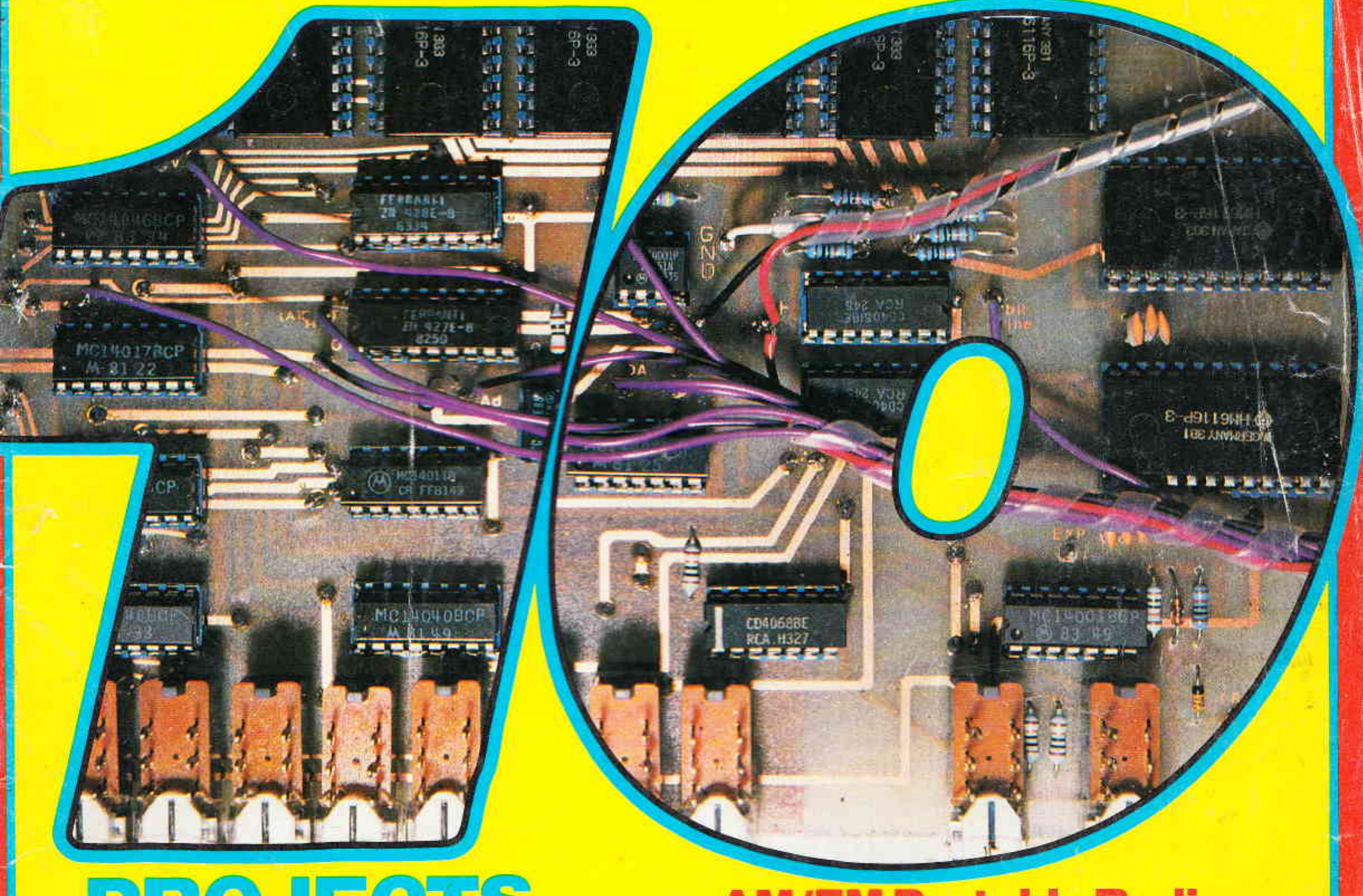
AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

NOV 1984 99p

BUMPER PROJECTS ISSUE



PROJECTS

to while away your evenings. Including:

AM/FM Portable Radio – Switch On and Tune In!

Video Vandal – Special Effects On-Screen In Your Own Home

Electron Speech Board – Turn Your Acorn Into A Chatterbox

Capacitance Meter – Simple, Direct-Reading Design

AU... USIC.... RADIO.... ROBOTICS..

electronics today INTERNATIONAL

NOVEMBER 1984 VOL 13 NO 11

EDITORIAL AND ADVERTISEMENT OFFICE
1 Golden Square, London W1R 3AB. Telephone 01-437 0626.
Telex 8811896.

Dave Bradshaw: Editor
Phil Walker: Project Editor
Ian Pitt: Assistant Editor
Jerry Fowler: Technical Illustrator
Paul Stanyer: Ad. Manager
Kerry Fowler: Copy Control
Jim Connell: Chairman

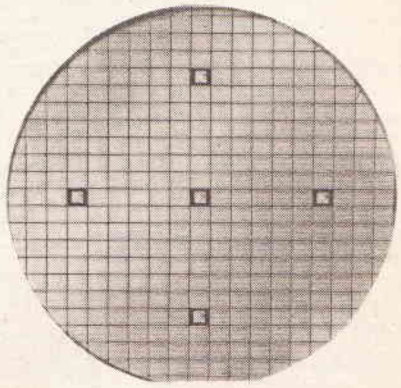
PUBLISHED BY:
Argus Specialist Publications Ltd.
1 Golden Square, London W1R 3AB.
DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.
12-18 Paul Street, London EC2A 4JS
(British Isles)
PRINTED BY:
The Garden City Press Ltd.
COVERS PRINTED BY:
Alabaster Passmore.

OVERSEAS EDITIONS and their EDITORS
AUSTRALIA — Roger Harrison
CANADA — Halvor Moorshead
GERMANY — Udo Wittig
HOLLAND — Anton Kriegsman

ABC **Member of the Audit Bureau of Circulation**

□ Subscription Rates. UK £14.35 including postage. For further details and Airmail rates etc, see the Readers' Services page.

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	**68p**
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

GAS/SMOKE DETECTORS

TGS812 or TGS813

£6 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**

VEROBOARD

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

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 Prol	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	—	**180p**
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	**380p**	—
2x40 way	**380p**	—

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

ANTEX SOLDERING IRONS

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

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female 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**	-	**220p**	**285p**
DIN41612 2 x 32 A + C	**295p**	-	**240p**	**300p**
DIN41612 3 x 32 A + B + C	**360p**	**385p**	**280p**	**395p**

DIL PLUG (Header)

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

ZIF DIL SOCKETS

24 pin	**575p**
28 pin	**695p**
40 pin	**845p**

RIBBON CABLE

price per foot

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

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	**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 CONNECTORS

	IDC	Solder
24 way IEEE	**475p**	**470p**
36 way Centronix	**525p**	**475p**
24 way Female	**490p**	**450p**

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 aA
0 2A
0 25V
0 50V AC
0 300V AC
"S"
"VU" **490p each**

CRYSTALS

32.768KHz	**100**
100KHz	**545**
200KHz	**370**
455KH	**370**
1MHz	**275**
1.008M	**275**
1.28MHz	**450**
1.6MHz	**395**
1.8MHz	**545**
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

BROTHER HR15 PRINTER

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

Price £339

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

ICL7660	**248p**	TAA550	**50p**
RC4194	**375p**	TDA1412	**150p**
RC4195	**160p**	78H05+5V/5V	**550p**
LM309K	**135p**	78H12+12V/5A	**640p**
LM317K	**250p**	78HG + 5V to + 25V 5A	**585p**
LM317KP	**450p**		
LM323K	**450p**	79HG − 2.25V to −24V, 5A	**685p**
LM337	**175p**		
LM723 Var	**30p**		

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**

CMOS

4000	20
4001	25
4002	25
4006	75
4007	25
4008	60
4009	45
4010	60
4011	25
4012	25
4013	60
4014	60
4015	60
4016	40
4017	60
4018	60
4019	58
4020	90
4042	43
4021	58
4022	67
4023	30
4024	50
4025	22
4026	90
4027	43
4028	45
4029	75
4030	35
4031	130
4032	70
4033	130
4034	146
4035	70
4036	275
4037	115
4038	75
4039	280
4040	60
4041	57
4042	50
4043	42
4044	50
4045	110
4046	60
4047	60
4048	55
4049	38
4050	35
4051	70
4052	60
4053	60
4054	85
4055	85
4056	85
4057	1000
4059	435
4060	68
4061	500
4062	986
4063	85
4066	45
4067	245
4068	25
4069	25
4070	25
4071	25

4072	25
4073	26
4075	25
4076	68
4077	25
4078	25
4081	25
4082	25
4085	60
4086	60
4089	125
4093	37
4094	70
4095	95
4096	100
4097	275
4098	80
4099	110
4160	95
4161	96
4162	96
4163	96
4174	96
4175	105
4194	105
4408	850
4409	850
4410	725
4411	750
4412	805
4415	590
4419	280
4422	770
4435	850
4440	900
4450	360
4451	350
4490	450
4500	395
4501	38
4502	60
4503	40
4504	99
4505	385
4506	100
4507	45
4508	130
4510	55
4511	55
4512	55
4513	150
4514	115
4515	115
4516	55
4517	275
4518	48
4519	32
4520	53
4521	115
4522	125
4526	60
4527	65
4528	68
4529	150
4530	90
4531	130
4532	65
4534	400

4536	275
4538	80
4539	90
4541	95
4543	70
4544	150
4546	40
4549	400
4553	245
4554	180
4555	35
4556	55
4557	250
4558	120
4559	395
4560	180
4561	104
4562	350
4566	165
4568	250
4569	175
4572	45
4580	255
4581	125
4582	99
4583	100
4584	60
4585	70
4597	330
4599	155
40085	90
40097	45
40098	42
40100	215
40101	130
40102	140
40103	412
40104	120
40105	270
40106	60
40107	55
40108	325
40109	100
40110	235
40114	240
40161	194
40163	75
40174	75
40175	75
40181	220
40182	80
40192	75
40193	95
40194	70
40195	75
40244	196
40245	196
40257	196
40373	220
40374	220
45106	586

OPTO ELECTRONICS

LEDs with clips

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

ISOLATORS

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

OPTO

OCP71	120
ORP12	85
ORP61	86
BPX25	250
BPW21	320
TIL139	225

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**
- **KAGA TAXAN PRINTER:** Compatible control codes as FX/RX Printers and Near Letter Print with 3K Buffer **£249**
- **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 interlace 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.

DISC DRIVES

(CUMANA)
DRIVES CASED with PSU & CABLES

- **CS100** — Single Cased with PSU, 40 track, 5¼" S/S 100K **£129**
- **CD200** — Twin Cased with PSU, 40 Track, 5¼" S/S 200K **£265**
- **CS200** — Single Cased with PSU, 80 Track, 5¼" S/S 200K **£175**
- **CD400** — Twin Cased with PSU, 80 track, 5¼" S/S 400K **£349**
- **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) **£199**
- **MITSUBISHI Twin Slimline,** 5¼" Cased with PSU, DSODD, 2 Megabyte. (800 K with BBC) **£425**

5¼" DISKETTES (Lifetime Warranty)

- **10 3M Diskettes Single side Double density** **£17**
- **10 3M Diskettes Double side Double density** **£28**

N.B Carriage on Drives £7 securicor

SPECTRUM 32K UPGRADE

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

£22

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)
★ Interface 1, Interface ` & Microdrive compatible.
★ Configuration program creates customised M/C driver to suit your printer.
★ 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**

BBC & MICROCOMPUTER & ACCESSORIES

BBC Model B **Only £325**

(With every BBC Micro purchased, we will give you absolutely FREE a DATA Recorder plus 5 games software worth £80.) 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, Light-pen 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.

Rapid Electronics

MAIL ORDERS:
Unit 1, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

BARCLAYCARD VISA

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	55p	86p	90p	150p
Right angle	90p	135p	200p	350p
Sockets solderlugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
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

SCRs

▶C106D	35
400V 8A	70
400V 12A	95

SOLDERING IRONS

Antex CS 17W Soldering iron	430
2.3 and 4.7mm bits to suit	85
Antex XS 25W soldering iron	530
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

VERO

Verobloc	395
Veroboard Size 0.1 in matrix	
2.5 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

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 15p.
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.

MICRO

2716	310	27128-250	1225	6800	200	6522	330
2532	380	6116P3	520	6802	280	6532	520
2732 one time programmable	360	6264P15	2980	6809	600	6551	540
2732	430	4116P4	70	6810	140	8085A	320
2764-250	595	4164-15	480	6821	140	8156	380
2764 BBC	595	41256-15	2850	6840	360	8251	350
		Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
		Z80A CTC	320	6875	500	8259	400
		Z80A S10	880	6880	100	MC1488	70
		Z80A DMA	880	6502	370	MC1489	70

SOCKETS

	Low profile	Wire wrap
8 pin	7p	28p
14 pin	10p	45p
16 pin	11p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	15p	75p
24 pin	17p	82p
28 pin	15p	95p
40 pin	25p	135p

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

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
Caramic 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 gery ribbon	14P/ft
20 way grey ribbon	28p/ft

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	65
▶12V Electronic buzzer	70
▶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	21
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

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		

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

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

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

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

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 - 180p 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 - 90p.
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	70	70	70	–
16 way	75	80	80	–
20 way	90	90	95	130
26 way	105	110	115	155
34 way	115	130	130	180
40 way	140	140	145	210
50 way	165	165	170	240
60 way	195	195	200	–

LINEAR

		IC7611	98	LM358	50	LM3915	265	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM13600	110	NE570	370	TL061	40
555CMOS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	150	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	130	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	LMI0C	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	TDA1006	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	265	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	40
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	TI590	30
BC108B	12	BC212	10	BF182	35	BU208	170	2N3442	120	TIP29A	35	TI591	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	16
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	5.008MHz	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

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2½ x 2"	95
71x46x22mm	50	6 x 4 x 2"	120
95x71x35mm	86	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	25	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	26	4034	145	4054	70	4081	18	4502	50	4529	80
		4017	43	4036	270	4055	70	4082	20	4503	45	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	18	4019	35	4040	46	4060	70	4086	60	4508	115	4538	70
4001	18	4020	48	4041	55	4063	80	4089	120	4510	48	4543	65
4002	18	4021	55	4042	45	4066	24	4093	26	4511	50	4549	390
4006	65	4022	60	4043	45	4067	230	4094	70	4512	50	4553	215
4007	18	4023	18	4044	50	4068	18	4095	70	4514	115	4555	50
4008	50	4024	35	4046	60	4069	18	4097	260	4515	115	4556	50
4009	40	4025	18	4047	52	4070	22	4098	70	4516	48	4559	390
4010	40	4026	120	4048	50	4071	18	40106	38	4518	48	4560	110
4011	18	4027	28	4049	26	4072	18	40109	100	4520	48	4584	38
4012	18	4028	40	4050	26	4073	18	40163	75	4521	110	4585	65
4013	26	4029	45	4051	48	4075	24	40173	100	4526	70	4724	140
4014	50	4030	18	4052	48	4076	60	40175	75	4527	60		
4015	42	4031	125	4053	60	4077	24	40193	90	4528	45		

LS TTL

		LS20	22	LS75	38	LS123	70	LS161	60	LS221	78	LS365	42
		LS21	22	LS76	28	LS125	37	LS162	60	LS240	105	LS366	42
		LS22	22	LS78	28	LS126	37	LS163	60	LS241	80	LS367	42
LS00	22	LS26	22	LS83	68	LS132	53	LS164	70	LS242	80	LS368	42
LS01	22	LS27	22	LS85	82	LS136	35	LS165	95	LS243	80	LS373	80
LS02	22	LS30	22	LS86	35	LS138	48	LS166	88	LS244	80	LS374	80
LS03	22	LS32	22	LS90	40	LS139	48	LS170	120	LS245	88	LS375	55
LS04	22	LS37	22	LS92	50	LS145	92	LS173	80	LS247	77	LS377	100
LS05	22	LS38	22	LS93	45	LS147	130	LS174	60	LS251	55	LS378	88
LS08	22	LS40	22	LS95	58	LS148	115	LS175	60	LS257	55	LS390	82
LS09	22	LS42	60	LS96	120	LS151	55	LS190	75	LS258	55	LS393	82
LS10	22	LS47	78	LS107	42	LS153	80	LS191	55	LS259	90	LS399	115
LS11	22	LS48	78	LS109	42	LS154	220	LS192	75	LS266	28	LS541	115
LS12	22	LS51	22	LS112	42	LS155	55	LS193	75	LS273	80	LS670	170
LS13	35	LS55	22	LS113	32	LS157	48	LS195	60	LS279	55		
LS14	45	LS73	28	LS114	32	LS158	48	LS196	75	LS283	70		
LS15	22	LS74	28	LS122	56	LS160	60	LS197	75	LS353	85		

The Rapid Guarantee

★ Same day despatch ★ Competitive prices
★ Top quality components ★ In-depth stocks

ORDERING INFO. All components brand new and to full spec. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £20 in value 'Minimum order £5'. Send cheque/P.O. or Access/Visa number with order. Our new 50 page catalogue is given free with all orders over £20. Available at 70p each. Callers welcome. Telephone orders welcome with Access or Visa. Official orders accepted from colleges, schools etc. Export orders no VAT but please add for carriage. We are open Monday to Friday.

EDITORIAL

In this issue, we have two projects that are the direct result of examinations in electronics. On page 50, Giles Read's 'Video Vandal' was made as the practical component for an 'A'-level electronics course; and on page 77, Damon Hart-Davies' 'Perpetual Pendulum' was the result of the requirements of an 'AO' syllabus.

These two projects are quite different, in complexity and in purpose. Yet there is one factor in common: both authors have used a lot of skill and resourcefulness to get the electronics to do what they want. Both authors spent a long time developing their own circuitry finding that at first it didn't work as intended, then modifying and trying again until the darned project did what it was meant to do.

This is the fundamental process of electronics: design a circuit to do the job, build it, try it out, and when it doesn't work (how many circuits *do*, first time?) find out why and modify. Without learning how to diagnose faults and design around them, we don't see how anyone can fully understand electronics.

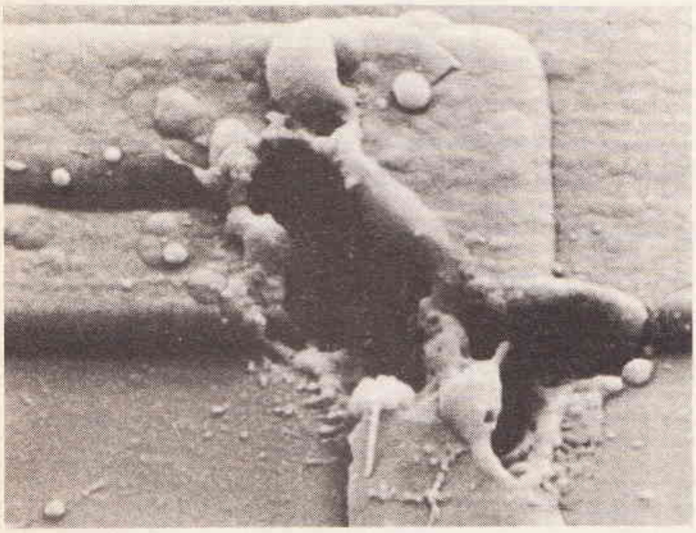
Because of this, we are deeply worried by a growing tide of technical enquiries from people who are building ETI projects as part of their 'O', 'AO' or 'A'-level or 'Tech' course. We fail to see what anyone can gain from following someone else's footsteps so closely, even if they *do* understand the circuit they are building. However, the person who comes to us for advice frequently does not understand the circuit sufficiently to do the debugging and to pick up the odd error that has slipped past the ETI editorial team. Even more worrying, it's quite often painfully apparent that the person teaching them doesn't understand the circuit either.

The introduction of electronics into schools and colleges is something that should have happened many years ago; better late than never, but better even later than not properly. We are most concerned at the toleration — even encouragement — of some examining boards of non-original course work. The whole objective of electronics is the designing and building of circuits and we cannot see how anyone should be allowed to pass an examination in electronics if they haven't partaken, even in the smallest way, in this central activity.

Finally, a word to our older readers: don't worry, the 'editorial' spot will not be a permanent feature of the magazine. We'll only be using it when we have something we think worth saying.

ETI

DIGEST



Zap Your Silicon!

The above electron micrograph is of a portion of an 8085 IC's surface after it has been zapped with a simulated static discharge. It shows just what damage static can do to ICs.

The picture was supplied by Hartley Measurements Ltd, who are marketing a new computer-controlled unit which will test for devices' sensitivites to controlled static discharges. The unit can administer varying pulses, up to a maximum of 4kV with a rise-time of 15ns, and then, using a built-in curve plotter, display an analysis of the characteristics of every pin before, during and after the test.

The unit in question is called the Autozap 200RD, and Hartley say that it makes the measurement of static sensitivity faster and more accurate than ever before. Hartley Measurements Ltd, Unit 4, Bear Court, Daneshill East, Basingstoke, Hampshire RG24 0QT, tel 0256 56695.

FPLAs Come To Town

Texas Instruments have announced two field-programmable logic arrays (FPLAs) providing the highest performance available — propagation delays of 20 nanoseconds maximum/10 ns typical — and supplied in compact, 24-pin, 300-mil packages. By comparison, other 20- and 28-pin FPLAs offer propagation delays of 30ns maximum/20ns typical and 50ns maximum/35ns typical, respectively, and only the 20-pin device is supplied in a space-saving package. The TIFPLA839 (three-gate outputs) and TIFPLA840 (open-collector outputs) have 14 inputs, 32 product terms and six outputs. Output polarity is programmable.

These sorts of devices are used as high-speed, datapath logic replacements. In most applications, designers use field-programmable logic to fill the gap between SSI/MSI catalogue (eg TTL) logic devices and large-scale integration (LSI) and gate arrays. Like programmable array logic devices, FPLAs are used primarily as random logic replacements to "glue" together system building blocks. They are used in applications including minicomputers and superminicomputers, peripherals, professional computers and automated office equipment.

The basic FPLA logic structure is a programmable-AND array which feeds a programmable-OR array. This configuration provides greater programming flexibility than widely used PAL devices. The FPLAs use a titaniun-tungsten (TiW) fuse technology developed at TI in 1970 to improve programming reliability. Proven TiW construction essentially eliminates the tendency of a blown fuse to grow back by insulating it with a layer of titanium oxide.

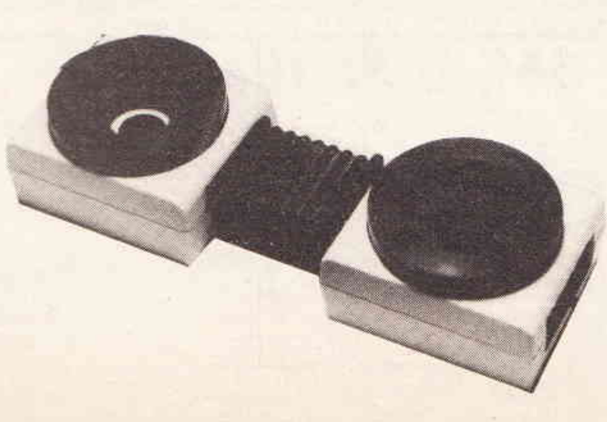
The TIFPLA830 and TIFPLA840 are fabricated in an oxide-isolated Advanced Schottky technology to provide 20ns maximum performance. Each device consumes 180 milliamps maximum.

The TIFPLA839 and TIFPLA840 operate from a single 5 V (+/-5%) supply. The devices will be available from TI and authorised distributors towards the end of this year. Military-temperature range versions, designated with an "M" suffix, will be available later. Texas Instruments Limited, Manton Lane, Bedford, MK41 7PA, tel 0234 63211.

Digital Cassette Deck

Our resident gnome still managed yet another boo-hoo, this time leaving off the supplier for the deck of the digital cassette deck. The supplier is, in fact, Cirkit (formally Ambit), the order code is 72-03600, and the price is £38.00 plus VAT plus P&P. Unfortunately, Cirkit inform us that they are out of stock but they will have plenty in a month or so! Cirkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire, tel 0992 444111.

● Hah! The cheek of it! Marshall's of 85 West Regent Street, Glasgow G2 2AW (tel 041 332 4133) have used an illustration from *Elektor* on the front cover of their new catalogue. And they dare to charge 75p for it! Well, we shan't give them a mention, shall we?



What's This Ear?

Cirkit have branched out into computing with the collaborative launch of a low-cost and potentially world-beating acoustic modem; their partners in the enterprise are Protek Computing Limited, the home computer product marketing and development specialists.

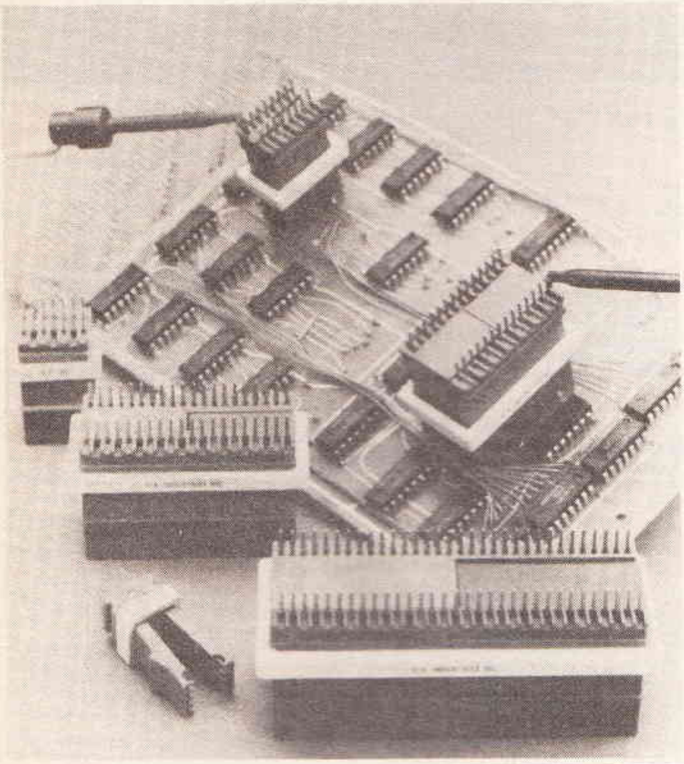
When they claim low cost, these chaps really mean it — the final price in the shops will be £59.95 for the modem, which will need a standard RS232 interface to drive it. However, do not despair if your micro doesn't have RS232; Cirkit and Protek will be marketing a range of adaptors, and Spectrum, BBC B and Commodore 64 versions will be available with appropriate software from the launch date. Prices are £24.95 for the Spectrum version and £14.95 for the other two.

