDFORD             *
140   REM *  DATE    : AUGUST 1985              *
150   REM *                                     *
160   REM *  PURPOSE : TO GENERATE PROGRAMMING  *
170   REM *            INFORMATION FOR  A 2716  *
180   REM *            EPROM TO ALLOW A SET OF  *
190   REM *            BOOLEAN EQUATIONS TO BE  *
200   REM *            IMPLEMENTED.             *
210   REM *                                     *
220   REM ***************************************

230   DIM ARR%(2048),X$(16),E$(8),EQN$(8),BA%(20),IB$(20),NV%(20),
            OP$(20),D%(11),OD%(8),OV%(8)
240   UR% = 32000% : REM *** SET TO HIGHEST AVAILABLE RAM ***
250   XX$="0123456789ABCDEF"
260   FOR N%=0% TO 15%
270   X$(N%)=MID$(XX$,N%+1%,1%)
280   NEXT N%
290   PRINT : PRINT "ETI BOOLEAN TO EPROM PROGRAM FOR 2716" : PRINT

300   INPUT "INPUTS,OUTPUTS USED";IT%,OT%
310   IF IT%>11% OR IT%<1
            THEN PRINT "INPUTS SHOULD BE IN RANGE 1-11" : GOTO 300
320   IF OT%>8% OR OT%<1
            THEN PRINT "OUTPUTS SHOULD BE IN RANGE 1-8" : GOTO 300

330   REM ... INPUT AND SYNTAX CHECK EQUATIONS - ONE PER OUTPUT USED
340   FOR N%=0% TO OT%-1%
350   PRINT "OUTPUT";N%;"=";
360   INPUT E$(N%)
370   EQN$(N%) = ""
380   FOR I%=1% TO LEN(E$(N%))
390   C$=MID$(E$(N%),I%,1%)
400   IF C$=" " THEN 420
410   EQN$(N%) = EQN$(N%)+C$
420   NEXT I%
430   IF LEN(EQN$(N%))=0% THEN 350
440   BC%=0% : L$="("
450   FOR I%=1% TO LEN(EQN$(N%))
460   C$=MID$(EQN$(N%),I%,1%)
470   IF C$=" " THEN 550
480   IF ((C$<"0" OR C$>"9") AND C$<>"(" AND C$<>")" AND C$<>"/"
         AND C$<>"A" AND C$<>"+" AND C$<>"*") THEN
         PRINT TAB(I%+11%);"^" : PRINT "INVALID CHARACTER" : GOTO 350
490   IF (L$="(" AND (C$="*" OR C$="+" OR C$=")"))
      OR (L$=")" AND (C$="(" OR C$="/" OR (C$>="0" AND C$<="9")))
      OR (L$="/" AND C$<>"(" AND (C$<"0" OR C$>"9"))
      OR ((L$="+" OR L$="*") AND (C$="+" OR C$="*" OR C$=")"))
      OR ((L$>="0" AND L$<="9")
            AND (C$="(" OR C$="/" OR (C$>="0" AND C$=<"9")))
      THEN PRINT TAB(I%+11%);"^" : PRINT "SYNTAX ERROR" : GOTO 350
500   IF (C$="A" AND IT%<11%) OR
            ((C$>="0" AND C$<="9") AND C$>CHR$(48%+IT%-1%)) THEN
            PRINT TAB(I%+11%);"^" : PRINT "UNUSED INPUT" : GOTO 350
510   IF C$="(" THEN BC%=BC%+1%

800   FOR I%=1% TO LEN(EQN$(N%))
810   C$=MID$(EQN$(N%),I%,1%)
820   IF C$=" " THEN 940
830   IF C$="/" THEN NV%(BC%)=1% : GOTO 940
840   IF C$="(" THEN BC%=BC%+1% : OP$(BC%)="" : GOTO 940
850   IF C$=")" THEN X%=BA%(BC%) : BC%=BC%-1% : GOTO 900
860   IF C$>="0" AND C$<="9" THEN X%=D%(ASCII(C$)-48%)
870   IF C$="A" THEN X%=D%(10%)
880   IF C$="+" THEN OP$(BC%)="+" : GOTO 940
890   IF C$="*" THEN OP$(BC%)="*" : GOTO 940
900   IF NV%(BC%)=1% THEN NV%(BC%)=0% : X%=NOT X%
910   IF OP$(BC%)="+" THEN BA%(BC%)=BA%(BC%) OR X%
920   IF OP$(BC%)="*" THEN BA%(BC%)=BA%(BC%) AND X%
930   IF OP$(BC%)="" THEN BA%(BC%)=X%
940   NEXT I%
950   IF BA%(0%)<>0% THEN ARR%(A%)=ARR%(A%) OR 2%^N%
960   IF A%=0% THEN OV%(N%)=BA%(0%) : OD%(N%)=0%
970   IF BA%(0%)<>OV%(N%) THEN OD%(N%)=-1%
980   OV%(N%)=BA%(0%)
990   NEXT N%
1000  NEXT A%
1010  REM ... PRINT SUMARY OF EQUATIONS AND HEX DUMP OF DATA
1020  PRINT : PRINT "BOOLEAN EQUATIONS :"
1030  PRINT
1040  FOR N%=0% TO OT%-1%
1050  PRINT "OUTPUT";N%;"= ";E$(N%);
1060  IF OD%(N%)=-1% THEN PRINT : GOTO 1110
1070  PRINT " *** ALWAYS ";
1080  IF OV%(N%)=0% THEN PRINT "LOW "; : GOTO 1100
1090  PRINT "HIGH ";
1100  PRINT "***"
1110  NEXT N%
1120  PRINT : PRINT "EPROM MEMORY DUMP (HEX) :"
1130  C%=0 : A%=0%
1140  FOR N%=0% TO 2^IT%-1%
1150  IF C%<>0% THEN 1190
1160  PRINT
1170  H% = INT(A%/256%) : GOSUB 1600 : PRINT H$;
1180  H% = A%-256%*INT(A%/256%) : GOSUB 1600 : PRINT H$;"    ";
1190  C%=C%+1 : A%=A%+1
1200  IF C%=16% THEN C%=0%
1210  H%=ARR%(N%)
1220  GOSUB 1600
1230  PRINT H$;"  ";
1240  NEXT N%
1250  PRINT
1260  IF IT%=11% THEN 1340
1270  PRINT : PRINT "REMAINING LOCATIONS UNPROGRAMMED"
1280  PRINT : PRINT "INPUT(S) ";
1290  FOR N%=IT%+1 TO 11%
1300  PRINT X$(N%-1%);
1310  IF N%<>11% THEN PRINT ", ";
1320  NEXT N%
1330  PRINT " SHOULD BE TIED TO 0V"
1340  PRINT
1350  REM ... WRITE TO MEMORY IF REQUIRED
1360  INPUT "WRITE TO MEMORY BLOCK FOR EPROM PROGRAMMER USE ";Q$
1370  IF LEFT$(Q$,1)="N" THEN 1650
```

```
520   IF C$=")" THEN BC%=BC%-1%
530   IF BC%<0% THEN PRINT TAB(I%+11%);"^" :
            PRINT "BRACKETS MISMATCH" : GOTO 350
540   L$=C$
550   NEXT I%
560   IF BC%<>0% THEN PRINT TAB(I%+11%);"^" :
            PRINT "BRACKETS MISMATCH" : GOTO 350
570   IF L$="/" OR L$="+" OR L$="*" THEN PRINT TAB(I%+11%);"^" :
            PRINT "SYNTAX ERROR" : GOTO 350

580   REM ... INSERT BRACKETS TO GIVE 'AND' PRIORITY OVER 'OR'
590   REM ... NOT USING 'FOR' LOOP SINCE LIMIT CHANGES IN LOOP
600   IB$(0%)=")" : BC%=0
610   I%=1%
620   C$=MID$(EQN$(N%),I%,1%)
630   F$=MID$(EQN$(N%),I%+1%,1%)
640   IF C$="(" THEN BC%=BC%+1 : IB$(BC%)=")"
650   IF F$="*" AND C$<>")" AND IB$(BC%)=")" THEN IB$(BC%)="(" :
            GOSUB 1560
660   IF (C$="+" OR C$=")") AND IB$(BC%)="(" THEN IB$(BC%)=")" :
            GOSUB 1560
670   IF C$=")" THEN BC%=BC%-1
680   I%=I%+1% : IF I%<=LEN(EQN$(N%)) THEN 620
690   IF IB$(0%)="(" THEN EQN$(N%)=EQN$(N%)+")"
700   NEXT N%
710   REM ... GENERATE DATA FOR EACH REQUIRED MEMORY LOCATION
720   FOR A%=0% TO 2%^IT%-1%
730   FOR I%=0% TO 11%
740   D%(I%)=0%
750   IF (A% AND 2%^I%)<>0% THEN D%(I%)=-1%
760   NEXT I%
770   ARR%(A%)=0%
780   FOR N%=0% TO OT%-1%
790   BC%=0% : OP$(0)="" : NV%(BC%)=0%

1380  IF LEFT$(Q$,1)<>"Y" THEN 1360
1390  INPUT "ENTER START ADDRESS (HEX) ";Q$
1400  IF LEN(Q$)<>4 THEN 1390
1410  H%=0%
1420  FOR N%=0% TO 3%
1430  H$=MID$(Q$,N%+1%,1)
1440  FOR I%=0% TO 15%
1450  IF H$=X$(I%) THEN 1480
1460  NEXT I%
1470  GOTO 1390
1480  H%=H%+I%*16^(3%-N%)
1490  NEXT N%
1500  IF H%+2^IT%-1% > UR% THEN PRINT "INSUFFICIENT MEMORY HERE" :
            GOTO 1390
1510  FOR A%=H% TO H%+2^IT%-1%
1520  POKE A%,ARR%(A%-H%)
1530  NEXT A%
1540  PRINT : PRINT "DONE"
1550  GOTO 1650

1560  REM ... INSERT IB$() IN EQN$(N%)
1570  EQN$(N%)=LEFT$(EQN$(N%),I%-1)+IB$(BC%)+
            RIGHT$(EQN$(N%),I%)
1580  I%=I%+1%
1590  RETURN

1600  REM ... DECIMAL TO HEX
1610  HH%=INT(H%/16%)
1620  H%=H%-16%*HH%
1630  H$=X$(HH%)+X$(H%)
1640  RETURN

1650  END
```

Listing 1 The design software in BASIC.

each equation in turn, and the appropriate bit set in the byte for this location if the result is 1.

Within this loop a record is kept of any output bits which are always high or always low. After executing this loop, lines 1100-1540 print out the results. These results consist of a summary of the equations followed by a hex dump of the EPROM contents. In the equation summary, if a particular output is always either high or low, a warning message is printed to indicate that a logical error has probably been made. Once the dump has been printed, the user is given the option of writing the data to a RAM memory block for subsequent access by an EPROM programmer package.

Turning to the user of the program, the variable UR% must first be modified to the highest RAM memory available on the machine in use. The line in question is 240. Equations may be entered in equations may be entered in virtually any format consistent with a few basic rules. Inputs 0-10 are represented by the characters 0-9 and A respectively, the + sign is used to signify OR and the * sign to signify AND. The / sign is used to indicate that the following term is negated and brackets may be used. The AND operator takes precedence over OR and spaces may be added to improve readability. The following examples illustrate this notation:-

0 * 1 = *Input 0 AND Input 1*
2 + 3 = Input 2 OR Input 3
/A = NOT Input 10
0*1+2*3=(0AND1) OR2AND3)
0*(1+2)*3=0AND(1OR2)AND3
/(2 + 13) = NOT (2 OR 3)

If a syntax error is detected, the line in error is printed out with an arrow pointing to the location of the offending character. The nature of the error is also printed in plain English. The following error messages are possible:

INVALID CHARACTER	A character other than 0-9, A, +, *, /, (,) or space has been entered.
UNUSED INPUT	An unused input has been specified. For example the use of 5-A when 5 inputs (0-4) were specified.
SYNTAX ERROR	An invalid combination of characters was entered. For example two consecutive logic operators (*+).
MISMATCHED BRACKETS	The number of opening brackets is not equal to the number of closing brackets.

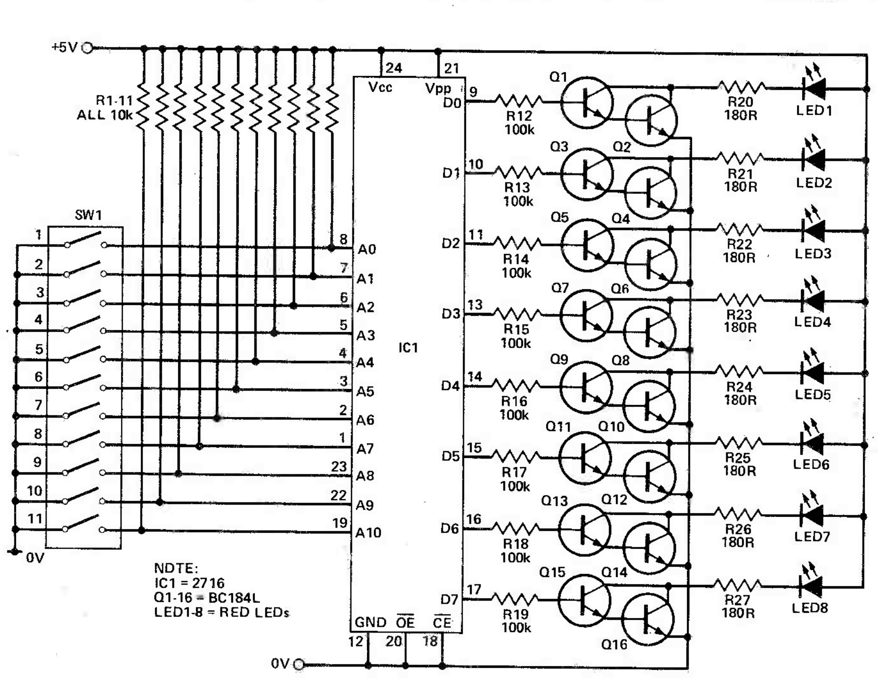


Fig. 1 Circuit diagram of the evaluation board.

PARTS LIST

RESISTORS (all ¼W, 5%)	
R1-11	10k
R12-19	100k
R20-27	180R
SEMICONDUCTORS	
IC1	2716 EPROM
LED 1-8	Standard Red LEDs
Q1-16	BC184L
MISCELLANEOUS	
SW1	12-Way DIL Switch
PCB; 24-Way DIL socket for IC1.	

Apart from these comments, the only other point which needs to be mentioned is that warning messages may be printed with the equation summary and hex dump. The following examples illustrate this:

OUTPUT 0 = 1 + /1
*** ALWAYS HIGH ***

OUTPUT 1 = 0 * /0
*** ALWAYS LOW ***

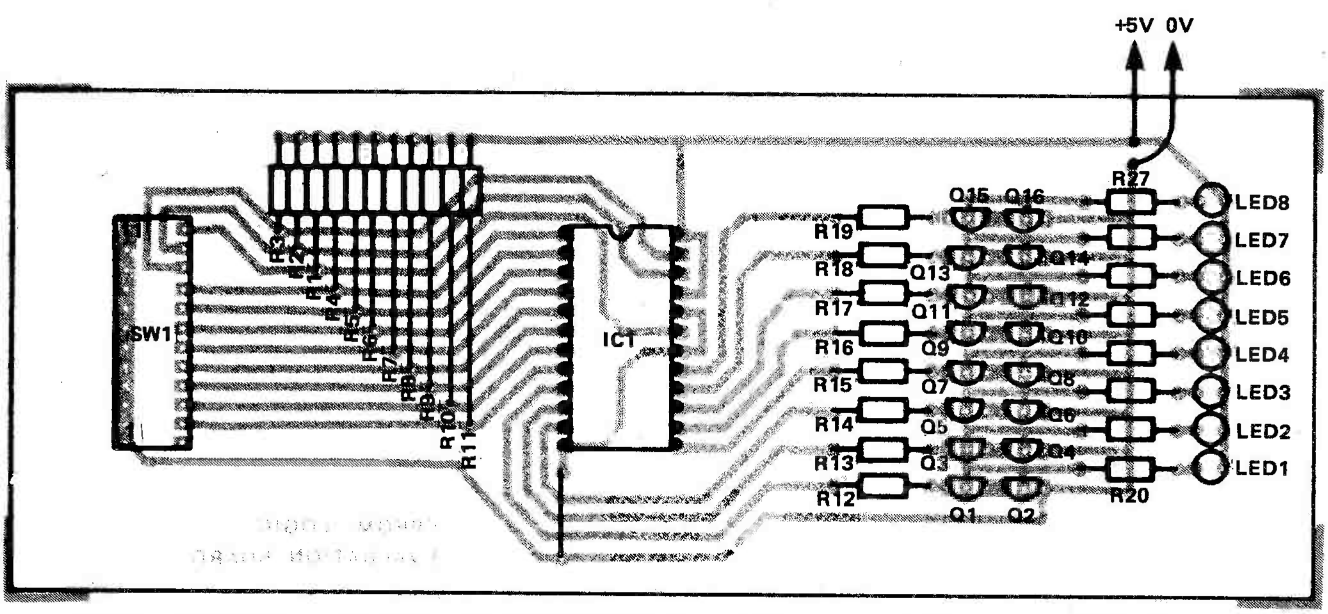
In these cases it is quite obvious that 1 OR NOT 1 will always give a high result and that 0 AND NOT 0 will always give a low result. Cases can be much more obscure, however, and the messages indicate that a logic error has probably been made. If a constant high or constant low signal is really required it isn't necessary to use an EPROM output to generate one!'

The Evaluation Board

To fulfil the requirements of an experimentation/evaluation board, the inputs should be easily programmable between logic levels and the state of the outputs should be displayed clearly. These requirements are provided by a row of DIL switches, one for each of the inputs (address lines) of the 2716 and a row of LEDs, one for each of the EPROM outputs (data lines). The 2716 EPROM was chosen purely because it is the least expensive yet still has 11 available inputs. The principles are clearly the same if a larger EPROM is used to give more inputs.

The circuit diagram is shown as Fig. 1. The board requires a low current 5V power supply or could be operated from a battery. The operation of the board is very simple and doesn't really justify a separate how it works section. The 11 address lines, which act as inputs, are held high by pull-up resistors R1-R11, logic lows being achieved, when required, by switching to 0V through the DIL switches SW1-SW11. The 8 data lines act as outputs and drive Darlington pairs Q1/Q2, Q3/4 etc and the LEDs are connected to these via current limiting resistors

Fig. 2 Component overlay for the evaluation board.



R20-27. $\overline{CE}$ and $\overline{OE}$ are held constantly low, ensuring that the outputs are always active and that any changes to the inputs will be reflected on the outputs immediately.

Construction of the board is quite straightforward and requires little comment. A socket must obviously be used for the EPROM, IC1, and care must be taken when installing the LEDs and transistors to ensure that they are the right way around. Some form of labelling will be required to identify the switch positions and LED numbering. On the prototype this was achieved simply by sticking down pieces of paper on which the required legends had been typed, but if you are after a really professional result you may prefer to use Indian ink or Letraset on the board and then apply a coat of clear lacquer for protection.

Using The Program And Board

For the purposes of this example, let us assume that it is required to implement 8 different functions of 6 inputs. This means that 8 outputs and inputs are needed and this is the answer to the first question asked by the design program. The functions required are shown in Fig. 3 as a verbal description, a circuit diagram of the discrete logic implementation and the Boolean equations. These functions are entered into the software in the form of the final equations given in each part of Figure 3, and the program output is shown as Listing 2. It will be noticed that 64 values are listed (2 to the power of 6) and that inputs 6 — A should be tied low by closing the switches SW7-11. If a 2716 is programmed with this data, spending a few minutes with the evaluation board will confirm that the functions are correctly implemented.

Other Function Types

Although all logic transfer functions can be expressed in terms of a set of Boolean equations, this is not always the most obvious way to describe a particular function. Cases where there is an easier way to describe the function include code conversions, for example binary to decimal, binary to BCD, BCD to 7 segment, etc. In these instances, it is perhaps not immediately obvious what the discrete logic

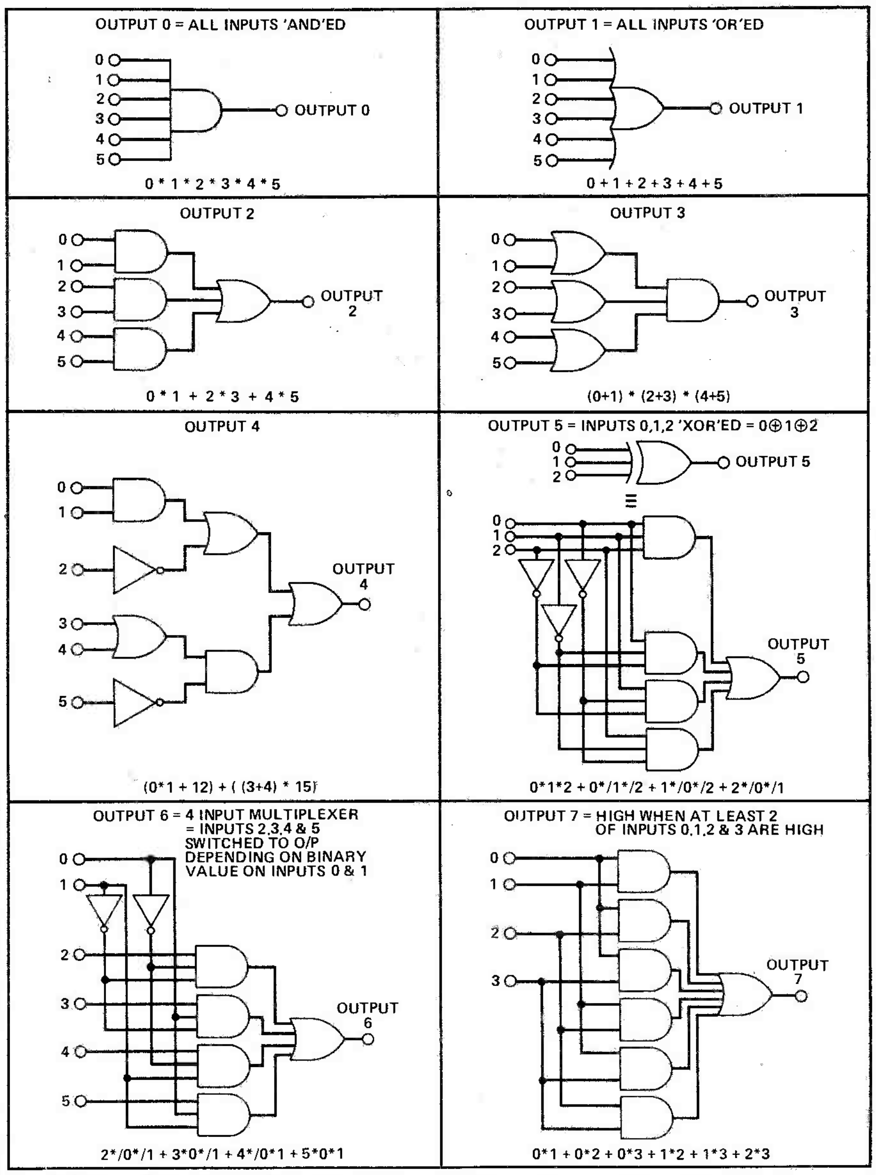
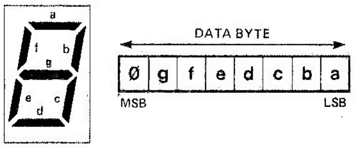


Fig. 3 6-input logic function examples with their Boolean equations.

