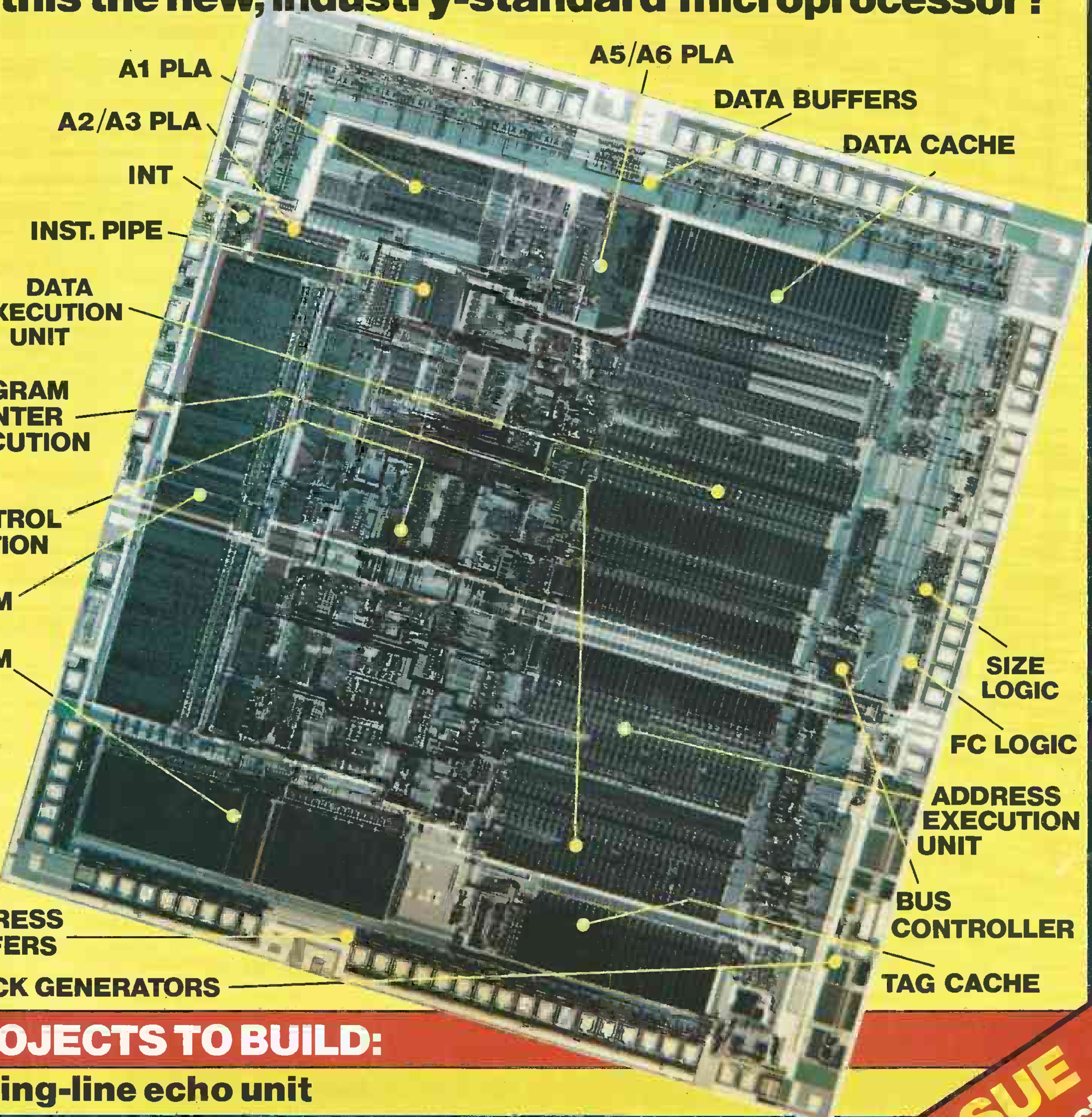
AN ARGUS SPECIALIST PUBLICATION

electronics today

INTERNATIONAL OCT 1984 99p

THE 32s ARE HERE!

Is this the new, industry-standard microprocessor?



PROJECTS TO BUILD:

Spring-line echo unit

Digital control port for the Spectrum

Disco/party strobe

150th ISSUE

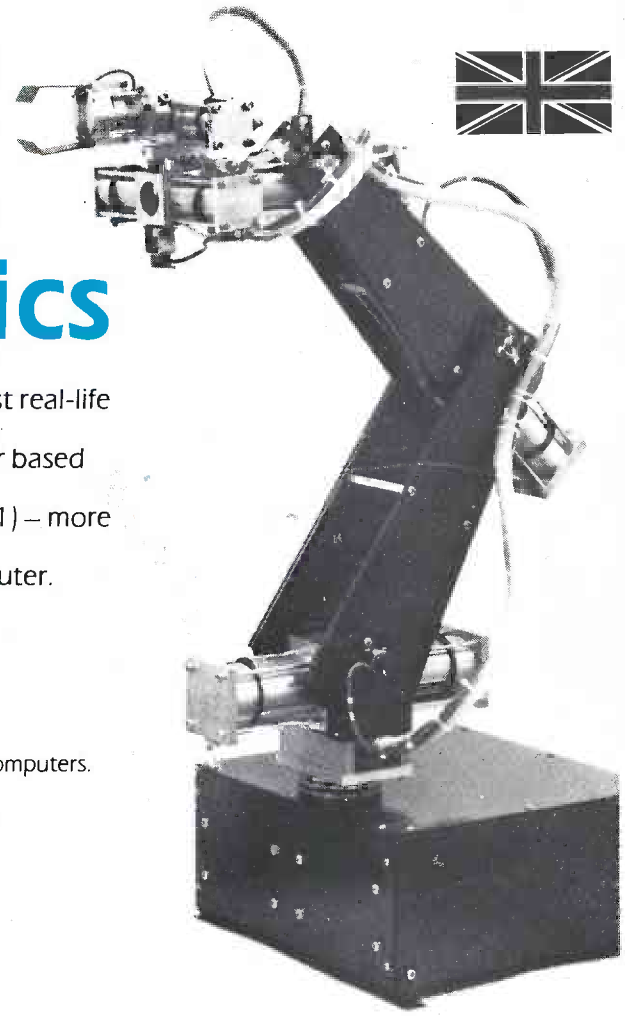
Cumulative project index

AUDIO....COMPUTING....MUSIC... OTICS..

neptune

for low-cost training in

real-life robotics



The advanced design of the Neptune 2 makes it the lowest cost real-life industrial robot.
It is electro-hydraulically powered, using a revolutionary water based system (no messy hydraulic oil!)
It performs 7 servo-controlled axis movements (6 on Neptune 1) – more than any other robot under £10,000.
Its program length is limited only by the memory of your computer.
Think what that can do for your BASIC programming skills!

And it's British designed, British made.

Other features include:

- Leakproof, frictionless rolling diaphragm seals.
- Buffered and latched versatile interface for BBC VIC 20 and Spectrum computers.
- 12 bit control system (8 on Neptune 1).
- Special circuitry for initial compensation.
- Rack and pinion cylinder couplings for wide angular movements.
- Automatic triple speed control on Neptune 2 for accurate 'homing in'.
- Easy access for servicing and viewing of working parts.
- Powerful – lifts 2.5 kg. with ease.
- Hand held simulator for processing (requires ADC option).

Neptune robots are sold in kit form as follows:

Neptune 1 robot kit (inc. power supply)	£1250.00
Neptune 1 control electronics (ready built)	£295.00
Neptune 1 simulator	£45.00
Neptune 2 robot kit (inc. power supply)	£1725.00
Neptune 2 control electronics (ready built)	£475.00
Neptune 2 simulator	£52.00
ADC option (components fit to main control board)	£95.00
Hydraulic power pack (ready assembled)	£435.00
Gripper sensor	£37.50
Optional extra three fingered gripper	£75.00
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.

mentor

desk-top robot

This compact, electrically powered training robot has 6 axes of movement, simultaneously servo-controlled. It gives smooth operation, and its rugged construction makes it ideal for use in educational establishments. Other features include long-life bronze and nylon bearings, integral control electronics and power supply, special circuitry for inertial compensation, optional on-board ADC, and hand-held simulator as the teaching pendant. Like Neptune, Mentor's program length is limited only by your computer's memory. Programming is in BASIC.

Mentor is all-British in design and manufacture and comes in kit form at an astonishingly low price:

Mentor robot kit (inc. power supply)	£345.00
Mentor Control electronics (ready built)	£135.00
Mentor Simulator (requires ADC option)	£42.00
ADC option (Components fit to control electronics board)	£19.50
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.

Cybernetic Applications

CYBERNETIC APPLICATIONS LIMITED

PORTWAY TRADING ESTATE, ANDOVER, HANTS SP10 3ET
TEL: (0264) 50093 Telex: 477019

electronics today INTERNATIONAL

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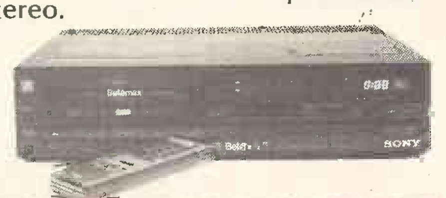
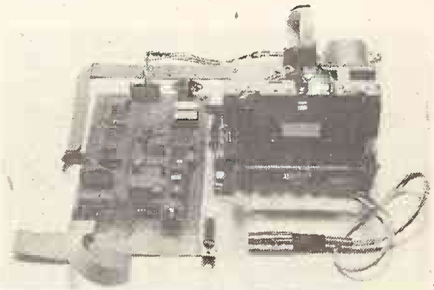
FEATURES



PROJECTS



INFORMATION

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

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

ROCKER SWITCHES

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

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

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	485p
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"

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

GAS/SMOKE DETECTORS

TGS812 or TGS813

£6 each

VEROBOARD 0.1in

2½ x 3¼ 95p
2½ x 5 110p
3¾ x 3¾ 110p
3¾ x 5 125p
3¾ x 17 420p
4¾ x 17 590p
Pkt of 100 pins 55p
Spot face cutter 150p
Pin insertion tool 185p

VA 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 8p

DALO ETCH RESIST PEN
Plus spare tip 100p

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

ULTRASONIC TRANSDUCER
40KHz 475 pr

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double sided	S.R.B.P. S/Speed
6" x 6"	100p	125p	9.5" x 8.5"
6" x 12"	175p	225p	110p

DILL 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

2x6 way	—	111p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	210p	175p
2x22 way	215p	250p
2x23 way	175p	—
2x25 way	285p	275p
2x28 way	190p	—
2x30 way	310p	—
2x36 way	360p	—
2x40 way	380p	—

SIL SOCKET 0.1" Pitch 20 way **65p**

ANTEX SOLDERING IRONS

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

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card 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	205p	236p	160p	320p
40 way	220p	250p	180p	340p
50 way	235p	270p	200p	395p
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	320p	220p	285p
DIN41612 2 x 32 A + C	295p	340p	240p	300p
DIN41612 3 x 32 A + B + C	360p	385p	280p	395p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	90p
16 pin	48p	105p
24 pin	88p	178p
28 pin	290p	295p
40 pin	250p	255p

ZIF OIL SOCKETS

24 pin 565p
28 pin 750p
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	80p	105p	160p	250p
Angle pins	150p	210p	250p	355p
PCB pins	120p	130p	195p	295p
Female				
Solder lugs	105p	160p	200p	335p
Angle pins	165p	215p	290p	440p
PCB pins	150p	180p	240p	420p
COVERS	80p	75p	75p	90p

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	475p	470p
36 way Centronix	450p	475p
24 way Female	525p	490p

PANEL METERS

FSD
60 x 46 x 35mm
0–50mA
0–100mA
0–500mA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0.6A
0.2A
0.25V
0.50V AC
0.300V AC
"S"
"VU" **490p** each

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	285
455KH	370
1MHz	275
1.008M	275
1.28MHz	390
1.6MHz	395
1.8MHz	515
1.8432M	250
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	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.7328MHz	250
7.68MHz	200
8.0MHx	150
8.089333M	395
8.86723M	220
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	175
12.528M	300
14.31814M	170
15.0MHz	240
16.0MHz	220
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295
116.0MHz	300

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-100 53R Coil, 6V DC (5V4 to 9V9) **190p**
RL6-111 205R Coil, 12V DC (10V7 to 19V5) **195p**
RL6-114 740R Coil, 24V DC (22V to 37V) **200p**

ASTEC UHF MODULATORS

Standard 6MHz **375p**
Wideband 8MHz **550p**

BUZZERS

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

LOUDSPEAKERS

Miniature, 0.3W- 8
2in, 3¼in, 2½in, 3in **80p**
2½in 40 , 64 or 80 **80p**

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular **£75**
- MICROVITEC 1431. 14" Colour RGB input Connecting cable incl. **£174**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£195** (car £7)
- KAGA 12". As above but Hi-Resolution **£259** (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 **98p**
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **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-1.3A; 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)
Specially wound for Multirail computer PSUs
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 **965p** (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	78LO5	30p	79LO5	50p
6V	78LO6	30p	—	—
8V	78LO8	30p	—	—
12V	78L12	30p	79L12	50p
15V	78L15	50p	79L15	60p

ICL7660 248p
RC4194 375p
RC4195 160p
LM309K 135p
LM317K 250p
LM317KP 450p
LM323K 450p
LM337 175p
LM723 Var 30p

TAA550 50p
TDA1412 150p
78H05 + 5V/5V 550p
78H12+12V/5A 640p
78HG + 5V to + 25V 5A 585p
79HG − 2.25V to −24V; 5A 685p

SOLDERCON PINS

Ideal for making SIL or DIL Sockets
100 pins 75p
500 pins 350p

ALUM BOXES

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

BROTHER HR15 PRINTER

A high quality Daisy Wheel printer at the price of a Dot Matrix printer.

Price £349

CMOS

4000	20	4072	25	4536	275
4001	25	4073	26	4538	80
4002	25	4075	25	4539	90
4006	75	4076	68	4541	95
4007	25	4077	25	4543	70
4008	60	4078	25	4544	150
4009	45	4081	25	4548	40
4010	60	4082	25	4549	400
4011	25	4085	60	4553	245
4012	25	4086	60	4554	180
4013	60	4089	125	4555	35
4014	60	4093	37	4556	55
4015	60	4094	70	4557	250
4016	40	4095	95	4558	120
4017	60	4096	100	4559	395
4018	60	4097	275	4560	180
4019	58	4098	80	4561	104
4020	90	4099	110	4562	350
4042	43	4160	95	4566	165
4021	58	4161	96	4568	250
4022	67	4162	96	4569	175
4023	30	4163	96	4572	45
4024	50	4174	96	4580	255
4025	22	4175	105	4581	125
4026	90	4194	105	4582	99
4027	43	4408	850	4583	100
4028	45	4409	850	4584	60
4029	75	4410	725	4585	70
4030	35	4411	750	4597	330
4031	130	4412	805	4599	155
4032	70	4415	590	40085	90
4033	130	4419	280	40097	45
4034	146	4422	770	40098	42
4035	70	4435	850	40100	215
4036	275	4440	900	40101	130
4037	115	4450	360	40102	140
4038	75	4451	350	40103	412
4039	280	4490	450	40104	120
4040	60	4500	395	40105	220
4041	57	4501	38	40106	60
4042	50	4502	60	40107	55
4043	42	4503	40	40108	325
4044	50	4504	99	40109	100
4045	110	4505	385	40110	235
4046	60	4506	100	40114	240
4047	60	4507	45	40161	194
4048	55	4508	130	40163	75
4049	38	4510	55	40174	75
4050	35	4511	55	40175	75
4051	45	4512	55	40181	220
4052	60	4513	150	40182	80
4053	60	4514	115	40192	75
4054	85	4515	115	40193	95
4055	85	4516	55	40194	70
4056	85	4517	275	40195	75
4057	1000	4518	48	40244	196
4059	435	4519	32	40245	196
4060	68	4520	53	40257	196
4061	500	4521	115	40373	220
4062	986	4522	125	40374	220
4063	85	4526	50	45106	586
4066	45	4527	65		
4067	245	4528	68		
4068	25	4529	150		
4069	25	4530	90		
4070	25	4531	130		
4071	25	4532	65		
		4534	400		

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 65
Green/Yellow 78
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
ILD74 145
ILQ74 275
TIL111/2/4 70
ILCT6 Darlington 135
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 170
SLOTTED Optical Switch similar to RS Comp.'s 195

COMPUTER CORNER

- **EPSON RX80 PRINTER: 100 CPS**, 9 x9 matrix, dot addressable graphics, condensed & double width printing, Normal, Italics & Elite Char., Tractor Feed, Bidirectional, Logic seeking £229
- **RX80 F/T Epson Printer.** As above but has both Tractor and Friction feed facilities £245
- **EPSON FX80 PRINTER 10"** Tractor & Friction Feed, 160 CPS, bi-directional Logic seeking, 9 x 11 matrix, hi-res bit image, Normal, Italic & Elite Char. Super & Subscript. Proportional spacing £319
- **SEIKOSHA GP100A.** 10" Tractor Feed, 80 Colmn. 30CPS, Normal and Double width Char. Dot Res Graphics £138
- **SEIKOSHA GP250X, 50 CPS,** Normal & Double width & height characters; RS232 & Centronics interface standard £179
- Printer Cable for our printers and BBC MICRO £7
- **TEX** EPROM ERASER with a safety switch £30
- **SPARE** 'UV' Lamp bulb £8
- C12 COMPUTER GRADE CASSETTES in library cases 36p
- 8½" & 9½" Fan Fold paper (1000 sheets) .... £7 + 150p carr

Call in at our shop for demonstration. Be satisfied before you buy or write in for our descriptive Micro Peripherals Leaflet.

SPECTRUM 32K UPGRADE

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

£18

SPECTRUM CENTRONICS/RS232 PRINTER INTERFACE

★ It was the first! It is still the best!
★ Centronics and BI-DIRECTIONAL RS-232 with full hand-shaking.
★ Obeys SPECTRUM LLiST and LPRINT.
★ Split-Speed Operation for RS-232.
(Use it to communicate with the BBC MICRO or OTHER PERIPHERALS)
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★ HI-RES screen dumps in 2 sizes on EPSON, SEIKOSHA, STAR, SHINWA, MANNESMAN TALLY, NEC, RITEMAN, KAGA, etc. This is a STANDARD FEATURE! Not an extra.
★ Compatible with TASWORD TWO and most professional programs.

Complete Unit incl. Software tape + manual **£29.95**
Special Interface Cable **£8**

DISC DRIVES

(BBC Compatible)

- **CS100** — Single Cased with PSU, 40 track, 5¼" S/S 100K £139
- **CD200** — Twin Cased with PSU, 40 Track, 5¼" S/S 200K £245
- **CS200** — Single Cased with PSU, 80 Track, 5¼" S/S 200K £205
- **CD400** — Twin Cased with PSU, 80 track, 5¼" S/S 400K £365
- **MITSUBISHI 5¼" SLIM LINE DISC DRIVES**
  Double Sided, Double Density, Track Density 96 TPI, Track to track access time 3msec.
- **MITSUBISHI Single Slimline,** 5¼" Cased with PSU. DSDD. 1 Megabyte (400 K with BBC) £225
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N.B Carriage on Drives £7 securicor

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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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- [ ] **IC Op Amp Cookbook** Jung £14.25
- [ ] **PLL Synthesiser Cookbook** H. Kinley £7.70
- [ ] **Active Filter Cookbook** Lancaster £13.40
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- [ ] **CMOS Cookbook** Lancaster £11.85
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- [ ] **BASIC Cookbook** K. Tracton £6.00
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REFERENCE BOOKS

- [ ] **Electronic Engineers' Handbook** Fink £56.45
- [ ] **Electronic Designers' Handbook** Giacoletto £59.55
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BARCLAYCARD VISA

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . 60p
Socket with 2m lead . . 120p

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

SOCKETS

SOCKETS	Low profile	Wire wrap
8 pin	6p	28p
14 pin	8p	45p
16 pin	9p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	16p	75p
24 pin	18p	82p
28 pin	23p	95p
40 pin	25p	135p

Professional ZIF sockets
24 pin 430p 28 pin 480p
40 pin 595p

SOLDERING IRONS

Antex CS 17W Soldering iron 530
2.3 and 4.7mm bits to suit . 85
CS 17W iron 430
Antex XS 25W soldering iron 560
3.3 and 4.7mm bits to suit 85
Solder pump desoldering tool 480
Spare nozzle for above . . 70
10 metres 22 swg solder . 100
0.5kg 22 swg solder . . 750

SCRs

▶C106D		30
400V 8A		70
400V 12A		95

VERO

Verobloc . 395
Veroboard Size 0.1 in matrix
1.5 x 1 26
2.5 x 3.75 95
3.75 x 5 120
3.75 x 17 350
4.75 x 17 455
VQ board 190
Veropins per 100.
Single sided 55
Double sided 65
Spot face cutter 145
Pin insertion tool . . . 185
Wiring pen 375
Spare spool 75p Combs . 6

TRANSFORMERS

3VA PCB Mounting
2x6V@0.25A;2x9V@0.15A
2x12V@0.12A,2x15V@0.1A 180p

6VA PCB Mounting
2x6V@0.5A,2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 270p

Standard. Chassis Mounting
6VA: 2x6V@0.5A; 2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 240p

12VA: 2x6V@1A; 2x9V@0.6A
2x15V@0.4A,2x20V@0.3A 350p

MICRO

		27128	2150	6802	280	6532	520
		6116P3	520	6809	600	6551	540
		6264P15	3420	6810	140	8085A	320
2716	310	4116P4	70	6821	140	8156	380
2532	380	4164-20	420	6840	360	8251	350
2732 one time programmable		Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
	360	Z80A CTC	320	6875	500	8259	400
2732	440	Z80A S10	880	6880	100	MC1488	70
2764-250	600	Z80A DMA	880	6502	370	MC1489	70
2764 BBC	625	6800	200	6522	330		

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets 425
Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts 50 6BA washers 50 6BA nuts
25 6BA ½" bolts 25 4BA ¼" bolts 50 6BA washers
50 6BA nuts 25 6BA ½" bolts.

CABLES

20 metre pack single core connecting cable ten different colours. 75p
Speaker cable . . . 10p/m
Standard screened . . 16p/m
Twin screened . . . 24p/m
2.5A 3 core mains . . 23p/m
10 way rainbow ribbon 26p/ft
20 way rainbow ribbon 47p/ft
10 way grey ribbon . . 14P/ft
20 way grey ribbon . . 28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	45
LM317K	270	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mW zen	6
▶1N4148	3	1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11

Clips to suit -3p each.

Rectangular:			
		TIL32	40
red	12	TIL111	60
green	17	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	35

Seven segment displays:
Com cathode. Com anode.
DL704 0.3" 95 DL707 0.3" 95
FND5000.5" 100 FND5070.5" 100
10 bar DIL LED display, red 180
5mm superbright LED 250mcd red 30

HARDWARE

PP3 battery clips . . 6
Red or black crocodile clips . 6
Bush pointer control knob . 15
Pr Ultrasonic transducers 390
▶6V Electronic buzzer . 60
▶12V Electronic buzzer . 65
▶PB2720 Piezo transducer . 75
▶64mm 64 ohm speaker . 70
▶64mm 8 ohm speaker . 70
20mm panel fuseholder . 25
Red or black probe clip . 35
4mm terminals . . 33
12 way 'chocolate' block . 30
ultra-min. 6 or 12v rel. SPDT 130
ditto, but DPDT . . 195

EURO CONNECTORS

Gold flashed contacts.	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

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

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP (header plug) jumper				
24 ins.	145	165	240	380
Dble ended DIP (header plug) jumper				
6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 . . . 150
SPECTRUM 2 x 28 way edge connector wire wrap. . . . 200
AMPHENOL PLUGS
24 way IEEE IDC. . . . 450
36 way Centronix IDC . . . 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

CAPACITORS

Polyester, radial leads, 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p, 0.15, 0.22 - 9p; 0.33, 0.47 - 13p, 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 80p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL	0.9A
1A 400V	35	200V	50

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	90	90	85	120
16 way	130	130	110	175
20 way	145	145	125	195
26 way	175	175	150	240
40 way	205	205	170	320
50 way	220	220	190	340
60 way	235	235	200	395
60 way	330	330	230	495

LINEAR

		IC7611	98	LM358	50	LM3915	270	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM13600N	120	NE570	370	TL061	40
555CMOS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	120	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	110	MC3302	75	NE5534	105	TL071	38
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	65	TL072	60
748	35	ICM7555	80	LM386	90	MF10CN	330	RC4558	40	TL074	110
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195	TL081	30
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220	TL082	50
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	105
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250	UA2240	140
CA3089	200	LM10C	325	LM733	70	ML928	210	SP0256AL2	425	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	Speech data	50	ULN2004	80
CA3130E	85	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	365
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90	ZN414	80
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65	ZN423	135
CA3136	100	LM3342	85	LM2917N8	195	NE555	20	TBA950	220	ZN424P	130
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165	ZN425E	350
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	270	NE566	140	TDA1022	490	ZN427E	600
										ZN428E	450
										ZN459	285
										ZN1034E	200

TRANSISTORS

				BC548	10	BFR40	23	2N1613	30	2N3906	10				
				BC549	10	BFR80	23	2N2218A	45	2N4037	45				
				BC557	10	BFR81	23	2N2219A	28	2N4058	10				
AC125	35	BC158	11	BC558	10	BFX29	30	2N2221A	25	2N4060	10	TIP35C	125		
AC126	30	BC158	10	BCY70	16	BFX84	30	2N2222A	20	2N4061	10	TIP36A	115		
AC127	30	BC159	10	BCY71	16	BFX85	30	2N2368	25	2N4062	10	TIP36C	130		
AC128	30	BC160	40	BCY72	16	BFX86	30	2N2369	18	40360	40	TIP41A	45		
AC176	25	BC168C	10	BD115	55	BFX87	30	2N2484	27	40361	50	TIP42A	45		
AC187	25	BC169C	10	BD131	40	BFX88	30	2n2646	60	40362	50	TIP120	60		
AC188	25	BC170	8	BD132	40	BFY50	27	2N2904	28	40408	50	TIP121	60		
AD142	120	BC171	10	BD133	50	BFY51	27	2N2904A	28	2N5457	30	TIP122	60		
AD161	42	BC172	8	BD135	35	BFY52	27	2N2905	28	2N5458	30	TIP141	110		
AD162	42	BC177	16	BD136	35	BFY53	30	2N2905A	28	2N5459	30	TIP142	120		
AF124	60	BC178	16	BD137	35	BFY55	30	2N2906	28	2n5485	35	TIP147	120		
AF126	50	BC179	18	BD138	35	BFY56	30	2N2906A	28	2N5777	45	TIP2955	70		
AF139	40	BC182	10	BD139	35	BRY39	50	2N2907	24	2N697	20	TIP3055	60		
AF186	70	BC182L	10	BD140	35	BSX20	22	2N2907A	24	2N698	40	TIS43 See VJTs			
AF239	55	BC183	10	BD204	110	BSX29	35	2N2926	10	2N706A	20	TIS43	40		
BC107	10	BC183L	10	BD206	110	BSY95A	30	2N3053	28	2N708	25	TIS44	45		
BC107B	12	BC184	10	BD222	85	BU205	160	2N3054	55	2N918	35	TIS45	45		
BC108	10	BC184L	10	BF180	35	BU206	200	2N3055	50	TIP29	35	TIS90	30		
BC108B	12	BC212	10	BF182	35	BU208	170	2N3442	120	TIP29A	35	TIS91	30		
BC108C	12	BC212L	10	BF184	35	MJ2955	99	2N3702	9	TIP29B	35	VN10KM	65		
BC109	10	BC213	10	BF185	25	MJE340	50	2N3703	10	TIP29C	35	VN46AF	94		
BC109C	12	BC213L	10	BF194	12	MJE520	50	2N3704	9	TIP30	35	VN66AF	110		
BC114	22	BC214	10	BF195	12	MJE521	90	2N3705	10	TIP30A	35	VN88AF	120		
BC115	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10	TIP30B	35	ZTX107	11		
BC117	22	BC237	10	BF197	12	MPF102	40	2N3707	10	TIP30C	40	ZTX108	11		
BC119	35	BC238	10	BF198	15	MPF104	40	2N3708	10	TIP31A	35	ZTX109	11		
BC137	40	BC308	10	BF199	18	MPSA05	23	2N3709	10	TIP31B	35	ZTX300	14		
BC139	38	BC327	12	BF200	35	MPSA06	25	2N3772	170	TIP31C	40	ZTX301	16		
BC140	29	BC328	12	BF244B	35	MPSA12	29	2N3773	195	TIP32A	35	ZTX302	16		
BC141	30	BC337	12	BF245	35	MPSA55	30	2N3819	32	TIP32B	38	ZTX304	20		
BC142	28	BC338	12	BF256B	45	MPSA56	30	2N3820	50	TIP32C	40	ZTX341	20		
BC143	30	BC477	22	BF257	32	MPSU05	55	2N3823	65	TIP33A	65	ZTX500	13		
BC147	10	BC478	22	BF258	30	MPSU06	55	2N3866	90	TIP33C	75	ZTX501	18		
BC148	10	BC479	22	BF259	30	MPSU55	55	2N3903	10	TIP34A	70	ZTX502	18		
BC149	10	BC517	30	BF337	35	MPSU56	55	2N3904	10	TIP34C	80	ZTX503	18		
BC157	11	BC547	10	BFR40	35	2N118L	22	2N3905	10	TIP35A	105	ZTX504	25		

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed.

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	6.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	16.0MHz	200

BOXES

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid		4 x 2¾ x 1½"	95
& screws		4 x 2¼ x 2"	95
71x46x22mm	55	6 x 4 x 2"	120
95x71x35mm	88	7 x 5 x 2½"	165
140x90x55mm	140	8 x 6 x 3"	205

TTL

		7412	25	7440	25	7476	40	74107	40	74157	80	74180	85		
		7413	36	7442	74	7480	50	74109	60	74160	90	74181	230		
		7414	60	7444	105	7483	65	74121	50	74161	90	74182	85		
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120		
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120		
7402	25	7420	28	7448	98	7489	170	74125	50	74164	115	74192	120		
7403	25	7421	30	7450	25	7490	55	74126	50	74165	90	74193	110		
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80		
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63		
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120		
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85		
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195		
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195		
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80				
7411	25	7438	45	7475	55	74100	125	74154	135	74179	90				

CMOS

		4016	32	4034	145	4054	70	4081	20	4502	50	4529	80
		4017	53	4035	270	5055	70	4082	25	4503	35	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	20	4019	35	4040	58	4060	65	4086	60	4508	115	4538	70
4001	20	4020	65	4041	55	4063	80	4089	120	4510	55	4543	65
4002	24	4021	55	4042	50	4066	33	4093	30	4511	55	4549	390
4006	65	4022	60	4043	50	4067	230	4094	70	4512	50	4553	215
4007	24	4023	24	4044	50	4068	24	4095	70	4514	115	4555	50
4008	50	4024	45	4046	65	4069	24	4097	260	4515	115	4556	50
4009	40	4025	24	4047	60	4070	24	4098	50	4516	55	4559	390
4010	40	4026	120	4048	50	4071	24	40106	43	4518	55	4560	110
4011	20	4027	35	4049	32	4072	24	40109	100	4520	55	4584	43
4012	24	4028	45	4050	32	4073	24	40163	75	4521	110	4585	65
4013	35	4029	60	4051	60	4075	24	40173	100	4526	70	4724	140
4014	50	4030	24	4052	60	4076	60	40175	75	4527	60		
4015	53	4031	130	4053	60	4077	24	40193	90	4528	55		

LS TTL

		LS20	24	LS75	42	LS123	80	LS161	60	LS221	85	LS365	45
		LS21	24	LS76	30	LS125	38	LS162	60	LS240	105	LS366	45
		LS22	24	LS78	30	LS126	38	LS163	60	LS241	95	LS367	45
LS00	22	LS26	25	LS83	70	LS132	50	LS164	80	LS242	95	LS368	43
LS01	24	LS27	25	LS85	82	LS136	35	LS165	100	LS243	95	LS373	98
LS02	22	LS30	24	LS86	30	LS138	55	LS166	140	LS244	95	LS374	98
LS03	24	LS32	24	LS90	40	LS139	55	LS170	170	LS245	145	LS375	60
LS04	24	LS37	25	LS92	48	LS145	90	LS173	90	LS247	80	LS377	115
LS05	24	LS38	25	LS93	48	LS147	130	LS174	87	LS251	60	LS378	90
LS08	22	LS40	24	LS95	60	LS148	110	LS175	80	LS257	60	LS390	78
LS09	24	LS42	60	LS96	120	LS151	80	LS190	80	LS258	60	LS393	78
LS10	24	LS47	80	LS107	40	LS153	80	LS191	55	LS259	130	LS399	110
LS11	24	LS48	80	LS109	40	LS154	220	LS192	80	LS266	30	LS541	120
LS12	24	LS51	25	LS112	40	LS155	55	LS193	80	LS273	95	LS670	200
LS13	35	LS55	25	LS113	35	LS157	50	LS195	60	LS279	55		
LS14	60	LS73	30	LS114	35	LS158	50	LS196	85	LS283	80		
LS15	24	LS74	32	LS122	58	LS160	60	LS197	85	LS353	90		

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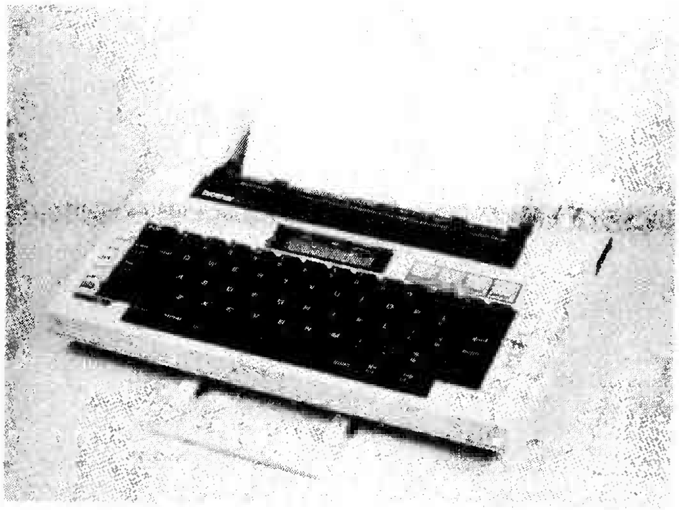


Plotting Brother

Brother have introduced a plotter/printer which not only functions as a portable typewriter and printing calculator but will also draw graphs. The BP30 Graph Writer features three type sizes, four colours, a correction buffer with a fifteen-character LCD display and is expected to sell for just under £180 inclusive.

The BP30 is essentially a plotter which uses miniature pens to 'draw' its characters. Four pens, red, green, blue and black, are held in a circular carrier which rotates to select the desired colour. The carrier moves along two parallel bars to provide horizontal movement while the roller moves the paper up and down to provide vertical movement. It is because it draws in this way rather than stamping pre-formed characters as most typewriters do that the BP30 is able to produce three different type sizes, micro, normal and jumbo, and can even print vertically up and down the page as well as across it in the normal way.

Four buttons move the pen carrier and the paper roller up, down, left and right to select the starting position and another button provides a choice of four different line spacings between text. An LCD display above the keyboard shows the user which line spacing, type size, print direction (horizontal or vertical) and mode have been selected and whether capital shift has been engaged or not, and also displays the last fifteen characters to be entered.

The BP30 has three text modes plus the graph mode. In Non Print mode no printing takes place and the machine can be used as a four-function calculator, the results appearing on the display. In Direct Print mode text is printed as it is entered on the keyboard. In Correction Print mode, the fifteen-character buffer is filled before anything is transferred to the paper, and errors spotted in the display can be corrected before printing using a cursor and insert and delete keys.

When Graph is selected, the display flashes up mesages inviting you to choose a graph type and then enter the appropriate data. Eight graph options are offered including shaded and unshaded pie charts and bar charts and single or multiple variable sets on bar charts and line graphs, and up to twelve variables can be displayed on each. When the data has been entered, a test facility allows the user to check the position of the complete graph and if necessary alter it before any marks are made on the paper. The machine automatically calculates percentages and angles, etc from the data given and presents the results in several colours.

ETI has had a BP30 on trial for the last month or so and has had enormous fun putting it through its paces. The most common complaint is that so potetnially versatile a machine should surely be equipped with an interface to allow it to be used as a computer printer. Brother were rather cagey about this at the press launch but hinted that an interfaceable version might be offered if there were sufficient demand. The machine is slower than conventional tvpewriters as one might expect of a plotter, but nonetheless managed to keep up with the fastest of us in all except the largest of its three type sizes. Since the jumbo size is unlikely to be used much except for headings and the like, this should not cause problems. The BP30 cannot cope with paper of varying thickness and should not therefore be used on envelopes, but otherwise worked well on all that we tried it on and produced a pleasing end result. The only real shortcoming we found was that the pens did not write well on greasy surfaces — we had to handle paper with care before inserting it because the BP30 would often fail to print over areas which had been in contact with fingers. A little more development work on the pens themselves would not go amiss.

The BP30 measures 337 xs 266 x 67 mm and weighs 2.7 kg including batteries. A mains adaptor is available as an extra. It will be available from a number of high street stores and the recommended price is £179.95 including VAT.

Banshee Siren

In our September issue we featured a versatile alarm system which we called the 'ETI BANSHEEE ALARM".

A. P. Besson of Hove, Sussex, have pointed out that they are the owners of the registered Trade Mark "BANSHEE" which they use on their range of electronic alarm sounders.