The modems will be made by Cirkit and marketed by Protek. Although the unit was designed by Cirkit in what must be record time — six months from initial design to full-scale production and marketing — the idea was hatched by both companies together, apparently due to them by chance occupying adjacent stands at a trade fiar.

The modem is seen as one in a series of collaborative projects between the two companies, although they were keeping tight-lipped about what any of the future projects might have been. However, they do seem to have perceived a need in the home computer market for products that make it possible for home computers to be used for more serious applications than games playing.

The modem will enable computer users to use the telephone network to access data bases such as Micronet, Prestel and BT Gold, to exchange software and messages with other users, to send telexes and to use electronic mail services. It can be used to transmit signals to the 1200/75 baud international standard. It can also operate on 1200/1200, software selected.

Cirkit say that their position as a major supplier of specialist items to trade and amateur markets put them in a very strong position for the development of this device. They were able to obtain and incorporate the very latest in ICs, well ahead of their rivals. This combined with the speed of the designing and marketing mean that if the Cirkit/Protek partnership can continue to deliver, they should become a formidable combination. Uncle Clive look out!



Stressless IC Clip

OK Industries' new 'Chip-Clip' IC test clip attaches by means of a snap action locking ring which simply slides down and snaps gently into the closed position for reliable positive contact.

OK say that the result is no stress to the IC because the clip spring is loaded in an outward, rather than inward, direction. Spacing in the open position is just enough to allow it to slide over the IC.

Clip contacts are gold plated and bodies are high dielectric nylon. The units are available in 8, 14, 16, 24-28, 36-40 and 64 pin sizes or in a kit form with the most commonly used sizes in a handy carrying case. OK Industries UK Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA tel: 0703 619841.

Ceramics Get Smaller

Breaking the size barrier are two new series of multilayer ceramic capacitors from G. English Electronics. Constructed using newly-developed techniques, these highly compact multilayer types are claimed to be ideally suited to applications in which film capacitors are conventionally used.

The X5T and Y5V series of multilayer ceramic capacitors, manufactured by NEC, are produced using a new, low-temperature fired technology and high dielectric-constant material. The ceramic formulation and processing techniques employed have enabled the introduction of these compact multilayer ceramic capacitors to meet application requirements normally satisfied by the more bulky film capacitor type.

Series X5T is available in preferred values from 0.001 to 1.5uF, ±10% or ±20%, at voltage ratings of 25, 50 and 100V DC. The series has good frequency characteristics, offers high reliability and high volumetric efficiency. The Y5V series may be supplied in preferred values from 1000pF to 4.7uF, at voltage ratings of 25V DC or 5V DC. The Y5V features an extremely high capacitance-to-volume ratio and low impedance at high frequencies, and is intended principally for bypass applications.

Both series of capacitor may be supplied taped, for automatic assembly, or individually, and both can withstand flow soldering. G. English Electronics Ltd, 34 Bowater Road, Woolwich, London SE18 5ST, tel: 01-855 0991.

Amateur Licence Changes

When they come to re-new their licences, the 55,000-odd radio amateurs (many of whom read ETI, and one of whom edits ETI) will notice some changes.

In fact the main change is cosmetic: the schedule, or table of frequencies available for use, is being tidied up to make it easier to see what frequencies are available for what sort of transmission, and whether amateurs have primary or secondary status on the band concerned.

However, there are a couple of non-cosmetic changes tucked away in the small print. The first is the transfer of functions of the Radio Interference Service from British Telecom to the Department of Trade and Industry; this is simply a reflection of an administrative change that has already taken place, presumably as part of the preparations for the sale of British Telecom.

The second change removes the restriction on the codes that can be used for radio teleprinter (RTTY) — up until now, amateurs have only been allowed to use International Telegraph Code No 2 with transmission speeds of 45.5 or 50 baud.

Gauge Your CRT

EMCO Electronics, Britain's largest supplier of data CRTs has recently introduced a simple defects control gauge to allow engineers to measure faults on cathode ray tubes.

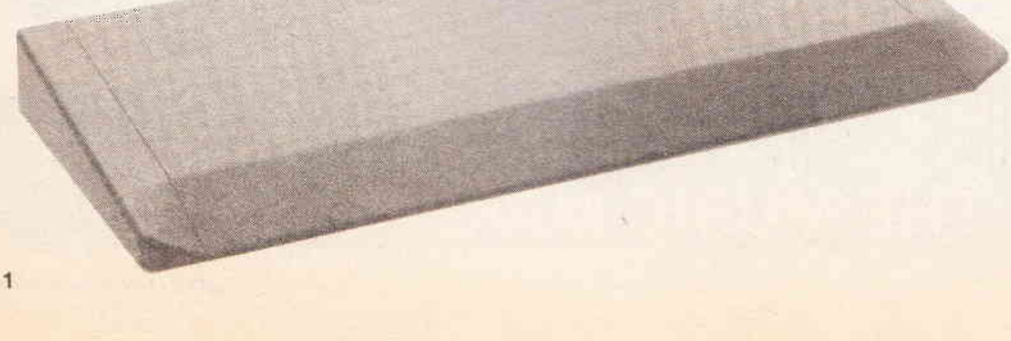
EMCO Electronics will be pleased to send one of these, free of charge, to engineers on request.

EMCO say that they distribute Britain's widest range of CRTs, from Fivre and VTM, as well as data display kits and monitors from Indesit. EMCO Electronics, Unit 1, 129/131 Coldharbour Lane, Camberwell, London SE5 9NY, Tel: 01-737 3333.

The second issue of the Anglia consumer wallchart is now available free of charge and features many new items. These include a new range of teletext ICs, an extended audio IC range and also a competitively priced universal tripler. Anglia consumer say that they ensure that all orders received before 4.00 p.m. are despatched the same day with Access/Visa credit cards readily accepted. For your free copy, contact Anglia Consumer, Burdett Road, Wisbech, Cambs., PE13 2PS, tel: 0945 63281.

● Brunel Computer Club will be at the Home Tech '84 Exhibition, October 26-29, Bristol Exhibition Centre, and they will be displaying several Cortex computers (ETI, Nov1982 et seq), and will be holding a Cortex surgery — all advice and help free of charge.

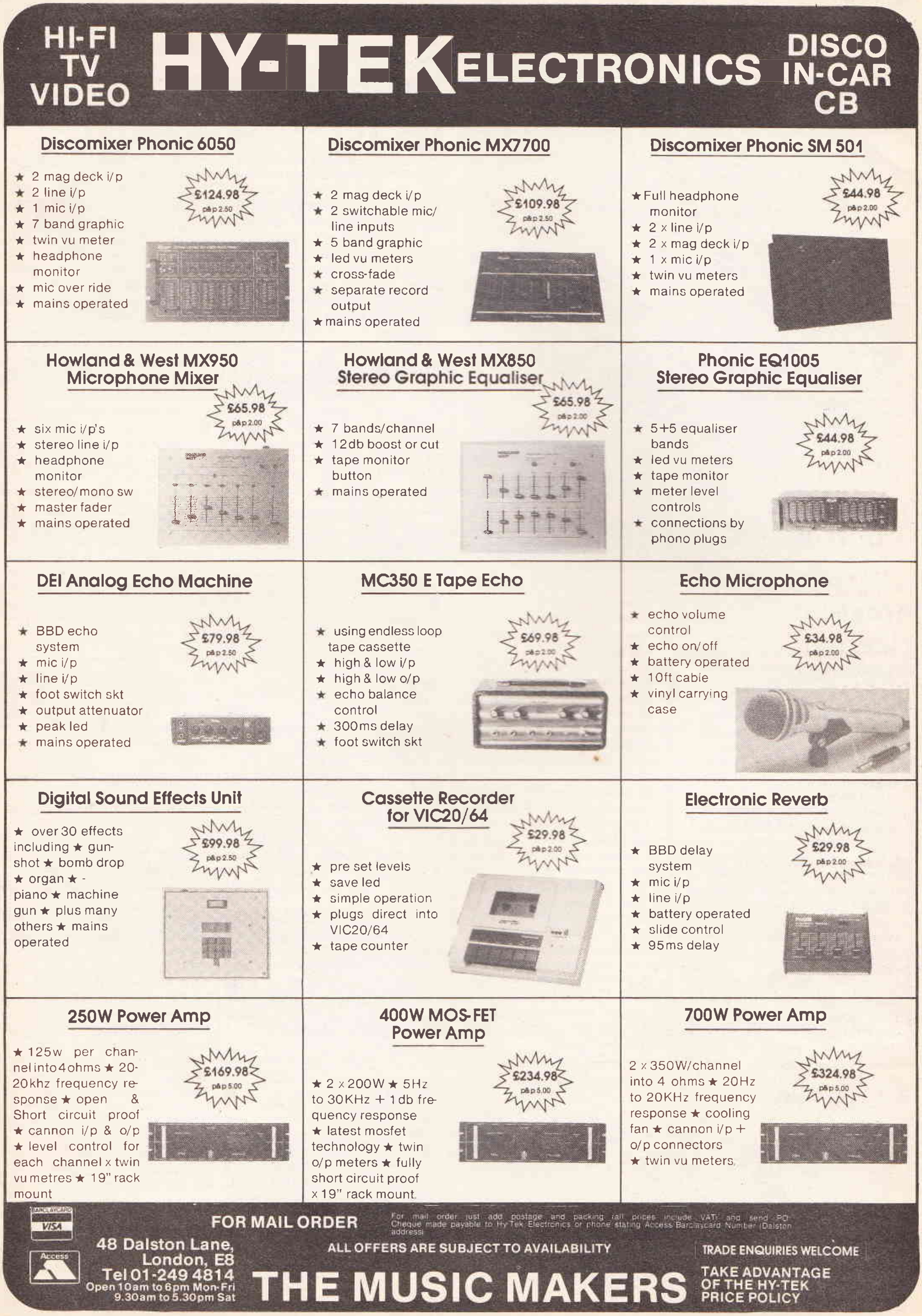
A Case For Fingers



A slim, modern design characterises the new 'Manta' keyboard case available from West Hyde.

It is moulded in beige ABS and incorporates a shallow ledge at the front to provide a hand rest for the keyboard operator. The case has moulded bosses to support a PCB and cable clamps for both circular and ribbon cables. The base plate is zintec steel which aids rigidity and provides extra weight to prevent unintentional movement.

The Manta keyboard case is available in three widths from West Hyde and is supplied complete with a cable grommet, feet and screws. West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET, tel 0296 20441.



HI-FI
TV
VIDEO
HY-TEK ELECTRONICS
DISCO
IN-CAR
CB
Discomixer Phonic 6050
★ 2 mag deck i/p
★ 2 line i/p
★ 1 mic i/p
★ 7 band graphic
★ twin vu meter
★ headphone monitor
★ mic over ride
★ mains operated
£124.98
p&p 2.50
Discomixer Phonic MX7700
★ 2 mag deck i/p
★ 2 switchable mic/line inputs
★ 5 band graphic
★ led vu meters
★ cross-fade
★ separate record output
★ mains operated
£109.98
p&p 2.50
Discomixer Phonic SM 501
★ Full headphone monitor
★ 2 x line i/p
★ 2 x mag deck i/p
★ 1 x mic i/p
★ twin vu meters
★ mains operated
£44.98
p&p 2.00
Howland & West MX950 Microphone Mixer
★ six mic i/p's
★ stereo line i/p
★ headphone monitor
★ stereo/mono sw
★ master fader
★ mains operated
£65.98
p&p 2.00
Howland & West MX850 Stereo Graphic Equaliser
★ 7 bands/channel
★ 12db boost or cut
★ tape monitor button
★ mains operated
£65.98
p&p 2.00
Phonic EQ1005 Stereo Graphic Equaliser
★ 5+5 equaliser bands
★ led vu meters
★ tape monitor
★ meter level controls
★ connections by phono plugs
£44.98
p&p 2.00
DEI Analog Echo Machine
★ BBD echo system
★ mic i/p
★ line i/p
★ foot switch skt
★ output attenuator
★ peak led
★ mains operated
£79.98
p&p 2.50
MC350 E Tape Echo
★ using endless loop tape cassette
★ high & low i/p
★ high & low o/p
★ echo balance control
★ 300ms delay
★ foot switch skt
£69.98
p&p 2.00
Echo Microphone
★ echo volume control
★ echo on/off
★ battery operated
★ 10ft cable
★ vinyl carrying case
£34.98
p&p 2.00
Digital Sound Effects Unit
★ over 30 effects including ★ gun-shot ★ bomb drop ★ organ ★ - piano ★ machine gun ★ plus many others ★ mains operated
£99.98
p&p 2.50
Cassette Recorder for VIC20/64
★ pre set levels
★ save led
★ simple operation
★ plugs direct into VIC20/64
★ tape counter
£29.98
p&p 2.00
Electronic Reverb
★ BBD delay system
★ mic i/p
★ line i/p
★ battery operated
★ slide control
★ 95ms delay
£29.98
p&p 2.00
250W Power Amp
★ 125w per channel into 4 ohms ★ 20-20khz frequency response ★ open & Short circuit proof ★ cannon i/p & o/p ★ level control for each channel x twin vu metres ★ 19" rack mount
£169.98
p&p 5.00
400W MOS-FET Power Amp
★ 2 x 200W ★ 5Hz to 30KHz + 1db frequency response ★ latest mosfet technology ★ twin o/p meters ★ fully short circuit proof x 19" rack mount
£234.98
p&p 5.00
700W Power Amp
2 x 350W/channel into 4 ohms ★ 20Hz to 20KHz frequency response ★ cooling fan ★ cannon i/p + o/p connectors ★ twin vu meters
£324.98
p&p 5.00
BARCLAYCARD VISA
Access
FOR MAIL ORDER
For mail order just add postage and packing (all prices include VAT) and send PO Cheque made payable to Hy-Tek Electronics or phone stating Access Barclaycard Number (Dalston address)
48 Dalston Lane, London, E8
Tel 01-249 4814
Open 10am to 6pm Mon-Fri
9.30am to 5.30pm Sat
ALL OFFERS ARE SUBJECT TO AVAILABILITY
TRADE ENQUIRIES WELCOME
THE MUSIC MAKERS
TAKE ADVANTAGE OF THE HY-TEK PRICE POLICY

Superkit II — Not The Movie

Superkit II is the second in the practical digital electronics Superkit series from Cambridge Learning. It consists of a dual instruction manual, written for use with both the Eurobreadboard and the GSC EXP300 breadboard, and a set of components in a plastic wallet. The components and breadboard from the first Superkit are also required to complete all the circuits.

The components in the kit include resistors, capacitors, a seven-segment LED display, integrated circuits, and wire. Superkit II explains how to design and use: adders; subtractors; couters (ripple, up/down, synchronous, decade, and Gray code); registers; pattern recognisers; and seven-segment displays.

Cambridge Learning say that the practical kit is backed up by their theory course, Digital Computer Design.

Superkit II costs £16.00
Superkit costs £22.00 or
both kits together are £35.00, (all prices inc. VAT and p&p) and can be ordered direct from: Cambridge Learning Ltd, FREEPOST, Unit NR, Rivermill Site, St Ives, Huntingdon, Cambridgeshire PE17 4BR. Telephone orders from credit card holders can be accepted on 0480 67446.

VDU Look-Alike LCD Controller

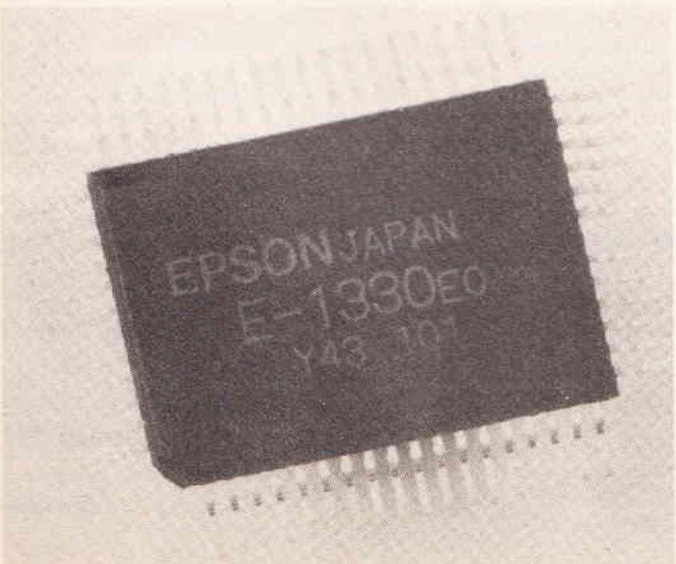
Norbain Displays Limited, the UK's leading specialist distributor of visible components, has launched a single chip graphics LCD controller designed to make graphic LCDs comptible with standard VDU applications in terms of the facilities available. "What a good idea", you might say, as we did here at ETI/

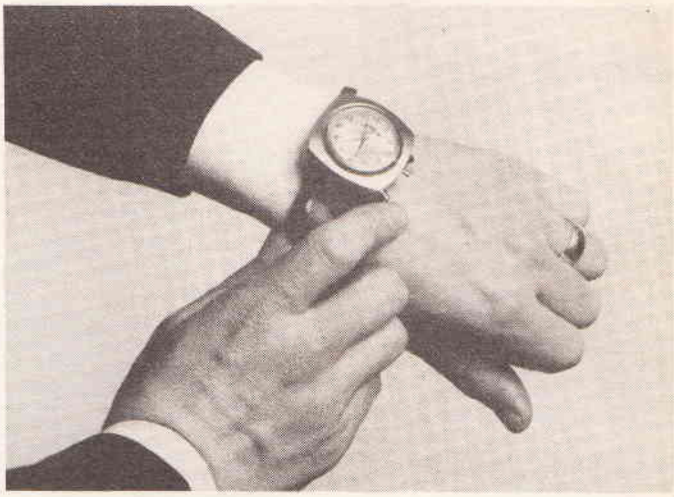
Manufactured by Epson in Japan and designated the E1330, the device is capable of receiving and interpreting all control commands and data from the 8080 and 68000 family microprocessors. The E1330 controller chip has been designed specifically to enable graphics LCD panels to directly replace VDUs in most typical applications.

The E1330 uses scrolling and layered functions to reproduce data stored in the display memory as diverse graphics on an LCD. As a complete LCD control circuit, it frees the main processing unit from all display tasks while providing features like standard text, using a built-in character generator, graphic text, inverse, underline, graphics, simple animation and flexible scrolling.

The device features a character display mode with 80 characters per line and 16 lines per screen, flexible scrolling by page or partial page, a two-screen layered function with reverse characters and underline and an internal and external character generation capability as well as a graphic display mode of 640 x 256 dots with a layered function of up to three screens.

Other features include a 64K display memory, an 8 bit parallel interface, high speed CMOS LSI and a clock rate of 6MHz all operating on a single 5V power supply. Norbain Displays Ltd, Norbain House, Boulton Road, Reading, Berkshire RG2 0LT, tel 0734 864411.



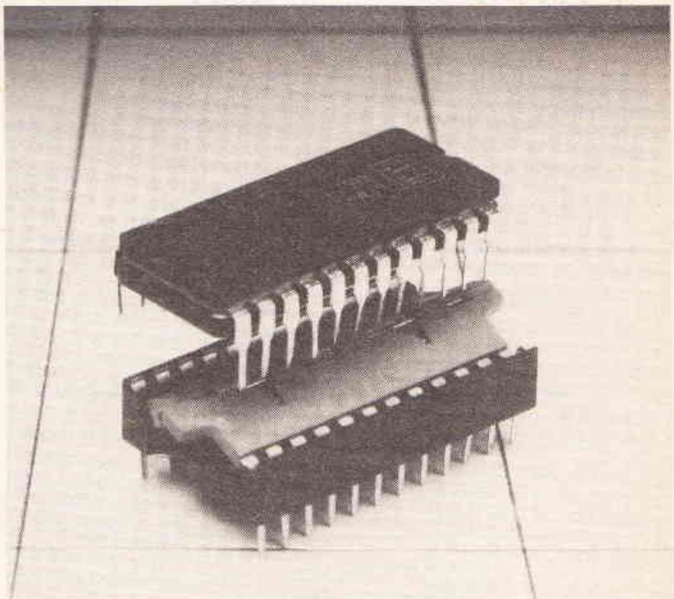


Life-Saving Timepiece

The watch on this man's wrist is much more than a timepiece. It could save his life.

In an emergency, a tiny circuit inside the wrist-watch can trigger a miniature radio device which either transmits a warning signal to a matching receiver in a neighbour's house, or automatically dials up the number of a 24-hr monitoring service. The unit can also be housed in a decorative pendant to be worn round the neck.

This valuable security device for elderly or housebound people is manufactured by Emerald Electronics Ltd of Alnwick. The printed circuit board, no more than an inch square, is made by BT-approved contractors GSPK (Circuits) Ltd, Manse Lane, Knaresborough, N. Yorks HG5 8LF, tel; 0423 865641.



New Style ZIF Sockets

No force is required to insert or remove ICs from Dage's new ZIF series IC socket range. The sockets have a hinged base with fingers that protrude by approximately 1.5 mm at either end. After the IC is inserted, a little pressure on these fingers cause the hinge to click over, locking the IC's legs in place.

Four versions are available, for ICs with 24-, 28-, 40- or 48-pins. All are low-profile style with a height of 5 mm. The contacts are made of copper-beryllium with either tin-lead or selective gold plating according to order.

The sockets are stackable, side-to-side, for high density PCB layouts. A lead-in entry point ensures easy IC insertion, with the point of contact located 0.8 mm from the top of the socket. Dage Eurosem, Rabans Lane, Aylesbury, Bucks HP19 3RG, tel 0295 33200. Telex: 83518.

OMP POWER AMPLIFIER MODULES

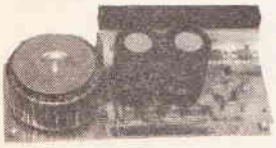
★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE S.A.E. 28p STAMP FOR CURRENT LIST

OMP POWER AMPLIFIER MODULES

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

OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV a 10K, Size 360 × 115 × 72mm. PRICE £32.99 + £2.50 P&P.

OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE £39.99 + £2.50 P&P.



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

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

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

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

19" RACK CASED MOS-FET STEREO AMPLIFIERS with twin power supplies and L.E.D. Vu meters plus X.L.R. connectors. Prices on application.

LOUDSPEAKERS

5 to 15 INCH Up to 300 WATTS R.M.S. All speakers 8 ohm Impedence.

POWER RANGE

8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £9.90. Available with black grille £10.90. P&P £1.50 ea.

12" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £26.00 + £3.00 P&P ea.

15" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 20Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. PRICE £34.00 + £3.00 P&P ea.

McKENZIE

12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco.
2" ally voice coil. Ally centre dome. Res. Freq. 45Hz. Freq. Resp. to 6.5KHz. Sens. 98dB. PRICE £24.99 + £3.00 P&P ea.

12" 85 WATT R.M.S. C1285TC P.A./Disco 2" ally voice coil. Twin cone.
Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £24.99 + £3.00 P&P ea.

15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £49.99 + £4.00 P&P ea.

WEM

5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £20.00 + £1.50 P&P ea.

8" 150 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £27.00 + £1.50 P&P ea.

10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £30.00 + £2.00 P&P ea.

12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £38.00 + £3.00 P&P ea.

SOUNDLAB (Full Range Twin Cone)

5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £8.99 + £1.00 P&P ea.

6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £9.99 + £1.50 P&P ea.

8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £11.99 + £1.50 P&P ea.

PANTEC

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

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt). **Price: £7.99 + 75p P&P.**

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled, professional performance. Range up to 3 miles. 35 × 84 × 12mm (12 volt). **Price: £12.49p + 75p P&P.**

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHZ. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £16.49.** Transmitter 80 × 50 × 15mm (9/12 volt). **Price: £10.29** P&P + 75p each. S.A.E. for complete list.

3 watt FM Transmitter

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

BURGLAR ALARM

Better to be **'Alarmed'** then terrified.

Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.

Indoor alarm — Electronic swept freq. siren 104dB output.

Outdoor Alarm — Electronic swept freq. siren 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

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

SAVE £148.00 Usual Price £228.85

BKE's PRICE £79.99 + £4.00 P&P

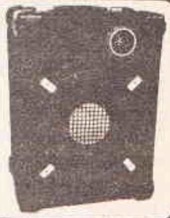
? Why buy a collection of self assembly boards!

OMP LINNET LOUDSPEAKERS

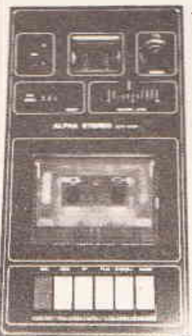
The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full Range 45Hz - 20KHz.

OMP 12/100 watts 20" × 15" × 12" £125.00 per pair
OMP 10/200 watts 18" × 15" × 11" £145.00 per pair
OMP 12/300 watts 20" × 15" × 11" £169.00 per pair

Delivery: Securicor £8.00 per pair



STEREO CASSETTE DECK



STEREO CASSETTE DECK Ideal for installing into Disco and Hi-Fi cabinet/Consoles. Surface mounting (Horizontal). Supplied as one unit with all electronics including mains power supply.

- ★ Metal top panel Black finish
- ★ Piano type keys including pause
- ★ Normal/Chrome tape switch
- ★ Twin Vu Meters
- ★ 3 Digit counter
- ★ Slider Record Level control

Size 171 × 317 mm. Depth 110 mm.

PRICE £35.99 + £3.00 P&P

1 K-WATT SLIDE DIMMER

- ★ Control loads up to 1Kw
- ★ Compact Size 4⅜" × 1" × 2½"
- ★ Easy snap in fixing through panel/cabinet cut out
- ★ Insulated plastic case
- ★ Full wave control using 8 amp triac
- ★ Conforms to BS800
- ★ Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £12.99 + 75p P&P (Any quantity)

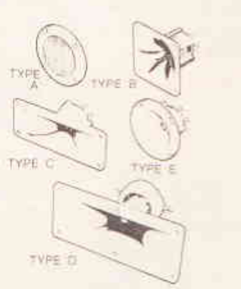
BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias) device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.