```
BOOLEAN EQUATIONS :

OUTPUT 0 = 0*1*2*3*4*5
OUTPUT 1 = 0+1+2+3+4+5
OUTPUT 2 = 0*1 + 2*3 + 4*5
OUTPUT 3 = (0+1) * (2+3) * (4+5)
OUTPUT 4 = (0*1+/2) + ((3+4)*/5)
OUTPUT 5 = 0*1*2 + 0*/1*/2 + 1*/0*/2 + 2*/0*/1
OUTPUT 6 = 2*/0*/1 + 3*0*/1 + 4*/0*1 + 5*0*1
OUTPUT 7 = 0*1 + 0*2 + 0*3 + 1*2 + 1*3 + 2*3

EPROM MEMORY DUMP (HEX) :

0000    10  32  32  96  62  82  82  B6  12  F2  B2  96  F6  D6  96  B6
0010    12  32  72  96  72  9A  DA  BE  12  FA  FA  9E  F6  DE  DE  BE
0020    12  32  32  D6  62  8A  8A  FE  12  FA  BA  DE  E6  CE  8E  FE
0030    16  36  76  D6  66  8E  CE  FE  16  FE  FE  DE  E6  CE  CE  FF

REMAINING LOCATIONS UNPROGRAMMED

INPUT(S) 6, 7, 8, 9, A SHOULD BE TIED TO 0V
```

Listing 2 The hex dump which results when the Boolean equations of Fig. 3 are entered into the BASIC program.



Display	Binary	Hex	Decimal
0	00111111	3F	63
1	00000110	06	6
2	01011011	5B	91
3	01001111	4F	79
4	01100110	66	102
5	01101101	6D	109
6	01111101	7D	125
7	00000111	07	7
8	01111111	7F	127
9	01100111	67	103
A	01110111	77	119
B	01111100	3C	60
C	00111001	39	57
D	01011110	5E	94
E	01111001	79	121
F	01110001	71	113

Fig. 4 Working out a single-digit, seven-segment LED decoder program by hand.

implementation and hence Boolean equations would be. In cases like this it will often be found more convenient to write a dedicated BASIC program to calculate the EPROM contents.

The conversion of 6 bit binary to 2 digit BCD provides an ideal example of such a solution. This example could be worked out by hand without too much difficulty, but in the general case the software solution will be more effective in terms of effort expended. Listing 3 shows the main loop of a program to calculate EPROM contents for this function. Following this main loop, the hex dump and copying to RAM portions of the main program in Listing 1 could be added. The hex dump produced by such a program is shown as listing 4. Even without blowing an EPROM and plugging it into the evaluation board, it is quite clear just by studying this dump that the function is truly implemented. (Please note that, in spite of their appearance, the values in the dump are hexadecimal not decimal!).

A rather more interesting example of code conversion is that of binary to decimal or hexadecimal 7-segment code. The driving of a single digit 7-segment display is quite trivial, requiring only ten values for the decimal case or 16 for hexadecimal. The calculation of the EPROM contents required can be done by hand as shown in Fig. 4.

For a two digit display the requirements are considerably more involved. The initial problem is that two digits require 14 outputs to drive them, compared

```
300     REM *** THIS LOOP CALCULATES EPROM CONTENTS
310     REM *** FOR 6 BIT BINARY TO BCD CONVERSION

320     FOR A%=0% TO 63%
330     TENS%=INT(A%/10%)
340     UNITS%=A%-10%*TENS%
350     ARR%(A%)=TENS%*16%+UNITS%
360     NEXT A%

370     IT%=6 : REM% *** THIS VALUE REQUIRED FOR HEX DUMP ETC
```

Listing 3 The main loop of a program which calculates the EPROM contents for a 6-digit binary to 2-digit BCD conversion.

```
EPROM MEMORY DUMP (HEX) :
0000    00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
0010    16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
0020    32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
0030    48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63

REMAINING LOCATIONS UNPROGRAMMED

INPUT(S) 6, 7, 8, 9, A SHOULD BE TIED TO 0V
```

Listing 4 The hex dump produced by the program given in Listing 3.

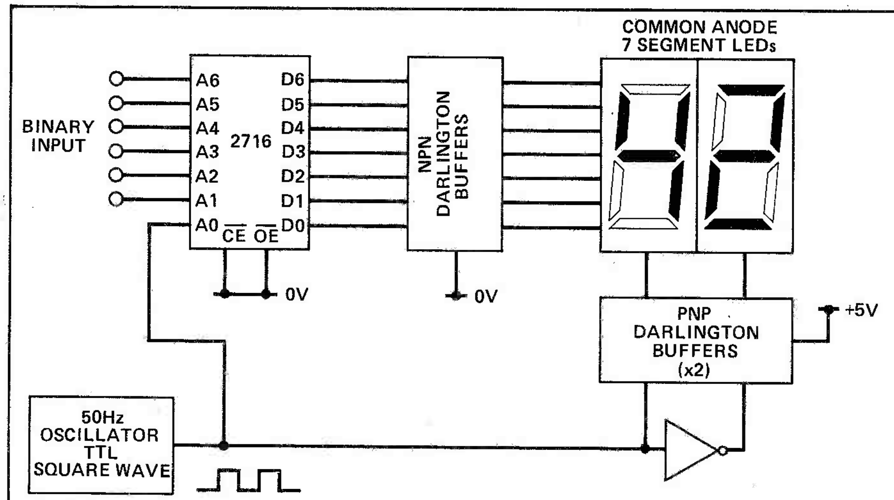


Fig. 5 Simplified circuit diagram of a 2-digit, seven-segment LED encoder using an EPROM.

```
300     REM *** PROGRAM PORTION TO CALCULATE EPROM CONTENTS FOR
310     REM *** 6 BIT BINARY TO TWO DIGIT DECIMAL 7-SEGMENT CODE

320     REM *** LOAD 1 DIGIT 7-SEGMENT DATA (OK FOR HEX TOO)
330     DIM SEG%(15)
340     DATA 63,6,91,79,102,109,125,7,127,103,119,60,57,94,121,113
350     FOR N%=0% TO 15%
360     READ SEG%(N%)
370     NEXT N%

380     REM *** MAIN LOOP
390     FOR A%=0% TO 126% STEP 2%
400     D%=INT(A%/2%)
410     TENS%=INT(D%/10%)
420     UNITS%=D%-10%*TENS%
430     ARR%(A%)=SEG%(UNITS%)
440     ARR%(A%+1%)=SEG%(TENS%)
450     NEXT A%

460     IT%=7% : REM *** REQUIRED FOR HEX DUMP ETC
```

Listing 5 The main portion of a program which calculates the EPROM contents for a binary to 2-digit, seven-segment display conversion.

with the 8 outputs available on the 2716 EPROM. The answer is to utilise the common LED driving technique of multiplexing the two digits. A simplified circuit diagram for such an arrangement is shown in Fig. 5. The common anode LED displays are both driven from the NPN Darlingtons which in turn are driven from the EPROM output data. The clock signal will drive the anodes of each LED in turn by means of Darlington drivers (in this case PNP) and an invertor. The clock frequency is high enough to ensure both LEDs appear to be constantly illuminated even though only one is actually on at a time. Since the clock signal is also used as an input to the EPROM, the resident program can be made to output the data for one of the two digits for a particular value of the other address bits, depending on the state of the clock input. This causes the correct data to be supplied to the currently illuminated digit.

The program to generate the required data is shown as listing 5. Once again the hex dump routines and so on will require appending to the end of this code. The program will obviously generate the two digits for each binary value in pairs of consecutive locations, with the units in the least significant byte of the pair. Listing 6 shows the output produced by this program.

```
EPROM MEMORY DUMP (HEX) :

0000    3F  3F  06  3F  5B  3F  4F  3F  66  3F  6D  3F  7D  3F  07  3F
0010    7F  3F  67  3F  3F  06  06  06  5B  06  4F  06  66  06  6D  06
0020    7D  06  07  06  7F  06  67  06  3F  5B  06  5B  5B  5B  4F  5B
0030    66  5B  6D  5B  7D  5B  07  5B  7F  5B  67  5B  3F  4F  06  4F
0040    5B  4F  4F  4F  66  4F  6D  4F  7D  4F  07  4F  7F  4F  67  4F
0050    3F  66  06  66  5B  66  4F  66  66  66  6D  66  7D  66  07  66
0060    7F  66  67  66  3F  6D  06  6D  5B  6D  4F  6D  66  6D  6D  6D
0070    7D  6D  07  6D  7F  6D  67  6D  3F  7D  06  7D  5B  7D  4F  7D

