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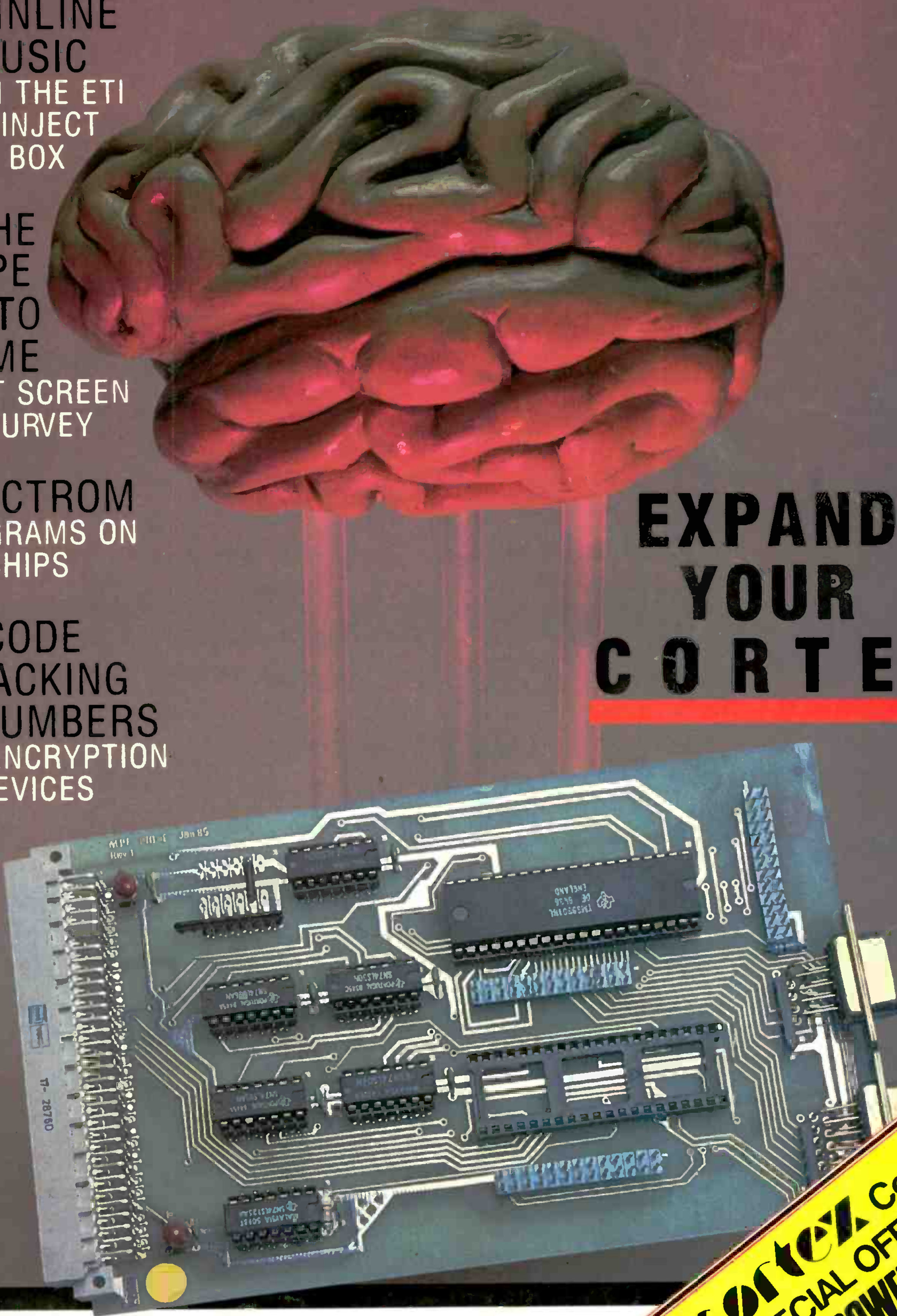
SEPT 1985 £1.10



MAINLINE MUSIC
WITH THE ETI DIRECT INJECT BOX

THE SHAPE OF TV TO COME
FLAT SCREEN SURVEY

SPECTROM
PROGRAMS ON CHIPS

CODE CRACKING BY NUMBERS
DATA ENCRYPTION DEVICES

EXPAND YOUR CORTEX

cortex Computer
SPECIAL OFFER from
POWERTRAN

.AUDIO....COMPUTING....MUSIC....RA ICS...

MICROBOX II THE 6809 SINGLE BOARD COMPUTER THAT YOU BUILD YOURSELF

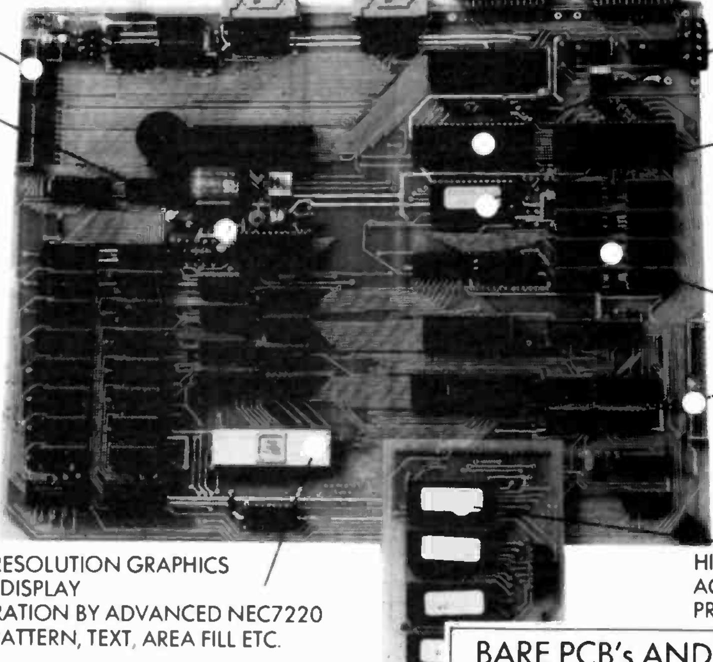
VIDEO OUTPUTS
KEYBOARD PORT
PRINTER PORT
SERIAL PORT
SERIAL PORT

SYSTEM EXPANSION BUS

BATTERY BACKED REAL-TIME CLOCK/CALENDAR

128KBYTES SHARED MEMORY RAMDISC
HIGH SPEED SILICON DISC ACTS LIKE A STANDARD 'FLEX' DISC

ALPHANUMERIC DISPLAY
108 x 24 CHARACTER FORMAT.
USER DEFINABLE CHARACTERS.
STANDARD VDU CONTROL FUNCTIONS



POWERFUL 68B09E 8/16 BIT MICROPROCESSOR

SYSTEM SUPPORT MONITOR (8KBYTES) containing:
DISC AND INPUT/OUTPUT DRIVERS
GRAPHIC PRIMATIVES
TERMINAL EMULATOR
UTILITY AND DIAGNOSTICS
"FLEX" BOOT AND CONFIGURE

60KBYTES USER MEMORY

FLOPPY DISC INTERFACE
SUPPORTS SINGLE OR DUAL, 40/80 TRACK, SINGLE OR DOUBLE DENSITY DISC DRIVES

EXTREMELY FAST, VERY HIGH RESOLUTION GRAPHICS
768 x 576 MONOCHROME DISPLAY
HARDWARE VECTOR GENERATION BY ADVANCED NEC7220 DEVICE. LINE, POINT, ARC, PATTERN, TEXT, AREA FILL ETC.

EPROM DISC (AND PROGRAMMER)
HIGH SPEED READ ONLY SILICON DISC
ACTS LIKE A STANDARD 'FLEX' DISC
PROVIDES 'INSTANT' SOFTWARE

***NOTE:** MICROBOX II WILL BOOT 'FLEX' FROM ANY STANDARD SYSTEM DISC.

BARE PCB's AND DOCUMENTATION
\+ SYSTEM SUPPORT MONITOR
\+ SYSTEM UTILITIES DISC – **£95.00**
FLEX + EDITOR + ASSEMBLER **£75.00**

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Ex VAT

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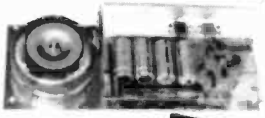
Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market i.e., Industry, Leisure, Instrumental and Hi-Fi, etc. When comparing prices, NOTE all models include Toroidal power supply, Integral 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.**

OMP 100 Mk II Amp. Module. 110wR.M.S. 4ohms I/P Sens 500mV – 10K Size 360 × 115 × 72mm **Price: £32.99 + £2.50 P&P**
OMP/MF100 Mos-Fet. Very high spec 110wR.M.S. both 4 & 8ohms I/P Sens 500mV – 10K Size 300 × 123 × 60mm **Price: £39.99 + £2.50 P&P**
OMP/MF200 Mos-Fet. Very high spec 200wR.M.S. 4ohms I/P Sens. 500mV –10K Size 300 × 150 × 100mm **Price: £62.99 + £3.50 P&P**
OMP/MF300 Mos-Fet. Very high spec 300wR.M.S. 4ohms I/P Sens. 500mV –10K Size 330 × 147 × 102mm **Price: £79.99 + £4.50 P&P**
Vu Meter. 11 LED's Plastic Case Size 84 × 27 × 45mm **Price: £8.50 + 50p P&P**



MF100

Vu METER

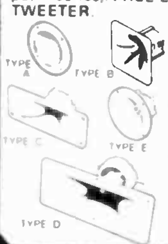
Full specifications available on request.

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.

LARGE (28p) S.A.E. FOR CURRENT LIST

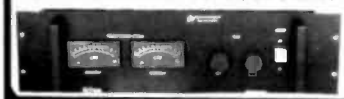
PIEZO ELECTRIC TWEETERS — MOTOROLA

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.**



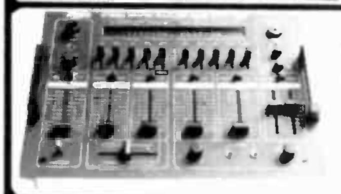
TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 40p P&P**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each + 40p P&P**
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion 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) 3¾" 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**

19" STEREO RACK AMPS



Professional 19" cased **Mos-Fet** stereo amps with twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4ohms).
MF200 (100 + 100)W £169.00
MF400 (200 + 200)W £228.85
MF600 (300 + 300)W £274.85
Securicor Delivery £10.00

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

LOUDSPEAKERS

Cabinet fixing in stock. S.A.E. for details.

Loudspeakers 5" to 18". Up to 300W R.M.S. S.A.E. for full lists. **McKenzie** speakers at advantageous prices. All speakers listed 8 ohm imp.

POWER RANGE
8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz magnet 1½" 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
15" 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 20Hz. Freq Resp to 2.5KHz. Sens 97dB. PRICE £37.49 + £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
6½" 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.
1½" voice coil. Res Freq 38Hz. Freq Resp to 20KHz. Sens 89dB. PRICE £12.99 + £1.50 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 £24.99 + £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 £24.99 + £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 £49.99 + £4.00 P&P ea

PANTEC HOBBY KITS

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

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.**

3 watt FM Transmitter

POSTAL CHARGES PER ORDER £1.00 minimum.

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Sales Counter. ★

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FEATURES

PROJECTS

ETCETERA

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SWITCHES

TOGGLE 2A 250V SPST 35p DPDP 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
SPDT moment	150p
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch Assorted Colours 75p each

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 68p

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

GAS/SMOKE DETECTORS

TGS812 or TGS813
£6 each
Holders for above 40p

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	280p	300p
Double ended	290p	370p	480p	525p

VEROBOARD 0.1in

2½ x 3¾	95p
2½ x 5	110p
3¾ x 3¾	110p
3¾ x 5	125p
3¾ x 17	420p
4¾ x 17	590p
Pkt of 100 pins	55p
Spot face cutter	150p
Pin insertion tool	185p
VQ Board	195p
DIP Board	395p
Vero Strip	95p

PROTO DECs

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

VERO WIRING PEN

+ spool	380p
Spare spool	75p
Combs	6p

DALO ETCH RESIST PEN
Plus spare tip 100p

ULTRASONIC TRANSDUCER
40KHz 475 pr

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

COPPER CLAD BOARDS

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

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	90p

EDGE CONNECTORS

	.1"	.156"
2x6 way	—	75p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	175p	160p
2x22 way	200p	170p
2x23 way	150p	—
2x26 way	250p	245p
2x28 way	180p	—
2x30 way	280p	—
2x35 way	300p	—
2x40 way	320p	—
2x43 way	400p	—
2x75 way	600p	—

SIL SOCKET 0.1" Pitch 20 way 65p

ANTEX SOLDERING IRONS

C15W	525p;	CS17W	545p
C18W	550p;	XS25W	570p
Spare Bits	85p;	Elements	230p
Iron Stand	175p;	Heat Shunt	30p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Carc Edge Conct
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	200p	236p	160p	320p
40 way	220p	250p	180p	340p
50 way	235p	270p	200p	350p
60 way	—	—	230p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	170p	—	—	175p
DIN41612 2 x 32 A + B	275p	-	220p	285p
DIN41612 2 x 32 A + C	295p	-	240p	300p
DIN41612 3 x 32 A + B + C	360p	385p	280p	395p

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	575p
28 pin	695p
40 pin	845p

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 PLUGS

	IDC	SOLDER
24 way IEEE plugs	485p	460p
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 AC
0-300V AC
"S"
"VU" 465p each

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	220
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.608MHZ	200
4.80MHz	200
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	150
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	175
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 250V AC 195p

DOUBLE POLE Changeover, 6A 30V DC or 250V AC
RL-113 53R Coil, 6V DC (5V4 to 9V9) 190p
RL8-111 205R Coil, 12V DC (10V7 to 19V5) 195p
RL8-114 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
2¾in 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 £66
- MICROVITEC 1431, 14" Colour RGB input. Connecting cable incl. £175
- MICROVITEC 1451, 14" Medium resolution £237
- 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 £5

Carriage £7 Securicor

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	50p	7905	50p
12V	7812	50p	7908	60p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	50p	7918	50p
			7924	50p

100mA TO92 Plastic package

5V	78L05	30p	79L05	50p
6V	78L06	30p	—	—
8V	78L08	30p	—	—
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	60p

ICL7660	248p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	78H05 + 5V/5V	550p
LM309K	135p	78H12+12V/5A	695p
LM317K	250p	78HG + 5V to + 25V 5A	585p
LM317	99p	79HG − 2.25V to −24V; 5A	785p
LM323K	450p		
LM337	175p		
LM723 Var	30p		
78S40	225p		

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 2½ x 1½"	90p
5 x 2½ 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

SPECIAL OFFER

	1+	10+
2764-250nS	299p	275p
27128-250nS	695p	675p
6116LP-120nS	250p	255p
6264LP-150nS	735p	699p

CMOS

4000	20	4075	25	4543	70
4001	25	4076	70	4548	40
4002	25	4077	25	4549	400
4006	70	4078	25	4553	245
4007	25	4081	25	4554	180
4008	60	4082	25	4555	35
4009	45	4085	60	4556	55
4010	40	4086	60	4557	250
4011	25	4089	125	4558	120
4012	25	4093	40	4559	395
4013	35	4094	70	4560	150
4014	60	4095	95	4561	104
4015	60	4096	100	4562	350
4016	40	4097	275	4566	160
4017	55	4098	80	4568	250
4018	60	4099	110	4569	175
4019	60	4160	95	4572	45
4020	80	4161	96	4580	255
4021	60	4162	96	4581	125
4022	70	4163	96	4582	99
4023	30	4174	96	4583	100
4024	50	4175	105	4584	55
4025	25	4194	105	4585	55
4026	90	4408	850	4597	330
4027	45	4409	850	4599	155
4028	45	4410	725	40085	90
4029	75	4411	750	40097	45
4030	35	4412	805	40098	42
4031	130	4415	590	40100	215
4032	65	4419	280	40101	130
4033	130	4422	770	40102	140
4034	146	4435	850	40103	412
4035	70	4440	900	40104	120
4036	250	4450	360	40105	220
4037	115	4451	350	40106	60
4038	75	4490	450	40107	55
4039	280	4500	395	40108	325
4040	60	4501	40	40109	100
4041	60	4502	60	40110	235
4042	50	4503	40	40114	240
4043	45	4504	100	40161	194
4044	50	4505	350	40163	75
4045	110	4506	100	40174	75
4046	60	4507	45	40175	75
4047	60	4508	130	40181	220
4048	55	4510	55	40182	80
4049	40	4511	55	40192	75
4050	35	4512	55	40193	95
4051	70	4513	150	40194	70
4052	60	4514	115	40195	75
4053	60	4515	115	40244	196
4054	85	4516	55	40245	196
4055	85	4517	275	40257	196
4056	85	4518	50	40373	220
4057	1000	4519	35	40374	220
4059	420	4520	55	45106	586
4060	70	4521	115		
4061	500	4522	125		
4062	986	4526	60		
4063	90	4527	65		
4066	45	4528	70		
4067	245	4529	145		
4068	25	4530	90		
4069	25	4531	120		
4070	25	4532	65		
4071	25	4534	365		
4072	25	4536	250		
4073	25	4538	80		
		4539	80		
		4541	95		

OPTO

OCP71	120
ORP12	85
ORP61	86
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	145
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	25p
14 pin	40p
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18 pin	47p
20 pin	60p
22 pin	70p
24 pin	72p
28 pin	90p
40 pin	120p

BT TELEPHONE CONNECTOR

LJU 1/4A	Mini Line Master	435
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 WAY	BT Plug	65p

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied.

£20

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- EPSON RX80 F/T Printer £219
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- BROTHER HR15 Daisywheel £329

Cable for above printers to interface with BBC Micro £7

- TEX EPROM ERASER — Erases up to 25 Eproms. Has a built-in safety switch £30
- SPARE 'UV' Lamp Bulb £8
- C12 Computer CASSETTES in Library cases 35p
- 8½" & 9½" Fan Fold paper (1000 sheets) .... £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)
CALL IN AT OUR SHOP FOR A DEMONSTRATION ON ANY OF THE ABOVE ITEMS. BE SATISFIED BEFORE YOU BUY OR WRITE IN FOR OUR DESCRIPTIVE MICRO PERIPHERALS LEAFLET.

BBC MICRO WORDPROCESSING PACKAGE

A complete wordprocessing package (which can be heavily modified to your requirements, maintaining large discount). We supply everything you need to get a BBC Micro running as a word-processor. Please call in for a demonstration.
Example Package:
BBC Micro, with DFS Interface, Wordwise, Twin 400K TEC Disc Drives, 12" High-res green monitor, Brother HR15 Daisywheel printer, Beebcalc & Database software on Disc, 10 3M Discs, 500 sheets of paper, 4 way mains trailing socket, manuals and all cables.

Only: £999

5¼" DRIVES for the BBC Micro

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

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  (Securicor Carriage on Drives £7)
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- **OFS Manual** (comprehensive) (NO VAT) £7

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We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM. The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEB-CALC, Software (Educational Application & Games), BOOKs, etc, etc, Please send SAE for our description leaflet.

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RECHARGEABLE BATTERIES

Dry Fit Maintenance FREE by Sonnenschein. A300 07191315 12v 3 AH same as RS 591-770 NEW £13.95 A300 07191202 6-0-6 1.8 AH same as RS 591-382 EX EQUIP £4.99 Miniature PCB mount 3.6v 100 Mah as RS 591-477 NEW £1.00 SAFT VR2C 1.2v "C" size NICADS in 18 cell ex equipment pack. Good condition – easily split to single cells £10.50 + pp £1.90

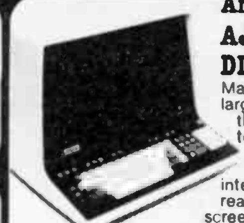
HOT LINE DATA BASE

DISTEL©

THE ORIGINAL FREE OF CHARGE dial up data base 1000's of stock items and one off bargains.
ON LINE NOW – 300 baud, full duplex CCITT tones. 8 bit word, no parity.

01-679 1888

Anderson Jacobson AJ510 VIDEO DISPLAY TERMINAL



Made by one of the USA's largest peripheral manufacturers the AJ510 Professional VDU terminal has too many features to include in space available – just a few are: internal Z80 cpu control, very readable 15" non glare green screen, 24 lines by 80 characters, 128 ASCII character set with lower case and graphics, standard RS232 interface, Cursor addressing, numeric key pad etc. Supplied in good TESTED second hand condition with full manual £225.00 + carr £10.00. Data sheet on request.

EX-STOCK INTEGRATED CIRCUITS

2732 ex equip £3.25, 27128 – 250ns NEW £12.00. 6116-200 £4.50, 6116-250 £3.95, 6264LP-150 £22.00, 4164-200 £3.50, 4864-150 £4.00, 4116-300, £1.20, 2114 £1.75, 6800 £2.50, 6821 £1.00, 68A09 £8.00, 68B09 £10.00, 68B09E £14.50, D8085AH-2 £12.00, D8086 £20.00, Z80A £2.99.

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference
SD5A As recommended by ZX81 news letter, matchbox size up to 1000 watt load **£5.95**
L2127 compact completely cased unit with 3 pin fitted socket Up to 750 watts **£9.99**

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of BRAND NEW professional cooling fans.
ETRI 99XUOI Dim 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard £9.95.
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. NEW £6.95
BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. OUR PRICE ONLY £12.95 complete with data.
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60

BUDGET RANGE VIDEO MONITORS

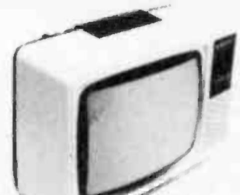
At a price YOU can afford, our range of EX EQUIPMENT video monitors defy competition!! All are for 240v working with standard composite video input. Units are pre tested and set for up to 80 col use on BBC micro. Even when MINOR screen burns MAY exist – normal data displays are unaffected.

1000'S SOLD TO DATE

12" KGM 320-321, high bandwidth input, will display up to 132 columns x 25 lines. Housed in attractive fully enclosed brushed alloy case. B/W only **£32.95**
24" KGM large screen black & white monitor fully enclosed in light alloy case. Ideal schools, shops, clubs etc. **ONLY £55.00** Carriage £10.00

A Major company's over production problems, and a special **BULK PURCHASE** enable **TWO** outstanding offers.

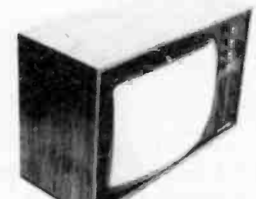
COLOUR MONITOR SPECIALS



'SYSTEM ALPHA' 14" 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 types of video input, **RGB** and **PAL** Composite Video, allow direct connection to most makes of micro computers and **VCR's**. An internal speaker and audio amplifier may be connected to your system's output or direct to a VCR machine, giving superior colour and sound quality. Many other features include 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 + Carr.



DECCA RGB 80-100 Monitor.

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, combine with the tried and tested DECCA 80/100 series chassis to give 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 directo to a **BBC MICRO** computer or any other system with a **TTL RGB** output. Other features include internal audio amp and speaker, Modular construction, auto degaussing 34 H x 24 D, 90 day guarantee. Supplied in **EXCELLENT** condition, **ONLY £99.00** + Carr. Also available **UN-MODIFIED** but complete with MOD DATA. Only £75.00.
Carriage and Insurance on monitors £10.00

DATA MODEMS

Join the communications revolution with our super range of **DATA MODEMS** with prices and types to suit all applications and budgets!!
Most modems are **EX BRITISH TELECOM** and are made to the highest standard for continuous use and reliability. RS232 interfaces are standard to all our modems, so will connect to ANY micro etc. with an RS232 serial interface.

DATEL 2B see **SPECIAL OFFER** centre of this ad.
MODEM 13A, 300 baud. Compact unit only 2" high and same size as telephone base. Standard CCITT tones. CALL mode only. Tested with data. *ONLY £45.00 + PP £4.50*.
MODEM 20-1, 75-1200 baud. Compact unit for use as subscriber end to PRESTEL, MICRONET or TELECOM GOLD. Tested with data. *£39.95 + PP £6.50*.
MODEM 20-2, same as 20-1 but 1200-75 baud *£99.00*.
TRANSDATA 307A. 300 baud acoustic coupler. Brand new with RS232 interface. **ONLY £49.95**
DACOM DSL2123 Multi Standard Modem, switchable CCITT or USA BELL 103 standard. V21 300-300, V23 75-1200, V23 1200-75 or 1200-1200 half duplex. Auto answer via MODEM or CPU. CALL or ANSWER modes plus LED status indication. Dim 2.5" x 8.5" x 9" **BRAND NEW** fully guaranteed *ONLY £268.00 + PP £4.50*.
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. Many features include Auto answer, 2 or 4 wire working etc. etc. **COST OVER £800.** *OUR PRICE £185.00*.
DATEL 4800, RACAL MPS4800 high speed good condition *£285.00 CARR £10.00*

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
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- CALL, ANSWER and AUTO modes
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- Built in test switching
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- Just 2 wires to comms. line

NOW ONLY £29.95

Order now – while stocks last. Carriage and Ins. £10.00

SAVE £250 SUPER PRINTER SCOOP

BRAND NEW CENTRONICS 739-2

ONLY £199

The "Do Everything Printer" at a price that will **NEVER** be repeated. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of *ONLY £199.00* + VAT Complete with full manual etc. Limited quantity – Hurry while stocks last. Options. Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way plg £12.50. Spare ribbon £3.50 each BBC graphics screen dump utility program £8.60. Carriage and Ins. £10.00 + VAT

HUNDREDS OF PRINTERS EX STOCK FROM £49.00. Call Sales Office for Details.

1 only large **CALCOMP 1036** AO 3 pen drum plotter and offline 915 magtape controller. Good working order. **£2500.00.**

ADD VAT TO ALL PRICES

EX STOCK

DEC CORNER

PDP 1140 System comprising of CPU, 124K memory + MMU 16 line RS232 interface, RP02 40 MB hard disk drive, TU10 9 track 800 BPI Mag tape drive, dual rack system, VT52 VDU etc. etc. Tested and running *£3750.00*

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DH11-AD 16 x RS232 DMA Interface	£2100.00
DLV11-J 4 x EIA Interface	£310.00
DLVII-E Serial. Modem support	£200.00
DUP11 Sych Serial data i/o	£650.00
DQ200 Dilog – multi RK controller	£495.00
DZ11-B 8 line RS232 mux board	£650.00
KDF11-B M8189 PDP 1123+	£1100.00
LA36 Decwriter EIA or 20 ma loop	£270.00
LAX34-AL LA34 tractor feed	£85.00
MS11-JP Unibus 32 kb Ram	£80.00
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MS11-LD Unibus 256 kb Ram	£850.00
MSC4804 Qbus (Equiv MSV11-L) 256 kb	£499.00
PDP11/05 Cpu. Ram, i/o, etc.	£450.00
PDP11/40 Cpu. 124k MMU	£1850.00
RT11 ver. 3B documentation kit	£70.00
RK05-J 2.5 Mb disk drives	£650.00
KL8JA PDP 8 async i/o	£175.00
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1000's of **EX STOCK** spares for **DEC PDP8, PDP8A, PDP11** systems & peripherals. Call for details. All types of Computer equipment and spares wanted for **PROMPT CASH PAYMENT**.

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

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DIGEST

Poor Employment Prospects In The Electronics Industry

Employment prospects in the Electronics industry have declined over the last few years and show few signs of improving in the coming months.

Those are some of the conclusions of reports recently published by staff and recruitment agencies working in the industry.

Stragegic Recruitment Ltd, who specialise in recruiting professional engineers, say that even the most inexperienced of young electronics engineers could readily find work last year provided they were prepared to travel. This year the situation is very different and many electronics graduates, especially those with weaker degrees, are finding jobs very hard to come by.

The company believed that this has been caused in part by the decline, in real terms, of defence spending in the UK. They suspect that many of the companys affected have reacted by reducing their intake of less-promising graduate trainees.

Figures published by the Standing Conference of Employers of Graduates are a little more optimistic but not much. They show a 5% increase in demand for recent graduates in the electronics and computing industries compared with 1984, but the demand for recent graduates in other manufacturing areas has increased by around 20% over the same period.

Leaving aside the graduate recruitment agencies and looking at the picture for all staff, the figures show that there are currently more jobs being created than lost but that the trend is turning downward. Temporary Services agency Manpower Ltd carried out a survey of major employers in the electronics industry and found that 37% planned to increase their staffing levels in the next three months while 14% planned to cut jobs. These figures are slightly worse than those for the last quarter when 42% of employers said they planned to take on staff and only 12% said they planned to make cuts.

Manpower found that the situation in the electonics industy is in line with that in other sectors. Prospects are a little better than they were last summer but the rate of improvement has slowed down when compared with the two previous years.

PCB Service

Once again we must apologise to our readers for the continuing problems with our PCB Service.

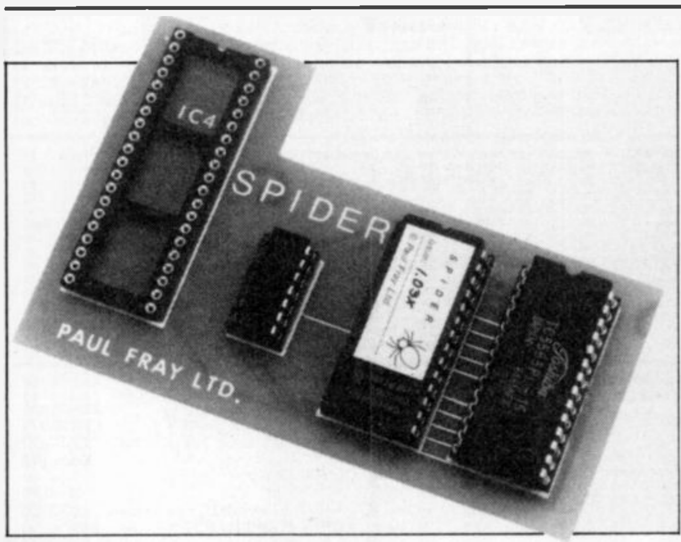
As we pointed out in the last issue, the company who manufacture our boards have recently moved premises and this has led to considerable delays in sending out boards.

Unfortunately, they have since decided that they no longer wish to operate the service and have suggested that we look for another supplier.

At the time of going to press we are in the process of negotiating with potential suppliers but nothing has been decided. For this reason, it is not possible for us to supply PCBs and so we have not included the PCB Service page in this issue.

We have no idea how long it will be before the Service is operating normally again but we hope it will be fairly soon. Those who have already placed orders may leave them with us and we will fulfill them as soon as we have a new supplier, but if readers prefer we will happily give them a full refund.

We do apologise for the inconveniences these delays have caused and trust that those affected will bear with us until we sort things out.



Real Time I/O Facilities For The BBC

Paul Fray Ltd have introduced an add-on for the BBC microcomputer which provides a range of BASIC commands to deal with real-time input and output events and also enables the computer to cope with more than one input at a time.

The device is called the Spider because, the manufacturers say, it is designed to capture events in the same way that a spider captures a fly. It consists of a butterfly board which plugs into the first sideways ROM socket and the User VIA socket and carries ROM based software and 8K of RAM.

The additional commands are stored in the ROM while the RAM allows the unit to capture input events which arrive while the computer is dealing with an earlier event. The later event can be dealt with in turn. Spider also provides a set of process timers which can time out independently of signals from external devices.

The spider is available in three versions, an economy model called Spider-B which works with the User Port and Printer Port only, an industrial model called Spider-X which uses the high performance 1MHz bus on the BBC, and a version called Spider-E which is designed for use with the range of industrial control Eurocards produced by Control Universal Ltd. Spider-E consists of ROM and RAM chips which plug directly into the Eurocards and does not therefore include a butterfly board.

The manufacturers say that the Spider can be used on control and measurement systems, robotics, burglar alarms and for running experiments in chemistry, psychology, engineering, etc. Spider-B costs £65.00 inclusive and the other two models cost £115.00 inclusive and all come with a comprehensive handbook which includes fitting instructions and programming examples.

Paul Fray Ltd, Willowcraft, Histon Road, Cambridge CB4 3HD, tel 0223-66529.

● OK Industries have published a colour brochure which describes their range of PacTec ABS moulded cases. The range includes small cases for hand-held devices such as calculators and control boxes, bench top cases for instruments and computer and video terminal housings. All are available in kit form with a range of accessories. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hampshire SO5 4SL, tel 0703-619 841

● Cambridge kits are offering their Sound Meter kit at £23.20 inclusive until the end of October, a saving of £4.00. The unit has been designed to comply with the requirements of BS5969 and offers 'A' weighted measurements from 40-120 dB. A knob sets the measurement level and an LED flashes if it is exceeded. The kit comes complete with PCB, instructions, etc, and can be obtained from Cambridge Kits, 45 Old School Lane, Milton, Cambridge CB4 4BS, tel 0223-860150.

● Electro-Match are primarly a trade and industrial component supplier but they will handle small orders from individuals as well. Their range includes slide, toggle, push-button and rotary switches along with plain and illuminated rocker and paddle switches, LC and crystal filters to commercial and MIL specifications for applications up to 500 MHz, quartz crystals and oscillators, terminal blocks, indicators and miniature lamps and circuit breakers and other protection equipment. Electro-Match Ltd, Daux Road, Billingshurst, Sussex RH14 9SJ, tel 0403 81-4111.