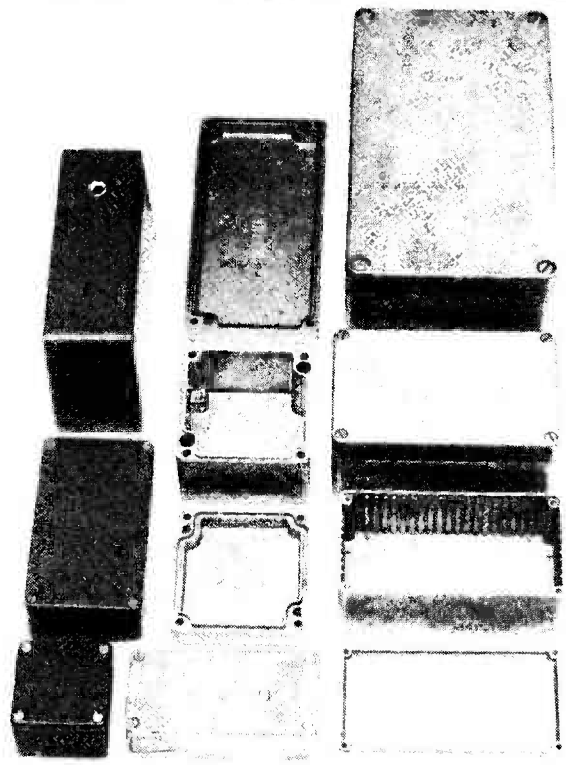
Obviously we intended no confusion by our article and have agreed to draw to our readers' attention the rights of A. P. Besson in the registered Trade Mark "BANSHEE". The company points out to us that although their product is intended mainly for use by the Fire and Security Industry, it is perfectly suitable for use by amateurs and can be pruchased directly from themselves.

If any reader is interested they should contact Miss Jane Squires at A. P. Besson, St. Josephs Close, Hove, East Sussex BN3 7EZ, tel 0273-722651.

An Interesting Case?

If you've got a problem with moisture, petrol or some other unwelcome liquid getting at a piece of electronics, then a new range of boxes from Boss Industrial Mouldings could be the solution (sorry!). They now offer four sizes of cases, from 40 by 52 by 75mm to 80 by 120 by 220mm, which incorporate an oil and petrol resistant neoprene gasket seal.

Also pictured are the new cases which include internal PCB supports, but these are not waterproof. For more information and sales contact Boss Industrial Mouldings, James Carter Road, Mildenhall, Suffolk IP28 7DE, tel 0638 716101. Incidentally, Boss say that most of their products are available in small order quantities through their sister company, Bimsales; any that aren't available through Bimsales, Boss will supply themselves direct to the public.



MARCO TRADING

RESISTORS CARBON FILM 5%

¼W 1R0 to 10M (E12 Range)	2p each. 15p/10. 1?p/100
½W 2R2 to 10M (E24 Range)	2p each. 15p/10. 75p/100
1W 10R to 2M2 (E12 Range)	7p each. 65p/10. 6.00/100
2W 10R to 2M2 (E6 Range)	8p each. 70p/10. 6.00/100

¼W Metal Film 1% 10R to 1M (E24 range) **6p each 50p/10.**

RESITOR KITS - each value individually packed

¼W pack 10 each value E12 — 10R to 1M 610 pieces	4.80
¼W pack 5 each value E12 — 10R to 1M 305 pieces	2.75
½W pack 10 each value E12 — 2R2 to 2M2 730 pieces	5.25
½W pack 5 each value E12 — 2R2 to 2M2 365 pieces	3.00
1W pack 5 each value E12 — 2R2 to 1M 353 pieces	15.00
2W pack 10 each value E6 — 10R to 2M2 317 pieces	18.00

RESISTORS — WIREWOUND Generally 5%

2.5W - 0.22 to 270R - Available in preferred values	0.20
4W - 1R0 to 10K - Available in preferred values	0.21
7W - 0.476R to 22K - Available in preferred values	0.25
11W - 1R0 to 22K - Available in preferred values	0.29
17W - 1R0 to 22K - Available in preferred values	0.37

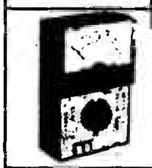
TERMINAL BLOCKS

2amp. 12 way	0.19
5amp. 12 way	0.20
10amp. 12 way	0.40
15amp. 12 way	0.46
32 amp. 12 way	0.90

CO-AXIAL LOW LOSS SPLITTERS

One In Two Out = £1.00
One In Three Out = £1.95
One In Four Out = £2.40
One In Five Out = £2.93
One In Six Out = £3.40

MULTIMETER SPECIAL



Russian type U4324 — (20,000 O.P.V)
DC Volts 0.6, 1.2, 3, 12, 30, 60, 600, 1200.
AC Volts 3, 6, 15, 60, 150, 300, 600, 900.
DC Curr. M/A 0.06, 0.6, 6, 60, 600, 3000.
AC Curr M/A 0.3, 3, 30, 300, 3000
DC Resistance: 0.2, 5, 50, 500, 5000K.
level dB −10 to +12.
Supplied with rechargeable batteries.

Price £12.00 incl. of p/p & VAT.

FUSEHOLDERS

20mm Panel Mounting	0.28
20mm Chassis Mounting	0.06
1¼" Panel Mounting	0.35
1¼" Chassis Mounting	0.12
Carline 1¼" holder	0.10

CHART RECORDERS

Brand new 3 channel pen recorders complete with charts spares kit. Full spec upon request — Once only bargain £40 + £10 p&p plus 15% VAT.

BUZZERS

SOLID STATE
6v and 12v — 80p each

LEDS

3mm	5mm
Red - 10p 10/**x	Red - 10p 10/85p
Green - 13p 10/1.00	Green - 13p 10/1.00
Yellow - 13p 10/1.00	Yellow - 13p 10/1.00

FUSES Prices per 10

1¼" Quick Blow. 100, 150, 250mA **£1.30.** 1, 1.25, 1.5, 2, 2.5, 3, 10, 15A **85p. 1¼" Time Delay.** 100mA **£3.50.** 150mA **£2.25** 250, 300, 500, 600, 750, 850mA **£1.64.** 1, 1.25, 1.5, 1.6, 2A **£1.64.** 2.5A, 3.15, 3, 5A **£2.82. 20mm Quick Blow.** 100, 125, 160, 200, 250, 315, 400, 500, 630, 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3A **40p. 20mm Time Delay.** 100, 125, 160, 200mA **£1.80.** 250, 315, 400, 500, 630, 800mA **£1.00.** 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3A **85p. 1" Mains.** 2, 3, 5, 7, 10, 13A **85p.**

SOLDERING SECTION

Antex 15W iron	5.00
Antex 18W iron	5.00
Antex 25W iron	5.20
Antex elements	2.00
Antex bits	0.95
Antex stands	1.90
Soldersucker	4.50
Spare nozzles for Soldersucker	0.45
Antex Soldering station complete with 1 iron — 30W or 40W	49.95
25W KIT — iron with 13A plug and stand	£8.40
15W KIT — iron with 13A plug and stand	£6.20

SERVICE AIDS

ALL SERVISOL PRODUCTS

Switch Cleaner	0.88
Circuit Freezer	0.96
Foam Cleanser	0.84
Aero Klene	0.78
Silicone Grease (Aerosol)	1.00
Antistantic Spray	0.82
Plastic Seal	0.88
Excel Polish	0.76
Fire Extinguisher 640g	2.80
Video Head Cleaner	0.88
Solda Mop (Std)	0.72
Solda Mop (L/Gauge)	0.72

Additional P&P on above 30p

NI-CAD

Universal Ni-Cad charger, charges PP3, AA, C, D
Price £5.00

MULTIBLOCK

Multiblock 4-Way Extension Socket
PVC body with internal cable grip fitted with 13A fuse and neon indicator. Max total load 13A 250V. Length 10½ Width 2½
Price £3.90 each (P&P) 25p in addition to 35p normal charge).

13A Mains Plugs **40p** 10/£3.50.

PLUGS & SOCKETS

	EACH	
Metal Co-ax Plug	0.18	10/1.50
Plastic Co-ax Plug	0.14	10/1.20
Single Junction Socket	0.80	10/6.00
Plastic Phono	0.10	10/80p
FM Plugs	0.20	10/1.75
1PL259	0.38	10/3.50
Reducer	0.15	10/1.25
¼in Plastic-Mono Plug	0.15	10/1.20
¼in Metal Mono Plug	0.30	10/2.30
2.5mm Plug Metal	0.15	10/1.40
3.5mm Plug Metal	0.16	10/80p
2.5mm Chassis Socket	0.10	10/80p
3.5mm Chassis Socket	0.10	10/1.20
2 pin ¼in Mono Chassis Socket	0.14	10/1.75
4 pin ¼in Mono Chassis Socket	0.20	10/2.70
6 pin ¼in Mono Chassis Socket	0.30	10/1.25
4mm Banana Plug - R or B	0.15	10/1.20
4mm Banana Socket - R or B	0.15	10/80p
PP3 Battery Connectors	0.08	10/1.25
PP9 Battery Connectors	0.15	10/1.25

POWER LEADS 4 Way Spider Plug **65p**

1984 CATALOGUE

Send now for our latest catalouge — 109 pages — packed with complete range of components — fully illustrated, price 65p per copy, includes 30p credit note, special offer sheets, order form and pre-paid envelope.

TOGGLESWITCH

SPST — 2 TAG — 65p
SPDT — 3 TAG — 68p
DPDT — 6 TAG — 72p
DPDT — 6 TAG — 85p (C-off)

ROTARY SWITCHES

1p 12w — 40p
2p 6w — 40p
3p 4w — 40p
4p 3w 40p

TRANSFORMERS

	1+	10+	100+	1000+
4.5-0-4.5v 400m/A	50p	45p	35p	30p
6-0-6v 100m/A	58p	52p	43p	40p
6-0-6v 500m/A	65p	60p	48p	45p

Carriage: 45p per transformer, £1.60 per 10; £4.50 per 100; £30 per 1,000

EUROPEAN ADAPTORS

These very high quality British made two pin European adaptors are ideal for driving Radios, cassette recorders, TV games, calculators etc. The adaptors fit in the UK shaver socket

REF	DC Voltage	Current	1+	10+	100+
EOB	4.5V	200m/a	50p	45p	32p
EM3	6V	200m/a	£1.00	80p	55p
EO9	6V	400m/a	£1.50	£1.25	85p

Postage & Packing: 45p per adaptor or £1.60 per 10. £4.50 per 100.

(1,000 off qty price on application)

BRIDGES

1½A 50V	0.2?
100V	0.28
200V	0.32
400V	0.40
600V	0.50
800V	0.58
2A 100V	0.52
200V	0.55
400V	0.61
600V	0.67
800V	0.70
6A 100V	0.66
200V	0.68
400V	0.74
600V	0.80
800V	0.86
10A 50V	2.20
100V	2.24
200V	2.35
400V	2.50
600V	3.50
25A 50V	2.05
100V	2.25
200V	2.40
400V	3.20
600V	3.95

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"

ALL — £5.00

BRITISH TELECOM APPROVED PLUGS & SOCKETS

BT Plug and 4 core lead	£1.50
BT Plug only	65p
BT IPC Insertion tool	50p
BT Master Socket	£3.50
BT Secodary Socket	£2.50

ZENER DIODES

400mW Plastic ?V-75V 8p each 10/75
1.3W Plastic 3V-200V 150 each 10/£1.40
1.5W Flange 4.7-47V £1.26 each
2.5W Plastic 7.5-75V 67p each
20W Stud 7.5-75V £1.31 each

INTEGRATED CIRCUITS (£) EACH

AN240P	3.42	SN76530P	1.40
AN214QQ	3.88	SN76533N	1.60
AN7150	2.90	SN76650N	1.05
CA3065	1.75	SN76660N	0.75
CA4031P	2.88	SN76666N	0.80
CA4102	3.50	STK015	6.50
CA4250	3.50	TA7108P	3.20
CA4400	2.98	TA7120P	3.20
CA4422	3.07	TA7129AP	3.85
LC7120	5.33	TA7130P	1.65
LC7130	5.26	TA7172	1.80
LC7137	5.16	TA7193	5.50
LM380N	0.80	TA7172P	1.80
LM1303N	2.52	TA7176	2.50
HA1151P	3.12	TA7202P	4.18
MC1307P	1.85	TA7204P	1.86
MC1310P	1.85	TA7205AP	1.50
MC1312P	2.25	TA7208F	3.27
MC1327P	1.25	TA7210P	6.50
MC1330P	0.83	TA7222P	1.88
MC1349P	1.85	TA7223P	3.68
MC1350P	1.20	TA7227P	5.60
MC1351P	2.50	TA7310A	1.80
MC1352P	1.50	TA7609P	4.28
MC1357P	2.88	TA7611AP	2.88
MC1358P	1.30	TAA263	2.46
MC1496P	1.15	TAA310A	2.68
ML231B	2.10	TAA550	0.50
ML232B	2.10	TAA570	1.99
ML237B	2.30	TAA611A12	3.50
NE565	0.25	TAA611B12	2.85
C-mos 555	0.88	TAA630S	3.90
NE556	0.80	TAA661B	1.70
SAA1024	5.35	TAA700	2.80
SAA1025	8.40	TAA840	3.38
SAS560A	2.50	TAD100	2.80
SAS560S	1.85	FM FILTER	1.20
SAS570S	1.85	TBA120A	1.00
SAS580	2.85	AS,S,SA,SB	1.20
SAS590	2.82	QT,U,UQ	1.32
SC9503P	1.10	TBA120B	1.30
SL432A	4.00	TBA231	1.45
SL901B	5.20	TBA281	2.65
SL917B	6.25	TBA395	1.20
SL1327Q	1.10	TBA480Q	1.50
SN76003N	2.44	TBA400	2.30
SN76013	1.90	TBA510	2.60
SN76023ND	2.90	TBA510Q	2.80
SN76033N	2.45	TBA520/Q	1.60
SN76110N	1.12	TBA530/Q	1.30
SN76115N	2.00	TBA540/Q	1.40
SN76131N	1.65	TBA550/Q	1.52
SN76226ND	1.80	TBA560C	1.70
SN76227N	1.10	TBA560CQ	1.40

TBA570	1.50
TBA641BX1	4.50
TBA673	2.40
TBA700	2.85
TBA750	2.80
TBA800	1.60
TBA810P	1.10
TBA810S	1.20
TBA820	1.60
TBA890	3.88
TBA920/Q	3.00
TBA940/2A	3.05
TBA970	4.05
TBA990	1.88
TCA160C	3.90
TCA270S	4.00
TCA270SA	4.02
TCA800	3.10
TCA940	1.90
TDA440	3.80
TDA1002	1.90
TDA1003A	5.50
TDA1004A	2.90
TDA1006A	2.40
TDA1035S	4.50
TDA1044	4.30
TDA1170S	3.00
TDA1190	1.88
TDA1200	2.98
TDA1270Q	3.70
TDA1327A	1.66
TDA1352A/B	1.56
TDA1412	1.20
TDA2002	2.80
TDA2020	4.60
TDA2030	2.78
TDA2140	5.90
TDA2521	4.10
TDA2523	3.50
TDA2530	2.70
TDA2540	3.80
TDA2541	2.80
TDA2560	3.50
TDA2571A	2.50
TDA2581	3.20
TDA2590	3.20
TDA2591	2.98
TDA2593	2.98
TDA2610	3.20
TDA2611A	1.94
TDA2640	2.90
TDA2680	3.40
TDA2690	3.50
TDA3950A/B	2.80
UPC554C	1.32
UPC557H	0.90
UPC566H	2.95
UP575C2	2.70
UPC1016C	1.10
UPC1025H	2.90
UPC1032H	0.90
UPC1156H	4.20
UPC1158H	0.76
UPC1163H	0.98
UPC1181H	1.60
UPC185H2	3.75
UPC1212C	1.30
UPC1230H	3.90
UPC1350C	3.90
UPC1367C	3.40
UPC1378H	4.40
UPC2002H	2.80

Type	Price (£)
2SC1507	0.63
2SC1678	1.06
2SC1758	0.68
2SC1909	1.20
2SC1923	0.30
2SC1945	2.88
2SC1953	0.74
2SC1957	0.76
2SC1969	2.88
2SC2028	0.73
2SC2029	1.00
2SC2078	1.05
2SC2091	0.73
2SC2098	2.90
2SC2122A	3.20
2SC2166	1.20
2SC2314	0.80
2SC2335	1.50
2SC2749	2.70
2SC2752	0.60
2SD234	0.64
2SD348	3.30
2SD986	0.62
2SK134	3.80
2SK135	1.90
3N126	1.90
3N211	2.52
3SK45	0.76

ROTARY POTS

0.25W CARBON
LOG 4K7 — 2M2
LIN 1K — 2M2
32p ea. 10 for £3
Any 100 for £27.50

VEROBOARD

2½ x 3¾	85p
2½ x 5	£1.00
2½ x 17	£3.07
3¾ x 17	£1.05
3¾ x 5	£1.15
3¾ x 17	£4.10
4¾ x 17¾	£4.95
Pkt of 100 pins	50p
Spot face cutter	£1.48
Pin insertion tool	£3.50
Vero Wiring Pen & Spool	£3.50
DIP board	£3.85
Vero Strip	£1.25

IC SOCKETS Dil to Dil

8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
16 pin	0.11	1.00/10
18 pin	0.14	1.60/10
22 pin	0.21	1.95/10
24 pin	0.25	2.25/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

D CONNECTORS

	9 way	15 way	25 way
MALE			
Solder lugs	80p	105p	160p
Angle pins	150p	210p	250p
FEMALE			
Solder lugs	105p	160p	200p
Angle pins	165p	215p	290p
COVERS	85p	80p	80p

VOLTAGE REGULATORS

78L05 - 30p
78L12 - 30p
78L15 - 30p
7805 - 55p
7812 - 55p
7815 - 55p
LM317K - 3.50
LM317T - 90p
LM340KC £1

VALVES

Type	Price (£)
DY802	0.88
DY86/87	0.75
ECC81	0.95
ECC82	0.65
ECC83	0.75
ECC84	0.65
ECC85	0.90
ECC88	0.95
ECF80	0.95
ECH81	0.75
ECH84	0.75
ECL82	0.75
ECL86	0.98
EF80	0.65
EF86	1.60
EF183	0.75
EF184	0.75
EH90	0.94
EL34	2.50
EL84	0.69
EL509	5.50
EM87	2.55
EY86/87	0.67
EY500A	1.65
PCC84	0.50
PCC85	0.65
PCC89	0.74
PCC189	0.85
PCF80	0.75
PCF86	1.25
PCF200	1.95
PCF801	1.45
PCF802	0.85
PCF806	1.20
PCL82	0.90
PCL83	2.50
PCL84	0.90
PCL86	0.98
PCL805/85	1.35
PD500	3.75
PFL200	1.35
PL33	1.50
PL36	1.45
PL81	0.85
PL82	0.75
PL83	0.65
PL84	0.75
PL95	2.00
PL504	1.20
PL508	2.40
PL509/519	5.95
PY88	0.80
PY500A	2.40
U26	1.90
UCH81	0.90
UCL82	1.70
6J5GT	1.75
6SJ7	2.20
30FL12	1.60

TRANSISTORS + DIODES

Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)
AC127	0.30	BC108	0.10	BC302	0.32	BD244A	0.65
AC128	0.30	A,B or C	0.12	BC303	0.32	BD375	0.32
AC128K	0.36	BC113	0.14	BC307	0.10	BD410	0.76
AC132	0.55	BC114	0.12	BC308A	0.10	BD434	0.68
AC141	0.26	BC115	0.12	BC323	0.99	BD436	0.68
AC141K	0.40	BC116	0.15	BC327	0.14	BD437	0.76
AC142	0.26	BC117	0.22	BC328	0.14	BD438	0.75
AC142K	0.48	BC118	0.17	BC337	0.12	BD439	0.68
AC151	0.45	BC119	0.30	BC338	0.12	BD507	0.48
AC152	0.45	BC125	0.12	BC350	0.14	BD508	0.53
AC176	0.28	BC140	0.28	BC440	0.30	BD509	0.54
AC176K	0.46	BC141	0.42	BC441	0.32	BD510	0.48
AC187	0.26	BC142	0.30	BC461	0.32	BD517	0.58
AC187K	0.40	BC143	0.30	BC547	0.12	BD520	0.66
AC188	0.26	BC147	0.08	BC548	0.12	BD699	1.25
AC188K	0.40	A or B	0.10	BC549	0.12	BD707	0.88
ACY40	0.88	BC148	0.08	BC550	0.18	BDX18	2.35
AD142	1.10	A or B	0.10	BC550C	0.18	BDX32	2.10
AD143	1.10	BC149	0.09	BC557	0.18	BF115	0.32
AD149	0.96	BC157	0.10	BC558	0.12	BF117	0.54
AD161	0.40	BC158	0.10	BCX34	0.27	BF119	0.82
AD162	0.42	BC159	0.10	BCY70	0.15	BF120	0.38
AD161/AD162	0.98	BC160	0.30	BCY71	0.17	BF123	0.40
AF106	0.48	BC161	0.30	BCY72	0.18	BF125	0.42
AF114	2.10	BC168B	0.12	BCZ10	1.68	BF127	0.38
AF115	2.10	BC169C	0.10	BCZ11	1.45	BF152	0.16
AF116	2.10	BC170	0.14	BD124P	0.80	BF154	0.23
AF117	2.10	BC170B	0.12	BC130Y	0.68	BF157	0.40
AF118	0.85	BC171	0.10	BD131	0.34	BF158	0.22
AF121	0.62	BC171	0.10	BD132	0.34	BF159	0.24
AF124	0.48	A or B	0.08	BD131/BD132	0.95	BF160	0.23
AF125	0.48	BC172	0.08	BD135	0.32	BF167	0.30
AF126	0.48	A or B	0.10	BD136	0.36	BF173	0.25
AF127	0.48	BC177	0.20	BD137	0.36	BF177	0.42
AF139	0.68	BC178A	0.22	BD138	0.38	BF178	0.30
AF178	0.68	BC182	0.09	BD139	0.38	BF179	0.32
AF239	0.68	A,B or C	0.09	BD140	0.38	BF180	0.35
AF279S	0.75	BC182L	0.09	BD144	1.60	BF181	0.35
AL100	2.50	A,B or C	0.09	BD145	1.82	BF182	0.32
AL102	1.88	BC183	0.09	BD150A	0.51	BF183	0.32
AL113	2.20	A,B or C	0.10	BD159	0.65	BF184	0.32
ASY80	1.75	BC183L	0.08	BD160	1.65	BF185	0.32
AU110	1.40	A,B or C	0.12	BD165	0.45	BF194	0.08
AY102	4.32	BC184L	0.12	BD175	0.60	BF195	0.10
BA102	0.34	A,B or C	0.10	BD182	1.00	BF196	0.10
BA110	0.67	BC207	0.15	BD183	1.10	BF197	0.10
BA121	0.40	BC208	0.16	BD184	1.20	BF198	0.14
BA129	0.38	BC212	0.09	BD201	0.72	BF199	0.16
BA148	0.16	A,B or C	0.10	BD202	0.87	BF200	0.26
BA154	0.08	BC212L	0.08	BD204	0.80	BF222	0.48
BA155	0.10	A,B or C	0.10	BD222	0.50	BF224	0.20
BA156	0.08	BC213	0.09	BD225	0.86	BF224J	0.16
BA157	0.28	A or B	0.10	BD232	0.45	BF240	0.20
BA164	0.14	BC213L	0.10	BD233	0.60	BF241	0.20
BB104B	0.52	A or B	0.10	BD234	0.62	BF244	0.26
BB105B	0.30	BC237	0.11	BD235	0.63	BF244A	0.28
BB105G	0.48	BC238	0.12	BD236	0.63	BF244C	0.24
BB110B	0.42	BC239C	0.14	BD237	0.65	BF245A	0.28
BC107	0.10	BC251	0.12	BD238	0.56	BF254	0.15
A or B	0.12	A,B or C	0.14	BD241	0.60	BF256	0.40
		BC301	0.30	BD243A	0.80	BF257	0.32

Type	Price (£)	Type	Price (£)	Type	Price (£)	Type	Price (£)
BF258	0.30	BT101/300	1.15	BYX36/150	0.22	TIP32	0.40
BF259	0.32	BT101/500	1.25	BYX36/600	0.28	TIP32C	0.60
BF262	0.30	BT102/300	1.35	BYX48/300	0.72	TIP33A	0.63
BF263	0.30	BT102/500	1.65	BYX49/300	0.47	TIP34A	0.72
BF270	0.30	BT106	1.50	BYX55/350	0.29	TIP41C	0.46
BF271	0.26	BT108	1.30	BYX55/600	0.33	TIP42A	0.52
BF273	0.18	BT109	1.18	BYX71/600	1.18	TIP47	0.60
BF274	0.32	BT116	1.25	BYZ12	0.42	TIP110	0.88
BF323	0.92	BT119	3.62	C106D	0.80	TIP2955	0.60
BF336	0.26	BT120	3.60	E1222	0.40	TIP3055	0.60
BF337	0.26	BT121	3.02	E5024	0.30	TIS43	0.32
BF338	0.26	BT138/600	1.30	GET872	0.48	TIS88	0.40
BF355	0.42	BT151/560R	0.90	ITT44	0.04	TIS90	0.25
BF363	0.82	BT151/300R	1.15	ITT2002	0.11	TIS91	0.28
BF367	0.24	BTY79/400R	2.80	ME0402	0.20	ZTX108	0.12
BF371	0.27	BU100A	2.30	ME0404/2	0.24	ZTX109	0.12
BF422	0.38	BU104	2.00	MEU21	0.60	ZTX212	0.28
BF450	0.38	BU105	1.20	MJ400	1.25	IN4001	0.05
BF457	0.33	BU105/02	1.56	MJ2955	0.90	IN4003	0.05
BF458	0.36	BU108	1.80	MJ3000	1.98	IN4004	0.06
BF459	0.44	BU124	1.75	MJE240	0.60	IN4006	0.07
BFR39	0.22	BU126	1.35	MJE340	0.54	IN4007	0.07
BFR40	0.22	BU133	1.80	MJE370	0.88	IN4148	0.05
BFR41	0.22	BU204	1.35	MJE520	0.48	IN5400	0.12
BFR51	0.30	BU205	1.30	MJE2955	0.99	IN5402	0.15
BFR61	0.32	BU206	1.70	MJE3055	0.75	IN5405	0.16
BFR62	0.28	BU208	1.55	MPSL01	0.28	IN5406	0.18
BFR88	0.34	BU208A	1.63	OA47	0.10	IN5408	0.20
BFR90	1.72	BU208/02	2.05	OA90	0.08	IS920	0.08
BFT41	0.38	BU326S	1.75	OA91	0.09	2N697	0.55
BFT43	0.38	BU407	1.55	OA95	0.18	2N706A	0.33
BFW10	0.79	BU407D	1.80	OA200	0.06	2N2904	0.28
BFW44	0.76	BUX80	3.70	OA202	0.15	2N2906	0.24
BFX29	0.28	BUY20	1.75	OC25	2.10	2N2926G	0.10
BFX30	0.30	BUY69A	2.80	OC26	1.70	2N3053	0.22
BFX80	3.56	BUY69B	1.98	OC28	1.50	2N3054	0.56
BFX84	0.48	BY101	0.48	OC29	2.47	2N3055	0.45
BFX85	0.26	BY118	1.10	OC35	1.75	2N3702	0.10
BFX86	0.26	BY122	0.68	OC36	1.75	2N3704	0.10
BFX87	0.26	BY126	0.12	OC42	0.72	2N3708	0.10
BFX89	0.65	BY127	0.15	OC42K	1.40	2N3772	1.90
BFY50	0.21	BY133	0.18	OC44	0.72	2N3773	2.70
BFY51	0.21	BY135	0.25	OC45	0.58	2N3904	0.16
BFY52	0.21	BY164	0.44	OC71	0.50	2N3906	0.16
BFY57	0.40	BY179	0.66	OC72	0.52	2N5294	0.48
BFY90	0.90	BY182	0.87	OC81	0.68	2N6107	0.71
BFY90S	1.34	BY184	0.40	OC200	2.46	2N6126	0.68
BR100	0.20	BY187	0.72	OC202	2.20	2SB337	1.60
BR101	0.44	BY189	4.75	ORP12	0.85	2SC1172Y	2.90
BR103	0.58	BY198	0.44	R2008B	1.50	2SC1173Y	0.82
BRC4443	1.76	BY199	0.47	R2010B	1.52	2SC1302	1.40
BRY39	0.38	BY206	0.24	SHG1.5	0.40	2SC1226	0.84
BRY56	0.42	BY207	0.24	TAG1/100	1.40	2SC1279	0.50
BRY61	0.86	BY210/400	0.25	TAG3/400	1.78	2SC1306	0.92
BSS17	0.56	BY210/600	0.26	TIC44	0.45	2SC1307	1.40
BSS27	0.92	BY210/800	0.30	TIC45	0.45	2SC1413A	2.70
BSX19	0.34	BY223	1.20	TIC46	0.48	2SC1444	1.45
BSX20	0.34	BY227	0.26	TIC47	0.70	2AC1449	0.63
BSX59	0.62	BY229	0.30	TIC106A	0.70		
BSX76	0.29	BY238	0.68	TIP30A	0.46		
BT100A/02	0.94	BYX10	0.24	TIP31C	0.54		

BNC 50R Plug	£1.10	NC555 - Reducer for PL259	15p
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Tolerant Buffers

Monolithic Memories have introduced four new eight-bit buffers which are specifically designed for use where system noise is a problem. The buffers all have Schmitt-trigger inputs to improve their noise immunity and the manufacturers claim that no other buffers on the market have this feature.

The SN54/74DS310, SN54/75S340, SN54/74S341 and SN54/74S344 all possess tri-state outputs, low current PNP inputs to reduce loading and are pin-compatible with the SN54/72S210/240/241/244 series. Operating on a five volt supply, the 'S310 and 'S340 have a maximum data to output delay of 15ns and a worst-case current demand with outputs high of 80 mA, 50 mA typical, while the 'S340 and 'S344 have a maximum delay of 22 ns and a worst case demand of 130 mA, 80 mA typical. Power dissipation for the two groups of devices is 250 mW and 400 mW respectively.

The new buffers are available in 20-pin skinnydip plastic and ceramic packages and are marketed by MicrOlog Ltd, 1st Floor, Elizabeth House, Duke Street, Woking, Surrey GU21 5BA, tel 04862-66771.

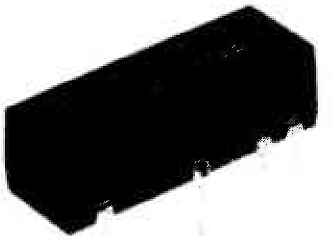
Stereo TV Sound

In our March issue we reported plans by the BBC to make experimental television broadcasts using digitally-encoded stereo sound. Initial experiments using the system, which employs a digitally modulated second sound carrier, had already been made using the Wenvoe transmitter in South Wales, and the next stage was to be full transmission from the Crystal Palace transmitter to test the compatibility of the system with existing monophonic television receivers. The BBC have now told us that such a transmission took place on May 24th when a pop concert was broadcast after official closedown. The programme consisted of an analogue video recording previously used for a simulteneous television and stereo radio transmission, and the associated digital sound recording was replayed into the stereo transmission system without being converted into analogue form. The BBC believe that this was the first 'all digital' transmission of stereo television sound and say that they are now confident that a digital system is the best way to obtain stereo from terrestrial transmitters.

Consultation with the IBA, the home office and industry aimed at establishing a standard UK specification is now well under way and an early agreement is anticipated. Meanwhile, the BBC plan to further test the sysxtem by making occasional broadcasts during normal programme hours.

BBC Engineering Information Department, Broadcasting House, London W1A 1AA, tel 01-927 5432.

Buffered Delay Lines

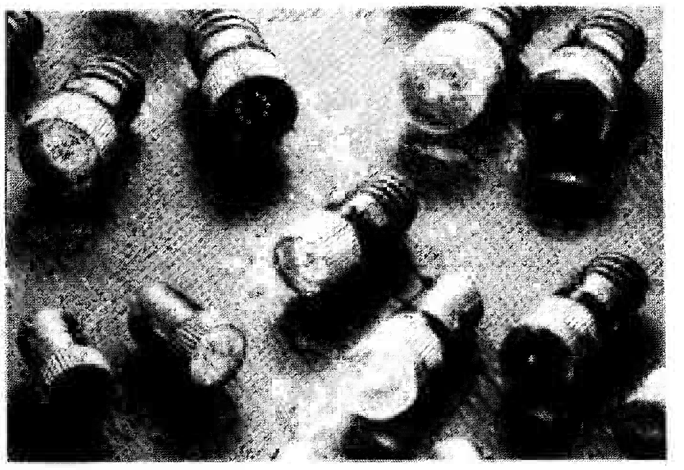


Ashcroft Components Ltd have announced the RHT series of buffered (active) delay lines. These lumped constant devices incorporate Schottky TTL logic elements (equivalent to 74SO4) in the input and output terminals.

The modules can be used as TTL elements with precisely fixed delay time. Any change of delay time due to temperature variations is minimised by using a delay line whose coefficient is complementary to that of the IC.

The seven types available cover total delay times from 20 nanoseconds to 250 nanoseconds with corresponding delay times per tap of 4ns to 50ns and rise times of 3 or 4 ns. All have 5 outputs available to the user.

Significant PCB area savings may be achieved with the RHT series. Their used can considerably simplify the design of digital circuitry and provide highly accurate pulse timing. For further details contact Ashcroft Components Ltd, 28 Somerford Road, Cirencester, Gloucestershire GL7 1TW, tel 0285-67756.



TurboLeds Are Here

General Instrument Lamps have been appointed sole UK and European agent for the new range of TurboLeds. These multichip solid state lamps are available in wire terminal form or with midget flange, miniature bayonet or miniature screw caps as plug in replacements for incandescent lamps. Red, Yellow and Green versions in 6V, 12V and 24V ratings can be supplied and as a bridge rectifier is included in the lamps, they can be operated from AC or DC supplies.

A major feature of TurboLeds is the metal shroud which acts both as a reflector and a heat radiator to avoid excessive chip temperatures which can cause the premature failure of high light output LEDs. Full details on the complete range of TurboLeds are available from General Instrument Lamps Ltd, Beetons Way, Bury St Edmunds, Suffolk IP32 6RA, tel 0284-62411.

When Is 32 Bits 32 Bits?

On page 23 we take a look at Motorola's 68020 32-bit microprocessor. What is beyond dispute is that this is a true 32-bit microprocessor, with 32-bit architecture and 32-bit data and address busses. On this basis, and the fact that pre-production samples were already in wide circulation with equipment manufacturers, we have accepted Motorola's claim that it is the first true 32-bit microprocessor.

However, the story doesn't end there. A number of other manufacturers have 'true 32-bit' microprocessors, and these include Nat Semi, NCR and AT&T. Exactly who was the first and what 'true 32-bit' means will doubtless be cause for much argument amongst semi-conductor giants. And who can blame them, with a market worth an estimated $3.3 billion at stake?

We here at ETI will be keeping a watchful eye on this squabble, and will keep our readers informed. Meanwhile, our advice to those of you involved in this trade is to keep your heads down!

● Looking for some education? Then you might do worse than contact ICS Publishing Company (UK) Ltd who organise a number of professional technical courses. ICS Publishing Company (UK) Ltd, 3 Swan Court, Leatherhead, Surrey KT22 8AD, tel 0372-379211.

● Things still aren't looking too bright for the electrical industry. Business information company Dun & Bradstreet Ltd tell us that company liquidations in the industry during the first six months of 1984 totalled 388, a 2.9% increase over the figure for the same period last year. Bankruptcies among firms, partnerships and individuals totalled 62, a 58.9% inrease over the figure for the first half of 1983 but no worse than the figure for the latter half of the year.

● Tele-Production Tools have introduced a solution which can be used to retrieve components from potted assemblies. Called Stironol, the solution disintegrates epoxy and polyester resins but will not attack most metals in normal use and is also non-toxic and non-flammable. For details contact Tele-Production Tools Ltd, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW, tel 0702-352719.

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MS11-LD	Unibus 256 kb Ram	£850.00
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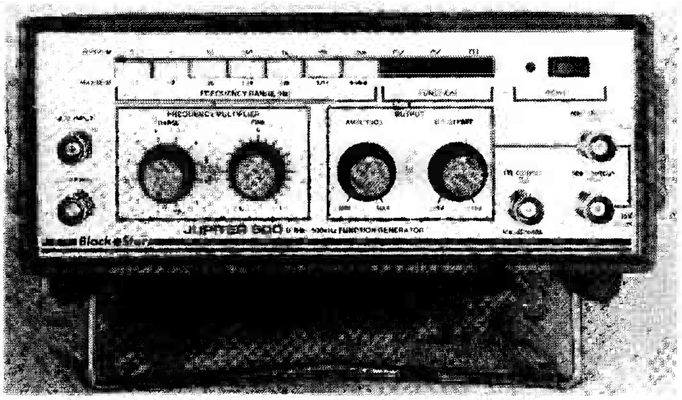


30V-out Function Generator

The new Jupiter 500 Function Generator is claimed to be a rugged, mains-operated instrument offering features unique in its price range. Both amplitude and frequency are fully programmable by an external voltage and an exceptionally high output of up to 30V peak-to-peak is available.

The frequency range of the Jupiter 500 is 0.1Hz to 500kHz in 7 switched decade ranges with fine frequency control. Sine, square, triangle and TTL (30 loads) waveforms are selectable and an adjustable DC offset up to 15V can be applied to the output.

The Jupiter 500 is supplied with a comprehensive instruction manual and a spare fuse and sells in the UK at £110.00 (+ VAT). An illustrated colour data sheet is available from: Black Star Limited, 9A Crown Street, St Ives, Huntingdon, Cambs PE17 4EB, tel 0480-62440.