REMAINING LOCATIONS UNPROGRAMMED

INPUT(S) 7, 8, 9, A SHOULD BE TIED TO 0V
```

Listing 6 The hex dump produced by the program given in Listing 5.

Conclusions

It is quite obvious that by the use of programmable logic in the form of an EPROM, it is possible to implement a wide range of logic functions varying from the very simple to the quite sophisticated. The board and software presented here provide a means of verifying this and makes an interesting and educational experimental project. It is hoped that the board will also be used to aid the design of practical projects making use of programmable logic. By using the evaluation board it is possible to experiment with the programmable portion of such a project before incorporating it into the main design. **ETI**

DIGITAL SOUND SAMPLER

Nothing could be sampler than building the analogue board. Paul Chappell shows the way.

The component layout for the analogue board is shown in Fig. 1. Construction should not present any difficulties. The main point to watch is that all the through-hole connections are made. It's easy to leave one out! Some through links are made via component leads, so be sure to solder these at the top whenever there is a pad for them.

Enclosed cermet trimmers are recommended for RV1 to RV6, although I have provided extra holes in the board to allow open cermets or carbon presets to be used (as a last resort). Good quality polystyrene capacitors should be used for the filters — the tighter the tolerance the better — and you may wish to use 1% resistors around the MF10s. The connectors for the power supply, bus and control lines can be of any type — if you have any problem finding a 12-way connector for the control signals, use an 8-way and a 4-way connector side by side. If you decide to socket the expensive ICs — the AM6072s, CMP01 etc. — the extra few pennies for good quality gold plated sockets will be well repaid. Some ICs cannot be socketed because through connections are made on their leads.

To test the analogue board without the control board, the circuit must be made to drive itself. The on-board oscillator can be used to drive the mobile filters and the ADCs can be made to sample continuously with a few temporary connections to the control lines. To test the signal path, proceed as follows.

1) Join FCLK(1) to FCLK(2) on the control line connector.
2) Wire IC7 pin r to FCLK (1),(2).
3) Connect OE to +5V.
4) Connect STM to 0V.
5) Connect SCS, SCC, SFM(1) and SFM(2) together.
6) Connect the keyboard trigger input to +5V.
7) Connect a signal source (microphone, signal generator, tape recorder output from hi-fi, etc.) to the signal input and an

PARTS LIST

RESISTORS (all ¼W 5% unless stated)

R1, 18, 22, 54, 69, 74	1k0
R2, 3	680R
R4, 5, 29, 30, 31, 46, 47, 48	12k
R6, 7, 19, 20, 32, 33, 49, 51, 52, 70, 73	10k
R8, 9, 11, 12, 13, 15, 34, 35, 37, 38, 39, 41	15k
R10	39k
R14	13k 1% metal film
R16, 17, 23, 56, 60, 71	100k
R21, 44, 45, 66	470R
R24, 25, 27, 28, 42, 43	2k4 1% metal film
R26, 55	3k9
R36	9k1 1% metal film
R40	7k5 1% metal film
R50, 59, 62, 67, 68	4k7
R53, 72	22k
R61	56k
R63	390R
R64	82k
R65	3k3
RV1	200k
RV2	500k
RV3	2k
RV4, 6	10k
RV5	20k

(all horiz. cermet trimmers)

CAPACITORS

C1	100µ 25V tantalum
C2, 4	47µ 25V tantalum
C3, 5, 12, 13, 15, 20, 23, 29 32-42	100n ceramic
C6, 7, 11, 14, 21, 22, 27, 31, 43-46	10µ 25V tantalum
C8, 9, 16, 17, 18, 24, 25, 26	1n0 polystyrene
C10	100p ceramic
C29	150p polystyrene
C30	4µ7 25V tantalum

SEMICONDUCTORS

IC1	NE5534
IC2, 12, 15, 16, 17	LM318
IC3, 20, 21	741
IC4	LM311
IC45, 13	MF10
IC6	CMP01
IC7	74LS86
IC8	74LS74
IC9	Am2502
IC10, 14	Am6072
IC11	74LS541
IC18, 19	74LS374
IC22	ZN448
Q1	BF244A
Q2	BC212
D1-4, 7-9	IN914
D5, 6	9491
LED 1	Red panel mounting LED
LED 2	Green panel mounting LED

MISCELLANEOUS

IC sockets (3x18-way, 1x8-way); Molex connectors (0.1" pitch 12-way plug and socket, 0.1" pitch 8-way plug and socket, 0.2" pitch 5-way plug and socket); PCB.

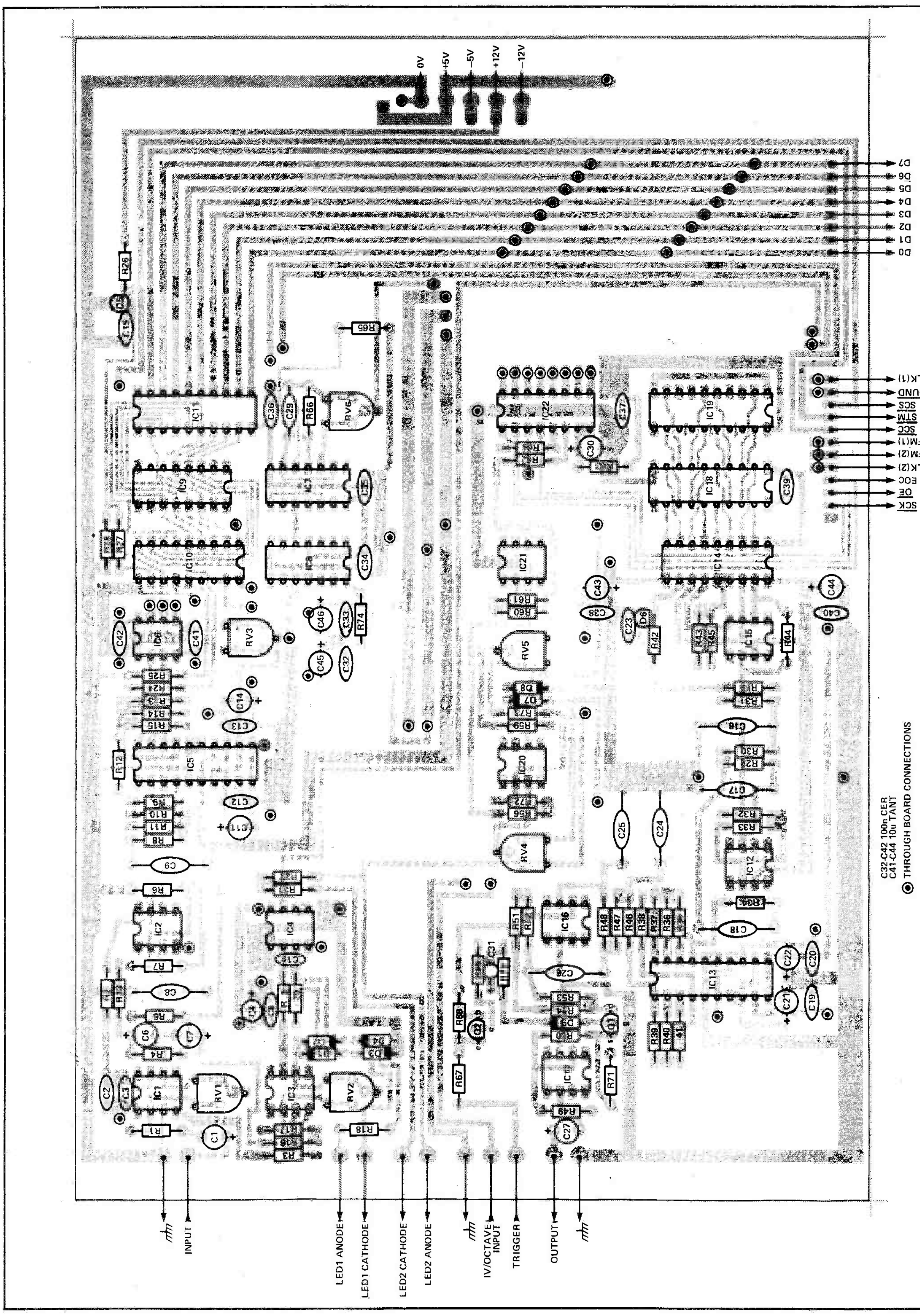


Fig. 1 Component overlay for the analogue board.

amplifier to the signal output of the board.
8) Set all presets to mid position.

If the board is now powered up, the A to D section of the circuit should sample continuously and the D to A section should take each generated code and translate it back into analogue form. A signal applied to the input should therefore follow the entire audio path and emerge at the output.

Fault Finding

If there is no signal from the output, or if the sound is distorted, the following test procedure should identify the troublesome area.

First, check pin 6 of IC1 with a 'scope. The input signal should emerge from this pin considerably amplified and RV1 should control the gain. Next check pin 6 of IC2 to make sure the signal is present there too. Now proceed to pin 20 of IC5. If there is no signal, inspect pins 10 and 11 to make sure the clock signal — a square wave of about 1MHz — is present. No clock means that the circuit around IC7c/d is not oscillating (or possibly a faulty connection, of course. You did remember steps 1 and 2, didn't you?).

To check the A to D conversion, the best way is to synchronise your 'scope to SCC — either by connecting the external sync. to this signal, or even better by viewing it on one channel of a dual beam 'scope.

The SCC signal should spend about 90% of its time at logic 1 and drop to logic 0 briefly about once every 10μS (assuming the clock is running at the nominal 1MHz rate. You can adjust the clock frequency with RV6). Check each data bit in turn (on the connector at the edge of the board) with the other 'scope channel. Each data bit should go to 1 at some time during every period when SCC is at logic 1, regardless of whether or not there is an input signal to the circuit (you are watching the trial setting of each bit by the successive approximation register). With an audio signal at the input to the circuit, you will see two traces on most of the data lines: one where the line drops back to zero again after about 1μs and one where it remains at logic 1 until SCC goes low and high again. You will see both traces at once because both situations will occur during each cycle of the input wave.

If everything is functioning correctly up to this point, the A to D conversion is taking place. Now we've got to get the audio signal back again. Check pin 11 of IC18 and the same pin on IC19. They should both follow SCC, since you effectively connect them all together in step 5. Keeping the 'scope synchronised to SCC, check the data on pins 2 to 9 of IC14. The voltage on all these pins should remain constant while SCC is high, but may change on each low to high transition. Pin 9, the lowest order data bit, should certainly change, even with a very small audio input to the circuit. As the signal level increases, the higher order data lines will also change. On the data lines that do change, you will see both traces at once on the 'scope (one remaining at logic 0, one at logic 1) for the same reason as before.

From here the signal can be traced — back in analogue form — at pin 6 of IC15, pin 6 of IC12, pin 20 of IC13 (check the clock on pins 10 and 11 again if there is no signal from here), pin 6 of IC16 and finally at pin 6 of IC17. If the signal gets lost between IC16 and IC17, check the keyboard trigger circuit (Q1, Q2). If the keyboard trigger input is grounded, the audio output from the circuit should cease; taking it to +15V will allow the sound to emerge. There should be no 'click' when the trigger voltage is changed.

The circuit around IC3 and IC4 must generate a logic signal to inform the control circuit that a suitable audio signal to be sampled is present at the input. Connect your 'scope to SOUND on the control line connector. With a very small audio input to the circuit, the signal should remain at logic 1; as the input level increases, SOUND should begin to oscillate between logic 1 and logic 0. The exact level at which this happens can be controlled by RV2. With the LEDs connected at the edge of the board, the green one (LED2) should begin to light as soon as the input level is great enough to trip SOUND; the red LED (LED1) will light when the signal reaches a higher level still, giving a rough indication of the input signal level.

Testing The Keyboard Interface

First of all, remove all the connections made in steps 1 to 8 for testing the audio circuit, then make the following links.

1) Connect 0E to 0V
2) Connect STM to +5V
3) Connect EOC to SCK via the transistor circuit shown in Fig. 2.
4) Connect a variable voltage source of 0 to +5V to the 1V/octave input. (A battery and a 1k0 pot will do).

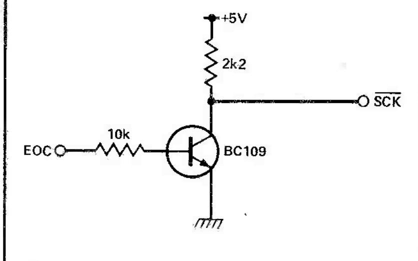


Fig. 2 Test circuit for the keyboard interface.

With the input at 0V, adjust RV4 until the voltage at the junction of D7 and D8 is also at 0V. Check that pin 6 of IC21 is at 0V too. Keeping the meter on IC21 pin 6, increase the input voltage. The voltage shown by the meter should also rise, and should be about half the input voltage. (You can make its exactly half by adjusting RV5, but don't bother too much at this stage.)

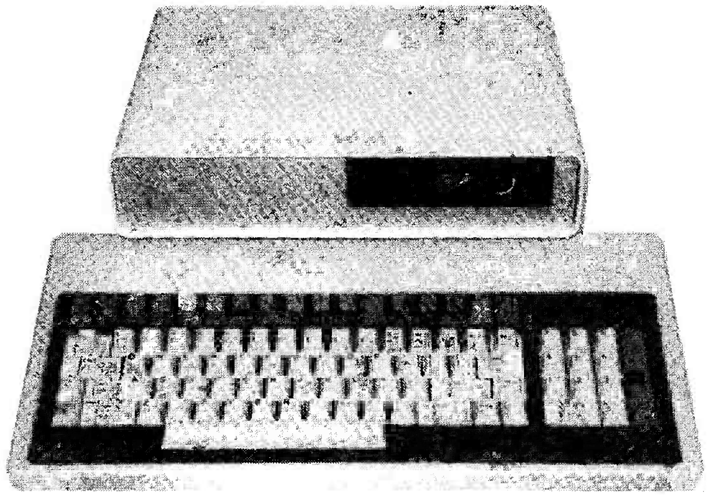
Finally, check the data lines. During the time that EOC is high the contents of the data lines will represent the voltage present at the input. If you have a steady hand on the input voltage control, you will see the data lines stepping through the normal binary sequence as the input rises from 0V. As the codes of interest occur when EOC is high — about 10% of the time — you will need a 'scope to see it.

This concludes the testing. Setting up the various presets for best results will be described in a later article. **ETI**

BUYLINES

The ICs and various other parts for the sampler are available from Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. Please write for details. Metal film resistors can be obtained from Maplin Electronic Supplies Ltd., PO Box 3, Rayleigh, Essex, SS6 8LR (tel: 0702 554155). The PCBs will be available from our PCB Service.

6809-BASED MICROCOMPUTER



Gary Mills discusses the choice of I/O devices and case to complete the system before going on to describe the testing and initial power-up procedures.

With assembly of the boards complete, the next step is to select and interface the appropriate input/output devices, attach a power supply, and install the complete system in a case or cases. Diagnostic test routines can then be run using the ROM monitor program.

The board can be used either with a separate keyboard and video monitor or with a serial terminal which includes both keyboard and VDU. Unless you already have such a terminal, you will probably wish to use separate devices. There is a wide range of suitable equipment to choose from.

The video monitor chosen may have either a composite video or a TTL interface. Using the composite video interface, any monitor that sinks 1 volt into 75 ohms will do. Since this is an almost universal standard, most composite video monitors can be used. Because the video resolution of the board is very high, the higher the resolution of the monitor, the better your display will look. 20MHz or over is a good figure to go for. Also, the picture will improve significantly if the video phosphor is a long persistence type, for example P39 or amber. Monitors that satisfy the requirements above include the Phillips Computer Monitor 80, No. BM7502/05 G (green) or A (amber), and the Kaga/Taxan KX1201, KX1202, and KX1203.

Pin No.	Signal
1.	Gnd
2.	TTLVID
3.	HSYNC
4.	VSYNC

Table 1 Pin connections on the TTL-Video output socket, SK8. Pin 1 is the pin nearest the composite video output socket, SK9.

Pin No.	Signal
1.	Gnd
2.	XMIT
3.	RCVE
4.	RTS
5.	CTS
7.	Gnd
11.	+5v
25.	−12v

Table 2 Pin connections on the RS232 serial ports, SK3 and SK4.

Pin No.	Inner row	Outer row
1, 2	DO	+5v
3, 4	D1	Gnd
5, 6	D2	Gnd
7, 8	D3	Gnd
9, 10	D4	Gnd
11, 12	D5	Gnd
13, 14	D6	Gnd
15, 16	nc	Gnd
17, 18	STROBE	Gnd
19, 20	RST	-12v

Table 3 Pin connections on the parallel keyboard port, SK2.

TTL video monitors can also be interfaced to the board. One of the commonest types is the IBM compatible monitor. There is a slight problem here in that the signals required (HSYNC, VSYNC and TTLVIDEO) are active high while the signals coming from the board are active low. To get around this problem, inverting buffers can be connected to the TTL video output lines. This is not available as a modification from Micro Concepts, but those who require it should not have too much difficulty sorting it out for themselves.

Keyboards

As with monitors, the 6809 board can be interfaced to a wide range of keyboards, including both parallel and TTL-serial types.

The WD2123 chip was expressly chosen because it can support serial TTL keyboards, and for greatest flexibility the RS-232 drivers were also provided. To interface a serial TTL device such as a keyboard, it is necessary to circumvent the drivers. Remove the 75189 receiver chip and replace it with a header, jumpered so that each input line connects directly to an output. When the port is required as an RS232 interface, swop back to the driver. Two serial TTL keyboards which would be suitable are the IBM Work-Alike from Diamond H Controls, Vulcan Road North, Norwich NR6 6AH, tel 0603-45291, and the GAT-0414

Pin No.	Signal
1	PA4
2	PA3
3	PA5
4	PA2
5	PA6
6	PA1
7	PA7
8	PA0
9	Gnd
10	PC7
11	PC6
12	PC5
13	PC4
14	PC0
15	+5v
16	PC1
17	PB7
18	PC2
19	PB6