Hitachi Micro-processor Design Kit

Hitachi have introduced a kit which contains everything necessary to enable designers to use the company's 6301 family of microprocessors.

The kit includes an EPROM-on-chip CMOS microcomputer, the HD63701XOC, an adaptor which converts the 40-pin microcomputer pin-out to a 28 pin arrangement so that the on-chip EPROM can be programmed in standard EPROM programmers, and a full set of documentation including a user manual, data sheets, etc.

Hitachi say that the kit will be useful because of the wide range of choices available with the 6301 family.

The complete kit costs £80.00. For further details contact Stuart Miller at Hitachi Electronic Components (UK) Ltd, Hitec House, 221-225 Station Road, Harrow, Middlesex HA1 2XL, tel 01-861 1414.

A Rhum Do

The Islanders of Rhum may not have to rely on the Pony Express but their local communications system does have a certain element of old-tech in it.

For the fifteen telephone customers on the tiny island off Scotland's west coast rely on an exchange which is powered by water.

A man-made dam in a rocky stream channels water to the generator and the main problem the island's part-time British Telecom engineer has to cope with is debris obstructing the flow. More serious problems mean that an engineer has to make the five-hour journey from the mainland — and risk being stranded for days if the weather turns bad.

● Texas Instruments have added two new titles to their product reference library, The TTL Data Book: Volume Two and a Supplement to the TTL Data Book: Volume Two, both of which deal with Advanced Schottky (AS) and Advanced Low-power Schottky (ALS) devices. The Data Book lists over 300 devices with information on packaging, function, ratings, operating conditions, etc and includes a glossary and a function selector. The Supplement completes the specifications on 51 devices and includes a complete functional index of all TI logic devices. The Data Book costs £8.00 and the Supplement costs £5.60. Post and packing costs £1.50 per book. Texas Instruments Ltd, PO Box 50, Market Harborough, Leicestershire.

New Goonhilly Antenna Uses Advanced Transmission Technologies

British Telecom International have announced that their latest satellite dish antenna will be one of the first in the world to operate in four frequency bands. This, along with the use of advanced transmission technologies, will enable it to handle four times as many calls as existing antennas.

The 32-metre diameter Goonhilly 6 antenna at Goonhilly Downs Earth Station in Cornwall will become fully operational later on this autumn. Unlike other antennas at Goonhilly, it will transmit in two frequency bands, 14GHz and 6 GHz, and receivie simultaneously at 11 GHz and 4 GHz.

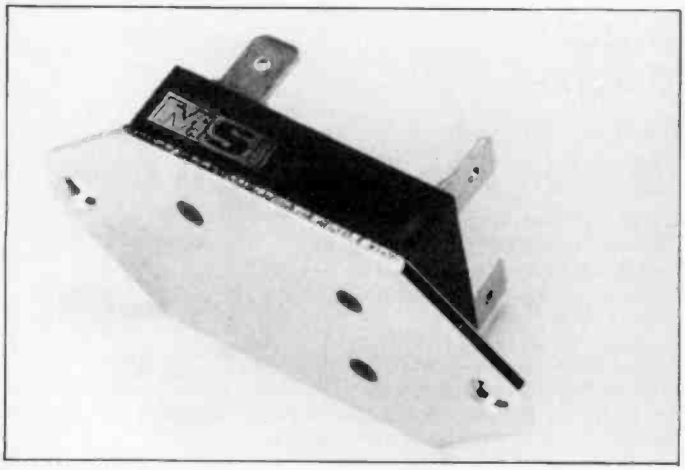
The new antenna has been designed to work with new transmission technologies known as Time Division Multiple Access (TDMA) and Digital Speech Interpolation (DSI). Whereas traditional methods allocate a different frequency to each call, TDMA information is sent in separate bursts on one frequency with each burst having its own time slot. DSI exploits the fact that each participant in a telephone conversation is usually silent for about two-thirds of the time, and uses these blank periods to interpose bursts from other conversations.

TDMA allows a satellite to receive a number of signals simultaneously from different dish antenna which need not be at the same location. Four satellite earth stations situated in the USA, France, Germany and Canada send reference signals to transmitting earth stations to ensure that the TDMA bursts do not overlap but arrive at the satellite in sequence every two milliseconds.

Goonhilly 6 will work to an Intelsat satellite over the Atlantic and, like the other antennas at the earth station, will handle ordinary telephone calls, telex, computer data, facsimile transmissions, television signals and new, specialist services such as teleconferencing. The TDMA system will handle telecommunications traffic at 64 kbit/s but can also be used for digital applications at speeds of up to 2 Mbit/s.

In addition to Goonhilly 6, BTI are converting three aerials at their other satellite earth station at Madley, in Herefordshire, to TDMA working. Aerial 2 at Madley will work to an Intelsat Atlantic Ocean satellite, Aerial 1 will work to an Intelsat Indian Ocean satellite and Aerial 4 will work to a Eutelsat satellite to provide TDMA services to Western Europe.

Eutelsat, the European satellite organisation, intend to carry all of their telephone and data transmissions using TDMA while Intelsat expect that about 30 percent of their global telecommunications traffic will be TDMA-based by 1990. BTI expect most Western European Countries to install terminals similar to Goonhilly 6 and anticipate excellent export sales of the TDMA/DSI equipment.



Zero-Crossing Relay

Norbain Electro-Optics are distributing a new solid state relay manufactured by MSI Electronics. Designed for use where RFI and line disturbances must be kept to a minimum, the relay will only switch the AC supply to the load when the voltage is below 20V.

The EZ240D10 series relays have maximum load currents of 10A, 25A and 45A and corresponding peak single cycle surge capacities of 115A, 250A and 400A. In additon, they can withstand a continuous one second overload of 24A, 60A and 80A respectively.

The control circuit requires an input of from 3 to 32V and has must-operate and must-release voltages of 3V and 1V respectively. The input is optically isolated to provide an isolation voltage of 2.5kV and the response time is 10ms.

Norbain Electro-Optics Ltd, Norbain House, Boulton Road, Reading, Berkshire RG2 0LT, tel 0734-864411.

EPROM Protects Software

Rapid Recall are distributing a new Intel EPROM which includes a data protection mechanism. The 128K device encrypts its data according to a user-selected key number and can be arranged so that it will only reveal its contents when connected to one or more similarly coded devices.

Intel have chosen to call the new device a KEPROM. The 27916 KEPROM is organised as 16K x 8 and is pin compatible with the standard 27128 EPROM. It has an access time of 250ns, an intelligent programming algorithm for fast programming and a standby mode which reduces current consumption to 40mA without increasing access time.

The data protection features are selected by programming a special EPROM bit. In the KEPROM configuration, an initialisation sequence involving a handshake between two devices must be carried out before the data can be read. One device sends its encrypted key to the other for comparison and if the two agree, they then swop roles and repeat the procedure. Only when both comparisons have proved favourable is the stored data made available to the system user.

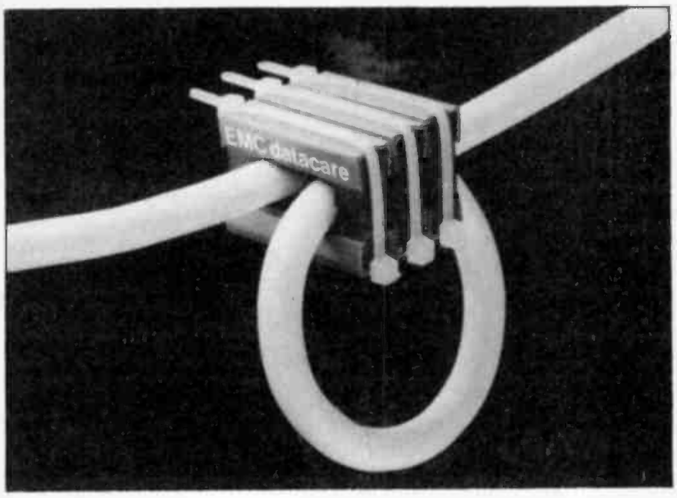
The second configuration is called Key Manager and can be used where a system contains many KEPROMS. It allows the authentication handshake to be carried out with devices having different keys and access gained only to those which are authorised. The Key Manager is capable of handshaking with up to 1024 different keys.

In the third configuration, 27128, the KEPROM is fully erasable and fully re-programable and resembles the standard 27128 EPROM in every respect. All standard 27128 modes are available for use in this configuration.

The key is a 64-bit number programmed into a special portion of the device. Without knowing this key, no-one can gain access to the memory array. It cannot be read once programmed and is known only to the system or software designer.

Rapid Recall Ltd, Rapid House, Denmark Street, High Wycombe, Buckinghamshire HP11 2ER, tel 0494-26271.

NEWS: NEWS: NEWS



Clamp-On RF Choke

EMC Datacare have introduced a clip-on choke which can be attached to existing cables to reduce radio frequency interference (RFI) in audio, digital and telecommunications equipment.

The D910 series common mode chokes are built up from pairs of ferrite 'U' cores, allowing them to be slipped over cables without having to first disconnect one of the cable ends. Cables up to 10mm in diameter can be accommodated while multi-turn chokes can be fashioned in thinner cables simply by forming a few loops before the 'U' sections are attached.

EMC Datacare say that most RFI problems arise because cables act as aerials, and that the unwanted signals which result can be reduced without affecting normal operation of the equipment. They suggest applications for the chokes in domestic radio, TV and audio equipment as well as in computers, process control and telecommunications systems.

An introductory kit containing eight choke modules is available for £22.00 plus VAT. The kit includes application notes to enable the user to install the chokes successfully. A data sheet for the 910 series chokes is available on request. Contact Richard Marshall at EMC Datacare Ltd, Power Court, Luton, Bedfordshire LU1 3JJ, tel 0582 450 092.

● Electro Cables have published a new catalogue describing their range of computer, co-axial, multi-core, control and instrumentation cables. The range includes cables manufactured to DEF and various other international standards and copies of the catalogue can be obtained from Electro Cables Ltd, Faraday House, Faraday Road, Hinckley, Leicestershire LE10 3DE, tel 0455 617422.

● *International Rectifier have published a 4-page leaflet which describes their range of gate turn-off (GTO) thyristors. The devices described have voltage ratings up to 2500V and current ratings up to 550A, and copies of the leaflet can be obtained from International Rectifier, Hurst Green, Oxted, Surrey RH8 9BB, tel 08833 - 3215.*

● *Axiom Electronics are distributing a folder which contains brochures on three of the Panasonic product ranges the company handles. One brochure describes the range of super-high capacitance memory back-up capacitors, the second covers opto-electronic devices including LEDs, seven segment displays, level meters and one to four digit numerical displays, and the third covers brushless DC fans. Copies of the folder are available free from Axiom Electronics Ltd, Turnpike Road, Cressex Estate, High Wycombe, Buckinghamshire HP12 3NR, tel 0494 - 442181.*

● **General Instrument Lamps have issued a new guide to spark gap tubes. As well as describing their own range of products, the 8-page leaflet explains the operation of spark gap tubes in protection circits and gives advice on how to choose the most suitable device for each application. Copies are available from General Instrument Lamps Ltd, Beetons Way, Bury St. Edmunds, Suffolk IP32 6RA, tel 0284 - 62411.**

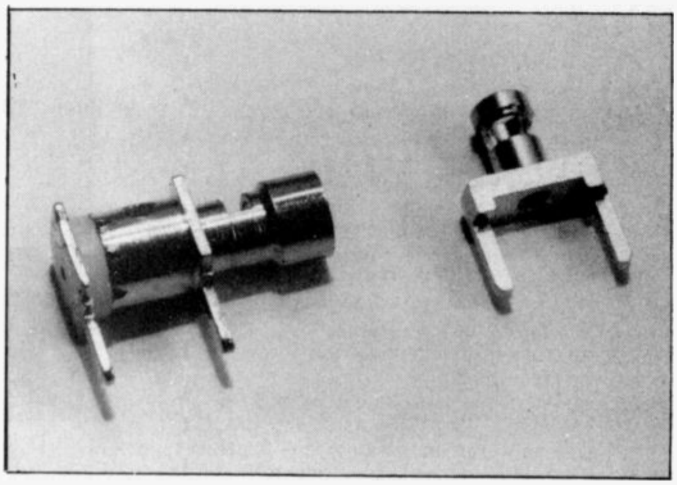
● Greenweld Electronics have sent us a copy of their 1985 catalogue. Its 48 A4 pages list a wide range of components as well as test gear, books and modules and include a six-page bargain list of once-only offers. The cost is £1.00 inclusive from Greenweld Electronics, 443 Millbrook Road, Southampton SO1 0HX, tel 0703 772 501.

● Electronic Brokers have started a quarterly newspaper for test and measurement equipment buyers. The 12-page first issue describes new products from Philips and other manufacturers with whom Electronic Brokers have distribution agreements, and there are also articles on second-hand equipment along with current prices. Electronic Brokers Ltd, 140-146 Camden Street, London NW1 9PB, tel 01-267 7070.

● The Indium Corporation of America have published a 20-page A4 colour brochure which describes their range of special solders for the electronics industry. It includes a guide to the properties of popular alloys such as tin/lead and a glossary of soldering terms. The brochure is geing distributed in this country by Dage (GB) Ltd, Intersem Division, Rabans Lane, Aylesbury, Buckinghamshire HP19 3RG, tel 0296-33200.

● Daturr manufacture a wide range of cases and accessories including 19" racks, small moulded cases with or without sloping panels, and industrial tools, assembly benches, test equipment trolleys, etc. They are principally industrial suppliers but will accept orders from anybody subject to a minimum value of £25.00 Daturr Ltd, Albany Park, Camberley, Surrey GU15 2PL, tel 0276 - 681212.

● Century Communications have published an 'Epson Printer User's Handbook'. Covering the FX, MX and RS series printers, it moves from the installation and connection of the machines with different computers to the procedures used for printing special characters and typefaces. The book can be ordered through regular booksellers and. costs £9.95. The ISBN number is 0 7126 0561 4.



PCB Co-Axial Cable Terminators

Dean Electronics have introduced a rarge of cable terminators which allow co-axial cables to be attached securely to printed circuit boards.

The terminators have built-in strain relief which overcomes the problem of breakage caused by flexing which is common with directly soldered cables. They are also far cheaper than the existing alternative, which is to use a pair of mated connectors.

The terminators have been designed for use with 2 mm and 3 mm wire or with RG178/U and RG188/U co-axial cables. They are available in versions to suit either vertical or right angle take-off of the cable.

For further details contact Dean Electronics Ltd, Glendale Park, Fernbank Road, Ascot, Berkshire SL5 8JB, tel 0344-885661.

ATTENTION ALL WRITERS . . .

. . . or just those of you who sometimes think "I could do better than that!"

We want to hear from you!

The magazine you hold in your hand is part of ASP's electronics group of titles. These include *ETI, Ham Radio Today, Digital and Micro Electronics,* and our new magazine, *Electronics.* All these magazines are looking for new authors, so if you've designed something for yourself that you think may be of interest to others, or if you've a subject you'd like to write a feature article on, then drop us a line with an outline of what you have in mind.

We particularly need:
- Projects for the Commodore Vic 20 and 64, the Amstrad, the BBC A and B, and the Electron computers;
- Simple projects that do something useful, perhaps in a novel or instructive way;
- Radio projects (not necessarily for radio amateurs);
- Features on amateur satellite radio.

If you're interested in writing for us, send an outline of your proposed article to: Dave Bradshaw, Group Editor (Electronics), Argus Specialist Publications, 1 Golden Square, London W1R 3AB.

Please note that while we take ever care, we cannot be held responsible for the loss of unsolicited manuscripts. We advise all authors to keep a photocopy or carbon copy of any article they send us.

NEWS: NEWS: NEWS:

Diary

Personal Computer World Show — September 4-8th
Olympia, London. For details see July '85 ETI or 'phone 01-486 1951.

Electronics for Peace: London Group Meeting — September 5th
London New Technology Network, Camden, London, 7.30 p.m. A debate on the need for nuclear weapons in the UK defence programme. For details contact Louis Barman, 89 Acre Road, Kingston-upon-Thames, Surrey KT2 6ES, tel 01-541 1825.

Vacation School On Cable Television — September 9-13th
Leeds Polytechnic. Residential course organised by the IEE in association with the IERE. For details contact the IEE, Savoy Place, London WC2R 0BL, tel 01 - 240 1871 extension 270.

Radio Amateurs Examination Course — September 10th
Bradford & Ilkley Community College, Bradford. Enrolment commences for three courses, one leading to the City & Guilds 765 Radio Amateurs Examination, one in preparation for the Post Office Morse Examination and one project-based course on construction for the Radio Amateur. Contact the Course Tutor, P. Nurse, Bradford & Ilkley Community College, Great Horton Road, Bradford, West Yorkshire BD7 1AY.

Interconnection Europe '85 — September 10-12th
Cumberland Hotel, Marble Arch, London. For details see February '85 ETI or 'phone 0582 - 417438.

Programming in C: Hands-on Workshop — September 24-27th
Venue to be announced. For details see July '85 ETI or 'phone 0372 - 379211.

Computer Graphics Course — September 24-27th
Venue to be announced. For details see July '85 ETI or 'phone 0372 - 379211.

Semiconductor International — October 1-3rd
NEC, Birmingham. For details see August '85 ETI or contact Cahners at the address below.

System Security Conference — October 2/3rd
Tara Hotel, London. For details see August '85 ETI or contact Online at the address below.

Internepcon UK — October 10-11th
Metropole Hotel & Brighton Centre, Brighton. For details see August '85 ETI or contact Cahners at the address below.

Technology Engineering Fair — October 8-11th
NEC, Birmingham. For details see August '85 ETI or contact Cahners at the address below.

Computer Graphics '85 — October 15-18th
Wembley Conference Centre, London. For details see August '85 ETI or contact Online at the address below.

Electronic Displays '85 — October 29-31st
Kensington Exhibition Centre, London. Exhibition and conference covering all aspects of electronic displays. For details contact Network Events Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX, tel 0280-815226.

Cellular Communications International — November 5-7th
Wembley Conference Centre, London. Conference and Exhibition which covers many aspects of the subject including technical developments, regulation and control, marketing, etc. The cost is £465.00 for the full three days. Contact Online at the address below.

Addresses:
Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01 - 891 5051.
Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner Middlesex HA5 2AE, tel 01 - 868 4466.

ETI

READ/WRITE

Radiation Effects

Dear ETI,
Congratulations on your June issue. It is a very informative and interesting issue. I particularly liked the two articles 'The Job Market', about conditions in Scotland, and 'The Number Jungle', which detailed device description codes.

Please let's have more in similar veins. I would find most useful an article — or series — on electromagnetic radiation through the spectrum, propagation methods (aerials, etc.), an explanation of terms, and of the effects of fields of all kinds on the common things around us and on people.

Not too tall an order for people of the calibre of your contributors!

Best wishes
Tony Wilson,
Bath

From the Electronics Personality of The Year to the Electronics Magazine of The Decade (well, if you can't blow your own trumpet, who will?), praise indeed. Thanks, and we hope to do even better in the future. As far as electromagnetic radiation is concerned, we're working on it. Well-founded rumour suggests that Michael Heseltine might have had his brain softened by exposure to an electromagnetic field at the right frequency in the vicinity of some nuclear base or other. On the other hand, he could have been born like that. We think we should be told .... — Ed.

Help-line

Dear Sirs,
Re: Mr. Leslie's letter, ETI, May 1985

1) Slider pots under 40mm. Try Cirkit.

2) Stepped rotary pots. These were very popular with the BBC a while ago, and I believe they were made by Painton or Welwyn; but a good one can be made using a 24 or more pole switch and a resistive attenuator network. (It could save a great deal of money. There are several 'small' production companies who could make them up — try Datong, Bramley, Leeds as a start).

3) Stepped sliders. As above, but the switches were very noisy. Try the plastic pots from Penny & Giles at Christchurch, Dorset.

4) Knobs. Contact Cirkit or Sifam direct (Vero or BICC-Burndy may help). Other firms who may help include BCD Electronics, 200 Hessle Road, Hull, or Chase Electronics in Harrogate.

5) Notes. Strange designs of pots may be obtained from Flight Link controls of Hampshire. They sometimes advertise in the electronics press.

Yours sincerely,
D. R. Coomber,
Staffs.

Plug-compatible

Dear Sirs,
We would very much appreciate your having us mentioned in your magazine.

Our club was established in December, 1983 and has divisions in Antwerpen, Limburg, West-Vlaanderen, Oost-Vlaanderen and Brabant.

Actually we have about 700 members.

Meetings take place twice a month on the first and third Friday, at 8pm in Antwerpen.

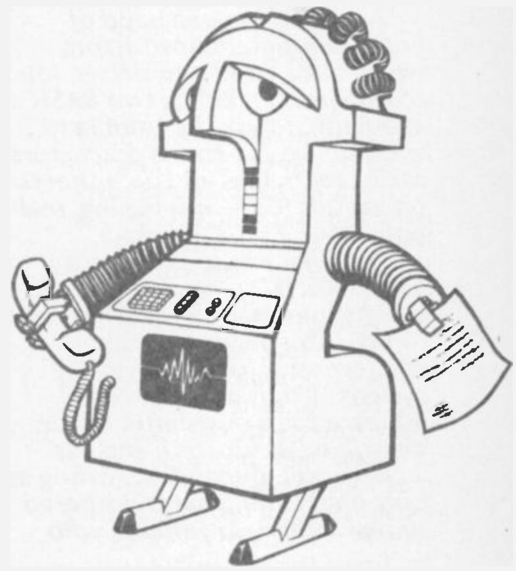
Contact address:

Section ANTWERPEN:
VZW CCCBA
BINDSTRAAT 19
B-2600 BERCHAM ANTWERPEN

Greetings from Antwerp
Secretary Antwerpen
Commodore Computer Club Belgium
E. De Decker.

AUNTIE STATIC'S PROBLEM CORNER

Having recently acquired aspirations above our station in life, we have decided to employ the services of an agony aunt. Claire Rayner watch out. Our very own Auntie Static is keen to receive questions from ETI readers of a revealing and intimate nature! To start the ball rolling, Auntie has picked a couple of letters from our mail bag. Please write to us with any technical queries at the usual address: ETI, ASP Ltd., 1 Golden Square, London W1R 3AB. We can't guarantee to answer all questions, but we'll do our best. It would help us if your letter were typed and the envelopes marked 'Technical Problems'.



General Purpose

Dear Auntie Static,

I have found a circuit in an electronics book that I would like to build but it uses a TRS1046B transistor that nobody has heard of. Do you know where I can get one, or can you suggest an equivalent? The circuit is for a BFO.

Also, can you tell me why there are so many different types of transistor when they all do more or less the same thing?

Yours sincerely,
Michael Fluke,
Wirral.

As you didn't send the circuit of the Beat Frequency Oscillator, it is not easy to advise you. The chances are, however, that any small-signal transistor that will operate at a high enough frequency will do the trick. If the transistor is NPN, you won't go far wrong if you choose a common or garden BC109.

Asking why there are so many types of transistor is much the same as wondering why there should be so many types of car. Transistor manufacturers are constantly juggling with the various parameters at their disposal. Perhaps one with extra luggage space would be useful? Maybe we could make a four wheel drive version of the BC109? Would people buy one that was more tough-on-the-streets than a 2N3055?

At any level of technology it is only possible to improve one parameter — fast switching time, let's say — at the expense of another — gain, perhaps. As technology marches on, it becomes possible to achieve faster switching times AND higher gain, or maybe super-fast switching and the same gain, and a whole new set of parameter combinations becomes possible, giving rise to a splurge of new types.

Unlike cars, however, in transistor terms the old model Ts and Ford Populars continue to be produced alongside the latest sleek and glossy models, so the list continues to expand indefinitely.

For shopping trips and suchlike, any old car will do. Similarly, if you just want a bit of gain, any old transistor will be OK. By all means buy the most advanced type if it takes your fancy. Who am I to say you shouldn't do your shopping in a Ferrari? But you will be just as well off with a cheap 'n' cheerful one. A BC109 will be perfectly OK for 95% of magazine projects, even if the author does specify a HGK89-pr/12 NM56 issue 16, or whatever.

The time you have to be careful in your selection is when the circuit requires something special in the way of fast switching, high gain, low noise, and so on. When this happens, you have to use the type specified or take a careful look at the data books to find a suitable substitute. Otherwise, just stick to general purpose devices — Auntie.

Towers of Strength?

Dear Auntie Static,

Please can you tell me why an IC as popular as the TL072 does not appear in 'Towers International Linear IC Selector?' Also, is the IC a TL-072 or a TLO-72? Is the prefix TL or TLO?

Yours sincerely,
Andrew Morris,
London NW8.

I can't really say how the compilers of data books go about selecting the devices to be included. Perhaps the TL072 was introduced after all the data was collected? If you would like information on this op-amp, however, the place to look is the Texas 'Linear Circuits Data Book' available from RS Components at £9.00. RS will only supply trade and professional customers, but you can order through Crewe-Allan and Company, 51 Scrutton Street, London EC2, who will make a small charge to cover their own expenses.

The prefix is 'TL' which stands, believe it or not, for 'Texas Linear'. The prefix 'TLC' is also used, for linear CMOS devices — Auntie.

ETI welcomes all letters and contributions large or small. Any letter we receive is liable to be published unless marked 'Not For Publication'. We reserve the right to edit letters for reasons of space.

In general, please *type* your contributions using double-spacing and wide margins. Any diagrams should be neatly drawn in ink on plain paper and PCB foil patterns (if enclosed) should be at 2:1 scale. Please print any program listings at 4½ inch column width or (if more suitable to the listing) we may accept listings at 9 inches column width. The specifications for listings are meant to facilitate layout and avoid errors that may creep in if listings have to be re-typed. As a guideline, 4½ inches is most suitable for BASIC or other high-level language listings while 9 inches would suit hex-dumps or annotated assembly language listings. Please send any letters and contributions to ETI, ASP Ltd., 1 Golden Square, London W1R 3AB.

Shame . . .

Dear Sir,

As a regular reader of your magazine, I would be very thankful if you will please publish the enclosed letter plus my name and address

As a member of a band of home computer constructors, which has a good newsletter, lots of software, including two BASICs and Forth, I took the trouble to write to five top chip manufactures asking for details and data sheets on various ICs — interfacing, real time clock, DACs, etc.

The idea was to build up a 'DATA BANK' so members could get the information that they need to use that special chip, for whatever they're adding to the system next. It may have even appeared as a newsletter article describing its function and use.

However, things went wrong as only one manufacturer bothered to reply. This was Ferranti, who supplied a good deal of useful information. In fact, I wrote again and they sent details of the ZN447-9 ADCs, the ZN1035E programmable timer (.01 sec-3 months, MPU bus compatible) to name but two!! WELL DONE FERRANTI!

To those like Motorola, Nat Semi, GI, etc., who found it all too much trouble, I say shame on you, we the public are the ones who buy your products, you should keep us informed, it can only help your sales?. . . .

Our system is the INTERAK. Newsletter is INTERAKTION.

Suppliers:

Greenbank Electronics,
92 New Chester Rd.
New Ferry,
Wirral,
Merseyside,
L62 5AG

Lastly, anyone out there in manufacturing or retail business who would like to send us Data sheets or details would be most welcome!

Yours faithfully,
Mel Saunders,
Leicester.

Readers who would like to comment are invited to reply to Mel at 7, Drumcliff Road, Thurnby Lodge, Leicester, LE5 2LH. For our part, I must confess to ignoring the Interak system in our editorial. This is an omission we hope to rectify soon — keep taking ETI to find out more. As for the IC manufacturers, the point is well made. Unfortunately, they only seem to be interested in volume manufacturers and not in the ordinary consumer. This seems to be very short-sighted of them, since 'the ordinary consumer' is often the person who comes up with a startlingly new (and profitable) application. Tell them you're John or Susan Smith from Everytown and you might as well not exist. Say that you're actually representing United International Amalgamated Products Inc., and you'll never hear the end of it. Some advice: get yourself some headed notepaper and . . . . Well, I'll leave the rest to your imagination — Ed.

ETI

THE SHAPE OF THINGS TO VIEW

Keith Brindley looks at the technologies competing for space on your walls and in your pockets. From now on, he says, the viewing figure that matters will be flat and squarish.

Television owes its largest debt to John Logie Baird who, in 1925, demonstrated a mechanical system. By 1936 the world's first quality television service was opened by the BBC, using an electronic 405-line monochrome system developed by EMI, and broadcasts using this system have continued to within only the last few months, when the service was finally closed to make the radio wavebands available for other services.

The first major change to television — in Britain, at least — occurred when 625-line broadcasting became common. The higher number of scanned lines, coupled with better electronic transmission methods, improved picture quality enormously. The second change came with the advent of colour broadcasts, some twenty years ago.

You may be forgiven if you think that these changes in television weren't particularly mind boggling. However, we're now about to witness a complete *revolution* in television technology (or, to be more precise a *number* of revolutions) which will completely change television, turning it into a much more sophisticated system and providing us with near-perfect pictures and sound, coupled with features and facilities John Logie Baird would never have thought possible.

Flat Round The Corner

Three of the changes — digital television, satellite/cable television and higher definition television are still a way off in worldwide terms. A fourth change, however, is about to take place now.

No-one will have missed the recent emergence of Sir Clive Sinclair's tiny, pocket-sized television: the TV was first announced some four years ago, but has only recently been readily available (having been pipped to the commercial post by a much more expensive clone, based on similar principles, by Sony of Japan). It is one of the first examples of *flat-screen television,* that is, a TV receiver whose picture is shown on a thin display device.

The display device used in Sinclair's TV is not a new concept, merely an ingenious adaptation of existing methods. The device used till now in all commercial TV receivers is the basic cathode ray tube (CRT), shown in principle in Fig. 1. The operation is well known. An electron gun at the rear of the tube fires an electron beam towards the inside front surface of the tube (the screen), while the beam is electronically or electromagnetically focused, directed and controlled in strength, to make up the picture on a phosphor layer on the screen's surface.

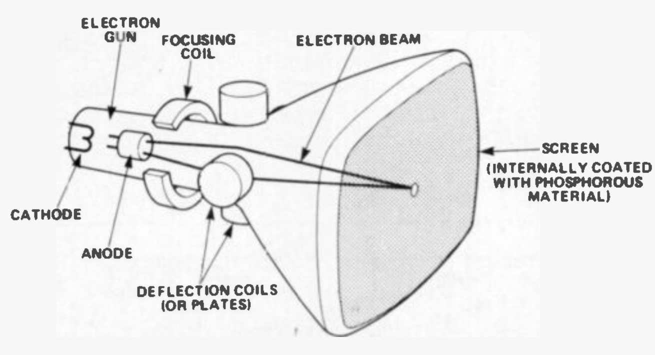


Fig. 1 Traditional cathode ray tube.

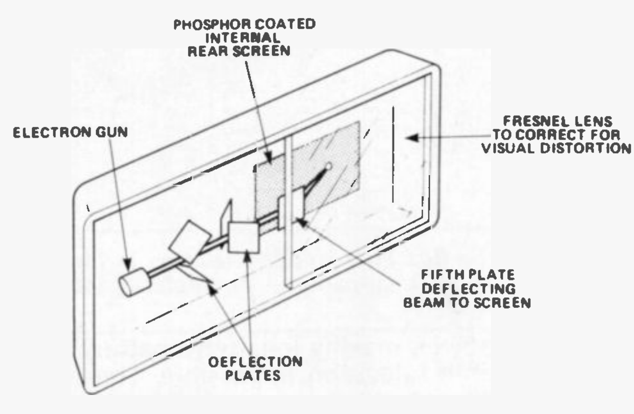


Fig. 2 The Sinclair flat screen tube.

Sinclair's adaptation (Fig. 2) has the electron gun mounted at the side of, and parallel to the screen. Instead of hitting the inside front surface of the screen, Sinclair's electron beam bends backwards and the picture is viewed through a Fresnel focusing lens. The electronic controlling circuitry is largely unchanged.

The CRT has been with us for a long time. All practical television systems have been based around the CRT as a display device, right from those early days of the 1930s. Until recently, no real alternative existed which was capable of the high resolution and operating speed required. To give a rough idea of the resolution which a typical television affords, it's useful to think in terms of pixels (picture elements). Standard 625-line British television allows a picture composed of something like a *quarter of a million* pixels to be created on the screen. CRTs can easily be manufactured to display this number of pixels, and, in fact, CRTs capable of displaying well over three times this number of pixels are readily available in the OEM markets, for special-purpose products such as arcade games or computer graphics.

But the CRT does have its drawbacks. First, it's bulky, often measuring more from back to front than it does in the width of the viewing area. Second, it's a vacuum device, which largely defines the maximum screen size (the larger the screen the thicker the glass needed to prevent collapse). Third, the CRT uses a

The Epson Elf, the first LCD colour television in the world. The Elf's two inch LCD flat-panel — a completely integrated display.

great deal of power, making long-term battery operation in a portable television impossible. These three factors have prevented the economic manufacture of really small or really large CRTs for use in TVs.