Price £32.35 each. £2.50 P&P

PIEZO ELECTRIC TWEETERS MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 40p P&P.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.49 each + 40p P&P.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.49 each + 40p P&P.**

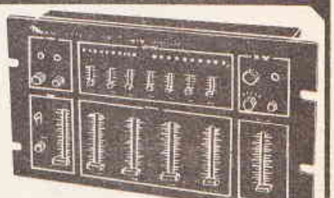
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £8.99 each + 40p P&P.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.49 each + 40p P&P.**

LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. **Price £3.99 + 40p P&P.**

STEREO DISCO MIXER

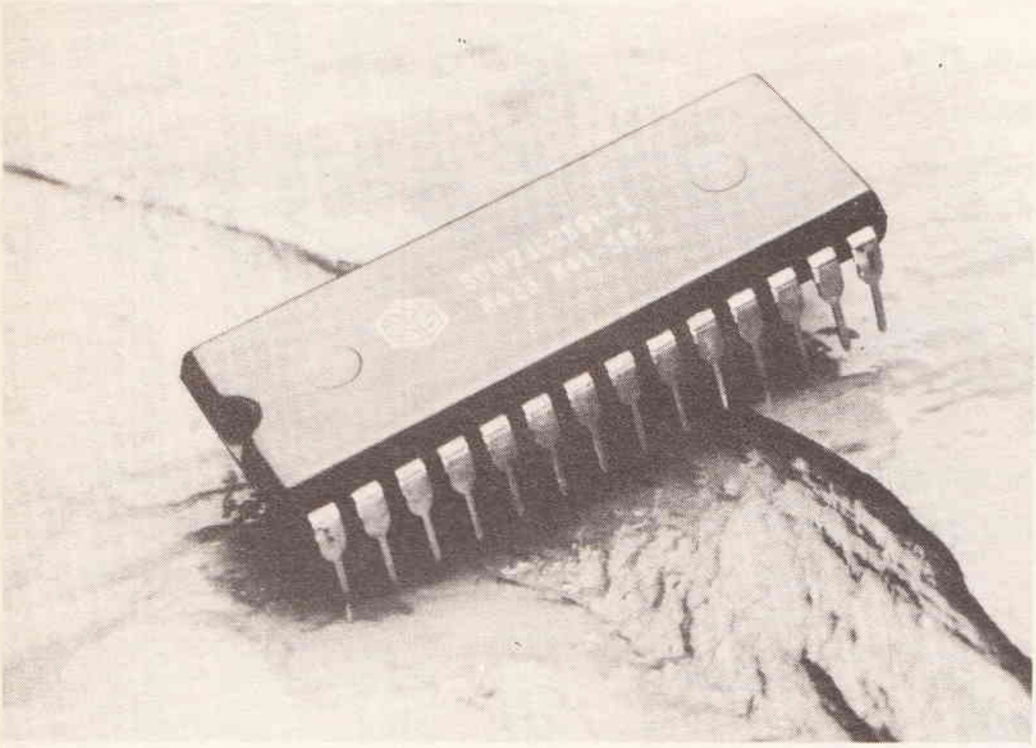
STEREO DISCO MIXER with 7 band graphic equaliser and 10 segment L.E.D. Vu Meters. Many outstanding features.
5 Inputs with individual fader controls:—
2 Mag. turntable, 2 Aux. plus Mic. with talk-over switch. Headphone monitor. Master output control with Hi-Low outputs. Compatible with our OMP Power Amplifiers.
Size: 360 x 200 x 120 mm. Supply 240V/50Hz AC.



PRICE £119.99 + £3.00 P&P

B. K. ELECTRONICS

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR TEL: 0702-527572



Hurry now to re-new your subscription to the British Amateur Electronics Club, as their subscription rates rise as of 1st January 1985 from £5.50 to £7.00 (UK and Eire; otherwise from £7.00 to £8.50 surface mail or £8.50 to £12.50 airmail). BAEC may be contacted at "Dickens", 26 Forrest Road, Penarth, South Glamorgan.

One of the problems of DIY loudspeaker building is that you can't tell what the results will be like. However, Wilmslow audio have solved this problem by opening a hi-fi studio at Church Street, Wilmslow, where you can hear ready-made and kit loudspeakers and amplifiers. Wilmslow Audio Ltd, 35/39 Church Street, Cheshire SK9 1AS.

Philips Test and Measuring is offering a useful, full-colour A2-size poster giving essential facts about their very latest instrumentation. The poster, free on application, would grace any laboratory or test room wall and can be obtained from Philips Test and Measuring, Pye Unicam Ltd, York Street, Cambridge CB1 2PX, tel 0223-358866, telex 817331.

Buff Up Your Computer

Developed specifically for the home computer enthusiast and the semi-professional user by Memorex's Media Retail Division, the Computer Care Kit will be available from major retailers and independent stores. However, this is one clean-up kit that won't stop you playing those smutty computer games, reported in certain Sunday papers.

The comprehensive range of products consists of: VDU and TV Screen cleaning kit, comprising twenty foil sealed sachets of cleaning tissues and two anti-static cloths and priced at £4.95; case and keyboard cleaning kit also priced at £4.95 and comprising aerosol spray foam, cleaning cloth and cotton buds; disc drive and head cleaning kit with ten disposable head cleaners and aerosol spray cleaner for wet and dry action, costing £9.95; and a storage case for 5.25" floppy discs, costing £2.25. Each kit comes complete with a set of instructions.

Approved Irons

The British Electrotechnical Approvals Board for Household Equipment have given their seal of approval to Cooper Tools for the company's Weller SI15, SI 25, and SI 40 soldering irons, plus the WH1 and WH2 hobby kits. These are the only soldering-related products currently on the market which are entitled to display the BEAB mark.

The BEAB mark indicates that an electric appliance meets the requirement of the British Standard BS 3456 and enables consumers to identify products which are of sound manufacture and are deemed safe to use. This is a particularly important form of assurance since the use of inferior electrical goods can result in serious or sometimes fatal accidents.

Cooper Tools' emphasis on product quality and safety was further highlighted by the presentation of a National Safety Award from the British Safety Council. Only a small percentage of Britain's workplace qualify for this award each year which is won by achieving a lower accident incident rate than the national average. Cooper Tools Limited, Sedling Road, Wear, Washington, Tyne & Wear, NE38 9BZ, tel: 091 416 6062.

World's Fastest ROMs, Episode 192

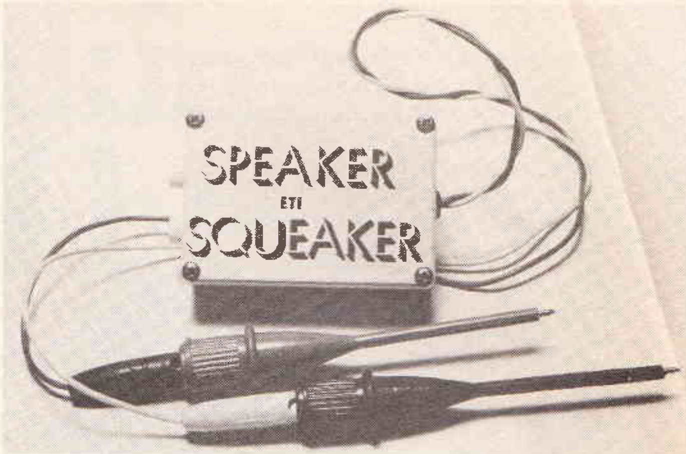
A new line of high density 256K CMOS ROMs with access times as fast as 75 nanoseconds is now available from Solid State Scientific, Inc., Willow Grove, PA, USA. These new devices, announced recently, are claimed to be the fastest 256K CMOS ROMs in the world. No doubt, it will not take long for someone to come along and dispute that claim.

The ROMs have been under development for approximately one year and are now being produced on a 2 micron HCMOS II process. Price in production volumes is below $20 each. On request, prototypes can be made available in as little as three weeks; and production volumes in seven weeks.

The new ROMs feature worst-cast access times of 100 and 120 ns over the commercial temperature range (0° to + 70° C). Industrial (–40° to + 85° C) and military (–55° to + 125° C) temperature range devices are available with 150 ns worst case access times. Under typical operating conditions, all versions operate with access times as fast as 75 ns. They also feature, under worst case conditions, operating current of 25 mA maximum, standby current of 100 uA maximum, and LSTTL-bompatible inputs and outputs. In addition, they are asynchronous and fully static; no clocks or strobes are required.

They are pin compatible with NMOS EPROMs, so the EPROMs can be used for prototyping, providing due allowance is made for the EPROMs slower speed. More complete details on these 23C256 256K CMOS ROMs are available upon request from Solid State Scientific, Inc., 3900 Welsh Road, Willow Grove, PA 19090, USA, tel (USA) 215 657-8400.

SPEAKER SQUEAKER



For roadies who have better things to do with their vocal chords than shout 'testing' all the time, Phil Walker has designed a self-contained loudspeaker tester.

If you ever find yourself setting up loudspeaker systems for discos, groups or public address etc, sooner or later you will need to check various parts of the equipment. This tiny piece of test gear should make life a lot easier.

One way to test continuity is to use a mulimeter on the ohms range but this has at least two disadvantages in that you have to look at the scale (often in poor light) to see what is happening and it does not prove that a loudspeaker is working even if the resistance reads correctly. This project has the advantage that it gives an audible indication of continuity from its built in sounders and will also drive a loudspeaker connected to its terminals.

The Circuit

The heart of the project is the LM3909 IC. This was originally designed as a low power LED flasher but will function quite well as an audio oscillator under the right conditions. A notable feature of the device is that it will operate from a single 1.5 volt dry cell. This enables us to build a very simple and compact unit.

Most of the circuit is completely standard except that we have used two low impedance earpieces instead of a loudspeaker. This was done so that the complete project would fit into a small plastic box. If you can find a small loudspeaker with a coil impedance of 16 ohms or more this would do instead or alternately an eight ohm speaker in series with a coil (50 turns of 22 swg enammelled wire wound on a 2BA steel bolt) may be worth a try.

In operation the battery supply is completed via the test probes and the external circuit. If the resistance of the external circuit is low enough the LM3909 will oscillate and produce a tone from the two earpieces. The frequency and loudness of this tone will depend on the resistance and reactance of the external circuit and the characteristics of E1 and E2. Our prototype was just audible at 100 ohms resistance between the probes.

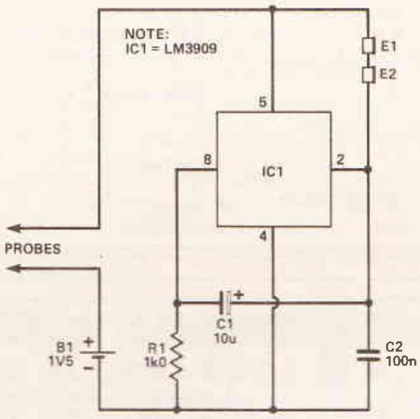
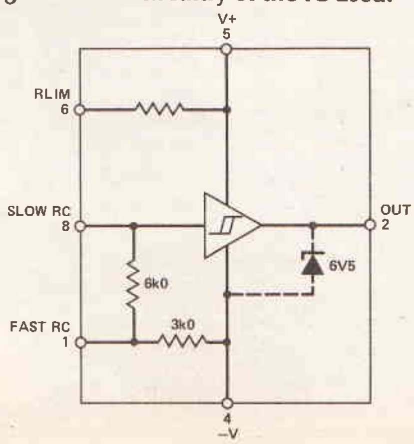


Fig. 1 Circuit diagram of the Speaker Squeaker.

HOW IT WORKS

All the active components in this project are contained in the LM3909 IC. This can be considered as a Schmitt trigger switch and a few resistors. In this case there is no polarity change between input and output. C1 provides feedback between input and output while the rest of the components help to determine the frequency of oscillation.

Fig. 2 Internal circuitry of the IC used.



Construction

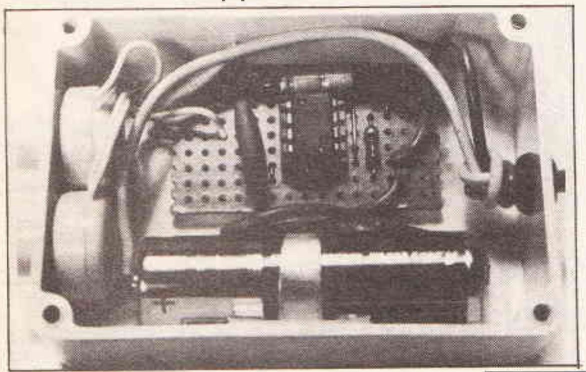
This project is a little unusual in that we have not designed a PCB to go with it. Instead we used a small piece of 0.1" matrix Veroboard 13 by 9 holes. This accommodates the four components quite easily , and the only point to watch is that four of the tracks need to be broken as shown in the diagram. Make sure the tracks run parallel to the long edge of the board.

IC1 and IC2 must be inserted the right way round and the battery connection must also be correct. The wires to the battery were soldered in place but a holder could be used if you wish and have room.

The earpieces E1 and E2 usually come with a length of wire and a miniature jack plug already fitted. These should be cut off leaving about 2 inches of wire on the earpiece. One wire from each earpiece should then be soldered together and insulated with tape or sleeving. The remaining wires can be connected to the cicuit board.

In our model the probe wires were knotted inside the case and went out through a small grommet.

This prevents the wires from being pulled out. The earpieces were pushed through holes in the side of the case and secured with a little glue. The battery was held in a self adhesive cable clip and the circuit board was fastened down with a double sided sticky pad.



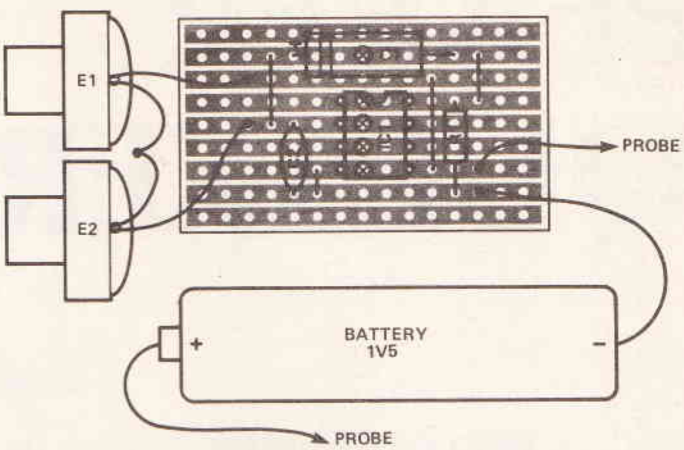


Fig. 3 Veroboard layout for the project.

ETI

BUYLINES

No problems here at all. There's no PCB to worry about and the case, earpieces and IC are all available from a number of suppliers including Maplin, TK Electronics and Cricklewood.

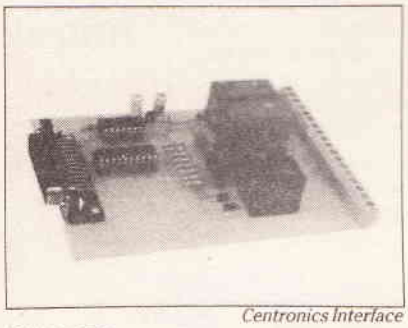
PARTS LIST

RESISTOR	
R1	1k0 ¼W carbon film
CAPACITORS	
C1	100n ceramic disc
C2	10µ16V electrolytic
SEMICONDUCTOR	
IC1	LM3909
MISCELLANEOUS	
E1,2	miniature 8 ohm earpieces
B1	1.5 volt dry cell (preferably alkaline)

Verobox type 202-21025 2.9 x 2.0 x 1.0 inch; test probes; piece of Veroboard, 9 by 13 holes; grommet or strain clips relief bush; battery holder or clip.

Cirkit. Making it bigger and better.

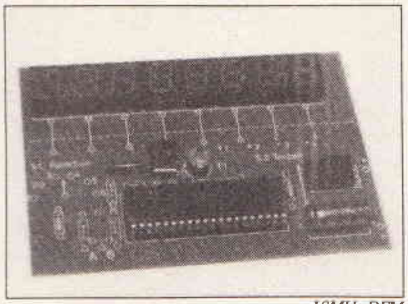
Cirkit stock all the components, accessories and tools and the kits you're looking for. Designed and selected to offer the best possible standards at the best possible price.



Centronics Interface

Cirkit Kits

CIRKIT ELECTRONICS TOOL KIT Contains: 15W Soldering Iron 2 spare bits, heat shunt, solder, pliers, cutter, screwdriver	40-00007	15.56
AUDIO FUNCTION GENERATOR Versatile waveform generator with sine, triangular and square wave outputs. On board mains PSU	41-01302	27.00
STEREO 40W AMPLIFIER Single board 40W per channel stereo amplifier	41-01301	38.00
STEREO VU METER 5 LED per channel stereo VU meter for use with stereo amplifiers	41-01401	11.50
5W AUDIO AMP A very compact audio output stage for use in a wide range of equipment	41-01406	4.60
UNIVERSAL AMP A universal audio pre-amp with a gain of 10	41-01604	6.45
MONO REVERBERATION UNIT Single channel, spring line reverb unit to add echo effects to tape recording etc.	41-01602	10.00
TONE GENERATOR AND DETECTOR Very low distortion tone generator and signal detector for circuit fault finding	41-01603	10.45
10MHz DFM 8 Digit LED digital frequency meter and period measurement	41-01500	54.10
50MHz PRESCALER Extend the range of the 10MHz DFM to 50MHz	41-01501	8.55
1-5MHz PRE AMP Low frequency pre-amp and waveform shaper for the 10MHz DFM	41-01502	5.13
70cm PRE AMP Low noise, miniature pre-amp for the 70cm amateur band	41-01506	4.78
70cm CONVERTER 70cm to 144MHz low noise converter featuring pre-aligned helical filter, schottky diode mixer and low noise transistors	41-01405	21.50
1-30V 1mA-2A PSU Adjustable 1-30V Power supply with pre-setable current limit from 1mA-2A	41-01600	37.46
5-12V 1A PSU Adjustable PSU from 5-12V with current protection, 1 amp max output	41-01504	6.45
1-30V 1.5A PSU 1-30 volt adjustable PSU with protected output up to 1.5 Amps	41-01402	10.45
3 DIGIT LED DVM DVM to read up to 99.9 volts or configured as an ammeter to read up to 9.99 amps	41-01403	17.00
INFRA RED LINK Single channel IR Link with relay output	41-01300	9.60
TEMPERATURE SENSOR Thermistor based temperature sensor with relay output	41-01303	6.20
LOCOMOTIVE SOUND GENERATOR Realistic steam sound and whistle for model railways	41-01304	9.20
LAMP DIMMER Control lamps and drill speed	41-01305	5.70
WATER LEVEL ALARM Alarm to indicate high water level or flooding	41-01601	2.70
3 NOTE CHIME Doorbell chime with adjustable tones	41-01503	7.00
2M PRE AMP Miniature low-noise MOSFET pre-amp for the 2m amateur band	41-01307	3.91
2M CONVERTER Low noise 144MHz-28MHz amateur band converter	41-01306	17.35
2M POWER AMP 20W - 10dB gain - power amplifier for the 2m band. Automatic TX switch over, RX pre-amp, robust construction	41-01404	32.87

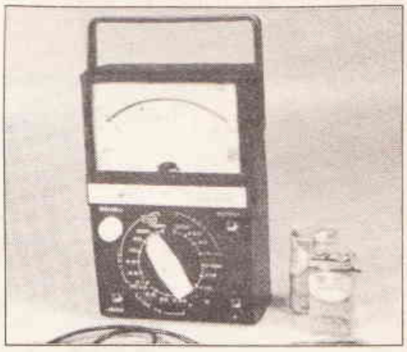


10MHz DFM

CRYSTAL CALIBRATOR Crystal reference calibrator for alignment of receivers, outputs at 4, 2, 1MHZ, 100, 50 AND 10KHz	41-00801	4.32
CB NOISE SQUELCH Improves to mute performance of the majority of CB rigs	41-01605	5.40
CENTRONICS INTERFACE Connect your personal computer to the outside world via the Centronics printer output	41-01406	22.50
70cm PA 10W Power amp to boost the output of handheld and portable 70cm transceivers	41-01505	33.82

Selected Lines

BBC to Centronics Connect Cable		03-10019	7.25
Dragon to Centronics Connect Cable		03-10017	7.25
C12 Computer Cassette		21-00012	0.55
Interface 84 multiplexed Ram Card		40-84000	59.95
Z80A industrial controller		40-82000	54.95
EPROM Eraser 84T		40-82001	59.95
6502 Micro Controller		40-65020	54.95
6802 Micro Controller		40-68020	54.95
PB2720	80dB Piezo Buzzer	43-27201	0.55
10M15A	10.7 Center Freq.	20-10152	2.10
10M08AA	10.695 Center Freq.	20-11152	3.49
FC177	LCD (Freq.)	39-17700	20.00
CM161	LCD Clock	40-80161	8.25
8 x 0.3"	IC socket	28-00800	0.12
14 x 0.3"	IC socket	28-14000	0.13
16 x 0.3"	IC socket	28-16000	0.13
6V	KUIT-A Relay	46-80000	0.48
9V	KUIT-A Relay	46-80001	0.48
12V	KUIT-A Relay	46-80002	0.48
CX120P	COAX Relay	46-90120	11.96
CX520D	COAX Relay	46-90520	26.98
CX540D	COAX Relay (BNC)	46-90540	26.98



HT-320
Multimeter (20kΩ-V) 56-83201 14.00

Please add 15% VAT to all advertised prices and 60p post and packing. Minimum order value £5 please. We reserve the right to vary prices in accordance with market fluctuation.
Just send for our catalogue or visit one of our three outlets at:

200 North Service Road, Brentwood, Essex. CM14 4SG;
53 Burrfields Road, Portsmouth, Hampshire. PO3 5EB;
Park Lane, Broxbourne, Hertfordshire. EN10 7NQ.

To: Cirkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire. EN10 7NQ.
I enclose 85p. Please send me your latest catalogue and 3 x £1 discount vouchers!
If you have any enquiries please telephone us on Hoddesdon (0992) 444111.

Name ________________

Address ________________

Telephone ________________

Area of Special Interest ________________

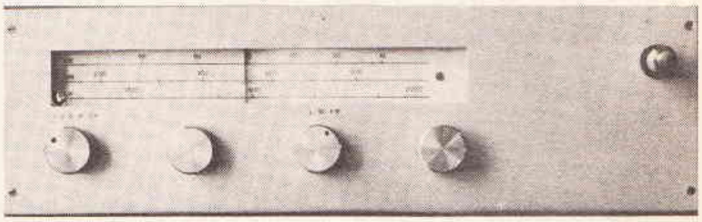
ETI11

Cirkit
Bigger Stock. Better Service.

NEW WINTER CATALOGUE OUT NOW!


ANTEX
a world of soldering
ANTEX
SK5
SOLDERING KIT
Free 'How To Solder' booklet and pack of solder
ANTEX "HOW TO SOLDER"
Tomorrows Soldering Technology Today.
ANTEX has a worldwide reputation for quality & service & for many years has been one of the best known & most popular names in soldering. Always at the forefront of technology, ANTEX is continually researching new and better ways of achieving more accurate, reliable, and cost effective soldering. On ANTEX Soldering Irons, the advanced design of the interface between the element & the bit allows more efficient heat transfer to the bit and improved stability of the temperature at the point of contact with the work. Indeed, experiments have shown that an XS25 watt iron can be used for tasks where a 40 watt iron would normally have been required.
ANTEX Soldering Irons exhibit exceptionally low leakage currents & hence are suitable for use on Static Sensitive Devices. Sophisticated temperature controlled soldering units have recently been added to the ANTEX range.
ANTEX
MODEL TCSU 1
1 2 3 4 5 6 7 8 9 10
TCSU1 Soldering Unit
ST4 Stand
SK5
Soldering Kit
Model XS
Model CS
Model C
TCSU-D
Temperature-Controlled
Soldering Unit
Model C
– 15 Watts. Available for 250, 220, 115, 100, 50 or 24 volts
Model XS
– 25 Watts. Available for 240, 220, 115, 100, 50, 24 or 12 volts
Model XS-BP
– 25 Watts. 240 volts, fitted with British Plug
ST4 Stand
– To suit all irons
SK5 Soldering Kit. Contains model CS 240v Iron, an ST4 Stand and solder.
SK6 Soldering Kit. Contains model XS240v Iron, an ST4 Stand and solder.
SK5-BP and SK6-BP
Soldering Kits as above with British Plug
Model CS
– 17 Watts. Available for 240, 220, 115, 100, 50, 24 or 12 volts
Model CS-BP
– 17 Watts. 240 volts, fitted with British Plug
TCSU1
– Very robust temperature controlled Soldering Unit, with a choice of 30 Watt (CSTC) or 40 Watt (XSTC) miniature irons.
Range 65°C to 420°C.
Accuracy 2%
TCSU-D
Elegant Temperature Controlled Soldering Unit with 50 W Iron (XSD) and built around FERRANTI custom-made ULA. Range Ambient to 450°C. Accuracy ± 5°C. Zero crossing switching. Detachable sponge tray.
ANTEX
Made in England
ANTEX (Electronics) Ltd.,
Mayflower House, Plymouth, Devon. Tel. 0752 667377 Telex 45296
Please send literature, price list and my nearest stockist to:
Name
Address
Telephone

AM/FM PORTABLE RADIO



It's quite a long time since ETI last featured a radio project, as a glance at last month's index will show. L. Boullart makes good the omission.

As everyone knows, it is not really possible to compete with the majority of commercial portable radios. However there still exists something of a gap between the very cheap, flimsy, gadgets and the expensive, sophisticated sound machines.

Apart from the fun of DIY, it is worth the effort to build a reliable receiver with good sensitivity and acceptable sound quality at a reasonable price.

The present design is not spectacularly innovative as it uses well-tried techniques, but it is absolutely reliable. Practically all alignment problems have been eliminated so anyone who can hold a soldering iron should be able to achieve optimum results.

The block-diagram of figure 1 shows the different sections of the receiver. These consist of an AM-FM turnhead, separate IF amplifiers for AM and FM, an audio IC and the power supply.

Tunerhead FF 317

Although this is not the latest word on tunerheads, it contains a well-made FM amplifier with MOSFET VHF amplifier and a separate transistor for the oscillator circuit. Apart from the three-section FM tuning capacitor it also contains a two-section AM-gang, used as CV2. A 3:1 reduction drive is also provided, which will allow a simple dial assembly. The positive supply voltage must be connected via a 150 ohms resistor.