20	PC3
21	PB5
22	PB0
23	PB4
24	PB1
25	PB3
26	PB2

Table 4 Pin connections on the EPROM disc board connector, SK6.

from Verospeed. Any serial keyboard used should be set to 9600 baud, eight data bits and no parity on start-up.

The second keyboard option is the parallel interface. Quite a few low cost parallel interface keybards can be found, but caution must be exercised. Make sure that the keyboard is ASCII encoded, and that it has a full set of upper and lower case letters, numbers and punctuation marks. The keyboard must provide a negative going strobe of at least one millisecond width to the board with each character.

If you are going to use a serial terminal instead of a separate keyboard and monitor, it should be set to 9600 baud, 8 data bits and no parity. The board requires RTS/CTS handshaking. If this is not available from the terminal, link the two pins together.

Power Supplies

The next piece of equipment is the power supply. There are two important considerations here, the dimensions of the power supply which must be determined in relation to the cabinet you are going to use, and the output current and number of voltage rails required. This in turn depends on whether you will also be powering your drive(s) with the same supply, whether you use the serial driver chips, and what the power requirements of your keyboard are.

The general requirements for the power supply are +5 volts at 2.5 amps, +12 volts at 2 amps, and -12 volts at 0.1 amps. This assumes that you will be powering two drives, and that you have a separate keyboard drawing a small amount of power. One supply which is suitable is the Model PRD 303 from Power Rail Electronics Ltd, tel 0582-600277. This unit is recommended for use with the Vero Total Access case used on the prototype because it fits easily within the limit the cabinet places on height.

The Case

This board does not necessarily require a case. Indeed, as we mentioned in the last issue, a prototype can be found mounted to the wall of the designer's workroom. However, a case does protect things, and it can also help to collect and organize the cables, power supply and drives.

The case pictured is from Vero and is a Total Access case type 212-8154H. To use it you will also need a chassis plate type 212-27826K. Use of this case requires that you mount the disk controller cable socket and the buss extension socket vertically. The power supply should be the one mentioned above, or should conform to the dimensions of the case. There is sufficient room available inside it to mount one 5 ¼ or two 3 ½ inch drives.

Further, a slot must be cut in the front of the cabinet to allow the EPROM disk to be installed. A connector cannot be taken out to the front of the case because the extension of the EPROM connector would create too hgh an impedance. Micro Concepts will substitute a reduced size EPROM board, in the kit if you specifically ask for it. This will fit fully within the cabinet but must be soldered on to the main board rather than socketed. In practice this only means you will have to replace EPROMs rather than replace the whole EPROM board.

The board should be mounted to the chassis plate with four standoffs. The fit is a bit snug, so make sure you mark the holes correctly before you drill.

The Total Access case is the only one we have tried using, but there is no shortage of other case designs for those who don't mind experimenting a little with mounting and connector positioning. Vero sell several larger sizes of Total Access case which would allow more flexibility in the choice of power supply, number and type of disc drives and in the use of the EPROM disc board. There are also a large number of other cases on the market which would no doubt be suitable. For those who want a really professional look, a number of manufacturers offer suites of matching cases to house processor, monitor, keyboard, disc drives and peripherals in several combinations of stacking and distributed units. One such packaging system from Vero was described briefly in a short item in last month's News Digest, and West Hyde Developments and OK Industries are among the other manufacturers who produce this type of case.

Power-Up And Testing

Assuming that you have purchased your hardware, assembled the board, tested for continuity, inserted the ICs, and connected the peripherals, the next steps are as follows.

First set the switches on SW1 to match the peripherals you have connected. The appropriate settings are shown in Table 5. Now connect power to the board. If all

Hardware	Switch Settings 1	2	3	4
Parallel keyboard and video monitor	off	off	off	off
Serial keyboard on Port 1 and video monitor	on	off	off	off
Serial Terminal on 1	on	on	off	off

Table 5 SW1 switch settings to select peripherals.

Pin No.	Inner row	Outer row
1, 2	Gnd	nc
3, 4	Gnd	nc
5, 6	Gnd	nc
7, 8	Gnd	Index
9, 10	Gnd	Select 0
11, 12	Gnd	Select 1
13, 14	Gnd	nc
15, 16	Gnd	Motor on
17, 18	Gnd	Direction
19, 20	Gnd	Step
21, 22	Gnd	Write data
23, 24	Gnd	Write gate
25, 26	Gnd	Track 0
27, 28	Gnd	Write prot
29, 30	Gnd	Read data
31, 32	Gnd	nc
33, 34	Gnd	nc

Table 6 Pin connections on the floppy disc port, SK5.

is well a header and a prompt will appear. The prompt should look like this

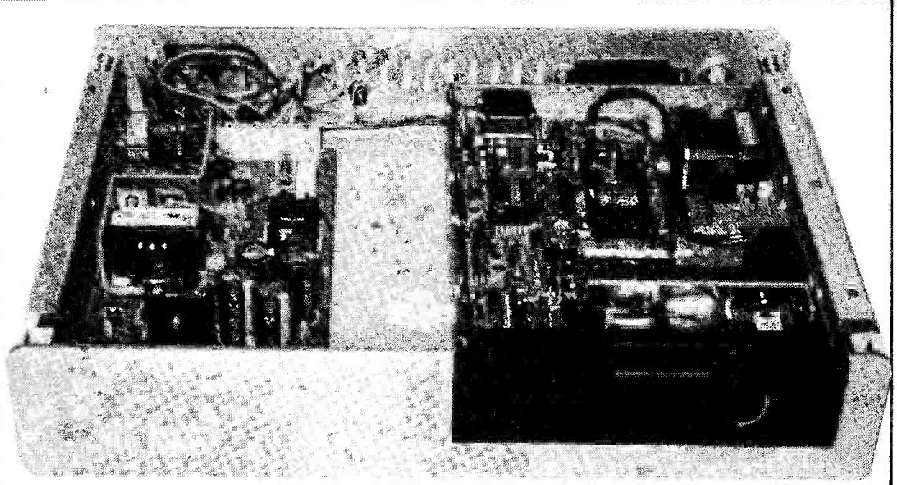
=>

Try typing a few characters. If they appear correctly on the screen, use the TM (test memory) command to test memory from 0000 to DE00. While the test is proceeding, tap the board gently. This will show up any bad solder joints.

Now switch off, disconnect all connections to the board and fit the NiCad battery. Be extremely careful not to short circuit it, as it can break open and foam over, damaging the board and making a mess. Momentarily short pin 22 of the clock chip to ground. This will cause it to load the default values into its RAM on power up.

Memory	
AD=	ASCII dump of memory
HD=	Hex dump of memory
ME=	memory examine
PM=	Poke memory with value
FM=	Fill memory with value
SM=	shift a block of memory
FI=	find ASCII string in memory
TM=	test memory
DR=	display registers
CD=	calculate displacement
Input/Output	
SI=	Set keyboard input port
SO=	set output port
SB=	set baud rate
LK=	load ASCII text from keyboard
Real Time Clock	
DC=	display contents of RTC memory
MC=	modify contents of RTC memory
Disc	
DF=	format disk
TS=	test stepping
TD=	test drive
RS=	read sector
WS=	write sector
Running Programs	
JU=	jump to program
CP=	continue program after software interrupt
RP=	run program
Flex	
BF=	boot Flex from disk
BO=	boot Flex from wherever it was last booted
JT=	jump to Flex warm start

Table 7 A list of monitor commands, arranged according to the area they serve.



An internal view of the computer showing the power supply and disc drive installed below the chassis.

Reconnect the board. If you have drives, now is the time to hook them up. They should be set for head load with motor on and the drive selected.

A further suite of routines in the monitor which can be used for testing the disk drives is listed in Table 7.

If you have got this far and have Flex, you are ready to boot it. If you don't have Flex, you can still use some of the powerful monitor commands. A list of commands is given in Table 7, each with a short description.

If there are problems with the board here are some things you might check:

are the configuration switches set correctly?

are your serial devices connected correctly?

are any of the chips getting overly hot?

do any of the address or data lines look shorted?

is the 16MHz clock being generated?

are E and Q getting to the processor?

are the DRAMS getting the correct signals?

is the MONO9 EPROM getting the correct signals?

are there any spurious interrupts?

is there a video signal?

Pin No	Inner row	Outer row
1, 2	D6	Gnd
3, 4	D7	Gnd
5, 6	D4	Gnd
7, 8	D5	Gnd
9, 10	D2	Gnd
11, 12	D3	Gnd
13, 14	D0	Gnd
15, 16	D1	Gnd
17, 18	BUSY	Gnd
19, 20	STROBE	Gnd

Table 8 Pin connections on the printer port, SK1.

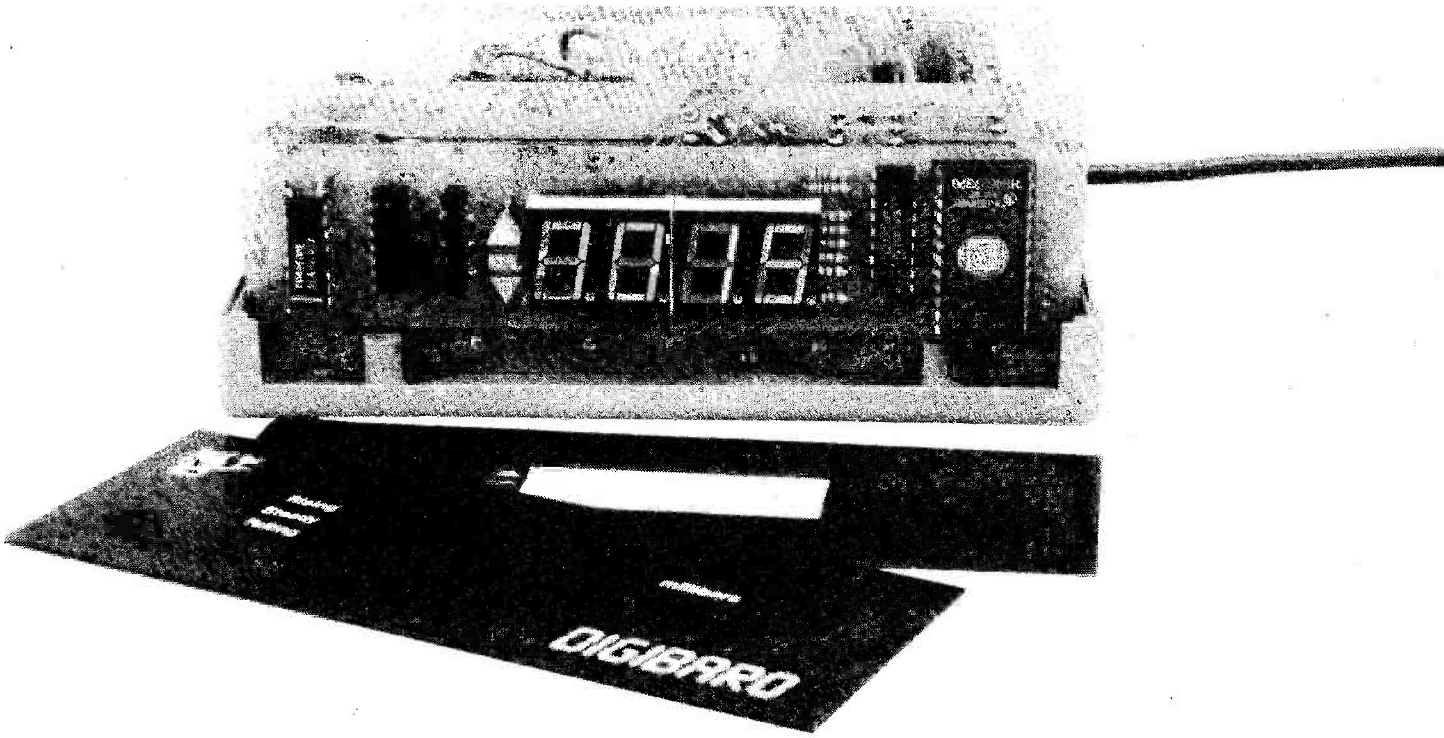
Pin No	Inner row	Outer row
1, 2	+5v	+5v
3, 4	Gnd	Gnd
5, 6	BA0	IC19 pin 6
7, 8	BRTS	BA1
9, 10	BD1	BD0
11, 12	BD3	BD2
13, 14	BD5	BD4
15, 16	BD7	BD6
17, 18	BA2	BR/W
19, 20	BA4	BA3
21, 22	16MHz	BE
23, 24	WDS	Q
25, 26	RTC	LPEN
27, 28	I/02	RDS
29, 30	I/01	I/OBUFF
31, 32	NMI	RST
33, 34	FIRQ	IRQ
35, 36	TTLVID	VSYNC
37, 38	Gnd	Gnd
39, 40	-12v	+12v

Table 9 Pin connections on the expansion bus socket, SK10.

● Next month's concluding article will discuss applications and the use of the machine and will include a list of some of the Flex software available. A basic kit for this project is available from Micro Concepts, 2 St. Stephens Road, Cheltenham, Gloucestershire GL51 5AA, tel 0242-510525. **ETI**

THE DIGIBARO

Ken Wood supplies the EPROM listing to go with last month's digital barometer design.

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0010   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0020   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0030   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0040   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0050   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0060   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0070   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0080   10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10
0090   10 10 10 10 10 10 10 10 10 10 10 10 34 34 34 34
00A0   34 34 34 34 34 34 34 34 34 34 34 34 34 34 34 34
00B0   34 34 34 34 34 34 34 34 34 34 34 34 34 34 34 34
00C0   34 34 34 34 34 34 34 34 34 34 34 34 34 34 34 34
00D0   34 34 34 34 34 34 34 34 34 34 34 34 34 34 34 34
00E0   34 34 34 34 34 34 34 34 34 34 34 34 34 34 34 34
00F0   34 34 34 34 34 34 34 34 34 34 34 34 34 34 34 00
0100   00 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0110   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0120   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0130   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0140   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0150   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0160   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0170   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0180   40 40 40 40 40 40 40 40 40 40 40 40 40 40 40 40
0190   40 40 40 40 40 40 40 40 40 40 40 40 64 64 64 64
01A0   64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
01B0   64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
01C0   64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
01D0   64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
01E0   64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 64
01F0   64 64 64 64 64 64 64 64 64 64 64 64 64 64 64 00
0200   00 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0210   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0220   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0230   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0240   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0250   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0260   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0270   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0280   80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0290   80 80 80 80 80 80 80 80 80 80 80 80 A4 A4 A4 A4
02A0   A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4
02B0   A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4
02C0   A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4
02D0   A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4
02E0   A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4
02F0   A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 A4 00
0300   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0310   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0320   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0330   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0340   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0350   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0360   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0370   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0380   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0390   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
03A0   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
03B0   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
03C0   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
03D0   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
03E0   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
03F0   08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0400   49 E4 E4 E4 E4 E4 D6 D6 D6 D6 D6 D6 D6 D6 D6 D6
0410   D7 D7 D7 D7 D7 D7 D7 D7 D7 D7 34 34 34 34 34 34
0420   34 34 34 34 F7 F7 F7 F7 F7 F7 F7 F7 F7 F7 F6 F6
0430   F6 F6 F6 F6 F6 F6 F6 F6 B7 B7 B7 B7 B7 B7 B7 B7
0440   B7 B7 24 24 24 24 24 24 24 24 24 24 73 73 73 73
0450   73 73 73 73 73 73 76 76 76 76 76 76 76 76 76 76
0460   E4 E4 E4 E4 E4 E4 E4 E4 E4 E4 D6 D6 D6 D6 D6 D6
0470   D6 D6 D6 D6 D7 D7 D7 D7 D7 D7 D7 D7 D7 D7 34 34
0480   34 34 34 34 34 34 34 34 F7 F7 F7 F7 F7 F7 F7 F7
0490   F7 F7 F6 F6 F6 F6 F6 F6 F6 F6 F6 F6 B7 B7 B7 B7
04A0   B7 B7 B7 B7 B7 B7 24 24 24 24 24 24 24 24 24 24
04B0   73 73 73 73 73 73 73 73 73 73 76 76 76 76 76 76
04C0   76 76 76 76 E4 E4 E4 E4 E4 E4 E4 E4 E4 E4 D6 D6
04D0   D6 D6 D6 D6 D6 D6 D6 D6 D7 D7 D7 D7 D7 D7 D7 D7