Knowing these drawbacks, some manufacturers have been looking round for alternatives to the CRT. The first of these to get off the production line is the LCD television. A number of Japanese manufacturers have recently launched colour televisions using LCD 'flat-panels', although none as yet in the UK. Two of these manufacturers, Seiko and Epson (a Seiko subsidiary), have produced their televisions as part of a research and development programme concurrent

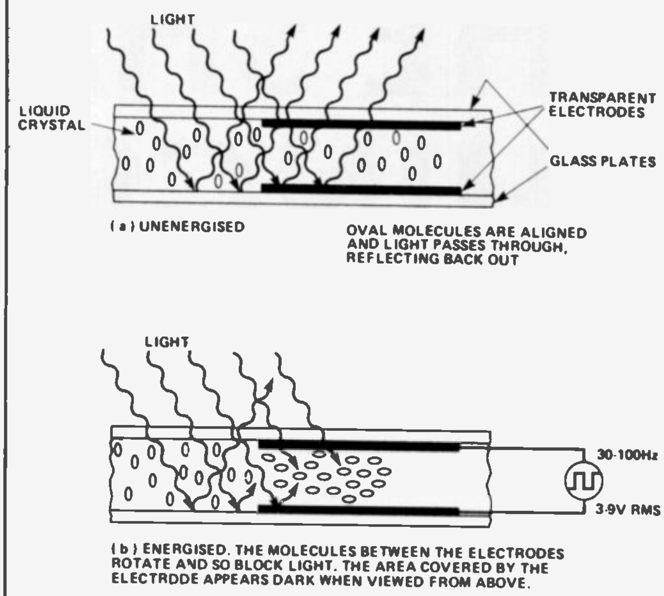


Fig. 3 Incident light LCD uses organic molecules rotated by an electric field.

with their work in computers. The third manufacturer, Casio, makes digital watches, so it's interesting to speculate what Casio's future products may be. (Another watchmaker, Citizen, is also developing a colour LCD television, although it's only in prototype form as yet.)

The Dark Crystal

In contrast with CRTs (pun intended) basic LCD devices have a number of differences. They are *non-emissive*, generating no light on their own, merely refracting or not refracting (as the case may be) background light, as shown in Fig. 3. Computer-type LCDs presently available on many portable computers use this non-emissive facility to allow background light to be reflected in a controlled manner, making up the required display pattern. Generally, in such an LCD, the individual pixels of the display are addressed by multiplexing If the individual liquid crystal elements could operate fast enough, this same system

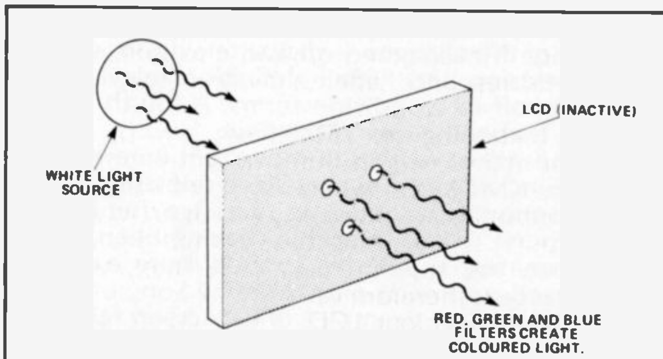


Fig. 4 A rear-illuminated LCD can be used for colour displays.

could, in principle, be used as the display for a monochromatic television — the light and dark areas created on the LCD making up the picture in much the same way that light and dark areas created by the

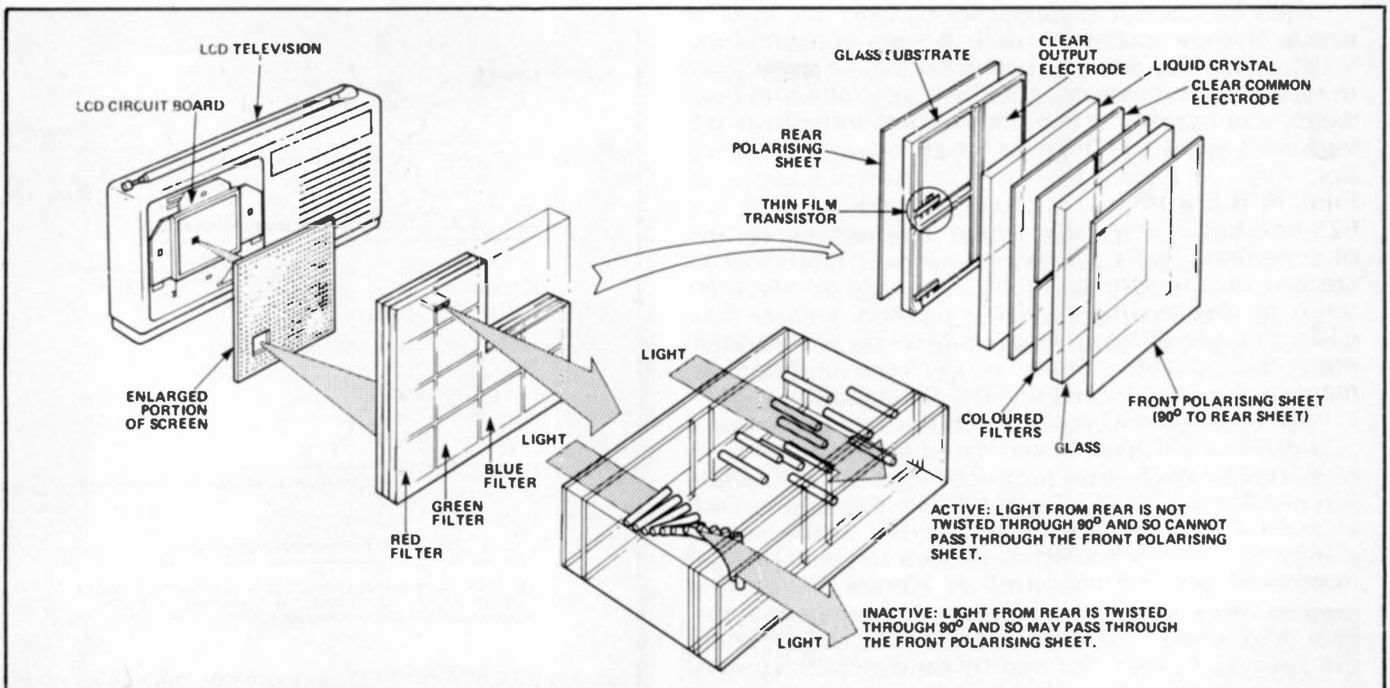


Fig. 5 Exploded view of a colour television LCD flat-panel.

electron beam on the screen of a monochrome CRT create a picture.

For a colour television simple multiplexing isn't good enough. There is no colour and basic multiplexed LCD pixels don't show great contrast because each pixel in effect, is off for longer than it is on due to the serial nature of the multiplexing process and the existence of a threshold voltage below which the pixel remains translucent. The first problem is simple to beat: colour LCDs must be *backlit* with either a built-in light of some sort, or an external light source, such as sunlight. Light passing through the LCD is then filtered by electronically controlled red, blue and green filters to produce the colour display (Fig. 4).

It is the second problem, however, which has held back the development of colour LCD televisions till now. The answer has been to use *thin film transistors* (TFTs) operating as bistable switches, one at each junction of column and row in the multiplexed matrix. Each pixel has its own TFT which, when addressed in the matrix, rapidly turns on, in turn switching the LCD pixel on. The associated TFT keeps the pixel opaque (on) once it has turned on and also greatly reduces the pixels' response time, to a value approaching that of CRTs.

The technology of TFTs is not new. It has been used for many years in the production of silicon-on-sapphire CMOS ICs, where layers of semiconductor crystal materials are physically grown on to a sapphire substrate. ICs built using this method are extremely fast since the sapphire is an insulator and circuit capacitance is therefore very low.

In the new colour LCDs the TFTs, along with the LCD rear electrodes, are made by growing the semiconductor material onto a glass substrate (also an insulator). The whole arrangement complete with a layer of liquid crystal, a common, transparent, front electrode, and red, blue, and green filters, is sandwiched between the glass substrate and another glass sheet (Fig. 5). Two polarising filters are included,one at the front and one at the rear of the sandwich.

The operation of such LCDs is illustrated in Fig. 5. They are a variety known as *twisted nematic* liquid crystals where light from the rear is rotated through 90 degrees when the device is inactive. The rear polarising sheet ensures that all light enters in the same plane. The front polarising sheet, on the other hand, has an axis at 90 degrees to the rear one, so the light, after twisting, leaves the pixel and passes through a red, blue or green coloured filter and is thus visible when viewed from the front, as a coloured dot. In this state the pixel is inactive.

When the TFT at that pixel is addressed and the device is made active, the light passing through the pixel is *not* rotated through 90 degrees, and so cannot pass through the front polarising sheet. No colour is seen and the effect is of a black dot.

In the same way that a colour picture is made up on the screen of a colour CRT in triads of red, blue, and green dots, so the LCD picture can now be composed. There are still, however, significant disadvantges to LCD television displays:

- as each dot may only be fully on, or fully off (unlike a CRT dot which can be of any intensity between full on and full off), the display is only capable of producing a maximum of eight (that is, 2^3) colours, including pure black and pure white;
- the quality of the colour display is limited largely by the variation in thicknesses of the various layers in the LCD sandwich — the more constant the thickness of the layers, the more constant and non-varying are the colours produced. Obviously, it becomes increasingly difficult to manufacture constant thickness layers the larger they are, so this problem will have to be overcome before large-sized LCD displays can be made;
- the resolution of LCD televisions is, at present, much lower than CRTs. The Epson/Seiko 50mm LCD device, for instance, has only 52,800 pixels in a 240 by 220 matrix. Once the constancy problems of making larger devices has been overcome, it will be a simple enough step to make them with greater numbers of pixels.

LCDs do have advantages, though, not the least of which is their extremely low power consumption, making long-life battery consumption an easy goal. They are also extremely light. It's easy to see that LCD displays are going to make significant inroads in the television market, in the near future.

Bright Lights

There are, of course, other alternatives to the CRT after the LCD. *Electroluminescent* (EL) displays will probably be the next type to surface as television displays. And their potential is possibly greater than the LCD's, purely because the brightness of individual pixels is variable. Their power consumption is, however, much greater than LCD flat panels.

The EL display works in much the same way that a LED does — a voltage is generated across a thin layer of material, which then produces light. Zinc sulphide is typically used in EL displays; it is a phosphorescent material similar to those used on the inside screen surface of CRTs, but which is excited to generate light merely by the application of an electric field rather than by being struck by electrons. Other phosphorescent materials may also be used. Like LCD flat-panels, the basic EL panel is formed by sandwiched layers of electrodes and glass, as shown in Fig. 6.

Coloured television displays using EL panels will be more tricky to make, however — whichever phosphorescent material is used only emits light of one frequency. The answer will probably be to overlay three thin-film EL layers, one of red, one of blue, and one of green, in a single flat-panel. One Japanese manufacturer has already reported such a prototype, so it won't be too long before EL flat-panel colour displays for televisions are commercially available. Unlike LCD flat-panels, the size of EL displays is not restricted by production quality.

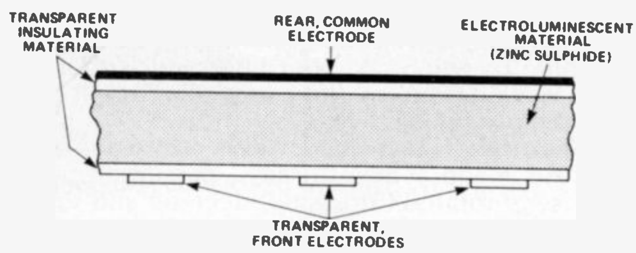
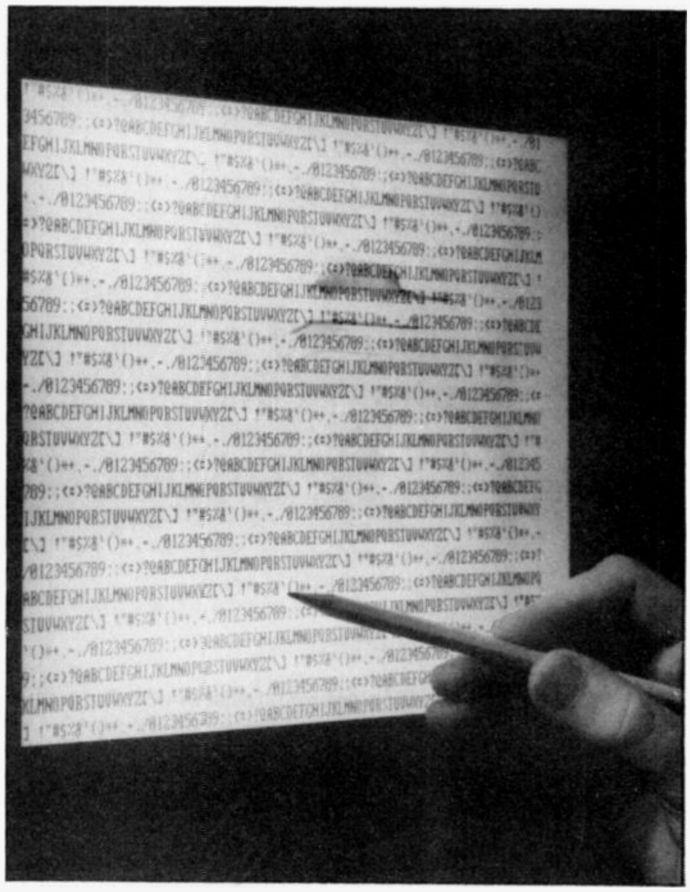


Fig. 6 Electroluminescent display.

There are no other emissive displays which have the potential of EL. The other contenders, *plasma panels* and *vacuum flourescent* displays, both require high operating voltages and are non-solid-state. They would be little better than the CRT. But there is one more non-emissive display which may become a contender in the television display race: the *electrochromic display* (ECD). ECDs are only a recent development and few viable devices have as yet been made.

Electrochromism is the property of a material to change colour by redox reaction. Furthermore, the reaction is reversible and so the material changes back in colour, too. Manufacture is, compared with LCD flat-panels, relatively simple as the demands of constant thickness layers are not required. However, present ECDs have a very slow response time and poor long-term reliability They will, no doubt, be greatly improved over the coming years, to the extent where they may take a significant slice of the market.



The latest LCD display from STC using smectic A liquid crystals which retain their opacity and therefore do not need thin film transistors.

The State Of The Art

In summary, we can see that although the CRT is still the only real device presently capable of displaying television pictures to the high standard expected of them, other devices are most definitely on the horizon. At present there are two main contenders to take over from the CRT, the LCD and the EL flat-panels, but others may soon arrive.

The technologies of LCD and EL displays are still quite young. A number of manufacturing improvements to each of these, roughly equivalent to the manufacturing improvements obtained when ICs began to replace discrete components, could boost their potential enormously. The development of LCD flat-panels using TFTs is the first step towards such manufacturing improvements, and within only a few years we can expect to see display devices matching the complexity of modern integrated circuits, in a single panel.

It may be that large EL panels will assume the role of the home-based, high-quality flat-panel, hung on the living-room wall. Here their relatively high power consumption will be of no problem. LCD flat-panels, on the other hand, are more likely to be used as the display in truly pocket-sized portable televisions, with long battery life. Whatever happens, the effect on television itself will be dramatic.

ETI

TRAINING FOR THE FUTURE?

Cassandra foretold the downfall of Troy, but she was right. Are the Cassandras of the UK electronics industry just as right? Gerry Kelly investigates.

Alarm bells, which for some time have been ringing loudly outside, seem to be resonating at last in the corridors of the Department of Trade and Industry. The cause for concern is the growing shortage of trained personnel and graduates in the information technology sector of the electronics industry.

In April, 1984, a committee composed of politicians, civil servants, academics and several big cheeses from the electronics industry was set up. Under the chairmanship of John Butcher MP, the Parliamentary Under Secretary at the DTI, the committee has so far produced two reports. A third should have just been published.

Announcing the publication of the first report in July 1984, John Butcher MP said that, 'the major supply side constraint within the UK IT capacity is the shortage of people with appropriate IT skills'. The object of the report, according to Butcher, was 'to face the problems of manpower shortages head on and to focus attention on the best way forward.' But many commentators and policy-makers from all sides of the electronics industry have already condemned the committee's work as 'too little, too late.'

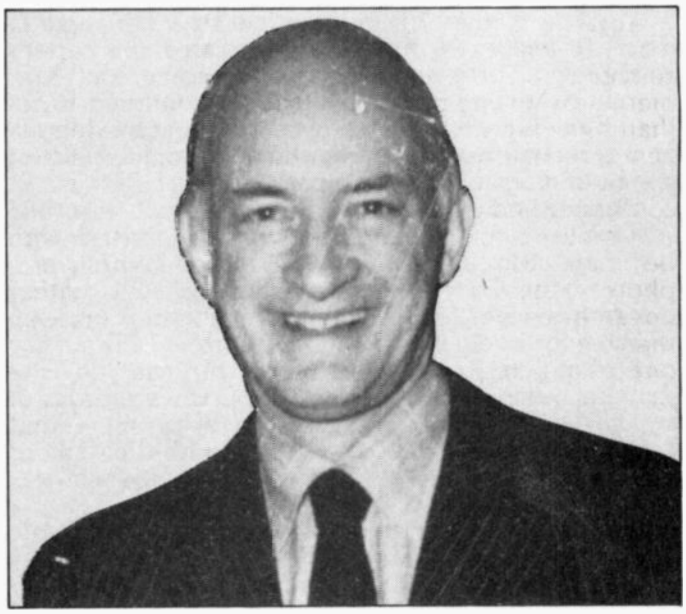
It is estimated that the shortfall in IT trained personnel was 1,500 in 1984 and that this will rise to around 5,000 by 1987-8. All of this is most alarming for an industry already falling badly behind its foreign competitors. But the problem was seen by others some time ago.

Butcher, Baker . . .

The National Economic Development Council IT sector working party warned as long ago as February 1983 that a national policy, including action for training, was needed for the IT Industry. Viewed in isolation, the sector working party stated, trends in the UK IT Industry were satisfactory, but when judged against its competitors the picture was worryingly different. It still is.

Information Technology is the fastest growing industry in the world. The UK industry is expanding at a rate of 8% per annum. The world average growth rate, however, is 15%. According to the first report of the Butcher IT Skills Shortage Committee, 'in some sectors such as semiconductors and data communications the world growth rate is 20%'. They go on to stress that manpower constraints are losing market share for the UK.

The UK share of the IT market worldwide is 5% and decreasing. In fact, it's been decreasing at least since the NEDC sector working party warned — in



Geoffrey Pattie: froze cash for microelectronics support programmes.

1983 — that current trends will see future decline. Despite the apparent concern of John Butcher's committee, other moves at the Department of Trade and Industry, in the words of the Electronics Bulletin produced by the Association of Scientific, Technical and Managerial Staffs (ASTMS) 'spell bad news for the microelectronics industry.'

The former IT Minister, Kenneth Baker, left the DTI months ago to oversee the break up of the GLC and the Metropolitan councils. The first action of his successor, Geoffrey Pattie, was to freeze Government spending on microelectronics support programmes to industry. The DTI's support for training initiatives through schools, colleges and ITeCs has been just as fearlessly progressive! Mr Pattie and his Department are, as ASTMS argues, 'neatly sidestepping the issue of the crucial shortage of professionally qualified IT staff.'

ITSA Knockout

The DTI has promoted an IT Skills Agency (ITSA) to act as a link between industry, universities and Government. The first Butcher report recommended 'a new partnership between Industry and the Education system.' The ITSA seems to be badly equipped for anything so grandiose. Sited within the confederation of British Industry, it will be staffed by only two to four people. Tim Webb — an ASTMS national officer — says that, 'it will have no proper database, no facilities to analyse what skills are needed and where and how to obtain them in the necessary short period of time. At best it may improve communications. More likely it will provide a permanent smoke screen for government inaction.'

But why, it is fair to ask, is there a skills shortage, anyway? One popular, common myth is that the universities and polytechnics are overflowing with undergraduates occupying themselves with sociology, or delving into the mysteries of Middle English at the expense of technical and technologically based courses. A myth it is, though. The real picture is that despite the fact that the output of graduates with IT skills continutes to decline, in 1983 nine out of ten applicants for computer science courses were turned away at ten universities.

The fact is revealed in an article by Peter Large in *The Guardian* on 10 April this year. Large, the paper's technology correspondent, was musing on Mrs. Thatcher's recent Far East tour and wondered if her 'Victorian vision of British education might be dented' by seeing the successes in the electronics field of some of Britain's Far Eastern competitors.

Despite some fanciful nonsense about a future, post-industrial 'Nation' (which has dispensed with both capitalism and marxism), Large pinpointed problems in the Government's training policy, or rather lack of it, which should have the electronics industry reaching for a very big bottle of aspirin.

Blaming lack of investment through all the Thatcher years and during the Labour governments of the seventies, Large charges, 'it's astonishing that ministers are able to get away today with their talk of tackling "skills shortages" when the evidence was before them years ago.'

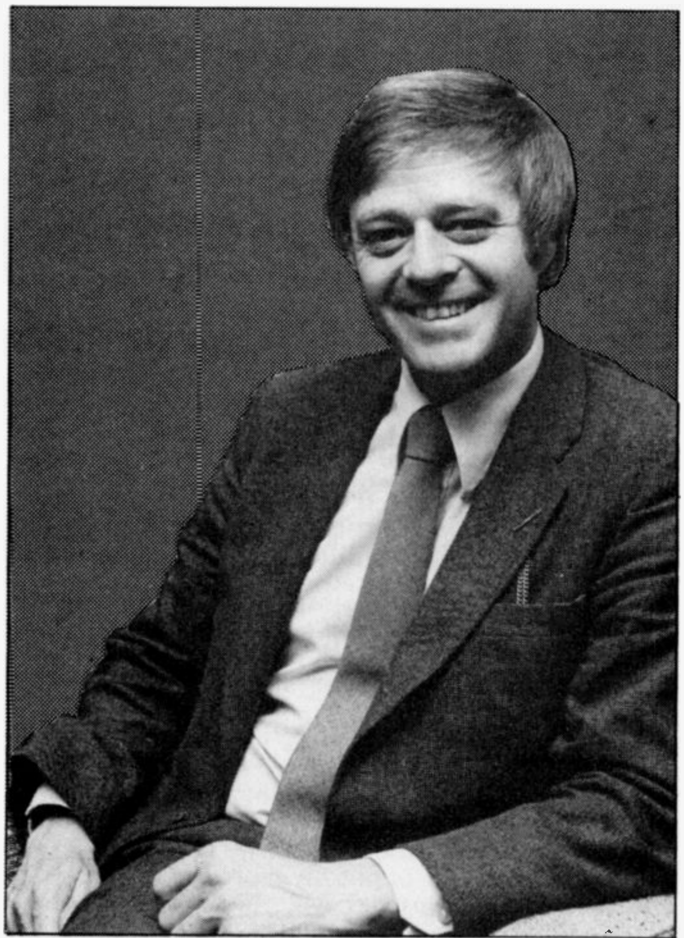
One example he cites is a National Economic Development Office warning in 1980 that Britain was short of at least 25,000 computer specialists. NEDO said that even without that problem the UK would still need 500 new computer programmers a month until 1986. If tackled immediately, the problem could have been resolved by 1985. This warning seems to have been received with the same scant attention given to other attempts to give notice of the approaching crisis.

Crisis Management . . .

Peter Large thinks that the Government is missing the point. Japan, South Korea and Singapore are pouring lots of money into higher education but the investment is not 'aimed merely at meeting the narrow, cannon-fodder demands for particular (and perhaps short-lived) technical skills.' Instead, the emphasis is on producing multi-skilled graduates, able to adapt to rapidly changing needs in an an industry which is subject to sudden and great shifts.

Thatcher's government, on the other hand seems to be wasting massive amounts of money in what Large dismisses as 'low-level "vocational stuff" — mainly serving the needs of the past and trying to appease the squeals of outdated industrial bosses.'

Despite talk of 'the urgency of the situation', the IT Skills Shortage Committee hardly seems to be an adequate response .In the first place, Tim Webb alleges, the Government only responded to the crisis when they were pressed to do so by the powers that be in the electronics industry. The Government had always regarded the evidence as hearsay and had apparently ignored the various reports from bodies like the NEDC, some of which predicted dire consequences for the electronics industry if drastic action was not taken.



John Butcher: his committee's report was condemned as 'too little, too late'.

It was Plessey who raised the alarm and it was the CBI who took notice. The Butcher committee includes among its members T.G. Rogers, Personnel and Europe Director of Plessey. Also on the committee are Robert Telford, Chariman of Marconi, David Baldwin, the UK Managing Director of Hewlett Packard, and Professor J. Parnaby, the Group Director of Manufacturing Technology for Joseph Lucas Limited. The IT Skills Agency, woefully inadequate though it may be, was the initiative of the CBI Education Foundation and was established in line with the proposals of the first report of the IT Skills Shortage Committee.

. . . What Crisis . . .

Perhaps the inadequacy of the Government's response stems from their belief that there is very little wrong with the present educational set-up. Their view seems to be that existing structures for training and education are 'capable of meeting the challenge.'

They see their role not as one of providing the bulk of the material needed to meet the situation but as acting as a catalyst.

The second of the IT Skills Shortages Committee reports states that the Government considers that training must be regarded by *employers* as a vital investment for the future.' Tim Webb, when asked about the Government's policy said,'Oh, they do have a policy. It is to have no policy. Like their policies elsewhere, they believe that market forces will regulate the situation.'

This was certainly echoed by one source we spoke to at the Department of Trade and Industry. He said that there was no policy on training of academics or other personnel. The Butcher Committee had looked into the shortfall in the number of engineers or properly qualified people and produced two reports, but the Government's attitude was, he said, that training was a matter for industry.

. . . What Management?

In the first Butcher report, the 'New Partnership Between Industry and the Education System' seems to be a plan to get the industry to provide the means to resolve the crisis. Among the proposals are the setting up of 'IT Training companies' and increased industrial sponsorship of students on relevant under-graduate and post-graduate courses. They also expect industry to provide expensive leading-edge equipment to universities and polytechnics. Needless to say, there is very little talk of increased Government investment in education. Indeed, the brief of the Butcher Committee seems to be merely to note the difficulties and suggest how other people can sort them out.

There is no doubt, though, that the situation is serious. Plessey recently complained to a House of Lords Sub-Committee that, had they been able to, they would have recruited an extra 700 engineering graduates in the past three years. They are talking about a 12.5% gap between the supply of and demand for suitably qualified staff for the foreseeable future.

Hewlett Packard is worried that there will be a serious shortage of skilled personnel in the latter part of the decade. A Policy Studies Institute survey warns of the microelectronics industry *already* having 21,000 less engineers than it needs.

Knowledge, And Then What?

All of this is noted in the IT Skills Shortages Committee reports, but are the measures suggested adequate to deal with the problem?

The NEDC Sector Working Party was saying that, although the UK should be able to excel in IT, 'negative factors . . . are of such significance that unless they are addressed as a matter of urgent national priority, by 1990 the UK could be out of the IT business.'

And the biggest 'negative factor' of all is the skills shortages' problem.

'The reports from Butcher are all good stuff, but were all pretty well known beforehand,' says Tim Webb. He accuses the Government of 'sleight of hand'. Not only have they ignored the omens in the past, but, he believes, they are going to do very little to avoid the problems of the future.

'If you see a man hanging from a ledge by his fingertips and you walk past and do nothing to help him, then I suppose you could be said to have taken a position, to have a policy. That's what the Government's position on the IT industry is.'

ETI

THE REAL COMPONENTS

John Linsley Hood continues his series on components with a look at power switching devices.

It is tempting to think of electronics as being neatly divided into analog and digital, with everything falling into either one category or the other. However, there is a third field which, in terms of the sheer quantity of cash involved, is probably as big as either of the others, and that is the field of power switching systems.

The development of power switching devices began with the invention of the circuit shown in Fig. 1. Some clever but unsung electronics engineer realised that if two silicon transistors are connected so that each receives a base input current from the other, both will always be on or off at the same time. Thus, if either of the transistors is caused to conduct, both will turn hard on and remain so until the DC supply is removed. The circuit will not work with germanium transistors because of their high leakage currents.

This useful little circuit could be employed, for example, to latch on a relay after the arrival of a pulse. When a brief positive pulse is applied to the base of Q2, as shown in Fig. 2, the circuit will switch on and continue conducting until it is switched off by removing the supply. Alternatively, in the case of a simple DIY thyristor like this, the circuit can be switched off by applying enough voltage to the base of Q3 to pull Q2 base below the 0.55V required for it to remain in conduction.

Using a couple of small-signal transistors in this way produces a very sensitive thyristor, but it is prudent to include a couple of resistors in the base circuits (R1 and R2 in Fig. 2) to reduce the likelihood of inadvertent switch-on due to leakage currents.

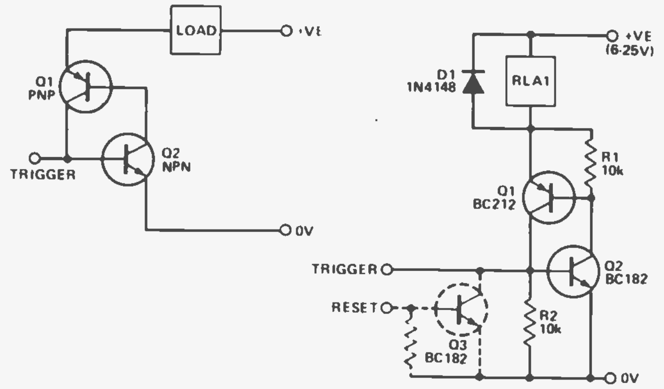


Fig.1 Two silicon transistors arranged as a thyristor and Fig. 2, a latching relay using the circuit.

Having devised this circuit layout, it was observed that the two transistors could be combined as shown in Figs. 3a and 3b, to give the four-layer PNPN device of Fig. 3c. The connections on this will normally be labelled cathode (K) and anode (A), by analogy with a thermionic rectifier diode, and the trigger electrode (Q2 base) will be labelled as the gate.

For the device to work, the product of the current gains of Q1 and Q2 should be greater than unity. Commercial devices of this kind tend to have fairly

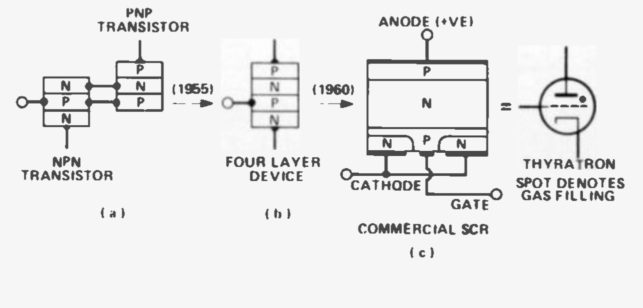


Fig. 3 The evolution of the Silicon Controlled Rectifier (or SCR) type of thyristor.

thick base regions, which allow for much higher working voltages and greatly reduce the likelihood of spurious triggering by very brief voltage spikes or the inevitable leakage currents.

The Silicon Controlled Rectifier

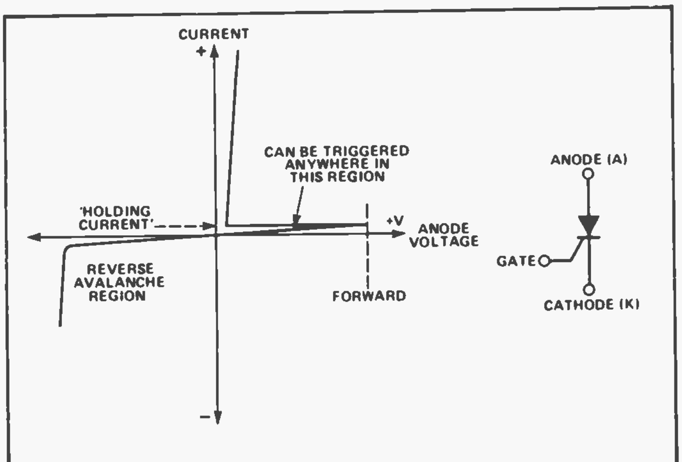
A number of names have been used for this device, of which the two most common are thyristor — by analogy with the thyratron valves which they have largely supplanted — and silicon controlled rectifier (SCR) which is a good description of the way it works. Typical characteristics for an SCR are shown in Fig. 4. The comparison with a rectifier explains the choice of circuit symbol, shown in Fig. 5. However, all of these four and five layer devices are correctly known as thyristors and the common SCR should strictly be called a reverse blocking triode thyristor — but people seldom do!

A thyristor will normally be open-circuit for potentials applied in either direction, but in the case of a forward voltage, a small trigger current injected into the gate will rapidly switch the device into its conducting mode. The forward voltage drop depends to some extent on the size of the device in relation to the amount of current passing through it, but it can be as low as about 1V.

The practical advantage of this kind of device is that massive amounts of current can be switched by the relatively brief application of a smallish trigger current to the gate. 500-1000 amperes can be controlled by a gate current of as little as 50mA. Most popular transistors only have current gains in the region of 5-25 at high collector currents, so for these to switch 1000 amps would require a pretty hefty base drive.

A further advantage of the SCR is that, because the internal current gain doesn't need to be very high for it to work, the junction layers can be fairly thick and not very heavily doped. This means that the maximum hold-off voltage can be very high — in excess of 5000V for some types.