AM Section

The heart of the AM amplifier and detector (Fig.2) consists of an HA1197 IC by Hitachi. It contains an HF-IF section and a detector. To improve signal-to-noise ratio, the low impedance input is preceded by an FET source-follower, Q2. The gate of the FET has a very high input impedance, so the usual practice of using taps on the MW and LW coils on the ferrite rod can be dispensed with. The total signal strength from the antenna coils (which is not great anyway!) can therefore be put across the gate input with no significant loss. At MW mid-band (1 MHz) we get

$$Z = 2\,\pi f L0$$
$$= 10^6 \times 6.28 \times 234 \times 100$$
$$= 146\ k$$

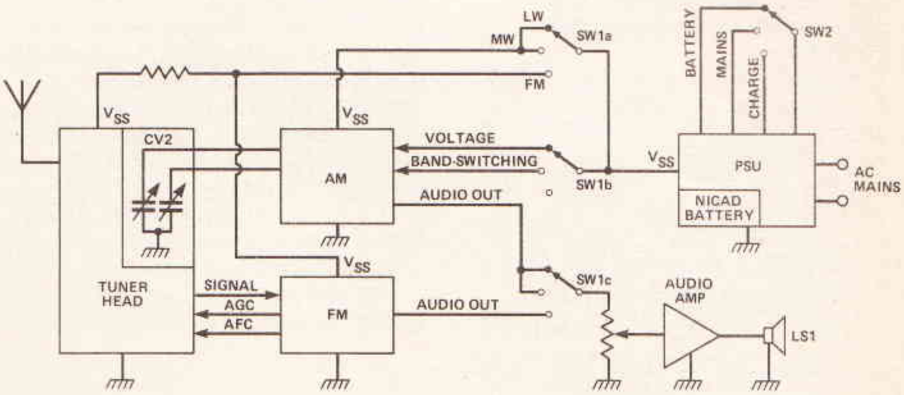
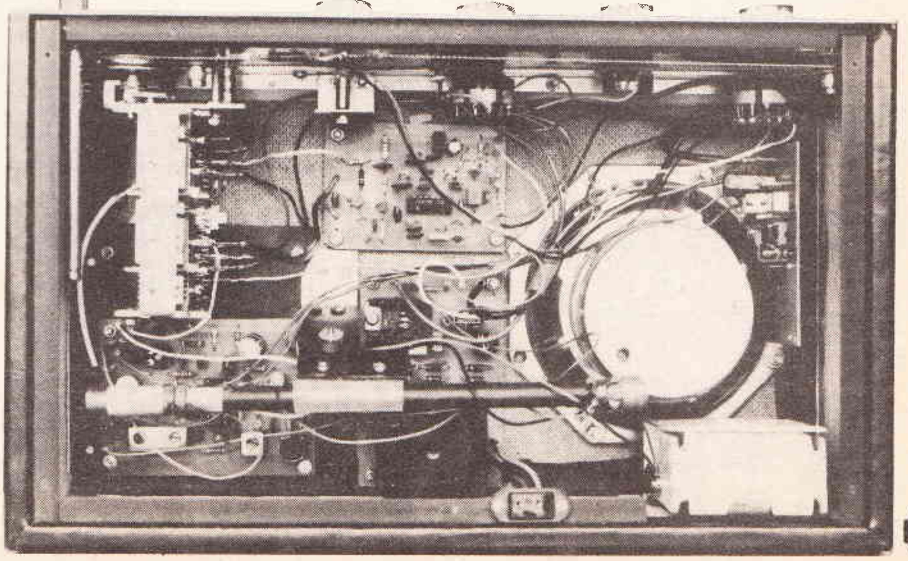


Fig. 1 Block diagram of the complete AM-FM tuner



To avoid losses and unwanted atmospherics on the connecting wires, band switching is effected directly on the printed circuit board by means of transistors Q1 and Q3. The arrangement is somewhat unusual: the antenna-coils are connected in series for long wave reception and on medium wave the LW coil is short-circuited, by applying the positive supply voltage to the base of Q1. For the oscillator section, additional capacitors (C6 and CV3) are switched into the circuit by means of Q3. Note that the LW coil is damped by a 120 — 150k resistor, R3, to avoid instability and improve frequency response: a long wave coil with a Q factor of 100 will result in a bandwidth of 200 kHz/100 = 2 kHz, which means a very poor audio response!

The tap on the oscillator coil, L4, is shunted with a 68 R resistor, R7, and the connection to the tuning capacitor has a 3 μH choke, L3, in series. This can be made up of a 1 M0 0.33 W resistor with 50 turns of 0.15 to 0.25 mm wire wound at random. As a result, the oscillator voltages across the tap will be reasonably constant over the entire tuning range (approximately 150 mV).

AM selectivity is mainly determined by the CFU bandfilter, L5, in the IF section. The secondary should be damped by a 5k6 resistor, R8.

At the detector ouput is an 8—10 kHz whistle filter comprisng L7 and C22. The coupling capacitor C23 has been chosen for a time-constant of 100 μS to compensate

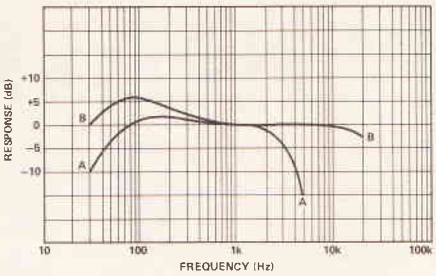


Fig. 3 Audio-response curve for AM (A) and FM (B)

for a moderate amount of bass-lift in the audio amplifier (of which more later on). Too much bass lift on AM would result in "boomy" sound! The AF frequency response is shown in Fig. 3, curve A.

FM Section

The IF amplifier of Fig. 4 is built around the time-honoured CA 3089 IC. It should be noted however that the phase-detector coil arrangement has been replaced by a ceramic filter type CDA 10.7 MA. Two more ceramic filters precede the CA3089, together with Q4, which compensates for the losses of the filters and offers some gain into the bargain. With the use of ceramic filters throughout the IF amplifier, no alignment procedure is required and yet the results are quite satisfactory: harmonic distortion is below 0.35% with a frequency deviation of $\pm$ 50 kHz.

In conjunction with the FF317 tunerhead, the useful sensitivity at the antenna input should lie in the neighbourhood of 1 μV, which is rather exceptional for a portable receiver. With this kind of sensitivity, the AGC connection on the FF317 becomes a very useful feature, because without it overload on strong stations could hardly be avoided.

The AFC output of the CA 3089 is of the wrong polarity for the FF317, so a polarity-reversing stage has been added with Q5. For simplicity's sake, the AFC is not switchable. This could easily be arranged, making use of pin 10 of the IC with a 4k7 resistor in series, but in the authors opinion it is quite unnecessary. Although the amount of AFC in the present design is adequate to compensate for the oscillator drift, under normal circumstances even the weakest signals should not be pulled away by strong neighbours. R37 (3k3) may need some adjustment in order to keep the potential at the collector of Q5 below 7 volts with a supply voltage of 12 volts. If so, just solder the appropriate parallel resistor on the copper side of the PC board.

Audio Amplifier

Once again an IC, TBA 820M has been chosen for simplicity and reliability (see Fig. 5). It requires a minimum of external components and delivers a clean 1.2 Watts audio power into an 8 ohm load with a 12 V supply. Distortion is 0.25%, quite acceptable for a portable radio. Besides, it offers the possiblity of adding an external bass-boost circuit. The components have been carefully chosen to achieve optimum results with the specified loudspeaker and

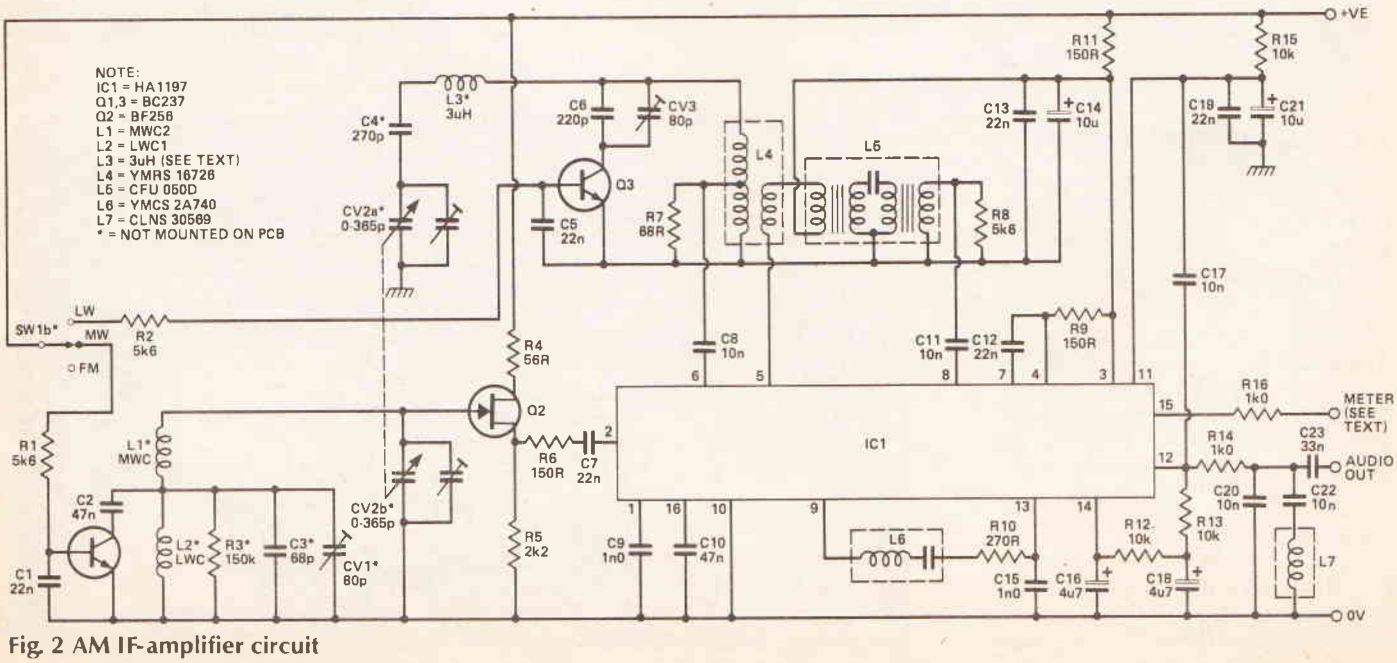


Fig. 2 AM IF-amplifier circuit

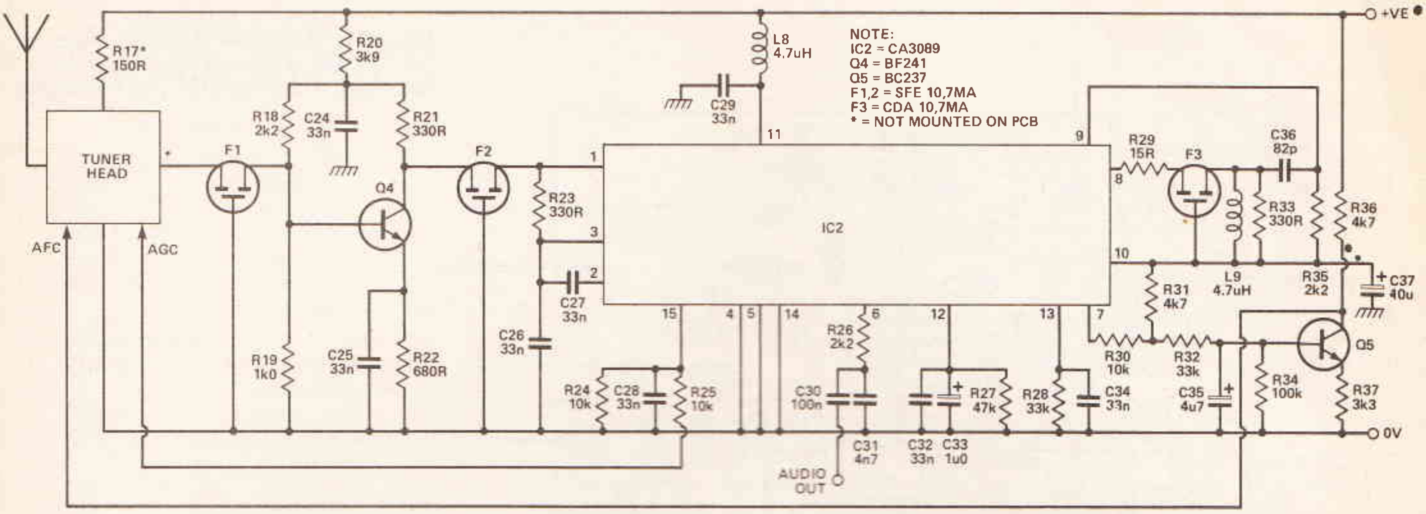


Fig. 4 FM IF-amplifier circuit

enclosure. Since the response of the loudspeaker-enclosure assembly begins to fall off in the region of 200 Hz, bass-boost reaches a maximum of 5.5 dB at 90 Hz and then drops steeply to 0 dB at 30 Hz, controlled by the time-constants of R39, C38 and C43, pin 1 at the TBA 820M output. The overall frequency response on FM can be seen in Fig. 3, curve B.

Several combinations of small woofers and tweeters were tried out, but in the end the Phillips AD 5061M8 full-range loudspeaker was considered the best choice for this particular application.

Although modesty priced, it gives a very good account of itself in a small enclosure: good attack, smooth and clear treble without shrillness. Of course one can't expect a full-fledged reproduction of the bass-drum (or the hammer in Mahler's 6th Symphony!) from an enclosure of barely 5 litres . . .

Power Supply

It stands to reason that a portable radio has to be battery-powered; yet we must bear in mind that the apparatus will often be used in a place where a mains outlet is available. For this reason, a mains supply should be included. On the other hand, the price of the usual carbon-zinc batteries has gone up steadily. With a current drain of 24 mA on AM and 38 mA on FM and with another 10 mA added at quite a modest sound volume, the prospect becomes very gloomy . . .

The modern solution lies in the use of NiCad batteries. They must be about the only item on the market that has become cheaper! Another advantage is that their potential voltage remains fairly constant over the entire discharge

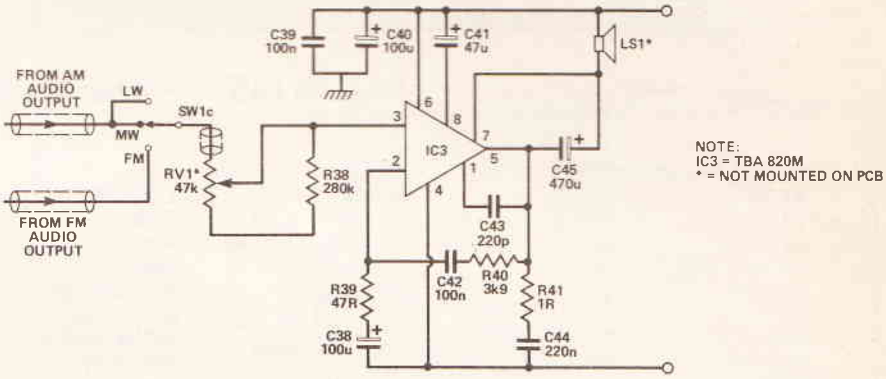


Fig. 5 Audio amplifier circuit

period and they can be recharged by the built-in power supply (Fig. 6). This arrangement also makes it possible to play the set normally while the batteries are being charged. The capacity of the NiCad cells is from 10 hours on FM to 14 hours on AM, when the receiver is playing at a moderate volume. This is not a very cheap solution, of course, but we should consider that, when compared with only six replacements of the carbon-zinc batteries, the NiCads are already less expensive.

The power supply circuit is quite straightforward, but the 7812 regulator should be mounted on a small heatsink.

On position 4 of the switch SW2, the NiCad batteries are charged through a constant current source Q6. Full charge takes 16 hours at a current of 45 mA. Adjust RV1 for a voltage drop of 0.45 V over R3, which brings the charging current to 45 mA: 0.045 x 10 = 0.45 V.

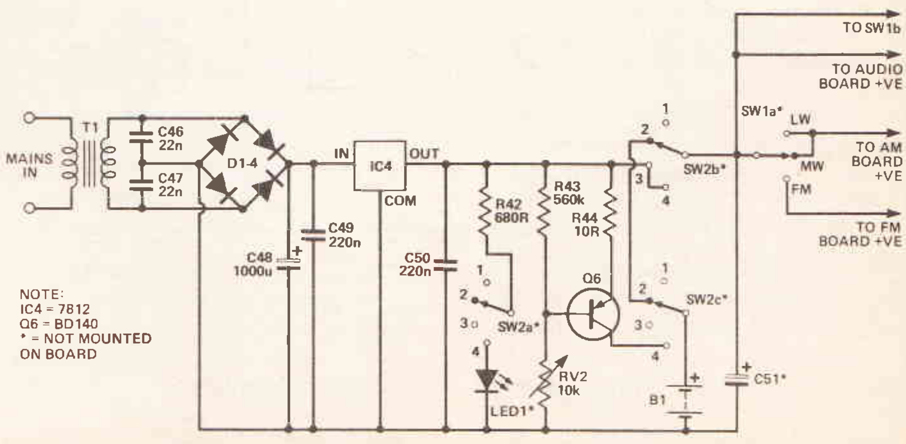
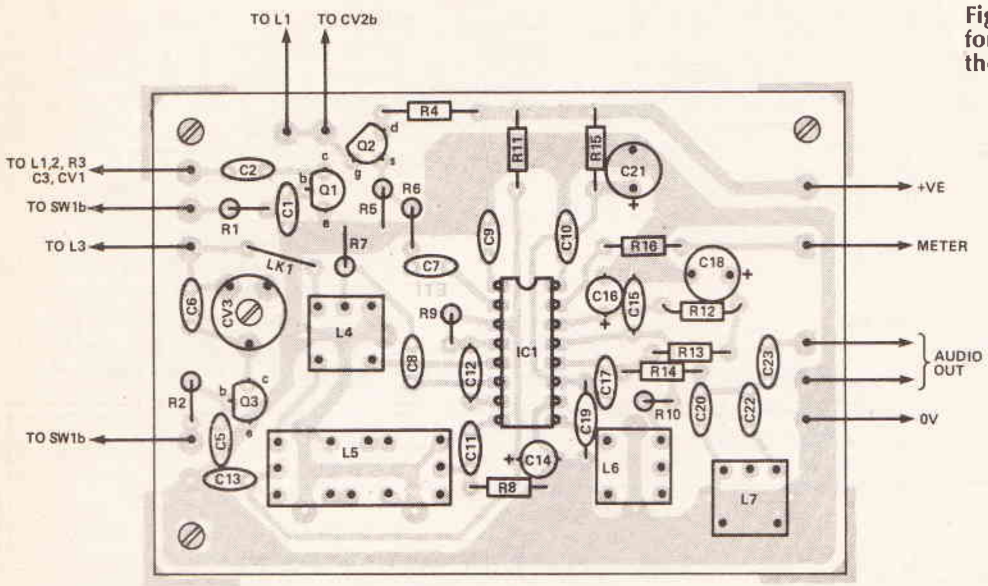


Fig. 6 Power supply circuit

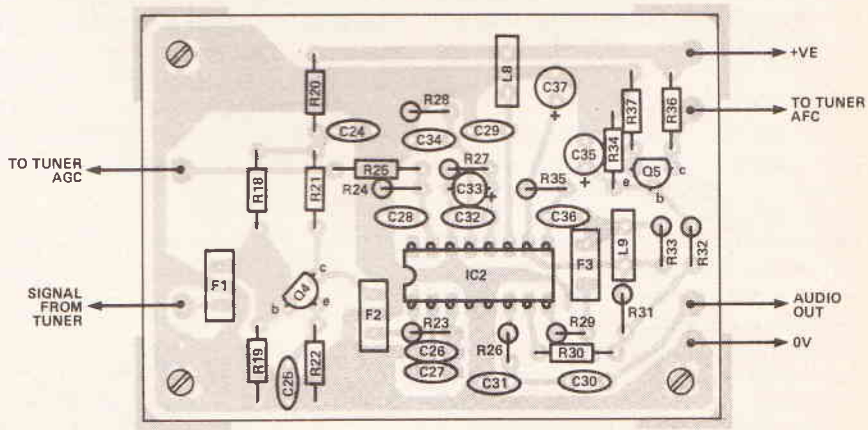
Figs. 7,8, 9 and 10 Overlay diagrams for the AM IF Board, The FM IF Board, the audio board and the power supply.



PARTS LIST — AM BOARD

RESISTORS (all ¼ W 5%)	
R1,2,8	5k6
R3	150k
R4	56R
R5	2k2
R6,9,11	150R
R7	68R
R10	270R
R12,13	10k
R14,16	1k
R15	10R
CAPACITORS (all ceramic or silver mica unless otherwise stated)	
C1,5,7,12,13,19	22n
C2,10,	47n
C3	68p
C4	270p
C6	220p
C8 11,17,20,22	10n
C9,15	1n0
C14,21	10u 16V radial electrolytic
C16,18	4u7 16V radial electrolytic
C23	33n
CV1,3	80p trimmer
CV2	365p (contained within tuner head)
SEMICONDUCTORS	
IC1	HA1197 (Hitachi)
Q1,3	BC237
Q2	BF256
MISCELLANEOUS	
L1,2	MWC2 and LWC1 coils mounted on ferrite rod aerial
L3	3uH (see text)
L4	YMRS 16726
L5	CFU 050D
L6	YMCS 2A740
L7	CLNS 30569
SW1b	3 (or 4) pole, 3 way rotary switch (see audio and PSU boards)
PCB; mounting bracket for ferrite rod.	

PARTS LIST — FM BOARD



RESISTORS (all ¼ W, 5%)	
R17	150R
R18,26,35	2k2
R19	1k0
R20	3k9
R21,23,33	330R
R22	680R
R24,25,30	10k
R27	47k
R28,32	33k
R29	15R
R31,36	4k7
R34	100k
R37	3k3
CAPACITORS (all ceramic or silver mica unless otherwise stated)	
C24-29,32,34	33n
C30	100n
C31	4n7
C33	1u0 16V radial electrolytic
C35	4u7 16V radial electrolytic
C36	82p
C37	10u 16V radial electrolytic
SEMICONDUCTORS	
IC2	CA3089
Q4	BF241
Q5	BC237
MISCELLANEOUS	
F1,2	SFE 10, 7MA
F3	CDA 10, 7MA
L8, 9	4.7 uH RF choke
PCB; tuner head, type FF317; rod antenna and/or socket for external antenna.	

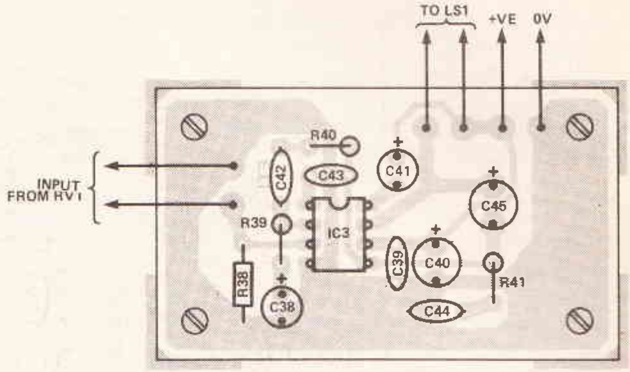
PARTS LIST — AUDIO BOARD

RESISTORS (all ¼W 5%)

R38	820k
R39	47R
R40	3k9
R41	1R0
RV1	47k log. potentiometer

CAPACITORS

C38,40	100u 16V radial electrolytic
C39,42	100n
C41	47u 16V radial electrolytic
C43	220p
C44	220n
C45	470u 16V radial electrolytic



SEMICONDUCTOR

IC1	TBA 820M

MISCELLANEOUS

LS1	8R Phillips AD 5061M8 or similar
SW1c	3 (or 4) pole, 3 way rotary switch (see PSU and AM boards)

PCB.

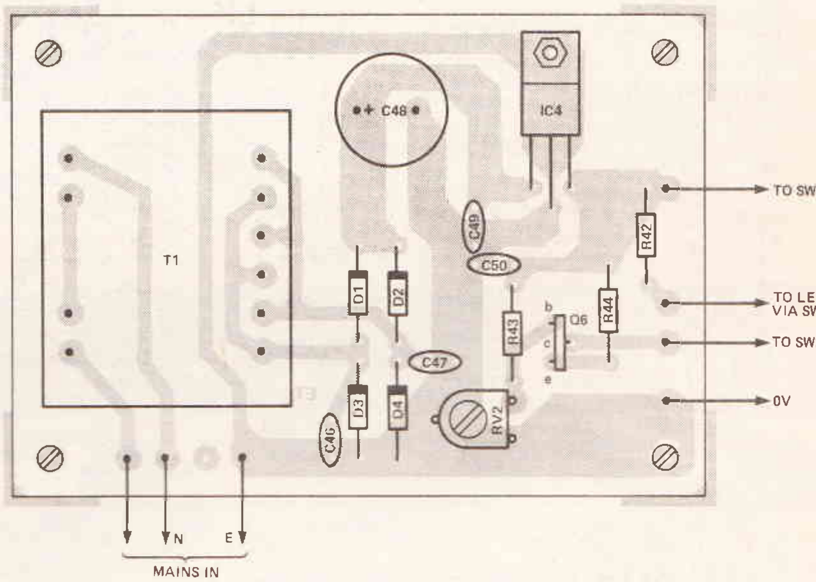
PARTS LIST — PSU

RESISTORS

R42	680R
R43	560R
R44	10R
RV2	10k horizontal skeleton preset

CAPACITORS

C46,47	22n Ceramic
C48	1000u 25V radial electrolytic
C49,50	220n Ceramic
C51	1000u 16V axial electrolytic



SEMICONDUCTORS

IC4	7812
Q6	BD140
D1 — 4	IN 4007
LED1	Red LED, panel mounting

MISCELLANEOUS

B1	12V NiCad pack eg. 8 off AA NiCad cells in series
SW1a	3 (or 4) pole, 3 way rotary switch (see audio and AM boards)
SW2	3 pole, 4 way rotary switch
T1	15V 6VA PCB mounting transformer (eg. Drake P0615)

PCB; small heatsink; nut and bolt to mount IC4; mains input socket or mains cable and strain relief bush.

Construction

Four PC boards are needed; Figs. 7 to 10 show the lay-out. They can easily be hand-made at home by means of transfers and a bottle of ferric chloride (I did!). Of course, you can buy them from the ETI PCB service.

You could buy a proprietary brand of case to house the radio (plastic, of course, not metal), but our experience suggests that with radios, the best results are obtained by making your own, provided you are reasonably handy with a saw and glue. What follows is a description of how to make the prototype's case.

The sides of the case were made from four pieces of 8 mm plywood and the top of the case was made up with 5 mm hardboard, but 8 mm ply might be more suitable. Counter-sunk screws were used to mount the speaker, PCBs and to bolt on the control sub-panel. Obviously, a cut-out for the loudspeaker cone is also needed as well.