Fastest 32 x 8 Bipolar TTL Prom?

Monolithic Memories have introduced what they claim to be the industry's fastest 32 x 8 bipolar, TTL programmable read-only memory (PROM) device, the 53/63S081A.

The PROM has a guaranteed access time of 15 ns and is 40% faster than present 32 x 8 bipolar TTL PROMs. Power supply current of the 63S081A is 125 mA maximum and the output drive capability is 16 mA.

Special on-chip circuitry and Ti-W fuse links in the 63S081A provided for pre-programming and testing, ensuring high reliability with programming yields of greater than 98%. Other features include PNP inputs for low input current, three-state outputs and full Schottky clamping. The devices are available in both plastic and ceramic 16-pin, dual-in-line packages.

Further details on the 63S018A 32x8 TTL PROM are available from Monolithic Memories Limited, Monolithic House, 1 Queens Road, Farnborough, Hants GU14 6DJ, tel: 0252-517431.

Op-amp SOA Restrictions Eased?

Teledyne Philbrick say that they've alleviated the safe operating area restrictions and secondary breakdown problems suffered by virtually all power op-amps with the introduction of their TP1463. The 1463 is the third in a series of high-speed FET input power op-amps, and incorporates a class A-B complementory VMOS output stage which is what is claimed to make the difference.

The 1463 comes in an eight-pin TO3 package, can operate on supplies of +15V to +40V and can supply up to 1A (minimum). The slew rate is 80V/us despite the internal compensation for unity gain stability, and the gain-bandwidth product is 7.5 MHz.

Potential applications for the device include video yoke drivers, distribution amplifiers, CRT displays and gyro and oscillator drives for inductive and capacitive loads. A deatiled preliminary data sheet is available from MCP Electronics Ltd, 38 Rosemont Road, Alperton, Wembley, Middlesex HA0 4PE, tel 01-902 6146.

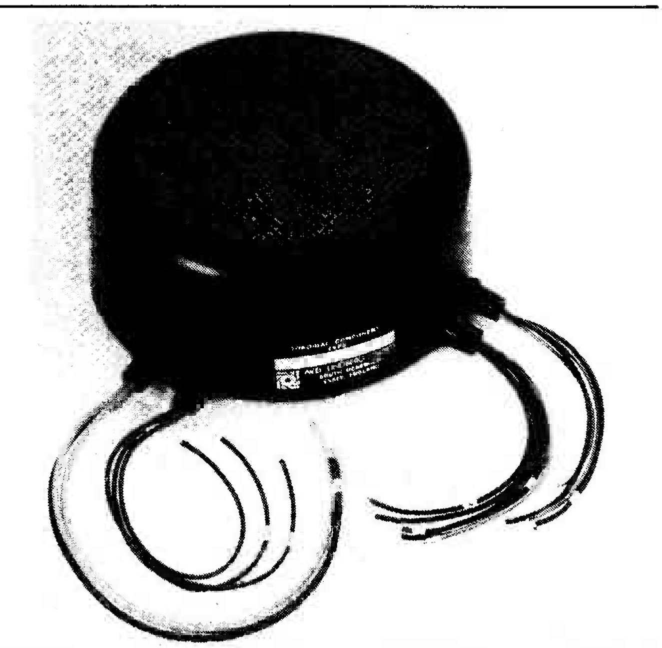
Hi-fi Mains Transformers

That every component in an audio amplifier is capable of degrading the performance is without doubt. However, it is debatable just how far one can go in the other direction — selecting 'hi-fi' components for use throughout the amplifier, not just for the few 'critical' components.

The transformer manufacturers Avel Linburg Ltd have entered the fray with the announcement of a new range of toroidal high-power transformers especially made for very high quality audio. The range spans power outputs of between 500VA and 2kVA and dual outputs of 60 to 70 V RMS can be ordered. They can supply transformers with two sets of secondaries, as a compromise between using two transformers for a stereo amplifier and using just one transformer to supply both channels.

Avel-Linburg don't say what it is about their transformers that makes them particularly suitable for hi-fi, although they do claim that they can tailor transformers to suit designers' electrical and mechanical constraints, including the lowest possible radiated noise figures.

We must point out that audio-enthusiast readers will be disappointed unless they're small manufacturers — Avel Linburg make it clear that these transformers are available only as 'relatively short production runs', and not as one-offs. Avel Linburg Ltd, South Ockendon, Essex RM15 5TD, tel 0708-853444.



● Do you need an expensive instrument, but only for a short time? Then you could hire rather than buy. Microlease PLC of Forbes House, Whitefriars Estate, Tudor Road, Harrow, Middlesex HA3 5SS (tel 01-427 8822) will lease for as short a period as one week, and offer many instruments including the new Keithley 175 autoranging data-logging DMM with IEEE interface.

● The latest data books from Hitachi can now be purchased directly from Hitachi Electronic Components (UK) Ltd, Hitec House, 221/225 Station Road, Harrow, Middlesex HA1 2XL, tel 01-861 1414. The most recent additions to the data books available are the 1984 editions of the microprocessor and memory data books, details of which appear in the new brochure from Hitachi.

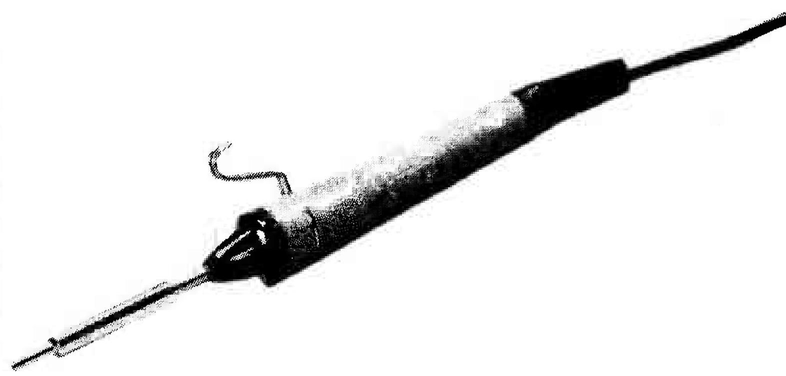
● The Decorative Lighting Association have issued a warning about an imported nightlight for children which they belive to be potentially dangerous. The Glowlight takes the form of an electrical plug which fits directly into a 13A socket and then gives off light, but there have been cases where the plastic cover has become detached and exposed the live mains connections. Anyone who has such a nightlight and has any doubts about its safety should contact the Director of the Assocation on 058-84658.

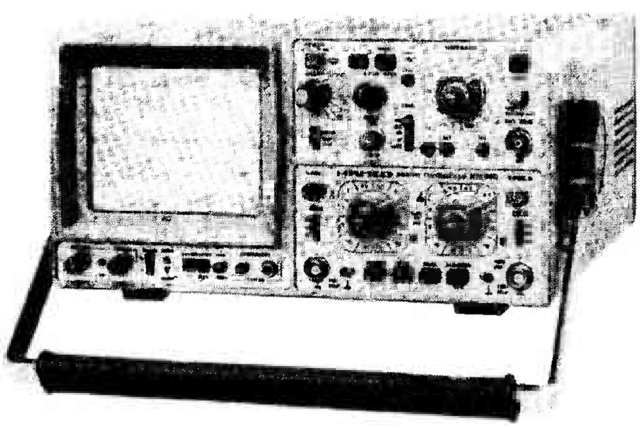
● Coutant Electronics Limited, Kingsley Avenue, Ilfracombe, Devon EX34 8ES (tel 0271-63781) have published a short-form catalogue of switched mode, hybrid, linear, DC-input and lab PSUs.

Handy New Iron

A new miniature soldering iron, the Oryx M3, has been introduced by Greenwood Electronics. Developed for light production applications but equally suited to the hobbyist market, it is rated at 17 watts and has a normal operating temperature of 380°C. It has been ergonomically designed and is perfectly balanced to give the correct 'feel' to experienced operators.

Supplied complete with a replaceable push-on tip and stainless steel storage hook, this new Oryx iron is available in 12V, 110V and 210/240V versions and the 12 volt iron is fitted with a cigar-lighter plug for mobile work. Greenwood Electronics, Portman Road, Reading, Berks. RG3 1NE, tel 0734-595844.





New Oscilloscopes

Levell Electronics have released details of two new dual channel oscilloscopes that they supply. The HM204-2 has a bandwidth of DC to 20MHz (−3dB) and the HM605 (pictured) has a bandwidth of DC to 60MHz (−3dB).

These multi-function oscilloscopes have sensitivities of 1mV/cm to 50V/cm with a signal delay line built in so that the trigger edge of a waveform can be viewed. A variable sweep delay from 100ns to 1s enables detailed signal analysis by expanding any section of a waveform. The sweep range is variable from 10ns/cm (including x10 magnification) to 1.25s/cm for HM204-2 and from 5ns/cm to 2.5s/cm for HM605.

Both oscilloscopes have a built in component tester for checking electronic components individually or in circuit and a 1kHz/1MHz square wave calibrator for probe compensation and system checks. A Z-modulation input is also provided.

Levell offer free delivery in the UK and discounts based on mixed total order value. Levell Electronics Ltd, Moxon Street, Barnet, Herts. EN5 5SD, tel 01-449 5028.

Hullabaloo!

Next time you go to the loo in central London, you could attract some attention! Let us assure readers that this is extremely unlikely to occur, but if one of the new-fangled automatic public conveniences goes wrong with you inside, it will automatically summon a repair man.

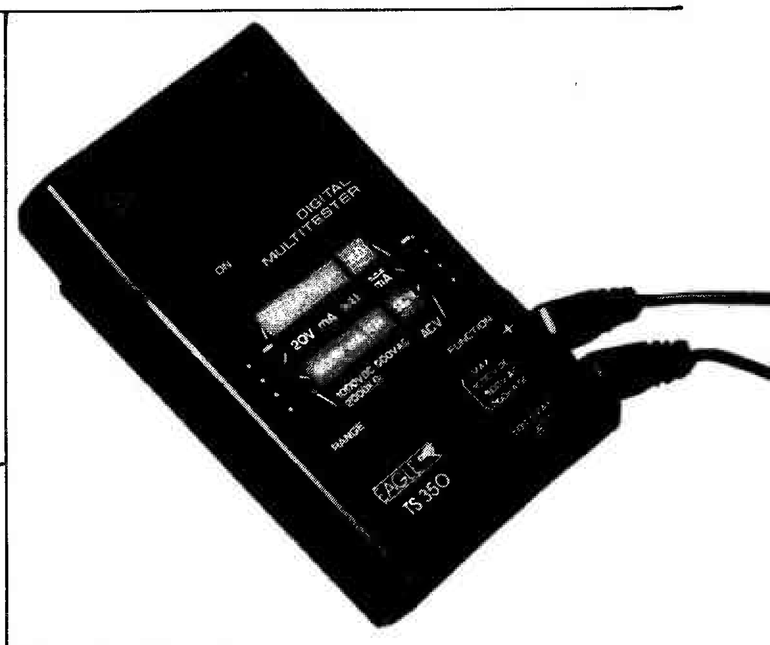
This is because the auto-loo has a Dynamic Logic D1230 Microlog located in its technical compartment. This item will detect any faults, and then report the fault via the ordinary telephone network to a master station. The master station logs the call from this and other loos in the area, and presents information to operators in plain English. The master station is also capable, if required, of ringing up the service engineer directly, and, with additional equipment installed, it can describe the fault and location to the engineer.

Let us assure you that if you're sitting in an auto-loo with the door jammed and waiting for the engineer to arrive, it should take the engineer no more than four hours to reach you!

●Semiconductor Supplies have issued a sixteen page catalogue and price list which covers their range of cases, racks, connectors, wiring systems, hand tools, PCB accessories etc. The minimum order charge is £2.00 and copies of the catalogue are obtainable upon request from Semiconductor Supplies International Ltd, Dawson House, 128-130 Carshalton Road, Sutton, Surrey SM1 4RS, tel 01-643 1126.

●Bradford and Ilkley Community College is again running a course for those wishing to take the Radio Amateurs Examination. The course begins in September, enrolment will take place on September 11th, and in addition to the basic course there are also classes for existing 'B' licence holders and for licensees who wish to gain a more in-depth knowledge of radio topics. Contact P. Nurse, Department of Electrical & Electronic Engineering, Bradford & Ilkley Community College, Great Horton Road, Bradford, West Yorkshire BD7 1AY, tel 0274-753111.

●They're probably not the first to launch a peripheral for the dratted thing, but they're the first we've heard of: Cambridge Systems Technology now make a Centronics interface for the much-maligned Sinclair QL computer. Contact Cambridge Systems Technology, 30 Regent Street, Cambridge CB2 1DB, tel 0223-323302.



Eagle Test Meter

Eagle International have launched a pocket size 3½ digit LCD multimeter, model TS 350, which is available through all leading electrical wholesalers at a trade price of £21.95 (excluding VAT). Pocket size, budget priced analogue multimeters have long been popular and Eagle now feel the time is right to offer a similarly convenient instrument which can offer digital sensitivity and accuracy.

The TS 350 has 12 mm LCD display, auto zeroing and polarity reversal. There are 13 measuring ranges including 1,000 V DC, 500 V AC and 200mA DC. Mode and range selection is by means of two simple slide switches.

The meter comes complete with shrouded, finger stop type safety probe and as with all Eagle instruments, it is covered by a two year guarantee. Eagle International, Precision Centre, Heather Park Drive, Wembley, Middlesex, HA0 1SU, tel 01-902 8832. ETI

SIMPLE ECHO UNIT

Are you a bathroom baritone or a cave contralto? Bring the same life to the living room and pzazz to the parlour with this simple echo unit. Design by Phil Walker.

Do you sing in the bath? Go on, admit it! How much better music sounds when there are a lot of hard, reflecting surfaces around to provide plenty of echoes, as you will know if you if you have ever listened to music in a concert hall. But when you move from the concert hall or bathroom to a small room which has thick curtains and soft, upholstered furniture all of that rich, reverberant sound is lost. If there is an echo in such surroundings, it is unlikely to be from the opposite wall which will provide a single, strong echo rather than the multiple echoes which add so much to the sound.

The ETI EZEKO (Easy-Echo, geddit?) is designed to help you recapture some of that life and richness when singing or playing in acoustically dead surroundings. It's a simple mechanical (spring-line) echo unit which operates from a nine-volt battery and provides a variable depth effect. It is designed to be used with a suitable microphone and amplifier and is equipped with an output level control. To make things even simpler there is no on-off switch: the unit switches on automatically when a jack plug is inserted into the output socket.

Circuit

The basic component in this project is the spring line unit. It works as a mechanical delay line. A signal is fed into one of the drive coils which causes the springs to vibrate. A short time later the vibrations reach the other end of the springs and cause a voltage to be induced in the receive coil. In this particular unit there are two springs in parallel which naturally have slightly different delay times. This simulates the natural echo effect where sound would usually be reflected off of more than one surface. In addition, the vibrations in the springs do not traverse the springs once and stop but are

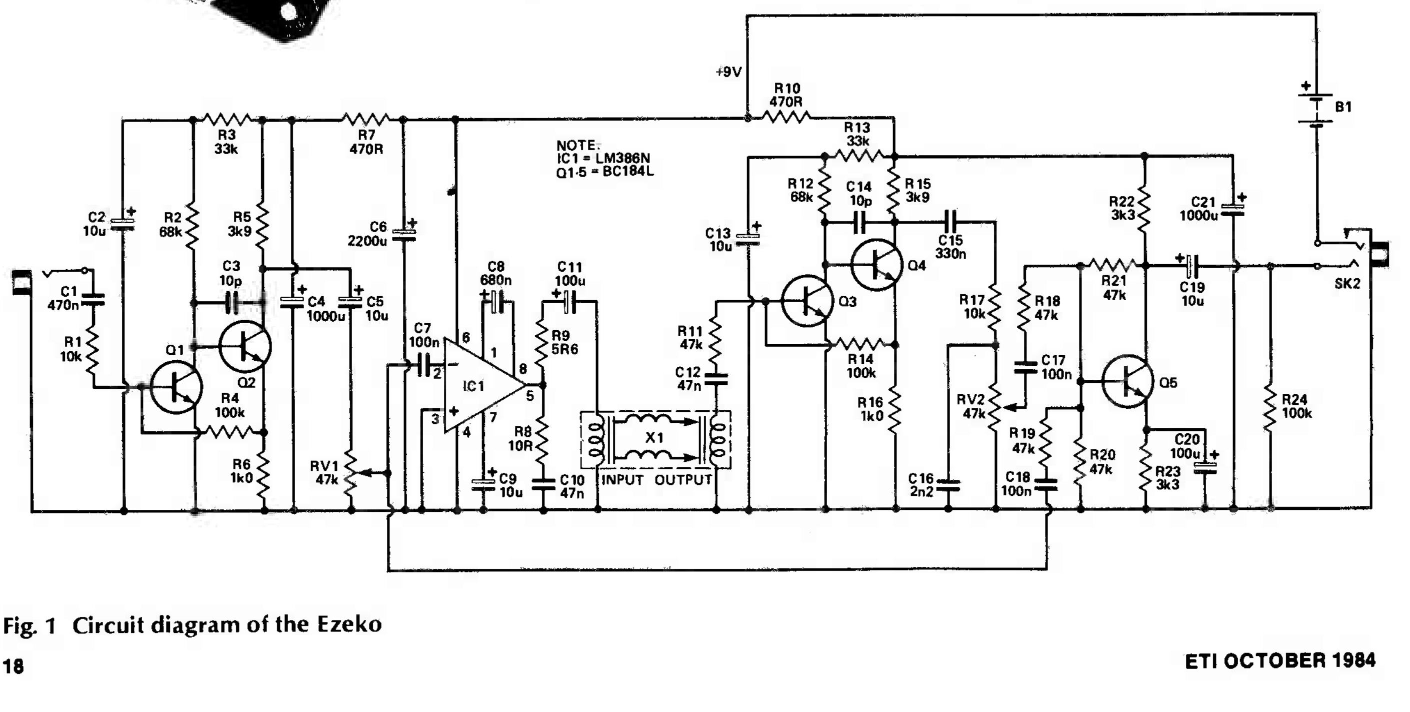


Fig. 1 Circuit diagram of the Ezeko

reflected back and forth many times, decaying slowly in amplitude.

Due to the nature of the device the spring exhibits a very uneven frequency response. This is not altogether a bad thing but some of the major effects need sorting out. The circuitry we have developed to go with this project works in two stages. The first operates around the drive amplifier to boost the higher frequencies relative to the lower frequencies. A single capacitor C8 connected to IC1 does this and gives a response which starts rising at about 200 Hz and levels off again at 2 kHz. A resistor is also included in series with the drive coil to reduce the low frequency loading effect on the amplifier output caused by the falling impedance of the drive coil.

The second stage of equalisation occurs after the output signal has been amplified by the receiving amplifier and consists of a passive shaping network before the echo level control. The combination of this and the driver compensation with the spring line response can never give a flat response overall but the effect is quite audible.

The rest of the circuit consists of a pre-amplifier before the overall level control RV1 and a final mixer circuit to combine the direct and delayed signals into the output signal. An active circuit was used here to reduce the amount of signal leaking back to the input of the spring driver amplifier causing spurious feedback whistles. Fairly extensive decoupling of the power supply lines was found to be necessary for battery operation and this is provided by R7/C4, C6 and R10/C22.

HOW IT WORKS

This is a simple circuit which can be considered in four main parts. These are: — input amplifier, spring driver, spring output amplifier and output mixer. Of these, the first and third are vitually identical in operation. Each consists of a two transistor direct coupled amplifier whose overall gain is controlled by feedback from the emitter of the output device to the base of the input device. The output from this configuration is approximately equal to the voltage generated by the input current to the stage flowing through the feedback resistor (R4 or R14) mulitiplied by the ratio of the output transistor collector and emitter resistors (R5/R6 or R15/R16). In the case of the input amplifier the input voltage is converted to an equivalent current by R1. In the case of the spring output amplifier it is virtually a current anyway since the output coil is a fairly high impedance but, being a inductance, the impedance seen by the amplifier circuit is not constant with frequency. To overcome this effect R11 is placed in series with the pick-up coil and has the effect of flattening the frequency response somewhat. It also has the effect of damping the resonant peak caused by the interaction between C12 and the pick-up coil inductance. The small value capacitors C3 and 14 are present to ensure the high-frequency stability of the arrangement.

The second part of this project is the spring driver. This is configured around an IC power amplifier device, the LM 386. This chip was specially deigned with battery operation in mind and needs few external components for normal operation. In this project we are using it to drive into a very inductive load and a small value resistor is put in series with the spring coil to keep the load impedance from falling too low. C11 prevents the DC component at the output of the chip from appearing across the drive coil. C10 and R8 are normally included where highly reactive loads are being driven to help maintain stability.

The gain of the LM386 is set internally at x20 but by connecting suitable components across pins 1 and 8 this can be raised to about x200. For the purposes of this project we require the gain to be low up to about 200 Hz and then rise. This is accomplished by connecting a suitable value of capacitance across these pins calculated to produce the correct response with the internal resistances on the chip.

The final part of the project is the output mixer. This is a very simple device but it was found necessary to make it active rather than passive to avoid unwanted feedback of signal from the mixer input to the spring driver input. The direct input signal is taken from the master gain control (RV1) to the mixer input via R19 and C18. The echo signal goes via a simple band pass network C15,C16,R17 to the effect control (RV2) and thence via R18 and C17 to the mixer input.

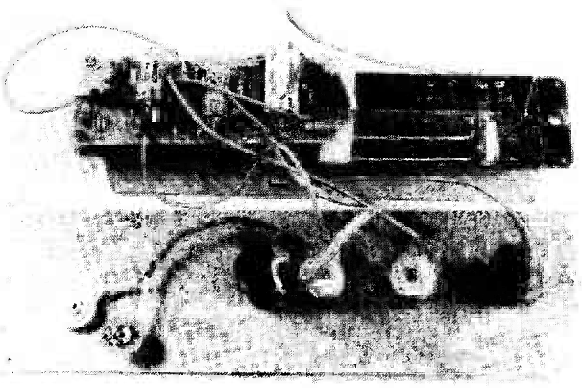
The mixer circuit is a simple common emitter amplifier. Because of the feedback from the collector to the base it has a low impedance which effectively isolates the direct and echo signal paths from each other. The total current flowing in from the two inputs is made to flow through R21 and the resulting voltage appears at the collector of Q5. From here C19 couples it to the output voltage socket.

Construction

The construction of this project is quite straightforward if the usual care is taken over the component polarity and placement. Do note that C13 and C14 are not mounted the same way around as the rest of the capacitors. The orientation of the transistors and IC should be followed carefully. There are spaces for an extra resistor and capacitor near C16 if you wish to alter the frequency response.

If you use the specified case there should be plenty of room for the components and a PP9 battery. In our prototype the PCB was attached to the spring unit which was then wedged and glued into the case with foam rubber backing pieces. If you have time it would be a good idea to work out an alternative which holds the battery more securely but leaves it accessible for replacement. The spring line should be mounted on something to avoid microphony and similar external noises being coupled into the spring.

The wiring to the front panel and spring unit should be done



PARTS LIST

RESISTORS (¼W 5% carbon film)		C8	0μ68 Tantalum bead
R1,17	10k	C10,12	47n
R2,12	68k	C11,20	100μ 16V axial electrolytic
R3,13	33k	C15	330n
R4,14,24	100k	C16	2n2
R5,15	3k9		
R6,16	1k0	**SEMICONDUCTORS**	
R7,10	470R	Q1,2,3,4,5,	BC184L
R8	10R	IC1	LM386N
R9	5R6		
R11,18,19,20,21	47k	**MISCELLANEOUS**	
R22,23	3k3	X1	short spring line unit
RV1,2	47k log. pot.	SK1	mono ¼ inch jack socket
		SK2	mono ¼ inch jack socket with MAKE contact
CAPACITORS (ceramic or polyester unless stated)		Case	281 x 152 x 80 mm see Buylines
C1	470n	B1	PP9 battery
C2,5,9,13,19	10μ 16V axial electrolytic	PCB; battery clips; knobs, foam rubber, wire etc.	
C3,14	10p		
C4,21	1000μ 16V axial electrolytic		
C6	2200μ 16V axial electrolytic		
C7,17,18	100n		

with screened wire and if possible as shown in the diagram. This should avoid earth loops and other unwanted effects. Take care with the connections to SK2 as this is the on/off switch as well as the output socket. The 0V from the PCB is connected via the screen of the cable to the contact on the socket which will touch the sleeve of the plug. The core of the cable from C19 connects to the tip contact. The remaining core of the cable from the +ve rail on the PCB connects directly to the −ve battery clip, so make sure you leave sufficient wire for this. On the specified jack socket there is another contact which is positioned so that it is normally unconnected but which connects to the contact which touches the sleeve of the plug when a jack is inserted. To this extra contact a length of wire must be connected and taken to the −ve battery clip. Thus when the jack plug is inserted the battery is connected to the circuit. When withdrawn the power is turned off.

BUYLINES

The spring line unit is available from Maplin Electronic Supplies. The jack socket with the make contact and the case are available from Electrovalue, jack type S2/MNS and case PI-CASE FP4B. The PCB is available from our PCB service.

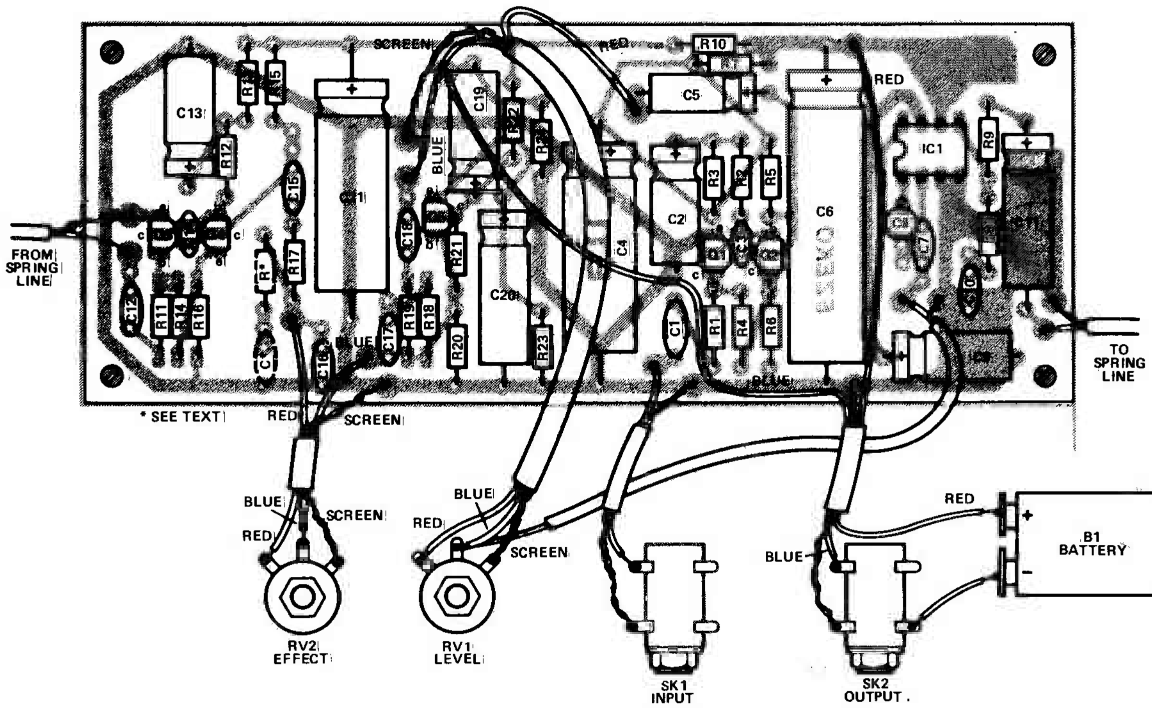
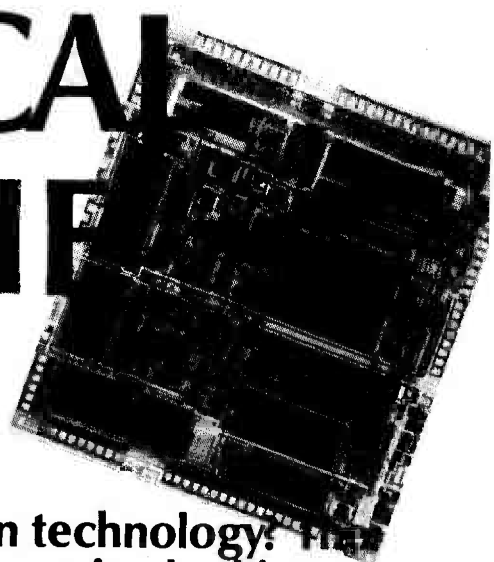


Fig. 2 Overlay diagram; note the provision for an extra resistor and capacitor (see "Construction").

ETI

THE TECHNICAL GUIDE TO THE MC68020



One small piece of silicon — or a giant stride in technology? The new 32-bit micro from Motorola has some impressive-looking vital statistics. Phil Walker has been looking at the data to find out if it lives up to expectations.

This monolithic monster is claimed to contain about 200,000 transistors and able to operate at sustained rates of two to three MIPS (million instructions per second) and burst rates of over 8 MIPS. With address and data busses both 32 bits wide this gives it pretty awe-inspiring power.

The MC68120 is the latest addition to the 68000 family which includes the 16 bit MC6800 and the 8-bit MC68008 used in the Sinclair QL. As such, it has been designed so that software written for the earliest members of the family will run on it. This is necessary these days as the investment in creating new software is a major consideration when using a new device.

Another feature of great interest to the system designer is that this device can use the currently available support devices in the 68000 family by the neat trick of varying the effective data bus width according to what type of device is being addressed. However, the designer is not limited to the existing support devices and there are at least two other devices in the pipeline, the MC68881 floating-point co-processor for high level maths functions and the MC68851 paged memory management unit to take care of allocation and protection of the 4 gigabyte addressing range of the MC68020.

The MC68020 is expected to find applications in computer aided design, personal and business computers, high performance colour graphics systems, telecommunications and robotics. It obviously provides another attack on the mainframe and minicomputer fields although it will probably expand the whole market rather than simply substitute for them.

The Inside Story

Inside the unusual 1⅜ inch square package with its 114 pins there lurks a .375 by .350 inch slab of silicon. In this are the 200,000 or so transistors which make up the microprocessor. To get them on Motorola have used a 2 micron HCMOS process

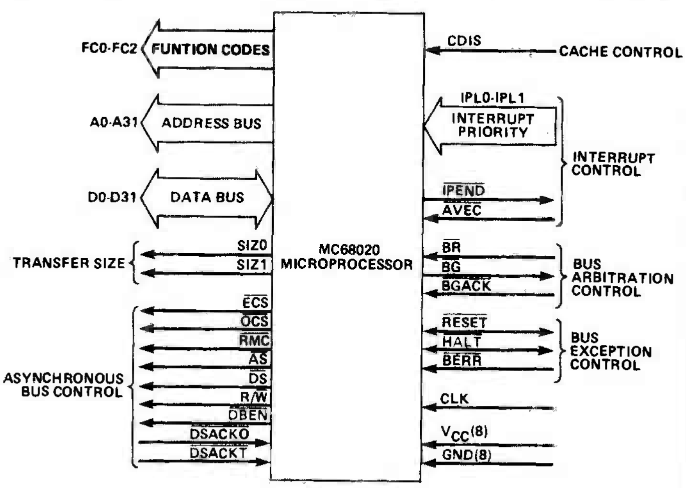
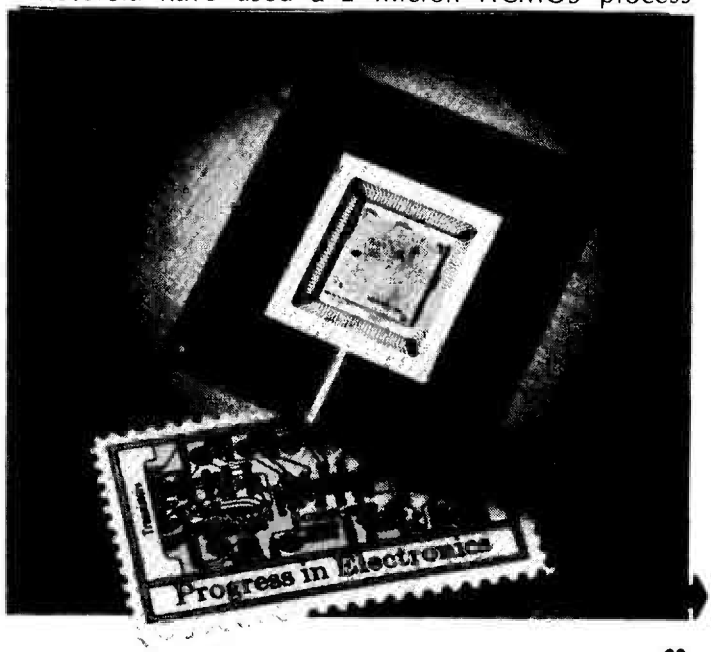


Fig. 1. Signal groups in and out of the MC68020.



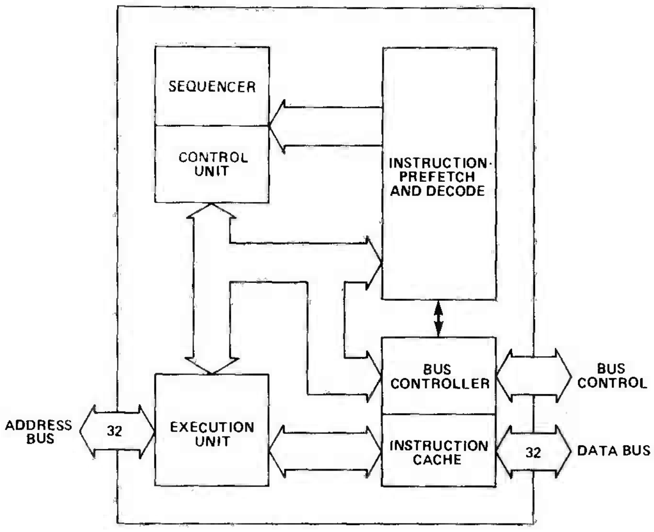


Fig. 2 Block diagram.

which basically means that everything is small.

On the chip itself things are controlled by the master clock which is specified to run at 16.67 MHz or 60 nanosecond period. The whole circuit dissipates less than 1.5 watts (pretty cool). All the registers, logic and arithmetic units, program counters, stack pointers and external address and data busses are 32-bits wide. Because multiplexing has not been used on the external signals, it is the first true 32 bit microprocessor.

The 32-bit address bus allows access to over 4,000,000,000 32-bit words (I wonder if anyone will ever provide this much memory?). However, the main purpose is to allow each program to access any of the 4 gigaword logical address space but, by using virtual memory techniques, only a small fraction of the address space need exist as physical memory or other functions.

Different Levels

The effect of this sort of approach is that there are two operating levels to a machine. The *supervisor* level takes care of resource allocation such as memory and I/O devices to each user program. The *user* level is where a program will run until it tries to make use of a resource which is not allocated to it, not present (memory space or data not physically present) or even not allowed to the user program. At this stage, control reverts to the supervisor mode which either makes the resource available (transfers from mass storage, reallocates memory or allocates the required I/O device etc.) or aborts the user program. In this sort of environment it is possible (at least in theory) to prevent user programs from getting unauthorised access to the operating system. This is very important in machines where many user programs may be running quasi-simultaneously.

The MC68020 is configured in a slightly different way for supervisor and user modes. In fact the main difference is than slightly more information is available in supervisory mode from the extra registers about the processor status interrupt and error handling functions. In the user mode there are eight data registers, a user stack pointer and program counter also 32-bits wide. There is also a condition code register of which only five-bits are useful to the user.

in the supervisory mode there are two more stack

Mnemonic	Description
ABCD	Add Decimal with Extend
ADD	Add
ADDA	Add Address
ADDI	Add Immediate
ADDQ	Add Quick
ADDX	Add with Extend
AND	Logical AND
ANDI	Logical AND Immediate
ASL, ASR	Arithmetic Shift Left and Right
Bcc	Branch Conditionally
BCHG	Test Bit and Change
BCLR	Test Bit and Clear
BFCHG	Test Bit Field and Change
BFCLR	Test Bit Field and Clear
BFEXTS	Signed Bit Field Extract
BFEXTU	Unsigned Bit Field Extract
BFFFO	Bit Field Find First One
BFINS	Bit Field Insert
BFSET	Test Bit Field and Set
BFTST	Test Bit Field
BRA	Branch
BSET	Test Bit and Set
BSR	Branch to Subroutine
BTST	Test Bit
CALLM	Call Module
CAS	Compare and Swap Operands
CAS2	Compare and Swap Dual Operands
CHK	Check Register Against Bound
CHK2	Check Register Against Upper and Lower Bounds
CLR	Clear
CMP	Compare
CMPA	Compare Address
CMPI	Compare Immediate
CMPM	Compare Memory to Memory
CMP2	Compare Register Against Upper and Lower Bounds
DBcc	Test Condition, Decrement and Branch
DIVS,DIVSL	Signed Divide
DIVU,DIVUL	Unsigned Divide
EOR	Logical Exclusive OR
EORI	Logical Exclusive OR Immediate
EXG	Exchange Registers
EXT	Sign Extend
JMP	Jump
JSR	Jump to Subroutine
LEA	Load Effective Address
LINK	Link and Allocate
LSL, LSR	Logical Shift Left and Right
MOVE	Move
MOVEA	Move Address
MOVE CCR	Move Condition Code Register
MOVE SR	Move Status Register
MOVE USP	Move User Stack Pointer
MOVEC	Move Control Register
MOVEM	Move Multiple Registers
MOVEP	Move Peripheral
MOVEQ	Move Quick
MOVES	Move Alternate Address Space
MULS	Signed Multiply
MULU	Unsigned Multiply
NBCD	Negate Decimal with Extend
NEG	Negate
NEGX	Negate with Extend
NOP	No Operation
NOT	Logical Complement
OR	Logical Inclusive OR
ORI	Logical OR Immediate
PACK	Pack BCD
PEA	Push Effective Address
RESET	Reset External Devices
ROL, ROR	Rotate Left and Right
ROXL, ROXR	Rotate with Extend Left and Right
RTD	Return and Deallocate
RTE	Return from Exception
RTM	Return from Module
RTR	Return and Restore Conditon Codes
RTS	Return from Subroutine
SBCD	Subtract Decimal with Extend
Scc	Set Conditionally
STOP	Stop
SUB	Subtract
SUBA	Subtract Address
SUBI	Subtract Immediate
SUBQ	Subtract Quick
SUBX	Subtract with Extend
SWAP	Swap Register Words
TAS	Test Operand and Set
TRAP	Trap
TRAPcc	Trap Conditionally
TRAPV	Trap on Overflow
TST	Test Operand
UNLK	Unlink
UNPK	Unpack BCD
COPROCESSOR INSTRUCTIONS	
cpBcc	Branch Conditionally
cpDBcc	Test Coprocessor Condition, Decrement, and Branch
cpGEN	Coprocessor General Instruction
cpRESTORE	Restore Internal State of Coprocessor
cpSAVE	Save Internal State of Coprocessor
cpScc	Set Conditionally
cpTRAPcc	Trap Conditionally

Fig. 3 Summary of the instruction set. As you won't be able to get your hands on one of these for a while, we haven't bothered with the machine code . . . (Illustration taken from the data sheet).

pointers, a vector base register, alternate function code registers and two registers associated with the internal instruction cache. The 16-bit status register available in supervisory mode includes the five-bits of the user condition in addition to a three-bit interrupt priority mask, two-bit trace enable flag and bits which indicate the supervisory/user and master/interrupt conditions.