04E0   D7 D7 34 34 34 34 34 34 34 34 34 34 F7 F7 F7 F7
04F0   F7 F7 F7 F7 F7 F7 F6 F6 F6 F6 F6 F6 F6 F6 F6 49
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0500  49 E4 E4 E4 E4 E4 D6 D6 D6 D6 D6 D6 D6 D6 D6 D6
0510  D7 D7 D7 D7 D7 D7 D7 D7 D7 D7 34 34 34 34 34 34
0520  34 34 34 34 F7 F7 F7 F7 F7 F7 F7 F7 F7 F7 F6 F6
0530  F6 F6 F6 F6 F6 F6 F6 F6 B7 B7 B7 B7 B7 B7 B7 B7
0540  B7 B7 24 24 24 24 24 24 24 24 24 24 73 73 73 73
0550  73 73 73 73 73 73 76 76 76 76 76 76 76 76 76 76
0560  E4 E4 E4 E4 E4 E4 E4 E4 E4 E4 D6 D6 D6 D6 D6 D6
0570  D6 D6 D6 D6 D7 D7 D7 D7 D7 D7 D7 D7 D7 D7 34 34
0580  34 34 34 34 34 34 34 34 F7 F7 F7 F7 F7 F7 F7 F7
0590  F7 F7 F6 F6 F6 F6 F6 F6 F6 F6 F6 F6 B7 B7 B7 B7
05A0  B7 B7 B7 B7 B7 B7 24 24 24 24 24 24 24 24 24 24
05B0  73 73 73 73 73 73 73 73 73 73 76 76 76 76 76 76
05C0  76 76 76 76 E4 E4 E4 E4 E4 E4 E4 E4 E4 E4 D6 D6
05D0  D6 D6 D6 D6 D6 D6 D6 D6 D7 D7 D7 D7 D7 D7 D7 D7
05E0  D7 D7 34 34 34 34 34 34 34 34 34 34 F7 F7 F7 F7
05F0  F7 F7 F7 F7 F7 F7 F6 F6 F6 F6 F6 F6 F6 F6 F6 49
0600  49 E4 E4 E4 E4 E4 D6 D6 D6 D6 D6 D6 D6 D6 D6 D6
0610  D7 D7 D7 D7 D7 D7 D7 D7 D7 D7 34 34 34 34 34 34
0620  34 34 34 34 F7 F7 F7 F7 F7 F7 F7 F7 F7 F7 F6 F6
0630  F6 F6 F6 F6 F6 F6 F6 F6 B7 B7 B7 B7 B7 B7 B7 B7
0640  B7 B7 24 24 24 24 24 24 24 24 24 24 73 73 73 73
0650  73 73 73 73 73 73 76 76 76 76 76 76 76 76 76 76
0660  E4 E4 E4 E4 E4 E4 E4 E4 E4 E4 D6 D6 D6 D6 D6 D6
0670  D6 D6 D6 D6 D7 D7 D7 D7 D7 D7 D7 D7 D7 D7 34 34
0680  34 34 34 34 34 34 34 34 F7 F7 F7 F7 F7 F7 F7 F7
0690  F7 F7 F6 F6 F6 F6 F6 F6 F6 F6 F6 F6 B7 B7 B7 B7
06A0  B7 B7 B7 B7 B7 B7 24 24 24 24 24 24 24 24 24 24
06B0  73 73 73 73 73 73 73 73 73 73 76 76 76 76 76 76
06C0  76 76 76 76 E4 E4 E4 E4 E4 E4 E4 E4 E4 E4 D6 D6
06D0  D6 D6 D6 D6 D6 D6 D6 D6 D7 D7 D7 D7 D7 D7 D7 D7
06E0  D7 D7 34 34 34 34 34 34 34 34 34 34 F7 F7 F7 F7
06F0  F7 F7 F7 F7 F7 F7 F6 F6 F6 F6 F6 F6 F6 F6 F6 49
0700  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0710  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0720  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0730  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
0740  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
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07A0  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
07B0  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
07C0  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
07D0  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
07E0  08 08 08 08 08 08 08 08 08 08 08 08 08 08 08 08
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0800  8D 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0810  7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0820  7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0830  7F 7F 7F 7F 7F 7F 7F 7F 77 77 77 77 77 77 77 77
0840  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
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0880  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0890  77 77 77 77 77 77 77 77 77 77 77 77 7D 7D 7D 7D
08A0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
08B0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
08C0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
08D0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
08E0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
08F0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 8F
0900  8D 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0910  7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
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0940  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
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0960  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0970  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0980  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0990  77 77 77 77 77 77 77 77 77 77 77 77 7D 7D 7D 7D
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09B0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
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09E0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
09F0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 8F
0A00  8D 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0A10  7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0A20  7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0A30  7F 7F 7F 7F 7F 7F 7F 7F 77 77 77 77 77 77 77 77
0A40  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0A50  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0A60  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0A70  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0A80  77 77 77 77 77 77 77 77 77 77 77 77 77 77 77 77
0A90  77 77 77 77 77 77 77 77 77 77 77 77 7D 7D 7D 7D
0AA0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
0AB0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
0AC0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
0AD0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
0AE0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D
0AF0  7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 7D 8F
0B00  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B10  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B20  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B30  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B40  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B50  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B60  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B70  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B80  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0B90  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0BA0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0BB0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0BC0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0BD0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0BE0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0BF0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0C00  00 37 3F 51 7F 77 7D 41 5E 57 63 37 3F 51 7F 77
0C10  7D 41 5E 57 63 37 3F 51 7F 77 7D 41 5E 57 63 37
0C20  3F 51 7F 77 7D 41 5E 57 63 37 3F 51 7F 77 7D 41
0C30  5E 57 63 37 3F 51 7F 77 7D 41 5E 57 63 37 3F 51
0C40  7F 77 7D 41 5E 57 63 37 3F 51 7F 77 7D 41 5E 57
0C50  63 37 3F 51 7F 77 7D 41 5E 57 63 37 3F 51 7F 77
0C60  7D 41 5E 57 63 37 3F 51 7F 77 7D 41 5E 57 63 37
0C70  3F 51 7F 77 7D 41 5E 57 63 37 3F 51 7F 77 7D 41
0C80  5E 57 63 37 3F 51 7F 77 7D 41 5E 57 63 37 3F 51
0C90  7F 77 7D 41 5E 57 63 37 3F 51 7F 77 7D 41 5E 57
0CA0  63 37 3F 51 7F 77 7D 41 5E 57 63 37 3F 51 7F 77
0CB0  7D 41 5E 57 63 37 3F 51 7F 77 7D 41 5E 57 63 37
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0F60  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
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0F80  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0F90  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0FA0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0FB0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0FC0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0FD0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0FE0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
0FF0  80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
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Checksum: 8BAB

ETI

RS232-CENTRONICS CONVERSION

D.J. Virden has come to the rescue of numerous readers who want to convert an RS232 into a Centronics output.

If you have a computer equipped with a RS232 port, but your printer has a Centronics interface then you will have to beg, steal or build a serial-to-parallel converter, not a cheap bit of equipment by any means. RS232 printers also tend to be more expensive than their Centronics equivalent, but many portable and cheap micros sport only the RS232 output.

The RS232 interface was developed as a standard to ensure compatibility between equipment from different manufacturers. The output levels from the interface can be anywhere between +3V and +15V for an on state and −3V to −15V for an off state. The area between −3V and +3V gives some degree of noise immunity. The output data is asynchronous, using stop and start bits to achieve synchronisation. Fig. 1 shows the transmission sequence of a complete byte.

The Circuit

The heart of the interface is the General Instruments AY-3-1015D UART (Universal Asynchronous Receiver/Transmitter), whose sole purpose in life is to convert serial data to parallel and vice versa. However, only the receiver section of the device is used in the circuit. The chip can also cope with parity and any number of data bits from five to eight. The number of stop bits can be one or two. The circuit is shown in Fig. 2.

Data from pin 2 (Tx) of the RS232 plug is fed to Q2 which converts the bipolar data signal to a TTL level. This TTL level is fed to the serial input of the UART. The UART strips the data byte of its sync bits, and presents the byte in parallel to the data lines RD1-RD8. Each time a data byte is received the DAV latch is set, signalling that data is available. This line is connected via a monostable (IC5) to the printer's data strobe. Data strobe is brought low and the byte is stored in the printer's buffer. While it is doing this the printer signals that it cannot accept more data by setting BUSY high. BUSY is connected via Q3 to CTS (pin 5). When the data byte has been stored, the printer sets BUSY low and sends an acknowledged pulse which is used to reset the DAV latch, enabling another byte to be sent.

IC2c and d and XTAL1 form an oscillator whose output is fed to the dividers, IC3 and IC4. The outputs from the dividers are used for the clock input of the UART. The clock rate is 16 times the desired baud rate. For example, the clock rate required for a receiver rate of 2400 baud is 16x2400 = 38.4KHz. The baud rate is selected by connecting wire link LK1 to the appropriate divider output, marked A, B, C and D.

If lower baud rates are required, replace the 7493 counter with a CMOS 4040 12 bit counter. This will allow speeds down to 75 baud. This should only be required when the equipment you are using to transmit the data is incapable of higher speeds, as the Centronics itself is capable of keeping up with all but the highest baud rates.

IC6 and IC7 are used to buffer the signals going to and from the printer. These are open collector as the printer inputs are all pulled up to 5V.

In Use

A power supply for the unit is not given. It is worth examining the feasibility of using the printer's power supply. The Microline 80, for example, has a power pin at 10V DC, 150mA (P34), which could be used to derive the required TTL supply of 5V, and one at 23V AC, 50mA (P36), which could be the source for the bipolar swing required by the RS232 specification. Figure 3 shows the connections to this printer — other printers with Centronics inputs may differ slightly and you should check with the manual.

Pull-up resistors are not necessary with SW1 since all inputs to the 1015 are pulled-up internally. Table 1 shows the effect of each switch on the data transmission parameters.

After the unit is constructed select the transmission

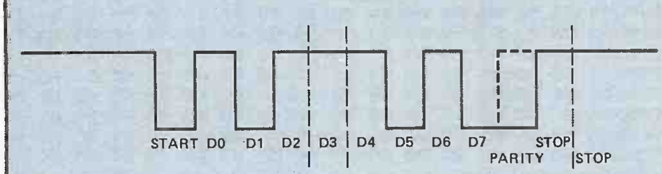


Fig. 1 Typical asynchronous data format for one byte.

SW1	a	b	DATA BITS	c	d	PARITY	e	STOP BITS
	1	1	5*	X	0	off	1	1
	1	0	6	1	1	odd	0	2*
	0	1	7	0	1	even	—	—
	0	0	8	—	—	—	—	—

(combination of two stop bits and five data bits gives 1½ stop bits.)*

1=Switch closed. Use DIL switch unit or independent miniature toggles.

Table 1 Transmission parameter selection using SW1.

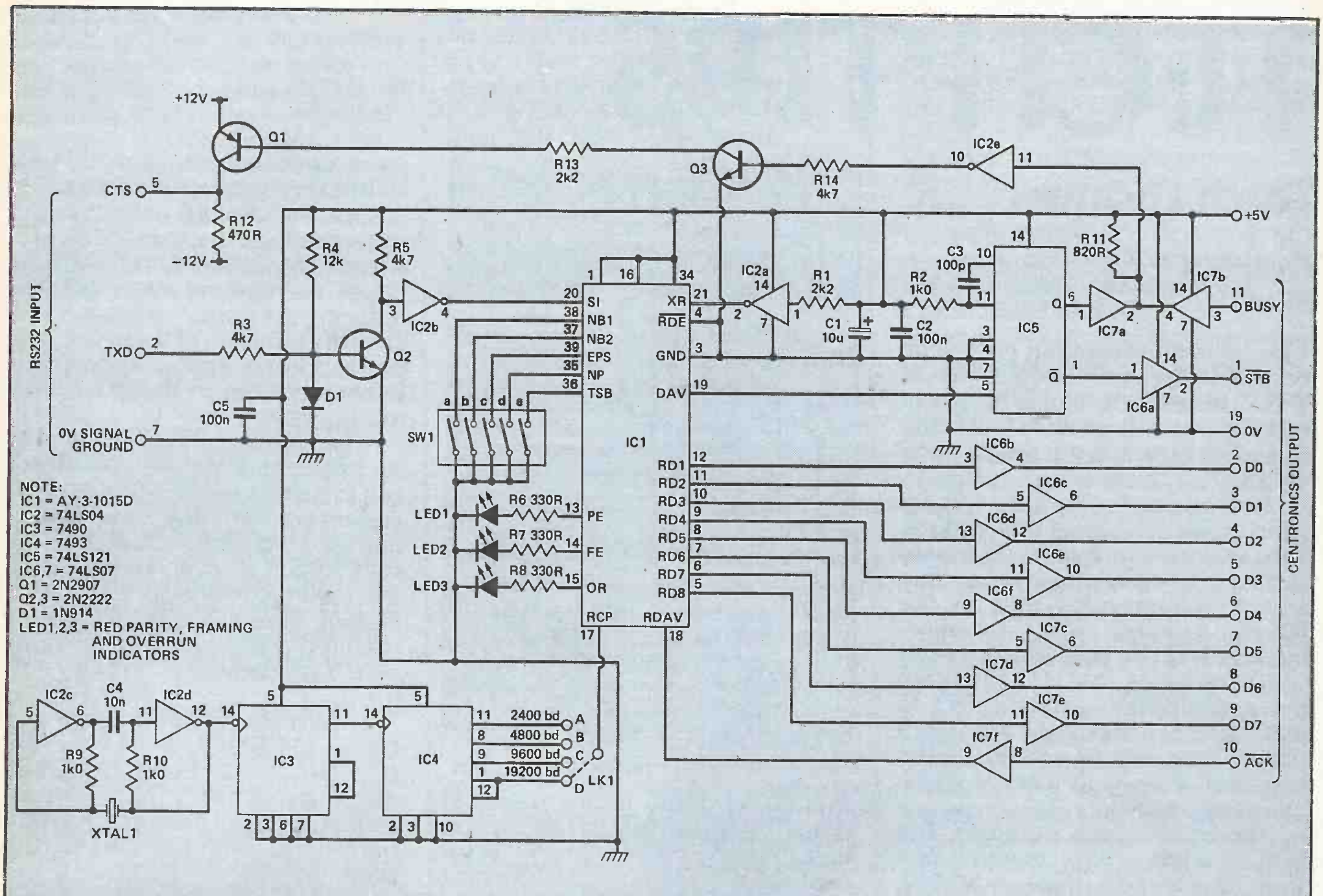


Fig. 2 The circuit of the interface.

parameters required — baud rate, parity and number of data and stop bits. Switch off the printer and computer while you connect up the leads. Test the unit is working by sending text to the printer. Refer to your users' manual on how to do this.

If the interface does not seem to work, check the error LEDs. If the frame error LED is on, you are either running the unit at the wrong baud rate or have the parity switch in the wrong position. The overrun LED indicates that a byte has not been read from the UART. If this occurs check the connections from the unit to the printer. The parity error LED indicates that the parity check has returned an incorrect value. You will probably need to confirm the settings on your printer and adjust SW1 accordingly.

PIN NO.	FUNCTION
1	DATA STROBE
2	DATA BIT 1
3	DATA BIT 2
4	DATA BIT 3
5	DATA BIT 4
6	DATA BIT 5
7	DATA BIT 6
8	DATA BIT 7
9	DATA BIT 8
10	ACKNOWLEDGE
11	BUSY
12	PAPER END
19-30	0 V
34	10 V DC (150mA)
36	23 V AC (50mA)

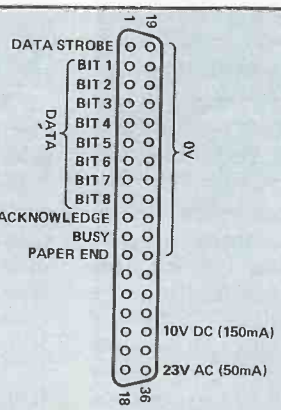


Fig. 3 Connections to an Oki Microline 80 printer.

The CIRCUIT SOLUTION section is designed to provide original design ideas and solutions more comprehensively than TECH TIPS but without the complexities of a full-scale project. Readers are invited to experiment and design their own stripboard or PCB layouts.

ETI

TECH TIPS

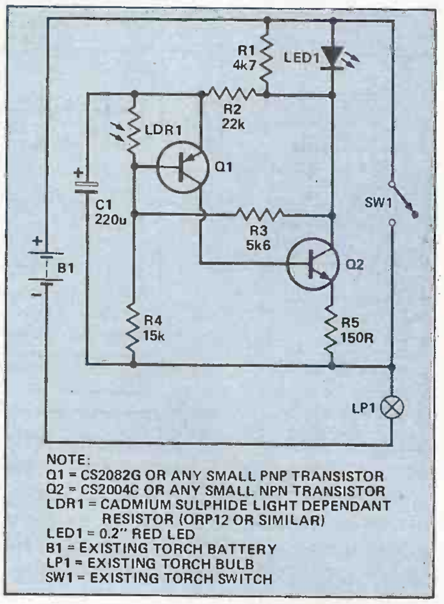
Torch Locator

L.M. Loong
Hong Kong

Having been caught out on several occasions by unexpected power cuts, I resolved to find a means of making my torch easier to find in the dark. This circuit is the result of my efforts.

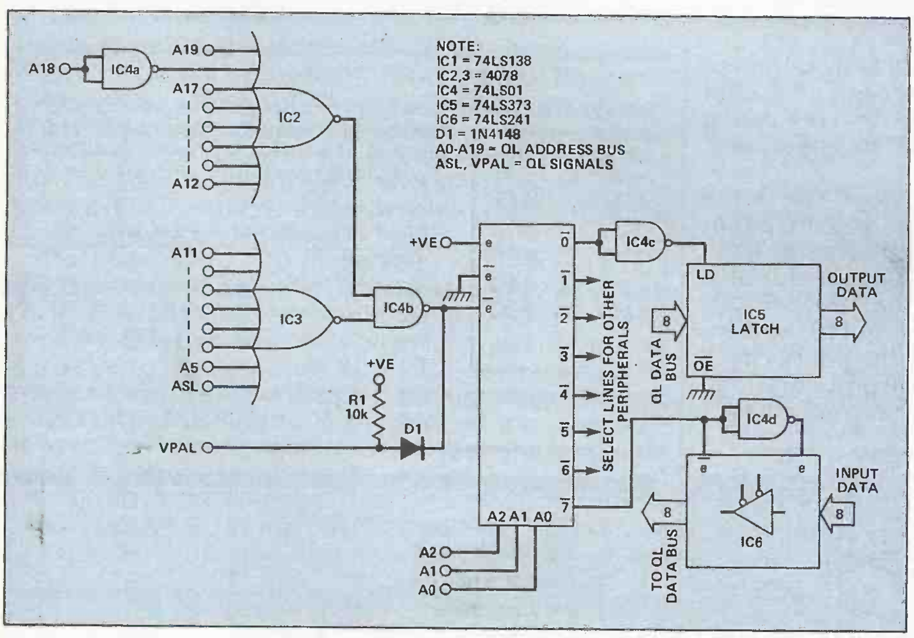