There are a total of three control panels! First, there's the sub-panel onto which the control pots and switches are mounted, along with the aerial and the tuning scale and pulley for the tuning drive cord; next is the plywood panel and finally, the neat control panel itself. With plywood back and front, it should be possible to dispense with the plywood panel, as

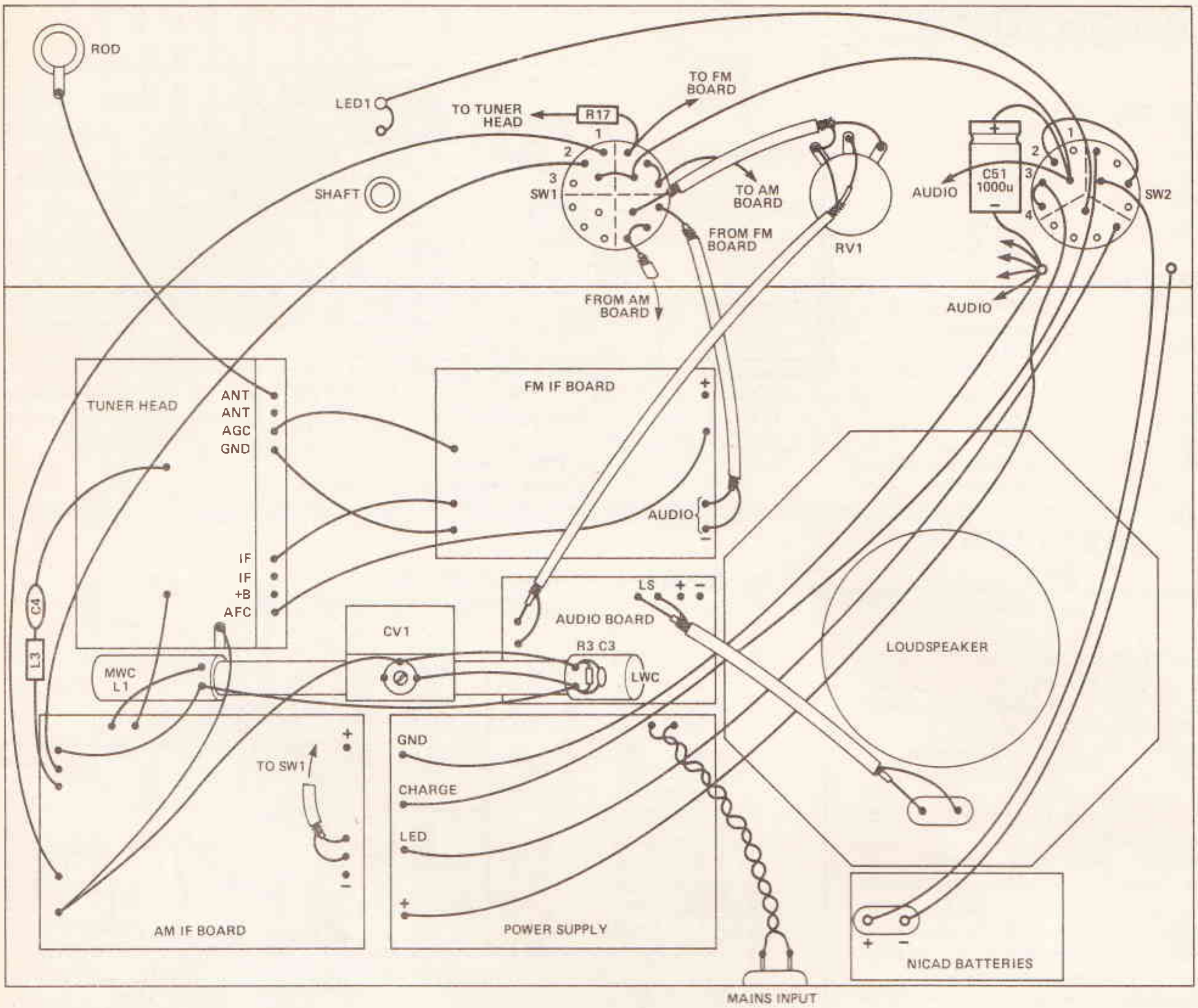


Fig. 11 Wiring diagram for the complete set

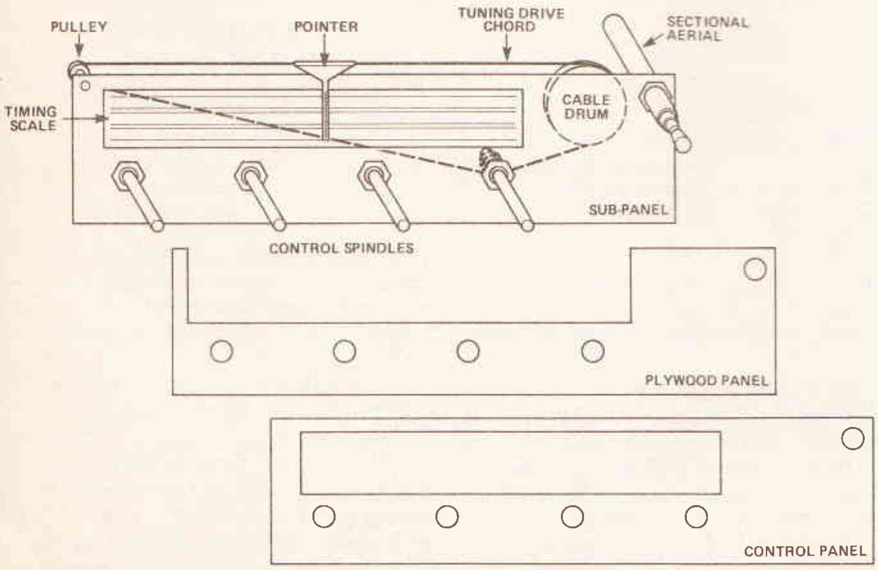


Fig. 12 Construction of the receiver front panel!

the case should be strong enough without it.

With a 3:1 reduction drive on the variable capacitor, a cable drum of 35 to 40mm will give a scale length of 168 to 192mm, which is ample for most purposes. If no scale drum is available, a knob of suitable dimensions will do the trick.

Fig. 11 shows details of the inter-wiring in the case, and Fig. 12 shows details of the control panel. However, these are as a suggestion only, you'll have to work out your own exact details depending on what you have available, the size of the cable drum, etc.

Alignment

FM: Theoretically, no adjustments have to be carried out. If you do want the last decibel or so, connect a sensitive voltmeter to pin 13 of the CA3089 (across R23) and try carefully to increase the signal level on a weak station by adjusting the trimmers on the 2HF sections of the variable capacitor.

AM: A little more work has to be done on the medium and long wave bands.

1. Switch to MW. The band has to cover from 525 to 1580 kHz.

2. Connect a high impedance

meter with a 0.5V scale to pin 15 of the HA 1197 (a connection is provided on the PC board).
3. If you have an RF generator, turn it to 525 kHz and tune the rejection coil L7 for maximum signal level.
4. Adjust the oscillator coil, L4, at the lower end of the scale. Move the MW, L1, coil on the fourth ferrite rod for maximum signal level.
5. Now turn the RF generator to1580 kHz and adjust the oscillator trimmer on the variable capacitor at the other end of the scale. Adjust the HF trimmer for maximum signal level.
6. Repeat operations 4 and 5.
7. Next, go to 650 kHz and move the MW coil to reach a maximum.
8. Finally, adjust the HF trimmer on the variable capacitor at a frequency of 1300 kHz.

Points 7 and 8 are carried out for a regretably simple reason: the difference between the incoming and the oscillator frequency should always be 470 kHz (the IF). Unfortunately, this cannot be the case over the complete band, because neither the coils nor the capacitance variations are identical. In practice the tracking error will show an S-curve (see Fig. 13). It is then merely a question of choosing the most appropriate spot for F1 and F2.

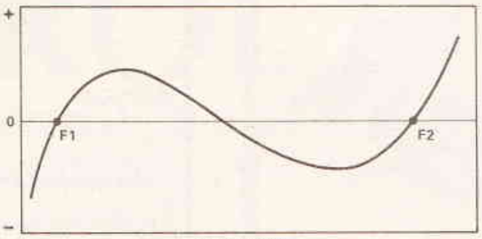


Fig. 13 General curve of the tracking error on MW.

If no RF generator is available, the above procedure may be carried out using the signal of the broadcasting stations at or close to the indicated frequencies. If you want to make a nice job of it, you can plot the points on a piece of graph paper and draw a curve, which will show what small corrections to apply.
9. The long wave band covers from 150 to 266 kHz. The same alignment procedure is followed. The LW trimmer is mounted on the bracket for the ferrite antenna. Final adjustment is carried out at 166 and 250 kHz.
10. The rejection coil L7 is once more adjusted for maximum signal strength.

Conclusion

Your portable AM-FM receiver may not be the cheapest on the market (far from it!), but the sensitivity and the pleasing sound quality will come as an agreeable surprise. Lastly, if the instructions and the lay-out diagrams are followed carefully, it is virtually impossible to go wrong.

BUYLINES

The tuner-head, the ferrite rod assembly and the coils and filters are all available from Cirkit (formerly Ambit) who advertise in our pages. None of the other parts should cause any problems and the PCBs are available from us. Note that only the electronic components are given in the parts lists.

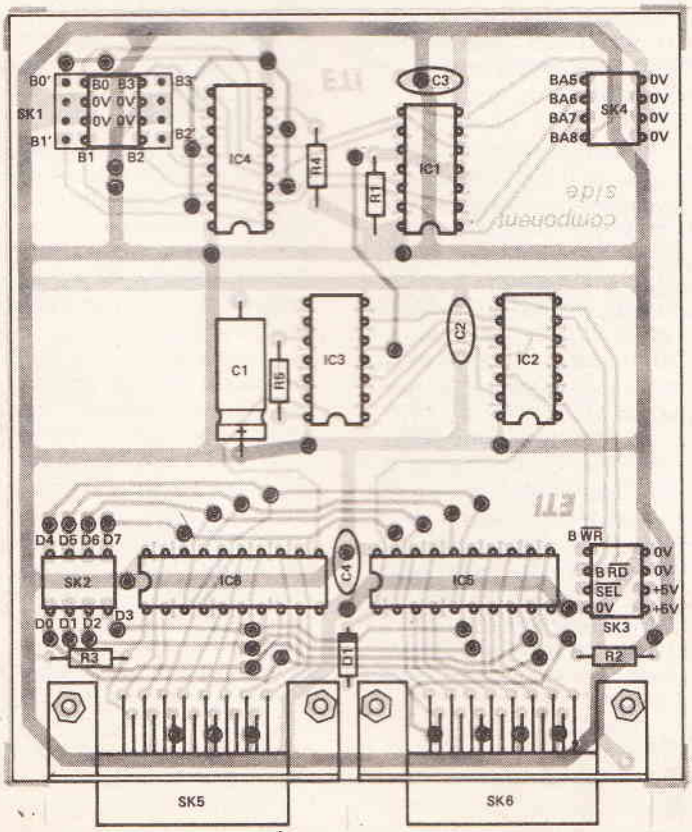
ETI

SPECTRUM CONTROL PORT

In the second and concluding part of this project, Mike Wynne Jones finishes the description of the construction and goes on to describe the software needed.

Begin constructing the I/O boards by inserting all the through links (soldered top and bottom), resistors and the diode into the board, followed by the capacitors and IC sockets. Then insert a low profile wire wrap socket in SK1 and solder it flush with the PCB. If you cannot get low profile wire-wrap sockets, an alternative approach is shown in Fig. 8.

Take another low-profile wire-wrap socket and break all the pins off at the shoulder before they enter the plastic socket body. If yours has no shoulder then try bending the leads outwards to about 90°: if this is not successful you should try the alternative method. Otherwise solder the remaining strips to the copper side of a small piece of 6 x 4 hole veroboard (Fig. 9). If you tin the board first it helps considerably. Next solder the legs you broke off the socket into the holes at the edge of the veroboard so that you end up with an 8 pin socket with legs on a 0.5 "spacing instead of the usual 0.3". This contraption should now fit comfortably over the SK1 you have already fitted and leave no unwanted connections. Make sure that it sits down level and in line with the existing socket and solder it into position. Clip off the leads of this part short and those of the original socket to about 2.3 mm but leave the leads of the original socket for the time being.



◉ = LINK THROUGH

Fig. 7 I/O board PCB overlay.

PARTS LIST — I/O BOARDS

RESISTORS	
R1-5	1k0 ¼ W 5%
CAPACITORS	
C1	100u 16V electrolytic
C2,3	100 n ceramic
C4	47n ceramic or 100n miniature ceramic
SEMICONDUCTORS	
IC1	74LS266
IC2	74LS02
IC3	74LS00
IC4	74LS283
IC5	74LS373
IC6	74LS374
D1	IN4148
MISCELLANEOUS	
SK1	2 off 8 pin DIL low profile wire-wrap DIL sockets and 1 off 8 pin standard DIL socket (or half of a 16 way DIL header — see text)
SK2-4	8 pin standard or low profile DIL wire wrap socket and 8 pin standard DIL socket (or half of a 16 way DIL header — see text)
SK5,6	15 way right-angle 'D' plug (see text)

PCB; 2 x 14 pin, 2 x 16 pin and 2 x 20 pin DIL sockets.

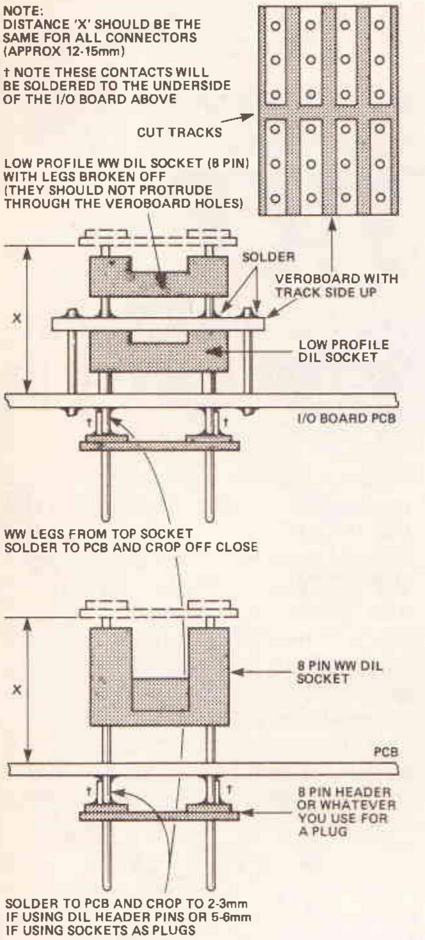


Fig. 8 Construction of SK1.

Insert but do not solder the other three 8 pin DIL sockets. Support the PCB such that it is level and parallel to a smooth flat surface and allow all the sockets to rest so that they are the same height above the PCB (with the DIL header parts plugged in). After making sure that they are also perpendicular to the PCB, solder them into position.

Now clip off the leads on the solder side to 2-3 mm (5-6 mm if you use DIL sockets instead of headers as the B plug parts). Insert the 8 pin (half of a 16 pin) DIL header plugs into the control board sockets and carefully position the I/O boards over them so that they are in the correct place. Now carefully solder them into position (this is the tricky bit!) — one or two pins only at this stage and then carefully remove the I/O board (now complete with plugs) from the control board and complete the soldering operation.

If you make more than one I/O card you can adjust the sockets to make sure that they all plug into each other. There should be enough lead length to allow this on all except SK1 so use this as a reference.

The reason for the elaborate construction is that the signals on SK1, the B signals, need to be processed on the I/O board before being passed onto the board above through a socket precisely above the socket through which they arrive. This construction technique is the reason for the double-height.

If you cannot get right-angled D connectors, take two ordinary D-type 15 way sockets and solder thicker than standard bare, single strand wires onto them. Bend these at 90° so that they fit into the holes on the board and let the sockets protrude a little over the edge of the board.

As many boards as are required may be made and stacked up on top of one another by means of the connectors described above, resulting in a sturdy tower. It is also a good idea to make a base for the system. Cut a piece of perspex, paxolin, SRBP or other plastic to the shape of the control board. Cut a smaller piece on the component side — dropping something conductive onto these strips could be fatal to the computer. The size of this piece is shown on the overlay diagram. Put the pieces of perspex in place and clamp them (not too tightly). Use a scriber to mark on the perspex the centre of the holes to be drilled by looking at the bolt holes in the PCB. Having done this, drill through the sandwich using a drill the size of the hole in the PCB — 2.5 mm or 0.1 inch if M2 or 8BA bolts are to be used. Four bolts of each of two lengths will be needed — one set have the PCB and one layer of perspex to go through, the others have the PCB and two layers of perspex. It is advisable to make small spacers to go between the perspex and the board out of narrow bore plastic tube, to allow for the gap needed for the soldererered connections. If no spacers are used, tightening the screws will cause unnecessary stresses in both the board and the pespex, leading to unsightly warping and possible damage to the board. Finally, glue four rubber feet onto the bottom of the lower perspex plate.

Testing

The first thing to do is to check your work until you are certain that it is perfect. Connect the control board up to the computer without the external power supply on and it should power up in the

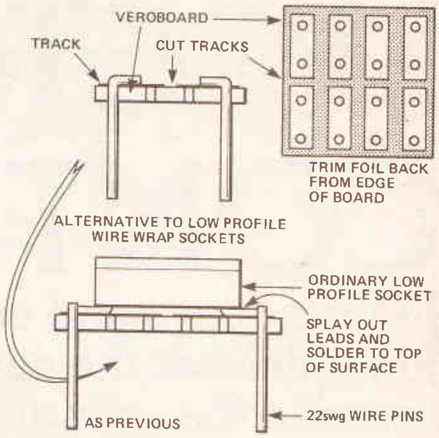


Fig. 9 Alternative for SK1 when low-profile wire-wrap sockets are not available.

usual way. If it does not, switch off IMMEDIATELY, and check the board until a fault is found. If this works, check that there is +5 V across pins 7 and 14 or 8 and 16 as appropriate of all IC sockets, and across the +V and 0V connections of SK1.

Switch off the computer and disconnect the board from it. Connect up the external power supply and +5 V should appear on pin 3 of IC1, but there should be no voltage detectable in any IC socket, nor on the connector back to the computer. If there is a voltage where there should not be, STOP NOW and check — it was at this point that the author blew every chip in his computer due to a faulty IC101.

If all is well, apply a voltage of 6V from batteries across 0V and +V on the edge connector and check that: —

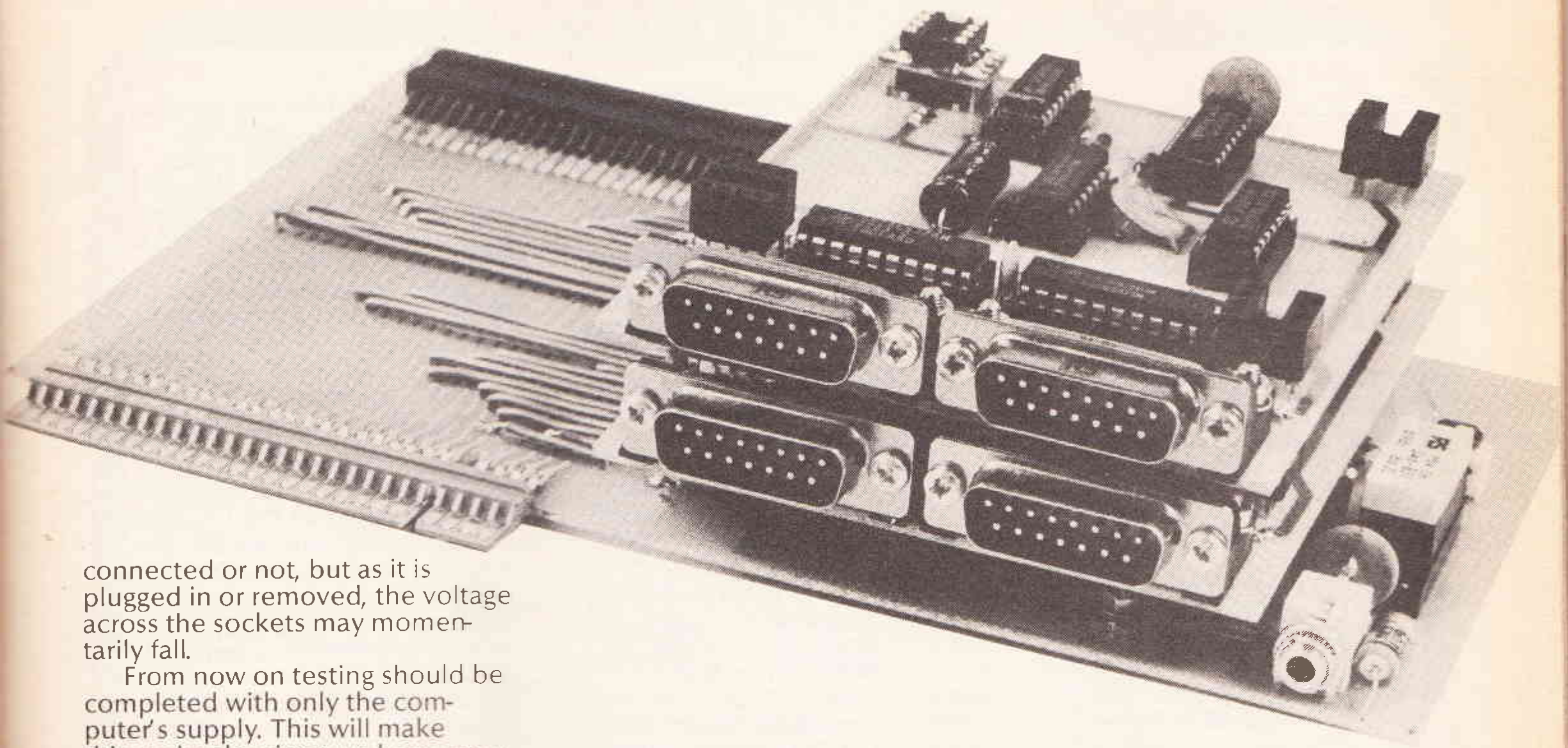
a) If only the battery supply is connected, the relay remains in its original position and 6V appears across the IC sockets.

b) If only the external power supply is connected, the relay stays in its original position and no voltage appears across any IC sockets.

c) If both supplies are in place, the relay clicks over, and 5V appears across the socket.

Even if all these tests work, look for shorts all over the board with a magnifying glass, concentrating particularly on the power supply section.

If everything has gone smoothly, remove all power, plug in the computer and switch on. Now plug in the external supply, but be ready to remove it immediately at the smallest sign of anything going wrong. As it is plugged in, the relay should click. 5V should now be present across all IC sockets whether the external supply is



connected or not, but as it is plugged in or removed, the voltage across the sockets may momentarily fall.

From now on testing should be completed with only the computer's supply. This will make things simpler since we know now that the power supply section works perfectly. Switch off and insert IC102,103 and 104 in that order, making sure that power-up proceeds in the usual way between each one, and if anything fails, switch off the and check until a fault is found. Power should always be removed for the insertion or removal of any integrated circuit.

Now switch off and plug in an I/O board without ICs, then go through plugging in ICs 1,3,2,4,5 and 6 in that order, testing power up each time as before. When all is complete, it is time for the acid test: will it actually work? Wire two D-type plugs to connect the 8 inputs of the board to the corresponding output bits. Type in this program and run it, with SW101 on the control board set to "LO".

```
10  FOR A=0 TO 255
20  OUT 31,A
30  PRINT A, IN 31
40  NEXT A
```

On any line of the screen, both numbers should be the same. If the numbers are all incorrect switch off and look for a fault. If only some are incorrect, the faulty bit can be determined by comparing the binary equivalents of the printed numbers.

Now change the 31s in lines 20 and 30 to 16415, move SW101 to "HI", and check that the program runs as before. Also check that on SK1 the following signals are correct: B0=1, B1=0, B2=0.

BUYLINES

There should not be too many problems with parts for this project. All the ICs are available from Technomatic and Rapid. The right-angle D-type plugs used were purchased from Electrovalue; other types are available, but we would suggest checking that they will fit the PCB (D-types come in curious lead spacings). The PCBs will be available through our PCB service.

Check each subsequent board by replacing the first one with it and carry out the same tests. Finally, plug them all in and check that each responds to the address (0 or 16384)+31+32 ×(the number of boards plugged in below the one in question).

Software And Use

If we wish to read from or write to the nth board in the stack in BASIC, then the address is:

$$31+(n-1)\times 32.$$

In machine code the instruction to use is IN A, nn or OUT nn, A provided SW101 is at "LO" and the board is the eighth in the stack or lower. If these conditions are not fulfilled, then we must resort to the instructions IN reg, (C) and OUT (C), reg. Of course, these instructions will not fail to work in the first page, but those previously described will in most circumstances be more convenient. When the second type of instruction is used, register pair BC should contain this pattern:

Bit Number	Contents
0-4	all one
5-8	number of the board in the stack, zero for the lowest.
9-13	all zero
14	state of SW101
15	zero

As an example, if we wish to continuously read numbers from the fourth board in the stack displaying the results on the screen, and output the one's complement of the number (all bits inverted) to the third board, this can be done as shown below (assuming SW101 is set to "LO").

From BASIC:

```
10  LET A= IN 127
20  PRINT  A
30  POKE 23692, 100: REM
ENDLESS SCROLL
40  LET A= 255 -A
50  OUT 95, A
60  GOTO 10
```

or from machine code:

```
START IN A, 127
CALL PRINT
CPL
OUT 95, A
JR START
```

or by using the more general addressing method:

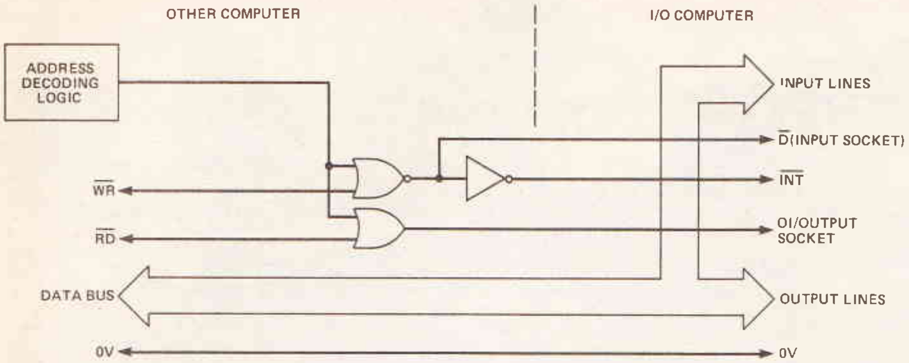


Fig. 10 Arrangements for exchanging data with another computer.

```
START   LD BC, 127d
        IN A, (C)
        CALL PRINT
        CDL
        LD BC, 95d
        OUT (C), A
        JR START
```

Note that the machine code versions are both endless loops — they serve merely as examples.