The instruction cache in the MC68020 is organised as 64 entries of 32-bits each. It is arranged that where possible the cache will be filled with suitable information so that the next instruction to be executed can be found in it rather than from external memory. There are two reasons that this is desirable, the first is that it takes less time to access the cache memory and the second is that data transfers can occur without being slowed down by the need to fetch instructions. It is basically a way of using otherwise wasted bus time in a useful way.

Some clever programming could be used to make further use of the instruction cache. It should be possible to arrange for small loops within the program to

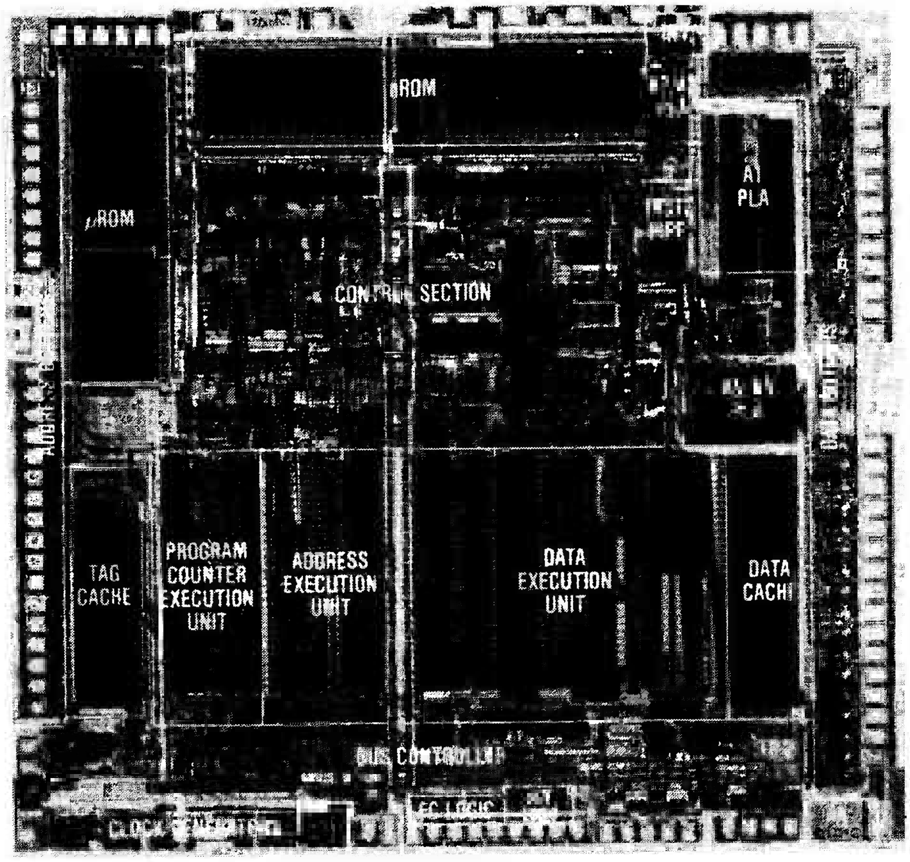


Fig. 5 Key to the parts of the die: Program Counter Execution Unit — calculates instruction addresses and maintains instruction stream pointers; Address Execution Unit — calculates operand addresses and stores user visible address register set; μROM — provides sequence control for the bus controller and micromachine; nROM — controls the operation of the micromachine; A1 PLA — provides initial decode of instructions, determines legality and provides initial microaddress; A2/A3 PLA — generates successive microaddresses associated with the instruction decode; A5/A6 PLA — decodes coprocessor operations; Tag Cache — contains the instruction tag information which includes the address and validity bit; Bus Controller — manages the cache and memory accesses; Data Execution Unit — where all the data operations are performed, contains the user visible data register set, a barrel shifter and elements of the instruction pipe; Data Cache — stores instructions, not data at all; Control Section — provides overall control.

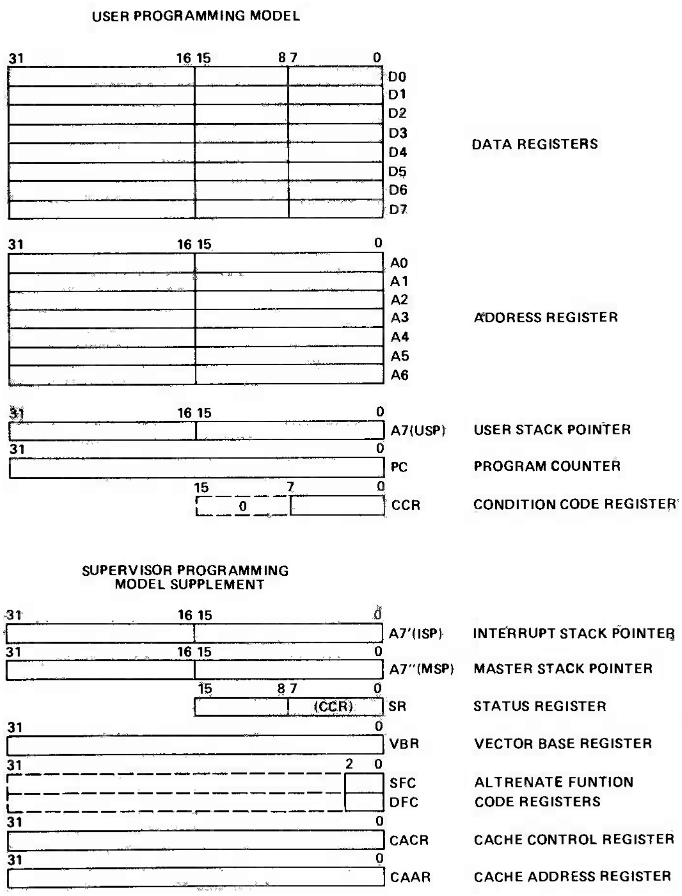


Fig. 4 The registers.

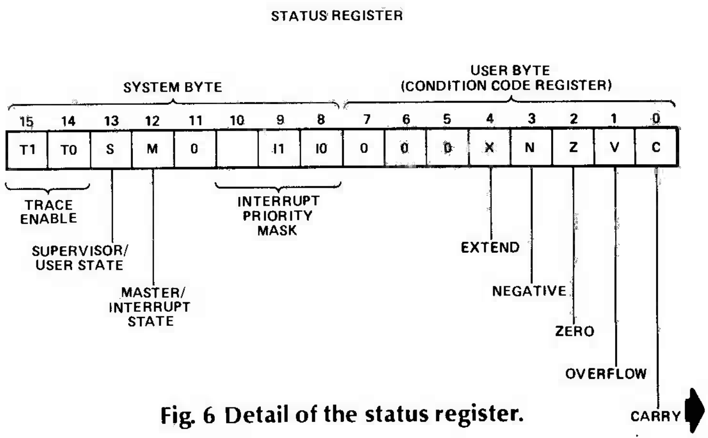


Fig. 6 Detail of the status register.

be entirely contained in the cache, so that the microprocessor will loop round for however many cycles are necessary without having to fetch any new instructions whilst it was in the loop.

Ins And Outs

The MC68020 claims 18 addressing modes and 7 data types. The address modes are shown in Fig. 8. They are made up of nine basic types with the option of modifying some types to provide extra flexibility. There is great flexibility in the way that the 16 address and data register may be used to access memory as base and index registers.

Data types are quite numerous as already mentioned. These vary from bits to quad words (64 bits long) and include bit fields of 1 to 32 bits, BCD digits (1 or 2 digits/byte) and integers of 8,16,32 and 64 bits long. Also operations on certain other types such as addresses and status words is possible.

As you can see from the summary of the instruction set there are most of the instructions you would expect of any processor system as well as a variety of test and branch and some less usual ones. All the instructions from previous members of the 6800 family are present with some additions and extensions to take account of the 32-bit capability and other enhancements. A useful feature for the large system is that upper and lower bounds checking is offered as opposed to the upper bound bound only in the MC68000 family to date.

Addressing Modes	Syntax
Register Direct	
Data Register Direct	Dn
Address Register Direct	An
Register Indirect	
Address Register Indirect	(An)
Address Register Indirect with Postincrement	(An)+
Address Register Indirect with Predecrement	−(An)
Address Register Indirect with Displacement	(d_{16},An)
Register Indirect with Index	
Address Register Indirect with Index (8-Bit Displacement)	(d_8,An,Xn)
Address Register Indirect with Index (Base Displacement)	(bd,An,Xn)
Memory Indirect	
Memory Indirect Post-Indexed	([bd,An],Xn,od)
Memory Indirect Pre-Indexed	([bd,An,Xn],od)
Program Counter Indirect with Displacement	(d_{16},PC)
Program Counter Indirect with Index	
PC Indirect with Index (8-Bit Displacement)	(d_8,PC,Xn)
PC Indirect with Index (Base Displacement)	(bd,PC,Xn)
Program Counter Memory Indirect	
PC Memory Indirect Post-Indexed	([bd,PC],Xn,od)
PC Memory Indirect Pre-Indexed	([bd,PC,Xn],od)
Absolute	
Absolute Short	xxx.W
Absolute Long	xxx.L
Immediate	#<data>

NOTES:

Dn = Data Register, D0-D7
An = Address Register, A0-A7
d_8, d_{16} = A twos-complement, or sign-extended displacement; added as part of the effective address calculation, size is 8 or 16 bits (d_{16} and d_8 are 16- and 8-bit displacements); when omitted, assemblers use a value of zero.
Xn = Address or data register used as an Index register, form is Xn.SIZE*SCALE, where SIZE is .W or .L (indicates index register size) and SCALE is 1, 2, 4, or 8 (index register is multiplied by SCALE), use of SIZE and/or SCALE is optional
bd = A twos-complement base displacement; when present, size can be 16 or 32 bits
od = Outer displacement, added as part of effective address calculation after any memory indirection, use is optional with a size of 16 or 32 bits.
PC = Program Counter
<data> = Immediate value of 8, 16, or 32 bits
( ) = Effective address
[ ] = Use as indirect address to long word address.

Fig. 8 Addressing modes (Illustration taken from the data sheet).

Exceptions To The Rule

There is a very powerful set of actions implemented in this device known as exceptions. These act rather like the interrupts of the normal eight-bit devices but can be generated in many more ways. Also, in many cases, the action taken when an exception is flagged is under the control of the user.

Exceptions can be generated either internally or externally. The external ones are the interrupts, bus error signal and reset request. The interrupt signals operate much as would be expected with the priority being flagged to the processor and a vector number being read in to define a particular action from the interrupting device. The bus error exception is used to prevent a failure of the data bus handshaking signals with any peripheral from locking up the processor indefinitely. To implement this, some form of timer is required on the bus control signals to detect the failure. The reset request input starts the system reset sequence.

Internal exceptions are quite numerous and have been expanded from the MC68000 set. They are generated by trace mode after each instruction, and by various conditional and unconditional trap and boundary checking operations. Also any errors in the address range, co-processor or illegal instructions including divide by 0 will generate an exception.

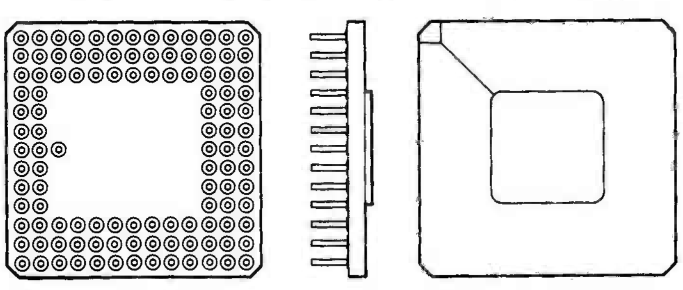


Fig. 7 Package mechanical details.

Once an exception has been recognised, the processor is put into supervisor mode and after a few more operations to keep things tidy, control is passed to one of the exception handling routines. The routine is selected using a combination of the vector number associated with the exception being processed and the current contents of the vector base register.

A very useful feature of the MC68020 for system development is that hardware which is not yet developed or available can be emulated in software. When the non-existent hardware is accessed an error is flagged and the processor jumps to a section of software which stimulates the required hardware. After this is executed, the processor resumes operation as normal.

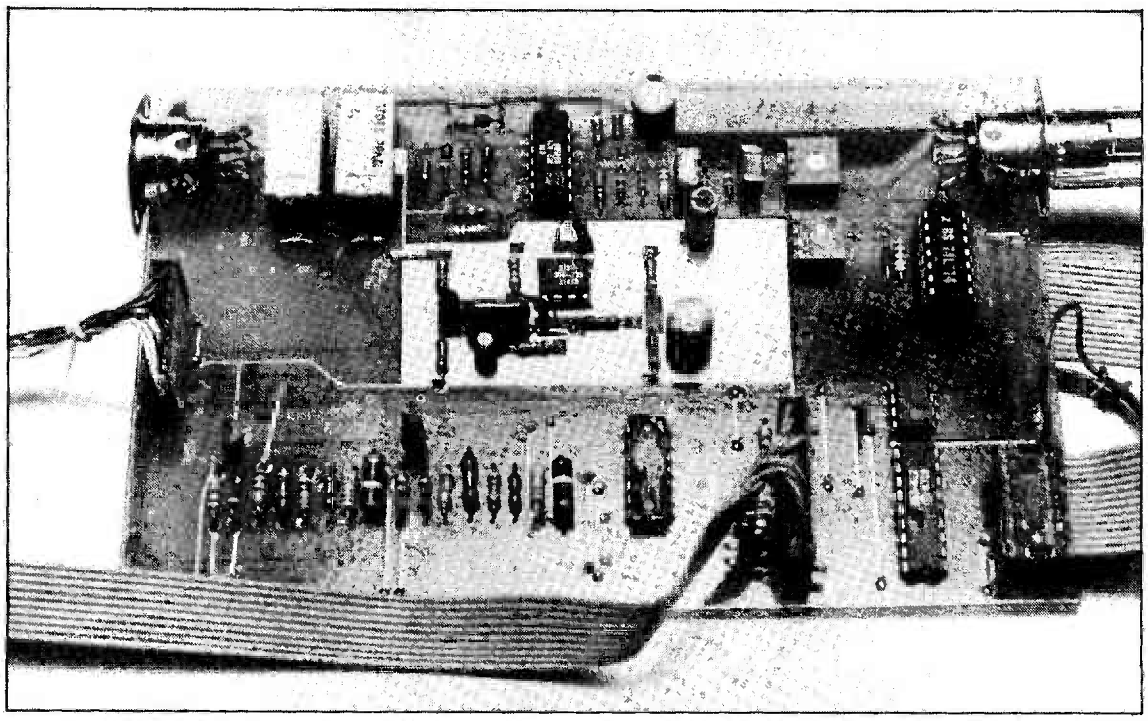
Reflections

Starting at around 'less than $500' it will probably be some time before this device is available outside the industrial and military markets and even when it is it will take a lot of money and nerve to sell a unit based on it in the consumer field. It will probably follow the usual price pattern of new semiconductor devices and fall to about a tenth (or so) of its launch price in five years. The speed and processing capabilities of this device and the market built up by previous members of the family will probably help it to carve out a large slice of the professional market in the future.

Initially I was going to try and compare this device to the typical 8-bit processors familiar to many of our readers but I did not feel that this would be too useful. The address capability of the MC68020 is vast, if each of the 65536 addresses of a typical 8-bit held 65536 bytes of data this is still only a quarter of the MC68020 capability. However, the basic capabilities of the 8-bit device are still there but very much enhanced and operating at a much higher speed. **ETI**

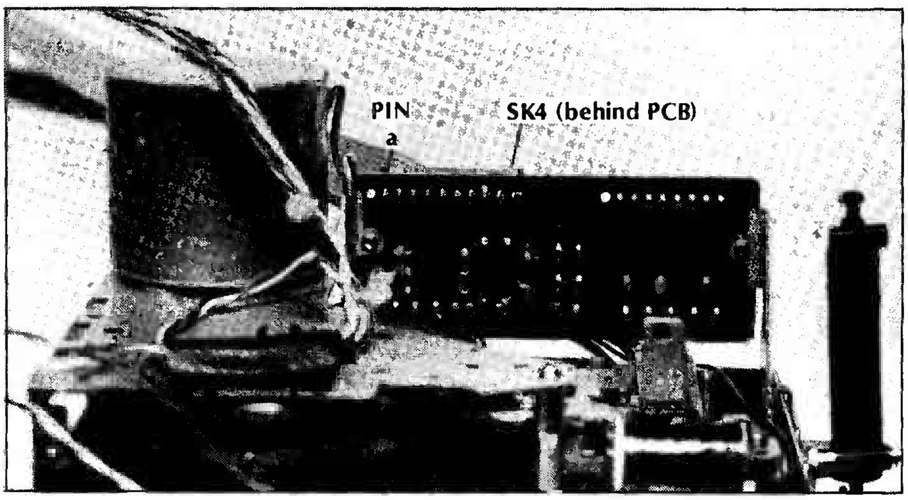
DIGITAL CASSETTE DECK

Why are our readers so impatient? Here is Bob Campell with the details of the project you've all been ringing, telexing, writing and generally pestering us about.



Construction is very straightforward as long as the PCB design is adhered to, but beware those of you that do not. The noise that can be induced, particularly in the read amplifier, through poor circuit lay-out must be heard to be believed. The extensive use of the earth or ground plane is a great help in alleviating this problem, but probably the most important feature is the single earth point.
Any configuration which has more than one route to mains earth will cause what is known as a 'hum loop'. Hi-fi enthusiasts, perhaps, are more familiar with this effect than the rest of us, but in effect the loop causes a 50Hz mains hum to appear at the input to the amplifier and with something like a 90dB amplification.

Fig. 1, last month shows how to connect the system up; the



The PCB on the deck onto which you must solder SK4; the pin connections are as follows: a (left-most pin in this photo) record solenoid; b, play solenoid; c, motor solenoid; d, fast forward solenoid; e, rewind solenoid; f, motor; g + 12V; h,i, record protection contacts; j, not used.

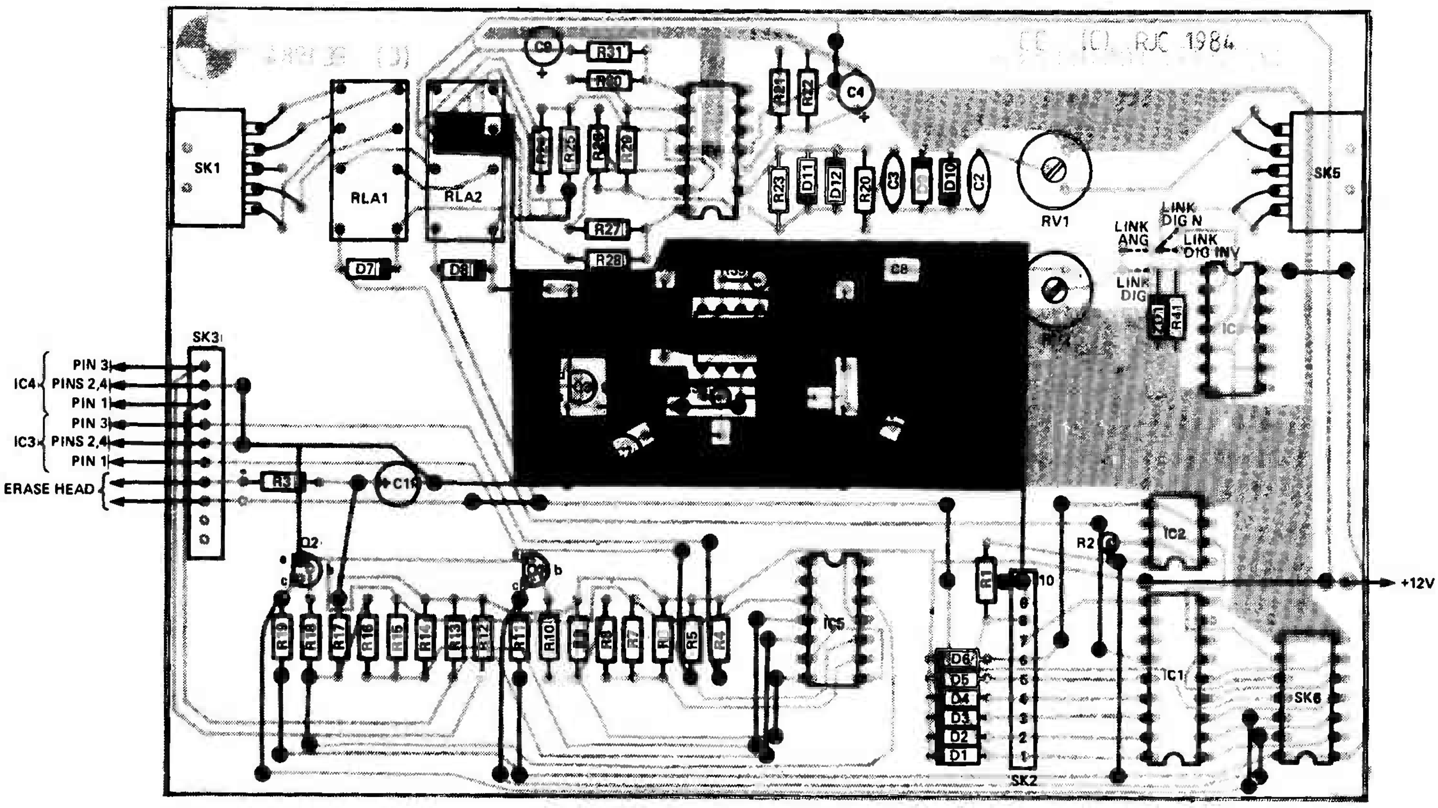


Fig. 7 Overlay diagram of the PCB

second power supply should be left floating and the screens on the signal lines should be connected at one end only, the computer end. It is also important to connect the metal frame work of the tape deck to the control board ground by only one route.

The PCB is relatively simple to make, all the usual rules apply. Through board links are shown. After assembly, check all tracks for shorts, etc, etc. Although sockets can be used for the amplifier chips it is not really recommended, as they can be another source of noise. Also, with the Darlington drivers, mounting them directly on the PCB will improve the heat dissipation.

Setting up the system mainly consists of adjusting the two potentiometers RV1 and RV2. RV1 is the output volume control, in effect, and should be adjusted as such, ie as one would with your normal cassette recorder. The other pot, RV2, in a roughly similar way, is equivalent to the recording level control. This should be adjusted to give an output from IC6a. Listen to the output with a small speaker or a small piezo transducer and a capacitor to AC couple it to the output of IC6a. The actual recording level is controlled by the two resistors R28 and R31. These control the current through the record head. The value used in the prototype, 10k, worked well giving adequate enough tape saturation without significant distortion, and was also sufficient to obviate the need to use the erase circuit.

The setting up of the EOT circuit is adequately covered in that section. It is worthwhile spending some time setting this up properly as proper automatic control of the tape deck is impossible without it.

PARTS LIST

RESISTORS (all ¼W unless stated)	
R1,2,9,11,17,19,37	1k0
R3	270R ½W
R4,12	390R ½W
R5,13	56k
R6,14,33,37	27k
R7,15,20,28,31	10k
R8,16,39	470k
R10,18,21,22,24, 25,34,35	4k7
R23	1M0
R26,29	100R
R27,30,38	100k
R27,30,38	100k
R32	220R
R40	470R
RV1,2	5k0 (or 4k7)

CAPACITORS	
C1,4,6	100µ 16V PCB electrolytic
C2,3	220n metal-lised polyester
C5	100n meta-lised polyester
C7	1µ miniature electrolytic
C8	2µ2 min-iature electrolytic

SEMICONDUCTORS	
IC1	ULN2803
IC2	DS3686N
IC3,4	See Buylines
IC5	LM319
IC6	TL074
IC7	TL072
IC8	74LS14
Q1,2	BC109 or similar
Q3	BF244
D1-12	1N4148
ZD1	4V7 zener diode

MISCELLANEOUS	
RLA1,2	DPCO 12V coil PCB mounting relays (see Buylines)
SK1,5	5 pin PCB mounting DIN socket
SK2,3,4	10 way 0.1" Molex male
SK6	14 pin DIL socket

2 female molex sockets to fit SK2,3,4; off crimp terminals for SK2,3,4; cassette mechanism Tenashin Denki type TN-3600;

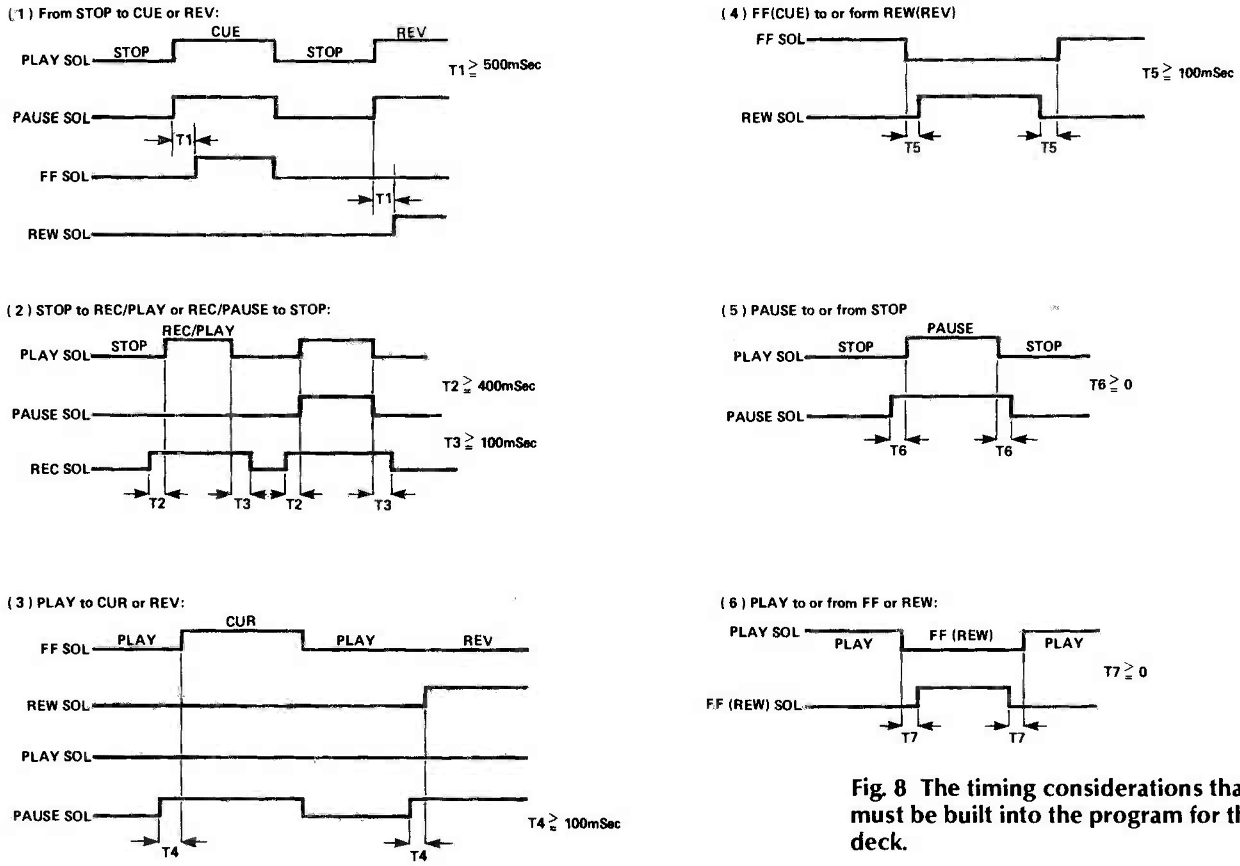
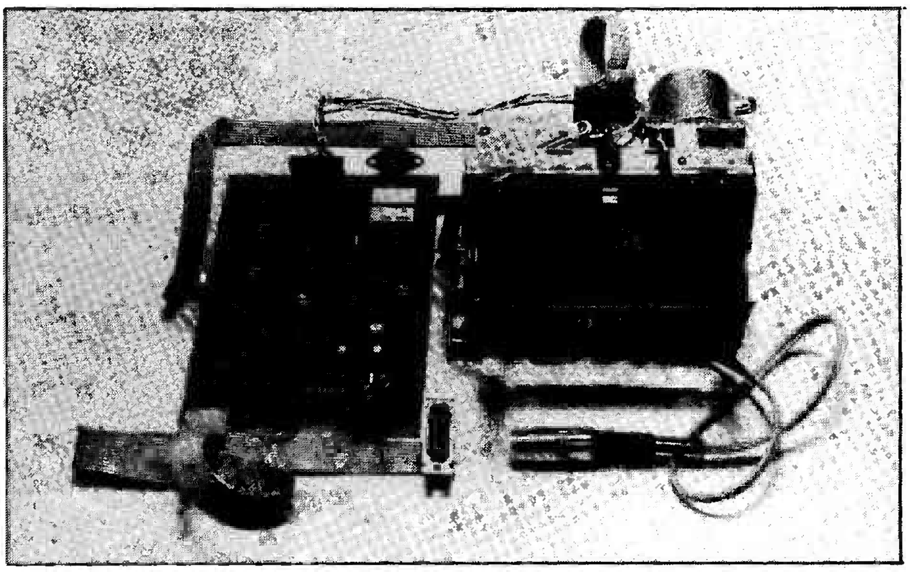


Fig. 8 The timing considerations that must be built into the program for the deck.



Programming Considerations

Although Table 1 last month lists all the required solenoid operations required to select any function, it is not sufficient just to switch them on or off as and when needed. Each solenoid has finite take-up and release times and these must be allowed for. Indeed, several conditions could develop excessive tension in the tape causing it to stretch or even break. The following conditions must therefore be avoided:

1) From STOP to CUE or REV: to ensure that the head is in contact with the tape before tape movement occurs, allow 500msec between selecting pause or play and FFWD or REW (see Fig 8);

2) From STOP to REC/PLAY or REC/PAUSE to STOP: to ensure that no solenoid switching noises are recorded allow 400msec between activating the REC and PLAY solenoids and release the PLAY solenoid at least 100msec before the REC (see Fig. 8b);

3) From PAUSE to FF or REV: when selecting either FFWD or REV from a PAUSE allow 100msec from deselecting PAUSE to selecting FFWD or REV or else the tape may still be trapped between the pinch wheel and the drive shaft, thus causing excessive tension in the tape;

4) From FFWD or CUE to REV or REW (or vice versa): at least 100msec should be allowed between selecting FFWD or CUE from REW or REV, or the inertia of the free running tape may cause the tape to stretch or snap.

BUYLINES

Two items here could cause problems, both for the same reason; IC3 and 4 and RLA1 and 2 are both RS types; IC3 and 4 are RS part number 301-606 and RLA 1 and 2 are 346-845. If you can't find someone who will obtain RS components for you locally, try Crewe Allan & Co, 51 Scrutton Street, London EC2. In both cases, alternative types should work although the odd change to component values or PCB-hacking may be required. The PCB is, as ever, available from us.

ETI

THE SOUND OF VIDEO

Getting high-quality stereo sound from a video cassette recorder may seem like magic — but it's been done. Vivian Chapel tells all. . .

Hey Presto! We gasp in astonishment as the stage conjuror pulls bouquets, pot plants and nosegays without limit from a small box resting on a tiny support in the centre of the stage. There is seemingly no way in to the box, and no way it could possibly contain all the things coming out from it. Yet there is a logical explanation.

The domestic video cassette is much like the conjurour's box. It can contain several hours of video programme requiring millions of bits of information per second plus full colour, plus sound. Packing all that in requires quite a few technical tricks and some sleight-of-hand. For a start, the slant-azimuth trick allows recorded tracks to adjoin each other without gaps and with no cross-talk

The low-frequency colour signal is unaffected by slant-azimuth, so to avoid colour cross-talk, the phase of successive lines of colour signal are phase shifted by 90° during recording and corrected to the original at playback. Any crosstalk that appears is thereby displaced by 180° and so is cancelled.

The main trick is that of helical scan whereby a tilted rotating head-drum lays diagonal tracks across the tape. This results in a writing speed of 4.85 m/s for VHS and 5.85 m/s for Beta, yet the actual tape speed through the recorder is only about one inch per second.

As the highest frequency recordable is proportional to the writing speed, such speeds permit the high video frequencies to be recorded. But there is a snag. Most of the tape width is taken up by the diagonal video tracks, which means there is little room for the 'poor relation' of television, the sound channel. Hitherto, this has been accommodated by a linear track along the top edge of the tape, and the writing speed is the same as the tape speed which is half that of the compact audio cassette, giving lo-fi sound.

This is too bad if the sound track carries only speech, but for music, the results are poor. Mind you, the sound circuits and speaker of the average TV set do not encourage any effort to produce better sound, but nonetheless it has been a glaring deficiency in the home video recorder.

Evidence of an interest in better video sound has been seen in the marketing of video recorders and pre-recorded tapes with stereo. The existing linear sound track is split into two separate ones. To avoid cross-talk, a margin or guard-band must be left between them, reducing the track width to less than half that of the single mono track, to 0.35 mm. Comparing this with the 0.6 mm width of the stereo compact audio cassette reveals a further cause of deterioration of sound quality, because noise level and the incidence of drop-out increases as the track-width decreases.

Something obviously has to be done, so the rival technical wizards at Sony and JVC dusted off their crystal calculators and closetted themselves in their inner sanctums, from whence snatches of weird incantations such as "magnetic depth multiplex" could occasionally be heard. Finally they emerged still mumbling mysterious mystical mouthings into their ancient white beards, then with a wave of their magnetic screwdrivers, yet another very large bouquet appeared from the conjurers black box. No less than full stereo hi-fi, the like of which you have never heard from even the highest grade audio recorder, and this without taking up a single extra millimetre of tape space.

Sony was first with Beta hi-fi which they demonstrated at the Chicago Consumer Electronics Show in 1982, and again the following year at Las Vegas. After this, both machines and pre-recorded tapes were released in Japan and America.

How It's Done

Before we can understand just where they put the sound channels we must take a look at the video spectrum as it is recorded. The luminance, or black-

Nice, but not cheap: the very latest Sony Beta hi-fi, the SL-HF 100UB retails at a cool £599.95 or thereabouts.

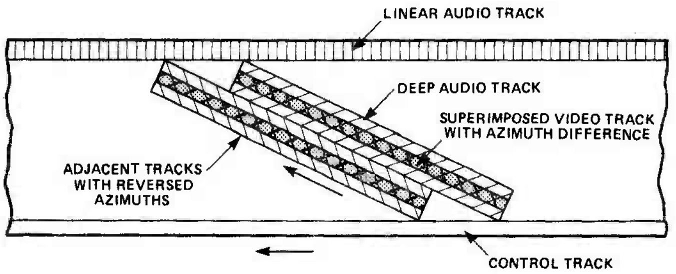


Fig. 1 Tracks on videotape. video tracks (shaded) on top of audio tracks (white). Azimuth differences shown by diagonal lines across the tracks. Audio (white) tracks are not actually wider than video but shown thus for clarity.

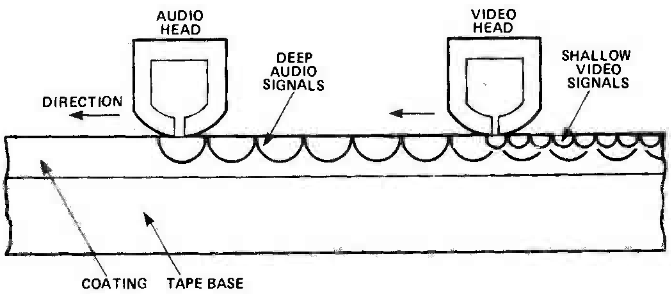


Fig. 2 Depth Multiplex recording. Wider gapped audio head lays track deep into tape coating. Smaller gapped video head lays surface track which partially erases audio, thus producing two-layer recording.

and-white signal is frequency modulated on a carrier at around 4 MHz with a deviation of 0.5 MHz either side of the centre frequency. With the VHS system, the FM signal occupies the space between 3.8 MHz and 4.8 MHz as shown in the illustration. Colour or chrominance information requires less bandwidth, so this is down-converted from the 4.43 MHz of the PAL colour carrier to 627 kHz. With the Beta format the luminance signal deviation is from 3.8 MHz to 5.2 MHz and the colour, 688 kHz.