However, there are snags. They are slow in operation, even the best of contemporary devices having practical frequency limits of only 15kHz or so, they can be triggered inadvertently by a too-rapid rise in the applied anode voltage, and they only conduct in



Figs. 4 & 5 The characteristics of an SCR and its symbol.

one direction. Bidirectional operation can be achieved by putting the SCR in the middle of a rectifier bridge, as shown in Fig. 6, but for lowish currents a simpler answer is to use a triac (or bi-directional triode thyristor, if you prefer its proper title). I will come to these later.

Another drawback is the need to maintain a holding current through the SCR once it has been triggered. As can be seen from the curve in Fig. 4, if the current through the SCR falls below this level at any time, conduction will cease until another trigger pulse is received at the gate.

A further problem is that, for current flows larger than the holding current level, the only way of turning the device off again is to momentarily reverse the potential applied to its anode. However, this does not bring about an instantaneous switch off because stored charge in the device will take some short time, ranging from a few microseconds up to a fraction of a millisecond, to disappear through recombination.

Unfortunately, most of the techniques used to increase the stand-off voltage capability or the maximum operating current will also make the devices slower in turn-off time. So high voltage or high power thyristors are likely to be more sluggish than their lower voltage or lower current brothers.

The problem of the device being turned on by a sudden increase in its anode voltage is almost inescapable and arises from the internal capacitance between the anode and the gate — a situation similar to the Miller capacitance in a transistor or valve. This internal capacitance does have one minor advantage, however, in that it allows the device to be turned off just a bit more easily if the rate at which the anode voltage is made to collapse is made high enough. This

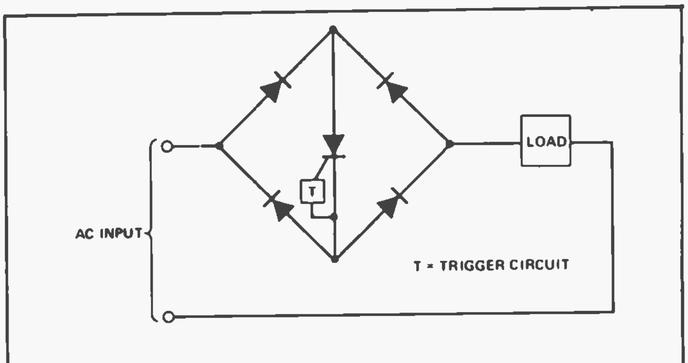


Fig. 6 An SCR connected for bidirectional operation.

is often employed in commercial usage where the devices are being used in a commutating mode. Here an external LC network can be used, in conjunction with another SCR, to suddenly reverse the anode potential and so turn off a conducting device.

SCRs In Use

The most common use of SCRs in industry is to convert DC Into AC, on a high power scale, by the use of circuitry such as I have shown in Fig. 7. The incoming AC is rectified and smoothed to produce DC which is then converted into variable-frequency AC for variable speed motor drive applications. For such a circuit to work reliably the inherent problems of the SCR must be accommodated.

In the particular case of the circuit of Fig. 7, it is imperative that SCR2 should not be turned on while

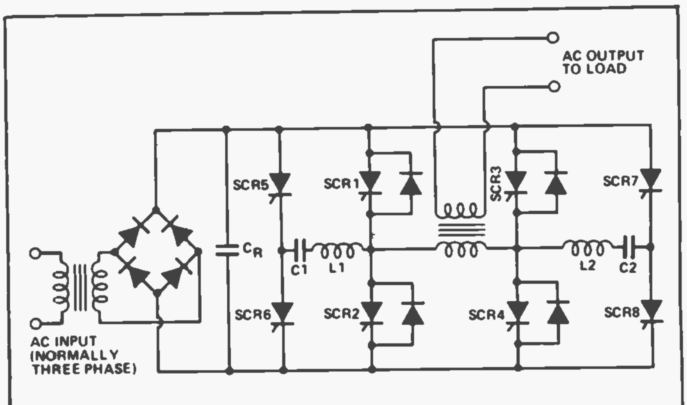


Fig. 7 A high power industrial AC-AC converter using SCRs. The trigger circuits have been omitted for clarity.

SCR1 is still conducting or fuses will blow. This depends partly on the correct operation of the triggering circuit — coupled to the SCRs in this instance by pulse transformers — and partly by the operation of the quench circuit (SCR5/6 and L1C1 or SCR7/8 and L2C2) which rapidly forces the main power SCRs into reversed polarity and turns them off.

A further use with which many electronics enthusiasts will be familiar is in the electronic ignition systems of cars or motorcycles.

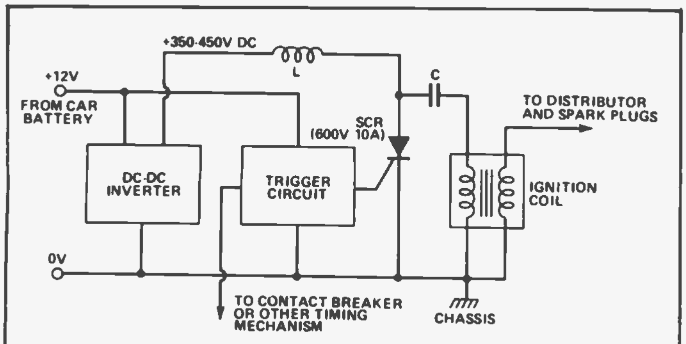


Fig. 8 The circuit of a typical transistorised car ignition system using an SCR.

Here, a transistorised DC inverter is used to generate a DC voltage in the region of 350-450V, which charges a capacitor, C, by way of the series inductor, L, and the primary of the ignition coil. At the correct point in the timing cycle, the thyristor is fired and becomes a very low resistance path which discharges the capacitor through the primary of the coil, producing the required high voltage on the secondary. The series inductor allows the capacitor to recharge more rapidly than a series resistor would.

Such systems offer much more consistent spark energy than the conventional high current and contact breaker arrangements, but can be a bit hard on the coil insulation if it is not designed for this application.

Diacs

For the proper operation of a thyristor, it is very important that the trigger pulse should be of adequate magnitude to turn it on fully and rapidly. If a slow or

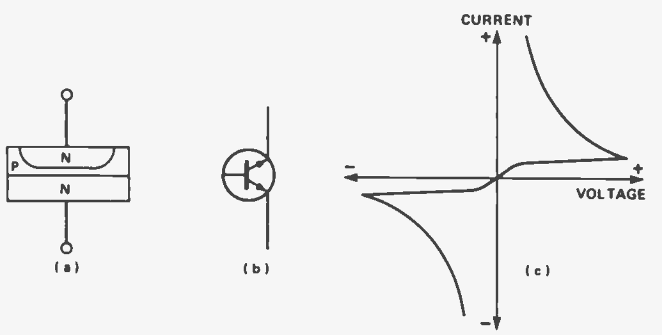


Fig. 9 A diac consisting of a pair of diode junctions formed on the same piece of P-type material.

low energy switch-on pulse is used, damage may sometimes occur to the thyristor because only that region of the thyristor chip immediately adjacent to the gate may be turned on, and the channeling of the discharge current through this limited region may cause overheating. Careful design of the thyristor chip to spread the turn-on region can help, but a better solution is to include a trigger device like a diac in the gate circuit.

These are two-terminal, bidirectional, trigger devices which are non-conducting until a certain input voltage threshold is exceeded, when they suddenly conduct. They are constructed by diffusing a pair of diode junctions, back-to-back, on the same P-type silicon slice, as shown in Fig. 9a. Their circuit symbol is shown in Fig. 9b and the current/voltage characteristics in Fig. 9c.

The doping and method of construction gives these diodes avalanche or zener characteristics, in which the reverse leakage occurs at a precisely chosen voltage level. This leakage current injects carriers into the P region, which then behaves as the base in an NPN transistor and allows current to flow at a reduced total device voltage, to inject a suddden pulse into the thyristor gate.

A rather superior type of device, also known as a diac, is, in effect a pair of parallel thyristors, chosen so that their breakdown voltage is only some 10-20V. This has the circuit symbol shown in Fig. 10a and the electrical characteristics shown in Fig. 10b.

Unfortunately, manufacturers do not always disclose the actual construction used, but the circuit of Fig 10c can be used to identify which device is which. If the voltage across the device in its on condi-

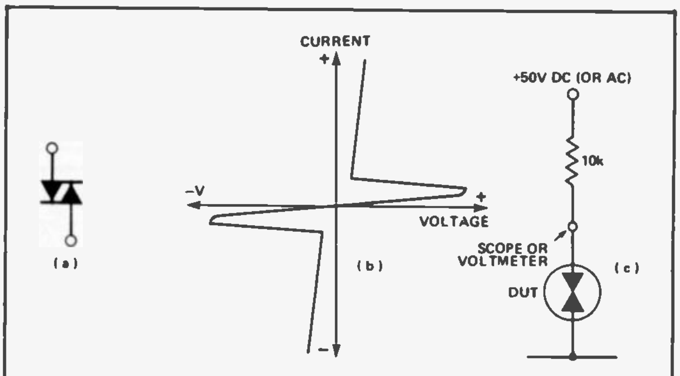


Fig. 10 An alternative method of constructing a diac using two parallel thyristors.

tion is only about 1V, it is of the type shown in Fig 10a. Better still, if the voltage source is 50V AC (50Hz) and an oscilloscope is connected across the device, it will draw the pictures of either Figs. 9c or 10b.

Triacs

These are a pair of four layer SCRs, one PNPN and one NPNP, which are combined together to make a five layer, NPNPN device which will work as an SCR in either direction. I have shown the arrangement in Fig. 11a and a typical device (a GE triac) in 11b. The circuit symbol used for this device is shown in Fig. 11c.

The voltage/current characteristic is of the kind shown in Fig. 10b, but with the difference that it can be caused to conduct or remain open-circuit depending on whether a trigger pulse is applied to the gate.

As it is an AC device there is no anode or cathode, so the contacts are described as main terminal 1

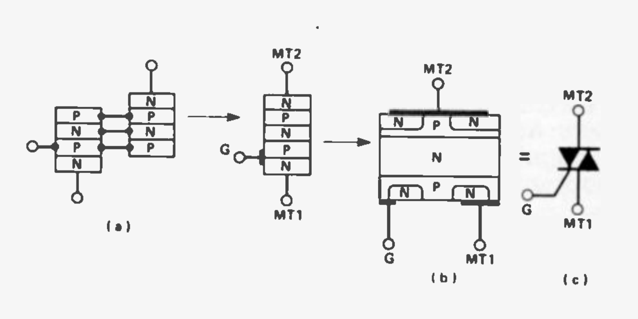


Fig. 11 The evolution of the triac.

(MT1) and main terminal 2 (MT2) to distinguish these connections from the gate. Apart from the requirement that the gate trigger voltage should be applied with respect to MT1, these devices are quite symmetrical in operation.

Because they are used on alternating voltage circuits in which the potential reverses every half cycle, they automatically reset after each conduction period. This allows power control by phase angle timing of the firing pulse, as I have shown in Fig. 12.

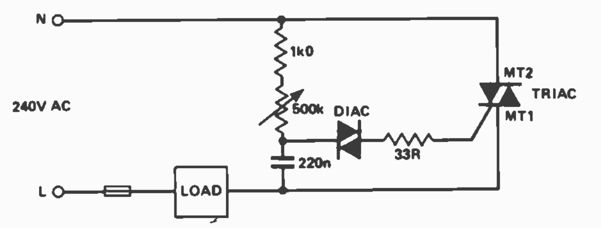


Fig. 12 A simple phase angle control lamp dimmer circuit using a triac.

This is a most useful type of circuit, and is much used for living-room lamp dimming and similar applications. It is also used in fade-dissolve circuits in photographic slide projection, though in these applications it is usual to employ more exotic firing circuits to allow prearranged rates of fade or operation from pre-recorded input tone signals.

Sadly, the triac is a rather less muscular device than its SCR relative, and is limited to perhaps 50A and 800-1200V. They also require a higher trigger

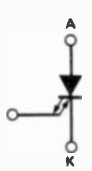


Fig. 13 The circuit symbol for a gate turn-off thyristor.

current than the unidirectional SCR. On the other hand, economies of scale in manufacture have allowed normal mains voltage units of up to, say, 25A, to be offered at 60-70p each.

The Gate Turn-off Thyristor

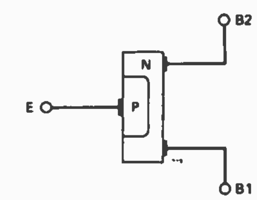
Also known as a GTO device, this is a recent development of the SCR which can be turned off by the application of a reverse bias to the gate trigger electrode. Although only some 10-50 mA may be needed to turn it on, perhaps a fifth of the total conducting current must be drawn out of the gate in order to turn it off again.

Nevertheless it is a useful device, and is rather faster in action than the typical SCR though at present less capable of handling high powers. The circuit symbol is shown in Fig. 13.

The Unijunction Transistor

This is a most useful little device which can be employed as a relaxation oscillator or pulse generator. Its construction takes the form which I have shown in Fig. 14, and it is sometimes described as a double base diode.

Fig. 14 The construction of a unijunction transistor.



The two bases are ohmic (non-rectifying) connections to a strip of fairly low conductivity N-type silicon, into which a P-type 'emitter' has been diffused. If a potential is applied between the bases, a small current will flow down the strip which is referred to as the leakage current. The potential-divider action of the silicon strip reverse biases the NP diode and prevents it conducting. This potential, related to the applied voltage across the strip, is known as the intrinsic stand-off ratio or ETA.

If the emitter voltage is raised so that it exceeds this potential by some 0.55V, the diode will conduct and inject carriers into the strip. These will be swept into the region of base 1, and cause the diode to

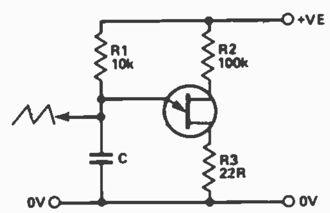


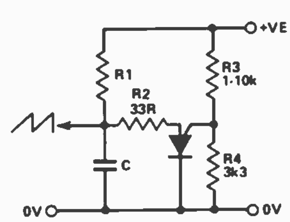
Fig. 15 A sawtooth generator circuit using a unijunction transistor.

become even more strongly forward biased. The emitter current therefore increases regeneratively until it is limited by the external resistance. This allows the construction of a very simple 'sawtooth' generator, of the form shown in Fig. 15.

Programmable Unijunction Transistor

This is a four-layer thyristor, with an anode gate, as distinct from the cathode gate of the normal SCR. If this is connected in the circuit shown in Fig. 16, the device will remain non-conducting until the voltage across C has risen sufficiently for the gate to be negative biased by one forward diode potential (about

Fig. 16 A sawtooth generator circuit using a programmable unijunction transistor or PUT.



0.55V), when it will suddenly conduct and discharge the capacitor. When the current flow falls below the holding value, the device will turn off and the charge cycle will begin again, as in the normal unijunction transistor circuit shown in Fig. 14.

However, the advantage of the PUT is that, as its name suggests, the trigger voltage can be programmed by the ratio chosen for R3 and R4. **ETI**

DATA ENCRYPTION

More and more people are finding it necessary to protect their data against unauthorised interference. Paul Chappell looks at the systems used and the theory behind them.

At the time of conjunction of Mercury and Venus , in the year of the great horned toad, there shall come to pass a dark time of computing from which not even the lowliest household in the land shall be excluded. The shadow of the computer will fall upon our central heating systems, income tax returns, the education of our children , verily it shall rule our lives, yea, even unto the sixth generation.

So quoth the sages a decade or so ago. As it turns out our central heating and tax returns remain pretty well inviolate and the only educational benefit seems to be in teaching children to program computers — rather like claiming that video recorders should be used in schools because they teach children to operate video recorders.

The latest prediction from the crystal ball gazers is that we shall shortly cease to write letters. The reasoning, such as it is, goes like this: the price of conveying bits of paper from one place to another is going up, the price of sending data by electronic means is going down, therefore we will soon abandon letters and use electronic mail. QED.

The most baffling thing is that when all this comes to pass we will, apparently, all be afflicted with a sudden passion for secrecy. Why on earth this paranoia will suddenly descend on us when, for the past century or thereabouts, we have been blithely sending letters that can be steamed open and talking on telephone lines that can be tapped, is beyond my powers of comprehension. Nevertheless, as the subject closest to our hearts will shortly be data encryption, ETI Cloak and Dagger Dept thought it was time to find out something about it.

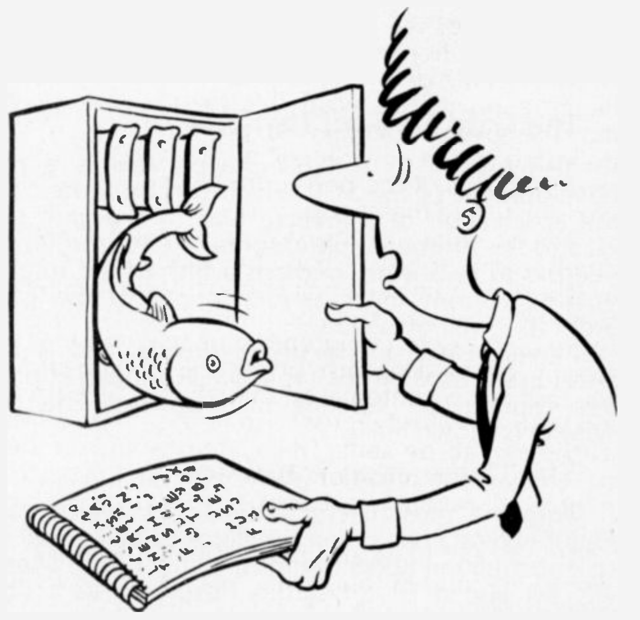
Codes And Ciphers

Codes and ciphers have been used throughout history to protect information. Julius Caesar is reputed to have used a simple shift cipher, well known to all schoolboys, in which the original message (*plaintext* in the jargon) is enciphered by replacing each letter with the next letter of the alphabet. This is a shift of one; the next-but-one letter would be a shift of two, and so on. Thus ETI would become FUJ, and very tasty it is too.

There is a difference between a code and a cipher, by the way. Suppose I agree with you that the word 'fusebox' means 'meet me outside the newsagent' and 'fish' means 'I've lost my copy of Electronics Digest'. To make use of this form of communication I might write you a letter and contrive, in the most natural way possible, to include a sentence like 'There is a fish in my fusebox'. You would instantly recognise this as meaning 'I have lost my copy of Electronics Digest so meet me outside the newsagent '.This is a code.

A cipher, on the other hand, is a general purpose method of substituting new symbols for those used to express the original message. The shift cipher is one example, morse code (morse cipher?) is another

Codes have the advantage of being impossible to break given only the coded message. As any word can quite legitimately be used to represent any other word or phrase, there is no way for anyone without extra information to get any leverage. The drawback of codes is that they can only be used to convey messages for which code words have previously been



arranged. If I wanted to say 'meet me outside the chip shop' there is no way to modify 'fusebox' to convey this new message.

Ciphers, with a few exceptions, can be cracked given sufficient time and computing power but have the advantage of being able to convey any message at all.

For electronic data communication we are concerned almost exclusively with information that can be represented in binary form. The preceeding discussion applies equally well to this; a code may involve agreeing that 010 will mean 1101011100, a cipher may say that every third '1' in the plaintext message is changed to '0' and every second '0' is changed to '1'. The general term for scrmabling a message is encryption, and unscrambling is called decryption. How is it done?

Requirements

Before leaping in to a description of current data encryption techniques, it would be as well to take a look at what we'd like them to do.

First of all, it goes without saying that we'd like the system to be secure — nobody should be able to make sense of any message they intercept, nor should they be able to inject their own message into the system and have it accepted as genuine. Oddly enough, it is not difficult to make a completely secure system if this is the only requirement.

Time after time, systems that were judged to be secure have been broken . . .

An example of such a system is the one-time pad. Both the sender and the receiver have identical lists (or pads) of random numbers. The encryption process proceeds in the same way as the shift cipher, except that the number of letters you shift by is taken from the number on the pad — a different shift for each letter. Each page of the pad is used once and then thrown away; hence the name.

This kind of system is *unconditionally secure* because no matter what information a cryptanalyst may be given — copies of plaintext messages and their encryption, anything at all short of a copy of the unused pages of the pad — he will be unable to decrypt any future messages.

The drawback of this system is that it is extremely cumbersome to use. A pad of numbers at least as long as the total number of characters in all the messages that are to be sent must be prepared and conveyed in some safe way to the intended recipient, and must be closely guarded against prying eyes. The encryption process can be automated but will not be easy to use because somebody must feed in the numbers as well as the text to be sent. The system is, in fact, in daily use for communication between governments and military commanders, but is not suitable for general use.

If we can't have an unconditionally secure system we must content ourselves with a *computationally secure* one. The idea is that, although the system can be broken with unlimited time and computing power, the effort and time involved would be so immense that it is for all practical purposes perfectly secure. Here we hit another little problem: how can we tell how much computation a cryptanalyst will be faced with?

I'll come back to this later on with reference to specific systems, but I should mention that it's not enough just to calculate the astronomic number of permutations that would have to be investigated on a trial and error basis. Time after time, systems that were judged to be secure in this way have been broken by the discovery of a mathematical pattern in the cipher that the designer was not aware of.

If a system is to gain wide acceptance it must be convenient to operate. From the user's point of view this means that the security aspect should be left as far as possible to the hardware. It should be possible to enter the message and have it conveyed safely to the intended recipient without having to take any further part in the encryption process or observe any special precautions. It may also be necessary to use the system to communicate with a number of different people, so standardisation of the hardware is essential.

Now, if the hardware is to be standard and readily available, any kind of encryption that involves performing some fixed process on the plaintext will not be secure. Transposing characters, substituting one symbol for another and similar procedures, however complicated, just won't do. Anyone intercepting the ciphertext can also buy the hardware and use it to obtain the original message.

The way around this is to standardise the hardware but allow it to be personalised by means of a key, in the form of a string of digits chosen by the user which controls the way the message is encrypted. The point is that anyone intercepting the message will also need to know the key to make any sense of it.

Finally, the possibility of adding a 'signature' to the message would be useful. It would allow the system to be used for transmitting contracts, for instance, and in general would allow verification that the sender is who he claims to be.

Now we know roughly what we'd like, let's see what's on offer.

Private Key Encryption

In this system the encryption algorithm is standardised and security depends on the use of a private key. The following example demonstrates how it works.

My algorithm is simple — modulo 2 addition. This is built into my encryption machine and I make no attempt to keep it secret. What I do keep secret is my key: 10010110. Let's suppose I want to send a message to the Editor explaining why this feature is a month late. The first thing I must do is to send him my key by courier (Jane, give this to Gary, will you? No, don't open it, it's secret!) Then I type in my message 'I overslept', whereupon my encryption machine generates the corresponding ASCII codes (ciphers?):-

1001001	0100000	1001111	1010110	1000101	......
I		O	V	E	......

My private key is added modulo 2 to each group of 8 bits:-

plaintext

10010010000010111100101101011010001..........

key

10010110100101101001011010010110100..........

ciphertext

00000100100111010101110111001100101..........

The editor's decrypting machine uses the same key and also applies modulo 2 addition to give the plaintext version of my message. Try it for yourself!

A more realistic system would involve using a much longer key. The key itself would not be added to the message but would be used to generate pseudo-random sequences of bits to be added.

This type of cipher is known as a ***stream cipher*** because it operates on each bit of the data stream individually. Another type that is widely used is the ***block cipher*** where chunks of data, or even the entire message, are altered as a whole by a combinatorial process controlled by the key. As the public key system described a little later uses this method I won't say anything more about it for the moment.

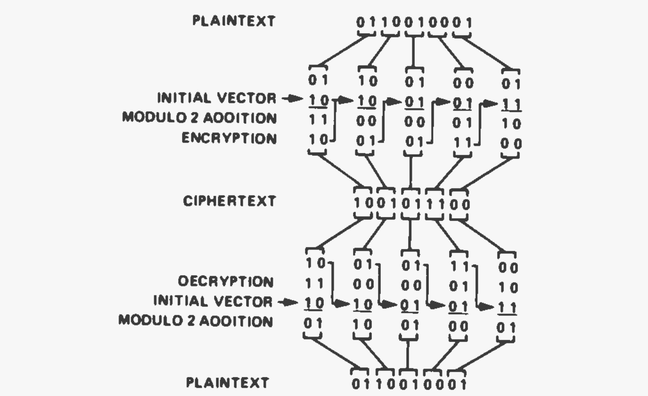


Table 1 An example of data encryption using the Chain Block system.

By far the most common private key system is DES, the Data Encryption Standard adopted in 1977 by the American National Bureau of Standards. The key used in this system is 56 bits long. ICs incorporating the DES algorithm are available from a number of manufacturers and a detailed description of the Intel 8294 is given further on in this article.

The Data Encryption Standard

A DES IC will operate on a 64-bit input block to produce a ciphertext block of the same length. The easiest way to use one is to split the plaintext message into 64-bit blocks and encrypt each block individually. This is known as an Electronic Code Book implementation. It is suitable for use with data to be stored on disk which would be dealt with in blocks anyway. For general purposes, however, it violates a golden rule of security; never encrypt data in the same way twice as this makes the system easier to break.

With a little extra hardware a Chain Block system can be made. The first data block of 64 bits is added modulo 2 to an Initial Vector, which is just an impressive name for a 64-bit long string of 1's and 0's. The vector for the first block to be encrypted will probably be supplied by the hardware — the person who is to receive the message must also have the vector. The result of the modulo 2 addition is then encrypted by the DES algorithm .

When the next block of 64 bits is read in, it is added modulo 2 to the encrypted version of the previous block and the result is then processed by the DES algorithm. The encrypted version of each block thus becomes an initial vector for the subsequent block.

An example will make the process a little clearer. For this we will use the ETI miniDES algorithm which, in the form of a look-up table, goes like this:

Input	Key=0 Output	Key=1 Output
00	01	10
01	11	00
10	00	11
11	10	01

You will see that miniDES operates on two bit data blocks and has a single bit key. For the purposes of the example we'll assume that a key of 0 has been chosen, so it's the first two columns of the table we're concerned with.

Let's suppose our plaintext data is 0110010001. The Electronic Code Book encryption of this will be 1100110111. Notice that whenever the plaintext block 01 is enciphered, it always results in 11.

Now we'll chose an initial vector for the Chain Block system, let's say 10. The encryption process will now proceed as shown in Table 1.

Notice that the plaintext block 01 is encrypted a different way on each occurrence: first as 10, then 01 and finally 00. Another feature of this arrangement is that errors in any block will carry through into all subsequent blocks (perhaps not in this simplified system, but they certianly do with the real DES algorithm). This prevents any tampering with the encrypted message. For instance if someone attempts to alter 'delete file 14' to 'delete file 15', the entire message will be corrupted.

Other possible implementations are Cipher Feedback and Output Feedback. Output Feedback in effect uses DES as a random number generator for a stream cipher. Cipher Feedback is similar, but the random numbers generated are 8-bits long and are added modulo 2 to 8-bit blocks from computer peripherals, etc.

Public Key Encryption

The main drawback of the private key system is the inconvenience of having to distribute the key to everyone you wish to communicate with. As the key should be changed from time to time, ideally after each message, and as multiple encryption with different keys is often used for additional security, the question of key distribution can become quite a headache.

Just imagine that a system could be developed which would allow any user to send this key quite openly to another, or even publish it in a public directory. It seems impossible at first sight — armed with your key and the method you've used to encrypt your data, even an amateur should be able to decipher any messages you send! Surprisingly enough, it is possible. The theoretical method was published in the mid '70s and the basis of a practical implementation shortly afterwards. The process described here is the Rivest-Shamir-Aldeman system, named after its inventors.

The basis of the system is a mathematical trick known as a *one-way function*. Many arithmetic processes are more difficult to perform in one direction than the other. For instance, it is generally more difficult to find square roots than it is to find the square of a number. For some mathematical functions the difficulty of reversing them is so immense as to be virtually impossible, or at least infeasible given the current state of computing power and mathematical theory. These functions can form the basis of a public key encryption process.

Imagine for a moment that you are a cryptanalyst in the pay of Universal Generality Inc (UGI to their friends) and you have just intercepted a message intended for International Monolithic Co (IMC). The message is the encrypted form of a single ASCII character and looks like this: 0110010

From a public directory, you obtain IMC's encrypting keys which are: a)5 and b)221.

You also know that IMC use a standard form of encryption which is: raise the message to the power of the first key, 5, and express the answer modulo the second key (mod. 221). The result is the encrypted message:

Can you decipher it?

It seems as if you have plenty to work with — you know how the encrypted message was produced from the plaintext and you also know the keys used to generate it. Surely you can just reverse the process to get back to the original message?

For some mathematical functions the difficulty of reversing them is so immense as to be virtually impossible . . .

A little experiment will quickly convince you that this is indeed a one-way function; you can't go back by the same route that you took on the way out. But where does that leave IMC? Surely they can't get the plaintext message back either? Here we have the essence of the Public Key system: yes, IMC can recover the message because there is a *trapdoor* in the encryption process which allows them to go back by a different route. IMC can use this trapdoor because they have the deciphering key, UGI can't because they haven't.

As an expert cryptanalyst you will have even more information at your disposal than I have already given you. You will know how IMCs secret key can be generated! IMCs second public key is the product of two prime numbers, 'p' and 'q'. These were selected at random by IMC when they were first setting up the system. The product of the primes (221) is published, but the primes themselves are known only to IMC.

The secret key was generated as follows: one was subtracted from each of the primes 'p' and 'q' and another number 'r' was formed by multiplying together the results, so r = (p−1) x (q−1). The secret key 's' was then formed by taking the multiplicative inverse modulo r of the first public key (5), in other words a number s was found such that s<r and s x 5 = 1 modulo r. Decryption is then carried out in the same way as the encryption process, with the secret key substituted for the first public key.

Your main task as cryptanalyst to UGI is to factorise IMCs second public key. If you can do this, you will be able to generate their private key and decipher their message. In this case it is not difficult, but suppose the second public key had been 6533431. Can you find the factors of this? (It can be factorised!).

Finding primes and testing for primality is a fairly fast process — to test a 130 digit number for primality would take a matter of minutes on an average minicomputer. On the other hand, to find the prime factors of a 130 digit composite formed by multiplying together two 65-digit primes would take quadrillions of years with the fastest computers and most efficient factorisation algorithms available today. It is this vast difference in computing times that allows the system to be set up, yet makes it infeasible to break.

Before getting too carried away by big numbers, it's worth remembering that a public key system devised by mathematicians at Stanford University in the USA, using a different process, has already been broken — and that was just for a $100 bet. If anyone can find a factorisation algorithm that will operate in a time comparable with finding primes the system will be useless — it would take as long to set up as it would to break.

Odds And Ends

There are many more facets to data encryption than it has been possible to mention here. If you are intrigued by the subject and would like to read more, the papers listed below will interest you. Martin Gardner goes into a little more detail about public key encryption and also explains how it offers the possibility of 'signing' messages. Diffie and Hellman describe public and private key systems, public key distribution systems, and have a good deal to say about encryption in general. This one may be a bit heavy going but the ideas are not complicated and there's plenty of interesting detail. Finally, Rivest, Shamir and Adleman explain the mathematical basis of their public key system, suggest ways of finding large primes and give an algorithm for encrypting and decrypting efficiently. The paper is very readable and the maths is not at all complicated.

The way to get hold of these papers is to copy out the details below, take them along to your local lending library and ask them to get copies for you. It will probably take a week or so as they will amost certainly have to send away for them, and there will be a charge for the photocopying.

Last of all, a quote from the paper by Diffie and Hellman. "Skill in production cryptanalysis has always been heavily on the side of the professionals, but innovation, particularly in the design of new types of cryptographic systems, has come primarily from the amateurs." So get your thinking caps on, folks.

Further Reading

M. Gardner "Mathematical Games". *Scientific American*, 237(2), Aug 1977, 120-124.

W. Diffie and M. Hellman "New directions in Cryptography". *IEEE Transactions on Information Theory*, IT-22(6), Nov 1976, 644-654.

R. L. Rivest, A. Shamir and L. Aldeman. "A Method for Obtaining Digital Signatures and Public Key Cryptosystems". *Communications of the ACM*, 21(2), Feb 1978, 120-126.

Intel 8294 Da

In this article-within-an-article, Brian McArdle describes an IC which can be used as the basis of a US standard data encryption system.

The Intel 8294 Data Encryption Unit is a 40 pin integrated circuit which implements the US Data Encryption Standard (DES). The standard was selected by the Federal Bureau of Standards in 1977 to safeguard computer data and must be implemented in hardware to avoid modifications by users.

The standard uses an algorithm to encrypt a plaintext block of 64 bits under the control of a key block of 56 bits to generate a ciphertext block of 64 bits. The same key block must be used to decrypt the ciphertext block and recover the plaintext block. The purpose of the key is to vary the encryption/decryption operation.

A user can choose from 2^{56} possible keys. The designers of the standard estimated that a computer that could make a search of the possible keys in approximately one day would not be available before 2000 AD. This now seems unlikely but for the present the standard is cryptographically secure.