Looking now at the user side of the hardware, there are several points to guard against:

1. Make sure that successive boards are plugged firmly into each other, and check that pins have not become bent between uses. Bad connections will have unpredictable results, but are unlikely to cause permanent damage.
2. Never overload the Spectrum power supply — always use the external source when this is possible.
3. Be careful not to take so much current fr the output IC that it heats up - t is one of the more costly integrated circuits.
4. It is unwise to connect both the + and the − connections on the input and output sockets to power rails of external hardware. If its voltage is not quite the same as that of the Spectrum or I/O boards, damage could occur.
5. Remember to treat all hardware outside the computer with care. A second's carelessness in computer interfacing could cause havoc, even though every effort has been made to make the system virtually bomb-proof.

Data Exchange With Another Computer

Figure 10 shows the basic requirements of hardware used to pass data between the I/O computer (the one plugged into the control board) and another computer. With this hardware, it is the other computer which dictates when data transfer takes place. It reads when it wishes and sends the I/O computer an interrupt when it has placed some data to be read. The software side of utilizing Spectrum interrupts has been detailed several times recently in a variety of publications and is not of direct relevance to the I/O control system, so it is not considered here. **ETI**

ACTIVE-8 LOUDSPEAKER

Having discussed the design process at some length in the first two articles in this series, Barry Porter now turns his attention to the construction.

The time has now arrived to do your Chippendale impression, having first checked that your home insurance policy covers such unlikely events as drilling holes in the dining table and spreading the latest high technology glue over the G-Plan.

Figure 1 shows the cabinet construction in sufficient detail to enable the average DIY duffer to build a pair without too many tears. The exact method of assembly is not too important, providing the final result is rigid and all joints are airtight.

Do not attempt to cut the veneered panels with a handsaw — find a supplier who is willing to cut them for you using a high speed circular saw. This will ensure that the edges are square, which is essential if you want the final result to have a professional appearance. The bare edges should be covered with matching strip veneer. Avoid the type that is ironed on — plain veneer is much better, and when attached with contact adhesive is less likely to drop off.

The most difficult part of the cabinet construction is preparing the front baffle. The drive units should be recessed using the templates provided to mark out the panel before commencing. If you do not have the correct tool to route out the rebated areas, it can be done by cutting through the veneer with a sharp knife, and forming the rebate with a chisel.

Recess an area around the tuning vent to a depth of 3.5mm using the T33 template. This is for the interchangeable escutcheon which is replaced with a similar sized blanking plate for closed box operation. These plates should be made from 10SWG alloy with a 75mm diameter hole in the escutcheon. They should have four fixing holes in the same positions as the T33.

The escutcheon and both drive units should be attached by M4.5 x 20 machine screws with Tee nuts fixed to the inside of the baffle. Do not be tempted to fix the units with woodscress, even though you will find some enclosed with the T33; use these for hanging your holiday snaps on a wall instead.

Before fitting the drive units, half fill the cabinet with BAF wadding or medium density polyurethene foam blocks, taking care not to pack the area behind the vent too tightly and leaving a six inch clearance around the base unit.

A suitably sized hole for the lead-out wires should be drilled through the cabinet bottom and made airtight by a liberal application of glue from the inside. The cable should be firmly attached to the inside of the enclosure with 'P' clips so that, if it is accidently pulled, the connecting tags on the drive units will not be damaged.

If you know that the amplifier you will be using has a common output earth terminal a 3 core connecting lead is sufficient, but if the speakers are ever likely to be used with unknown amplifiers, separate connections to each drive unit should be made available. Four core mains cable is quite suitable for this purpose, as only short lengths are used.

The prototype cabinets were fitted with 50mm dual wheel Kenrick castors, which certainly eased the job of moving them around during construction. If you are a believer in the theory that loudspeakers should be mounted on reinforced concrete pillars that

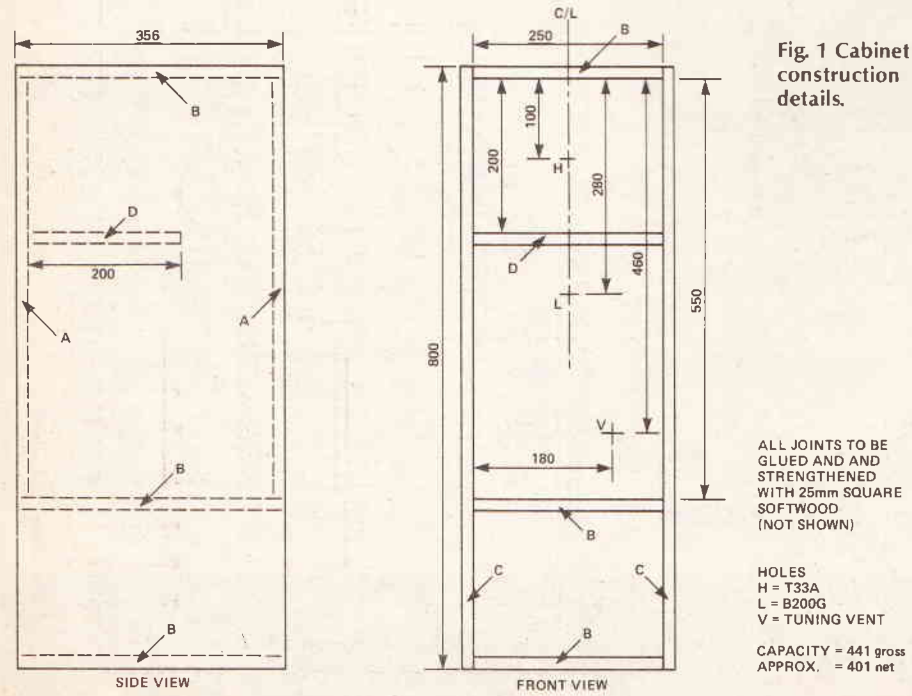


Fig. 1 Cabinet construction details.

descend half a mile into the bedrock (when surely seismic disturbances will influence the sound quality?) the castors can be replaced with carpet piercing spikes. In practice, no advantage has been found by doing this, which pro-

PARTS LIST — MOTHER BOARD & PSU

RESISTORS (all ¼ W 1% metal film unless otherwise stated)

R1,2	1k8
R3,4	8k2
R5,6	10k
R7	47k (see text)
R8,9	22R
R71	4k7
R72	2k2
R73	56R ½ W
R74,75	1k5

CAPACITORS

C1,2	1n0 polystyrene
C3	22p polystyrene
C4	100n polycarbonate
C5,62	22µ 16v non-polarised electrolytic
C6,7,64,65	100µ 25V radial electrolytic
C8,9,66-69	100n polyester
C61	10µ 25V radial electrolytic
C63	1000µ 25V radial electrolytic
C70,71	4,700µ 40V electrolytic (see text)

SEMICONDUCTORS

IC1	NE5534
IC9	7815
IC10	7915
Q6	BC143 or any PNP 1A T05 transistor
BR1	50V 2A bridge rectifier
BR2	209V 5A bridge rectifier
D2-5	1N4148
LED1	any panel-mounting LED

MISCELLANEOUS

FS1	200mA anti-surge fuse and PC-mounting holder
FS2	1A anti-surge fuse and panel-mounting holder
RL1	DPCO relay, 12V coil
RL2	DPCO relay, 12V coil, mains contacts
SW1	SPCO PC mounting
SW2	SPDT slide, toggle, etc.
T1	6-0-6V 3VA PC-mounting transformer
T2	12-0-12V, 500mA transformer

PCB; 5 off 10 way PCB plugs; relay holders as desired; mains outlet; audio connectors; cable, cable clips, etc.

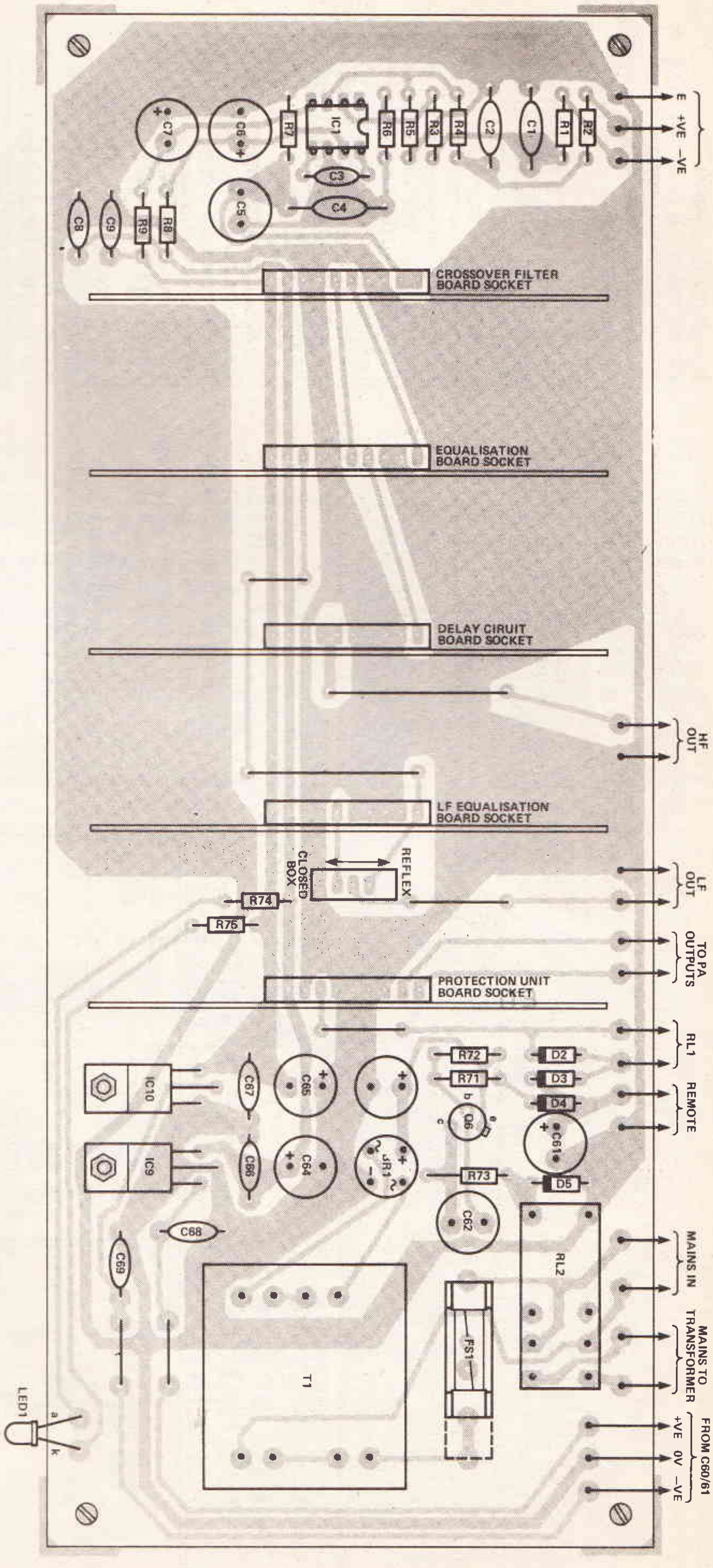


Fig. 2 Overlay of the mother board.

bably says something about the author's hearing or the quality of his living room carpet.

Should the final appearance require the drive units to be hidden from small sticky fingers or an inquisitive budgerigar, suitable grilles can be made from 12.5mm plywood covered with open weave material. Cut away the centre of the plywood to the point where the remaining frame is well clear of the units, while retaining sufficient strength to stay flat — about 50mm should cause no problems. Give the frame a coat of matt black paint before glueing or stapling the covering material into place. Attachment to the speaker

PARTS LIST — LF EQUALISATION CIRCUIT

RESISTORS (all ¼W metal film)	
R48,49	4k7
R50,53	110k
R51,52	15k4
R54,55	200k
R56	47k
R57,58	22R
CAPACITORS	
C46	1μ0 polycarbonate
C47,50	47n polycarbonate
C48	68n polycarbonate
C49	6n8 polystyrene
C51	100n polycarbonate
C52	22μ 16V non-polarised electrolytic
C53,54	100μ 25V radial electrolytic
C55,56	100n polyester
SEMICONDUCTOR	
IC8	NE5532
MISCELLANEOUS	
PCB; 10-way PCB socket.	

Construction

To make the filter unit as flexible as possible (not in the bendy sense), the mother board method of construction is employed. Although this is more costly in terms of the number of individual circuit boards, it does mean that changes can be introduced quite easily, and fault correction usually means replacing a plug-in board with a spare one.

The suggested mother board layout is shown in Fig. 2, and its overall size allows considerable freedom of choice when selecting a suitable enclosure.

Some circuitry has been placed on the mother board, namely the

PARTS LIST — PROTECTION UNIT

RESISTORS (all ¼W metal film unless otherwise stated)	
R59,60	39k
R61	220k
R62	100R
R63	100k
R64,69	10k
R65,66	56k
R67	22k
R68	330R
R70	27R 2.5W
CAPACITORS	
C57	100μ 25v non-polarised electrolytic
C58	100μ 25v radial electrolytic
C59,60	100n polyester
SEMICONDUCTORS	
Q1,3,4	BC184
Q2	BC214
Q5	BC143 or any 1A PNP T05 transistor
D1	IN4148
ZD1	6V2 300mW Zener
MISCELLANEOUS	
PCB; 10way PCB socket.	

Components not mounted on the circuit boards include the connectors, power supply transformer, rectifier bridge and smoothing capaciters. Ideally a toroidal mains transformer should be used, but as the circuitry is fairly tolerant of radiated hum fields a suitably specified frame type should not cause problems. The main smoothing capacitors should be at 4700uf 40V, but if space is not at a premium 10,000uf components can be used to advantage. These should be firmly clamped to the cabinet, and the rectifier bridge mounted directly to the supply rail terminals.

The type of signal connector used will probably be decided by the constructors financial status, but the input signals should be connected via multi way sockets with at least four pins. Good quality DIN connectors are acceptable, but professional XLR connectors are preferable. The accepted standard is that signal inputs use chassis mounted sockets, the type required for the 'Active-8' inputs being terms XLR-4-31. These should be wired to the following convention:

unbalanced, using an insulated phone socket. If you want to stick with professional connectors, the outputs should employ XLR-3-32 chassis mounting plus with signal on Pin 2 and Pins 1 and 3 joined to earth.

Whether used balanced or unbalanced, the input amplifier is DC coupled to the signal source, working on the assumption that pre-amplifier output stages are normally AC coupled. If you use one that isn't, it is quite permissible to place 10 or 22μf non polarized capacitors between the input socket and circuit board (not forgetting to place a 0.1μf polycarbonate in parallel).

The internal wiring is shown in Fig. 4, and should present no problems. (On reflection, if you have progressed this far without being removed by men in white coats, you will probably build the filter unit blindfolded!)

Next month we will conclude the construction details with the delay section overlay, and give Buylines (so don't phone us!). We'll also give some suggestions for extensions.

ETI

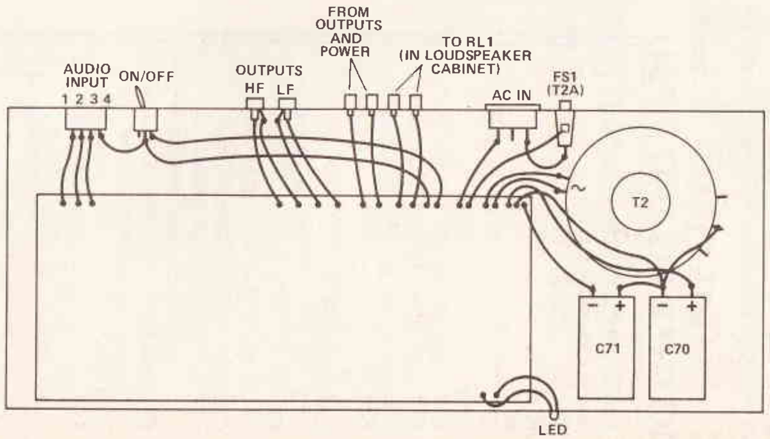


Fig. 4 Internal wiring diagram (note — BR2 not shown).

can be by the usual plastic socket fixings or, less attractively, strips of adhesive backed Velcro. If you intend packing your amplifier and filter unit in the open area at the bottom of the cabinet, the grille should be made long enough to hide the inevitable jumble of connecting cables from sight.

Once the cabinets are built and drive units installed, they may be set aside while work proceeds with the active crossover filters.

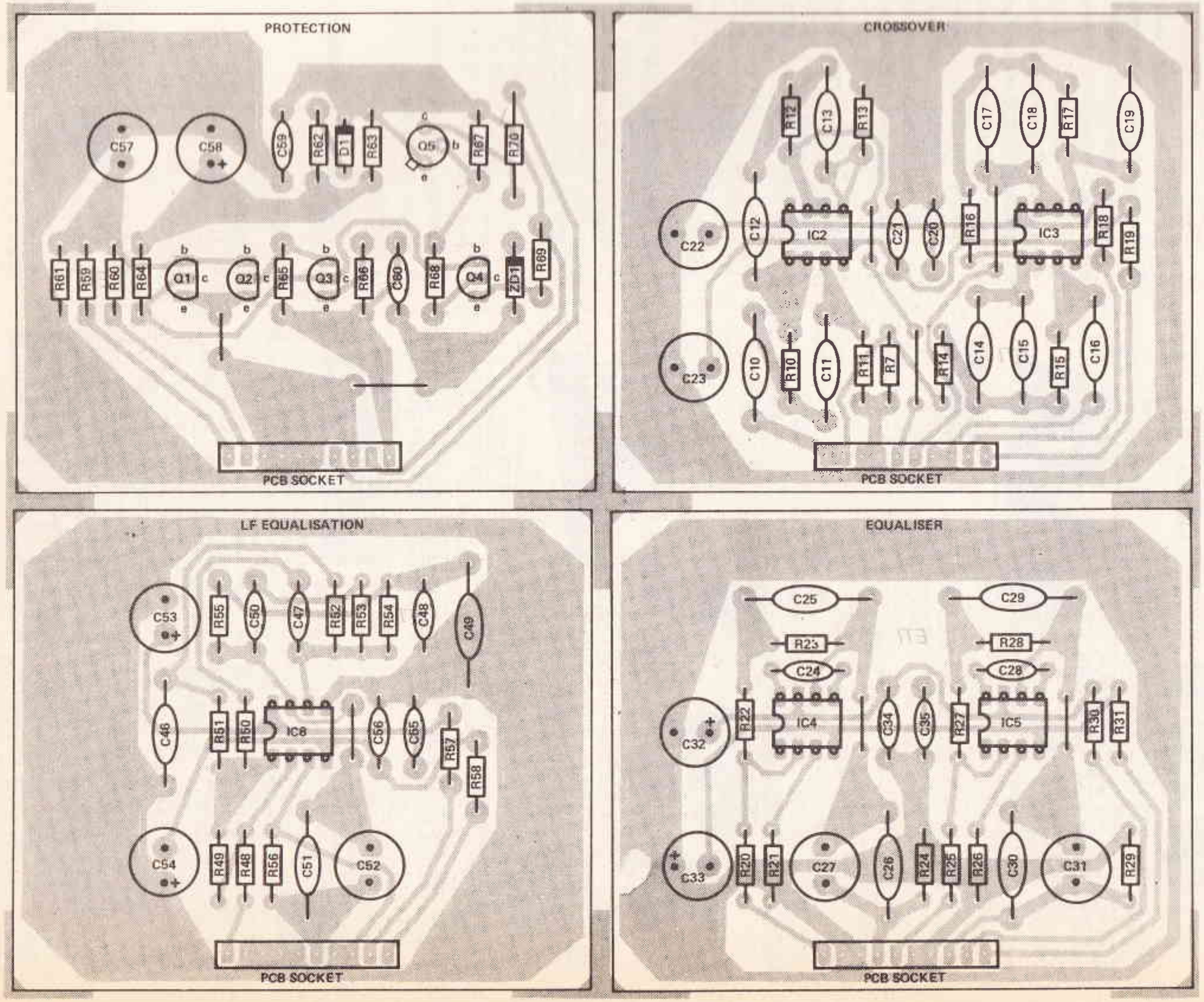
input amplifier, power supply stabilisers and remote mains switching unit, but the filter and equalisation stages are mounted on the plug-in cards shown in Fig. 3 (except for the delay unit, which will be given next month due to lack of space). Note that two locations are shown for R7; it should normally be placed at the output of the buffer, but if, for any reason, the buffer is not to be used, it should be placed at the input of the crossover filters instead.

Pin 1 — Signal earth
Pin 2 — Signal +
Pin 3 — Signal —
Pin 4 — Remote switching

If you use an unbalanced feed from your pre-amplifier, this should be taken to Pin 2, with Pins 1 and 3 joined together in the XLR cable plug.

The filter unit output is at low impedance, and the connection to the power amplifier should be

Fig. 3 Overlay of the protection, LF equalisation, crossover filters and equaliser sections.



PARTS LIST — CROSSOVER FILTERS

RESISTORS (all ¼W 1% metal film)	
R7	47k (see text)
R10,12,14,15,16,17	11k
R11,13	22R
R18,19	22R
CAPACITORS	
C10-19	3n3 polystyrene 2.5%
C20,21	100n polyester
C22,23	100µ 25V radial electrolytic
SEMICONDUCTORS	
IC2,3	NE5532
MISCELLANEOUS	
PCB; 10-way PCB socket.	

PARTS LIST — EQUALISER

RESISTORS (all ¼W 1% metal film)	
R20,27,28	10k
R21,26	100R
R22	6k8
R23	3k9
R24,29	47k
R25	20k
R30,31	22R
CAPACITORS	
C24,28	22p polystyrene 2.5%
C25	10n polystyrene 2.5%
C26,30	100n polycarbonate
C27,31	22µ 16V non-polarised electrolytic
C29	33n polystyrene 2.5%
C32,33	100µ 25V radial electrolytic
C34,35	100n polyester
SEMICONDUCTORS	
IC4,5	NE5534
MISCELLANEOUS	
PCB; 10way PCB socket.	

DIRECT-READING CAPACITANCE METER

Returning almost immediately to our pages after his recent Audio Design series, John Linsley Hood presents a simple, low-cost capacitance meter design.

Most electronics enthusiasts will have some means of measuring voltages and resistance values at their disposal. Indeed, the humble bench multimeter will do an adequate job in this respect, at a modest cost. However, knowing if the capacitor one has fished out of the junk box, or even out of the parcel of new components freshly delivered from Bloggs Electronics, is indeed what it's markings say it is will be a different mater.

A small gadget to measure capacitance values therefore makes a useful addition to the test bench, and can be invaluable if one is building an audio filter stage, a sine-wave oscillator, or anything else which requires accurate, or at least well matched values of capacitance.

One of the simplest ways of measuring capacitance is to connect the component under test to a suitable (low voltage) source of AC, and then measure the current which flows through it. For small values of capacitance, this is obviously not going to be very big, so some kind of electronic amplifier will be needed.

A suitable arrangement is shown in outline form in Fig. 1. The only specific requirement is that Rx must by very small in value in comparison with the impedance of the capacitor under test.

The Circuit

The actual circuit used in the instrument is shown in Fig. 2, and is simply a high input impedance milli-voltmeter having a FSD input sensitivity of about 27mV and built around a TL071 op-amp.

The range switch is chosen to give full scale capacitance value indications of 10pF to 100uF. The capacitance ranges increment in steps of 1:10:100, etc., using the given values for R1-R9, but there is no reason why the constructor should not adopt a 1:3:10:30 series by making the resistor bank have values in the 3M3, 1M0, 330K, 100K . . . sequence.

For testing electrolytics, it is desirable that there is a small polarising voltage on the capacitor under test. This is done by switching the lower end of the resistor bank of SW1 to the −5V line. This effectively puts the DC supply smoothing capacitor of this line in series with the capacitor under test, so it is advisable to make these large with respect to the 100uF maximum instrument range.

Construction

Virtually all of the low-voltage circuitry is mounted on the PCB, including the meter and the range-setting switch with its associated resistors. However, neither the transformer nor the mains fuse are mounted on the board because of the risk of AC pick-up from them.

Assembling the PCB should present no problems provided the overlay is followed carefully. Begin by soldering SW1 into place and then move on to the resistors and

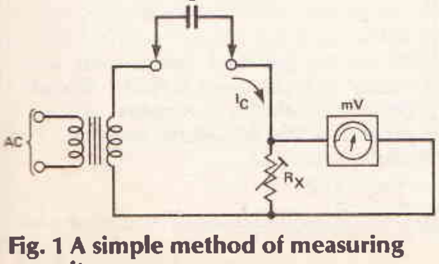


Fig. 1 A simple method of measuring capacitance.

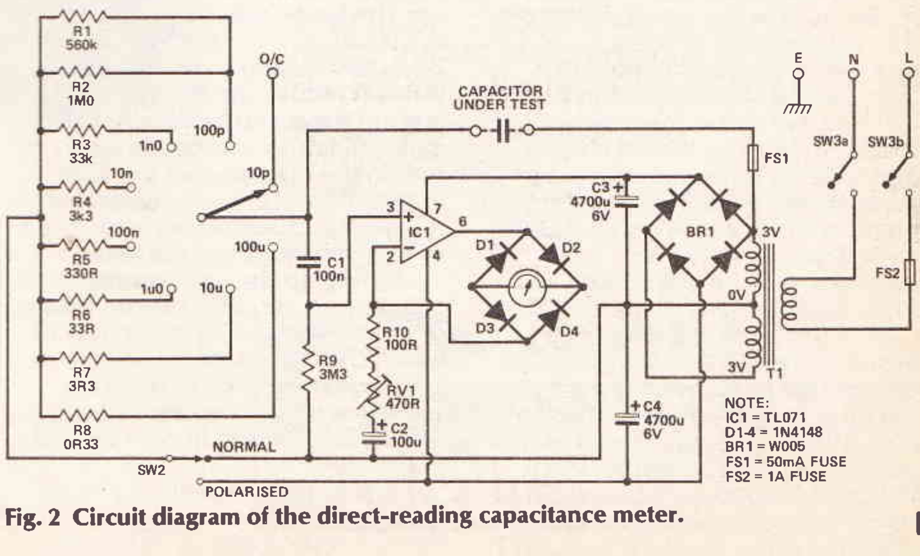
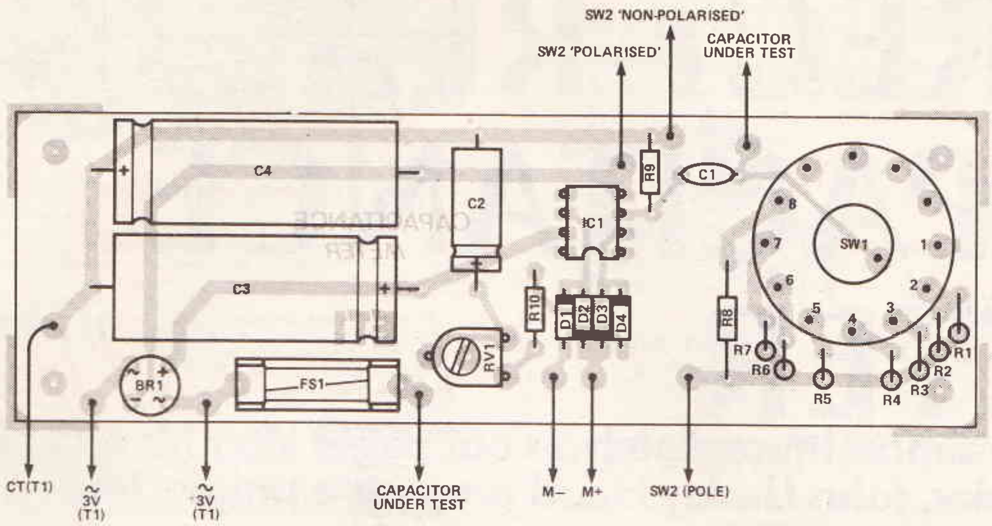


Fig. 2 Circuit diagram of the direct-reading capacitance meter.