Although the luminance deviation extends down to just 3.8 MHz in both formats, the sidebands continue on down with diminishing amplitude to the upper chrominance sidebands.

America and Japan use the NTSC (never twice same colour — Ed.) colour system which is simpler than the European PAL and SECAM systems. Also the field rate is higher, 60 per second instead of our 50, which means that the head drum must rotate faster as one frame of two fields must be recorded at each revolution. Hence the writing speed is faster. Yet there are fewer scanning lines in each frame, 525 to the European 625.

All this means that the lower luminance and upper chrominance sidebands do not meet for most of the time, on average picture content. This gap then provides the secret 'pocket' in which to conceal the sound channels. These are modulated as FM signals on a pair of carriers between 1 MHz and 2 MHz, and are fed to the rotating video heads along with the luminance and colour information.

The result is superb sound in stero with no increase in tape width or speed. However, there have been reports that very loud sound signals can affect the picture as the sound FM sidebands overlap those of the luminance signal.

Unfortunately, this system will not work with our PAL, 625-line, 50-field video standard. The spectrum is already tightly packed and there just isn't a gap; the luminance sidebands, although of reduced amplitude at this point, extend right down to those of the colour signal for most of the time.

So, Tommy Cooper-style, if the trick won't work one way you try another. VHS manufacturers, with their sights on Europe as well as America and Japan, produced a system that would work with any of the existing TV standards, and it was announced in July 1983. Sony also wanted to tap the European market, so in September of the same year revealed their answer at Berlin Radio Show.

It turned out that both were similar, but while the VHS method is the same for all standards anywhere in the world, Beta is stuck with their American system there, but has another quite different one for Europe. Not that that will affect users, because the different TV standards makes tapes incompatible anyway.

The VHS System

As with the original Beta system, the two audio channels are FM modulated on to a pair of carriers in the region between the upper colour and lower luminance sidebands. The centre frequencies are 1.4 MHz and 1.8 MHz. These, especially the latter, would overlap considerably the lower luminance frequenices and create picture disturbance if fed to the video heads and recorded along with the video.

Instead, a pair of separate audio-channel heads are used on the video drum to produce what is known as a *depth multilplex* recording. Before we describe how that works, to avoid any possible confusion it should be noted that using a pair of heads does not mean that each head takes one audio channel. A pair are also needed for the video signal so that as one is finishing its stroke and leaving the top of the tape, the other is just commencing its track at the bottom.

The same applies to the audio channel, two heads are required to provide a continuous recording. Both carriers are fed to both heads in turn to make their stroke.

What happens now is like over-filling a suitcase and then sitting on the lid to fasten it! When a magnetic field is set up across the poles of a magnet, the distribution of the lines of force extend outward in a roughly hemi-spherical configuration. It follows that the radius of the hemisphere, hence the distance from the poles depends on the spacing between them. The farther apart they are, the greater the radius, providing all other factors are the same.

A magnetic recording head is designed so that the poles of the electromagnet appear either side of the head gap which is a vertical slit. As the gap is filled with non-magnetic material, the field extends outward across the gap, hence through the tape which is in intimate contact with it. A narrow gap therefore produces a small, though intense field, while a broad gap gives rise to a larger, less intense field.

The audio channel has a large gap, so when it passes over the tape, it magnetizes deep into the coating. It is followed by the video head which has a much smaller gap, and so records only into the surface regions. At the same time it erases the audio information just put there by the previous head. The result is a two-layer recording; the audio signal at the bottom and video on top.

To produce the required flux density over this larger area, a larger magnetizing current is needed through the head windings, but this can be easily be arranged. Some writers, when describing depth multiplex recording, attribute the difference in depth of magnetic field to frequency, asserting that the video signal is recorded on the surface solely because it is of a higher frequency. This is not the case, as the lower frequency colour signal is included with the luminance and recorded by the video heads in the upper layers of the coating. The colour signal is two octaves below the upper sound carrier, these are 627 kHz and 1.8 MHz respectively.

It is true that with audio recorders there can be a variation of the depth of magnetization with frequency, and this effect was made use of with the two-layer ferrous/chrome tapes. With these, the high frequencies were recorded mainly in the upper chrome layer, and the lower ones in the ferrous coating underneath.

The external field across a gap tends to contract when the gap width is greater than one half wavelength of the recorded sound, this being due to self-erasure. For a recording head gap of 5 microns and a recording tape speed of 1⅞ in/s the effect begins at around 5 kHz.

However, with the VHS video system, the head gap is 0.3 microns and the tape writing speed is 4.85 metres per second. This puts the half-wavelength frequency of the gap at about 8 MHz which is above the upper sidebands of the luminance signal. As all recorded frequencies are below this half-wavelength point, frequency difference plays little part in the depth multiplexing.

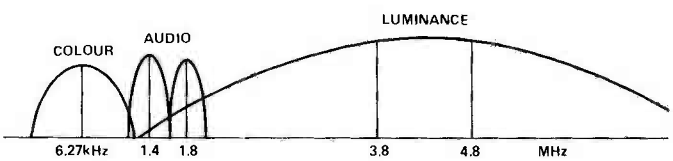


Fig. 3 Frequency spectrum of VHS system. Two hi-fi audio carriers occupy same space as lower luminance sidebands. Slant-azimuth recording by separate heads prevent interaction.

On Playback

Having then produced this two-layer recording, how are the signals sorted out at playback? Wouldn't there still be interaction between them? No, because by physically separating the signals on the tape, another trick mentioned earlier can be applied, that of slant azimuth.

The slit in an audio head is vertical and therefore records a series of vertical magnetic stripes along the tape. If the slit in any head replaying the tape is inclined from the vertical, then it bridges across the adjacent stripes, resulting in an effective increase in the width of the slit. For the narrowest stripes representing the short-wavelength high frequencies, the simultaneous appearance across the gap of adjacent opposite-polarity gives cancellation and zero output from the head. With wide stripes which are low recorded frequencies, the effect is minimal. So, a difference in the tilt or azimuth between recording and playback heads produces a loss of high frequencies, the greater the difference, the lower the frequency at which the cancellation commences.

While audio recorders adopt a vertical slit as a convenient standard, it doesn't have to be vertical. Any angle would perform just as well, providing both recording and playback heads are the same. This incidentally explains why a tape recorded on one recorder, and which sounds perfect played back on that machine, sounds lacking in treble when played back on another instrument. One has a non-vertical azimuth, but it could be either.

Coming back to the video recorder, adjacent video tracks are recorded by the two video heads which are offset in inclination from each other. Should one wander to an adjacent track during replay the azimuth difference is such as to produce very little output from it, so cross-talk is reduced to a minimum.

This same principle is used for the audio channels. Each audio head has an azimuth difference of 30° from the video head which follows it. So the audio track has a corresponding difference from the video track overlapping it. This is quite a large azimuth difference, — the video heads are only 12° from each other.

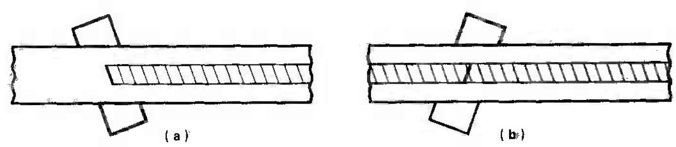


Fig. 4 Principle of slant azimuth. Head records magnetic stripes at the same angle as its gap, (a). Head with opposite tilt (b), has gap which straddles recorded stripes and gives zero output when they are narrow.

When the tape is played back then, the video and audio signals do not interfere. Hey presto!, the trick is complete hi-fi stereo has been literally buried in the tape, unsuspected until drawn out on command. And what hi-fi! a frequency response from 20Hz-20kHz, dynamic range greater than 80 dB, harmonic distortion less than 0.3%, and wow and flutter less than 0.005%.

It should be noted though that pre-recorded tapes with hi-fi sound will also have the conventional linear sound track, so that owners of non hi-fi machines will be able to play them. This applies both to VHS and Beta.

Sound-Only Recorders

Helical scan obviously has much to offer the hi-fi enthusiasts. Musical recordings made on one of these video recorders when linked to a hi-fi amplifier and speakers sound much better than even top flight audio recorders.

The writing speed is far higher than necessary and could be reduced without loss of quality in a sound-only machine, giving extended playing times. Furthermore, digital recording which requires a much greater frequency bandwith than analogue, is possible for domestic recorders with modest tape requirements.

A hint of what may lie ahead can be gathered from a prototype helical-scan audio recorder made by Sony. It uses cassettes half the size of compact cassettes, and a linear tape speed of only one-eigth. This allows playing times of some three hours. Recordings are digital, using a 16-bit code. The main problem is going to be finding enough space on the cassette to write the titles! **ETI**

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Amplifier, 12V DC portable radio booster		May	1975	55
Amplifier, Audio Design	part 1	Jun	1984	24
	part 2	Jul	1984	44
	part 3	Aug	1984	30
	part 4	Sep	1984	59
Amplifier, bench (Short Circuit)		Feb	1977	52
Amplifier, bench		Aug	1979	67
Amplifer, bench		Dec	1980	74
Amplifier for record players (Using the LM380)		Dec	1974	34
	Errata	Jan	1975	70
Amplifier for stereo testing		Jul	1977	30
Amplifer, guitar effects	part 1	Aug	1982	28
	part 2	Sep	1982	16
Amplifier, guitar practice		Mar	1982	121
Amplifier module, 50+50 watt		Jan	1976	33
Amplifier module, 300W		Apr	1980	58
Amplifier modules, 50/100W		Mar	1977	18
Amplifier, simple, 1.5W		Sep	1974	32
Amplifier, simple stereo		Mar	1975	26
Amplifier, stereo, 5 w.p.c.		Jan	1977	10
	Errata	Apr	1977	7
Amplifer, stereo, International-25	part 1	Oct	1975	26
	part 2	Nov	1975	54
	Errata	Dec	1975	76
Amplifier, stereo, 'Sweet Sixteen'		Jul	1976	38

Project		Month	Year	Page
Amplifier, System A	part 1	Jul	1981	52
	part 2	Aug	1981	40
	part 3	Sep	1981	66
	Errata	Oct	1981	13
Amplifier, the Audiophile		Oct	1979	55
	Errata	Oct	1980	11
Amplifers, phono, high quality		Feb	1982	45
Attenuator, variable 0-59dB		May	1973	53
Audio buffer		Jan	1980	82
Audio Design Amplifier	part 1	June	1984	24
	part 2	Jul	1984	44
	part 3	Aug	1984	30
	part 4	Sep	1984	59
Audio frequency meter, 50Hz-10kHz		Jul	1973	66
Audio level meter		Mar	1976	17
Audio limiter		Dec	1976	58
Audio noise generator		Apr	1976	22
Audio millivolter, 'A' weighted		Apr	1976	26
Audiophile Amplifier system		Oct	1979	55
	Errata	Oct	1980	11
Audiophile FM Tuner		Jan	1981	62
Audiophile moving-coil preamplifer		Jan	1980	29
	Errata	Feb	1980	17
	Errata	Apr	1980	15
Audio Power Meter		Jun	1976	29
Audio power meter		Mar	1979	67
Audio Spectrum Analyser		Jun	1978	27
Audio test oscillator, 30Hz-60kHz		Nov	1980	27
Audio Wattmeter, direct reading, 0-50W		Oct	1973	46
Auto-amp — 12V DC portable radio booster		May	1975	55
Auto volume control		Sep	1982	63
Balanced line preamplifier		May	1983	38
Bass Booster		Mar	1973	44
Bass enhancer for small loudspeakers		Jun	1977	53
Bench Amplifier (Short Circuit)		Feb	1977	52
Bench Amplifier		Aug	1979	67
Bench Amplifier		Dec	1980	74
Better Sound For £2!		Feb	1973	58
Bias optimiser for tape recorders		Jun	1980	44
Boosting amplifier output		Feb	1976	51
Bridging adaptor for the Series 5000 amplifier		Jul	1982	85
Bridging amplifier inverter		Oct	1978	41
Bridging two ETI 100W guitar amplifiers		Nov	1975	30
CCD Phaser		May	1978	57
	Errata	Jul	1978	7
Ceramic cartridge preamplifier		Sep	1975	41
Click elminator	part 1	Jan	1979	73
	part 2	Apr	1979	41
Clipping indicator for power amplifiers		Nov	1973	56
Compander (compressor/expander)		Nov	1977	11
Compressor/limiter		May	1983	32
	Errata	Jun	1983	11
Disco console, 100W stereo	part 1	Sep	1976	42
	part 2	Oct	1976	51
	part 3	Nov	1976	63
	Errata	Nov	1976	8

Project		Month	Year	Page
System A amplifier	part 1	Jul	1981	52
	part 2	Aug	1981	40
	part 3	Sep	1981	66
	Errata	Oct	1981	13
Tape noise limiter		Feb	1979	41
Tape recorder bias optimiser		Jun	1980	44
Three channel tone control (Short Circuit)		Oct	1977	34
Tone burst generator	part 1	Feb	1976	25
	part 2	Mar	1976	57
Tuner/amplifier, System 8000	part 1	Jun	1979	30
	part 2	Jul	1979	79
	Errata	Sep	1979	8
TV Sound Tuner		Sep	1980	73
TV Sound Tuner		Dec	1981	37
Upgrading Amplifier PSUs		Feb	1982	26
V3 Loudspeaker		Oct	1981	22
Visual Complex Sound Analyser		Apr	1981	21
Voice-over unit		Nov	1981	26
VU meter, LED		May	1980	78
Wattmeter, direct reading, 0-50W		Oct	1973	46
White noise generator, digital		Dec	1979	67

CLOCKS AND TIMERS

Project		Month	Year	Page
1-2 Hour Timer		Oct	1976	28
Comparator Module for the Digital Stopwatch		Jan	1976	41
Digital alarm clock/calendar		Sep	1973	16
Digital Clock		May	1981	65
Digital Stopwatch		Jan	1974	40
Digital Stopwatch		Dec	1975	20
Egg Timer		Aug	1977	26
Humane alarm — alarm clock add-on (Design competition)		Feb	1983	71
Long Period Timer, 1min - 20hrs		Dec	1979	55
Meter Beater		Feb	1975	28
Micropower Pendulum		Oct	1981	37
Modifying the ETI Digital Alarm Clock		Sep	1976	37
Multi-Option Clock	part 1	Nov	1977	23
	part 2	Dec	1977	19
Musical Alarm Clock		Dec	1980	32
Process controller/timer		Jan	1980	71
Rugby Clock	part 1	Aug	1982	60
	part 2	Sep	1982	39
	Errata	Nov	1982	75
School Timer		Apr	1984	59
Speaking Clock		Sep	1981	30
STAC Timer		Sep	1978	71
	Errata	Oct	1978	13
STD Timer		Nov	1976	10
Stopwatch/calculator		Apr	1976	10
	Errata	May	1976	8
Universal Timer		Aug	1976	18
Universal Timer		Jan	1981	36

COMPUTING

Project		Month	Year	Page
16 channel A to D board		Dec	1983	19
64 K DRAM Board		Sep	1983	64
6502 sound/DAC card		Mar	1983	48
Ace keyboard/joystick interface		Nov	1983	20
ADC, ZX81/Spectrum, 8 ch., 8 bit		Jan	1983	61
	Errata	Aug	1983	70
ASCII keyboard, System 68		Apr	1977	25
A to D board, 16 channel		Dec	1983	19
Atom keypad		Jun	1983	78
Cassette interface		Oct	1980	63
	Errata	Dec	1980	13
Centronics interface for the Cortex	part 1	Jun	1984	65
	part 2	Aug	1984	23
Centronics interface for the Sharp MZ80K		May	1984	47
Colour board for the Ace		Apr	1984	41
	Errata	May	1984	69
Computer Output Driver		Jul	1983	28
Control port for the Spectrum		Oct	1984	44
Cortex 16-bit computer	part 1	Nov	1982	24
	part 2	Dec	1982	55
	part 3	Jan	1983	42
	Errata	Dec	1982	83
DAC/ADC filter amplifier		Nov	1983	59
Digital Cassette Deck	part 1	Sep	1984	27
	part 2	Oct	1984	28
DRAM board, 64K		Sep	1983	64
DRAM Board,Z80		Mar	1984	45
EPROM Emulator	part 1	Jul	1984	22
	part 2	Aug	1984	50
EPROM Eraser		May	1984	17
EPROM board for the Oric/Atmos		Jun	1984	36
EPROM Programmer for the Triton		Jan	1980	42
EPROM Programmer, Universal	part 1	Aug	1983	45
	part 2	Sep	1983	37
	Errata	Jan	1984	61
	Errata	Apr	1984	33
EX42 Keyboard Interface		Sep	1984	23
Fast light Pen		Nov	1983	81
Joystick controller for 6502 micro-computers (Reader's Design)		Jun	1981	36
Low-cost VDU, ETI 560	part 1	Aug	1976	56
	part 2	Sep	1976	10
	part 3	Oct	1976	30
	Errata	Nov	1976	8
Marvin (Z80 Control Computer)	part 1	Aug	1983	65
	part 2	Sep	1983	59
	part 3	Oct	1983	56
	Errata	Nov	1983	96
Message Panel		Oct	1982	53
Message Panel Interface		Nov	1982	68
Microcomputer Expansion System	part 1	Dec	1981	22
	part 2	Jan	1982	58
	part 3	Feb	1982	76
	part 4	Apr	1982	26
Microtutor — machine code tutor	part 1	Aug	1982	50
	part 2	Sep	1982	72
	part 3	Oct	1982	46
	Errata	Apr	1983	11
Mini-Mynah Speech Synthesiser Board		Feb	1984	20
	Errata	May	1984	69
Multiple Output Port		Nov	1983	52
Music board, ZX81	part 1	Apr	1983	16
	part 2	May	1983	54
	Errata	Jun	1983	15
Numeric keypad for the Atom		Jun	1983	78
PseudoROM		Jun	1983	52
Real time clock/calendar for 6502 systems		Apr	1983	31
	Errata	Aug	1983	70
Sharp joystick interface		Aug	1984	42
	Errata	Sep	1984	68
Sound board, ZX (Design Competition)		Feb	1983	73
Sound/DAC card, 6502		Mar	1983	48
Spectrum control port		Oct	1984	44
Spectrum Joystick Interface		Jun	1984	49
	Errata	Aug	1984	66
Speech Synthesis Board		Feb	1984	20
	Errata	May	1984	69
Supply line status check with DVM		Feb	1983	85
Supply protector for ZX81s		Oct	1983	39
System 68 ASCII keyboard		Apr	1977	25
System 68 CPU board	part 1	Sep	1977	22
	part 2	Oct	1977	63
System 68 CUTS card	part 1	Jan	1978	61
	part 2	Feb	1978	45
System 68 PSU		May	1977	55
	Errata	Jun	1977	9
	Errata	Jul	1977	6
System 68 Software		Mar	1978	59
System 68 TTY Interface	part 1	Nov	1977	45
	part 2	Dec	1977	59
System 68 VDU	part 1	Jun	1977	33
	part 2	Jul	1977	54
System 68 VDU interface & Bus Structure		Aug	1977	45

Project		Month	Year	Page
System reset generator for home-built computers		Feb	1983	83
Tape save modification, ZX80		Oct	1983	63
Tape save modification, ZX81		Feb	1983	61
Temperature sensor & alarm for computers		Feb	1983	86
Time-out generator/system failure alarm		Feb	1983	84
Triton personal computer		Nov	1978	16
Triton 8K EPROM Card		Jun	1979	73
Typewriter Interface		Oct	1983	21
	Errata	Mar	1984	25
Universal EPROM Programmer	part 1	Aug	1983	45
	part 2	Sep	1983	37
	Errata	Jan	1984	61
	Errata	Apr	1984	33
User-defined graphics, ZX81		Mar	1983	23
Vector graphic display for home computers		Jan	1984	19
Z80 Control Computer	part 1	Aug	1983	65
	part 2	Sep	1983	59
	part 3	Oct	1983	56
	Errata	Nov	1983	96
Z80 DRAM board		Mar	1984	45
ZX80 DRAM upgrade		Feb	1984	29
ZX80 save modification		Oct	1983	63
ZX81 EPROM Programmer		May	1984	26
	Errata	Sep	1984	68
ZX81 music board	part 1	Apr	1983	16
	part 2	May	1983	54
	Errata	Jun	1983	15
ZX81 save modification		Feb	1983	61
ZX81 user-defined graphics		Mar	1983	23
ZX ADC, 8 ch,. 8 bit		Jan	1983	61
	Errata	Aug	1983	70
ZX-based burglar alarm		Dec	1983	31

GAMES

Project		Month	Year	Page
Alcohometer (reaction timer)		Dec	1981	79
Alien Attack		Jun	1981	61
Ambush	part 1	Apr	1979	61
	part 2	May	1979	48
Cannibals and Missionaries		Mar	1976	24
Coin Toss		Feb	1980	51
Dice		Dec	1979	32
Double Die		May	1979	26
	Errata	Jun	1979	9
Drunken Sailor Puzzle		Jan	1978	46
Dual Electronic Dice		Oct	1976	16
Electronic Decision Maker		Mar	1973	62
Electronic Dice		Jan	1976	58
Electronic One-Arm Bandit	part 1	Aug	1975	38
	part 2	Sep	1975	48
Electronic Win-dicator		May	1975	47
Family Ferry		Dec	1974	56
Hammer Throw Game		Jan	1978	29
Heads or Tails (Short Circuit)		Jan	1977	34
I Ching Computer		Feb	1982	60
Infinite Improbability Detector		Mar	1982	35
LED Dice (Short Circuit)		Feb	1977	49
LINC		Aug	1975	26
Mastermind		Jun	1977	41
Obedient Die		Mar	1984	54
Pinball Wizard		Nov	1979	24
Race Track Game		Jan	1978	36
Reaction Tester		Jan	1977	20
Reaction Timer		Oct	1979	75
	Errata	Jan	1980	11
Reflex Action		May	1976	62
Rifle for the TV Games Unit		Jul	1977	20
Roulette Game		Feb	1981	22
Skeet Game		Nov	1977	34
Sound Track game		Aug	1982	72
Space Invasion Game	part 1	Nov	1980	65
	part 2	Dec	1980	44
	Errata	Dec	1980	13
Space Invasion Game — Modifications		Jul	1981	94
Spirit Level (reaction timer) (Short Circuit)		Oct	1977	28
Stars and Dots Games		Jun	1978	17
	Errata	Jul	1978	7
Superdice		Jul	1981	71
Survival Game		Sep	1980	87
Tank Battle TV Game		May	1978	50
	Errata	Jun	1978	13
Touch Buzzer		Nov	1980	48
TV Chess Game	part 1	Oct	1978	48
	part 2	Nov	1978	44
TV Games Unit		May	1977	12
Wheel Of Fortune		Sep	1978	61

LIGHTING

Project		Month	Year	Page
Audio light display using LEDs		Aug	1979	87
Automatic Porch Light		Jul	1980	77
Colour Organ sound/light unit		Feb	1975	11
Dimmer, 500W		Jun	1975	30
Dimmer, 500W		Mar	1978	55
Dimmer for fluorescent lights		Nov	1972	42
Dimmer, Programmable Touch		Apr	1980	71
	Errata	Aug	1980	11
Dimmer, push-button		Feb	1975	30
Dimmer, stage		Mar	1979	50
	Errata	Apr	1979	13
Dimmer, touch		May	1981	79
Disco Lightshow Controller		Dec	1978	44
	Errata	Apr	1979	13
Disco/party Strobe (Finesse)		Oct	1984	52
Ecolight		Jul	1984	55
Emergency Lighting Unit		Oct	1972	41
Finesse light chaser		Dec	1983	44
Fluorescent Light Dimmer		Nov	1972	42
Fluorescent light inverter		Mar	1973	58
High Power Beacon		Aug	1976	30
Hi-power Strobe		Jun	1972	62
Inverter For Fluorescent Lighting		Mar	1973	58
Lampsaver		Dec	1983	69
Light chaser (Finesse)		Dec	1983	44
Light Wand		Mar	1982	73
Multiswitch — multi-point light switching		Nov	1983	47
Porch Light		Feb	1978	28
Push Button Dimmer		Feb	1975	30
Sound/light unit (ETI Colour Organ)		Feb	1975	11
Sound-To-Light unit (free PCB project)		Oct	1982	31
Spactracolumn		Dec	1982	65
Stage Dimmer		Mar	1979	50
	Errata	Apr	1979	13
Stage lighting unit	part 1	Jan	1983	22
	part 2	Feb	1983	34
	part 3	Apr	1983	42
	part 4	May	1983	79
	Errata	Aug	1983	70
Strobe, high power		Jun	1972	62
Visual Complex Sound Analyser		Apr	1981	21

MISCELLANEOUS

Project		Month	Year	Page
Allez Cat pest scarer		Feb	1982	89
Autocompass		Jun	1983	20
Auto-lume light operated switch		Nov	1974	28
Automatic Plant Waterer		Aug	1978	61
Battery eliminators, two		May	1972	30
Bike Speedometer		Jun	1975	23
CCTV Camera		Dec	1977	46
	Errata	Feb	1978	12
Coin Collector (metal locator)		Jul	1973	20
Compass, auto		Jun	1983	20
Desoldering Made Simple		Aug	1972	61
Digital Display		Oct	1975	15
	Errata	Nov	1975	77

MODEL CONTROL

MOTORING

Project		Month	Year	Page
Digital Tachometer		Jan	1979	36
Electronic ignition		Sep	1973	36
Electronic ignition system	part 1	April	1975	10
	part 2	May	1975	23
	Errata	August	1975	69
Electronic Ignition		May	1978	41
Flip-flop flasher		April	1975	42
Fuel Gauge		Jan	1983	46
Fuel Level Monitor		Sep	1979	53
Headlight Delay		Mar	1979	27
Headlight Reminder		Dec	1972	48
Headlight reminder		March	1975	34
Ignition timing light		Sep	1974	18
LED Tachometer		Jan	1981	49
Light Activated Tachometer		Feb	1979	50
Light Wand		Mar	1982	73
Meter beater		Feb	1975	28
Overspeed Alarm		Sep	1979	79
Parking Meter Timer		Jan	1982	29
Patch detector (Short Circuit)		Jan	1977	33
Revealer — body filler detector		Aug	1973	58
Rev monitor/limiter		Dec	1977	37
Screen Heater Controller		Sep	1979	89
Smart Battery Charger		Jul	1981	85
Tachometer		Jul	1977	32
	Errata	Sep	1977	8
Tachometer, Digital		Jan	1979	23
Tachomoter, LED		Jan	1981	49
Tachometer, Light Activated		Feb	1979	50
Tacho timing light		Dec	1974	18
Trafficator flasher		May	1975	46
Turn Indicator Cancellor		Apr	1973	70
Warning Indicator Monitoring System		Sep	1979	23

MUSIC AND EFFECTS

Project		Month	Year	Page
Accentuated Metronome		Feb	1978	17
Audio phaser		Dec	1976	29
Audio visual metronome		Nov	1972	47
Autochord rhythm generator	part 1	Nov	1978	56
	part 2	Dec	1978	80
Black Hole Choraliser		May	1980	90
	Errata	Sep	1980	11
Bomb drop sound effect		Apr	1982	50
CCD Phaser		May	1978	57
	Errata	Jul	1978	7
Chorus/Flanger		Jan	1984	33
Complex Sound Generator (Minisynth)		Oct	1978	17
Drum Machine		Apr	1981	75
Drum Synthesiser, ETI Staccato		Jun	1980	84
	Errata	Aug	1980	13
Drum Synthesiser, Midi		May	1984	62
	Errata	Aug	1984	66
Drum Synthesiser, Mini		Nov	1983	36
	Errata	Apr	1984	62
EZEKO spring-line reverberation unit		Oct	1984	18
Electronic Bongos (Short Circuit)		Aug	1977	24
Fuzz box (Short Circuit		Apr	1977	48
Fuzz/Sustain Box		Oct	1980	53
	Errata	Sep	1982	57
Guitar Effects Unit		Apr	1979	97
	Errata	Jun	1979	9
Guitar Note Expander		Apr	1981	95
Guitar Tuner		Jan	1982	41
	Errata	Mar	1982	9
	Errata	May	1982	11
Gunshot sound effect		May	1982	89
Hand-Clamp Synthesiser		Aug	1981	68
Metronome		Nov	1980	56
Metronome, Accentuated		Feb	1978	17
Metronome, Accentuated		Jun	1979	21
Metronome, audio visual		Nov	1972	47
Metronome (Short Circuit)		May	1977	39
Midi Drum Synth		May	1984	62
	Errata	Aug	1984	66

Project		Month	Year	Page
Mini Drum Synthesiser		Nov	1983	36
	Errata	Apr	1984	62
Minisynth (Complex Sound Generator)		Oct	1978	17
Multi-Option Siren		Jan	1981	22
Musical Box		Nov	1981	50
Music Processor		Nov	1981	38
	Errata	May	1982	11
New Sound For Your Guitar		Jun	1973	30
Organ, ETI Victory	part 1	Feb	1983	19
	part 2	Mar	1983	36
	part 3	Apr	1983	56
	part 4	May	1983	67
Phaser/explosion sound effect		May	1982	63
Playmate guitar effects amplifier	part 1	Aug	1982	28
	part 2	Sep	1982	16
Polyphonic Keyboard Controller		Jul	1979	36
Reverberation unit, solid state		Apr	1982	101
Reverberation unit, spring line		Dec	1974	46
Reverberation unit, spring-line		Oct	1984	18
Sound Bender (ring modulator)		Oct	1981	88
Sound Effects 1: Bomb Drop		Apr	1982	50
Sound Effects 2: Steam Train & Whistle		Apr	1982	118
Sound Effects 3: phaser/explosion		May	1982	63
Sound Effects 4: gunshot		May	1982	89
String Thing (Transcendent DPX)	part 1	Aug	1979	18
	part 2	Sep	1979	62
	part 3	Oct	1979	35
	part 4	Nov	1979	64
Synthesiser, ETI 3600	part 1	May	1975	42
	part 2	Jun	1975	32
	part 3	Jul	1975	54
	part 4	Oct	1975	41
	Errata	Jan	1976	84
Synthesiser, ETI 4600	part 1	Jan	1974	20
	part 2	Feb	1974	24
	part 3	Mar	1974	40
	part 4	Apr	1974	44
	part 5	May	1974	54
	part 6	Jun	1974	24
	part 7	Jul	1974	52
	part 8	Aug	1974	58
	part 9	Sep	1974	48
Synthesiser, Hand Clap		Aug	1981	68
Synthesiser, Polyphonic	part 1	Dec	1980	87
	part 2	Jan	1981	77
	part 3	Feb	1981	32
	part 4	Mar	1981	27
Synthesiser, Project 80 — Dual VCA		Aug	1980	78
Synthesiser, Project 80 — Monitor Amplifier		Oct	1980	79
Synthesiser, Project 80 — Noise Generator		Apr	1981	59
Synthesiser, Project 80 — PSU, VCO & VCLFO		Feb	1980	62
	Errata	Mar	1980	15
Synthesiser, Project 80 — VC envelope shaper		Sep	1980	93
Synthesiser, Project 80 — VC envelope shaper		Jul	1980	88
Synthesiser, Project 80 — VCF		May	1980	20
Synthesiser, Project 80 — VCM		Mar	1980	87
Synthesiser, Project 80 — VC State Variable Filter		Jul	1980	84
Synthesiser Sequencer		May	1981	36
Synthesiser, Transcendent 2000	part 1	Jul	1978	38
	part 2	Aug	1978	45
Temperature Stabilised Log. Convertor		Jan	1979	62
Touch Organ		Dec	1976	41
Transcendent DPX string synthesiser	part 1	Aug	1979	18
	part 2	Sep	1979	62
	part 3	Oct	1979	35
	part 4	Nov	1979	64
Transcendent Polysynth	part 1	Dec	1980	87
	part 2	Jan	1981	77
	part 3	Feb	1981	32

Project		Month	Year	Page
	part 4	Mar	1981	27
Tuning Fork		Feb	1980	79
Vocoder	part 1	Sep	1980	58
	part 2	Oct	1980	40
	Errata	Apr	1981	8
Waa-Phase Unit		Jun	1981	24
Waa-waa unit		Jun	1976	16
Waveform multiplier (chorus)		Jan	1983	71

PHOTOGRAPHIC

Automatic Contrast Meter		Apr	1982	39
	Errata	Jul	1982	35
Electronic flash trigger		Jun	1975	42
Enlarger Timer		Oct	1981	78
Exposure meter		Feb	1976	46
Flash Sequencer		Aug	1981	57
Flash sequencer		Jul	1983	63
	Errata	Aug	1983	70
Flash Trigger		Dec	1979	97
Flash Trigger		Oct	1980	30
Flash Trigger		Jul	1983	70
Photographic process timer		Aug	1972	38
Photo timer		Sep	1975	11
Printimer — 1½-3 minute timer		Nov	1974	44
	Errata	Dec	1974	71
Shutter Timer		Feb	1978	57
Slave flash		May	1972	48
Sound/light flash trigger		Aug	1976	46
Sound-operated flash		May	1972	44

RADIO

Aerial Matcher for SW Receivers		Apr	1974	31
Air Band Converter		Dec	1979	76
Chipmonk FM/AM Radio		Jun	1978	79
	Errata	Jul	1978	7
Crystal Calibrator		Mar	1981	39
Digital Radio Dial		Jan	1979	49
Headphone Radio, AM		Aug	1976	34
Marker Generator		May	1976	25
One-Chip Radio		Jan	1973	16
RF Attenuator		Sep	1976	62
RF Power Meter		Oct	1978	30
Speech Compressor		Oct	1979	47
Star Trek Radio		May	1978	62
Tic-tac Radio		Nov	1975	35
Two Metre Power Amplifier		Sep	1976	19
Two Metre VMOS Power Amplifier		Feb	1980	27

ROBOTICS

Digital PWM Interface for the Robot Motor Controller		Jun	1982	66
ETI Mobile 2 Robot	part 1	Aug	1982	82
	part 2	Sep	1982	25
Motor Speed Control for Robots		Jul	1982	59
Proximity Detector		Jun	1982	69
Robot Arm	part 1	Sep	1981	50
	part 2	Oct	1981	43
Robot Motor Controller	part 1	Mar	1982	61
	part 2	Apr	1982	94
	part 3	May	1982	34
Servo Arm Interface	part 1	Oct	1982	69
	part 2	Dec	1982	77

SECURITY

Alarm alarm		Jul	1977	29
Alarm extender		Nov	1983	39
Alarm Module		Mar	1983	63
	Errata	Aug	1983	70
Alarm, ZX-based		Dec	1983	31
Anti-Theft Auto Alarm		Jan	1974	16
Automatic Car-Theft Alarm		Aug	1972	50
Automatic Light Switch		May	1984	19
Automatic Porch Light		Jul	1980	77
Bansheee Siren Unit		Sep	1984	35

Project		Month	Year	Page
Burglar alarm system		Apr	1977	57
	Errata	Jun	1977	9
Burglar Proof Your Home		Jul	1974	30
Car Alarm		Mar	1975	24
	Errata	Jul	1975	68
Car Alarm		Dec	1978	16
Car alarm		Oct	1983	66
	Errata	Nov	1983	96
Car Security Device		Apr	1980	50
CMOS Burglar Alarm		Apr	1975	51
CMOS House Alarm		Jan	1978	16
Combination Lock		Mar	1981	74
Ecolight		Jul	1984	55
Electronic combination lock		Mar	1975	46
Home security system		Aug	1981	18
Infant Guard		Jan	1982	80
Infra-red intruder alarm		Jul	1972	54
Infra-red intruder alarm		Feb	1981	62
Infra-red intruder Alarm	part 1	Jul	1984	61
	part 2	Aug	1984	59
Logic Lock	part 1	Jun	1982	79
	part 2	Jul	1982	39
	Errata	Nov	1982	75
Porch Light		Feb	1978	28
Proximity Switch		Oct	1978	75
Radar intruder alarm		Aug	1975	21
Ultrasonic Burglar Alarm		Aug	1980	86
Warlock alarm system		Jul	1984	35
Watchdog home security system		Aug	1981	18
ZX-based alarm		Dec	1983	31

TEMPERATURE MEASUREMENT AND CONTROL

Differential Temperature Switch Module		Mar	1981	49
Digital Thermometer		Oct	1977	20
Economical Heater Controller		May	1982	22
	Errata	Jul	1982	35
Freezer Alarm		Dec	1977	30
Heater Controller		Mar	1980	67
Heat/Light Controller (free PCB project)		Oct	1982	25
Immersible Heater		Jun	1983	65
Micropower Thermal Alarm		Oct	1981	68
Seven-input Thermocouple Meter		Dec	1973	23
Temperature Alarm		Nov	1974	25
Temperature Alarm		Mar	1977	53
Temperature Controllers, three		Mar	1975	18
Temperature Meter		Aug	1974	30
Temperature Meter		Jul	1978	21
Temperature Meter Add-on for Voltmeters		May	1976	49
Thermemeter — Max/Min Memory Thermometer		Apr	1983	70
	Errata	Jul	1983	20
Under Temperature Switch Module		Mar	1981	51
Wine Temperature Meter		Dec	1978	31

TEST EQUIPMENT

1 kHz Function Generator		Mar	1977	55
All Purpose Power Supply, 30V, 1A		Aug	1978	75
Amplifier, bench		Dec	1980	74
Amplifier, bench (Short Circuit)		Feb	1977	52
Amplifier, bench		Aug	1979	67
Attenuator, audio		May	1973	53
Attenuator, RF		Sep	1976	62
Audio Frequency Meter		Jul	1973	66
Audio Millivoltmeter		Apr	1976	26
Audio Noise Generator		Apr	1976	22
Audio Oscillator with LCD DFM		Nov	1978	71
Audio Power Meter		Jun	1976	29
Audio Power meter		Mar	1979	67
Audio Spectrum Analyser		Mar	1978	27
Audio Wattmeter		Oct	1973	46

Project Index

ETI

SPECTRUM CONTRO

Give your Spectrum the power to control virtually anything with this versatile expandable I/O port. Design by Mike Wynne Jones.