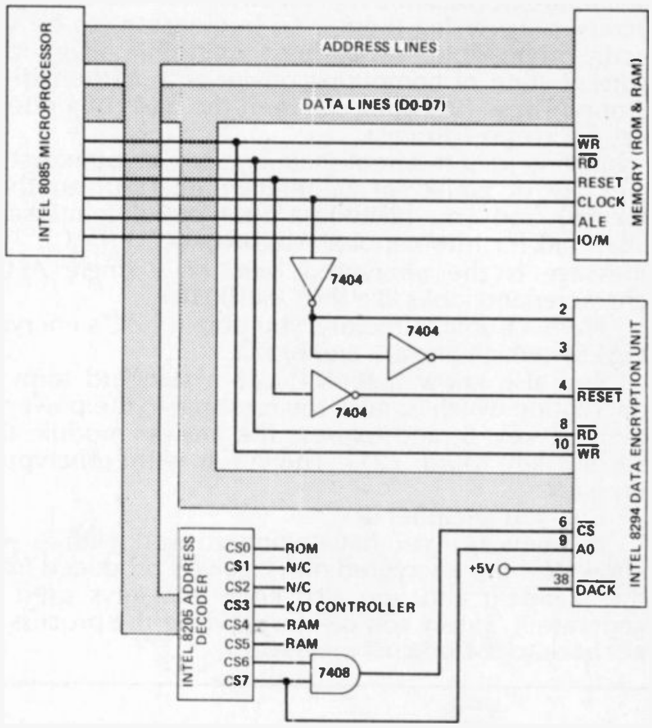


Fig. 1 The 8294 Data Encryption Unit connected to an 8085 microprocessor.

Organisation

The 8294 device has 4 main registers:

(1) Data Input Buffer: data written into this register can be part of a key, data to be encrypted/decrypted or a DMA block count depending on the previous command.

(2) Data Output Buffer: data read from this register is the output of the encryption/decryption operation.

(3) Command Input Buffer: the commands to the device are written into this register.

(4) Status Output Buffer: the status of the device is available in this register at all times. The functions of the various bits are

7	6	5	4	3	2	2	0
x	x	x	KPE	CF	DEC	IBF	OBF

OBF=1 indicates that the output from the encryption/decryption operation is available in the Data Output Buffer. IBF=0 indicates that data can be written into the Data Input Buffer or commands into the Command Input Buffer. DEC=0 implies the encryption mode. DEC=1 implies the decrypt mode. CF=0 indicates the end of an eight byte transfer. KPE=0 indicates that the eight key bytes have the correct parity(odd).

The four registers are accessed as follows:

$\overline{RD}$	$\overline{WR}$	$\overline{CS}$	A0	Register
1	0	0	0	Data Input Buffer
0	1	0	0	Data Output Buffer
1	0	0	1	Command Input Buffer
0	1	0	1	Status Output Buffer

where 0 and 1 correspond to +5V and 0V respectively(active low).

An interfacing arrangement for an Intel 8085 microprocessor in an SDK-8085 kit is illustrated in Fig. 1. The

ta Encryption Unit

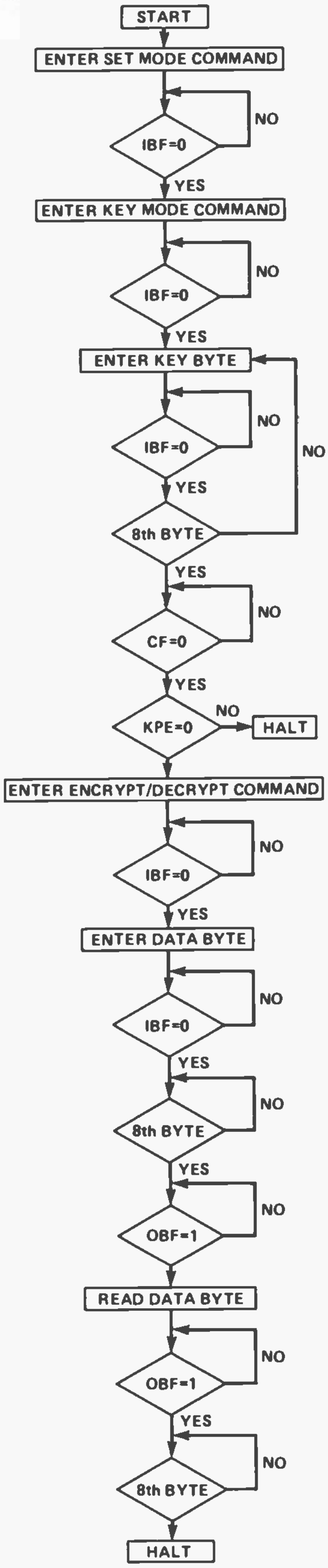


Fig. 2 A data conversion sequence for the circuit shown in Fig. 1.

kit has two unused chip select outputs at addresses $3000 and $3800. CS6=0 (address $3000) gives CS=0 and A0=1. CS7=0 (address $3800) gives CS=0 and A0=0. The Data Lines D0 to D7 are connected to the system's data bus. The MR, Clock, WE and RE inputs are connected to the corresponding outputs on the microprocessor.

Operation

The data conversion sequence is as follows:
(1) a set mode command is given by writing $0D into the Command Input Buffer;
(2) an enter key command is given by writing $40 into the Command Input Buffer;
(3) a key block is entered as eight bytes into the Data Input Buffer and each byte must have odd parity (the key blocks consists of 56 bits and the eight redundant bits are used as parity bits);
(4) an encrypt command is given by writing $30 into the command Input Buffer or, alternatively, a decrypt command is given by writing $20 into Command Input Buffer;
(5) a data block is entered as eight bytes into the Data Input Buffer;
(6) an encrypted/decrypted block is read as eight bytes from the Data Output Block.
The flow chart in Fig. 2 illustrates the procedure for the example in Fig. 1.

The program is written in machine code and is stored in locations $2000 to $2083. The key bytes are stored in locations $2084 to $208B and the data bytes are stored in locations $208C to $2093. In the example K=[A1,B0,C1,D0,E0,F1,A1,B0] and P=[11,22,33,44,55, 66,77,88]. After execution of the program the ciphertext block C=[B8,9F,F5,92,BE,53,05,26] has replaced the plaintext block. Successive plaintext blocks can be encrypted in this manner. The decryption operation is executed by placing $20 in location $2042.

Conclusions

The Intel 8294 Data Encryption Unit can be used to construct an inexpensive and secure cryptosystem. The encryption/decryption operation happens entirely within the device which is controlled by the microprocesor. However these operations would be simplified considerably for an operator by using an advanced microprocessor kit or microcomputer which would permit the key and data blocks to be entered during execution of the program.

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"Data Encryption Standard", *FIPS PUB 46,* National Bureau of Standards, Washington DC, USA (1977).
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ETI

THE SECOND LINE OF DEFENCE

Summer's here and the time is right for breaking into houses — or so Vivian Capel thinks. He lets us intrude on his thoughts in this prelude to a simple but ingenious project.

Any alarm system should only be considered a second line of defence. The best investment you could make is on good strong doors and windows and on the locks to go with them. Once your premises are as a physically secure as you can make them, you can start thinking about an alarm system to detect and deter intruders.

Some Alarming Thoughts

It is sometimes said that an alarm is of little use because no-one takes any notice when it goes off anyway. The main purpose of an alarm, however, is not to summon aid — although that is desirable — but to deter the thief. The very presence of a bell can be a deterrent, and many intending burglars will give a house with an alarm system in evidence a wide berth. Even if no-one comes running, an alarm attracts attention and that is the last thing the burglar wants, with its attendant risk of future identification.

If a thief should attempt an entry, either disbelieving or not noticing the bell box, a sounding bell will almost certainly scare them off. Burglars are usually scared and jumpy, especially when first entering. If a loud bell suddenly starts ringing, their overwhelming reaction is panic and to get out quickly. This is what you want: forget about catching the thief, it is more important to protect your property.

Many alarm systems have inherent reliability problems — which can render them useless. For example, all electronic components have a specified failure rate of so many items per thousand, set against time of use. There is a British Standard covering this (BS 4200). Active components, ICs and transistors are less reliable than passive ones. Yet many alarm circuits fairly bristle with ICs. But a circuit that does all required of it can be produced with very few active components, and so with greater reliability. Next month's project is an example.

It's estimated that 99% of alarms in the London area in which the police are called are false. False alarms clearly diminish the credibility of genuine ones and in addition can easily disturb neighbours.

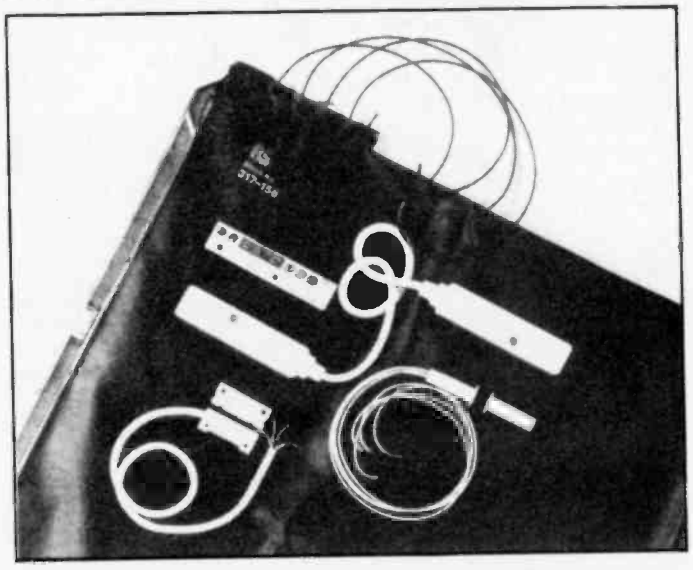
Many system designers are so intent on ensuring that nothing gets past their sensors that their systems become too sensitive and prone to false alarms. The choice of sensor is important, since some types have an inherent false alarm liability.

Powering arrangements are also important. The current requirement of many systems make mains power necessary. This means that battery back-up must also be provided with automatic switch-over in the event of a mains failure. Most likely any mains supply interruption will be short and well within the capacity of the battery to cover, but not necessarily. A 48-hour capacity is common, but what happens if a circuit-breaker trips while you are on holiday? Fridges, deep-freezes, door bells, video recorders and more are all often left connected to the mains in their owners' absence. A trip-out at the start of a fortnight away could leave the premises unprotected for most of that time.

Some systems use so little current that they can be run permanently on batteries, avoiding the risks of mains failure or malfunction of the automatic switch-over circuit, but limiting the power available to the alarm bell itself.

When the alarm is triggered, it should scare off the intruder and, possibly, alert neighbours and police within ten minutes or less. There is no point in the alarm continuing for a protracted period. This only creates annoyance and, in a battery system, drains the power source. The bell itself could be mains powered but many systems now include a timing device to limit the sounding of the alarm.

Some timers completely de-activate the system — which means that, if the intruder returns later, there is no alarm. One of the tricks of the professional burglar is to try to set off the alarm without any visible signs of



Alarm kit showing (clockwise from bottom right) surface mounting proximity switch (reed plus magnet), flexible tamper-proof jumper lead for bridging doors and windows (in two parts) and flush mounting proximity switch — all sitting on an undercarpet pressure mat.

attempted entry. Either the system switches off after 20 minutes or so, or the owner concludes that there has been a false alarm due to a fault, and so switches the system off until it can be checked. Then the burglar comes back and tries to set the alarm off again. If it doesn't function, the burglar can enter in safety. If it does go off, the owner may well feel certain there is a fault and switch the. system off. This ploy is commonly used on industrial premises where the manager has to be hauled out of bed from home and is only too ready to switch off to prevent a re-occurrence of an assumed false alarm.

Some timers avoid this problem by resetting so that any futher intrusion will again initiate an alarm. Obviously, this is a desirable feature.

Tamper protection is provided on some systems with a microswitch under the cover of the control or bell box. Any attempt to remove the cover sets off the alarm whether switched on or not. This is a necessary feature on industrial or business premises where the system could be easily nobbled during the day in preparation for a nightime visit.

With a domestic system it is really superfluous. Most visitors to your home are people you know or can check up on, and most systems have a test facility which would reveal any fault on switching on. There is no point in such protection at night or when you are away as the intruder would set the alarm off in getting in, before laying hands on the control box.

The same applies to self-actuating bells. These have internal batteries which power the bell if the cable from the control box is cut. While a prudent protection for industrial premises, it is unnecessary for domestic ones. The bell should be mounted in an inaccessible place and the cables passed through the wall to the back of the bell. In fact, there is a major disadvantage with self-actuating bells because the battery has to be renewed and tested from time to time, which involves climbing up to it.

Isabelle . . .

Sirens can give a higher sound output than bells, but current is usually higher, from half-an-amp upward for a motor type siren against 80-100 mA for some bells. Such a siren may need mains power, although there are some electronic sirens that give a healthy output at only 20mA.

The sound output of some devices is given at 1m distance, with others at 3m. As sound pressure levels decrease in proportion to distance from the source, a 3m figure should be a third of a 1m one for the same source, or 10 dB less. So simply subtract 10dB from a 1m specification to give the level at 3m.

These days there are so many sirens in general use on the roads that one used for a house security system could easily be lost. While individual preference may be exercised, this is a strong argument in favour of the bell.

Some bells are completely weatherproof and, in the case of underdome units, are very difficult to silence by physical attack. The centre dome screw usually needs a special tool to remove it, and there is little reason to house the bell in a box which will only reduce the sound. A box can also be filled with foam or other substance to effectively silence the bell, so an open bell, mounted well beyond access, can be less vulnerable than a boxed one. It also shows that you really have an alarm system and not just a dummy box.

The bell is usually mounted at the front of the house where it can be seen, but more illegal entries are made at the rear. There is a strong case for having two bells at the front and rear, or for having one inside the house. If fitted high in a stair well, an interior bell can make a terrifying noise. Two bells also give a margin of safety in case one should be defective. It is far better to spend money on two bells than to surround the first with a tamper-proof box.

Space Saving

The traditional alarm system with wiring all over the house to door and window contacts looks outdated. Ultrasonic, microwave or infra-red devices seem more attractive and less trouble to instal, but appearances may deceive!

Ultrasonic devices use the Doppler effect at sound frequencies from around 23-40 kHz. The microphone is usually housed in the same unit as the generator and receives direct sound and reflected sound from the room (Fig. 1). If anything moves in the protected area, the reflected frequency changes due to the Doppler effect. When mixed with the direct sound, a beat note is produced which is separated by a low-pass filter in the receiver, amplified, and used to trigger an alarm circuit.

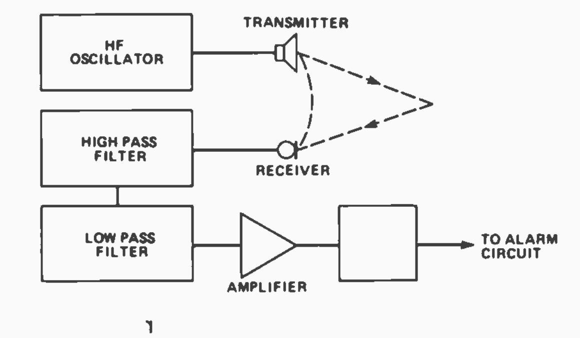


Fig. 1 Block diagram of ultrasonic detector.

Because it protects the space rather than the perimeter, the device is known as a volumetric sensor. You really need one alarm for each room, especially since the targets of burglary may be cash and jewellery found in a bedroom as easily as the living room or video hi-fi. Current requirement is 50-100 mA, so mains power is needed.

Ultrasonic alarms are extremely sensitive and virtually foolproof, which is also their main snag. They will respond to air turbulence caused by draughts, convected air from radiators, down-draughts from windows, or to the movement of curtains, pets — and even mice.

Some of the more elaborate ultrasonic alarms employ circuitry to recognise certain patterns made by turbulence and ignore them. But there is still a high probability of false alarms — they have even been known to respond to high-pitched external sounds such as brakes squealing.

Microwave detectors are also volumetric. They operate typically at 10.7 GHz, though other frequences are also used. The principle is similar to that of the ultrasonic sensor, utilizing the doppler effect, but current is greater at 150-250 mA.

Microwaves are not affected by air movement but they can travel through windows, doors, and even walls. Movement outside or neighbours on the other side of a party wall can set off the alarm. Sensitivity can be adjusted, but careful setting is required to get it right.

One unit is usually needed for each room although adjacent rooms could be covered with a high sensitivity setting. Deflector plates can be fitted to give a variety of polar patterns which is useful for awkwardly shaped areas, especially in industrial locations. Some microwave systems use the beam-breaking method rather than the doppler shift, but these are more suitable for outdoor perimeter protection.

Infra-red devices can be either active or passive. Active ones generate a beam across a protected area or along a perimeter to a receiver. The beam can be made to criss-cross the area or go around corners by means of reflectors. A receiver detects the beam and triggers the alarm if it is interrupted. The beam is modulated with a frequency of around 200 Hz, so that the system cannot be defeated by shining an infra-red lamp into the receiver. If the frequency is absent, the alarm is triggered. These systems are not very prone to false alarms and are commonly used for industrial protection.

Passive detectors are comparatively new. They are sensitive to the infra-red radiated from a human body, distinguishing between a body and sources like heating appliances or light bulbs by only responding to movement. The sensor has a curved reflector behind it, broken up into facets so that the polar response in front consists of a number of lobes with gaps in between (Fig. 2). Any source moving across the lobes produces a series of pulses in the detector, while stationary sources give rise to a steady signal. The alarm circuitry responds only to pulses.

A 90° total spread enables a corner-mounted sensor to cover the whole area of a room with a range up to 40 ft. (some models with a narrower polar response extend this to 160 ft.). Current requirement varies between 15-30 mA which is still rather high to be sustained solely by batteries, but a battery back-up to a mains unit should give reasonable emergency protection.

Passive IR detectors are undoubtedly the best volumetric sensors. They are much less prone to false alarms than the others, although pets can be a problem. You still need one for each area to be protected, and the control circuitry is often very sensitive.

Around the Houses

The conventional method of fitting contacts to vulnerable doors and windows protects the perimeter of an area rather than the space inside. If properly installed, with safeguards built in to the control unit, perimeter systems should give no false alarms other than those caused by forgetting to switch off!

The main disadvantage is the time and trouble taken in installation. Once installed, a simple perimeter system has more practical advantages than most exotic volumetric systems.

A variety of sensors can be used, but the simplest types employ a closed loop connecting a number of contacts in series. Reed switches are often used, the contacts fitted to the frame and the magnet in a matching housing to the door or window. Reeds have several advantages over microswitches or contact plates. There is no physical contact, and the magnet influences the contacts even when there are quite wide gaps between frame and door. Usually, the door

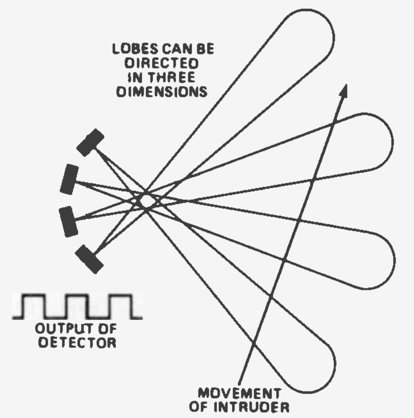


Fig. 2 Response lobes of infra-red detector. There can be as many as 15 lobes to each detector.

or window can open about an inch before the contacts switch, so rattling and vibration are no problem. Mechanical failure is rare. Contacts and magnets can be either flush or surface mounted, security and neatness being traded against convenience.

Conductive aluminium-foil tape can be applied to windows or other glass areas and included in the loop. Blocks are available for connecting foil to wiring.

More elaborate devices include vibration detectors for glass, so that blows or forcing will be detected even if no breakage occurs. Then there are acoustic detectors which sense the sound of forced entry such as breaking glass. These have a limited frequency response, usually between 6-8 kHz and are not very sensitive to other sounds. Some of them are small and light enough to be fixed to glass directly. Inertia sensors can be used to detect movement on fences and gates that would be difficult to protect otherwise. Such sophisticated sensors have specialized applications, and are not necessary in domestic systems.

One kind of sensor is both useful and cheap — and that is the pressure mat. Two metal foil sheets are separated by a layer of sponge-plastic with a large number of small holes. Pressure compresses the plastic allowing the two foils to make contact through the holes. Unlike door and window contacts, these are normally open-circuit and are not connected in the loop. But most control units will be able to use them.

The pressure required to make contact is rarely quoted by manufacturers and will certainly vary from make to make. A typical sample operated at 2.5-3 lb per square inch. The weight of a rug or carpet under which they are usually placed would not affect them, nor would a small animal be detected. It is easy enough to make your own pressure pads and they are extremely useful supplements to door and window sensors.

The beauty of a perimeter system using a simple loop and pressure mats is that it affords maximum protection and reliability for the minimum investment and complexity. Instead of sophisticated, expensive and error-prone sensors and control circuits, a handful of transistors and associated componets, along with some simple switches and pressure-pads, are all that's required. Next month, we feature an alarm circuit that could be built and installed in an evening, providing all the features of an elaborate microprocessor-controlled system at a fraction of the cost, guaranteeing trouble-free operation and frustration-proof protection.

ETI

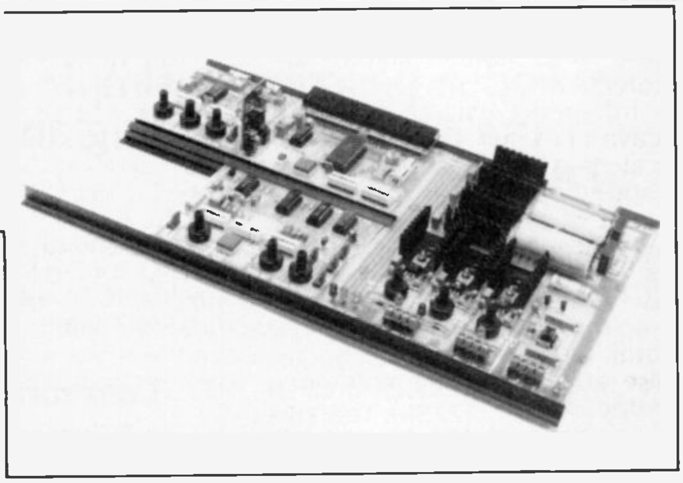
NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

Modular Test Gear To Build

We introduce a short series giving designs for a power supply, pulse generator, waveform generator, counter-timer and logic probe (not shown). Really useful test equipment you can build yourself for very little outlay. Perfect for the small lab or workshop.



Sunrise Light Brightener

As autumn begins to shorten the days, this ingenious project will allow you to waken easily with a gently brightening bedside light as your alarm. Using phase control and triac switching, the brightener can be preset or operated manually to turn on large loads (photofloods, for example) slowly. A controllable rate of voltage increase requires only a simple modification.

Automatic Test Equipment

ATE is not new, by any means, but it is an increasingly important area of research and development. The latest generation of ATE reflects the changes that are taking place daily in electronics and will also help to bring about more and more profound changes. We throw some much needed light on this complex topic in order to guide you round the maze of sophisticated fault-finding, functional testing and in-circuit testing.

Electron Plus-N

The Acorn Electron is a cheap computer which can be easily upgraded into a very useful machine. We publish a project designed to avoid the cost of buying commercial upgrade units — an interface unit with all the facilities built-in. With apologies to Acorn, we've called it the Plus-N, because it includes so many more features than the shop-bought Plus-One and Plus-Three. Interfacing the Electron is now only a question of how much imagination you can muster.

SAW — Came and Conquered?

From time to time we'll be dealing at length with new developments in component technology. To kick off, we listen to the latest sounds on the electronics hit parade. Surface Acoustics Wave devices use sound waves themselves to undertake complex filtering tasks — a radical departure from traditional electronic technology. Are they here to stay, or are they just a lot of noise?

Digital Sound Samplers

A review of some samplers within the reach of the individual purse is rounded off by an ETI project to build your own to be used in conjunction with a home micro. Until recently, sound samplers were extremely expensive and only available in the context of professional recording studios. But this exciting recording, synthesis and sound treatment technique is now within your reach. And while our sampler will be cheap to build, it will include features usually found only on pricey equipment. Compression-expansion, filtering, anti-aliasing and more.

PLUS:
Reviews, News, Comment, Tech Tips etc.

ALL THIS AND MORE IN THE OCTOBER ISSUE OF ETI. ON SALE SEPTEMBER 6TH.

Articles described here are at an advanced stage of preparation. However, circumstances beyound our control may dictate changes to the list of contents.

SPECTROM EPROM CARD

Peter Foden describes a simple technique for improving your Spectrum's memory — plug an EPROM into the beast, but first read this.

This project consists of a board that can be plugged into the rear expansion socket of the spectrum. It disables the top 32K of RAM and frees the area for an EPROM with a size of 2Kx8 up to 32Kx8 (2716 to 27256). The lower 16K RAM is left intact for use with disassembler programs or BASIC programs that can call the EPROM routines.

The board is simple in design and uses the minimum amount of components required to interface an EPROM to the Spectrum data/address bus. By a simple modification to the Spectrum's 32K RAM section a RAM chip-select line is provided, enabling the EPROM-board to function.

The Problem

One of the problems of trying to add an EPROM card to the Spectrum is the fact that all memory locations from 0 to 65535 (FFFFh) are completely accounted for: 0 to 16383 (3FFFh) for the ROM; 16384 (4000h) to 32767 (7FFFh) for the video and RAM; and 32768 (8000h) to 65535 (FFFFh) is occupied by the 32K RAM on an expanded 48K Spectrum. In the ZX81, Sinclair provides an $\overline{\text{RAMCS}}$ line as well as a $\overline{\text{ROMCS}}$ line (RAM and ROM chip select) in the Spectrum this was not carried over.

It is a simple matter to modify a 48K Spectrum to have a RAMCS line — at least, it is with Issue 2 machines onwards. The track between IC24 pin 8 and IC23 pin 10 is cut and a resistor of 2K7 inserted across the break. The unused edge connector position at 4A (between the keyway and D7) is then connected to pin 10 of IC 23. ICs23 and 24 are marked on the PCB, just next to the Z80. The track to be cut leads from IC24 pin 8 *on the component side* of the board and disappears under IC23. IC23 is a 74LS32 quad OR-gate, while IC24 is a 74LS00 quad NAND gate.

Construction And Use

A PCB overlay can be seen in Fig. 2, showing the three active components: an EPROM (IC2), the decoding chip IC1 and the diode D1. The EPROM is plugged into a 28-pin DIL IC socket and care must be taken when inserting and removing it. If you are feeling rich use a ZIF socket. By means of the links on-board any 2716, 2732, 2764, 27128 or 27256 EPROM (or equivalent) can be plugged in. The links are shown in Fig. 3 and can, of course, be replaced by suitable switches. The PCB consists of a double sided board, but since the circuit is simple, it could be built on Veroboard. However, this would complicate connection to the Spectrum. This can best be done by soldering the leads of a 28-way double-sided edge connector directly onto the PCB, as shown in the photograph.

Because of the minimal address decoding, if a 2716 is plugged into the EPROM card, echoes of the 2K bytes used are produced throughout the memory-map. Similarly for the 2732, 2764 and 27128, at 4K, 8K and 16K intervals respectively. Only a 27256 uses the whole 32K available.

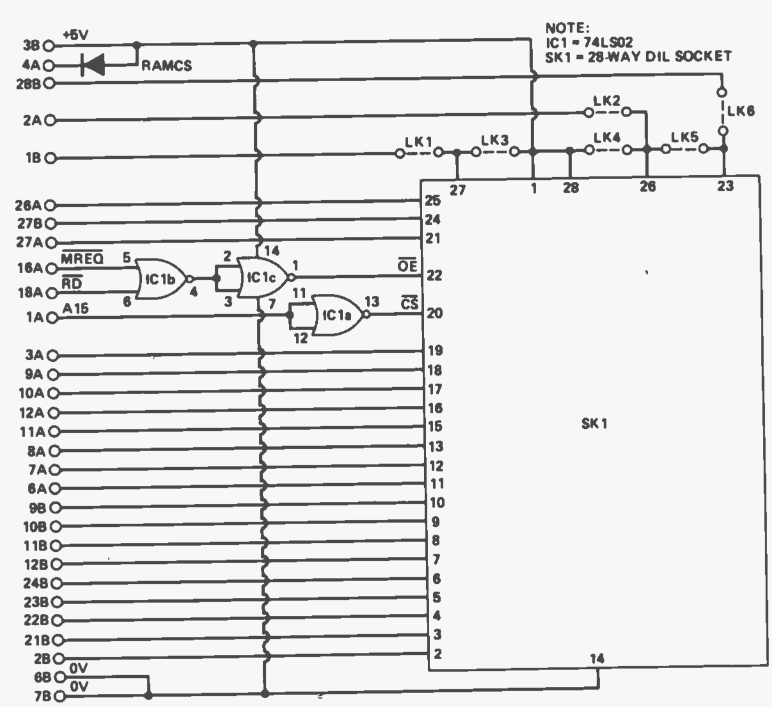
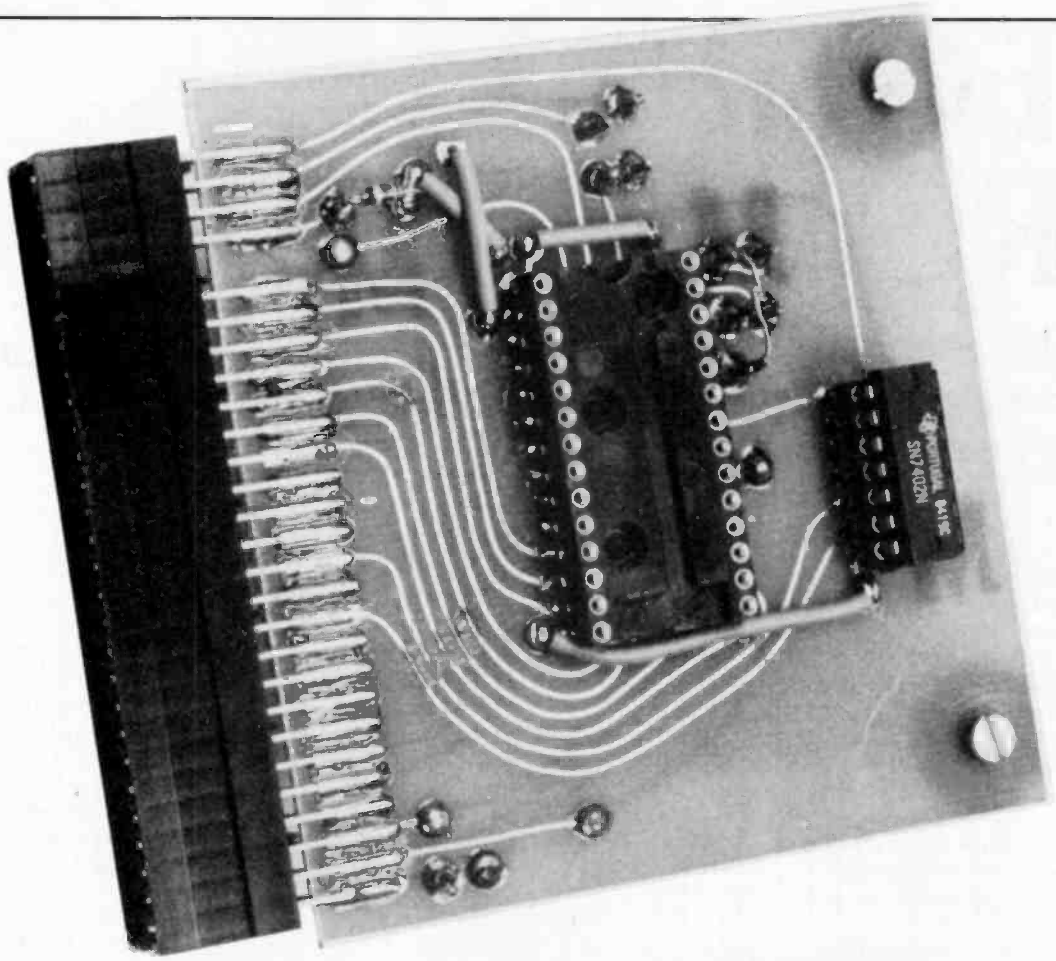


Fig. 1 Circuit diagram of the EPROM card.



The component side of the EPROM card ,note the soldering of the edge-connector.

(28 PIN)
LINKS 1-6 SET THE EPROM TYPE

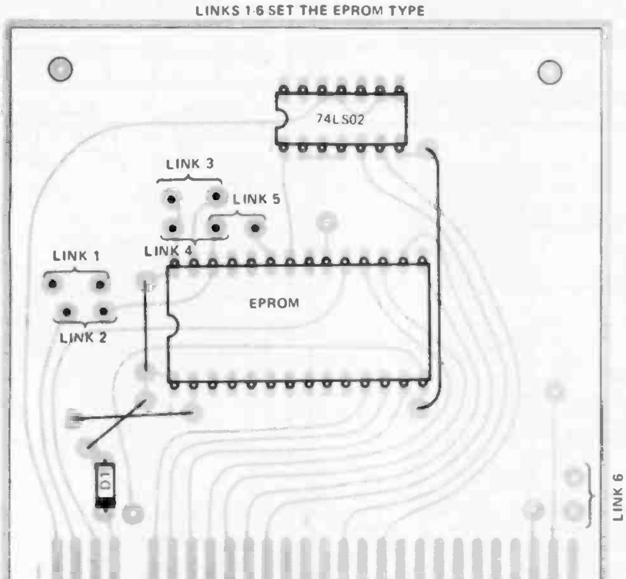


Fig. 2 Overlay diagram for the EPROM card.