Fig. 3 Component overlay of the PCB.



PARTS LIST

RESISTORS		**C3,4**	**4700u 6V electrolytic**	**T1**	**3-0-3V 3VA chassis mounting transformer**
R1	**560k**			**F1**	**50mA 20mm fuse and chassis mounting holder**
R2	**1M0**	**SEMICONDUCTORS**		**F2**	**loudspeaker-type twin spring terminals**
R3	**33k**	**IC1**	**TL071**		
R4	**3k3**	**D1-4**	**1N4148**		
R5	**330R**	**BR1**	**W005**		
R6	**33R**				
R7	**3R3**	**MISCELLANEOUS**			
R8	**R33**	**M1**	**100uA moving coil meter**		
R9	**3M3**	**SW1**	**1 pole 8 way rotary switch**		
R10	**100R**	**SW2**	**SPDT toggle switch**		
RV1	**470R**	**SW3**	**DPDT mains toggle switch**		
CAPACITORS					
C1	**100n**				
C2	**100u 16V electrolytic**				

PCB; diecast box; mains cable and strain relief bush; knob for SW1; spacers, nuts and bolts for mounting PCB and T1; screening material.

capacitors, taking care with C2, 3 and 4 which are electrolytic and must be inserted the right way around. Finally install the diodes and the op-amp, again taking note of polarity. The op-amp is a bi-FET device and requires no special handling precautions; some constructors may prefer to use a socket for it but this is not essential.

Because of the susceptibility of the high impedance input to AC pick-up, it is recommended that the instrument be housed in a diecast box. No particular type is specified, but you should choose one which is large enough to accommodate the PCB plus the off-board controls and which has sufficient depth to allow the transformer to be placed well away from sensitive parts of the circuit.

The test terminals should be positioned close to the appropriate pads on the PCB and then connected up using very short lengths of wire. These two leads should not, of course, be twisted together since this would introduce a certain amount of capacitance and thus affect the accuracy of the unit. SW2 presents no such problems and can be wired up in the normal way.

The transformer and the mains switch and fuse should all be positioned well away from the op-amp and the test terminals, particularly the terminal which connects to the wiper of SW1 since this point is at high impedance and therefore very sensitive to AC pick-up. The leads from the secondary of the transformer to the PCB should be tightly twisted together since this will reduce the magnetic field around them and hence the risk of pick-up. It may also be necessary to screen the op-amp and the high impedance terminal completely if the meter is to operate correctly on its two most sensitive ranges.

Setting up the instrument, on completion, requires the availability of a few good quality capacitors of which the capacitance is known to an adequate degree of accuracy. The value of RV1 can then be adjusted to give the best fit over several ranges.

It is possible to attach a pair of leads to the test terminals and use them to test capacitors in situ, but AC pick-up on the high impedance lead will introduce errors and this method can therefore only be used with large values of capacitance. In all other circumstances it is advisable to place the capacitor under test directly across the test terminals. If the size or construction of a capacitor prevents its being connected in this way, attach a flying lead to the low impedance test terminal (the one from the secondary of the transformer) and use this to connect to one side of the capacitor while the other side is inserted directly into the high impedance terminal.

BUYLINES

All of the specified components are readily available and suitable diecast boxes are sold by a number of suppliers. The PCB is available from us.

ETI

CUSTOMISED ICs

Customised ICs are catching on as fast as customised number plates. S.M. Smith explains how PLAs and ULAs have brought down the price.

In the past ten years or so the complexity and density of circuits integrated onto one chip has increased dramatically. This trend is continuing for the following reasons:

Size: usually, one chip is smaller than twenty. Smaller circuits fit into smaller boxes, which are cheaper to manufacture and transport than large heavy ones. If several PCBs can become one, inter-PCB connections are saved.

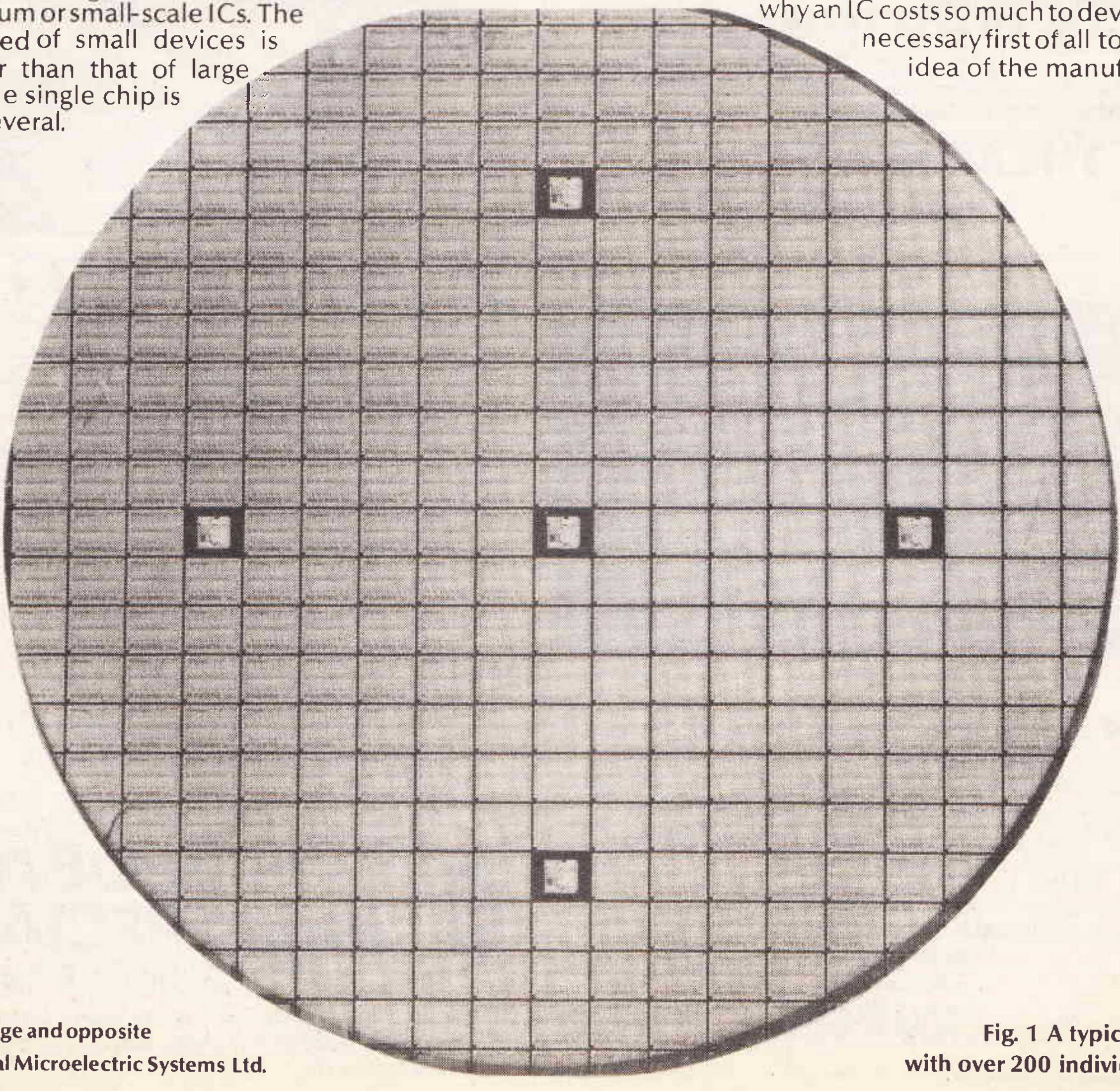
Power consumption: in general a single device consumes less power than several. The consequent drop in heat dissipation may allow natural instead of fan-assisted cooling, or reduction of heatsink sizes, or both. Also a less bulky power supply is needed. The whole equipment may then reduce in size and weight by far more than the initial amount caused directly by integration.

Speed: devices on large scale ICs tend to be smaller than those in medium or small-scale ICs. The switching speed of small devices is usually faster than that of large devices, so the single chip is faster than several.

Reliability: one chip is more reliable than several. Reducing the chip count in equipment reduces the number of interconnections and hence the probability of a faulty connection. More reliable equipment means cheaper equipment, as less money has to be allocated for fixing faults arising during and after production.

Security: a board full of TTL ICs is easily copied by unscrupulous competitors. An anonymous black plastic block can only be copied with a lot of effort.

There are several ways of putting a logic system on a chip, ranging from the full custom IC down to the familiar PROM. A fully custom integrated circuit is a complicated device that takes months to design and develop, and requires massive investment in plant to manufacture. To recoup the cost of this requires sales of either a huge number of devices at reasonable prices, or a few sales at ridiculous prices, the latter being luxury indulged in only by the aerospace and defence industries. To understand why an IC costs so much to develop, it is necessary first of all to have an idea of the manufacturing process.



Photos on this page and opposite are courtesy Racal Microelectric Systems Ltd.

Fig. 1 A typical wafer, with over 200 individual ICs.

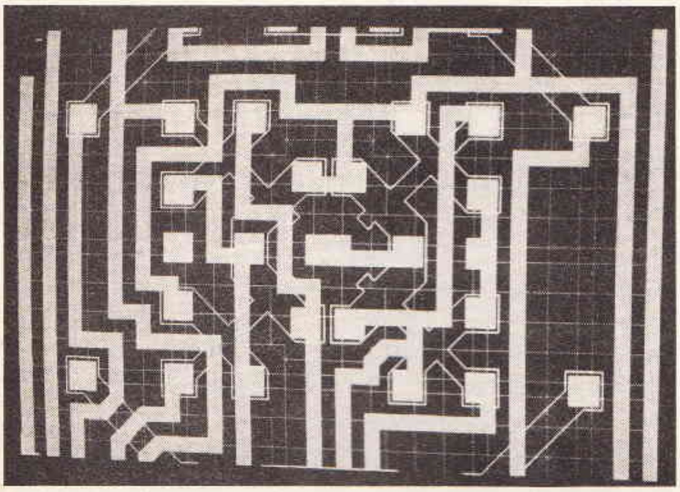


Fig. 2 Metal tracks laid out on a ULA, as seen on a VDU during design. The filled-in white area are metal tracks. the thin white lines outline transistors and diffused cross-unders, while the faint grey lines mark allowed track placements.

Integrated circuits are fabricated on thin sheets of silicon, 2" to 5" in diameter, called wafers. The silicon used for IC fabrication has to be extremely pure — 99.99999% pure. It must also be mono-crystalline, with the atoms laid out in a regular three-dimensional pattern and no defects. Since the wafer is polycrystalline silicon, a near-perfect layer of single-crystal silicon must be grown on the wafer surface, using a process called epitaxy.

Making Transistors

Transistors and resistors are made by *doping* the silicon with minute quantities of other elements, such as boron, gold, phosphor and indium. Obviously, a single transistor 3" in diameter is of little use, so the doping is introduced only to selected areas of the silicon surface. Areas to be doped are defined by holes in a layer of silicon dioxide on the wafer; the oxide prevents dopant reaching the silicon.

The shape and location of the holes in the oxide layer are ultimately determined by a pattern held in a computer. This pattern is converted into a 400 × full size master print which is photographically reduced in two or three stages onto a chrome-coated glass plate, the 'mask'. Several hundred patterns are repeated across the mask in a precise regular array, so one wafer will yield several hundred chips (see Fig. 1).

The wafer is coated with a photo-resistive polymer, which reacts to ultra-violet light (a similar process is used in PCB production). The mask is then placed over the wafer, in precise alignment with previous processing steps, and then the wafer is exposed to UV. The mask is removed and the unexposed resist is rinsed off with a solvent — the exposed resist, hardened under the ultra-violet, does not rinse away. Now the un-covered section of the oxide can be etched away with acid, leaving silicon exposed for doping.

The final mask defines the metallisation layer, which is a thin network of aluminium tracks interconnecting devices on the chip. There may be several metal layers, separated by insulating oxide layers.

There are around seven processing stages for each mask, and an IC design may require 5 to 12 masks. This makes the process long, expensive and error-prone.

The Expertise Gap

There are few engineers capable of designing an integrated circuit at this level of complexity, with control over doping levels, transistor sizes and so on. Fortunately, many applications do not require minute control over the electrical characteristics of the devices on the chip. Semi-custom logic design allows an ordinary logic designer to design an integrated circuit.

The most complex semi-custom approach is the standard cell. Here the designer has access to a computer database containing mask layouts for often-used devices and functions up to the complexity of, perhaps, a full adder. The designer extracts from the database the devices and functions needed; he or she may have some control over electrical performance if layouts are held for different versions of the same device.

This is still an expensive method; although design data has been previously calculated for each function required, new masks have to be made for each IC. To be cost effective, large returns on sales must be certain. The advantage over full custom is the lower expertise required of the designer and faster design time, with only a small loss in performance.

Uncommitted Logic

The next level down in terms of cost/time is the gate array, or uncommitted logic array (ULA), to which the bulk of this article is devoted. In the ULA the devices and some inbuilt interconnection are ready-fabricated. The devices are laid out in a regular array with channels between groups of devices for interconnection routing (Fig. 2). The designer's job is to complete the interconnection by specifying a metallisation mask layout.

Although the designer has no control over electrical performance of the devices, and some waste of silicon area is inevitable due to the fixed form of the array, the ULA is attractive because of its fast design time (5 to 12 weeks) and lower production costs (only one or possibly three new masks have to be produced). It is therefore suitable for projects expecting relatively low sales volume.

Fuse Programming

Next comes the fuse-programmable logic array (FPLA; some versions are called PAL or PLA). These come in a number of different versions, but basically consist of a set of AND gates feeding a set of OR gates. Fusible links control which of the chip inputs go to which AND input, and which AND output to which OR input. Some FPLA's incorporate D-types, registers and optional feedback loops to allow sequential circuits to be burnt in.

FPLAs have the advantage of very fast design time (a few minutes from specification of the logic function to production of the program for blowing the array). They tend to lack versatility compared with a ULA and make inefficient use of silicon. They have the advantage of in-house programming (no need to send them away to the manufacturer, with the attendant delays) and can be very cost-effective in some applications.

And PROMs Too!

The final option is to use the PROM (Programmable Read Only Memory). This has the advantage again of on-the-spot programming and may implement more complex logic functions than the FPLA. The required truth-table is programmed into the PROM; the address lines are used as the logical inputs, and the data lines are the required outputs. However, the PROM is a comparatively slow device, and its use may often be a waste of silicon; as an extreme example, an octal inverter (16 transistors in CMOS) implemented on a PROM requires 256 words by 8 bits — a 2K memory!

Because of the reasons above, the ULA is the most important of the routes to a semi-custom logic IC at present. It is likely to become more so in the future as the pace of technology quickens, demanding new designs in shorter timescales, and as the software tools for ULA design improve, allowing more fully automated design and design of larger chips.

CMOS is the fastest-growing gate array technology at the moment, due to it's combination of speed, power consumption, packing density and ease of design.

Designing A ULA

It would be almost impossible to design a ULA without the help of a computer. People are slow, they find checking boring and they make mistakes. Fortunately, computers are not yet intelligent enough to get bored.

The design starts, usually, with a 'breadboard' model of the circuit, in TTL or CMOS or whatever is most suitable. This stage is used to check if the ideas are correct; it may be considered unnecessary if a well-known design is being implemented. The design is then translated into a form suitable for putting on a ULA. There will be some differences between the breadboard and ULA versions of the circuit because in CMOS arrays some logic structure are more easily implemented than in bipolar technology or 4000-series CMOS.

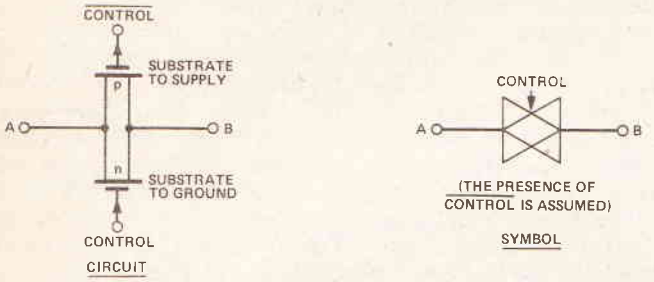


Fig. 3 The transmission gate.

One basic unit, fundamental to CMOS gate array design, is the transmission gate, a pair of P and N channel transistors with their sources and drains tied together, with complementary gate signals, Fig. 3. When CONTROL is high the N-channel transistor is turned on, and since $\overline{\text{CONTROL}}$ is low, the P-channel transistor is turned on too. Thus a signal can pass from A to B.

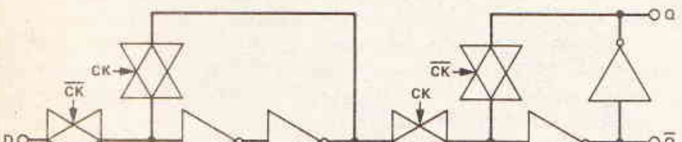


Fig. 4 D-type flip-flop (positive edge triggered) using 16 transistors (two per transmission gate, two per inverter — circuit not shown for inverter, but assumed very simple).

Using this construct, a D-type flip-flop, for instance, can be made with just 16 transistors, Fig. 4. An even more economical D-type can be implemented using only eight transistors, Fig. 5. This relies on the charge stored at X during CK lows. When CK goes high the signal progates to Q. Of course, the gate capacitance at X will leak, so a minimum clock frequency of a few kHz must be guaranteed.

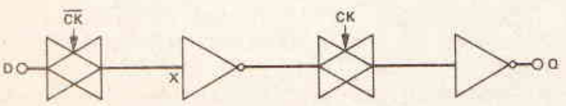


Fig. 5 Faster, more economical D-type using the gate capacitance at point X as a storage element.

Because transistors in the ULA are individually accessible, composite gates can be built up using less silicon area than if a gate array really were an array of gates, rather than transistors, Fig. 6.

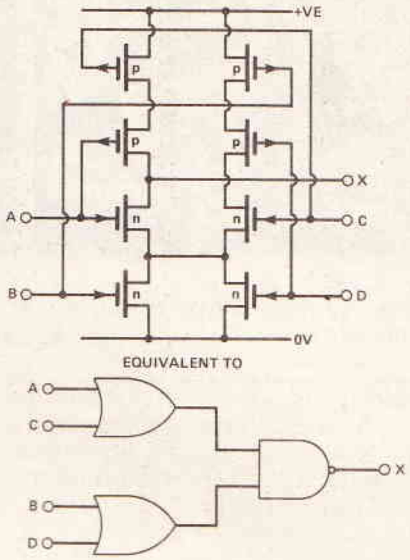


Fig. 6 Composite gate, where the gate function has been implemented directly rather than been broken down into individual elements.

Once initial design is completed, some verification of the design will be required. At around £10,000 per fabrication run, the 'suck-it-and-see' approach is not popular. This is where CAD (Computer Aided Design) is used.

Verification Procedure

Initially electrical characteristics, usually just propogation delay in logic design, are checked. Most common elements, inverters, AND gates, adders and so on will already have been simulated by the manufacturer, but a few special functions may require investigation.

To simulate a circuit at this level (device level) requires a program with device models incorporated, and a knowledge of the model parameters to use, things like channel length, oxide thickness and doping levels for very thorough simulations, or turn-on voltage and channel dimensions for more approximate simulations. The program takes its information from a file containing the circuit description, and a set of instructions on what to do to the circuit.

For propogation delay analysis, the circuit is stimulated with a know input waveform, and the program instructed to give the input and output voltages at, say, 1 ns intervals. The output can be plotted by another part of the program and delays read off, Fig. 7.

To simulate a whole circuit at device level is possible, but rather pointless; the detail is unnecessary and the program execution time too large. Other, circuit level, simulators are employed, for which the parameters used are simply gate delays. The output from this simulation is used to detect hazards and glitches which may not have been present in the breadboard model due to its different layout, logic family or size.

A hazard exists when different delay paths in a circuit cause the output to change state when it is not expected

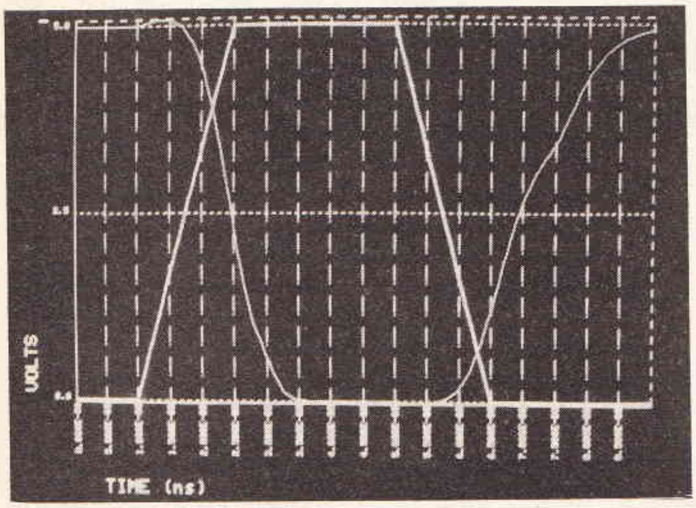


Fig. 7 Output from propagation delay analysis program.

to. The output of Fig. 8 should be low only when ABC=011. A transition of ABC from 001 to 111 should therefore have no effect on X — it will remain high. However it can be seen from the timing diagram that if the AND and NAND gates have different propogation delays (as they often do in practice) there is an output change.

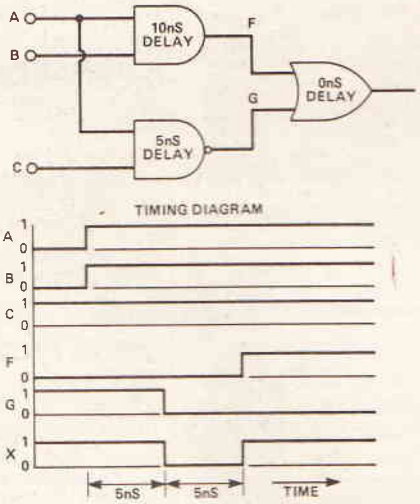


Fig. 8 An example of a timing hazard.

The presence of problems like this may mean the difference between success and failure of a design. Hazards can be eliminated by careful design, or made irrelevent by using fully synchronous (clocked) logic, essentially allowing the circuit plenty of time to settle between input changes.

Another important factor a designer must consider is testability. An IC may contain the equivalent of 2000 gates and yet have only 40 pins. It is not possible to put test probes inside an IC, as it is too small. Every test node must somehow be brought out to a pin, or at least a bonding pad.

Getting Stuck

The two most usual fault conditions in an IC are a gate input stuck at '1', and a gate input stuck at '0'. Consider the circuit of Fig. 9. If this circuit operated correctly, then input ABC=0 would produce the output X=0. However, if B is stuck at 1 the output will be 1. The pattern ABC=100 is a test for the fault B S-A-1 (B stuck at 1).

The problem in an integrated circuit is that the circuit of Fig. 9 may be 'buried' deep in the IC, and it is difficult to

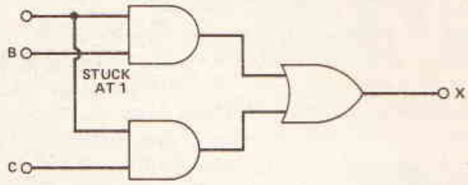


Fig. 9 Fault testing: suppose the input B is stuck at 1.

get the required test patterns to it — perhaps other circuits have to go through several states before the values on ABC reach 100. One rather elegant solution to this problem is called *scan design.*

Most logic circuits have flip-flops and registers on them. By designing a few more and adding some extra steering gates, the on-chip registers can be connected as a long shift register, and the latches used to hold test patterns.

Three extra pins are needed: 'TEST', 'TEST DATA IN' and 'TEST DATA OUT'. When TEST is high, the circuit is in test mode, and test data is serially fed in to the flip-flop chain. After a number of clock pulses the required test pattern is in the circuit under test. TEST is taken low and the circuit operated normally. Test outputs are sent to the registers. Then TEST goes high again and the output values are clocked out along the shift register to TEST DATA OUT.

There are algorithms for finding test patterns for the possible faults in a circuit. Given the logic diagram, correct software and some time, the computer can generate test patterns for most faults. It can also detail those faults which are undetectable with the circuit as it stands; such faults often indicate some redundancy in the circuit.

The gate level simulator can be used to simulate a faulty circuit. This may seem unnecessary, but it is useful to test the efficiency of test patterns.

The Layout

The next stage is the circuit layout. The designer will probably start with a paper sketch showing roughly where each functional block will go, and proceed from there. He or she will try to interconnect the blocks along certain allowed lines (there will be a set of design rules, governed by the accuracy of the manufacturing process, which determine track minimum widths and spacings, etc). There are automatic connection routing programs, but they are usually for two or more metallisation layers, while most ULA's have only one. People produce more compact layouts than computers, especially when constricted to fixed channels allowing only a certain amount of interconnection tracks.

Finally, automatically, semi-automatically, or manually, a layout is produced. The likelihood of an error, especially with a manual layout, is high.

A piece of software called a *design rule checker* will look for tracks too close together, incomplete tracks and so on, reporting back to the designer, who can edit mistakes at an interactive graphics terminal. There is also the question of whether the circuit drawn actually performs the intended function, even if it complies with the rules for physical layout. A *circuit extractor* program can work out the function of the layout, simulate it, and compare the results against those expected from the circuit. This is a difficult and time-consuming task, even for a powerful computer. The need for this stage can be reduced by careful design, or eliminated completely by the use of automatic layout and interconnection.