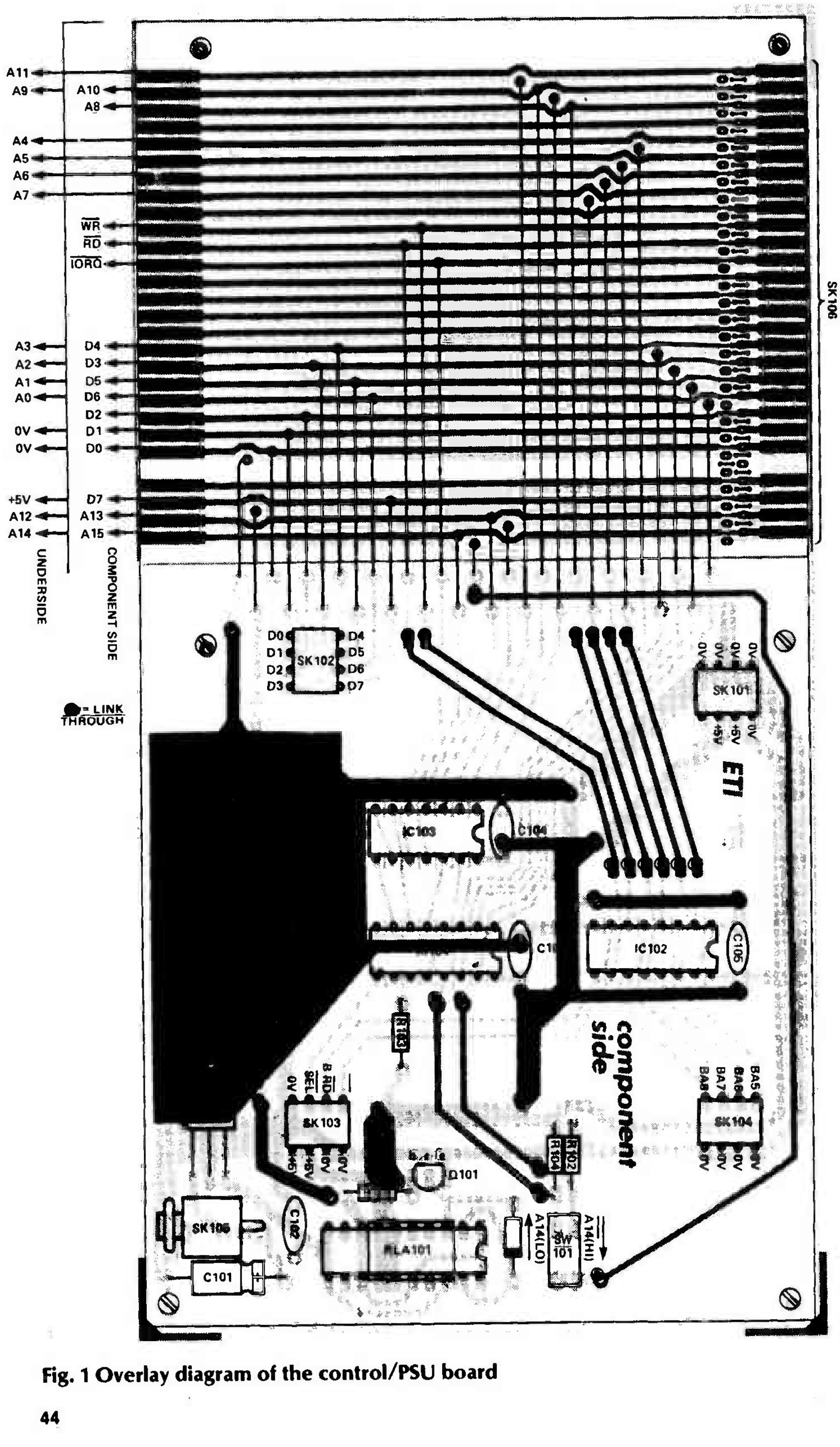


Fig. 1 Overlay diagram of the control/PSU board

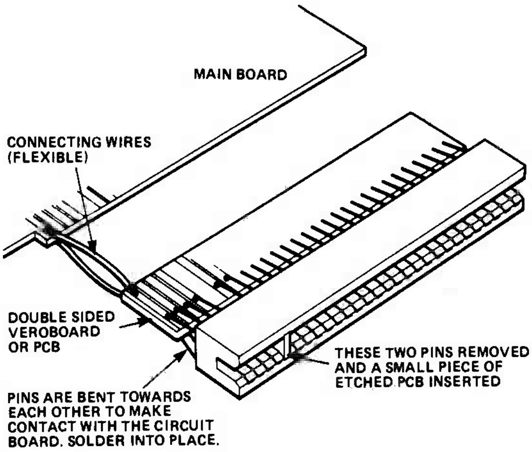
Although designed with no specific control application in mind, this digital I/O system has found a variety of uses including the control of a robot. It is extremely versatile and flexible in its configuration, being expandable from a single 8-line-in and 8-line-out board to a huge system with 128 input lines and 128 outputs — enough to control Sir Clive's notorious power stations several times over.

It's flexibility lies in its construction format: if more I/O lines are required than currently available, one merely builds another I/O board and plugs it into those already present, forming a tower of up to 16 I/O boards on top of the control board. Connections are made between them via four 8-pin DIL wire-wrap sockets.

The control board (for want of a better name) is the one which plugs into the Spectrum. It provides an edge-connector like the Spectrum's for connecting up other peripherals, an external back-up power supply and a certain amount of address-decoding logic and signal-buffering. Each I/O board has pins to plug into the board beneath, sockets to accept another board above, the I/O logic and two 15-way D-type input and output connectors.

For flexibility in the Spectrum system, there are two ranges of I/O map positions with a hardware switch which indicates which position is taken. In order to comply with constraints imposed by the Spectrum hardware, each board must be mapped to an address (31 + a multiple of 32). This can be done just at face value, taking up most or all of the space in the first page; this space, however, is required for other peripherals such as joystick interfaces (for manoeuvring your robot's arm) and analogue interfaces. By adjusting SW101, a switch whose position sets the valid state of A14, the address can be changed to (168384 + 31 + a multiple of 32). It is the number on lines B0 — B3 which indicates what that number is to be for a particular I/O

OL PORT



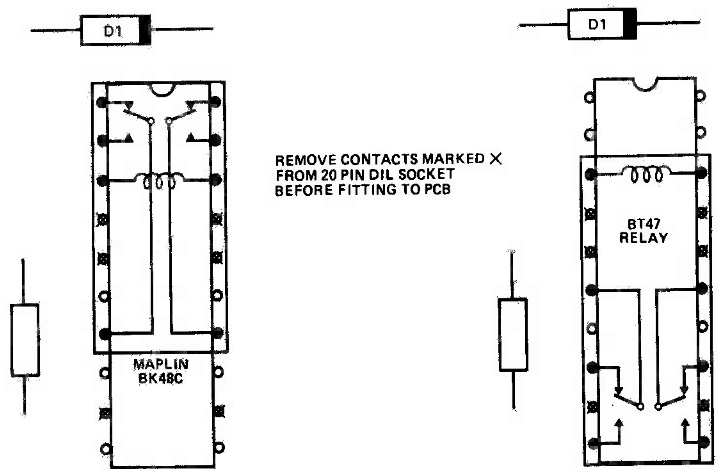


Fig. 2 (left) Making a flexible connector.

Fig. 3 (above) Mounting details of alternative relays.

board. Thus the control-board, the one which plugs directly into the computer, puts the number 0000 on B0 — B3, and each I/O board uses the number passed to it from the board below to formulate its address, before adding one to the number and passing it on to the board above. Thus each I/O board maps itself to a certain multiple of 32, and enables itself when the number on A5-A8 (a multiple of 32) is the same as that on B0-B3, no matter where in the stack of boards it is placed: the first is always the lowest, the next 32 higher, and so on.

As stated earlier, up to 16 I/O boards can be plugged together in this way, so two pages of I/O are taken up by the complete system. In the unlikely event of more than 128 lines each way being required (!), more could be facilitated by making a second control board, plugging this into the edge-connector of the first and having one set with A14 low for validity and one with it high, doubling the capacity to a colossal 512 I/O lines.

It was thought wise to include on the control board an extra power supply, as the Spectrum's runs close to its limit. For this, it was decided to use the supply enclosed with ZX printers, these supplies being redundant with Spectrum-owners. People building this project were deemed likely to be the sort of people who would have printers. However, for those who have not, the supply is a 9V DC unregulated source, capable of supplying 1.2A maximum. It is terminated with a 3.5 mm jack plug, wired so that the tip is positive.

If the computer's supply is connected and the external one is not, the boards should still be allowed to function, drawing power from the computer. But if the external supply is connected and the computer's is not, they must not receive power: this would allow ICs on the I/O boards to apply voltages to chips in the computer which otherwise have no power connected, possibly resulting in considerable damage. The I/O boards must only receive power from the external source when *both* sources are operational — at all other times they can be connected to the computer's +5V rail. This action is achieved by the components associated with RLA 101 on the control board.

Construction

It is strongly recommended that our double sided circuit boards should be used as it is extremely difficult to make the boards, especially where an edge connector is involved, and the four DIL socket connectors must be positioned precisely the correct distance apart.

Begin assembling the control board by cutting the pins of the edge connector to about half an inch and then bend them towards each other in pairs across the connector (Fig. 2). Insert the small edge connector mounting board between them and solder it in place at each pin. Now make the connections between this and the main board using thin flexible wire. The purpose of this arrangement is to prevent vibrations from disturbing the connections, and to allow flexibility so that the mismatch in height between the computer and the external circuit boad does not matter.

PARTS LIST — CONTROL/PSU BOARD

RESISTORS	
R101-104	1k0 ¼W 5%
CAPACITORS	
C101	10u 16V electrolytic
C102-105	100n ceramic disc
SEMICONDUCTORS	
IC101	7805
IC102	74LS367
IC103	74LS27
IC104	74LS133
Q101	BC182L
D101	1N4001
MISCELLANEOUS	
SW101	SP C/O DIL switch
RLA101	6V two-pole C/O miniature relay (see text and Buylines)
SK101-104	8 pin standard or low profile DIL socket
SK105	3.5mm jack socket
SK106	28 way double-sided edge connector, keyway at position 5, to suit Spectrum

PCB; M3 nut and bolt for IC101; 2 x 16 pin, 1 x 14 pin and 1 x 20 pin DIL sockets for ICs and RLA101; four off rubber feet; perspex sheet; nuts and bolts to secure perspex; 28 way Veroboard strip for edge connector.

The external power source is connected via jack socket SK105, and is regulated to +5 V by IC101, a 7805 voltage regulator. C101 and C102 form part of the regulator's stabilising cicuitry.

The switching action between sources is done by RLA101. When it is in its normally closed state (ie the coil is *not* energised), the +5 V rail is connected to that of the computer. This occurs when the computer's supply is absent (Q101 is switched off), or when the external supply is absent (relay coil receives no power), or both. However, if both sources are connected properly, Q1 switches on and the relay coil is energised. This allows the I/O equipment to take its power from the external source.

When RLA101 is switched off, the magnetic field in the coil decays, causing a large back-EMF. D101 shorts this potential, preventing damage to Q101.

Signals RD, WR and A5-8 are not required by the control logic. However, they are monitored by several gates on the I/O boards. As the fanout of the gates driving these lines in the computer may not be adequate, they are buffered by IC2. B0-3 are all tied to 0 V on the control board, as this is the number passed to the first I/O board.

The general enable line from the control board to the the I/O boards is SEL(ECTED); general because it indicates that one of them is addressed, but not which one. It is produced by IC4, whose inputs must all be high to produce a low (active) output. Thus, A0-A4 must all be high (necessary to avoid interference with other hardware already in the Spectrum system), and so must the outputs of IC103 a,b and c. These are three-input NOR gates, and their inputs must all be low to produce high signals at the corresponding inputs of IC104: A9-13 and A15 must all be low as set out in the addressing requirements, and IORQ (standing for In/Out Request (bar)) to indicate that the operation taking place is a valid I/O operation rather than a memory operation. The valid state of A14 is set by the switch, SW101. It is set depending on whether we wish the system to be mapped from 31 onwards or from 16384 + 31 (ie 16415) onwards. If the switch is set to "HI", IC104 detects a high signal, and the input of IC103a is pulled low by resistor R102. If it is set to "LO", R104 pulls the input of IC4 high, and the input of IC103a, pin 9, detects a low signal on A14.

Thus when the correct general address is present on the bus (ie not including A5 — A8), and IORQ is low, SEL goes low, signalling to the I/O boards that if A5-A8 are correct for a particular board, that board should then activate.

The data bus signals are not required by the control board, so they pass over it to the stack of I/O boards.

Capacitors C103-105, are physically close to the logic ICs to increase stability in the circuitry, as recommended by the manufacturers.

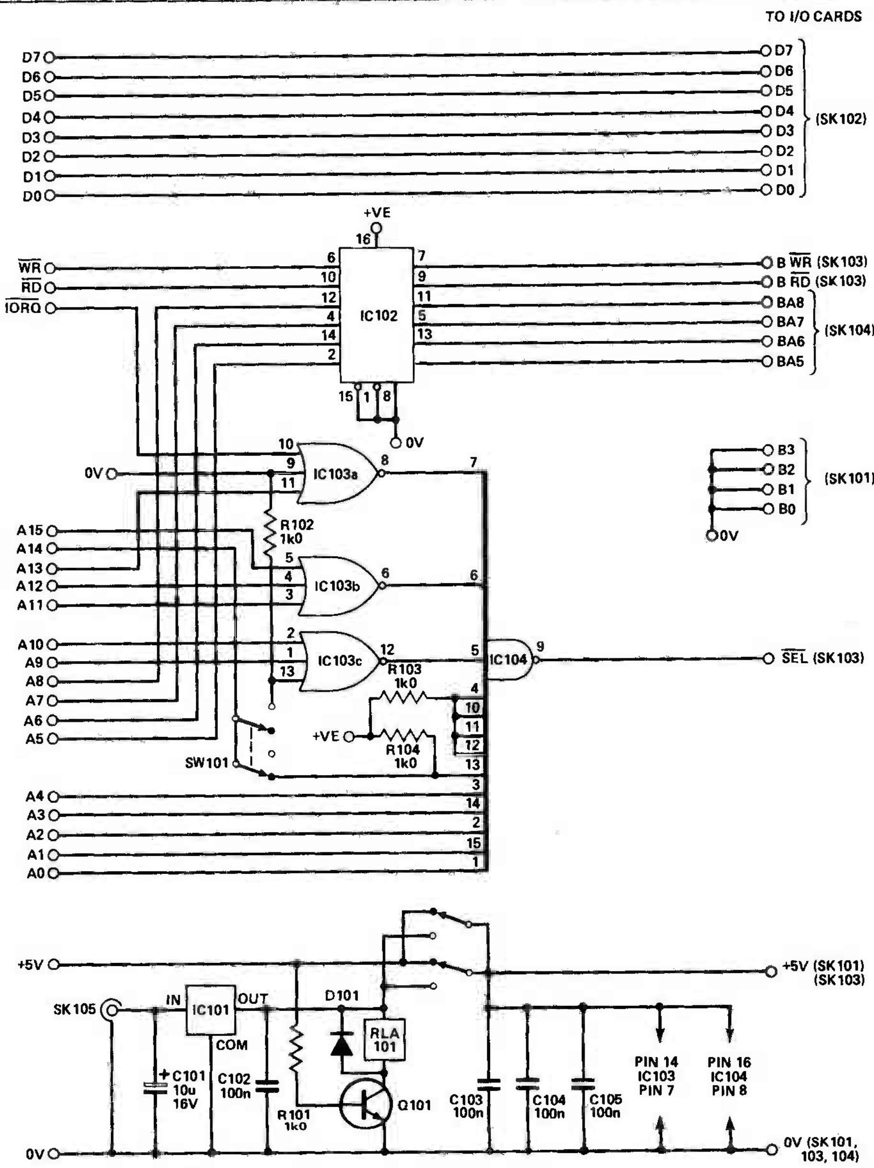


Fig. 4 Circuit diagtram of the control/PSU section.

Turning to the I/O boards, IC1 is a quad exclusive NOR package. These have outputs which are low when the inputs are different (L-H or H-L) and high when the inputs are the same (H-H or L-L)

Each of the gates in IC1 has an open collector output. This means that it can only drive the output low if required — the high level is being established by R1. If any of the address inputs BA5 —7 do not match their corresponding B0 — 3 inputs then the output of that section of IC1 will go low. This will drive all the other outputs low as well and thus the input to IC3b will be low. This is known as a "Wired AND" connection since it acts just like a 4 input AND gate without an actual device being used.

B0,1,2,3 (the B is merely an arbitrary letter) indicate what number should be present on A5-A8 for a particular I/O board to activate. A5 is compared with B0, A6 with B1 and so on, by IC1a-d. For a particular board to be activated SEL must be low, and so must the output of IC3b on that board. These two lines are monitored by IC2a, giving a high output and thus a low output on IC3a when conditions for that board to function are fulfilled.

The number passed to board one on the B-bus is 0000, 0001 to board two etc., so to make the order in which the boards are plugged in irrelevant, each board must add one to the number passed to it from below before passing it on to the board above. This is implemented by IC4 — a four-bit adder with 0000 as one input and the carry input high.

The low output from IC3a is processed with RD by IC2b, giving a high output to activate the input chip. It is, however, activated by a low signal, so inverter IC2C is included in the signal path to cause the necessary inversion when the input chip is activated, applying the input data to the data bus. Its internal latches are disabled through D1 to prevent the data from changing during read should external hardware

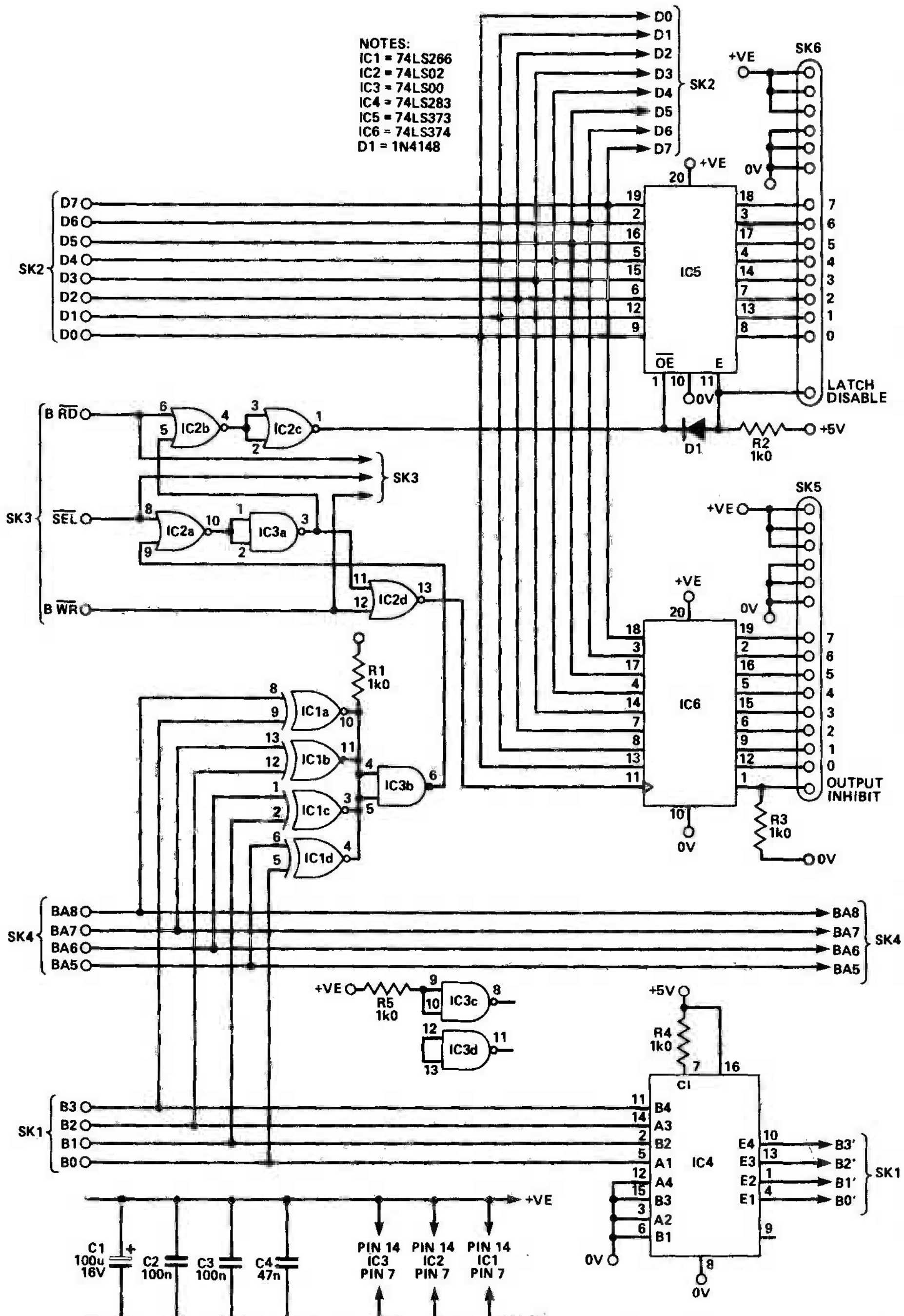


Fig. 5 The I/O board circuit.

attempt to cause this to happen. The data on the data bus is thus read by the microprocessor. The latches in IC5 can be disabled by external cicuitry: inputs are ignored, and only the previous data read. This action is very useful if the inputs are connected directly to the data bus of another computer, and is caused by pulling the EXTERNAL LATCH DISABLE connection low.

For ouput (a write instruction) the ouput of IC2d goes high, clocking the D-type flip-flops in IC6, and thus moving the data from the data bus onto the output lines. The output can be made high-impedance (again useful if they are to be connected to the data bus of another computer), by pulling OUTPUT DISABLE high.

Next make connections, using single strand insulated wire, between the row of holes and the strips between the edge connectors again as shown in the overlay diagram. The rows of holes for connections are staggered to prevent the introduction of weakness into the board. Edge connector strips on the underside of the board are shown in red in the overlay diagram, and those on the component side in black.

When all this interwiring has been completed and thoroughly checked, solder all the through-board links top and bottom into place and the resistors and the diode. All components should be soldered on the underside of the board. Now insert and solder the IC sockets, SW101, IC101, and the capacitors. The four sockets in the corners of the board for connection to the I/O boards are standard 8 pin DIL IC sockets.

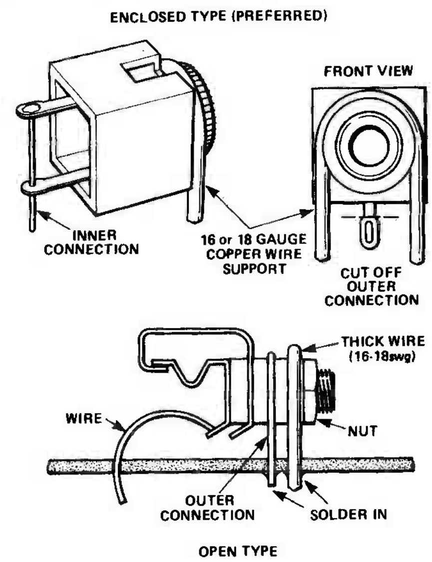


Fig. 6 Mounting details of SK105.

Next insert the relay and jack socket. The orginal relay is a very compact device from Maplin, and it is a good idea to fit it in a 14 pin low profile DIL socket with pins 2-4 and 11-13 removed or to use a suitably modified 16 or 20 pin socket if the alternative type is used. The best type of jack socket is a chassis-mounting sort with a plastic housing, as these sockets have a flat side to them which rests on the surface of the PCB. Printed circuit mounting jack sockets are only widely available in the quarter inch standard size. The socket is held steady by a piece of 16 or 18 SWG wire passing over the threaded section on the front and through the two holes in the board, with the ends soldered firmly.

Hint — when inserting the through links, use the old resistor lead or 22 SWG tinned wire. Flatten the end with pliers or bend a small angle to retain it.

Next month, we shall conclude the description of the port with construction details of the I/O boards and notes on testing, use and connection between computers. **ETI**

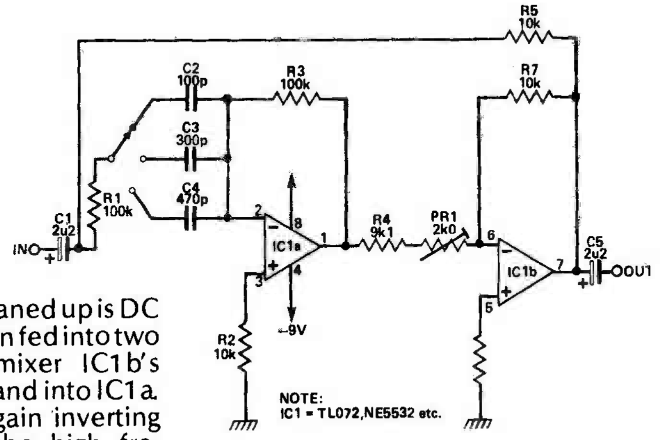
TECH TIPS

Hiss Reducer

S. P. Giles
London

The circuit goes some way towards offering a cheap reduction in the annoying hiss present on bad VHF reception signals and hissy tape recordings. It is based on the principle that two signals equal in all respects other than phase will cancel out when mixed together. If we create an out-of-phase version of the hiss and mix it with the original, it will cancel out.

The signal to be cleaned up is DC blocked by C1 and then fed into two separate paths, to mixer IC1b's inverting input via R5 and into IC1a. The latter is a unity gain inverting amp which inverts the high frequency content of the input signal passed through by C2, C3 or C4. The IC1a output is then passed to mixer IC1b via R4 and PR1, which for best results should be a multiturn preset.



To set up, connect a temporary link between R1 and IC1a's inverting input, which will allow IC1a to pass all of the input. Hook up the input to a radio tuned to a hissy VHF station and the output to an

A440 Tuning Reference

C. Robertson
Edinburgh

This circuit was developed as a result of a demand by several friends for a cheap and reliable A440 tuning reference which could be connected to an existing amplifier/studio talkback system. The frequency reference used was a 4.433MHz crystal, this having the advantage of being cheap, accurate and readily available.

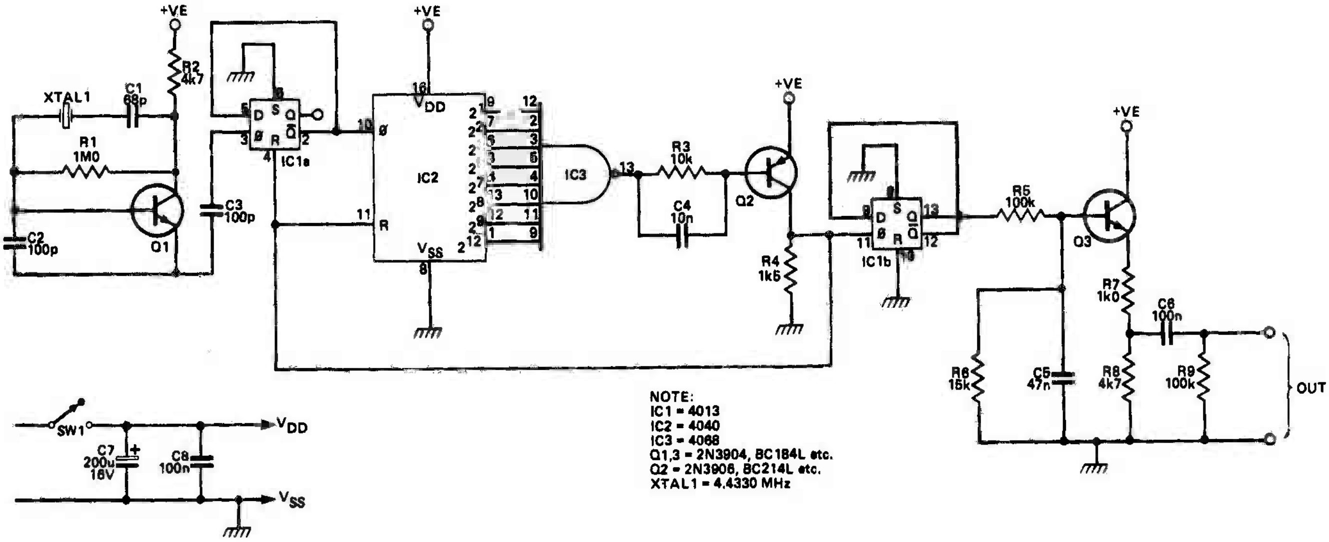
If 4.433Hz is divided by 10075 or 10011101011011_2 the resultant frequency is exactly 440Hz. However, in order to simplify the circuit, this is rounded to 10076 or 10011101011100_2. This gives a resolution of 0.5% which is quite sufficient for all but the most critical of applications, bearing in mind that a pitch difference of about 6% is equivalent to one semitone.

The crystal oscillator based round T1 has its output divided by two by IC1a, a D-type flip-flop which subsequently feeds the clock input of the 12 stage ripple counter, IC2. The appropriate outputs of the counter are ANDed via IC3 and Q2 and fed back to the reset inputs of both IC2 and IC1a, (Q2 is an NPN type in order to reduce power consumption). This produces a narrow negative-going pulse train of 880Hz which is presented to IC1b, a second D-type divide by two circuit. This produces the 440Hz reference with a precise 50/50 mark space ratio. Q3 and its associated components reduce the signal to approximately line level and perform wave shaping.

The power supply is a single 9V PP3 battery connected via a simple SPST switch with decoupling performed by C7 and C8. Current drain is typically 4mA.

The prototype was constructed on a small printed circuit board in an ABS box measuring 120 x 80 x 30 mm. It should be noted that although the inputs to IC3 are arbitrary, the pin connections shown give the simplest PC layout if the chips are positioned side by side with the 4040 on the left, pin 1 top right.

Finally, although the unit was designed to run from a PP3 battery, it will run equally well on supplys of up to 18V such as those found in many mixers and pre-amps, although it is advisable to increase R2 and R7 accordingly.

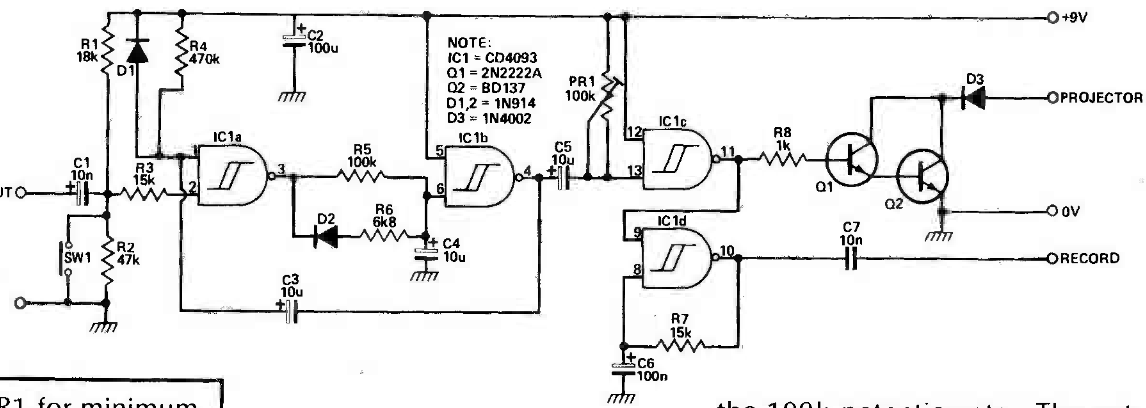


amplifier. Adjust PR1 for minimum output — headphones would help here. Now remove the temporary link and make sure S1 is switched to position (a); you should hear the original signal with its hiss. Moving S1 to positions (b), (c) and (d) will result in the hiss gradually becoming less audible with position (d) giving the most dramatic reduction at the expense of losing a little high frequency response.

The values of C2, C3 and C4 can be altered to suit the inidividual IC1, a dual op-amp, should of course be a low noise type such as NE5532 or TL072 and C2 - 4 should of course be polyester types.

Slide Advance Unit

Ian Lamb
Harare, Zimbabwe



This unit either encodes to or decodes from one channel of a stereo tape deck a 1kHz tone to activate the remote advance of a slide projector. The other channel is utilised for commentary of the slide series.

When pin 2 is pulled low, either by closing switch SW1 or by applying an audio signal, the normally low output on pin 3 goes high, charging the capacitor on pin 6. This eventually causes pin 4 to switch low, which pulls pin 1 low for a period of 3 seconds and pin 13 low for a period controlled by the setting of the 100k potentiometer. The output of this gate (pin 11) pulsing high activates the 1 kHz oscillator for the recorder and provides base drive to the Darlington pair connected across the remote jack of the slide projector. The 100k potentiometer is adjusted for the correct length of pulse to advance the slide tray.

At the end of the 3 second period, pin 1 is again high and if pin 2 has also returned high then the outputs on pin 3 going low discharges the capacitor on pin 6 which in turn switches the output on pin 4 to the a high, leaving the unit ready for the next negative going input signal.

ETI

ETI PCB SERVICE

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

Note that these are all the boards that are available — if it isn't listed, we don't have it.

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

1979
☐ E/794-1 Guitar Effects Unit 3.04
☐ E/794-2 Click Eliminator 7.64
☐

1980
☐ E/808-3 Ultrasound Burglar Alarm 3.30
☐ E/8010-1 Cassette Interface 3.37
☐ E/8010-2 Fuzz/Sustain Box 3.76

1981
☐ E/811-1 LED Tacho 4.75
☐ E/811-2 Multi-Option Siren 3.68
☐ E/814-2 Drum Machine (2 boards) 6.44
☐ E/814-4 Guitar Note Expander 3.68
☐ E/816-8 Waa-Phase 1.76
☐ E/816-9 Alien Attack 4.00
☐ E/817-1 System A-Input (MM or MC) 3.05
☐ E/817-2 System A — Preamp 5.95
☐ E/817-3 Smart Battery Charger 2.27
☐ E/818-3 Hand Clap Synth 4.57
☐ E/818-5 Watchdog Home Security (2 boards) 6.11
☐ E/819-1 Mains Audio Link (3 boards) 8.45
☐ E/819-4 Laboratory PSU 5.21
☐ E/8110-1 Enlarger Timer 3.91
☐ E/8110-2 Sound Bender 3.05
☐ E/8111-1 Voice Over Unit 4.57
☐ E/8111-2 Car Alarm 3.23
☐ E/8111-3 Phone Bell Shifter 3.40
☐ E/8112-4 Component Tester 1.71

1982
☐ E/821-3 Guitar Tuner (2 boards) 6.38
☐ E/822-1 Ripple Monitor 2.21
☐ E/822-2 Allez Cat Pest Repeller 1.93
☐ E/822-5 Moving Magnet Stage 4.01
☐ E/822-6 Moving Coil Stage 4.01
☐ E/823-4 Capacitance Meter (2 boards) 11.66
☐ E/825-1 DV Meg 3.13
☐ E/826-1 Ion Generator (3 boards) 9.20
☐ E/826-4 MOSFET Amp Module 7.80
☐ E/826-5 Logic Lock 3.52
☐ E/826-6 Digital PWM 3.84
☐ E/826-7 Optical Sensor 2.00
☐ E/826-9 Oscilloscope (4 boards) 13.34
☐ E/827-4 Hotwire 3.02
☐ E/827-5 Bridging Adapter 2.74
☐ E/828-1 Playmate (3 boards) 8.28
☐ E/828-4 Kitchen Scales 2.12
☐ E/829-1 Auto Volume Control 2.12
☐ E/829-2 Dual Logic Probe 2.22
☐ E/8211-4 Pulse Generator 6.08
☐ E/8212-1 ELCB 2.77
☐ E/8212-2 Servo Interface (2 boards) 6.75
☐ E/8212-4 Spectracolumn 5.54

1983
☐ E/831-1 Fuel Gauge 3.45
☐ E/831-2 ZX ADC 2.59
☐ E/831-3 Programmable PSU 3.45
☐ E/833-1 SoundBoard 12.83
☐ E/833-2 Alarm Module 3.62
☐ E/833-3 ZX81 User Graphics 1.07
☐ E/833-4 Logic Probe 2.50
☐ E/834-1 Real Time Clock 8.74
☐ E/834-2 Thermemeter (2 boards) 9.74
☐ E/834-4 Stage Lighting — Main 13.73
☐ E/834-5 Stage Lighting — Display 3.45
☐ E/835-1 Compressor/Limiter 6.19
☐ E/835-2 Single PSU 3.16
☐ E/835-3 Dual PSU 4.01
☐ E/835-4.2 NDFL Amp 7.88
☐ E/835-5 Balance Input Preamp 3.23
☐ E/835-6 Stage Lighting Autofade 6.19
☐ E/835-7 Stage Lighting — Triac Board 4.74
☐ E/836-1 to 3 PseudoROM (3 boards) 3.62
☐ E/836-5 Atom Keypad 5.18
☐ E/837-1 Flash Sequencer 2.67
☐ E/837-2 Trigger Unit Main Board 2.67
☐ E/837-3 Trigger Unit Transmitter 1.66
☐ E/837-4 Switched Mode PSU 16.10
☐ E/838-1 Graphic Equalisr 9.10
☐ E/838-2 Servo Fail-Safe (four-off) 2.93
☐ E/838-3 Universal EPROM prog 9.64
☐ E/839-1 NiCad Charger/Regen 3.77
☐ E/839-2 Digger 3.40
☐ E/839-3 64K DRAM 14.08
☐ E/8310-1 Supply Protector 2.19
☐ E/8310-2 Car Alarm 3.98
☐ E/8310-3 Typewriter Interface 4.17
☐ E/8311-1 Mini Drum Synth 3.07
☐ E/8311-2 Alarm Extender 3.21
☐ E/8311-3 Multiswitch 3.59
☐ E/8311-4 Multiple Port 4.34
☐ E/8311-5 DAC/ADC Filter 3.22
☐ E/8311-6 Light Pen 4.60
☐ E/8311-7 Logic Clip 2.51
☐ E/8311-8 MC Head (JLLH) 3.17
☐ E/8312-1 Lightsaver 1.85
☐ E/8312-2 A-to-D Board 12.83
☐ E/8312-3 Light Chaser (2 bds) 7.54
☐ E/8312-4 ZX Alarm 6.04

1984
☐ E/841-1 Vector Graphics 8.27
☐ E/842-1 Speech Board (Mini-Mynah) 10.97

MODULAR PREAMP:
☐ E/842-2 Disc input (mono) 3.73
☐ E/842-3 Output stage (stereo) 3.73
☐ E/842-4 Relay/PSU 3.73
☐ E/842-5 Tone, main (mono) 3.73
☐ E/842-6 Tone, filter (stereo) 3.73
☐ E/842-7 Balanced output (st) 3.73
☐ E/842-8 Headphone amp (st) 3.73
☐ E/842-9 Mother board 9.01
☐ E/843-1 Power Meter 5.81
☐ E/843-2 Z80 DRAM 9.79
☐ E/843-3 Obedient Die 3.76
☐ E/844-1 School Timer 4.07
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FINESSE DISCO/ PARTY STROBE

Ian Benton, whose Finesse Light Chaser/Sequencer design appeared in our December 1983 issue, here sets out to dazzle us with another example of his design skills

An essential component in any disco's repertoire of lighting effects is the Xenon strobe light. The versions available at present range from the quite sophisticated (and horrendously expensive) to the rather boring constant speed variety which are still none too cheap.