HOW IT WORKS

The circuit diagram for the EPROM Card can be seen in Fig. 1. The 32K RAM is addressed whenever A15 is high, this line is intercepted and inverted by IC1a. This provides the $\overline{\text{CS}}$ for the EPROM. To ensure that the EPROM is only enabled at the correct time, control lines $\overline{\text{MREQ}}$ and $\overline{\text{RD}}$ are used to provide the $\overline{\text{OE}}$ (output enable) line for the EPROM via IC1b and IC1c. Only when A15 is high and $\overline{\text{MREQ}}$ and $\overline{\text{RD}}$ are both low will the EPROM put data onto its data output (D0 to D7) and so on to the Spectrum's data bus.

The data stored in the EPROM can be inspected by means of the PEEK command or machine code routines held there and run by the USR command.

On power up the RAMCS line is held at +5 by D1, the Spectrum goes through its initalisation process and promptly sets itself up as a 16K machine. This can be verified by carrying out the instruction, PRINT PEEK 2372+256*PEEK 23733. This should return the value of 32767 (indicating the last usable location of RAM). Without the board, the 32K RAM is enabled and this can be verified by repeating the above PEEKs. This time the value returned is 65535 — correct for a 48K Spectrum.

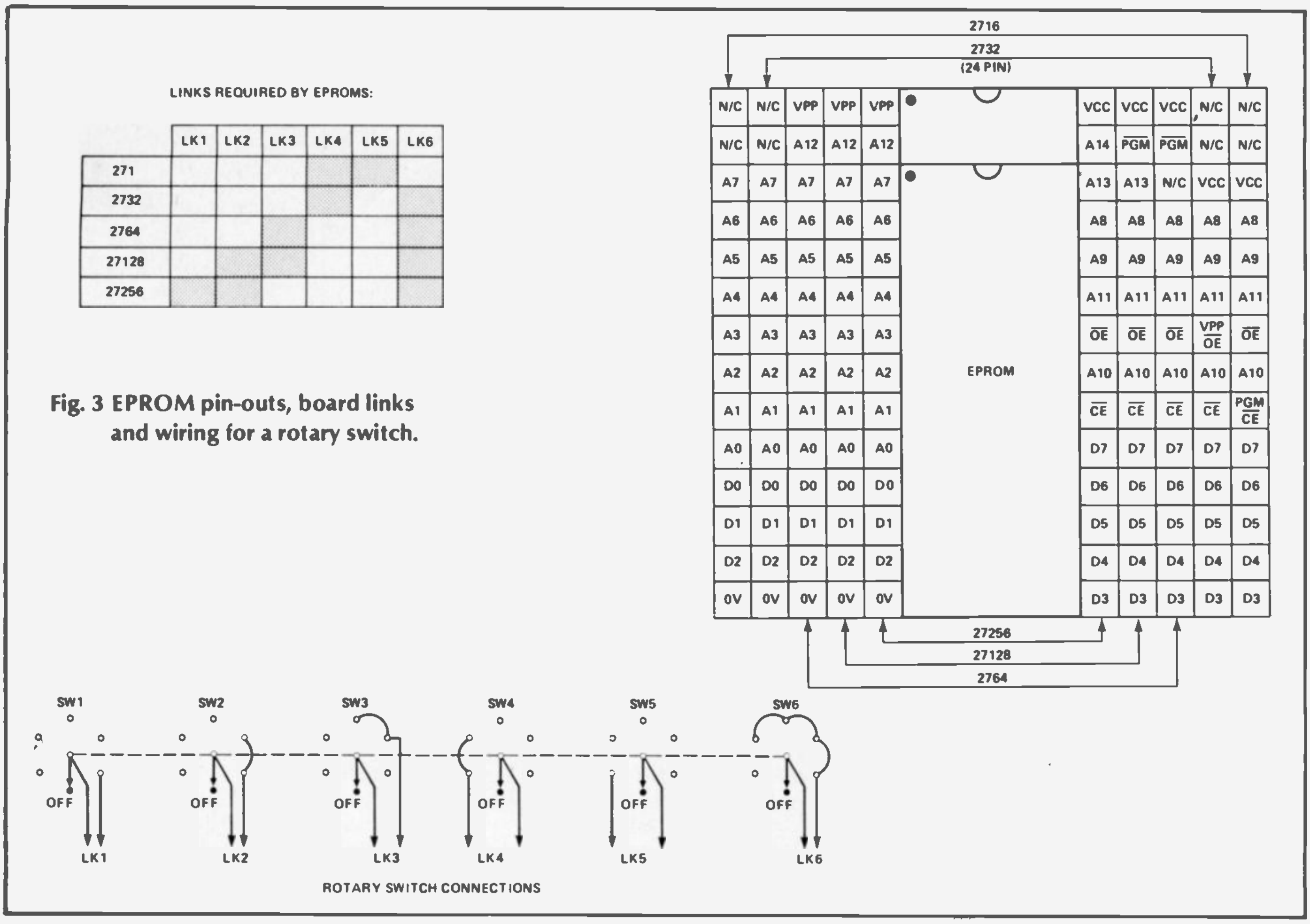


Fig. 3 EPROM pin-outs, board links and wiring for a rotary switch.

PARTS LIST

RESISTOR
R1 2k7

SEMICONDUCTORS
IC1 74LS02
IC2 any suitable EPROM
D1 1N4148

MISCELLANEOUS
PCB, 28-pin DIL IC socket, wire links or suitable switch/es, for example, 6-pole, 6-way rotary switch. Double-sided, 28-way edge connector (0.1 in. pitch).

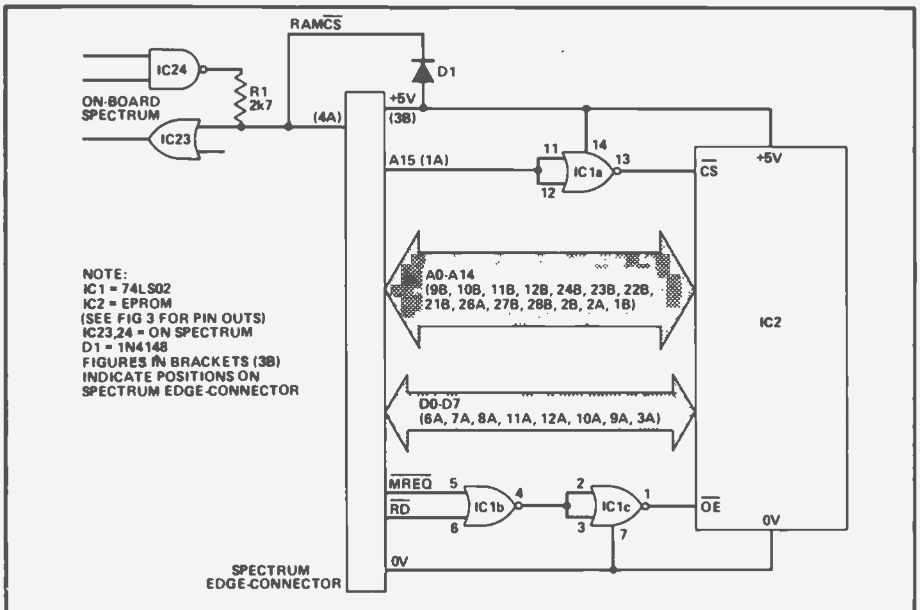


Fig. 4 Block diagram of the complete system.

Disassembly Of EPROMS

The card can be used to disassemble the machine code contained in EPROMS. The Spectrum's RAM can contain a disassembly program such as the excellent one available from D K'tronics, DISTRON. This is relocatable, which makes it useful when the machine code is stored in memory normally occupied by the disassembler. EPROMs can be checked and their contents displayed on the screen or dumped to a printer.

All that is needed is an EPROM programmer to put the data in there in the first place.

BUYLINES

The PCB will be available from our PCB service (but see the note in News Digest). If you choose to use a switch, it will have to be made up from a Mak-a-Switch or Wafa Switch kit. These are available from Watford and Cricklewood and probably many other places. Or you could use a six-way DIL switch, which is even more widely available.

ETI

DIRECT INJECTION BOX

Do people make fun of your PA system? Andrew Armstrong explains how extracting the mike can make things a little better.

Even with the large number of electric musical instruments in use today, sound is still frequently transferred from instrument to PA system by means of a microphone. Electric guitarists often regard their stage amplifier as part of the instrument and wish the sound to include the distortions, cabinet resonances and even the microphony in the case of a valve amplifier. This demands a microphone placed directly in front of the musician's loudspeaker, with all the consequent problems of distortion and increased risk of feedback.

Microphones have to be used in any case for vocalists and acoustic instruments, which makes it all the more important to avoid using them on electric instruments wherever possible so as to keep the risk of feedback to a minimum. Electric keyboards can usually be fed directly into the PA system, but an on-stage amplifier may still be required so that the sound can be heard by the musician and acoustic instruments too may need local amplification in the noisy environment of an amplified band.

The solution to some of these problems is a direct injection box, a unit which takes the incoming signal from the instrument (or from the microphone in the case of an acoustic instrument) and splits it to produce two outputs, one of which is fed to the main PA while the other is taken to a nearby amplifier and 'speaker controlled by the musician. A DI box (as they are generally known) usually has a high impedance input, a low impedance output for the mixer which is sometimes balanced, and either a high or low impedance output for the stage amplifier.

Well Balanced Design

The design to be described here is based around a very low noise dual op-amp which allows it to be used at low signal levels without significant noise problems. The gain is normally set at unity but a voltage gain of 2:1 can be achieved by making a few component changes. The unit operates from a single 9V battery and powers up automatically when a jack plug is inserted into the input socket. In addition, a low-voltage detector is included which lights an LED when the battery needs replacing.

The unbalanced output can be taken from the output of the first op-amp which gives a reasonably low impedance drive or, if preferred, can be connected directly to the input. The advantage of this arrangement is that the unbalanced output will then continue to operate even if the unit develops a fault or the battery runs down. The input impedance of the DI box circuitry is quite high and will not excessively load a connection made in this way.

The mixer output is balanced and can either be used directly with high impedance balanced inputs or set at 600R by adding two 300R resistances. A circuit for a low impedance balanced input has also been included, along with a Veroboard layout, to enable the unit to be used with equipment which does not already have a balanced input.

The normal type of balanced line to use for audio work is 600R. To be completely correct, the

BUYLINES

Most of the components are widely available from our regular advertisers and from the usual mail-order suppliers. Maplin stock the ICL8211 and the diecast box used for the prototype was obtained from Cirkit. We used a low-cost plastic XLR connector for SK2 but the standard metal type would be just as suitable. The PCB will be available from our PCB service, but see the note in News Digest.

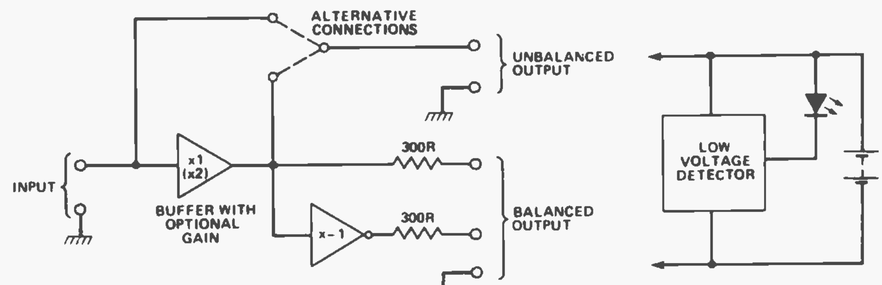


Fig. 1 Block diagram of the direct injection box.

source resistance for each signal connection should be 300R and each one should be terminated with a 300R resistance to ground at the receving end. In many cases, a high impedance is used at the receiving end and the sending end impedance is just 'low'.

As long as the signal level is suitable, this unit may be used as a proper 600R driver. The 5532 op-amp specified has very low noise, typically 5 nV/$\sqrt{\text{Hz}}$, so very low level signals may be used without a severe signal-to-noise penalty. The voltage swing which the op-amp can drive into 600R is somewhat less than it could drive into, say, 10k, so, taking account of the reduced efficiency when operating from a single 9V supply rather than a dual 15V supply, signals of over two volts peak to

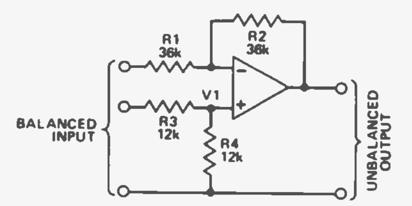
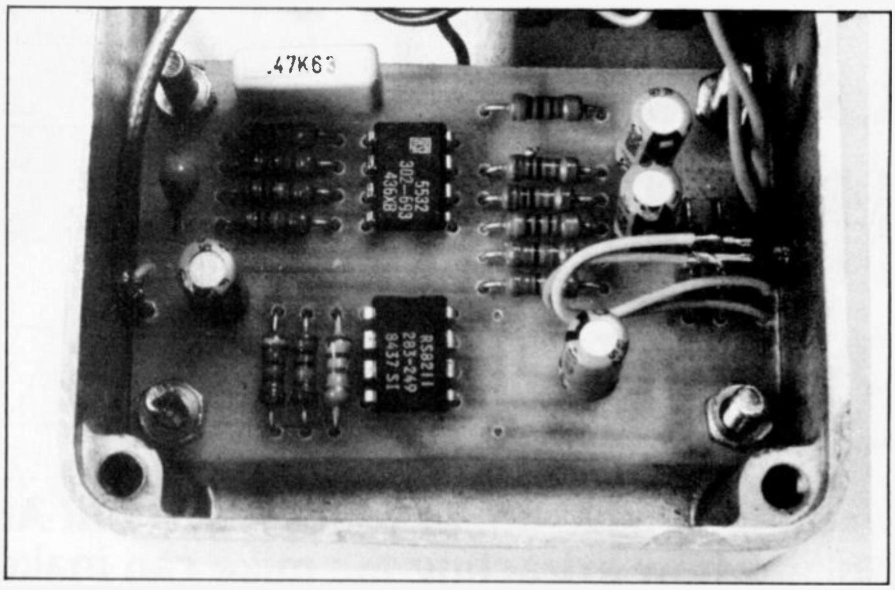


Fig. 2 Standard differential input arrangement.

peak may clip. When the battery is at its end-of-life voltage, the 5532 may only manage two volts peak to peak into a high impedance. This should be adequate for most purposes, but if it is not, the project may easily be adapted to give more output.

If the box is operated with 300R output resistors into a terminated 600R line, the output signal will be potted down by 2:1. To compensate for this, voltage gain is provided by the addition of optional components R4 and C2. Equally, if the input signal is of a very low level, adding these components will boost it to a level



considerably above that of the interference picked up on the line. This is particularly useful to prevent buzz from phase controlled lamps being audible on microphone circuits. For the purpose of driving a balanced line, a voltage gain of times two is required.

In order to gain the greatest benefit from the DI box, its output should be fed into a balanced (or differential) input. Unfortunately, the equipment you use it with may not have a differential input, in which case read on.

The circuit in Fig. 2 shows the conventional configuration of a differential receiver. Most text books show all four resistors in the circuit to be of equal value, but that is not always the best way to do things. At first glance, it would appear that the impedance on the non-inverting input is R3 + R4, while that on the inverting input is R1. This is not so. If the op-amp is working linearlly (ie not clipping) then for all practical purposes, the voltage on the inverting input of the op-amp is the same as that on the non-inverting input.

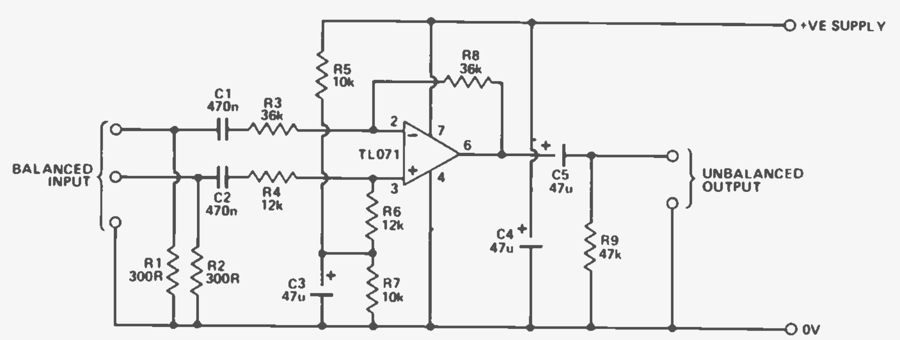


Fig. 3 Practical circuit for a differential input stage.

The non-inverting input has on it half the positive signal voltage, and since the inverting input has the same signal present, resistor R1 has a voltage across it equal to half the positive input signal plus the negative input signal. The signals are meant to be balanced, so the voltage across R1 is 1.5 times the negative input signal. The current flowing in this resistor is therefore 1.5 times as high as would be expected if R1 were feeding a virtual earth point, so the apparent impedance is 1/1.5 times

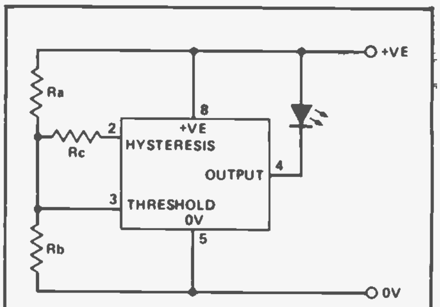


Fig. 4 Low voltage warning circuit using the Intersil ICL8211.

the value of R1. Therefore R1 should have a value of 1.5 times the desired input impedance. Another way to visualise this is to think of the virtual earth point as being one third of the way along the resistor from the inverting op-amp input to the input signal.

The component values shown in this circuit are for a 48k input impedance, 24k on each line. Should a 600R input impedance be required, it is probably best to use 300R resistors to load the input, rather than using very low value resistors round the op-amp. There are two reasons for this.

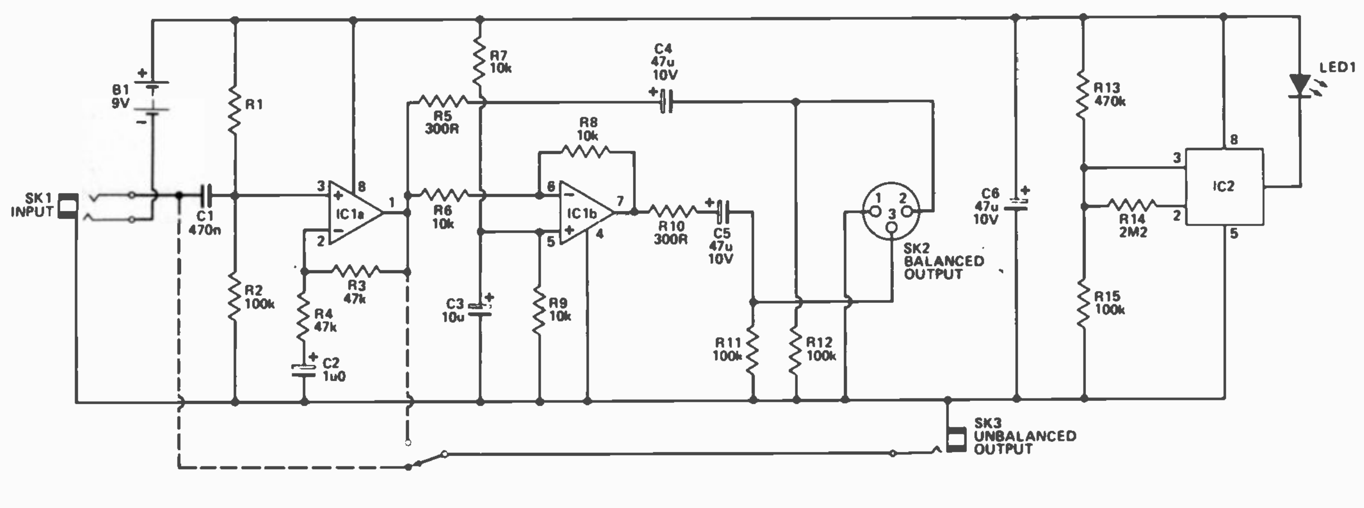


Fig. 5 Complete circuit diagram of the direct injection box.

First of all, the differential impedance of the circuit shown is correct, but the common mode impedance is not balanced. The addition of 300R load resistors will swamp any differences and the best performance will be obtained. The second reason is that the op-amp would be required to drive heavy currents into its feedback resistors if low value resistors were used round the op-amp, and this would restrict the output swing.

Power Consumption

The one drawback of the excellent NE5532 dual op-amp is that its current consumption is quoted as eight milliamps typical, sixteen maximum. If the DI box is to be used with reasonably large signals and not into a low impedance load, it may be preferable to use the LM358 op-amp in order to cut the power consumption. The gain bandwidth product of this device is only 1MHz, so there is not a lot of scope for providing voltage gain without the risk of slight degradation of sound quality.

Another alternative would be the TL072 which has a gain bandwidth product of 3 MHz and a noise figure of 18nv/$\sqrt{\text{Hz}}$, both of which are quite acceptable. This is a Bifet device, so it would be possible to use a very high input impedance if necessary, a megohm for example. The maximum current consumption of this is 5mA total, so the battery life should be reasonable.

If the application requires substantial voltage drive into a 600R load, the DI box may be constructed with 25V rated electrolytic capacitors and powered from two 9V batteries in series. There is not room in the case of the prototype unit for another battery, so a large sized case would have to be used. The low battery warning would have to be recalculated to work at a different voltage as well, of course, in order to give warning before the unit stopped working correctly, rather than afterwards.

HOW IT WORKS

IC1A works as a buffer with selectable gain, R4 and C2 being added only if voltage gain is required. The offset voltage on the inputs is minimised by having a similar net DC resistance on each input. The output of this buffer drives the in-phase output and also a unity gain inverter, IC1B, which in turn drives the other output. Both outputs have their impedance set by series resistors and are DC blocked by electrolytic capacitors. The capacitors are polarised by load resistors R11 and R12.

The low battery detector is based on a purpose designed IC which contains a very low current band gap voltage reference, a comparator, and a current limited output drive circuit. For this reason, the LED needs no current limiting resistor.

Low Battery Alarm

Mention of the power consumption brings us neatly on to the battery voltage detector. This uses an Intersil IC, the ICL8211. This handy chip draws a quiescent current of about 25μA and provides a current limited LED drive which switches on when the voltage on its threshold input falls below 0.15 volts. Referring to Fig. 4, the threshold voltage for the LED to switch off is given by the formula

$$V = 1.15 \times \frac{Ra + Rb}{Rb} \text{ volts}$$

Hysteresis is added by Rc, (R14 in the final circuit), but if this is not required pin 2 should be left open circuit.

The addition of hysteresis does not affect the switch off voltage but the switch on voltage is lowered. This voltage is calculated from the formula

$$V = \left(\frac{Ra \times Rc}{Ra + Rc} + Rb\right) \times \frac{1.15}{Rb}$$

The component values specified in the circuit diagram give nominal switching voltages of 6.55 (off) and 5.60 (on). If this end of life voltage is too low, it may be raised by reducing Rb in the sensing circuit.

Construction

Before starting to assemble the DI box, you must decide which of the various circuit options you wish to incorporate. Some of these will affect your choice of components while others, like the choice of unbalanced output take-off point, will only involve wiring changes. The components which may be affected are all marked in the parts list.

Assembling the PCB should present no problems at all. None of the components are static sensitive but take care that the two ICs are inserted the right way around and be careful when soldering the more closely grouped pads to avoid bridging.

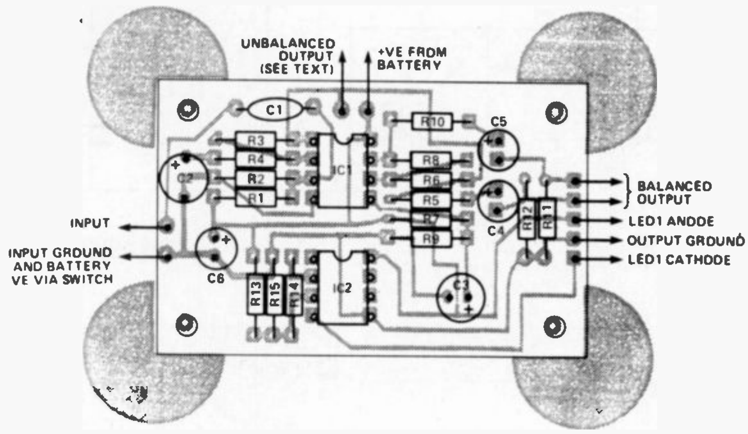


Fig. 6 Component overlay for the DI box PCB.

PARTS LIST

RESISTORS (¼ W 5% unless otherwise stated)	
R1,2,11,12,15	100k
R3	47k
R4	47k (see text)
R5,10	300R 1%
R6,8	10k 1%
R7,9	10k
R13	470k
R14	2M2 (see text)
CAPACITORS	
C1	470n polyester
C2	1µ0 tantalum (see text)
C3	10µ 10V radial electrolytic
C4, 5,6	47µ 10V radial electrolytic
SEMICONDUCTORS	
IC1	NE5532 dual op-amp (see text)
IC2	ICL8211 micropower sensor
MISCELLANEOUS	
SK1	¼" stereo jack socket
SK2	XLR 3-pole chassis plug (XLR-3-32 or equivalent)
SK3	¼" mono jack socket

PCB: diecast box, approx 110 x 60 x 30mm (BIM5003, Eddystone 7134P or similar; panel-mounting bush for LED1; PP3-type battery connector; nuts and bolts to mount SK2 and the PCB.

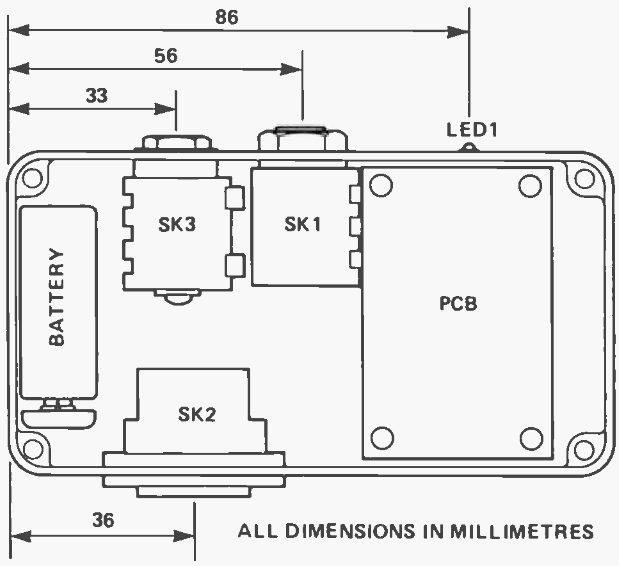


Fig. 7 Layout of the major components within the case.

Preparing the case involves a little more work. Almost any diecast box of the right size or a little larger should do but avoid ones which have PCB slots on the inside. The slots are not needed for this project and they make it more difficult to fit the jack sockets and the LED.

In order to fit everything in, the PCB should be installed first. It should held as far to one end of the box as possible and the four mounting holes drilled through the board into the metal, thus ensuring that they match up. The holes should then be countersunk on the outside of the box.

A line should be drawn, centred between lid and base, along both long sides. This is to enable the sockets and the LED to be mounted in line. The PCB should be temporarily dropped into place and a jack socket positioned next to it, not quite touching. The centre point of the socket should be marked and a hole drilled where this intersects the centre line. Few people will have drills of the size required and there is not room enough to use a chassis punch, so, unless you like filing, the use of a conecut is highly recommended. Conecuts take off metal at an alarming rate so check the fit often.

Once the first jack socket is fitted, the second one should be positioned next to it. There should be space for the battery between the second socket and the end of the case. The XLR socket should be positioned opposite the jack socket, again taking care to leave space for the battery. You will probably find that the upper fixing bolt of the XLR will be in the way of the lip on the lid of the diecast box. The lip should be filed away in the appropriate place to allow it to fit snugly.

The input socket is a stereo jack, even though the signal is mono. This enables the spare contact to be used to connect the battery negative to the PCB only when the input is plugged in. The negative wire from the battery clip should be connected to the middle connection of the input jack.

The unbalanced output may be connected either to the input, as a loop through arrangement, or it may be connected to the output of the first stage. A pad for this is provided next to the positive power supply pad on the PCB. Care should be taken to connect the LED with the correct polarity because it will only switch on, or fail to do so, when the battery runs low.

Thin co-ax is best for the connection of the input, which may be a very low level signal, while three wires twisted together should be used for the balanced output. The convention for the connection of XLR connectors is that the ground is connected to pin 1, the in-phase signal is connected to pin 2 and the out-of-phase signal is connected to pin 3. XLR connectors usually have the pin numbers marked on them.

Testing

If a regulated power supply is available it should be used for initial testing. Set the power supply to about 4V and connect up. If the LED does not light, then reverse its connections and try again. Once the LED works, increase the voltage until the LED goes off, then reduce it until the LED switches on again. Measure the voltage and check that it is about 5.6V. Individual units may vary due to component tolerance, but if the voltage is not acceptable the value of R13 or R15 should be changed.

Now apply 9V, either from a battery or from the power supply, and use a voltmeter to check that the op-amp output pins are at about 4.5V and that the outputs are at 0V. If they are not, the most likely fault is a reversed electrolytic capacitor. Finally, connect up a signal source and a suitable amplifier and check that everything works correctly and that the sound is all it ought to be.

A practical circuit for a differential input is shown in Fig. 3 and a Veroboard layout is shown in Fig. 8. The 300R input resistors are optional but should be included if the input is connected to a 600R balanced output. The power may be drawn from any DC source with a voltage in the range 6-30V or a dual rail supply could be used and the biasing component omitted. If the arrangement is to be battery powered, it might be an idea to include a low voltage monitor of the type used in the main DI box.

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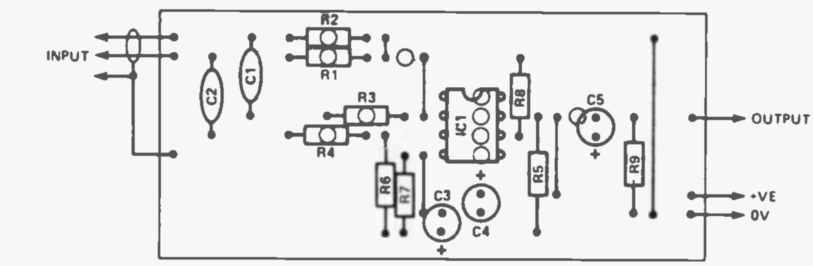


Fig. 8 Suggested Veroboard layout for the differential input stage.

ETI SORCERER STRING SYNTHESIZER

Graeme Durant's design performs the magic, turning digital strings into violin strings.

In last month's ETI, we introduced the Sorcerer and dealt with the keyboard circuitry and the key encoding system as well as the VCO and the power supply unit. This month, as promised, we deal with the major sound processing facilities — the chorus board and the envelope shaper. The circuits are shown and the principles of operation are handled.

Readers of the first part of the article will recall that so far we have seen how touching a key produces a trigger and a gate voltage as well as a binary number which is converted using a D-A device and a voltage-to-frequency converter into a note (or, rather, into three notes at octave gaps). In this month's enthralling episode, we see how the notes are filtered, delayed and mixed for chorus effect (if desired) and, finally, gated on and off and shaped by the envelope circuitry ready to astound your friends and amaze your neighbours.

Next month, we'll bring you full constructional details, PCB patterns and component overlays and some guidance on how to fit a moving mechanical keyboard to the Sorcerer — not to mention the Parts Lists and Buylines. For now, read on . . .

HOW IT WORKS
CHORUS CIRCUITS

The chorus circuitry takes the pulse train outputs from the VCO, filters them to make a smoother sound and feeds them to a bucket brigade delay line system to provide an apparent multiplicity of sound sources (Fig. 6). Before being fed to the delay lines, the mixed and filtered pulse-trains must go to a low-pass filter to remove the upper harmonics, which prevents aliasing.

The chorus effect is produced here by feeding the signal through three parallel delay lines, and mixing the outputs together. For maximum effect, each line delay time is modulated 120 degrees out-of-phase with the other two. This produces a rich enough chorus to simulate the multiplicity of sound sources required.