It consists of a simple oscillator which will flash an LED on and off. The current drawn by the LED is quite small and using a flashing rather than a steady illumination reduces the current demand. A further refinement is an LDR light sensor circuit which switches the LED off when there is sufficient ambient light to make it unnecessary. As a result, a battery life of at least a month can be expected even with torches which use penlight cells.

For construction purposes, the best type of torch to convert is one using D size cells (HP2, MN1300, R/LR20, etc.) and having plenty of space inside the case. It is also a good idea to get one with a lamp reflector made of silvered plastic, as the best place to mount both the LED and LDR is on the silvered surface. This ensures that the LED flashes are projected well and that the LDR picks up all the light around the reflector and biases the flashing circuit off, thus reducing the current demand. With care, the intrusion of these two components has negligible effect on the beam produced by the torch in normal operation.



The component values given are for 3 volt operation and allow the circuit to work down to 2.5 volts. As the current consumption is minimal, the normal 3 volt torch bulb, although still in circuit, is not illuminated whilst the flashing circuit is operational. The flashing circuit is effectively short-circuited when the normal on/off switch is operated to switch on the torch.

Whilst the circuit diagram gives Q1 as a CS 2082G and Q2 as a CS2004C, these being Hong Kong made transistors I had to hand, almost any small plastic cased silicon transistors will function in their positions.



Interfacing The QL

Greg Parker
London N11

Now that the Sinclair QL costs only £200 or so it is within reach of the electronics experimenter. It may even replace the Spectrum as the computer workhorse for which most interface projects are made. It is, however, a bit more complicated to interface than the old faithful Z80 with all its ideal I/O capabilities.

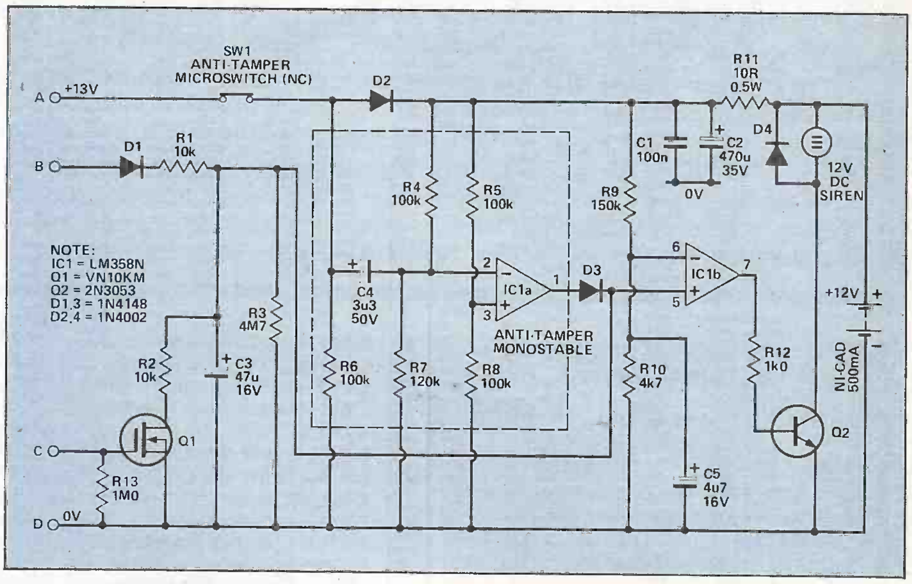
Looking at the edge connector pin-out (in the manual) it can be seen that various devices have been added to the basic 68008 to confuse matters. So I wrote to Sinclair Research for some explanation; they replied that a book costing £15 would help — please send a cheque. Unwilling to spend £15 on a book, I decided to rely on common sense and designed this circuit.

The standard 68000 accesses a peripheral by setting up the address and data busses and asserting the Address Strobe (ASL) line. If the address is correct the peripheral replies with a Valid Peripheral Address (VPAL) signal. The 68000 then confirms this with a Valid Memory Address (VMAL) signal, inserting wait states to allow for slow peripherals. On the QL, the VMAL line is not brought to the edge connector so proper handshaking cannot be assured, but the circuit shown seems to work well.

The two NOR gates and IC4a decode the address bus — when the address 4000x(h) is accessed VPAL is pulled low and IC1 is enabled. IC1 decodes the low 3 address bits and outputs a SELECT signal to the appropriate peripheral. An output latch and an input 3-state buffer are shown as examples. The devices are selected from BASIC by PEEKing or POKEing the appropriate address (the addresses from 40000(h) to C0000(h) are specifically reserved for expansion I/O).

Self-Activating Siren

Steve Brown,
Woking



This simple analogue self-activating siren for an intruder alarm offers several functional advantages over its more usual digital rivals but uses only one 8-pin IC.

The main features are:

- virtually tamper proof
- fault protected
- automatic reset
- siren disable
- retriggerable while siren sounds
- uses 4-core cable — 2 signals, 2 power.

The siren is activated by a retriggerable monostable (for example, a 4047B or NE555) in the control unit which sends a 2s duration logic pulse to input B. The pulse length is kept short for security reasons but is long enough to fully charge C3 via D1 and R1 (C3 will be 95% fully charged in three R1C1 time constants or about 1.5s.

Op-amp IC1b compares the voltage across C3 with the threshold voltage V_{TH} which is set by the voltage divider R9, R10. For a +12V supply rail, V_{TH} is 365mV. When V_{TH} is exceeded at pin 5 of IC1b, its output saturates at +12V, Q2 turns hard on and the siren sounds.

As the siren sounds, C3 will exponentially discharge to 0V via R3. After a time t (=3.5xR3xC3s), the threshold voltage begins to exceed C3 voltage and the siren switches off. In practice, this time may be double its theoretical values (Table 1).

A surprise result in Table 1 is the relatively poor performance of low-leakage tantalum bead capacitors against electrolytics. This may be due to the fact that electrolytic capacitors usually have a high over-tolerance (up to +50%) and consequently offer better value for money. For longer on-times, V_{TH} can be reduced or R3 increased. However op-amp offset voltage and noise considerations will set a minimum V_{TH} while leakage currents through C3 will set a maximum on-time.

IC1a and its associated components form a classic op-amp monostable. When the +ve supply is interrupted a 1-2s logic pulse is transferred to C3 via D3 and the siren sounds as before.

Input C allows the siren to be controlled from the control unit. When the alarm is armed, input C is latched low. In SIREN TEST mode, input B goes high for the test duration and input C is also latched high. C3 discharges via Q1 and R2 immediately input B goes low. Similarly, input C is latched high for SIREN DISABLE mode and the siren is switched off and held off.

The op-amp circuits are filtered from the siren switch-on transient by C1, C2 and R11. These components can be omitted if a low current drain electronic siren is used. C5 provides extra filtering for V_{TH} and prevents oscillations around IC1b as the input voltages approach one another.

IC1 was selected for the ability of both inputs and outputs to swing from +Vcc to ground, although in practice, most op-amps can be used.

D1 and D2 provide tamper and reverse polarity protection while D4 would be added if the siren is an inductive device.

R	theory	tant.	elect.
IM5	247	345	400
3M3	543	780	850
4M7	773	1005	1440
O.C.	—	1860	2700

Table 1

ETI

ETI PCB SERVICE

In order to ensure that you get the correct board, you must quote the reference code when ordering. The code can also be used to identify the year and month in which a particular project appeared: the first two numbers are the year, the third and fourth are the month and the number after the hyphen indicates the particular project.

Our terms are strictly cash with order — we do not accept official orders. However, we can provide a pro-forma invoice for you to raise a cheque against, but we must stress that the goods will not be dispatched until after we receive payment.

1981

- ☐ E/8107-1 System A disc input, MM/MC 3.58
- ☐ E/8107-2 System A preamplifier 7.10

1982

- ☐ E/8202-5 MM disc preamp......... 4.13
- ☐ E/8207-1 Microphone switching unit 3.36
- ☐ E/8208-1 Playmate practice amplifier‡ 7.45
- ☐ E/8209-1 Auto volume control 3.59

1983

- ☐ E/8301-2 ZX81/Spectrum ADC..... 3.87
- ☐ E/8305-1 Stereo compressor/ limiter 8.83
- ☐ E/8305-3 Hi-fi power supply 4.48
- ☐ E/8305-4 NDFL power amplifier... 10.32
- ☐ E/8305-5 Balanced input preamp... 3.68
- ☐ E/8306-1 PseudoROM‡............ 3.77
- ☐ E/8307-1 Flash sequencer 3.67
- ☐ E/8307-2 Flash Trigger............ 3.67
- ☐ E/8307-3 Infra-red transmitter 2.21
- ☐ E/8308-1 ⅓rd octave graphic equaliser 11.59
- ☐ E/8309-1 NiCad charger/ regenerator 3.77
- ☐ E/8310-2 Car Alarm 3.99
- ☐ E/8310-3 Typewriter interface...... 4.11
- ☐ E/8311-1 Mini Drum Synth......... 3.85
- ☐ E/8311-8 JLLM MC disc preamp.... 3.85
- ☐ E/8312-3 Finesse light chaser..... 12.48

1984

- ☐ E/8402-1 Speech Board Mini-Mynah 11.47
- ☐ E/8402-2 MP (Modular Preamp) Disc input (mono) 3.80
- ☐ E/8402-3 MP Output stage (stereo) 3.80
- ☐ E/8402-4 MP Relay/PSU........... 3.80
- ☐ E/8402-5 MP Tone, main (mono) ... 3.80
- ☐ E/8402-6 MP Tone, filter (stereo)... 3.80
- ☐ E/8402-7 MP Balanced output (st) ... 3.80
- ☐ E/8402-8 MP Headphone amp (st)... 3.80
- ☐ E/8402-9 MP Mother Board....... 11.64
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- ☐ E/8405-6 Midi Drum Synth......... 3.63
- ☐ E/8406-1 Oric EPROM Bd 20.47
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- ☐ E/8412-2 Experimenter's DRAM... 14.72
- ☐ E/8412-3 Active-8: Motherboard... 12.22
- ☐ E/8412-4 Active-8: Protection Unit ... 3.69
- ☐ E/8412-5 Active-8: Crossover 3.69
- ☐ E/8412-6 Active-8: LF EQ 3.69
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- ☐ E/8412-8 Active-8: Delay Unit...... 3.69

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- ☐ E/8501-1 Active Bass speaker 2.82
- ☐ E/8501-2 DRAM Card Update...... 3.61
- ☐ E/8501-3 Digital Delay (2 bds) 27.18
- ☐ E/8502-1 Digital Delay Expander... 11.28
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- ☐ E/8503-1 Combo preamplifier...... 4.74
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- ☐ E/8503-4 THD meter battery PSU ... 1.59
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- ☐ E/8503-6 ParaGraph Equaliser filter bd 4.93
- ☐ E/8504-1 Framestore Memory 12.05
- ☐ E/8504-2 Framestore ADC/DAC.... 6.21
- ☐ E/8504-3 Framestore Control 17.26
- ☐ E/8504-4 Buzby Meter............. 3.56
- ☐ E/8504-5 CCD Delay 3.82
- ☐ E/8505-1 6802 board.............. 8.22
- ☐ E/8505-2 EPROM prog. update 5.28
- ☐ E/8505-3 Scoreboard controller, PSU and opto-isolator bds....... POA
- ☐ E/8505-4 Scoreboard digital driver ... 4.27
- ☐ E/8505-5 Stereo Simulator......... 3.64
- ☐ E/8506-1 Audio mixer main bd 6.40
- ☐ E/8506-2 Audio mixer PSU bd...... 3.98
- ☐ E/8506-3 Audio mixer RIAA bd 2.62
- ☐ E/8506-4 Audio mixer tone ctrl..... 2.85
- ☐ E/8506-5 EPROM Prog MkII...... 14.90
- ☐ E/8507-1 Noise Gate 5.72
- ☐ E/8508-1 RCL Bridge............ 12.25
- ☐ E/8508-2 EX42/BBC Interface...... 3.25
- ☐ E/8508-3 EPROM Emulator......... POA
- ☐ E/8509-2 Direct Injection Box...... 2.90
- ☐ E/8509-1 SpectROM............. POA
- ☐ E/8510-7 Sorcerer Boards .... POA
- ☐ E/8510-9 Sunrise Light Brightener... 6.61
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- ☐ E/8512-1 Specdrum Connector....... *
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- ☐ E/8512-3 Specdrum .... *
- ☐ E/8512-4 DI Compression Gate .... *

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- ☐ E/8601-1 Autowipe.................. *
- ☐ E/8601-2 Walkmate.............. POA
- ☐ E/8601-3 MTE Counter/timer...... POA
- ☐ E/8602-1 Digibaro‡ 11.80
- ☐ E/8603-1 Free PCB .... *
- ☐ E/8603-2 Programmable logic bd... 5.52
- ☐ E/8603-3 Sound Sampler Analogue bd.......... POA

* PCB available from another source. See the original article for details.

‡ Several boards supplied as one. Purchaser must separate.

How to order: indicate the boards required by ticking the boxes and send this page, together with your payment, to: ASP Readers' Services, PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Hertfordshire HP2 4SS, tel 0442-41221. Payment in sterling only please. Prices subject to change without notice.

PLEASE ALLOW 28 DAYS FOR DELIVERY

Total for boards	£...........	
Add 50p p&p	0.50	
Total enclosed	£...........	

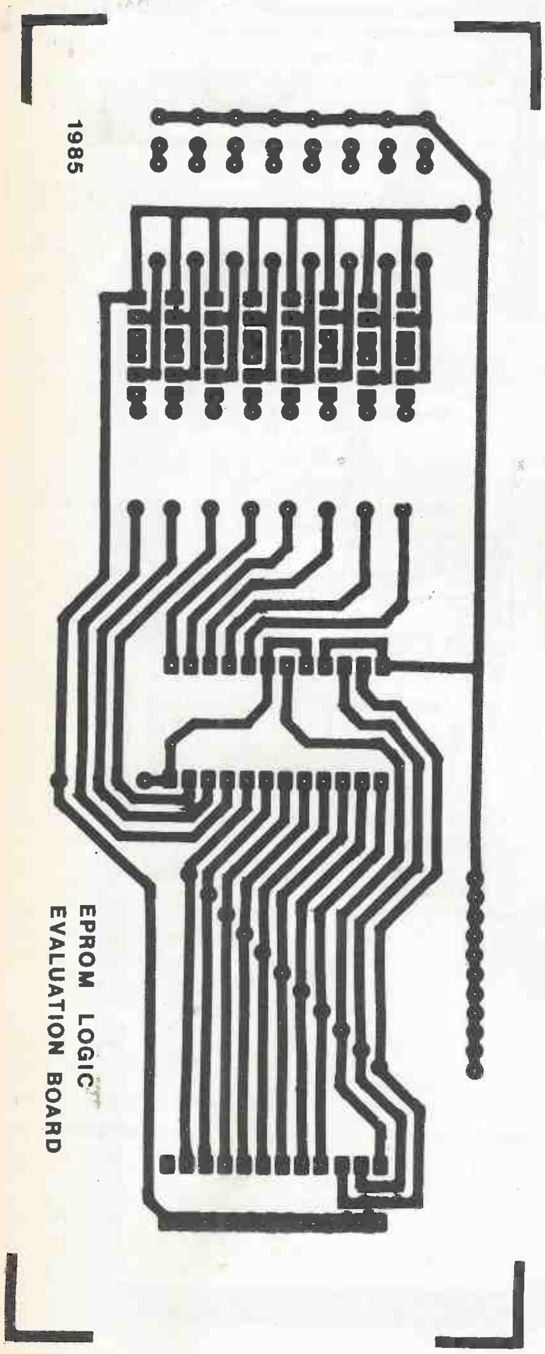
Signed ....

Name ....

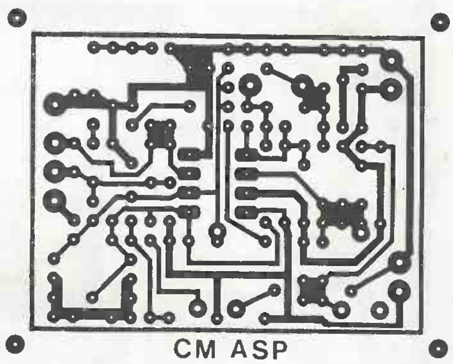
Address ....

....

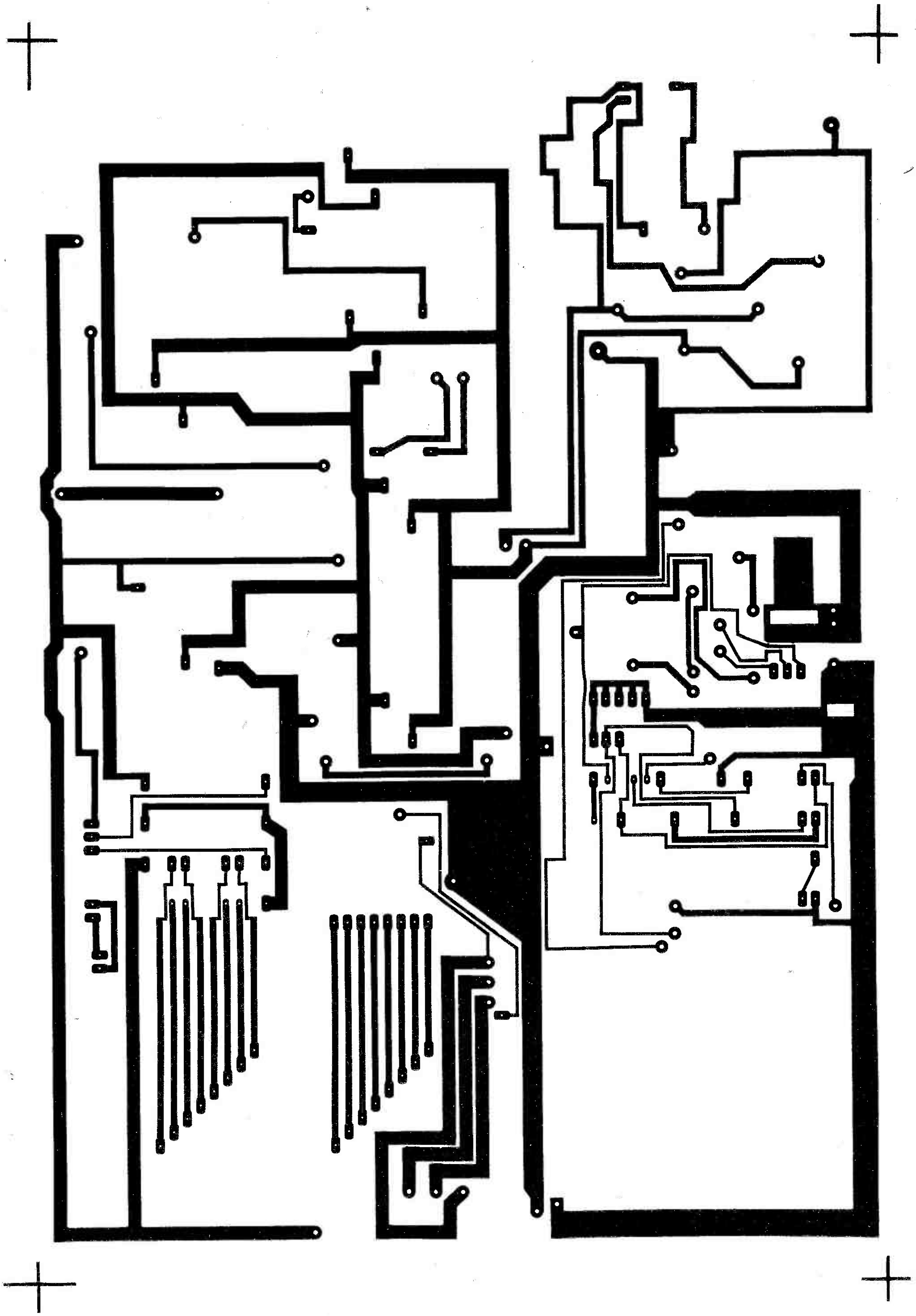
PCB FOIL PATTERNS

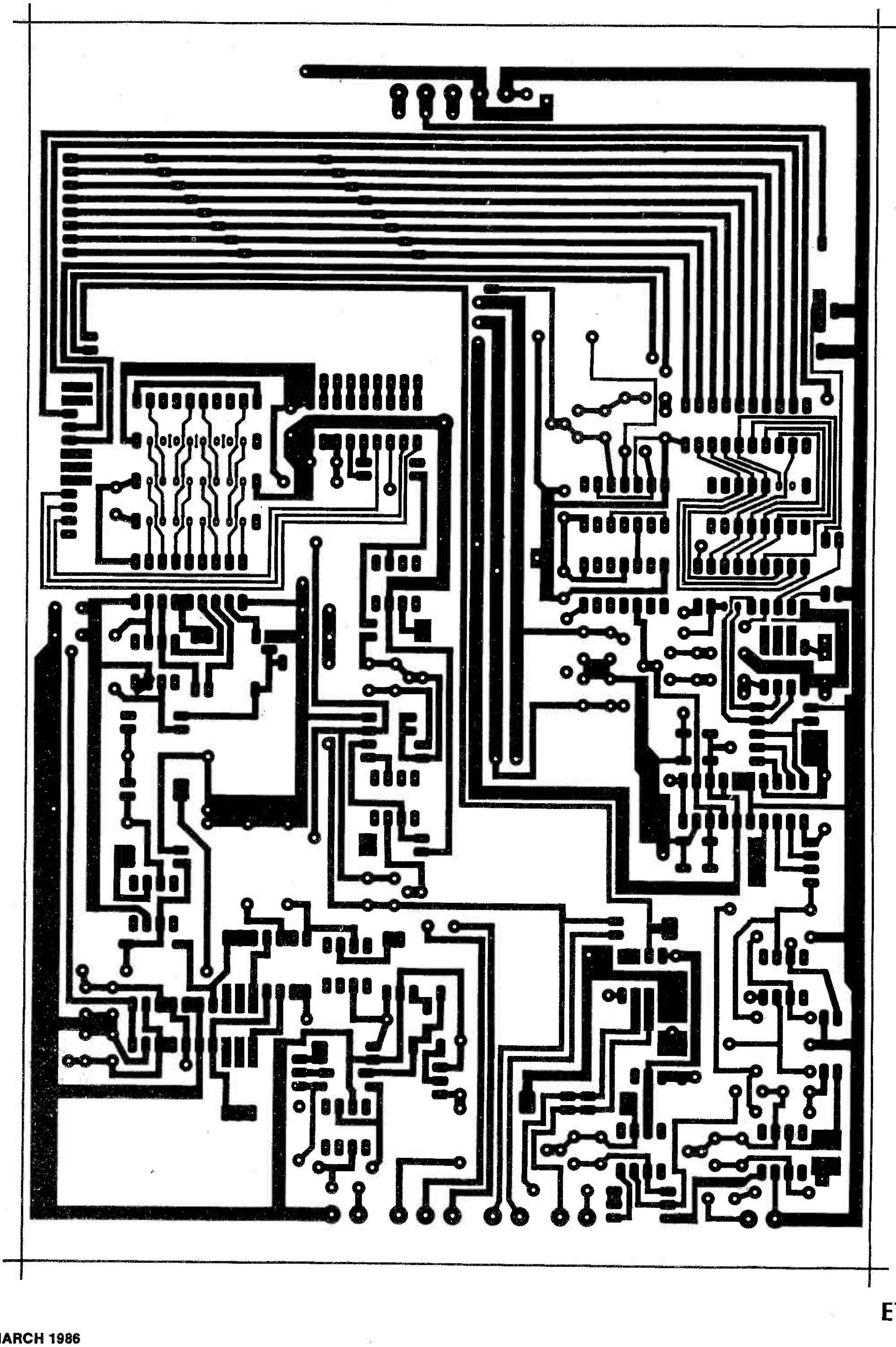


The foil pattern for the programmable logic evaluation board.



The foil pattern for the free PCB, just in case you want to make up some extra ones! The board will not be available through our PCB Service, but we have had a quantity made up and these will be available until stocks are exhausted from Argus Readers' Services at the address given on the PCB Service page. The cost will be £1.00 each and cheques, postal orders, etc should be made payable to ASP Limited. Please enclose a stamped, self-addressed envelope.





ETI

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Write For ETI

We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you all the boring details. (Don't forget to give us your telephone number).

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So far as we know, all our advertisers work hard to provide a good service to our readers. However, problems can occur, and in this event you should:

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OOPS!

Corrections to projects are listed below and normally appear for several months. Large corrections are published just once, after which a note will be inserted to say that a correction exists and that copies can be obtained by sending in an SAE.

Single Board Controller (March 1985)

There were a number of errors in the parts list. RP2 is listed as a 10k SIL pack but is actually four separate resistors, and the same applies to RP3. RP4 is also listed as a SIL pack but should consist of seven commoned resistors. R13 is always required, not just when a cassette interface is used as stated.

The Real Components (May 1985)

In Fig. 1 on page 20, the connections for the Texas L and 2N transistors are incorrectly shown. They should read B, C and E from the top.

Heat Pen (June 1985)

The instruction in the penultimate paragraph on page 49 should read "... adjust RV2 for 2.73V...", not 2.37V as stated.

Low Cost Audio Mixer (June 1985)