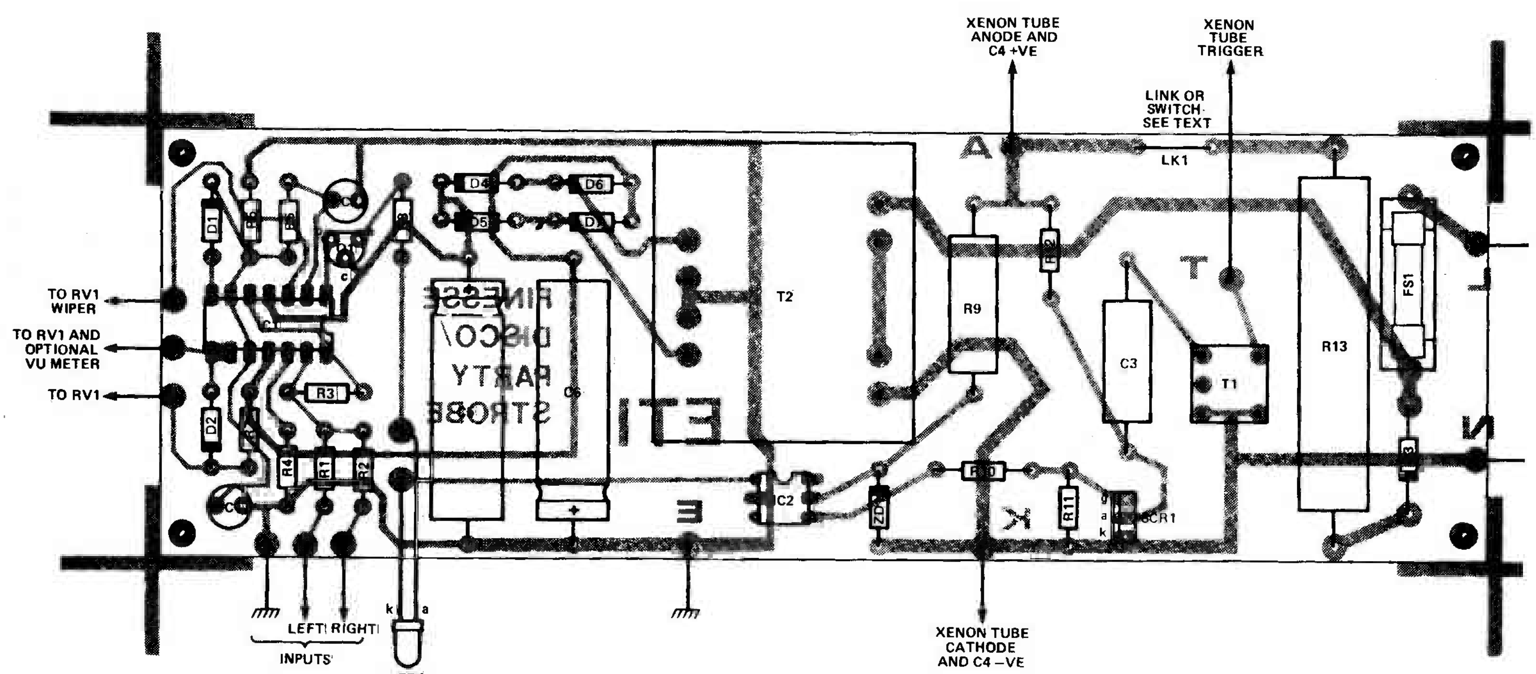
The FINESSE strobe light can add an impressive strobe light display to the disco set-up at a reasonably small capital outlay, so it is ideally suited to the newcomer whose lighting equipment budget must take second place to the audio side of things. It might equally well be used to create atmosphere and stimulate dancing at any party, in the home or elsewhere.

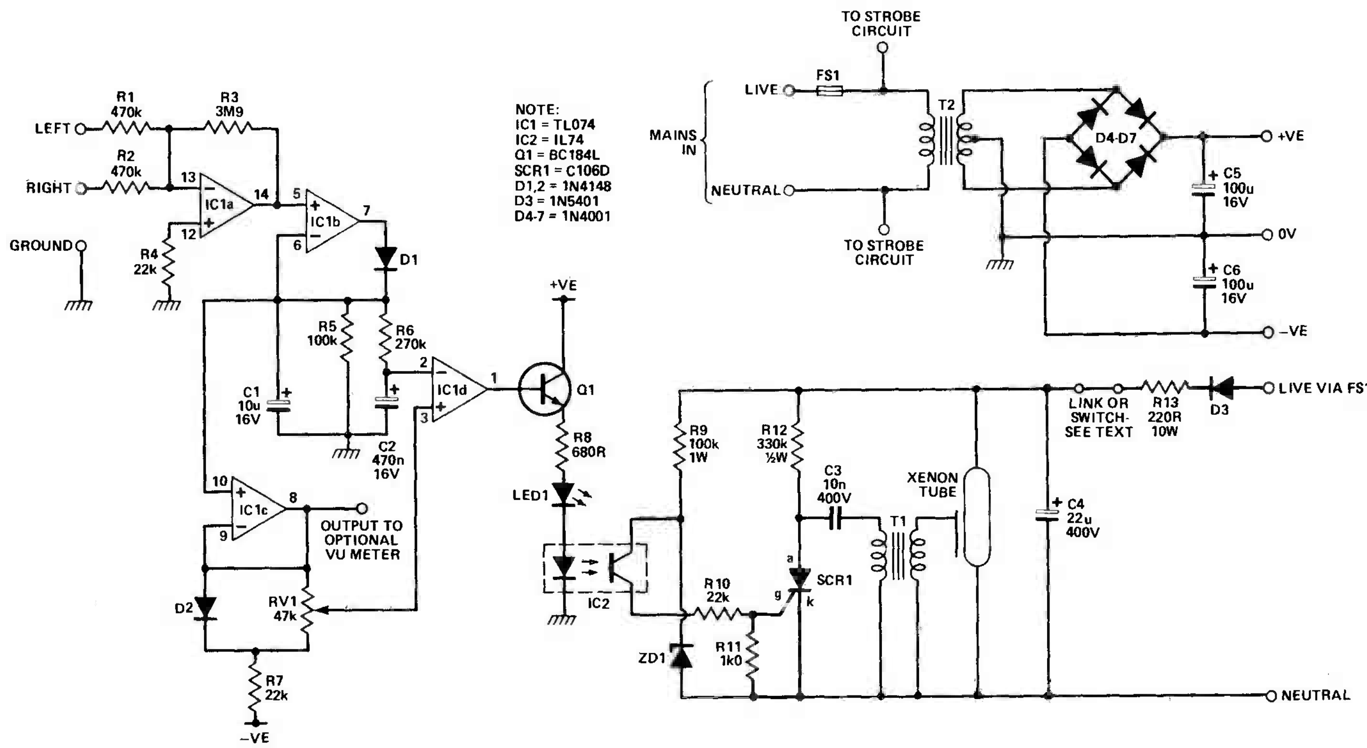
The unit automatically flashes in time to the beat of the music so no speed control is required; a level control is however, provided to compensate for music with less emphasised beat. The unit connects directly to the output of an audio amplifier or to the sound-to-light output which is provided on most disco consoles.

The operation of the circuit is best divided into two sections which will be dealt with separately: the audio amplifer and processor and its DC power supply; and the high voltage strobe and triggering circuitry.

Direct connection to the audio source is preferred for this circuit because with ALC (automatic level control) and a microphone, when the level of the sound drops, the strobe unit will be triggered by background noises. It may also be triggered by the sound made by the sudden expansion of the Xenon tube as the strobe flashes, causing it to flash continuously at high speed under conditions of low ambient sound. This is a distinct advantage for a light chaser as it does not appear as though it has 'got stuck' when the volume is lowered but for a strobe light, the effect is, to say the least, annoying.

Direct connection means than the audio circuitry must be completely isolated from the mains, and this is done by using a small transformer and an optoisolator. The output of the transformer is conventionally rectified and smoothed to provide a split rail power supply of approximately ±12V DC and earth and the optoisolator (IC2) is used to transfer the triggering pulse from the audio circuitry to the triggering circuit.





PARTS LIST

RESISTORS (¼W 5% unless otherwise stated)	
R1,2	470K
R3	3M9
R4,7,10	22k
R5	100k
R6	270k
R8	680R
R9	100k 1W
R11	1k0
R12	330k ½W
R13	220R 10W
RV1	47k
CAPACITORS	
C1	10u 16V tantalum
C2	470n 16V tantalum
C3	10n 400V polyester
C4	22u 400V
C5,6	1000u 16V
SEMICONDUCTORS	
IC1	TL074
IC2	IL74
Q1	BC184L
SCR1	C106D
D1,2	1N4148
D3	1N5401
D4,5,6,7	1N4001
ZD1	22V 400mW zener
LED1	any LED
MISCELLANEOUS	
T1	strobe trigger transformer
T2	9-0-9V, 6VA PCB mounting
FS1	PCB mounting 20 mm fuse holder and 1A fuse
LP1	Xenon tube

PCB; case; reflector and lens assembly; DIN or other socket for audio input; mains cable and strain relief bush; wiring, PCB mounting pillars, etc.

MAINS IN

Construction

The components of both the audio circuitry and the power supply and trigger circuitry are all mounted on one PCB. Solder in the resistors first followed by the diodes and the ICs last (IC1 is a JFET/biplolar device and does not require handling precuations). As usual, make sure that none of the tracks are bridged by small pieces of solder, especially where the high-voltage and power supply components are concerned.

The strobe tube mounts on top of C4 as this reduces the length of the current wires to a minimum. It

HOW IT WORKS

The left and right audio channels are summed by IC1a which is configured as an inverting summing amplifier with a gain of 18dB to produce an audio signal of approximately 4V RMS.

IC1b, D1, C1 and R5 form a peak level detector with a time constant of 1 second. This is smoothed by R6, C2 and fed to the inverting of the comparator, IC1d. The peak level signal is buffered by IC1c and connected through D2 and R7 to V_{peak} and V_{peak} -0.65V. This signal is compared to the smoothed sound level by IC1d.

Thus the output of IC1d goes high, turning on LED1 and the emitter-follower Q1 which is used as a buffer. A pulse is transmitted to the optoisolator IC2, whenever the peak sound level exceeds the average (smoothed) sound level by an amount determined by the setting of RV1.

The effect of using a diode rather than a voltage divider is that when the music fades, the peak voltage is reduced by a greater amount than the smoothed voltage. This effects a reduction in sensitivity and cuts off the strobe towards the end of a record, keeping it turned off until the next record is faded in.

The mains is half-wave rectified by D3 and charges C4 up through R13 to approximately 340V DC. With SCR1 non-conducting C3 charges up over approximately 10ms through R12 and T1 primary. This leaves one plate at 0V and one plate at 340V.

When the phototransistor in IC2 conducts, SCR1 is triggered forcing the +ve side of C3 to 0V. The other plate goes to -340V and discharges through T1 producing a pulse of about 5kV on the secondary. This is passed to a metallised strip along the outside of the Xenon tube and ionises the gas inside. This then conducts strongly discharging C4 in about 1ms with a peak current of more than 50 Amperes and a peak power in excess of 1kW depending on the tube used.

R9 and ZD1 limit the collector voltage of the phototransistor to 22V since most opto-isolators have a 30V V_{ceo} limit.

The ringing of the tuned circuit formed by T1 and C3 turns off SCR1 on the first transistion through 0V provided that the current flowing through R12 is less than the holding current.

is probably better if you can find a tag ended or radial leaded version for this component. The Xenon tube most be totally enclosed for reasons of safety as 340V is present on its +ve terminal and 5kV on the metallised strip along its length. Mounting is left up to the constructor, but one method is to use the lens unit from a RING halogen driving light, remove the bulb-holder and fix C4 to the back of the unit with the Xenon tube soldered onto its terminals.

It may also be possible to use the storage capacitor and tube from an existing simpler strobe — the value of C4 is non-critical — in which case the housing will not cause any problems. If a metal case is used it should obviously be earthed; if a plastic case is used do no let it come into contact with R13 which gets extremely hot.

Before switching on check that the tube, C4 and D5 are all correctly connected as well as making the usual check for dry joints, etc. Electrolytics have a nasty pyrotechnic suicidal tendency when connected wrongly, big electrolytics especially, so be particularly careful here. If spurious triggering occurs in use the input voltage is too high; R3 should be reduced until no distortion can be heard using a crystal earpiece on IC1a output.

Modification

The design can be modified in a number of ways to suit individual requirements. If link LK1 is removed from the strobe live line and a switch inserted instead, the unit can be adjusted to flash correctly using D3 as an indicator without the Xenon tube itself flashing. The output of IC1c provides a buffered peak level signal and this could be used to drive a VU meter if desired.

It is also possible to modify the circuit to drive two tubes simultaneously. To do this, duplicate the strobe circuitry from the optoisolator onwards, reduce R8 to 560R and connect the additional optoisolator diode in series with the existing one. Bear in mind that the additional strobe circuitry will carry high voltages and assemble and insulate it accordingly. If you can afford it, the best solution would be to use a second PCB, either a full board from our PCB service or a home-made one whch reproduces just the relevant part of the layout. If the full PCB is used, it is a simple matter to connect up the optoisolator diode using one of the earth pads and the LED cathode pad, and to wire this into the board carrying the power supply and audio supply and audio circuitry in series with the LED.

BUYLINES

All components are standard except the Xenon tube and transformer (and possilbly the optoisolator; Type IL74 is specified but other types should work providing their V_{ceo} is 25V or more and the pinout is the same). Xenon tubes are available with trigger transformers from Tandy in two sizes and are surprisingly cheap. Maplin also supply a tube, but this has axial leads which may cause mounting problems. The PCB is designed for the Tandy transformer which should still work with the Maplin tube. The PCB is, of course, available from our PCB service.

ETI

ACTIVE-8 LOUDSPEAKER

This month, Barry Porter completes the design work on the latest ETI active loudspeaker.

The Active-8 was evaluated with both 12 and 24 dB per octave filters and no difference could be heard between them, so the 4 pole version was chosen as this gives slightly more protection to the high frequency unit by virtue of its steeper slope. It also has the additional advantage of reducing the level at the resonant frequency of the T33 — about 950hz — by about 40 dB, where its effects may be safely ignored. The response of both high and low pass sections is shown in Fig. 6 and the circuit of this part of the network in Fig. 7.

Drive Unit Equalisation

If each drive unit had a flat frequency response over its range of operation, life would be much more enjoyable for all concerned. Unfortunately this is not the case, so additional circuitry has to be used to correct the major inaccuracies. The Active-8 units were measured in free field conditions (free local playing field would be more accurate!) resulting in the plots of Fig. 8

Looking at the B200G response first, this shows a 6dB rise between 300 Hz and 3 kHz which the equalisation circuit shown in Fig. 9 cancels with reasonable accuracy, as the corrected plot shows.

The T33A also exhibits a response that rises with frequency, so a similar circuit is used to counteract this.

It will be seen from Fig. 8 that the T33A is slightly more sensitive than the B200G — about 3dB if the low frequency output at 1 kHz is compared to the 10 kHz output from the high frequency unit. This difference will be corrected at a later stage by placing a 3dB attenuator in the high frequency signal path.

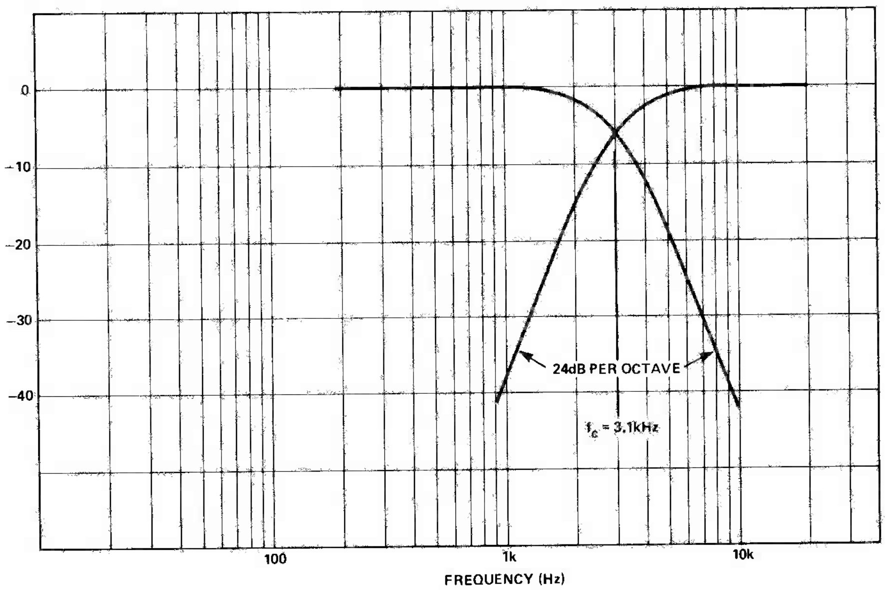


Fig. 6 Crossover filter response.

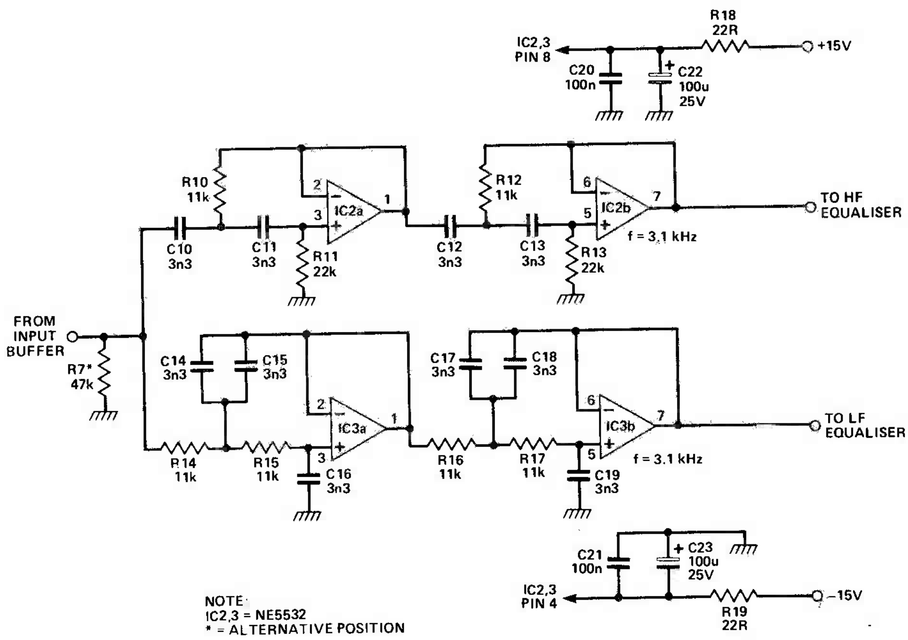


Fig. 7 Crossover filter circuitry.

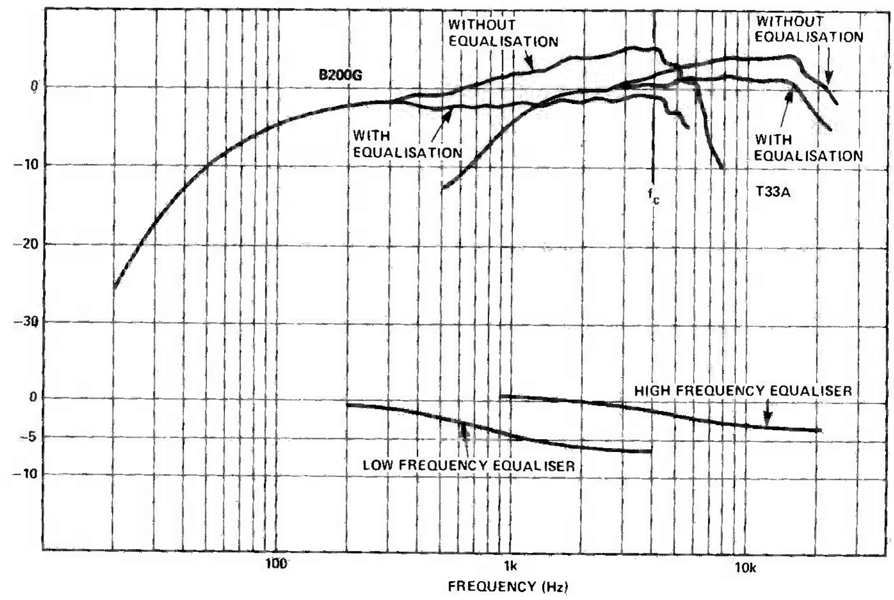


Fig. 8 Free-field response of the drive units.

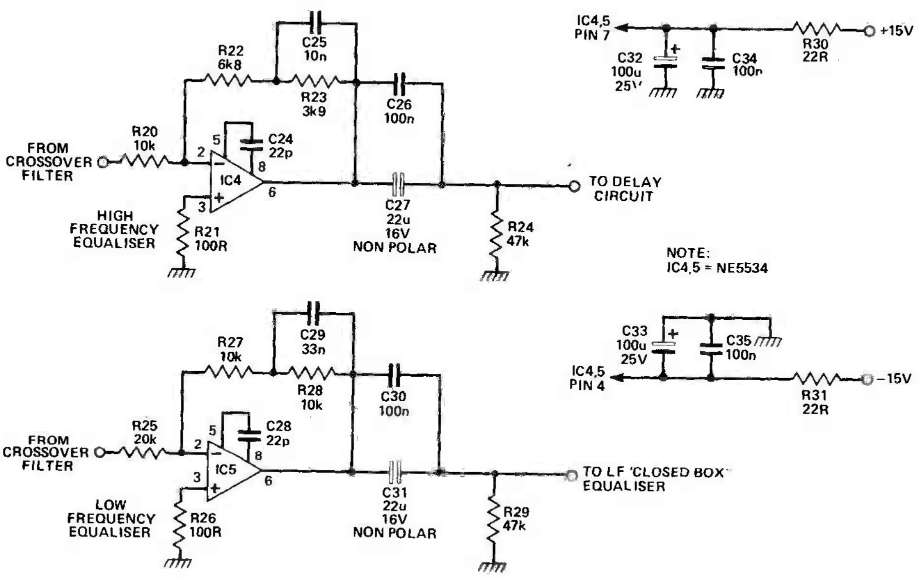


Fig. 9 Equaliser section circuitry.

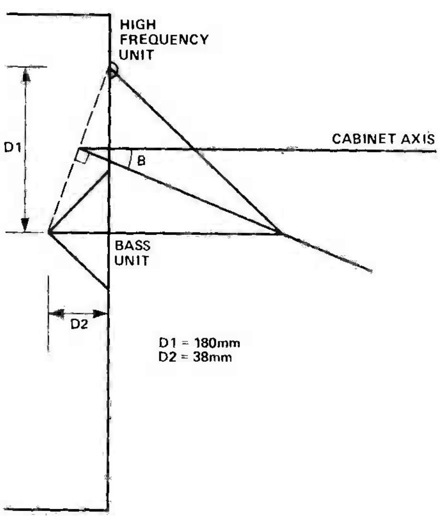


Fig. 10 The effect of the displacement of the speaker coils.

Time Delay

Ideally, the two drive units should have their acoustic centres on a plane that is perpendicular to the speaker axis. This is not the case however, as the T33a radiates from a point approximately 38mm in front of the B200G. Referring to Fig. 10, it can be seen that the radiation pattern will be tilted downwards at the crossover frequency by:

$$B = \text{Atan}\left(\frac{D_2}{D_1}\right) = 11.9^\circ$$

This could be compensated for by mounting the T33A on a different plane to the B200G, but this would introduce a number of mechanical difficulties in avoiding diffraction effects from the cabinet edges. The alternative solution applied to the Active-8 is to delay the high frequency signal by the amount of time it takes sound to travel 38mm, which is:

$$t_d = \frac{D2}{V} = \frac{38 \times 10^{3}}{343}$$

A suitable delay circuit formed from cascaded all-pass filters, is shown in Fig. 11. Each stage gives a delay at the crossover frequency of:

$$t = \frac{2RC}{1 + (2\pi f RC)^2}$$

$$\approx 27.6 \text{ ms } (110.5 \text{ ms total})$$

The use of this delay ensures that both units are in phase along the cabinet axis, so no vertical directivity shift occurs over the crossover region. Colouration in the critical mid-range is therefore minimised, and the improved dispersion characteristics assist in the production of a very stable stereo image with a considerable presence of depth information.

The previously mentioned 3 dB attenuator in the high frequency signal path is formed at the output of the delay circuit by R44 and R45.

Closed Box Operation

Although the 'Active-8' may prove quite acceptable with reflex loading, there are certain advantages to be gained from replacing the vent escutcheon with a blanking plate and reverting to closed box operation.

Although curve A in Fig. 1 may not look too promising, especially if your musical taste runs to material with more than its share of bass emphasis, remember that this is the anechoic response. Under normal listening conditions, room boundary reflections will give a perceived increase in low frequency output.

Closed box response rolls off at 12dB per octave, and therefore exhibits less transient overshoot and ringing than the 24dB per octave reflex response. Although the Active-8 will give good performance when used as a closed box in a small listening room, it will not have sufficient bass output for use in larger rooms. The technique employed to resolve this problem works like this:— as we have seen, the closed box response rolls off at 12 dB per octave, so if circuitry is placed in the low frequency signal path that introduces a counteracting 12dB per octave lift, the acoustic output of the speaker will remain flat at lower frequencies. Obviously, the equalisation cannot continue to rise in level, so at the point where it flattens the speaker roll-off will start, still retaining a 12dB per octave sope and with a Q value that is decided by the electronics. A suitable low frequency equalisation circuit is shown in Fig. 12. The Active-8 values are based upon the following parameters.

$$f_O = 48\,\text{Hz}$$
$$Q_O = 0.505$$
$$f_P = 13.2\,\text{Hz}$$
$$Q_P = 0.5$$
$$A_{DC} = 22.4\,\text{dB}$$

This gives a considerable increase in bass output without too much danger of either the circuitry or bass unit running out of headroom. As an experiment, the author applied the same low frequency equalisation technique to a pair of large domestic speakers with 300mm bass drivers, but kept the response flat to about 5Hz. The bass was certainly impressive, although analogue records could not be played due to turn table and cutting lathe rumble causing excessive cone movement. Both analogue and digital master tapes caused no problems, and it was clear that, although there was no musical information at very low frequencies, the extremely good phase characteristics of the speakers gave weight and solidity to the lower register that is lacking in all but the largest studio monitors.

The bass equalisation circuit is

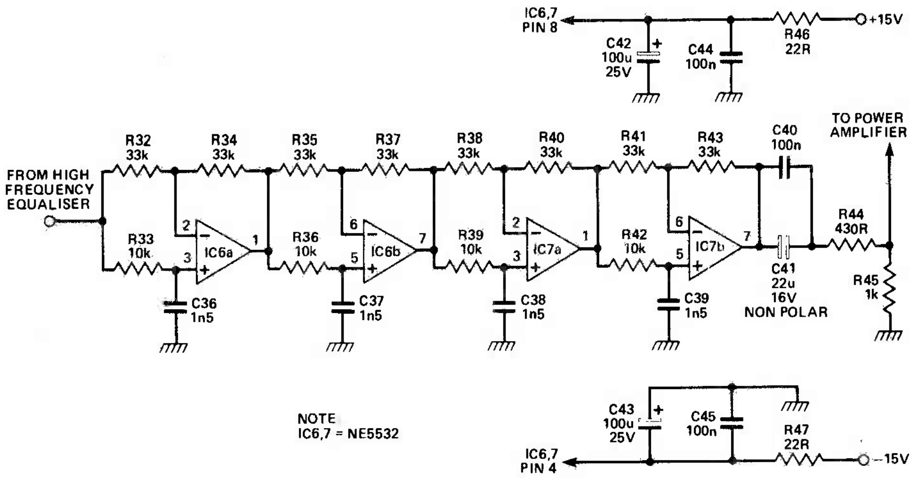


Fig. 11 Delay circuit.

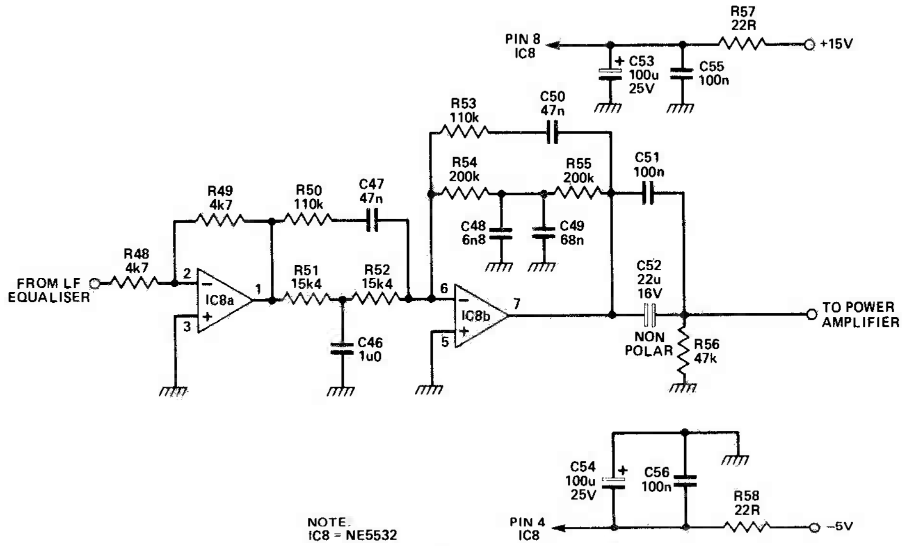


Fig. 12 Low-frequency equaliser for closed-box operation.

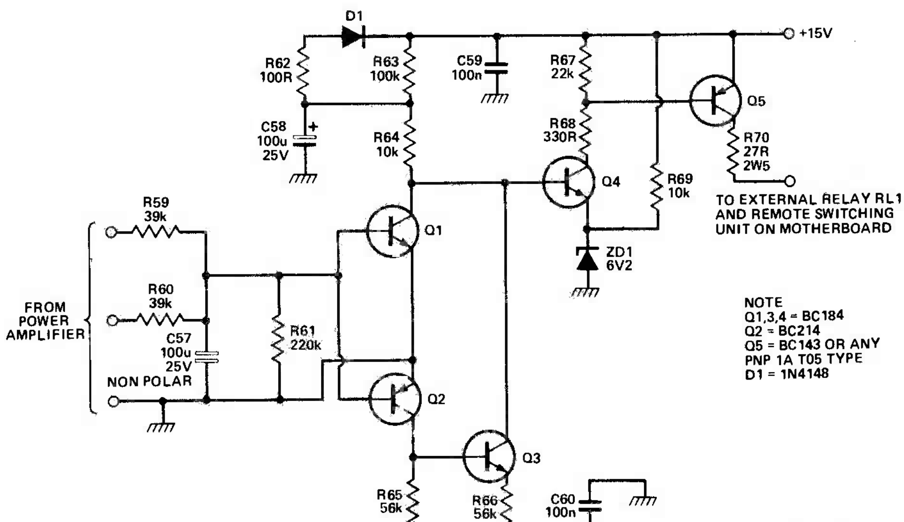


Fig. 13 Protection unit.

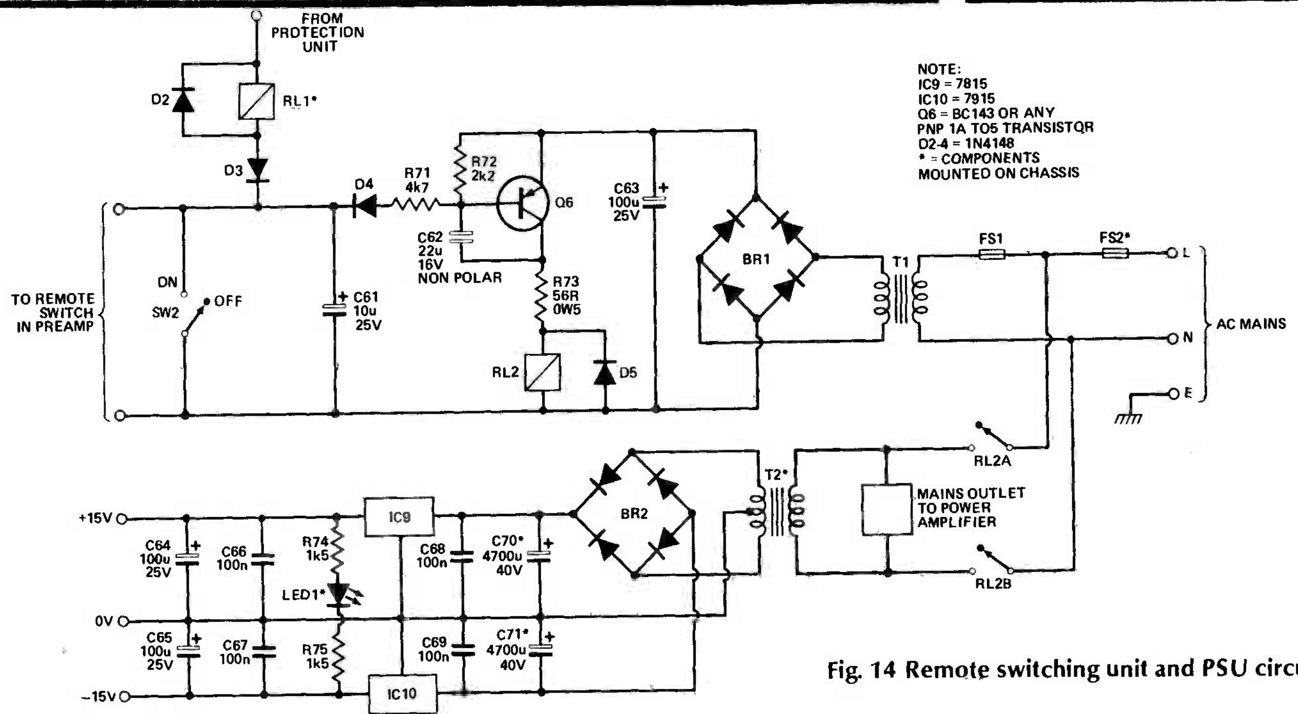


Fig. 14 Remote switching unit and PSU circuitry.

only used when the speakers are operated in the closed box mode, and therefore provision must be made to bypass it when necessary. As the circuit of IC8b (Fig. 12) is inverting, a further inverting stage — IC8a — has been added to maintain phase integrity. The choice of Q_P at 0.5 was made to minimise the low frequency phase shift, with f_P being set at a frequency that allowed the use of standard capacitor values. The resistor values are shown as calculated, but the nearest E24 values may be used with no noticeable change in performance. Similarly, the 75nF capacitor is approximated by the paralleled combination of 68nF and 6.8nF (C48, 49).

Switch-On Delay

One problem encountered with the prototype Active-8 speakers was that switching them on or off required the adoption of a procedure not far removed from doing a pre-flight check on the family 747. It was all too easy, for example, to switch off the preamplifier while power was still applied to the filter units and power amplifiers, the reward being a superb example of transient handling as the drive units attempted instant self-destruction. To avoid this, the power amplifiers had to be switched on last. And switched off first. In spite of several feet of advisory Dymo tape, this sequence was not always adhered to, so to avoid wear and tear on drive units and nerves, the circuits of Fig. 13 and 14 were incorporated.

Together, these units provide remotely controlled mains switching, delayed connection of amplifier to drive units, disconnection of drive units before mains switch-off and continuous protection against excessive DC voltages at the power amplifier outputs.