The delay times of the lines are deter-

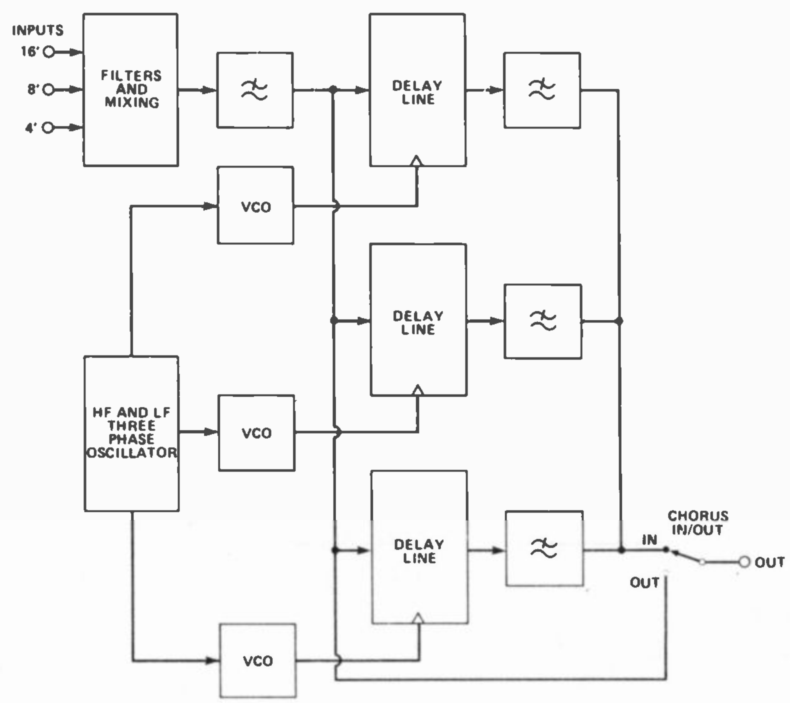


Fig. 6 Block diagram of the chorus section.

mined by the frequency of three VCO clock generators controlled by a three-phase oscillator. The delay line outputs are mixed after being fed through low-pass filters, needed to remove the clock breakthrough onto the signal as a result of the untreated input signal.

The circuit diagram is shown in two parts: the clock generation section (Fig. 7) and the audio section (Fig. 8). IC29 and IC30 (Fig. 7) form two simple three phase oscillators, each made up out of three integrators, wired up in a loop. The circuit is inherently unstable and will always oscillate, the outputs being roughly trapezoidal in shape and 120 degrees out-of-phase with each other. The oscillator built around IC29a, IC30c and d, runs at about 0·5Hz, whereas the other built around IC29b, IC30a and b, runs at around 5Hz. The oscillator output pairs are mixed and then filtered by C37, C40 or C43, to produce three roughly sinusoidal outputs. each consisting of a large 0·5Hz signal with a smaller 5Hz signal superimposed on top. These are used to modulate the clock VCOs, IC31, IC32 and IC33, and give a realistic tremolo effect.

The VCO ICs used are CMOS 4046 phase-locked loop devices. These contain several building blocks suited to the construction of PLL circuits, but we only use the VCO and an internal exclusive OR gate wired up as an inverter. The delay lines require a two phase clock signal, and the inverters are used to produce a second phase.

The VCOs are programmed by the capacitor across pins 6 and 7, and the resistors on pins 11 and 12. We want to sweep between about 50kHz and 100kHz, to produce delays of between 5ms and 2·5ms respectively. The line delay in the devices used in Sorcerer is equal to 256 divided by the clock frequency and the VCOs are programmed accordingly.

The VCO ICs are powered from +10V and –5V, as are the delay line chips, and the supplies are well decoupled to stop clock signals leaking onto the supply lines. The outputs from the VCOs, at pins 4, and the inverted second phase at pins 2, go to the delay line circuits.

The three octave spaced signals are filtered by passive high and low-pass filters formed by C56 to C64 and R177 to R184 (Fig. 8). The three filtered signals are mixed at the virtual earth input of IC34a and a variable DC bias level is added to the signal by RV10. This is adjusted so that the input signal is at the centre of the delay line's linear operation region. IC34b is wired up as a 10kHz low-pass filter to further eliminate aliasing.

IC35 to IC37 are the delay line devices. Sorcerer uses a little known Matsushita device, the MN3010, which is a dual 512 stage analogue bucket brigade device. Unfortunately, the two lines cannot be independently clocked, because of on-chip intermodulation, although lower noise operation is gained by paralleling the lines in each IC.

Another cause of intermodulation is the coupling of the clock frequencies between channels, via other common connections like the supply rails. This is avoided by very heavy decoupling at every opportunity. C71 to C73 decouple clock frequencies feeding back out of the delay line inputs. The two resistors connected to pin 4 of each delay line hold the gate supply voltage at about one volt above the negative rail.

The signal outputs, via presets from pins 8 and 13 which null out some of the heavy signal clock content, go to more 10kHz low-pass filters (IC38 to IC40) to remove the rest of the clock breakthrough from the signal. The three outputs are combined at IC41 — a virtual earth mixer. IC42 is a quad analogue switch half of which is controlled by the front panel switch SW5 to route either the chorus signal or the pre-chorus signal to the envelope shaper without going to the front panel. C83 blocks the input DC bias, if the pre-chorus signal is selected.

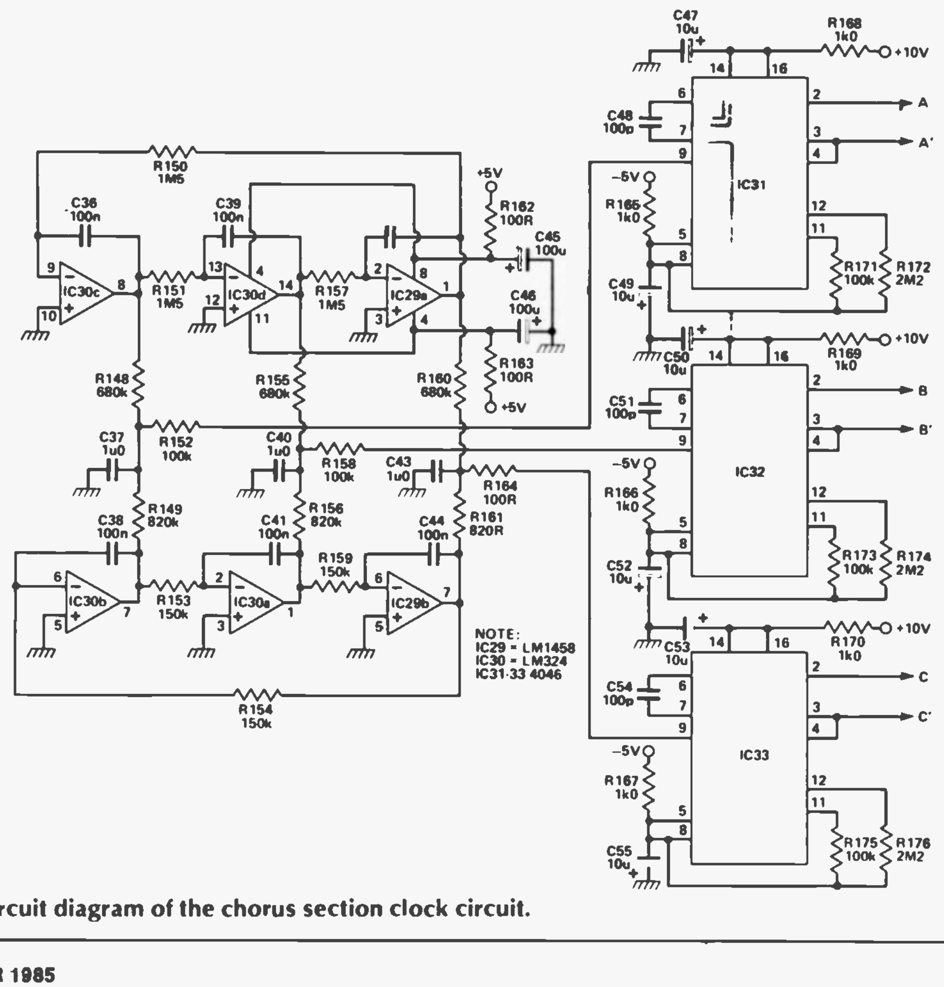


Fig. 7 Circuit diagram of the chorus section clock circuit.

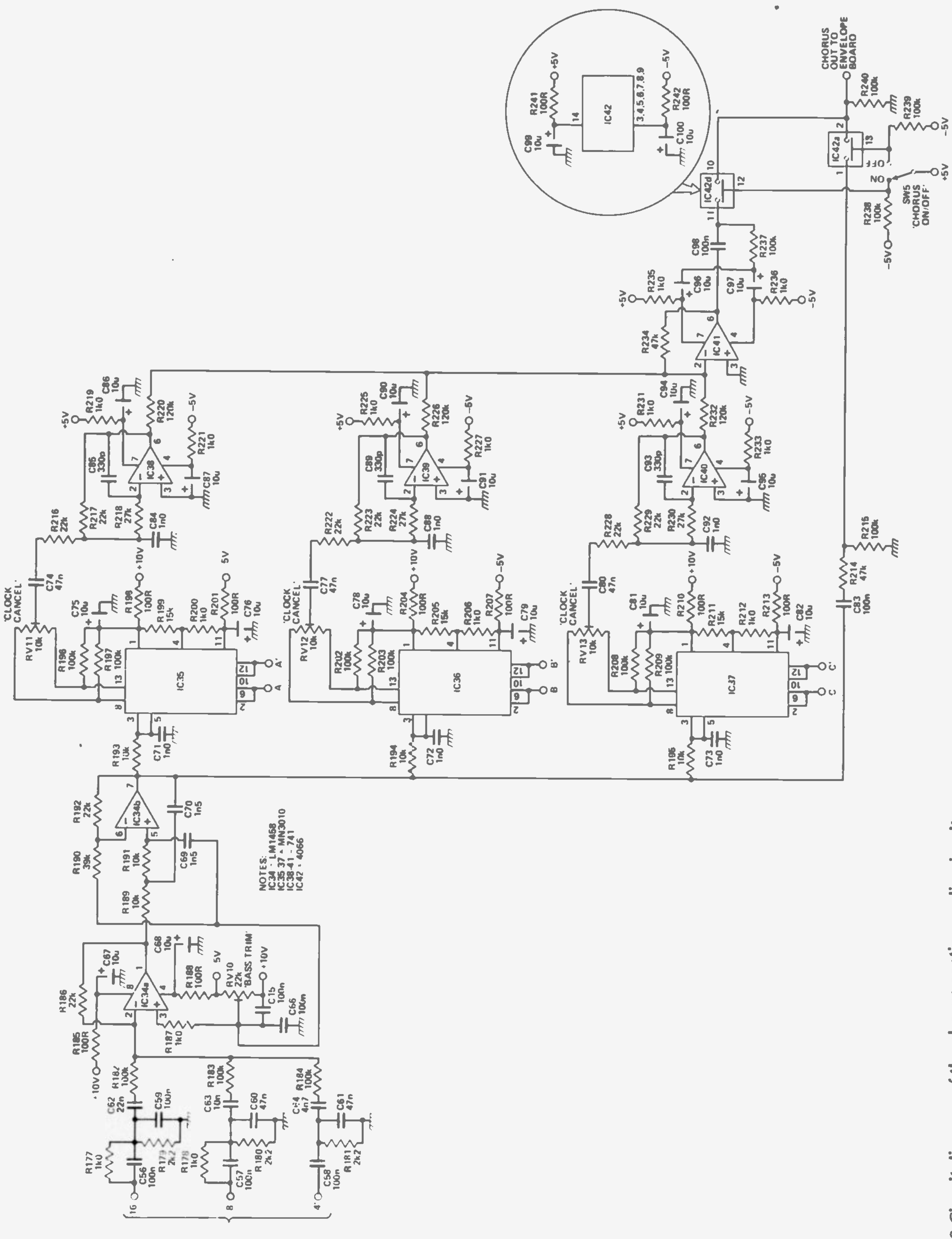
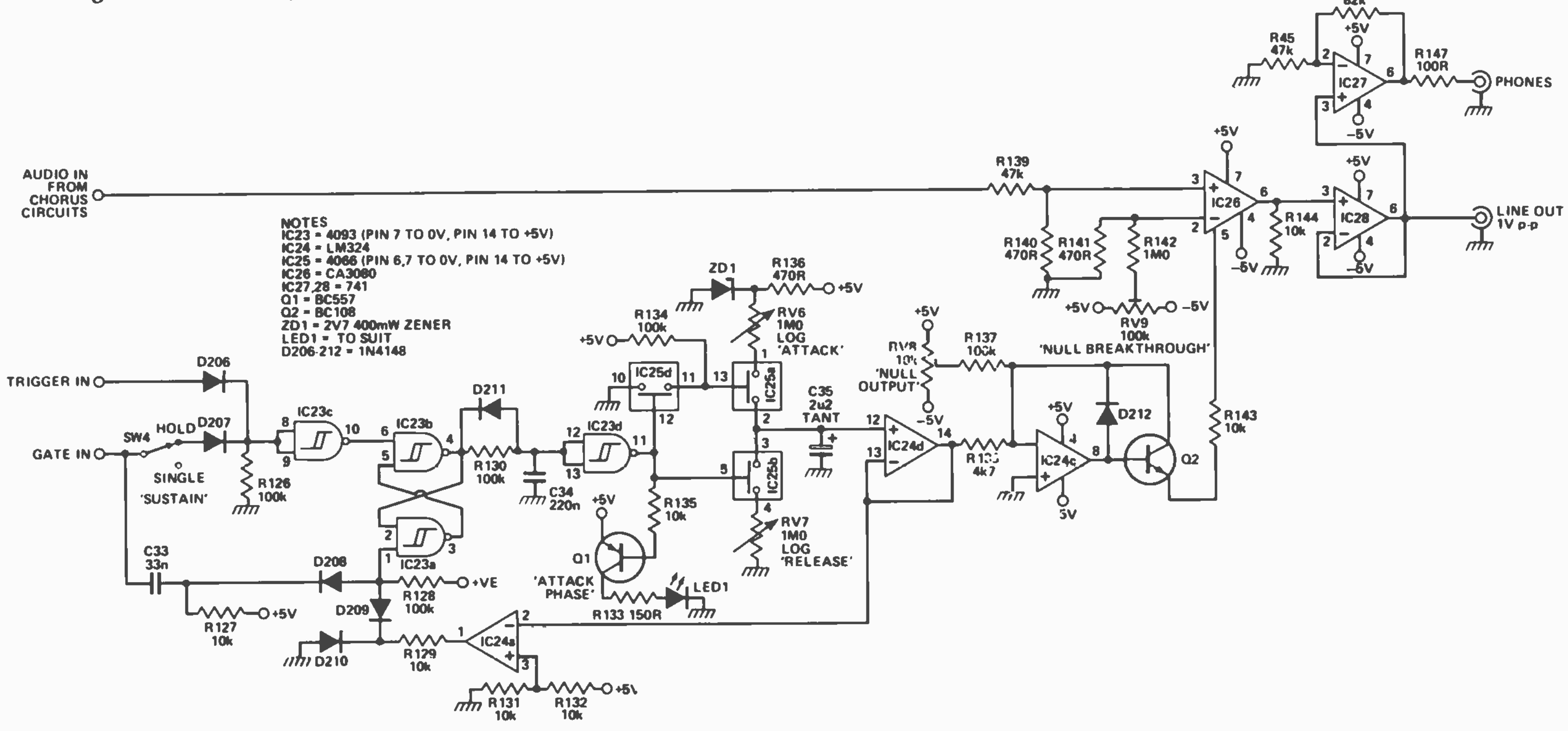


Fig. 8 Circuit diagram of the chorus section audio circuit.

Fig. 9 Circuit diagram of the envelope shaper and output stages.



HOW IT WORKS
ENVELOPE SHAPER

The circuit can be split into two sections: an envelope generator (IC23, 24, 25) which produces a changing voltage proportional to the required amplitude contour and a voltage controlled amplifier (IC26, 27, 28) which uses this voltage contour to control the amplitude of the audio output.

A positive trigger pulse from the keyboard will initiate a cycle of the generator. After passing via D206 (half a diode OR gate) it will be inverted by IC23c and, assuming pin 1 of the IC is high, pin 4 will latch high. After a delay of about 80ms (R130 and C34) pin 11 will go low. The delay allows the VCO to settle to its newly set pitch, avoiding pitch slew.

Now, CMOS switches IC25b and d are turned off allowing pin 13 of IC25 to rise high by R134 and turn on IC25a. C35 will start to charge up via the attack potentiometer RV6, from a 2.7 volt reference based on ZD1 and R136. IC23d also turns on Q1 which lights a front panel LED to indicate the attack sequence. The voltage on C35 is buffered by IC24d and goes to the input of a voltage comparator IC24a. The other input to this comparator is held at about 2.5 volts by R131 and R132. When the voltage on C35 passes this threshold the output of the comparator will go negative, taking pin 1 of IC23 low, resetting the RS latch and taking pin 11 of IC23 high. (The delay being by-passed by D211). IC25b and d are turned on and IC25d turns the attack switch off.

C35 starts to discharge via RV7, the 'Release' potentiometer. If the 'Sustain' switch SW4, is in the 'Hold' position, D207 will hold the latch 'Set' until the gate signal goes low. The envelope shaper stays at full output volume until the key on the keyboard is released. C33 and R127 form a falling edge detector which will reset the latch, ensuring that the release phase always occurs immediately a key is released.

The buffered contour voltage at the output of IC24d goes to a precision voltage-to-current converter built around IC24c and Q2. This drives a proportional current through R143 into IC26, an operational transconductance amplifier whose gain is varied by the current flowing into pin 5. R139 and R140 cut the input signal level to about 20 mV peak-to-peak, avoiding signal distortion. RV9 is a preset used to null out the input offset voltage of IC26. If this were not done a DC voltage similar to the control voltage could appear at the output. RV8 similarly nulls the signal output when C35 is completely discharged.

The current output of IC26 is dumped into R144 to produce a voltage, which is buffered by IC28 to form the line output.

ETI

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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.

Audio Design Buffer (September 1984)
There has been some confusion due to the cases of the various transistors (Fig 4, p.61). Q1 and Q11 are T092(E) (gate, source and drain for pins 1, 2 and 3), while Q2 and Q12 are T092(F) types (gate, drain and source). Q3, Q 4, Q13 and Q14 should be 'L' types with a T092(A) case (base, collector and emitter). The pin positions marked on the overlay are correct. The pins themselves may need to be bent to fit the PCB.

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.

Printer Buffer (July 1985)
There would seem to be a problem with the TMS4416 dynamic RAMs used in this circuit. They require an 8-bit row address refresh, while the Z80 only issues a 7-bit row address refresh signal. Luckily, the 4416's are quite tolerant with regard to refresh cycles, but if you leave your printer off-line for any length of time, you may lose data. The easiest, though not the cheapest, solution is to replace the 4416's with Hitachi HM 48416DRAMs, which are compatible in every way except that only 7-bit row address refresh signals are required. These ICs are available from Hicom Components, The Genesis Centre, Garrett Field, The Science Park, Birchwood, Warrington WA3 7BN (0925-825065) at a price of £4.30 each, plus VAT and £2.75 for post and packing.

From A to D... (August 1985)
On Fig. 5, p. 25, the bottom end of Q1's emitter resistor should go to −Vcc, not earth. The non-inverting input of the op-amp is connected to 0V, while the bottom right of the diagram should not be labelled 0V.

PARALLEL I/O FOR THE CORTEX

Now your Cortex can have a Centronics port, two joystick ports and 22 lines of programmable I/O. The brains behind this operation is Richard Roberts of MicroProcessor Engineering.

The Cortex project was initially featured in ETI in November and December 1982 and January 1983. The currently available Cortex II has a circuit and PCB which are the same as those featured in these articles in all major respects. The E-bus circuit is dealt with in ETI, December 1982 and is designed around the 74LS2001 chip which handles the bus arbitration and control logic. This is IC89 on the main board. Other chips involved in the E-bus interface which may not be present on existing Cortex boards are ICs 90 to 99.

The 74LS2001 is unavailable unless you have very good connections, so we have included a small circuit (Fig. 1) which can be built on a header and used to replace the 2001. It works for both the CRU (Communications Register Unit) I/O and memory expansion, and requires no modifications to the Cortex main board. The circuit does not allow for multiprocessors or bus time-out as it stands, but these features can be added. For those who are interested, a complete description of the E-bus, together with many examples of its use, can be found in 'E-bus System Design', Texas Instruments, Part No. MP402.

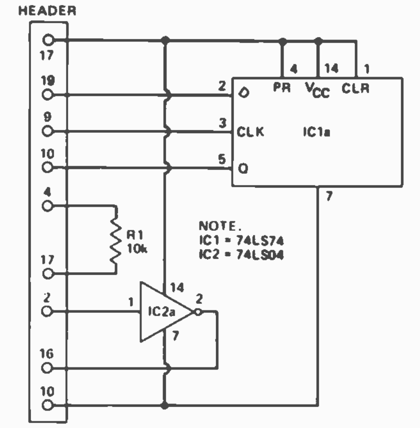


Fig. 1 Circuit of the header to replace the 74LS2001.

The 2001 replacement uses a 74LS74 dual latch to synchronise the E-bus READY line to the Cortex. One section of a 74LS04 hex inverter is used to invert the bus request signal to generate a bus enable.

Construction Of The Header

As this is such a simple circuit, we have not produced a PCB, but advise the use of a small piece of veroboard. Construction should begin by cutting spots as shown in Fig. 2. Then push 20 wire wrap pins, or a 20-way wire wrap DIP socket, into the header position (top left). Solder these and the two pin IC sockets into place, fix R1 across pins 4 and 17 of the header and then insert and solder the wire links. Finally, push the ICs into their sockets.

Installing The E-bus

Plug the header into the 74SL2001 position — the 20-pin IC socket on the main board marked IC89. For the E-bus to work, the links to ground by IC94 should be cut. Use a sharp knife to break each of the four tracks from pins 2, 4, 6 and 8 of this IC. If you have fitted the memory mapper (IC26), the four wire links below it should be removed. If any other E-bus components (ICs 90 to 99, in particular) have not been fitted then now is the time to fit them.

Switch on, and you should have a working E-bus interface. If the Cortex signs on, then it is likely that the E-bus will be functioning correctly. Any faults will probably be due to miswiring on the header (check the wire wrap pins), or to solder splashes on the main board. The E-bus can be connected to a backplane for easy insertion and removal of cards, such as the one featured here. Suitable backplanes are widely available. They should be designed for 32+32 way Eurocards (DIN 41612) and the backplane will fit a 64-way right-angled male A+C plug attached to the main board of the Cortex. The backplane sockets should be female for use with the following and subsequent expansion boards. Alternatively, 64-way rightangled female A+C sockets are available, respectively of IC7 and the Cortex board for direct connection

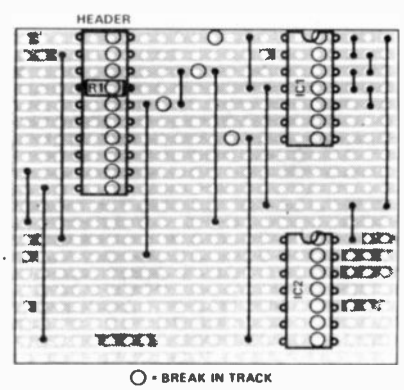


Fig. 2 Veroboard layout for the header.

of the parallel I/O board through the access port in the case.

Construction

The PCB designed to accomodate the interface is a standard double-sided through-hole plated Eurocard. Check the PCB for any shorts, especially on the component side. Fit all the IC sockets and DIN 41612 connector followed by all the passive components. If you are going to use the board only as a Centronics interface for the Cortex ,link out the fifth switch position on SW1 (address line A4, connector pin A 15),otherwise fit SW1. Now fit the two D-connectors and the two IDC strips. Refer to the photograph and overlay diagram (Fig. 4) for guidance. If you are planning to use a card front, use wire wrap pins in place of the D - connectors and wrap them, along with the Centronics port, onto connectors on the panel. Last of all, fit the ICs. None require any

HOW IT WORKS

The circuit used in the parallel board's CRU interface (Fig. 3) is designed to be generally applicable when attaching devices to the Cortex E-bus. Address decoding is performed by ICs 2,3 and 5 — remembering that with TI 9900 series devices the least significant bit is A15. A six way DIP switch connected to the appropriate inputs of ICs 2and 3 ensures that the board can be mapped according to the following table:

SWITCH No.	Address Line	Address
1	A8	0080h
2	A7	0100h
3	A6	0200h
4	A5	0400h
5	A4	0800h
6	A3	1000h

To map the board at 800h (as for a Cortex Centronics port), only switch 5 should be on.

Two NAND gates in IC6 and two inverters from IC4 give the two active low signals $\overline{SELA}$ and $\overline{SELB}$ which go to the chip enable pins of IC7 and IC8 respectively (the TMS9901 input/ output devices). A third inverter from IC4 is used to produce CRUCLK from CRUCLK on the E-bus.

CRU is gated on to the bus with a three-state buffer latched with BRDSEL (IC1b). The interrupt request (INTREQ) line from the 9901s is converted to the required open collector signal by IC1a.

Output to the printer is taken from IC7. P0 to P7 are the data bits, P9 provides the BUSY input and the inverted output of P8 is the STROBE signal. A pull-down resistor is placed on the BUSY line to produce a 'non-busy' signal when no printer is connected. If your printer requires an active low BUSY and an active high STROBE, refer to the section on testing.

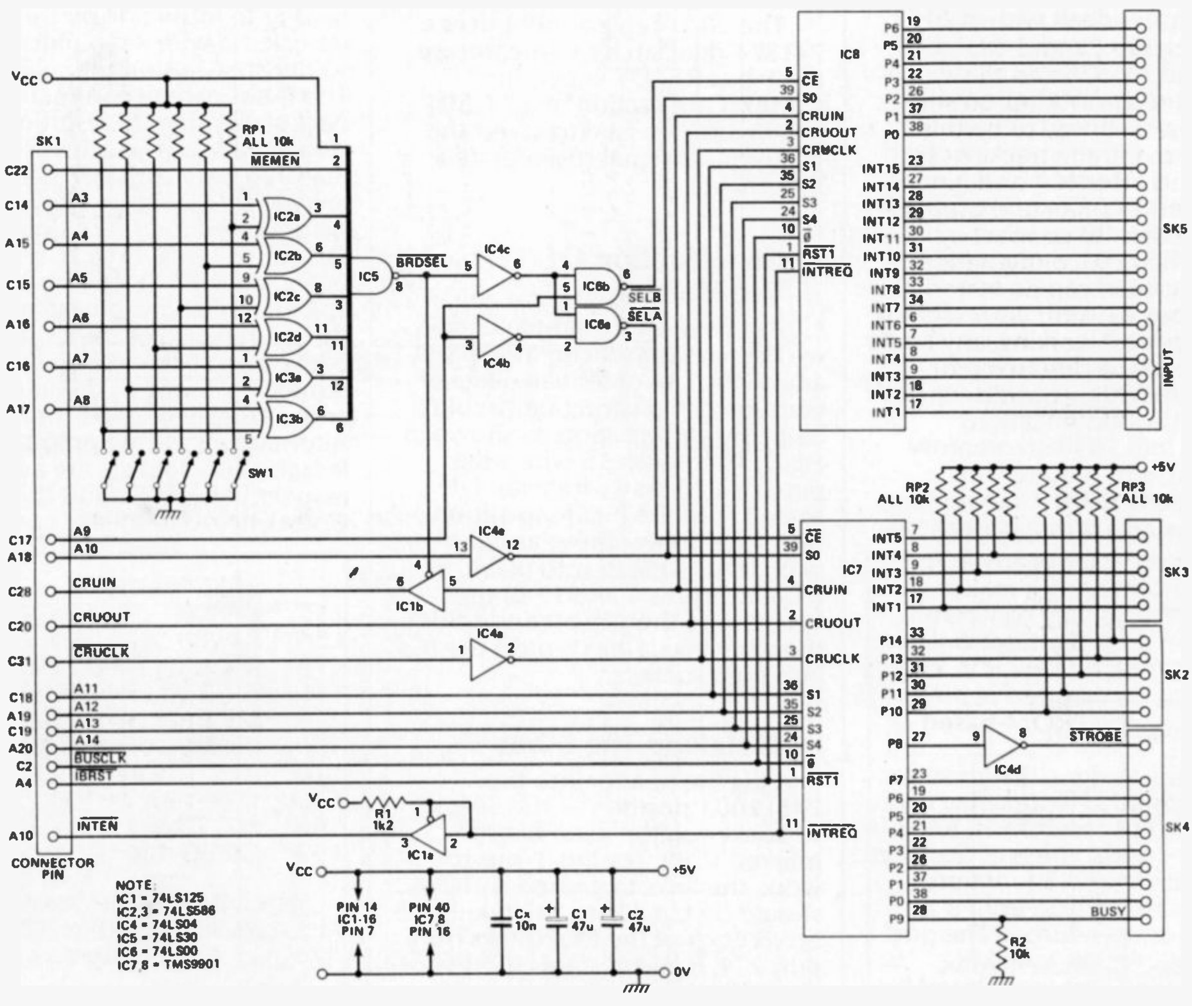


Fig. 3 Circuit diagram of the Parallel I/O board.

special anti-static handling and IC 8 is only necessary if you want the separate I/O lines.

Testing

When you plug the board into the Cortex, remember that the Cortex doesn't look like an E-bus back-plane but an E-bus board. On power-up the Cortex should act as normal. If it doesn't, your problem will most likely be a short on the address or bus control lines. If everything's okay (and assuming that you have mapped the board at 0800h), type UNIT 4 followed by a carriage return and there should be no visible response. Power down, plug the printer cable in and put the printer on line. Type UNIT 4 followed by a carriage return again and now, if you press any key followed by a carriage return, it should be echoed to the printer. If this fails check that your printer requires an active low STROBE signal and an active high BUSY signal.

If this is not the case, you will have to swap round P8 and P9 leads from pins 27 and 28, respectively of IC7 and the STROBE and BUSY lines on socket SK4. The easiest way to do this would be to cut the tracks near pins 27 and 28 of IC7 and near pins 1 and 11 of SK4 and then use short wire links to connect up the tracks in the new configuration.

The joysticks can be tested as outlined below. After you have the Centronics port working, any faults will probably be due to minor errors in the wiring or soldering.

Programming

The software to drive the Centronics port is already in the Cortex PROMs, which makes it very easy to use, The command, UNIT 4, enables the Centronics port and UNIT-4 disables it. The board must be mapped at 0800h to work with the PROM-based software.

Software to drive the joysticks is quite simple to write using the BASE and CRB commands. BASE is used to set the address of the port for use with the CRB function, which returns a value from a specified offset address. The port is wired so that the following offsets are low (value returned by CRB=0) when the relevant Joystick is active:

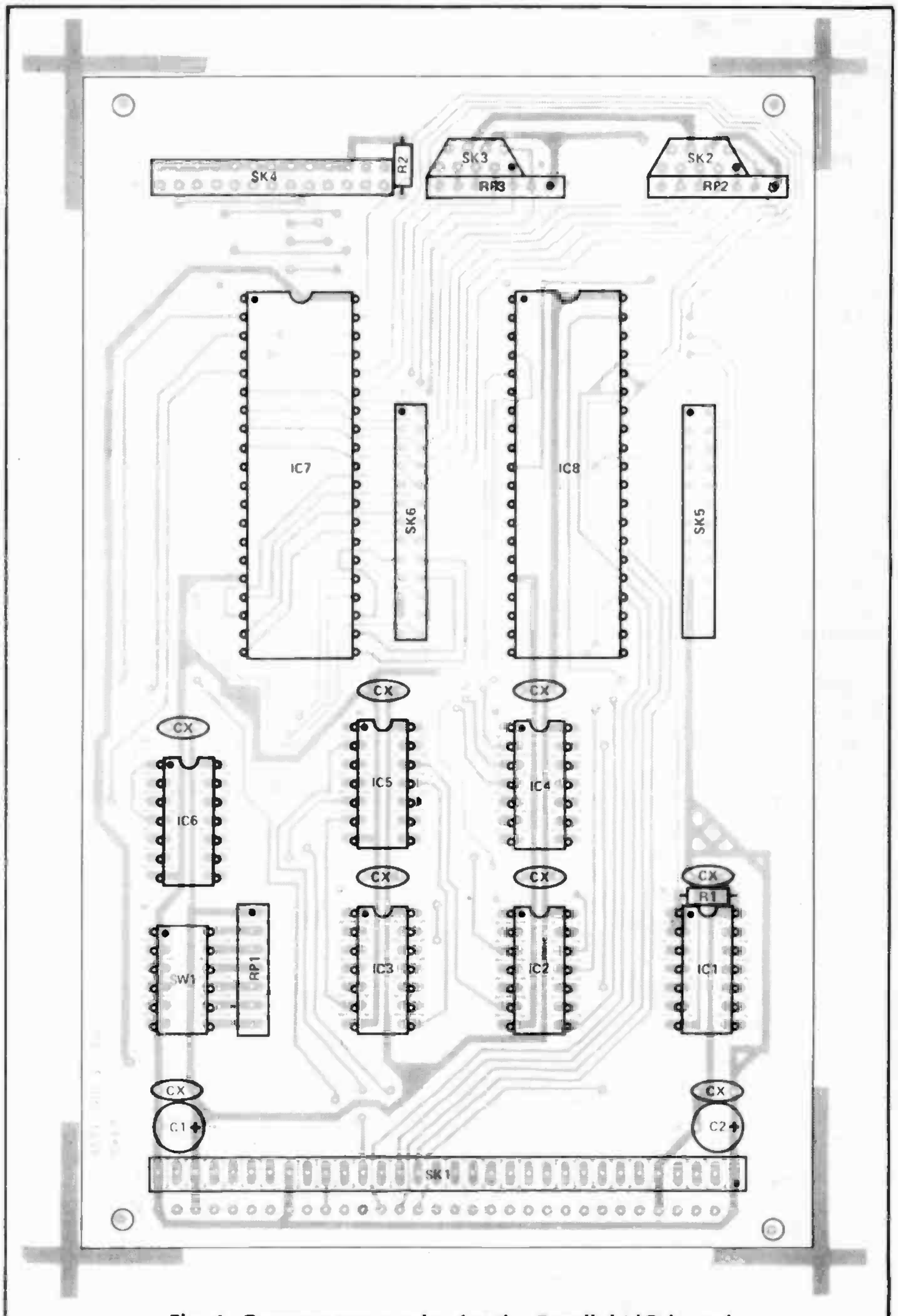


Fig. 4 Component overlay for the Parallel I/O board.