In Fig. 6 on page 39, the PCB foil pattern has been incorrectly shown as though from the copper side. The board is shown correctly from the copper side in the foil pattern pages. In Fig. 10 on page 40, the positive power rail at lower left should be shown connected to pin 8 of the TL072s, IC1-5).

Noise About Noise (July 1985)

In Fig. 5 on page 24, no connection should be shown between the cathode of the diode and the negative side of the 470u capacitor.

Printer Buffer (July 1985)

The case specified is actually larger than the one used for the prototype. It will, of course, work perfectly well, but if you want to a compact unit use a Verocase 202-21038H (180 x 120 x 65mm) rather than a Verocase 202-21035. The regulator IC17 should be bolted to the back of the case to provide heatsinking or, alternatively, fitted with a TO220 heatsink.

Please note that the designer, Nick Sawyer, has been in touch to inform us that the refresh problem we mentioned in September ETI is dealt with in the printer buffer software. In this case there is no need to replace the TMS 4416 dynamic RAMs, although as far as we know the replacement parts mentioned (Hitachi HM48416 DRAMs) will cause no problems. The full text of Nick Sawyer's letter will appear next month. Meanwhile, our apologies for any confusion caused.

Cortex Parallel I/O (September 1985)

Pins 1 and 2 of IC2 have been swopped over on both the circuit diagram (Fig. 1) and the Veroboard overlay (Fig. 2). Pin 1 should connect to pin 16 on the header and pin 2 should connect to pin 2 on the header.

Intel 8294 Data Encryption Unit (September 1985)

It should be apparent from the text, page 35, that an actual program has been omitted. This program is for use with the SDK 8085 kit only, and copies may be obtained from us on receipt of a stamped addressed envelope.

Tech Tips — Novel Input Stage (October 1985)

The caption against the lower figure should read "Low noise output at *minimum* gain", not maximum gain.

Chorus Unit (November 1985)

IC3 is shown on the circuit diagram on page 49 connected to the 9V supply. It should be connected to the 5V supply. The foil pattern connections to this IC are correct.

Foil Patterns (November 1985)

The foil patterns for the Modular Test Equipment Waveform Generator and the Chorus Unit are shown from the component side rather than the copper side.

REVIEWS — QL BOOKS

Introduction to SuperBASIC on the Sinclair QL
Price: £6.95
Advanced Programming with the Sinclair QL
Price: £6.95
Hutchinson and Co. Ltd., 17-21 Conway Street, London W1P 6JD

QL COMPUTING
Ian Sinclair. Price £5.95
Granada Publishing Ltd., 8 Grafton Street, London W1X 3LA.

With the Sinclair QL now selling (or, maybe, attracting dust) at £199, it seems a good time to look at some of the titles available for that machine. Hutchinson — like a number of other more-or-less foolhardy publishers — are in the throes of a QL series. The latest two additions add texts on Sinclair 'SuperBASIC' and 'Advanced Programming' to a list already featuring an introduction to the computer and books on word-processing and desk-top computing.

The SuperBASIC title contains all the usual ingredients, with chapters on topics ranging from how to plug the QL in to all the wonderful intricacies of procedure structuring and the like. Appendices deal with SuperBASIC keywords and computing terms.

All QLear?

The layout is clear and the text fairly readable. Simple exercises are included at the ends of most chapters, but there isn't anything outstanding to merit recommendation over many other books in the same vein — especially since the manual — although bad in many ways — will probably serve for most would-be QL users.

'Advanced Programming .. ' should not be regarded as a sequel to the previous book. In fact, the contents aren't so much advanced when compared to that book as just different.

Aimed at those people whom the author euphemistically calls 'practical' users, the book reminds me very much of books published around a decade ago with such unassuming titles as 'Computer Programming Made Really Easy' which then proceed to be as stodgy as a bowl of cold custard. In this case, 'advanced' seems to be a synonym for monotonous.

On the credit side, the last chapter contains some simple business and statistical programs which may be of some interest.

'QL Computing' by the redoubtable Ian Sinclair is yet another beginners' guide to SuperBASIC in an already flooded market. Much of the book is the usual standard fare we have come to expect from Ian Sinclair's word-processor and is, as a result, no better than the manual. The main body of the book, however, departs from the manual style of presentation in which keyword functions are summarized in alphabetical order. It is arranged in a prosaic fashion, with examples of usage and simple demonstrative programs to type in and experiment with. Consequently, the book has some degree of continuity and is more effective at teaching the rudiments of SuperBASIC than a manual style book, which may be useful for reference at a later stage.

In ConQLusion

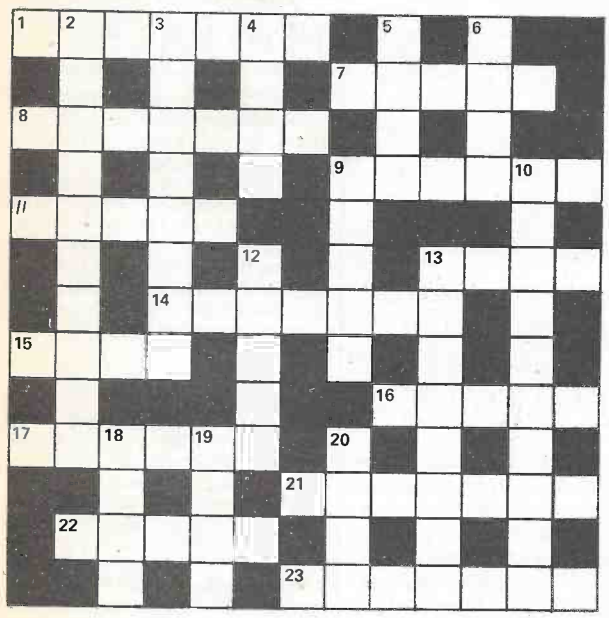
All the QL's assets are dealt with in this relatively comprehensive publication, including micro-drives, effective graphics and the usually neglected sound producing capabilities of the QL. If you are bemused by BASIC or just confused by computer, you could do a lot worse than buy 'QL Computing'.

None of the books dealt with have anything significant to say about the 68008 MPU at the heart of the QL. For electronics buffs, the presence of a 68008 (a 68000-series device with an 8-bit rather than a 16-bit data bus) is the most interesting fact about the QL. Next month, I hope to look at some books dealing specifically with machine code programming and assembly for the QL and, by extension, for 68000-family devices as a whole.

Leigh Chappell

CROSSWORD

No. 2 Solution next month



ACROSS

1) .... trigger, a circuit with hysteresis (7).
7) The smallest dot a micro can define on its monitor (5).
8) Another term for a monostable (3, 4)
9) Transducer found on an electric guitar or record player, for example (4, 2).
11) Bidirectional silicon controlled switch (5).
13) BASIC command, followed by a sequence of numbers or strings (4).
14) Something metals do in adverse conditions (7).
15) Type of aerial, based on a sphere with a focussed detector (4).
16) The opposite of cut (5).
17) ratio, the ratio of the heighth of a display to its width (6).
21) Moving from channel to channel in a stereo image (7).
22) A soldered connection (5).
23) This is essential for radio transmission, according to the Department of Trade and Industry! (7).

DOWN

2) The industry standard parallel printer connection (10).
3) Difference in impedance between an input and an output, leading to signal losses. (8).
4) Hand-held or other utensil such as a screwdriver, soldering iron, spanner, etc. (4).
5) Better quality audio equipment (2, 2)
6) BASIC command (4).
9) IBM's disc operating system (1, 1, 1, 1, 1).
10) Above the upper frequency limit of human hearing (10).
12) Movement away from a desired operating point, usually associated with temperature changes (5).
13) To remove contact oscillations from a switched line (8).
18) Non-reuseable, non-volatile memory (1, 1, 1, 1).
19) Central part of a loudspeaker on which the coil is mounted (4).
20) The most popular type of television aerial, comprising a half-wave dipole with parasitic directors in front and behind (4).

Solution to Crossword No. 1.

Across:

1) ELSE
3) Transmit
8) Eject
10) Monitor
11) TDK
12) Integer
15) EPROMs
16) Decade
19) Sprites
20) DFM
22) Dropper
24) Drain
25) Electron
26) Bell

Down:

1) Electret
2) Speaker
4) Remote
5) NPN
6) Meter
7) Turn
9) Trimmer
13) Greased
14) Terminal
17) AND gate
18) stereo
19) 'Scope
21) Edge
23) Pot

SCRATCHPAD
by Flea-Byte

I suppose, with great regret, that 1986 will become the year of Star Wars. Regret for a number of reasons. The first is in some ways the most profound — and that is a deep disturbance at the way Hollywood fantasies can be and have been co-opted by the real power-brokers in Washington and Moscow.

The public image of the latest American mega-plan to keep the world safe for democracy, apple-pie and Mickey Mouse comes straight out of James Bond movies and, of course, the Luke Skywalker saga. Actually, the Star Wars plan is known officially as the Strategic Defense Initiative (SDI), only I can't help but think that when an ageing Hollywood actor masquerading as President of the United States characterises a defence policy as though it was being produced by a special effects department, then things have got out of hand.

The core idea behind SDI is, of course, to use nuclear powered laser and pulse-beam weapons directed from earth-orbit at the missiles and missile installations of hostile foreign powers. That such weapons could just as easily be directed at civil nuclear installations, city centre sky-scrapers, factories, schools and hospitals seems to have been overlooked by most commentators. Even fewer people seem to have taken the trouble to ask whether such weapons are feasible or, more importantly, whether the idea of controlling them with super intelligent computer systems via a super-fast and secure communications network is anything more than a script-writer's dream.

Everybody knows the diasters and mistakes that can and do plague quite simple exercises in satellite deployment and space transport. The space shuttle is routinely required to deal with rogue satellites, and the shuttle itself has very nearly come to grief on more than one occasion (most notably in its early days when heat deflecting panels kept falling off because of the glue used to attach them). And yet the advocates of Star Wars are preparing, so they say, to risk millions of lives to the protection of such imperfect technology.

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The kind of thinking that suggests these people may be as far out to lunch as their satellites are out in space is best illustrated by the now-classic tale of the quest for a zero-gravity writing instrument. The problem was that even the most sophisticated capilliary action pens don't work in zero-gravity conditions. The ink blots, doesn't run freely or fails to adhere to the writing surface. NASA's best minds were put on to the job of coming up with a new kind of writing implement that would allow astronauts to take notes and jot down readings in space with 100% reliability. It took them months before they came up with the humble pencil.

The fact is that much of the time, the scientists and technologists live in a kind of fantasy world of gleaming machines and simple minds — well-ordered, well-behaved and well-intentioned. That's okay, because occasionally the machines do gleam and the minds are simple and then everything goes according to plan. The problems arise when dirty and complex reality intrudes.

Now, politicians are supposed to inhabit this real world. Politics, someone once said, is the art of the possible. So when politicians slip into improbable fantasies it's time to worry. None of this is to say that Star Wars couldn't work. It may do, but 'may' isn't good enough. The people who claim to protect us from megalomaniac excesses and totalitarian paranoia have slipped, with no apparent effort, into megalomania and paranoia. Surely that's what has happened when a film actor promotes a movie scenario as the policy of his government and heads of other governments across the world actually listen to him. The worst thing, of course, is that many ordinary citizens with no power at all find the Star Wars idea convincing — presumably because they've seen it at the movies or on their TV screens already.

Kings Of The High Frontier

The Star Wars concept is a direct descendant of a notion called 'The High Frontier', developed in the seventies by a group of right-wing thinkers in the US who, I'm told, still operate today. The High Frontier is, of course, the modern equivalent of the old American frontier — the Wild West. By analogy, life in the High Frontier will be brutal and violent and any latter-day Indians who get in the way had better watch out.

The old frontier, in case you'd forgotten, was merely another way of talking about the expansion and conquests of the original Union — the 13 Eastern states who broke with British rule in 1776. The white settlers of these states moved westwards at the point of a gun, taking land from the American Indians and attempting genocide on the way, (In this attempt they were very nearly successful.) They didn't use lasers, of course, but they did use a revolver known as the Colt Peacemaker.

Perhaps the movie Ronald Reagan thinks he's in is not a science fiction epic at all, but an old-fashioned western.

Resigned To Their Fate

I was interested to read of the resignation of Richard Ennals from his post as Alvey research manager at Imperial College. The Alvey project — under the auspices of which government funds are being distributed to academic and research institutions — is Britain's response to the Japanese programme to develop a 'fifth-generation computer'.