Operation of these functions is best understood by considering a switch-on — switch-off cycle. The small transformer, T1 (Fig. 14) is permanently connected to the incoming mains so about 17V DC sits on smoothing capacitor C63. Q6 is held off by R72, so the mains switching relay, RL2, is de-energised. The unit may be switched on locally, or by earthing the remote connection at the pre-amplifier; either action turning on Q6 by the pull-down of D4 and R71. RL2 is therefore energised, and contacts RL2A and RL2B apply mains voltage to the crossover unit power supply transformer, T2, and to the power amplifier via a mains outlet socket.

When the protection unit (Fig. 13) initially receives power, Q4 and Q5 are turned off, and the speaker drive units are disconnected due to RL1 being de-energised. As C58 charges up through R63, the bass voltage of Q4 rises until it reaches 6.8V, at which point the transistor turns on. The current which then flows through R67 and R68 turns Q5 on and RL1 is activated, connecting the drive units to the amplifier. This take about 6 seconds, which allows all voltages to settle and switching transients to disappear.

In operation, any excessive DC voltage appearing at the power amplifier output will be detected by Q1 or Q2. A positive voltage will turn Q1 on, pulling the base of Q4 down, so that both Q4 and Q5 are turned off, as a result of which RL1 will disconnect the drive units. If the offset voltage is negative, Q2 will be turned on. Current flowing through R65 will turn on Q3 which will pull down the base of Q4. Again, Q5 will also turn off, de-energising RL1 and disconnecting drive units.

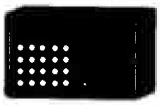
At switch-off, the remote connection is removed from earth, immediately causing RL1 to revert to its relaxed state as its OV path via D4 (Fig. 14) is broken. The drive units are therefore disconnected before the mains is switched. Q6 is held on for a short time by C62, so RL2 cannot switch the mains until the amplifier outputs are well and truly broken by RL1.

All this means that the Active-8 units can be switched on and off without fear of the clicks, bangs and thumps that are so often the hallmark of home produced equipment. The remote connections of each speaker can be joined together and taken by a single wire to the pre-amplifier where a single pole switch can be used to operate the speakers. The recent modular pre-amplifier article (ETI December, January and February) gave details for wiring the remote connections so that the speakers are automatically switched off whenever headphones are used, this being one of the several possible ways the system can be arranged.

Next Month: Construction.

ETI

MICROPROCESSOR TIMER KIT



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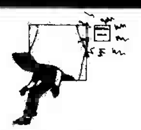

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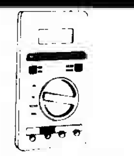

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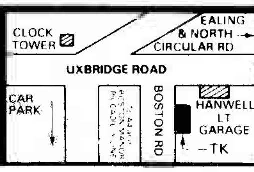

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COMMUNICATIONS SATELLITES PART 4

Drawing this short series to a close, Roger Bond takes a look at who's who and what all those long abbreviations mean.

No UFOs here, just level headed scientists and businessmen who put their skills to work. The USA, being a much bigger country than the UK, has many satellite carriers and some are listed below.

American Telephone and Telegraph (AT&T): Part of the Bell Company. It also has a long lines division who look after international cables.
General Telephone and Electronics (GTE)
RCA American: The famous recording company also builds satellites and is now also a satellite operator.
Hughes Aircraft: Has been in the satellite building business a long time and now plans to become an operator.
Southern Pacific Communications: Well known for its railways, and now in the satellite business.
Western Union: This is a telephone company (remember the old western?).
American Satellite: A combined business venture of Continental Telephone and Fairchild Industries.
Satellite Business Systems: This is a partnership including IBM.

These are the established carriers but no doubt there will be others in this profitable field particularly with the US Government's liberalisation of the telephone industry.

INTELSAT is an operating body whose governor is COMSAT (Communications Satellite Corporation). INTELSAT is made up of member governments and telecommunications representatives. A board of governors then works through a director general who has deputies for finance, administration, development, etc.

INTELSAT was formed in 1964 by eleven member countries, but the ranks have grown to a hundred. The USA has a 25% voting share and the UK plus Eire 11%, which reflects the usage of the satellites.

EUTELSAT was formed in 1977 by seventeen countries to operate the European Communications Satellite (ECS). The two biggest shareholders are France and the United Kingdom with 16% each, then West Germany and Italy with 11% each.

The first ECS was the Orbital Test Satellite (OTS) which was destroyed when the American THOR DELTA launcher exploded in 1977. The next OTS was launched the following year with a three year lifetime. After that came the ECS flights lanched by the European Space Agency (ESA) by their Ariane rocket from Korou in French Guiana, South America.

Since French Guiana is on the equator, the positioning of satellites is easier. Launches from Cape Caneveral have to be placed in a elliptical transfer orbit first. The lowest point of the ellipse (perigee) is about 170 km above the earth. The highest point (apogee) is at the correct altitude for a geostationary orbit and when the apogee motor is fired, the satellite is drifted into its final position.

Table 1 shows the ownership of some of the satellites and the frequency bands in which they operate. The name 'PALAPA' of the Indonesian satellite, means 'goodwill to all men'.

UNISAT is United Satellites Ltd, a company formed by marconi Space and Defence, British Telecom and British Aerospace. The day of television pictures direct from satellites should be upon us in 1986 when two UNISAT satellites each using six transponders for transmission should start beaming pictures. Most local councils says they have no objection to people installing one metre dishes in their gardens for receiving these signals.

ECS

ECS flight 1 (F1) has launched in June 1983 and has twelve transponders operating at 14/11 GHz. Each of the 20W transponders has a 72 MHz bandwidth and at present television is being broadcast to the Continent. The programme called Skychannel reaches an audience of half a million in seven European countries. Such is the power of television aided by satellites.

ECS flight 2 (F2) is due for launch in 1984 and will work TDMA via Madley 4. Quite apart from TDMA, this satellite is due to provide a revolutionary new facility called multi-services which included voice, data and videoconferencing. The whole idea is to provide businessmen with international access at bit rates from 64 Kbit/s up to 2 Mbit/s.

In this way a newspaper company can, for instance, print its foreign editors in the relevant countries making distribution thirty times faster. Other multinational companies like banks and oil companies will also welcome this facility.

ECS F2 to F5 will carry two extra transponders each for this service and later versions of ARIANE can carry this extra payload. These satellites will weigh about 650 kg compared to 440 kg for the OTS. The solar panels spanning 14 m altogether will deliver 1.3 KW compared to 750W for OTS.

In addition to point-to-point services there will be point-to-multipoint facilities similar to a control tower broadcasting to radio cars. The satellite will have aerials for a Eurobeam, three spot beams (east, west and Atlantic) and, of course, the multi-services global beam aerial. The satellite's shape is similar to that of INTELSAT V and the user should need a 5 m dish, which could be mounted next to the office or factory.

INTELSAT VI

By the end of 1985, the combined capacity of the INTELSAT V and VA satellites on the primary AOR and IOR routes will be saturated; the first of INTELSAT VI will take up position in 1986.

INTELSAT VI will be similar in shape to IV, with a spinning drum-shaped body carrying the solar cells and a de-spun platform carrying the aerials. However, the cylindrical body will be extended after launch, ie, it will be telescopic, making the total satellite length 12 m, of which 3.8 m is the outer cylinder length and 2.2 m is the inner cylinder. When folded down for launch, the satellite will be 5 m in height. The weight of the satellite will be about 2000 Kg.

The solar cells produce enough power for the satellite, which requires 2 kW, and to keep the stand-by 44AH batteries topped-up. The solar cells should last for the 10 years of life that the satellite is designed to have, rather longer than the life of the cells on INTELSAT VI which face the sun all the time.

The satellite is designed so that it could be launched either by the Shuttle or by AIRANE 4. With a Shuttle launch, it will need a perigee kick motor to get it into a high, equitorial orbit, and this will be carried in a cradle in the Shuttle's cargo bay.

The aerial array on VI is similar to that on V, except that where V has 88 feeds, VI has 146. This gives VI greater flexibility in the beam patterns that it can generate. VI will use satellite switched time division multiplex assignment, a technique presently used on the experimental L-SAT satellite, which means that the zone and hemi beams can be interconncected up to 64 times within each TDMA frame of 2 ms, making it exchange of information between users very flexible.

As with INTELSAT V, there are two steerable 14/11 GHz spot beams operating with linear polarisation. The receiver uses low-noise GaAs-FET preamplifiers and a frequency-changing oscillator whose frequency if controlled from the ground station. Transmit power is normally provided by travelling wave tubes, but the smaller zone beams require only about 3 W which can be supplied by semiconductors.

Other Applications

We have looked at the narrow field of telecommunications, so far, but let us now take a look at some of the other uses of satellites that are related.

TV Broadcast: Satellites are already used quite extensively for the passing of TV pictures and programmes from one broadcasting station to another, and lately to cable TV companies' relay stations (in community antenna television, or CATV). However, the next phase of this process is to be the direct broadcast of television to peoples' homes (direct broadcast by satellite, DBS, as already featured in ETI in March 1983.

DBS has already started in the USA by United Satellite Communications (USC) who are hoping to reach a total of 10 million homes. A US company, the Orion Satellite Corporation, has applied to the US authorities to launch two satellites to beam television to Europe in the Ku band. Costing £230m, and receiving backing from banks in New York and London, could this be the start of a new era of pirate broadcasting?

SATELLITE	FREQUENCY	COUNTRY
WESTAR-2	4-6	USA
USASAT-6A	11-14	USA
US SATCOM-2	4-6	USA
SATCOL-2	11-14	CANADA
ATCOL-2	4-6	COLUMBIA
GOES WEST	1-3	USA
LOUTCH P1	11-14	USSR
STATSIONAR-8	4-6	USSR
VOLNA-1	1-3	USSR
SIRIO	1-11	ITALY
SYMPHONIE-2	1-4-6	(FRANCE (W GERMANY
TELECOM-1A	4-6-7-8-12-14	FRANCE
COMSTAR D1	4-6	USA
GEOS-2	1-3	FRANCE
METEOSAT	1-3	FRANCE
ARABSAT 1	3-4-6	ARAB STATES
ZOHREH-2	11-14	IRAN
INSAT-1A	1-3-4-6	INDIA
PALAPA-2	4-6	INDONESIA
CSE	3-14	JAPAN

Table 1: Satellite owners and frequencies

However, economic worries continue to dog DBS. In the US, the prices being charged by USC compare badly with a competing CATV system provided by a cable company ($40 per month for five channels plus the cost of the antenna, around $300, for USC, as opposed to $25 per month for 54 channels for CATV).

The economic worries have reduced the plans of the BBC and the IBA steadily until, although neither will admit it publically, it appears in doubt that either will get in on the act; at the very most, the BBC will be opening two satellite channels, for which it will pay £12 million per channel for the use of the satellite. Added to this will be the cost of producing the programmes.

Meterology: At present data is received directly by many Countries through the Automatic Picture Transmission System (APT). During the 1980s several geostationary systems will be introduced, including Meteostat 2 and SIRIO2 by ESA. The USA will put up GOES east, west and central and the USSR, GOMS. Japan will have GMS2 and India INSAT 1.

Safety at Sea: Although the maritime satellites operate panic frequencies for ships in distress, more ambitious systems are operated by some countries. SARSAT, search and rescue satellite is operated by the UK, USA, Canada, Norway, Sweden and France. The USSR operates COSPASS, space system searching for aircraft and vessels in distress.

Radionavigation is an associate field of application and the World Administrative Radio Conference (WARC) has allocated specific bands in the range 1.5GHz to 265GHz. The US Navy will replace their Navigation Satellite System with the Global Positioning System (GPS), a much more ambitious project. The USSR uses their Tsikada satellites both for their navy as well as oil rigs.

Remote Sensing: This is used to study geology, land use, the environment and natural resources. About seventy-five countries participated in the USA's LANDSAT programme which studied crops, evaporation and soil temperature.

More than a hundred countries including the USSR and India have remote sensing. The frequencies used vary across the electromagnetic spectrum including infra red, microwave and the visible portion. Both active and passive sensors have been used and the advantage of microwave is that it is less prone to weather conditions.

Standard frequency and time signal: There is already a big demand for this from the general public, communications engineers, space scientists, navigators, instrument calibrators, astronomers, surveyors, TV and radio broadcast stations etc. At present a standard is derived from caesium by the National Physical Laboratory. A frequency standard is also broadcast by Rugby Radio Station.

The Future

The future is here, rolling down on us faster than we realise. Technologically, satellites are headed for continuous improvement. Space-to-space links mean that signals can reach their final destination without being beamed to earth at intermediate points. The USA's Tracking and Data Relay Satellite (TDRS) enables data to be collected by several geosynchronous satellites and delivered to a common earth station.

SS-TDMA is also a technology for the future, the great advantage of TDMA links being that noise on the satellite up link can be separated from the noise on the down link hence reducing the overalll system noise. However TDMA equipment is expensive for small countries and CFM may be preferable.

The USSR has pioneered the use of highly elliptic

APT	Automatic Picture Transmission
AOR	Atlantic Ocean Region
ARIANE	ESA's launch rocket
CCITT	Consultative Committee for International Telephone and Telegraph
CATV	Community Antenna Television
CFM	Companded Frequency Modulation
COMSAT	Communications Satellite Corporation
CES	Coast Earth Station
DBS	Direct Broadcast by Satellite
DSI	Digital Speech Interpolation
ESA	European Space Agency
EUTELSAT	European Telecommunications Satellite
ECS	European Communications Satellite
FDMA	Frequency Division Multiplex Assignment
GEOS	Geostationary Operational Environmental Satellite (ESA, NSA)
GOES	Environmental Satellite Geostationary Operational (ESA, NSA)
GPS	Global Positioning System
GFRP	Graphite Fibre Reinforced Plastic
IOR	Indian Ocean Region
INMARSAT	International Maritime Satellite
INTELSAT	International Telecommunications Satellite
MARISAT	Maritime Satellite
MAROTS	Maritime Orbital Test Satellite
MARECS	Maritime European Communications Satellite
NASA	National Aeronautics and Space Agency
OTS	Orbital Test Satellite
PKM	Perigee Kick Motor
PSK	Phase Shift Keying
SCPC	Single channel Per carrier
SPADE	Single channel Per carrier, Pulse code modulation, Assignment by Demand Equipment
SSOG	Satellite System Operations Guide
SSOP	Satellite System Operations Plan
SS-TDMA	Switched Satellite — TDMA
TASI	Time Assigned Speech Interpolation
TDMA	Time Division Multiplex Assignment
TWT	Travelling Wave Tube
TWA	Travelling Wave Amplifier
TDRS	Tracking and Data Relay Satellite
UNISAT	United Satellite Corporation
WARC	World Administrative Radio Conference

Table 2: The jargon every communications engineer will have to have at his or her finger-tips.

Molniya orbits. These have a high point of the orbit 38,00 km above the earth, and from the earth below this point, the satellite will be visible for around 8 hours per day. Moreover, for much of the time, it will be high above the horizon, and therefore much less likely to be obscured by hills or buildings. For this reason, the use of satellites with such orbits for radiomobile communication in the UK is being investigated.

Administration: With the vast number of satellites in use and the number of beams transmitted by each satellite because of frequency re-use, there is a real need for efficient spectrum management. However there is little to stop a wayward country from breaking a gentleman's agreement.

The strong demand for orbital positions has prompted INTELSAT to suggest a reduction in satellite spacing from 3° to 1°. This will require a thinner beam which can be generated by Georgian aerials Fig. 8. This simple but clever idea prevents the tripod of the subreflector interfering with the main beam.

Politics: For twenty years INTELSAT has administered satellites for the Western World but the choice of both manufacturers and launchers has grown steadily.

Britain has a thriving portion of the satellite business but Japan intends to enter it in a big way. They intend not only to sell the world satellites but also launch them with a vehicle costing $1.3bn and launching more than seventy satellites between 1984 and 2000. Their first launch, the CS-a with 4000 circuits, weighed 350kg and cost $800m to launch, three times the cost of a US launch using Shuttle.

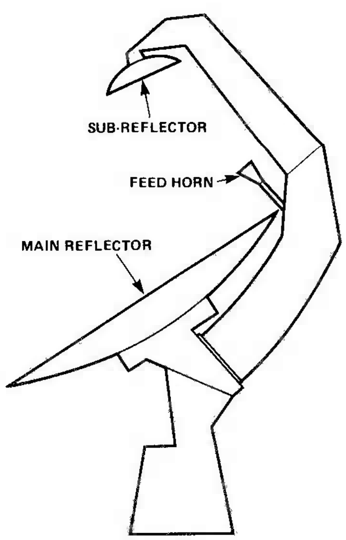

Fig. 1 The Gregorian antenna; the difference between this and an off-set Cassegrain is that in the former the sub-reflector is concave, whereas in the latter it is convex.

Conclusions

A mere thirty years has seen the first faltering steps in space become sure footed and accurate. Techniques and materials have progressed rapidly and up to now space has been used for peaceful purposes. But the super-powers are racing each other to put beam weapons in space so those harmless jelly beans squeaking across our video screens could well become reality. Meanwhile there is a real need for a space-age Steptoe and Son to go and collect all the jettisoned scrap iron floating about in space.

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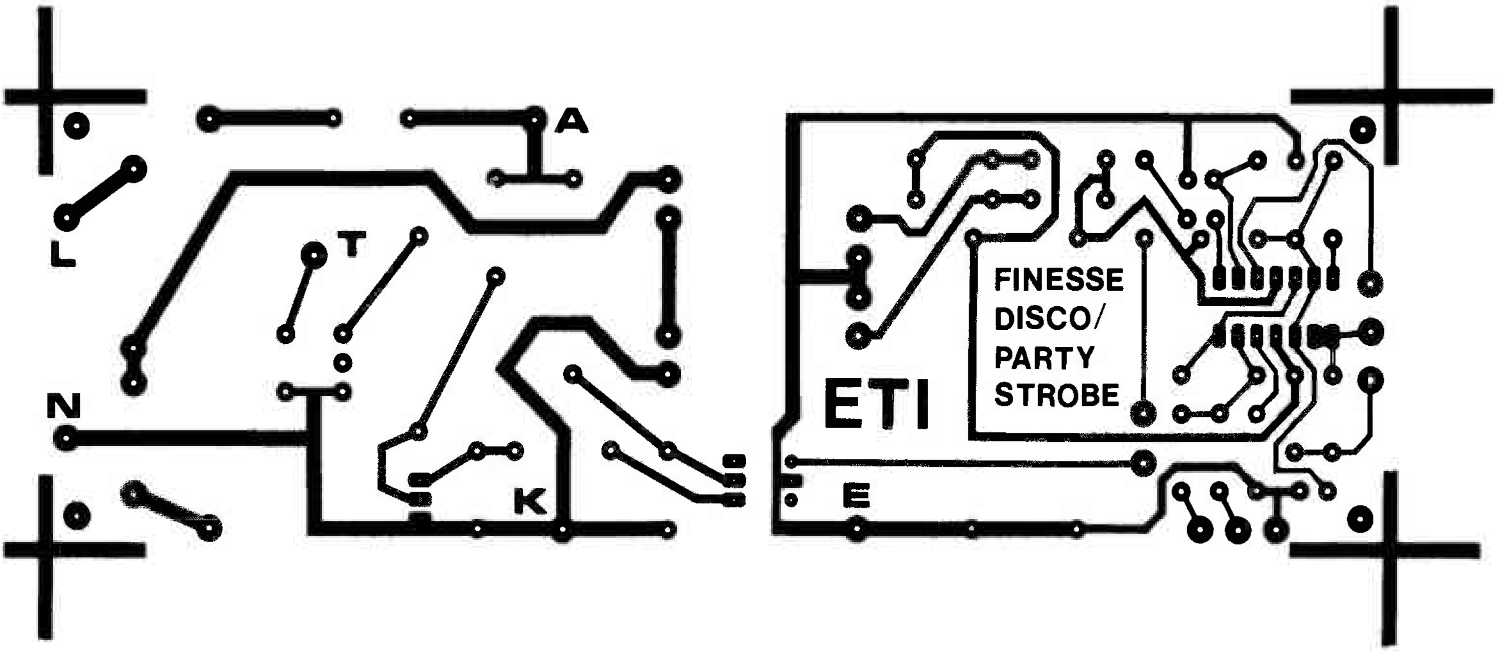
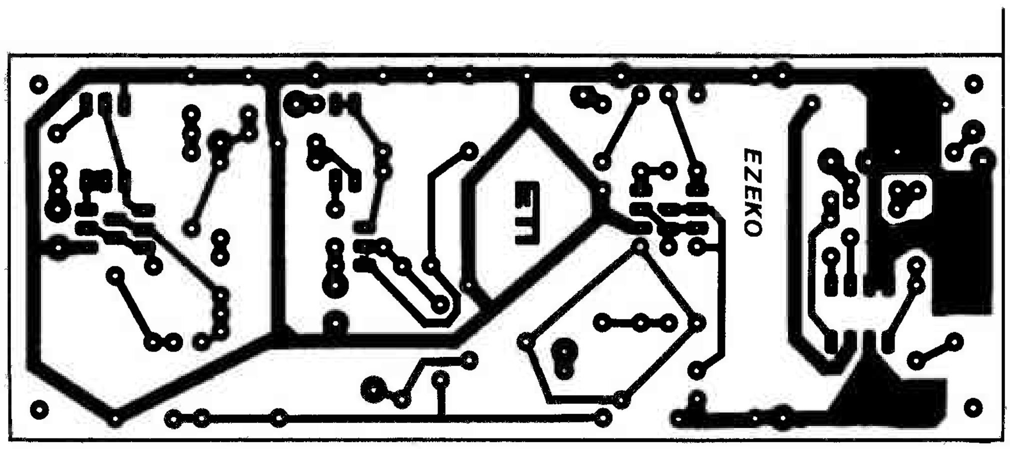
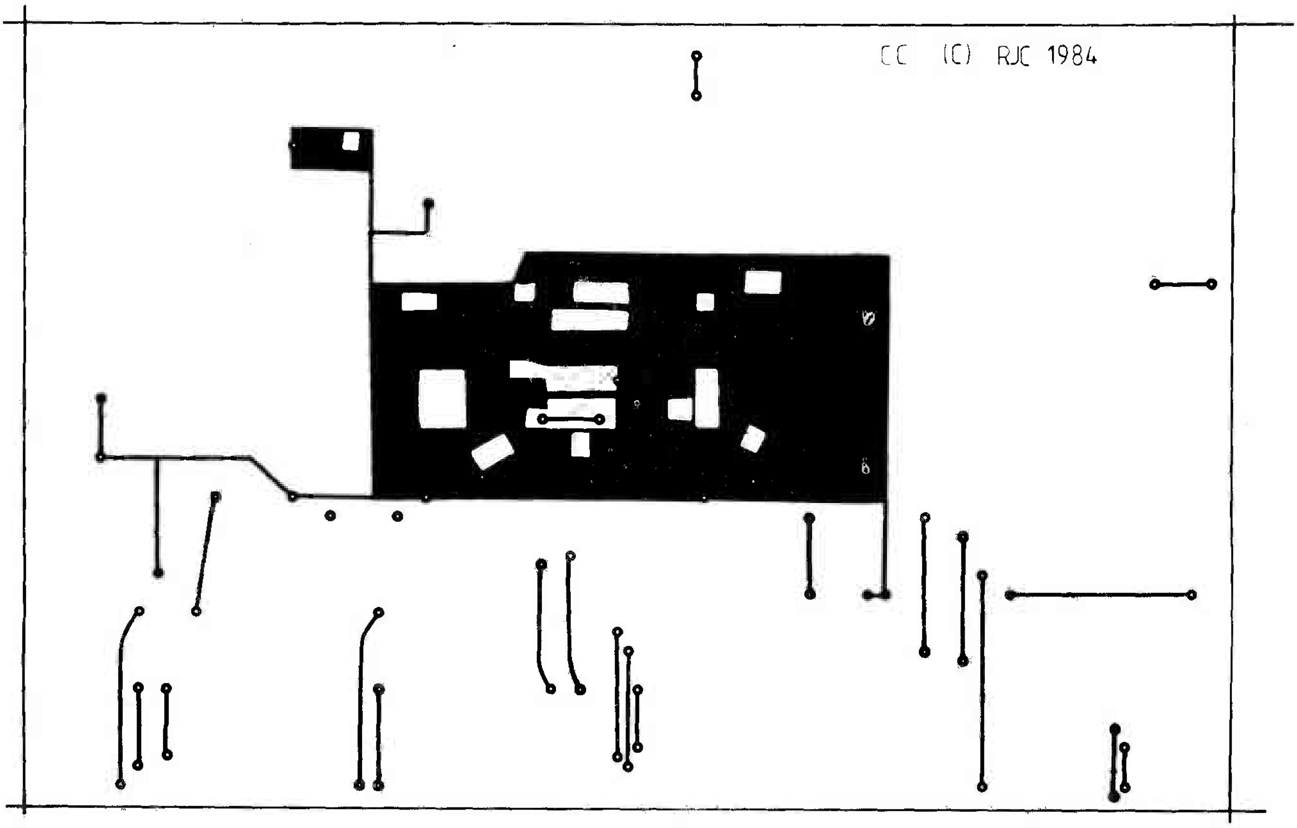


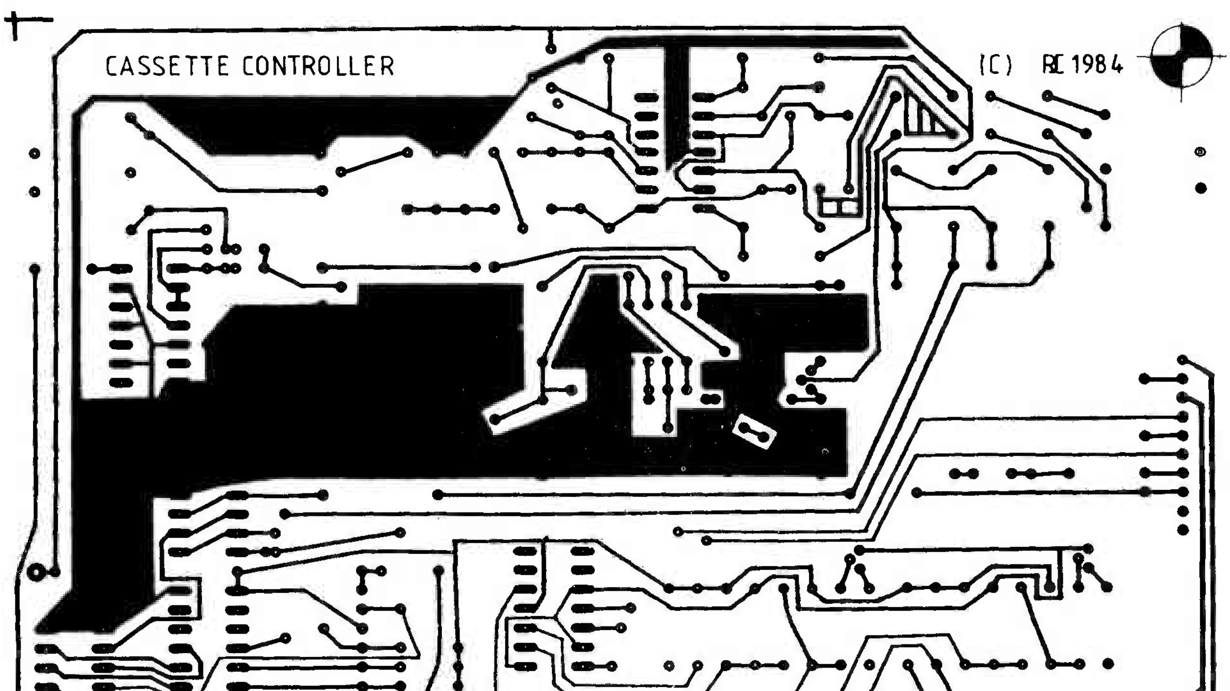
The foil pattern for the Finesse Disco/Party Strobe.

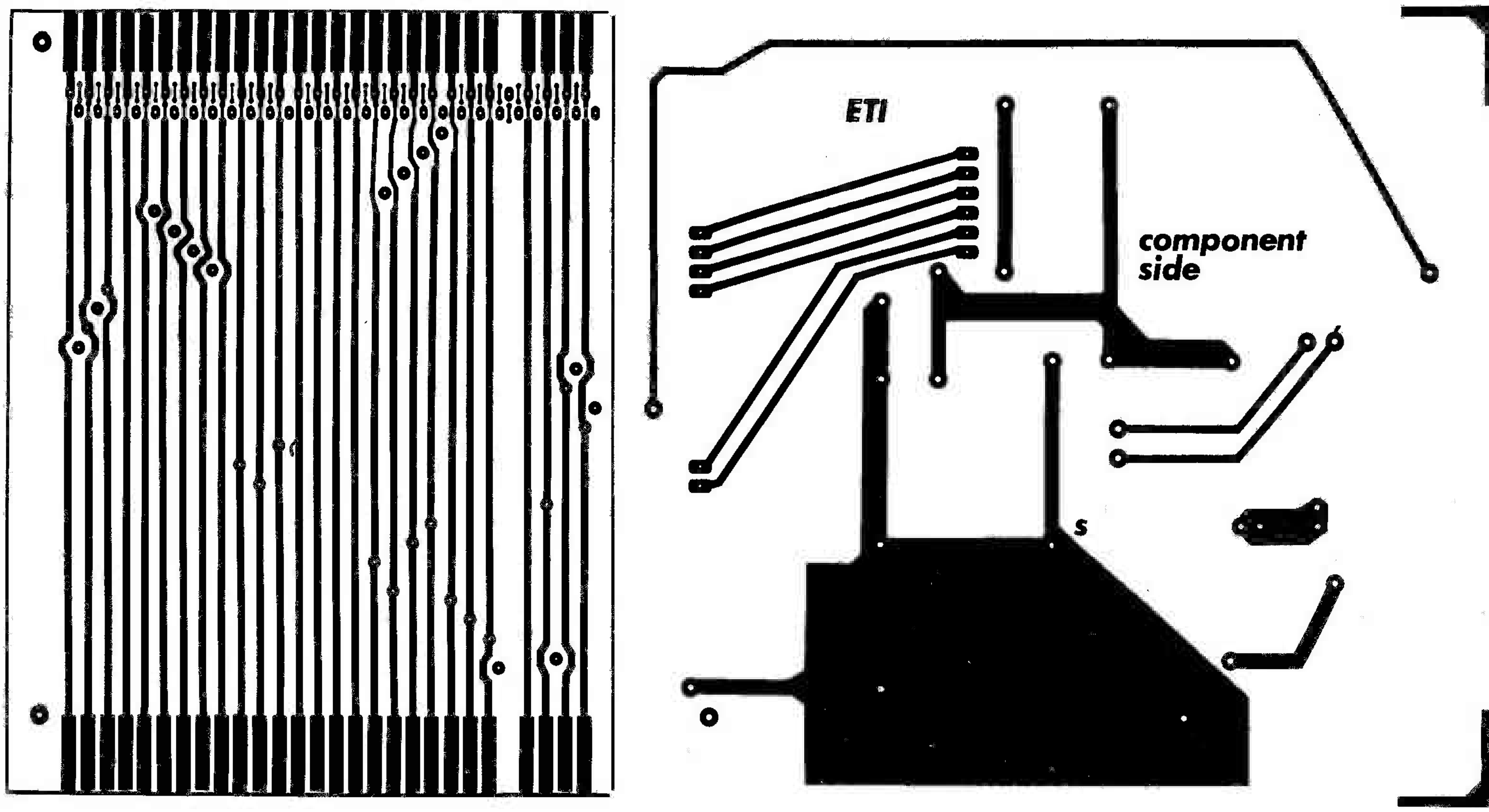


The pattern for the simple echo unit.

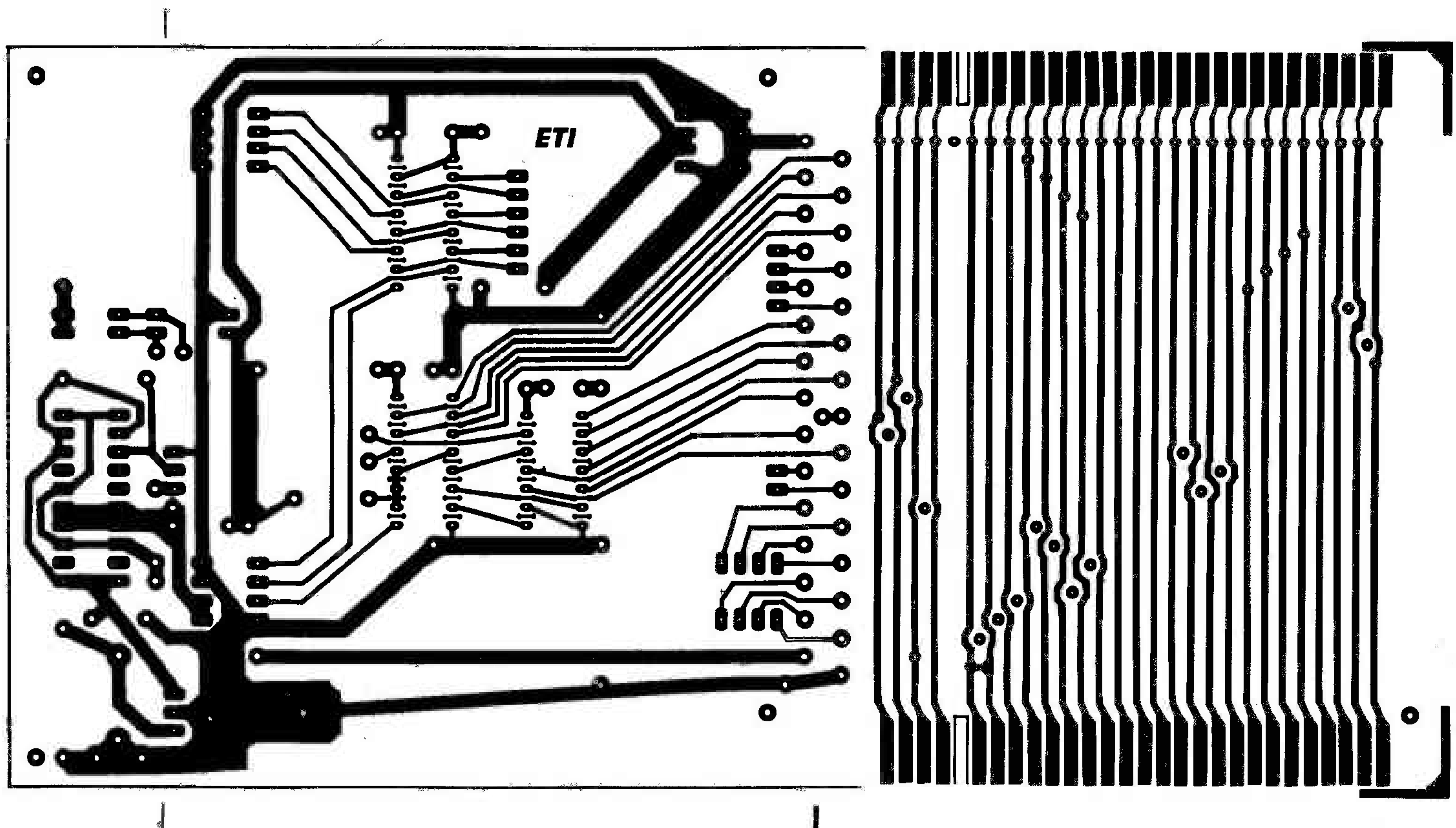


The top and bottom foils of the Digital Cassette Deck.





The patterns for the top and bottom of the control card of the Spectrum Control Port (this board will not be available from the PCB service until next month).



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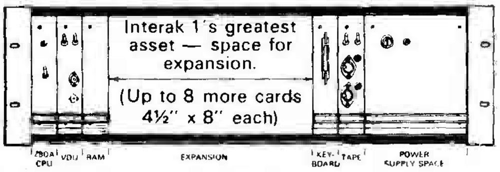

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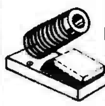

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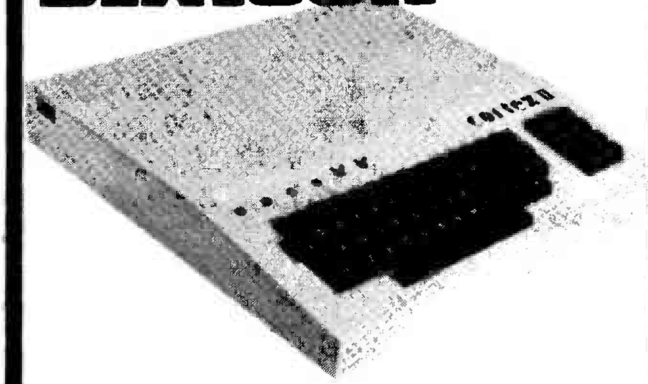

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Also, this issue will be a little bit thicker than usual, with sixteen extra editorial pages — putting us even further ahead of the competition.

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- Continuity Tester
- Electron Speech Card
- Mains Failure Alarm
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- AM/FM Portable Radio
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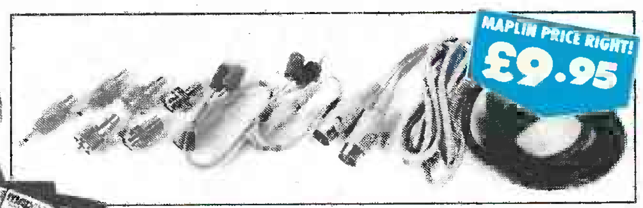

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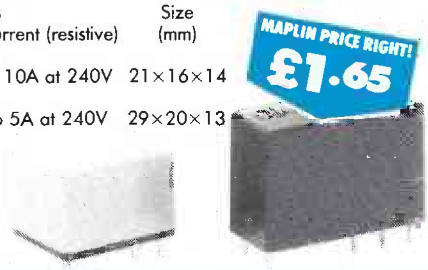

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