Offset	Function	Joystick
10	Right	1
11	Left	1
12	Down	1
13	Up	1
14	Fire	1
17	Fire	2
18	Up	2
19	Down	2
20	Left	2
21	Right	2

The offsets are arguments for the CRB function, so a very simple picture drawer could use the following program with a joystick in port 1:

```
100   BASE 0800H
110   X=100
120   Y=100
130   IF CRB(13)=0 THEN X=X-1
140   IF CRB(12)=0 THEN X=X+1
150   IF CRB(11)=0 THEN Y=Y-1
160   IF CRB(10)=0 THEN Y=Y+1
170   IF   CRB(14)=0   THEN
GRAPH: X=100: Y=100
180   PLOT X,Y
190   GOTO 130
```

Line 100 sets the base address and lines 130 to 170 test for movement of the joystick or fire button.

Of the uncommitted I/O lines available from the second

TMS9901, 16 can be used as input only. Applying an input current to an output pin can damage the TMS9901. The signal SELB is activated by address line A 9 going high and, therefore, the second 9901 is addressed 40h above the base set on the board. All lines can be read like the joystick ports after changing the BASE address to 0840h. Bits can be set or reset by the CRB command. To set each of the 16 outputs in turn, run;

```
100   BASE 0840H
110    FOR I=1 To16
120    CRB (I) = 1
130    NEXT I
```

For complete details of how to use the TMS9901, consult 'TMS9901 Programmable Systems Interface', Texas Instruments (part no. MP003).

Extensions

If you want further Centronics, or other, ports on your Cortex, you can patch a 16 word (32 byte) long address table at memory location 84h. Each 32-bit word holds either the address of a CRU mapped TMS9902 serial interface chip, or the address of a machine code program. If the lowest significant bit is set in this word, then the address is that of a TMS9902. If the MSB is set, then any output on that unit will have a delay on return characters. On current Cortex PROMs, the table is as follows:

Address	Unit	Value	Event	Notes
84h	01	808h	I/O to screen	mc routine
86h	02	081h	I/O to RS232	TMS9902
88h	03	181h	I/O to cassette	TMS9902
8Ah	04	754h	Centronics I/O	mc routine
8Ch	05	000h	not used	★
8Eh	06	000h	not used	★
90h	07	000h	not used	★
92h	08	000h	not used	★
94h	09	000h	not used	★
96h	10	000h	not used	★
98h	11	000h	not used	★
9Ah	12	000h	not used	★
9Ch	13	000h	not used	★
9Eh	14	000h	not used	★
A0h	15	000h	not used	★
A2h	16	000h	not used	★

If you want your Centronics printer on unit 5 instead of unit 4, for example, change memory location 8Ch to 754h, Typing UNIT 5 followed by a carriage return will now activate your printer port.

Connections

The following section gives the pin outs for sockets SK1 to SK6.

PARTS LIST
(MAIN BOARD)

RESISTORS (all 1/3W, 5%)

R1	1k2
R2	10k
RP1,2,3	7-pin 10k SIL resistor pack

CAPACITORS

C1, 2	47μ, 16V electrolytic
Cx	10n, 0.2 pitch decoupling

SEMICONDUCTORS

IC1	74LS125
IC2, 3	74LS86
IC4	74LS04
IC5	74LS30
IC6	74LS 00
IC7, 8	TMS9901

MISCELLANEOUS

SK1	64-way right-angled, male A+C DIN 41612 card connector
SK2, 3	9-pin right-angled, male D connector
SK4	13x2 right-angled IDC connector
SK5,6	13x2 straight IDC connector
SW1	6-way DIL switch

two 40 pin DIL sockets, six 14 pin DIL sockets, printer cable, PCB.

PARTS LIST
(2001 REPLACEMENT)

RESISTOR

R1	10k

SEMICONDUCTORS

IC1	74LS74
IC2	74LS04

MISCELLANEOUS

Veroboard, wire-wrap pins or wire-wrap socket (20-way), two 14-pin DIL sockets, wire for links

BUYLINES

The TMS9901 should be widely available, as should all other chips. Connectors and printer leads are available from Maplin, Watford, Technomatic, Cricklewood, etc. The PCBs are available exclusively from MicroProcessor Engineering Ltd., 21 Hanley Road, Shirely, Southampton SO1 5AP (tel: 0703 780084) at a price of £13.00 for the bare board, £36.00 partially populated or £48.00 fully populated.

(N/C means not connected or reserved).

SK1 PIN	A-ROW Function	C-ROW
1	GND	GND
2	PRES	BUSCLK
3	+12V	-12V
4	IORST	NMI
5	+5V	+5V
6	+BATT	N/C
7	N/C	N/C
8	N/C	N/C
9	N/C	N/C
10	INTEN	ALATCH
11	XA0	XA1
12	XA2	XA3
13	A/D/INT 0	A/D/INT 1
14	A/D/INT 2	A/D/INT 3
15	A/D/INT 4	A/D/INT 5
16	A/D/INT 6	A/D 7
17	A/D 8	A/D 9
18	A/D 10	A/D 11
19	A/D 12	A/D 13
20	A/D 14	A/D 15/CRUOUR
21	AREADY	MEMEN
22	DEN	READY
23	GRANTIN	GRANTOUT
24	PWRFAIL	BUSY
25	GND	GND
26	+15V	ANAHI
27	ANACOM	ANALO
28	-15V	CRUIN
29	#WE-	+5STBY
30	+5V	+5V
31	MEMWIDTH	CRUCLK
32	GND	GND

SK2 AND SK3

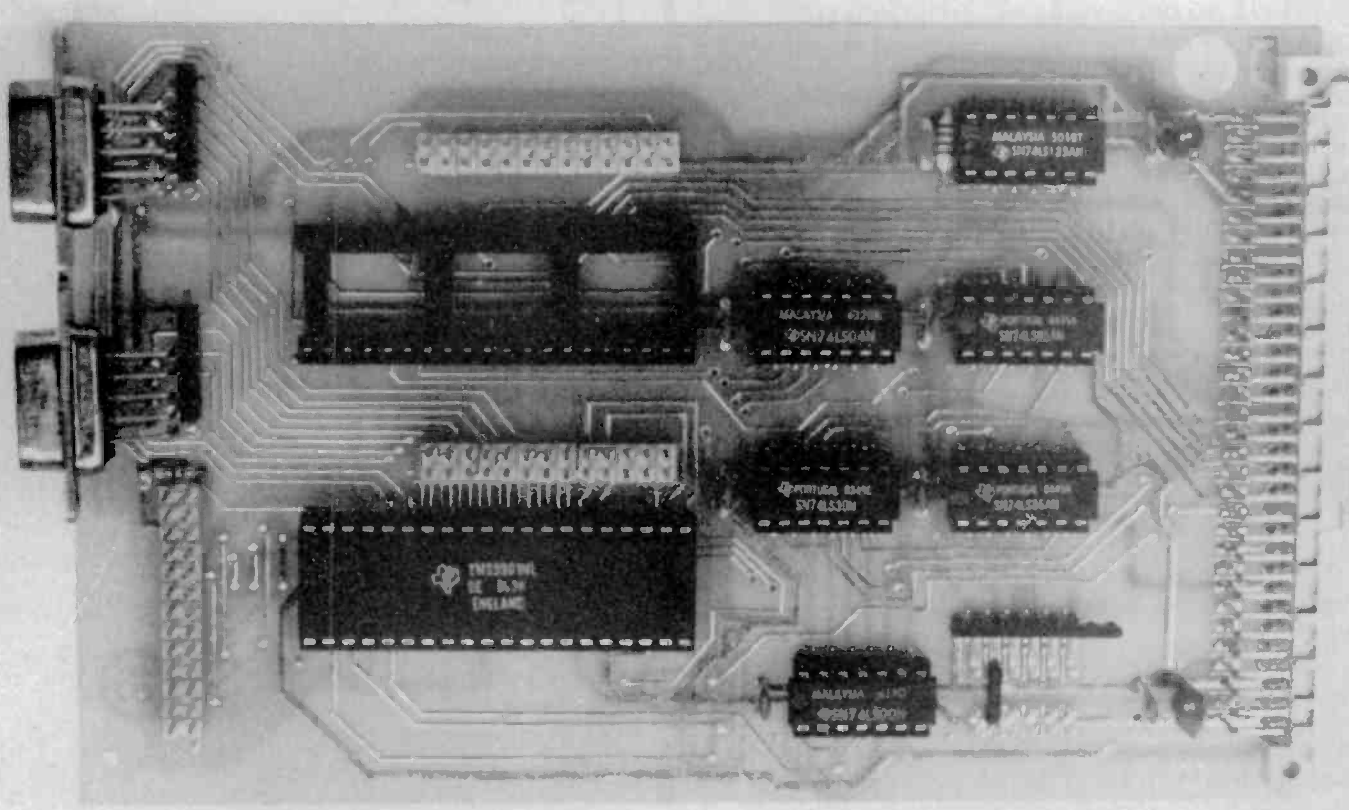
PIN	FUNCTION
1	UP
2	DOWN
3	LEFT
4	RIGHT
5	N/C
6	FIRE
7	+5V
8	GND
9	N/C

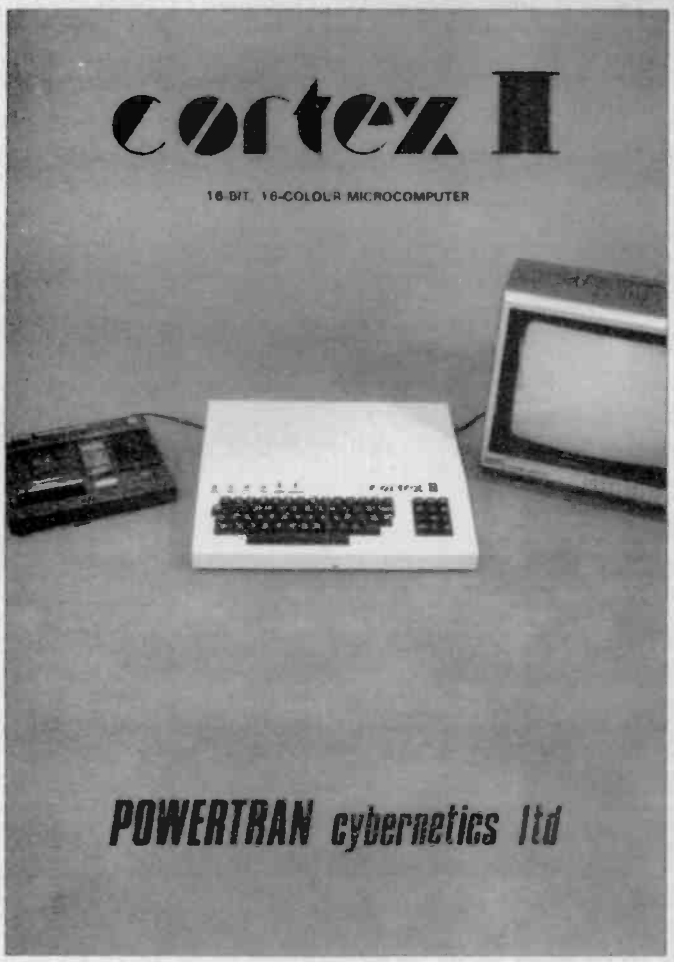
SK4

PIN	FUNCTION
1	STROBE
2	DATA 1
3	DATA 2
4	DATA 3
5	DATA 4
6	DATA 5
7	DATA 6
8	DATA 7
9	DATA 8
10	ACKNLG
11	BUSY
12	PE
13	SLCT
14-24	GND

SK5 AND SK6

PIN	FUNCTION	PIN	FUNCTION
1	INT7/P15	2	INT6
3	INT/8/P14	4	INT5
5	INT9/P 13	6	INT4
7	INT 10/P12	8	INT3
9	INT11/P11	10	INT2
11	INT12/P10	12	INT1
13	INT13/P9	14	P6
15	INT14/P8	16	P5
17	INT15/P7	18	P4
19	GND	20	P3
21	GND	22	P2
23	GND	24	P1
25	GND	26	P0


The cortex parallel I/O board configured for Centronics port and two joysticks only.



ETI

SPECIAL OFFER

For a limited period and only to readers of ETI, Powertran Cybernetics Limited are offering the Cortex II 16-bit micro in kit form at only £199 plus VAT.

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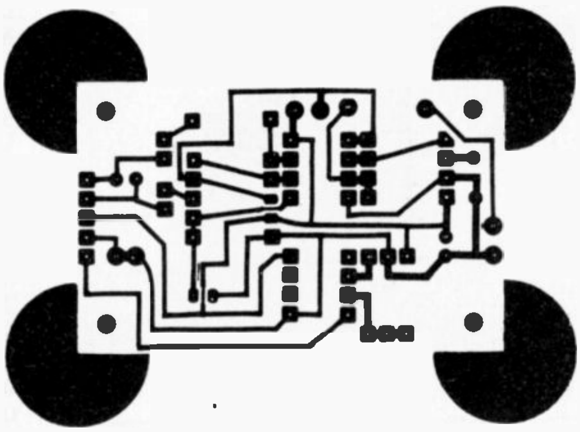
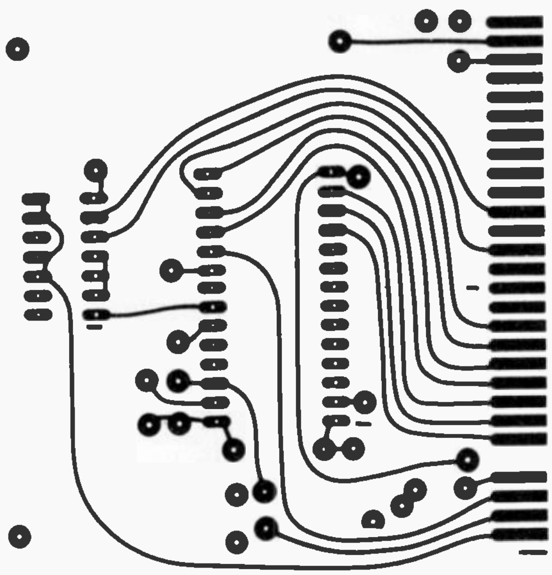
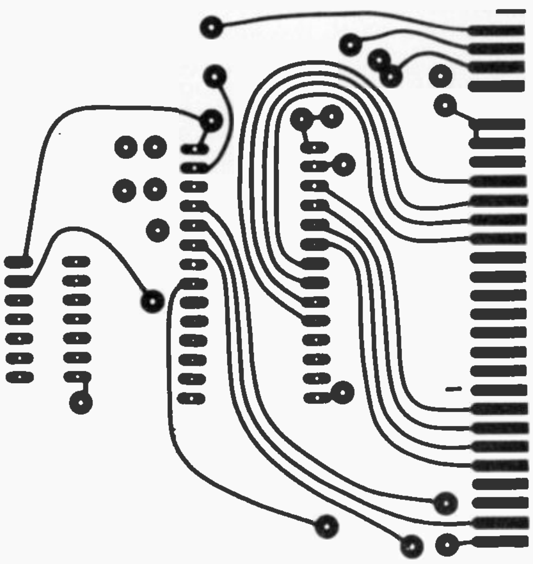


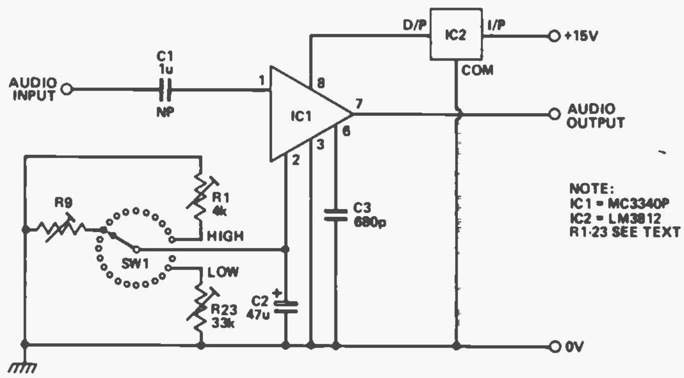
The foil pattern for the direct injection box board.





The top and bottom foils for the SpectROM board.

TECH TIPS



Audio Attenuator

D. R. Coomber
G8UYZ
Staffordshire

Noise-free attenuation of audio signals may be accomplished by the use of a simple rotary switch and an MC3340P electronic attenuator chip. The chip uses supplies from 9 to 10 Vdc, with input levels up to 500 mV, and output level above 2 V!!. Values of resistance will depend a great deal upon input and output levels and supply voltage. As will be seen, the suggested steps require a 24 pole switch. Values of step resistance should be in the range of 4k to 33k ohms, which will give from —90dB to +13dB gain, so few presets will enable the constructor to arrange the step levels to those used in broad-casting.

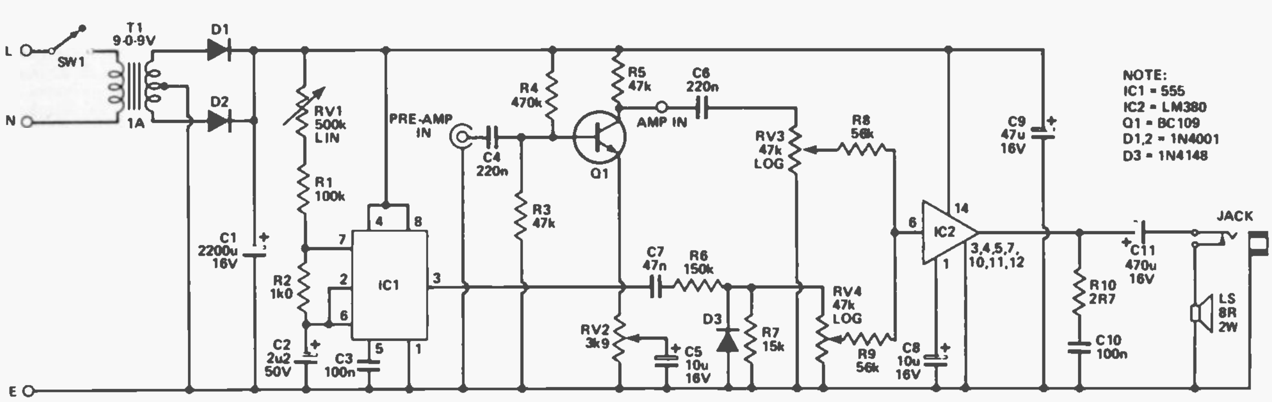
Combined Practice Amp and Metronome

J.C. Barker
Leeds

This practice amp was designed for use with a portable keyboard, but could equally be used with an electric guitar or other instrument. It consists of two parts: the amplifier which uses the ubiquitous LM380 audio amp IC and a metronome whose volume can be adjusted from zero and whose beat rate can be adjusted from 40 to 108 per minute — which happens to be the normal range of a clockwork metronome. A 555 timer is used in the astable mode, its output being shaped by C7, R6, D3 and R7. A suitable power supply is shown, built-in.

A third part of the circuit can be added before C6. This is a pre-amp which can be used if the output from your instrument is unable to fully drive the LM380. The components are C4, R3, R4, R5, RV2, C5 and Q1 and these can be left out if the pre-amp facility is not required. RV2 sets the required pre-amp level and should be a preset.

In use the amp can be simply adjusted for volume by setting RV3 with the metronome volume control (RV4) turned right down. Musical novices — most electronics hobbyists — or even experienced performers rehearsing can bring in the metronome by turning RV4 up. The LM380 used here (is the 14-pin version, with an output power of around 2W. A low impedance headphone could be plugged into the jack socket for personal practice.



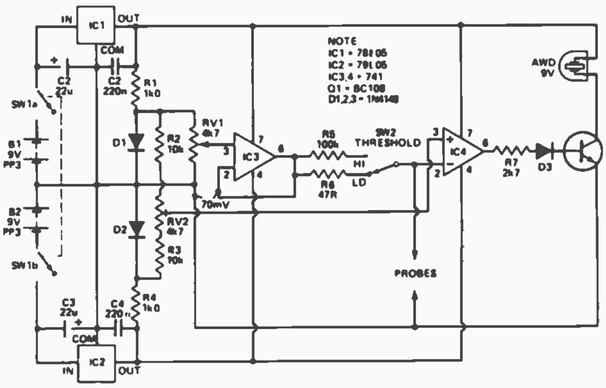
Sensitive Continuity Tester

M.J. Punnett
Swanley

This design is fairly simple using only four ICs, and could be built by an inexperienced constructor. The only possible difficulty lies in the calibration process, which requires a reasonable multimeter and a little patience.

For calibration, a voltmeter must be connected across the points marked on the circuit diagram and RV1 adjusted for a reading of 70mV. Known resistances should then be connected between the probes and RV2 adjusted for correct sensitivity on the HIGH thresholds range. In theory, the LOW range thresholds are given by R6/R5 multiplied by the HIGH thresholds. The specification requires the device to respond to 1K but not 3K on HIGH and to respond to 0R5 but not 1R5 on LOW. These specified values should be used in the calibration process. With a little care the threshold on HIGH can be set to within a couple of hundred ohms. Multiturn pots are recommended for RV1 and RV2.

The circuit action is simple. D1, D2 and the associated resistors and pots form a source of two stable reference voltages — one positive (set by RV1) and one positive or negative (set by RV2). IC1 is used as a voltage follower, to keep a potential of 70mV at the testing point (marked on the diagram). The selected HIGH or LOW resistor (R5 or R6) and the resistance between the probes act as a potential divider and IC2 as a comparator, comparing the probe voltage to the second reference voltage. There is no need to offset-null this device, as RV2 allows enough adjustment for it to be compensated for on the input. Since the test voltage is only 70mV, no semiconductor junction (not even germanium detector diodes) will be biased into conduction and no damage can be caused to delicate ICs.



REVIEWS

AN INTRODUCTION TO MICROPROCESSORS

Thorn EMI Home Electronics, Macmillan Education, Houndmills, Basingstoke, Hants RG21 2XS. price: £5.95

MICROELECTRONICS AND MICROPROCESSOR BASED SYSTEMS

Noel M. Morris, Macmillan Education, Houndmills, Basingstoke, Hants RG21 2XS. price : £8.95.

Two books on microprocessors have come my way this month. The first, and cheapest, is 'An Introduction To Microprocessors' which, despite the general title, deals exclusively with the 6502. The second, 'Microelectronic and Microprocessor Based Systems' is based on the 8085.

Both books cover the usual ground. There is the obligatory introduction to binary arithmetic, without which no book could ever be considered complete, although in the 6502 book it is tucked away in an appendix. There are diagrams of the internal architecture of the respective microprocessors, details of control signals and bus lines and such like, a pinch of software, a fairly large measure of D-to-A and A-to-D conversion, some odds and ends about interfacing, and there you have it.

For some reason, no book on microprocessors ever gets published without an explanation of how to light up a single seven-segment display (we've come a long way since the 555 and an LED) and both books cover this essential information in great detail.

★ ★ ★

Both books are similar in quality and presentation. The difference is in quantity — the 8085 book goes into greater detail and covers more ground than the other.

For the beginner who knows the basics of electronics and logic but nothing at all about computers, I would not be inclined to recommend them. It would be like being lost in the desert with a map which details each grain of sand but doesn't actually say where the edge of the desert might be, or where it is in relation to the rest of the world.

For the reader who has some experience with microprocessors, perhaps to the extent of writing machine code programs for a home computer or building a magazine project incorporating a microprocessor, they may well be useful. There comes a point in expermenting when the ideas that have been formed need to be sharpened up and extended. Either book would help here.

★ ★ ★

My general reservation about books of this type is that they tend to make heavy going of what are essentially very simple ideas. If a book is based on a particular microprocessor, it automatically takes on board all the baggage that goes with the chosen device — the detail that makes it versatile and convenient to use in 'real life'. The book then falls between two stools: on the one hand the morass of detail obscures the point the author is trying to make, on the other hand the information is not complete enough to apply to a practical design.

Nevertherless, there is a good deal of solid and useful information in both of these books, and as long as you are not a raw beginner or a professional engineer, you'll find plenty to interest you.

Paul Chappell

OPEN CHANNEL

One of the major problems with writing a column for a monthly journal such as as ETI is that press schedules and deadlines are such that the copy — the words I write, to the uninitiated — have to be on the editor's desk some seven or eight weeks before you, the reader, see the magazine on the news-stands. This means that anything written may well be out of date before publication occurs. Nowhere is this state of affairs more prevalent than in the world of electronics, where decisions taken by individuals, organisations or governments, can have extremely rapid and fundamental consequences.

In The Air Again?

As I write, the news has just broken that the direct broadcast by satellite (DBS) venture, which I have paid so much interest to over the last few months, has finally collapsed, with all sides in the negotiations firing broadsides at each other, and blaming all other parties for what was really a shambles of a situation.

To sum up, there have traditionally been two interested parties in the affair: the Club of 21, which is (was?) the operating consortium of companies wishing to take part in the broadcasting venture; and Unisat, the organisation consisting of satellite manufacturers and and operators who were to lease the necessary satellites for the job. The whole affair was originally set-up in this particular way by the Government, which is *officially* disinterested in how DBS is run, as long as it is on a commercial basis.

★ ★ ★

If you've followed this column over the preceding months' editions of ETI, you will have noted from my scepticism how badly I thought this situation has been handled. For a start, the officially disinterested Government appears to have been doing a certain amount of behind-the scenes wheeling and dealing to keep the Club of 21 from changing satellite suppliers. Second, Unisat seems to have priced the rent of their satellites abnormally high (although this changed over the last few weeks when the price was lowered significantly to prevent the club of 21 from pulling out altogether).

Technically, there is no problem which could not be overcome by the organisations involved. At root, the high cost of setting-up and running DBS along the lines laid down has proved too expensive by far. The Club of 21 could not be expected to provide a service which was so expensive that no-one would use it — such a service is no service at all — and yet that is what everyone seemed to be expecting of it. And so the game reached a stalemate only days ago, with the club of 21 saying that enough is enough, bringing to an end the matter of DBS, in one form at least.

So now we have to make two decisions (and when I say 'we', I really mean the Government): whether or not Joe (or Jo) Public actually does *want* DBS, and whether or not it is *necessary*. If DBS is wanted by the population, then the price which it is prepared to pay for it presents a problem which must be resolved. It could be argued that the Club of 21 has already found that out. If DBS is deemed to be a necessary step forward then the government must take up the gauntlet and pay for it — perhaps outright — with the taxpayers' money. Rumour has it that certain pawns in the government's game are now frantically running around trying to get the Club of 21 to reconsider, by offering financial inducements and concessions. These are too little and too late.

The French Government's attitude to DBS gives us the classic example of what I'm suggesting our Government ought to be thinking about. In a heavily subsidised deal (the Government has a one-third stake in the organising body, and is giving cash hand-outs left, right and centre to concerned electronics organisations), French DBS is scheduled to come on-air by the end of 1986 with a wide range of programmes, all paid for by advertising.

If we really do need DBS at all (something which I, for one, am not sure about), then let's cut the cackle and do it! If we don't, then let's forget all about it and concentrate on other matters.

★ ★ ★

Finally, if you read this column to find that my news is out of date and that further developments on the DBS front have occurred since my pen met paper, please try and remember the problems of the troubled journalist with long copy dates. I'll try and get it right, next time, and not write about such a volatile topic.

Keith Brindley

PLAYBACK

Another salvo has been fired in the continuing war between the British Phonographic Industry and practically everyone else. In their efforts to stamp out tape copying, the BPI circularised dealers, not too long ago, trying to warn them off selling twin cassette recorders because they could be used to duplicate copyright pre-recorded tapes. Manufacturer Amstrad, who makes a model having a twice normal speed copying facility, took them to court in July to establish that there was nothing unlawful in selling such decks because of a *possible* use. They further pointed out that a warning concerning illegal copying was included in their instruction book.

Unfortunately, Amstrad's gambit backfired and the High Court judge found in favour of the defendants, ruling that Amstrad had 'incited the procurement of copyright infringement.' The BPI is now asking for the withdrawal of all twin cassette decks from the shops, although they magnanimously have said that they will not ask for machines already sold to be returned!

By the same token, the police should ask for the banning of all private motor sales because some vehicles will be used, inevitably, as get-away cars from robberies. The sale of crowbars should be stopped because they are used for house-breaking. Or, a closer analogy, the sale of photocopiers should be prohibited because they are used extensively at libraries and elsewhere to reproduce copyright material from books and magazines.

* * *

The BPI want to have their cake and eat it. They are pressing the government to impose a levy on all cassette tapes sold to cover the 'loss' from copying pre-recorded tapes, yet they want to ban the means of doing it. They quote substantial loss figures, but how do they arrive at them? How can they possibly determine how many sales are lost through this means? Someone may buy a tape for his home hi-fi, then copy it for use in the car. If prevented from doing so, would such purchasers buy a duplicate tape, or would they just take the original when travelling?

If tapes are copied, where did the originals come from? Someone had to buy them: Unlike video piracy, in whcih films are often 'borrowed' from cinemas, there must be very few cases of tapes stolen for the primary purpose of copying. In fact, copying may actually stimulate sales.

* * *

No one wants to deny artists the just reward of their labours, but when the life styles of most pop stars are considered, and the balance sheets of the recording companies are taken into account, there doesn't appear to be a great deal of actual deprivation.

Imposing a tape levy would shift the injustice from those able to bear it on to the shoulders of those who are not: music students, amateur musical groups, dramatic societies, reading classes, language students, nature recordists, blind talking books and magazine compilers, to say nothing of ordinary folk who use blank tapes for a variety of quite legal purposes.

Authors have been subject to a similar injustice for years by having their books loaned by libraries by the thousands of issues without any recompense. Now they have been given a desultory sum of less than a penny a loan by the government. With the modern way of life, some injustices are inevitable. Activities of organisations like the BPI would add to them rather than otherwise.

Vivian Capel

TRAINS OF THOUGHT

The most obvious application of electronics in railway modelling — indeed, in any other form of modelling — is the control of DC motors. The rheostat-type controllers still available from some suppliers are, to say the least, crude devices; they starve the motor of current just when its demand is greatest as it starts from rest, causing trains to move with all the gentleness of a bullet from a rifle.

Two electronic techniques vie for the attention of the modeller, each with its own peculiar advantages and disadvantages.

Pulse Racing

Pulse width modulation (PWM) regulates motor speed by chopper action. During pulses the motor is free to draw all the current it needs to overcome inertia and get the load moving. Controllers can generate their own pulses, using a 555 set up as a multivibrator, for instance, or — my favourite technique — using the rectified mains as a source of pulses. In this latter case, the nulls could trigger a 555 set up as a variable interval timer.

• • •

The advantages of PWM are excellent starting and low-speed running and the avoidance of heat sinking on the output device. It is also comparatively easy to set up a circuit which will monitor the motor EMF (the back EMF) between pulses to give a direct-reading speedometer capable of servicing a speed-locking feedback loop. The disadvantages are motor noise and, worse still, motor heating. The latter is most problematic at sustained low speeds or when the motor is in a confined space, for example, in N-gauge model locomotives.

Going Loopy

The alternative to PWM is a simple closed-loop, (voltage-follower) system. At its simplest, this need consist of no more than a Darlington in emitter-follower configuration with its input from a pot across the supply. The supply may be smoothed or unsmoothed. More complex designs use the 741 or similar op-amps to compare the motor EMF with the setting of the speed control. IR Compensation can be provided by monitoring the motor current and incrementing the input voltage proportionately — this has the effect of speed locking.

• • •

The advantages are the total absence of motor noise and heating; the disadvantages are the need for substantial heat sinking on the output device and the lack of smoothness when starting as compared to a PWM circuit of similar sophistication.

Two-in-one

The two techniques are by no means mutually exclusive. The author's 'PWAyMan' controller combined the best features of both techniques. The speed control directly set the output pulse *height*, while pulse *width* was controlled by a comparator monitoring both speed control and motor EMF (between power pulses). At low speeds, pulse voltage was low eliminating both motor noise and heating while the feedback system kept trains rock steady over the most torturous of curves and gradients. A direct reading speedometer was also provided.

Roger Amos

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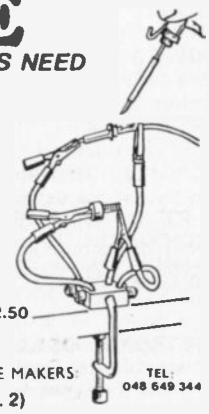

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