Ennal's resignation followed Margaret Thatcher's reply to a letter from Imperial College computer scientists asking her not to participate in SDI. Thatcher promptly declared her unswerving commitment to Ronald Reagan and all his works. The price of her commitment was high — a pat on the head, in return for which Britain will hand over to the US the results of all its research in areas related to SDI. Some crafty negotiating here!

Interestingly, the Imperial letter followed a visit to the college by executives from the American congomerate, United Technologies (they own Mostek), who were interested in getting their mits on computing and AI work from the college for use in their SDI work. Ennals' comment was that the Imperial research 'ain't for sale'.

It would appear, however, that Ennals' feelings and those of his team do not count for much. Not only are we selling-off the family silver (as Lord Stockton put it), but we're selling off the family silicon, too.

Heriot-Watt University has eagerly exchanged its expertise in opto-electronics for what appears to be a mess of potage. Imperial itself, along with Manchester University, is engaged in the biggest single computer development project in Britain, in collaboration with Plessey and ICL and with funding from Alvey. The Flagship project is a three-year research programme aiming at developing a parallel-processing computer based on experimental machines already installed at Imperial and Manchester. Researchers at both institutions have sought a formal agreement from Plessey and ICL that their work will not be put to military use. No such agreement has been forthcoming, and there is clearly consternation that Flagship is destined for a part in SDI.

★ ★ ★

So far, Richard Ennals' has been the only resignation stemming from worries over Britain's attitude to SDI. However, feeling against the military use of high tech research is very strong among many academics. Meanwhile, United Technologies — in the shape of their helocopter company, Sikorsky — are set to snap up Westland Helicopters, another piece in the British technological jigsaw. If they do so, it will — ironically — be in the face of determined opposition from former Defence Minister, Michael Heseltine, who now finds himself an uneasy bedfellow in Richard Ennals, son of a former Labour minister.

It may be that Heseltine knows more about SDI and its impact on British high technology industry than he is saying at the moment. It is certainly the case that Reagan's defence policy is causing havoc among the very nations it is supposed to aid and assist. To paraphrase that national hero, the Duke of Wellington: I don't know if it frightens the Russians, but by God it frightens me!

PLAYBACK

'CD or not CD, that is the question, whether 'tis nobler in the mind to suffer the slings and arrows of outrageous price-rises … '. There can be no doubt now that the compact disc is firmly established as the hi-fi audio record format. The market for players trebled last year (1985) to 530 million, and forecasts for this year are at least as high. Thousands of titles are listed on CD, of all types of music.

Virtually noise- and crackle-free and with minimal distortion, the medium has caught on in a big way. So, the writing is on the wall for the familiar vinyl LP. Nimbus is ceasing to manufacture its own label LPs, while it installs a second CD pressing plant at Monmouth to increase its present capacity from six to 15 million discs. Undoubtedly, other LP manufacturers will follow suit before long.

This will be the fourth major format change in the history of the gramophone. First the original cylinders gave way to shellac 78s. Then came the mono LP from which we progressed to the stereo 45/45 grooved disc. And now to CD, the biggest change of them all. The stereo disc served us well for some thirty years, but few will bemoan the passing of scratches,

OPEN CHANNEL

Historically, the PTTs (postal, telegraph and telephone companies) around the world were set up to ensure that a level of standardisation was maintained. Thus, any letter posted in one country, correctly addressed of course, would find its way to the addressee quickly and efficiently Any telegraph written would be delivered to the receiver promptly. Any telephone call would be instantly received. The PTTs of each country were given a monopolising control of postal, telegraph and telephone services in the land to make sure they had the power to enforce standardisation. The GPO was the British PTT, with complete control over the services.

Knowledgeable authorities were set up, comprising representatives from member nations, designed to specify standards which the PTTs were advised to follow. So far as telecommunications is concerned, the CCITT (International Telegraph and Telephone Consultative Committee) was, and still is, the main standards approving and advising authority. In effect, however, as the PTTs were generally the only provider of the services in any one country (such is the power of a monopoly), what they wanted was most often granted or implemented without approval anyway.

With such large, cumbersome organisations as the PTTs, time was of little concern. They had more-or-less the sole right to supply and take away services to or from the user (that is, thee and me) and it was not uncommon to have to wait for months on end to have a telephone line installed after application. New grades of service and new standards usually took years to be implemented, if at all. After all, that's what a monopoly is for, isn't it?

In the days of yore, this was of little problem. Few new services or standards appeared, anyway. And if too many telephones were rented to users the whole system would have to be updated, so it's better that users don't have an efficient service, otherwise they'll all want a phone, eh what?

Times change, however! New services are desired by users. Some want data comunication facilities; some want facsimile communication; some even want to be able to hold a conversation over the phone without having to shout over the crackles, hisses and pops (heaven forbid!). Eventually even the monopolising PTTs realise they cannot cope with the increased demands of the user and regulations are altered to de-monopolise them. Hence, the birth of British Telecom. Now customers (note the use of the word customers and not users) can have a phone installed within just a few days, and, what's more, they can buy it too rather than having to rent. New digital services are being provided. Without the monopoly, other organisations may provide parallel services which rival or even better BT's. The PTTs now have to compete to stay in existence. This all sounds too good to be true.

It is. Without monopolies the whole telecommunications area is much improved. Standards are, without doubt, advised and instated more rapidly now than ever before. But new European services still take a long time to appear because the regulations governing them are still based around the PTT's monopolising stranglehold. It has been said that new European service providers face a regulatory burden 100 times greater than those in America.

The problem is that each European country has its own set of regulations which must be adhered to if services are to be sold in that country. Not only that, there are often a number of bodies in each country (interested in such things as electrical safety and electromagnetic interference) which proffer their own sets of regulations. A service provider wishing to introduce, say, a new modem, must have it approved by the safety regulatory body, the telephone regulatory body, the electromagnetic regulatory body, etc, etc. In many cases the standards of each country's regulatory organisations are different, so the whole procedure must be gone through again, at each new country where the service is to be provided.

This situation must be changed. Yes, regulations must still be there, but they must be reduced to the minimum needed to protect the customer and the services, and they must be unified so that approval covers all countries. Preferably, one regulatory body in each country should maintain *all* regulations, be they of safety, interference, telephone standards, or other categories. Then the prospective provider of a new service would just need to apply to the regulatory body to have the service approved. Once approved the service may be marketed worldwide.

After all, this is surely the whole purpose of having worldwide standards — without this capability there is no point in having standards at all.

Keith Brindley

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surface static, warps, chipped styli, arm balancing and all the other irritations that have accompanied it.

The compact disc is not confined to audio. Laser video discs are well-established and are being developed in some haste as the latest mass-storage medium for computing. Recently, two huge industrial giants, Philips and Du Pont, have gone into partnership in a new venture called Philips Du Pont Optical (PDO) to produce and market CD ROM discs for storing computer information. Philips, of course, introduced the laser video disc and (lest it be forgotten) the compact cassette.

Pressing On

In manufacturing terms, CD ROMs and audio CDs are identical (like computer cassettes and music cassettes), only the software is different. PDO plans to set up a disc pressing plant sometime this year in North Carolina with a capacity of 50 million discs a year. The associated PolyGram factory in Europe is scheduled to increase production from 25 million to 50 million, and the field is wide open for growth.

One of the problems of disc manufacture is the time taken to apply the reflective aluminium coating to the plastic base. It must be done in a high vacuum. At present a small batch of discs are treated at a time in a vacuum chamber which takes 40 minutes to completely evacuate. PolyGram have developed a technique whereby each disc is treated in its own tiny cell, the vacuum taking only four minutes to achieve. This will greatly accelerate disc production.

Nearer home, Thorn EMI is due to start pressing discs in Britain during March, the planned output being ten million discs a year. Another firm, Distec also has plans to start a plant this year.

The disc shortage caused by the world-wide boom is therefore likely to be soon turned into a surplus. But here's the rub, to quote the bard once again. Disc-player prices have been tumbling in spite of the complexity and minimal production savings of mass production. They have fallen by 50% in the space of two years. On the other hand, disc prices — which should have dived as a result of mass production — have climbed steeply, by up to 25% in some cases. Why? Steve Dowdie, Sony's hi-fi products manager, says, 'CD is already more profitable than LPs and cassettes.' So the manufacturers must be taking advantage of the boom to make quick profits. Existing owners are unlikely to abandon the format because of escalating disc prices, so they are sitting ducks for the big rip off.

Take heart though. Think of all that over-production looming over the horizion. CD will continue to be upmarket for some time to come as player costs can't dip much more. We are unlikely to see a repeat of the 45-single, portable record player boom with CD — although a few over-priced CD portables have hit the streets. So, when those millions of excess discs hit the market, the tables will turn — and they won't be just those of the CD players!

Vivian Capel

ALF'S PUZZLE

Alf is inclined to get so carried away with his projects that he often works late into the night, long after the rest of us have gone home. Although we admire his dedication, there are times when the mistakes he makes by working on circuits when he is tired cause enough problems to keep him working late for the next fortnight.

One evening last week, we left him hard at work taping a printed circuit board for a small microprocessor board. The board contained an 8-bit micro and 64K of RAM. When we arrived at ETI Towers the next morning, there was the completed PCB master, all finished. Except that when we tested it, there were several mistakes. The address lines from the micro to the RAM section were all back to front so A_{15} on the micro joined to A_0 of the RAM address, A_{14} joined to A_1 , and so on. The data line connections were mostly correct, but D_3 and D_4 had somehow been swapped over on the way from the micro to the RAM.

We were cursing Alf loudly when Auntie Static walked in. We started to explain the problem to her, but she didn't seem at all worried. 'There's no need to alter the address lines,' she said. 'It will work as it is.' And without offering any explanation she dashed off to an appointment with her hairspring-dresser. 'Well, if it will work with the address lines back to front, I don't suppose it matters about the data lines either,' said Alf. 'Let's build it and see.'

Now we all know that when Auntie is in working order she is never wrong, but could she have blown a diode? Alf, on the other hand, is almost always wrong since he makes wild guesses about anything he's not sure of. But could luck be with him this time? Did the board work?

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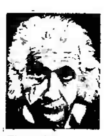

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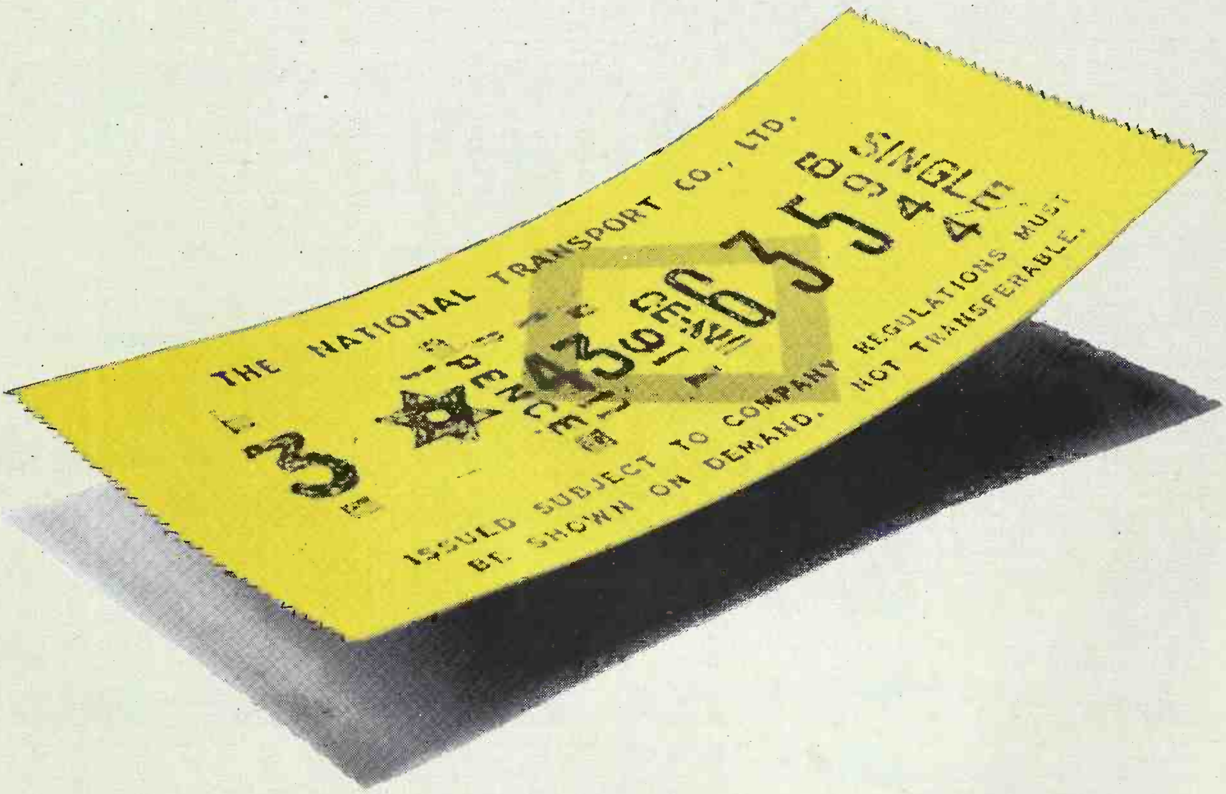

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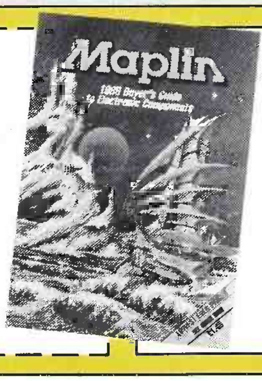

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