Finally the data describing the complete, checked layout are fed to another program which generates instructions for a machine which produces the metallisation masks. Masks traditionally are made by photographic reduction of a 400 × full size master, cut by a computer-controlled knife. Nowadays electron-beam lithography is common; an electron beam scans the actual size mask, exposing electron-sensitive resist. This latter method is more accurate than the first, allowing higher circuit densities, and, because each chip pattern is individually written, it costs little extra to change the program halfway and write two, three or four different metallisation layouts onto one mask. This allows smaller than usual quantities to be economically committed.

The Future

What of future developments? Most predictions are based on company forecasts, and they obviously predict a rosier future for whatever semi-custom method or technology they are marketing that their competitors do not have. However it is possible to say some things with reasonable certainty.

Silicon-gate CMOS arrays are likely to dominate the market in most applications, due to their combination of speed, density and low power. Low power density is important with high levels of integration — chips which dissipate more than a watt or so require special packaging to keep them cool and the package may cost more than the chip it houses.

Software is still chasing hardware in sophistication — 20 000 gate arrays are announced but no CAD system can adequately handle them yet. 30 000 gate arrays have been predicted for 1985. Array manufacturers are becoming aware of these difficulties, and are employing software writers to produce product-specific CAD tools at the same time as hardware designers work on the physical design of the array.

Most ULA sales are in the 300-1000 gate range, the very large arrays tending to be purchased by the computer industry. A recent FPLA chip (the AmPAL22V10 from Advanced Micro Devices) claims to offer the versatility of a 500 to 1000 gate array be celver design and the provision of over 5800 fuses. Perhaps we shall see FPLAs making headway into markets previously the domain of the gate array.

By the end of this decade CAD software may have advanced to the level where the standard cell will exceed the gate array in popularity. This is because most systems are not composed only of logic circuits — they contain RAM, ROM, EPROM and linear devices like op-amps, analogue to digital converters and voltage references. There are arrays which have linear functions and memory areas on them (an ordinary array wired as a RAM is very wasteful of silicon) but the problem is always how much space to allocate to each function. If too many choices are offered none will sell in large numbers and the advantages of mass production are lost. With a standard cell IC there are no such problems — as much ROM, etc, as is needed is fabricated.

Increasing levels of integration bring problems of pinout too — 64 pins is the usual maximum in a DIL package. However a semi-custom IC may be replacing a whole PCB with over 80 connections. We are likely to see more and more exotic packages such as flatpacks and pin-grid arrays (which look like a bed of nails from the pin side).

In conclusion, then, it seems likely that more and more products will employ semi-custom ICs of one sort or another. These ICs will be designed by ordinary circuit designers, using powerful software tools running on mini-computers or special-purpose micro-computers.

ETI

VIDEO VANDAL

Does Wogan leave you feeling green, or the news make you blue? Get your own back with ETI's video effects unit.

The Video Vandal is a colour video effects generator which can change a normal video image in many different ways. The effects available include:

(1) Posterisation, where the picture is resolved into a variable number of brightness levels in a way similar to, but more controllable than, photographic solarisation, as used in many pop videos;
(2) pseudo-Mosaic, where the picture is cut into vertical 'ribbons', an effect similar to that used in certain cigarette adverts in magazines;
(3) use with a computer as a frame grabber or for image analysis, and
(4) 'false colour', in conjunction with a suitable monitor or PAL encoder, where colours are used to represent different brightnesses in a manner similar to that of the well-known electronic Infra Red imaging systems.

This last effect is extremely eerie — it is very like the effect used in the title sequence of the BBC's Day Of The Triffids.

The circuit is shown in block diagram form in Fig. 1. The video signal is switched either 'straight through' or processed. If processing is selected, the signal is amplified, has the sync pulses stripped from it and has its maximum level limited, while a portion of the colour information is filtered off by a capacitor acting as a high pass filter. The syncless signal is presented to the analogue to digital converter chip whose clock is locked to the sync pulses. The digitised signal is next put through six 'bit switches' before being fed into a buffer and the digital to analogue converter and thence to the output section. Here, the sync and luminance are re-combined into a composite video signal which finally feeds, with the colour signal added, the output socket and, if selected, a UHF modulator.

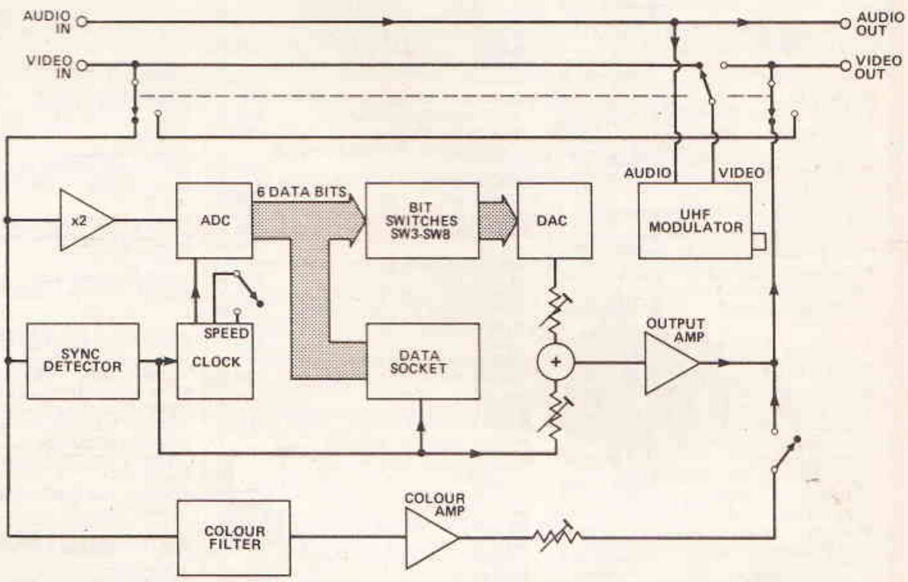


Fig. 1 Block diagram of the Video Vandal.

CONSTRUCTION

There is nothing particularly critical about the construction of the Vandal, provided the high frequencies are taken into account.

The boards should be assembled in the usual sequence of links, IC sockets, passive components, semiconductors. Do not insert the ICs (except the regulators) until you start set up. Be very careful when you handle the ADC chip, as it *is* static sensitive, and on a chip of that price all precautions such as an earthed metal working surface should be used — a stainless steel draining board is ideal (but don't drop anything down the plughole!). Once in situ, however, the ADC chip is fairly robust, as its input is protected by R19.

There are a lot of large-ish screened cables to connect, so care is recommended while working. The wiring diagram is intended to guide you as far as what goes where, and the use of cable ties when wiring is complete is a must. Audio quality screened cable may be used where screened cable is specified, providing the core is at least 7/0.2.

The bit switches should be connected to the DIL header plug via a length of ribbon cable, which is also used to connect the DATA socket. If there is interference on the video signal, then wrapping the ribbon cable with aluminium foil (and earthing it) is beneficial.

The connections to SW9 should preferably be made with

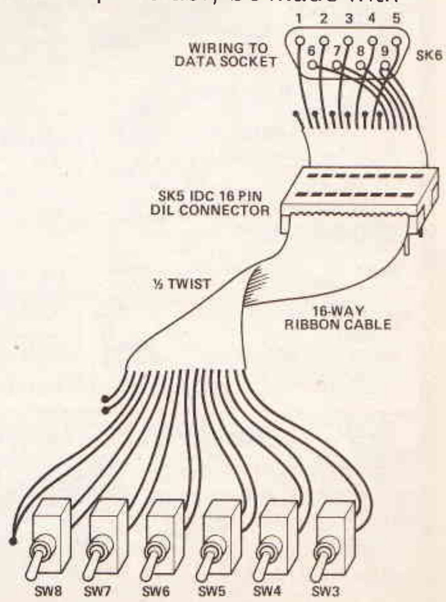


Fig. 2 Connecting up SK5, SK6 and the bit switches.

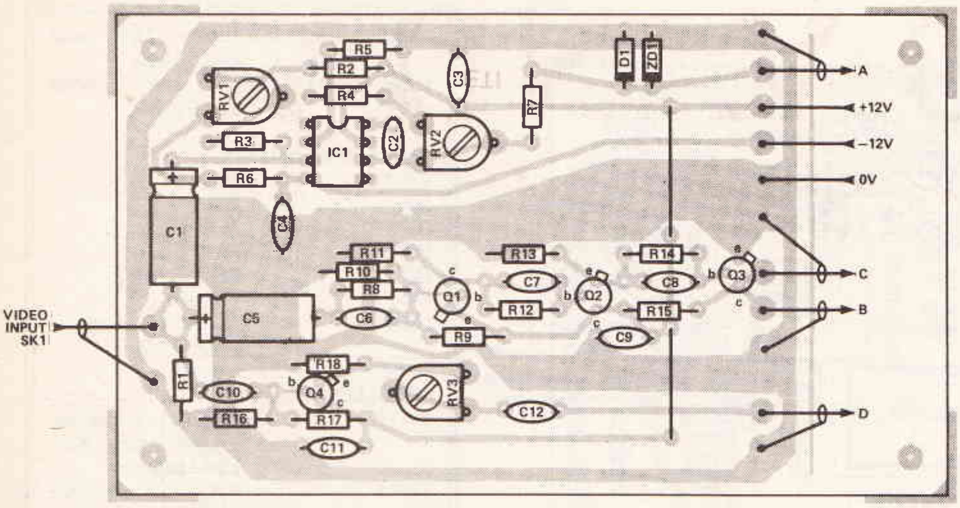


Fig. 3 Component overlay for the input board.

PARTS LIST — INPUT BOARD

RESISTORS (all ¼ W 5%)	
R1	68R
R2,3,6,9	10k
R4,5,13,14	1k0
R7	100R
R8,12	270R
R10	120k
R11	1k5
R15	560R
R16	220k
R17	100k
R18	1k2
RV1	10k horizontal preset
RV2	10k horizontal preset or lin. pot. — see wiring diagram.
RV3	220R horizontal preset
CAPACITORS	
C1,5	10u 16V radial electrolytic
C2	18p
C3,4,9,11	100n
C6,7,8	22n
C10	4n7
C12	1n0
SEMICONDUCTORS	
IC1	NE531
Q1	BC178
Q2-4	BC108
D1	OA91
ZD1	BZY88C 4V7
MISCELLANEOUS	
SK1	BNC socket
SW1a	DPDT miniature toggle (see also PSU board)
SW2	SPDT miniature toggle
PCB.	

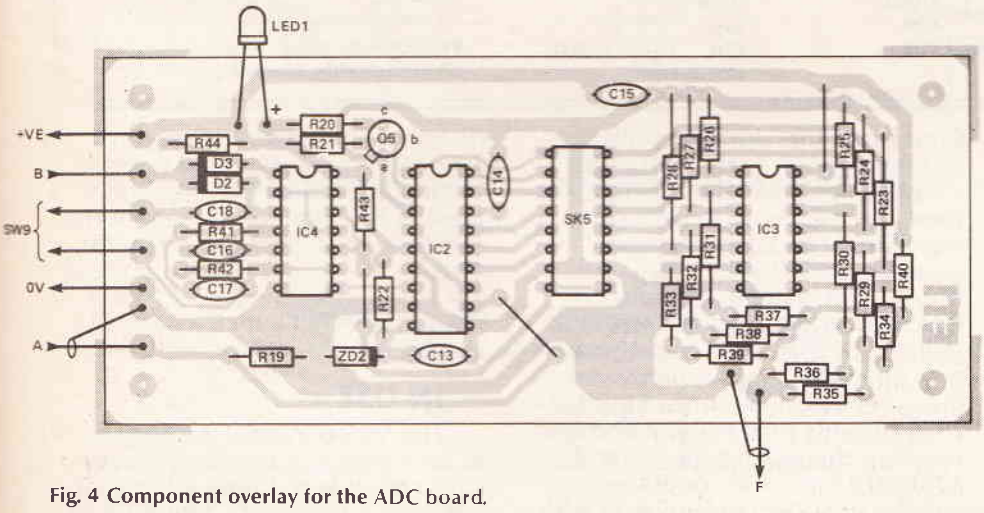


Fig. 4 Component overlay for the ADC board.

PARTS LIST — ADC BOARD

RESISTORS (all ¼ W 5% unless otherwise stated)	
R19	1M0
R20	220R
R21-28,43,44	1k0
R29,34,35,38,40	1k0 2% or better
R30	3k9 2% or better
R31	6k8 2% or better
R32	15k 2% or better
R33	22k 2% or better
R36	100R 2% or better
R37	1k2 2% or better
R39	10k 2% or better
R41,42	5k6
CAPACITORS	
C13,14,15	100n
C16	82p
C17	3p3
C18	120p
SEMICONDUCTORS	
IC2	RS 3300 ADC
IC3	7417
IC4	7404
Q5	BC108
D2,3	OA91
LED1	panel-mounting red LED
ZD2	BZY88C 3V9
MISCELLANEOUS	
SK5	16 pin DIL socket and 16 pin header to suit
SW3-9	SPDT miniature toggles
PCB; 16-way ribbon cable.	

low-capacitance wire, or simply use self-supporting solid wire. In the prototype, two torn off lines of ribbon cable were used. Remember to sleeve all the mains connections for safety.

SETTING UP

These instructions assume that a dual-trace oscilloscope with TV line triggering, a multimeter, a colour video source and a TV or colour monitor are available.

Assemble the Vandal, leaving all the ICs except the voltage regulators out. Set all presets to mid-travel. Switch on the mains and check that the supply voltages coming from the PSU are correct. If so, switch off and install ICI,

BUYLINES

Most of the components are available from any number of our advertisers, the UHF modulators are available for Cirkit and the PCBs from us. The ADC is an RS part (order code 302-069) and can be ordered through Crewe-Allan & Co, 51 Scrutton Street, London EC2.

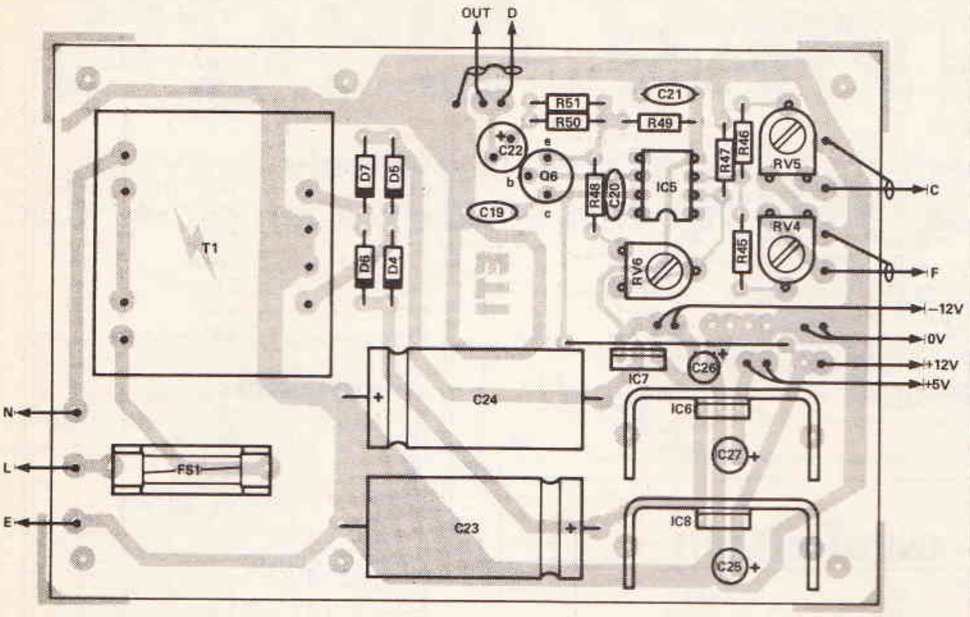


Fig. 5 Component overlay for the PSU board.

PARTS LIST — PSU & CASE

RESISTORS

R45,46	100k	
R47,52	1k0	
R48	100R	
R49	220k	
R50,51	150R	
RV4,5	47k	horizontal preset
RV6	10k	horizontal preset

CAPACITORS

C19,21	100n	
C20	18p	
C22	47u 16v	radial electrolytic
C23,24	1000u 25V	axial electrolytic
C25-27	4u7 16V	radial electrolytic

SEMICONDUCTORS

IC5	NE531
IC6	7805
IC7	7912
IC8	7812
Q6	BFY51
D4-7	1N4001
LED2	panel-mounting green LED

MISCELLANEOUS

SW1b	DPDT miniature toggle (see also input board)
SW10	SPDT miniature toggle
SW11	SPDT mains toggle
FS1	100mA fuse and PC-mounting holder
T1	12-0-12V 12VA PCB-mounting
MOD1	UM1286 (sound) or UM1233 (no sound) UHF modulator
SK2	BNC socket
SK3,4	phono sockets
SK6	9 pin 'D' socket
SK7	mains input socket

PCB; case; heatsinks for IC6 & IC8; knob; screened cable, mounting bolts, etc.

connect a colour video source (such as a video recorder) to the input, switch the Through/Process switch to Process and power up again. Connect channel 1 of the scope to the input, and adjust it until a steady display of one line (NOT a field) like Fig. 7a is obtained, with the timebase at about 100us. *All further instructions concerning the scope will refer to channel 2.* Next, connect the scope to the point marked A on the circuit diagram (the video output from the Input Board to the ADC/DAC) and adjust RV1 until the observed signal looks like that of Fig. 7b. Next, check that points B and C (the sync outputs) on the input board both have sync pulses which look like Fig. 7c present. Now connect the scope to point D (the colour detector output) with SW2 open. Check that there is a colour burst and some noise present, as shown in Fig. 7d. This completes the basic adjustment of the input board.

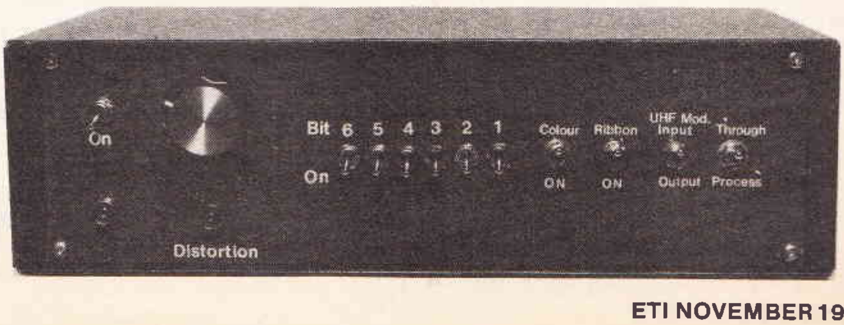
There are no adjustments to make to the ADC-DAC board.

Turn off the power again, wait at least a minute for the capacitors to discharge and insert the remaining ICs carefully. Turn on again. Check that the clock is oscillating by testing pin 7 of the ADC. This should show several megahertz (as shown in Fig. 7e) with SW9 open, less with it closed, but in both cases keying off with every sync pulse. Switch all the bit switches (SW3-8) on, connect the scope to point F (DAC output) and check that the signal looks roughly like that of Fig. 7b. Connect a 68 R (or 75R) dummy load resistor and the scope to the output socket, and adjust RV4 and RV5 until the signal is as shown in Fig. 7a, ie with the ratio of luminance to sync at about 70:30. Adjust RV6 until the output is about 1-1.5V peak-to-peak. Connect the monitor and with a colour video source adjust RV3 until the colours are at about the correct saturation level. The colour will go unstable and then disappear when RV3 is set too low: this is caused by the colour burst going below the detection level of the monitor. Note that the simple colour filter arrangement distorts the colour slightly and that the colour burst on the output is not to the CCIR specification, but in most cases it will be sufficient.

IN USE

The Video Vandal is designed to be strung into line between two video recorders during editing, or between a camera and monitor or recorder. It is possible to switch it in or out of circuit (except the modulator) so that it doesn't affect the signal if not required.

To set up the Vandal for use, switch the Through/Process switch to Process to put it in line and apply a video signal. Adjust the



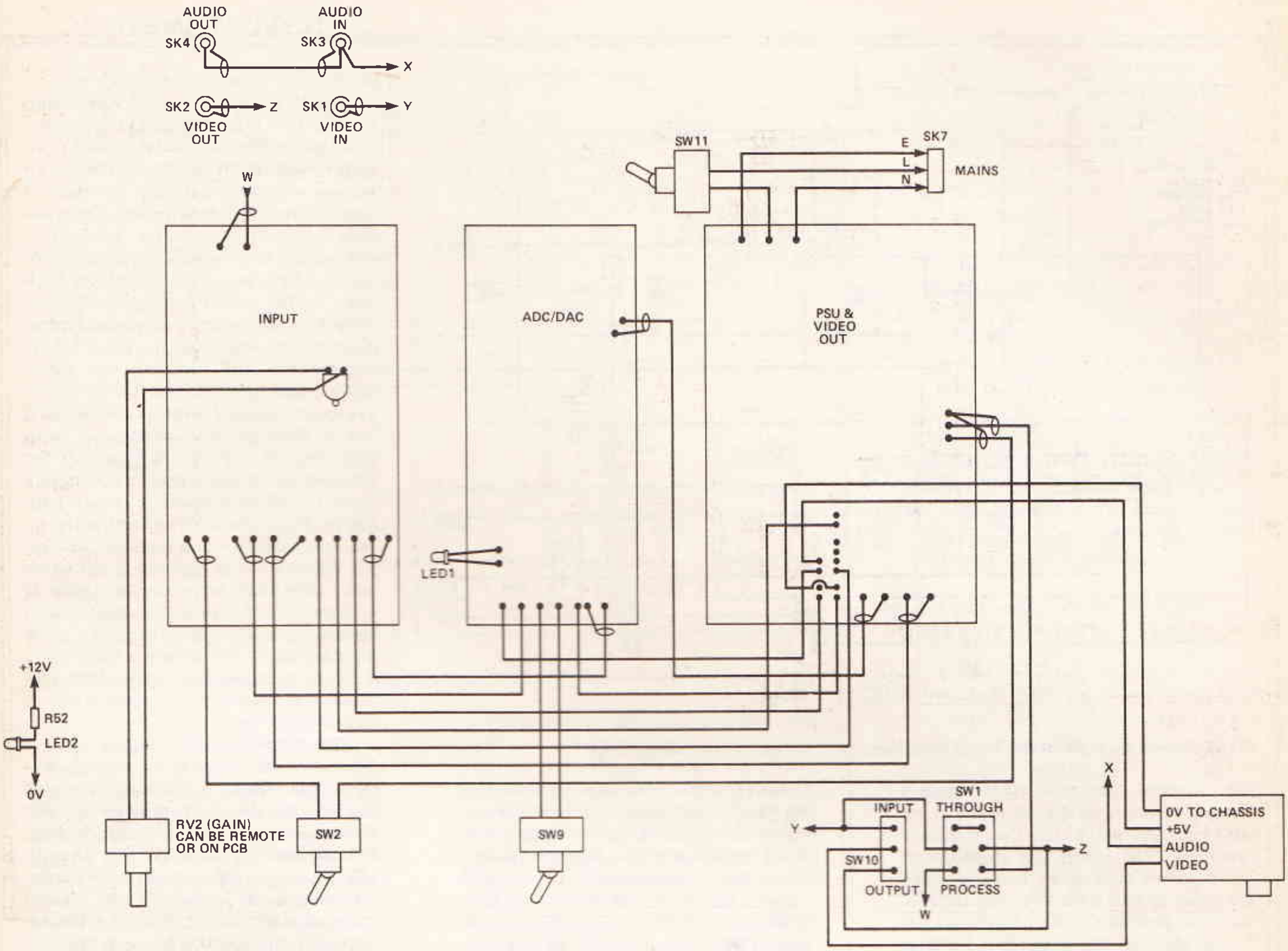


Fig. 6 Wiring diagram. Note that the connections to SK5, SK6 and the bit switches have been omitted for clarity.

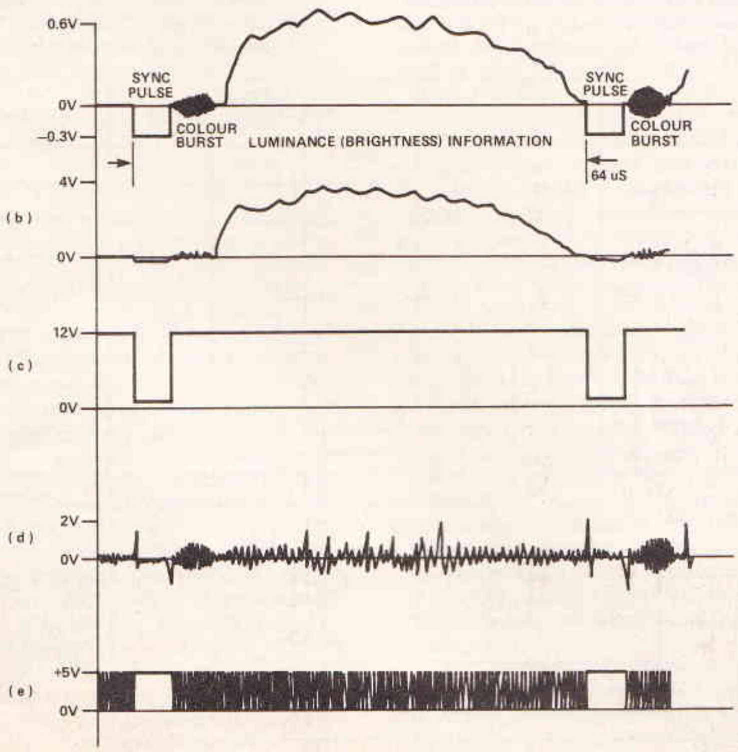


Fig. 7 Waveforms to be expected at various points in the circuit.

Gain control until the Distortion LED just doesn't light. Should you be working in monochrome, the colour switch SW2 should be switched to Off. If monitoring of the effects is required, then a TV (or whatever) should be connected to the UHF output. Now, taking the effects listed in the introduction in order:

1. Posterisation is achieved by switching the Bit Switches on and off. For example, eight levels of brightness (the setting most used by the Author) are achieved by switching on only bits 1, 2 and 3, the most significant bits. Another variation on this theme is to make any people on the screen look as though they have some kind of plague, by switching all bits except 1 on, and adjusting the gain control until their faces appear to have black patches on them.
2. The Ribbon (pseudo-Mosaic) effect is created by slowing the clock down with SW9. (Incidentally, if a 470K pot is connected in series with SW9 and C18 is increased to 220p, the stripe width becomes variable.)

HOW IT WORKS

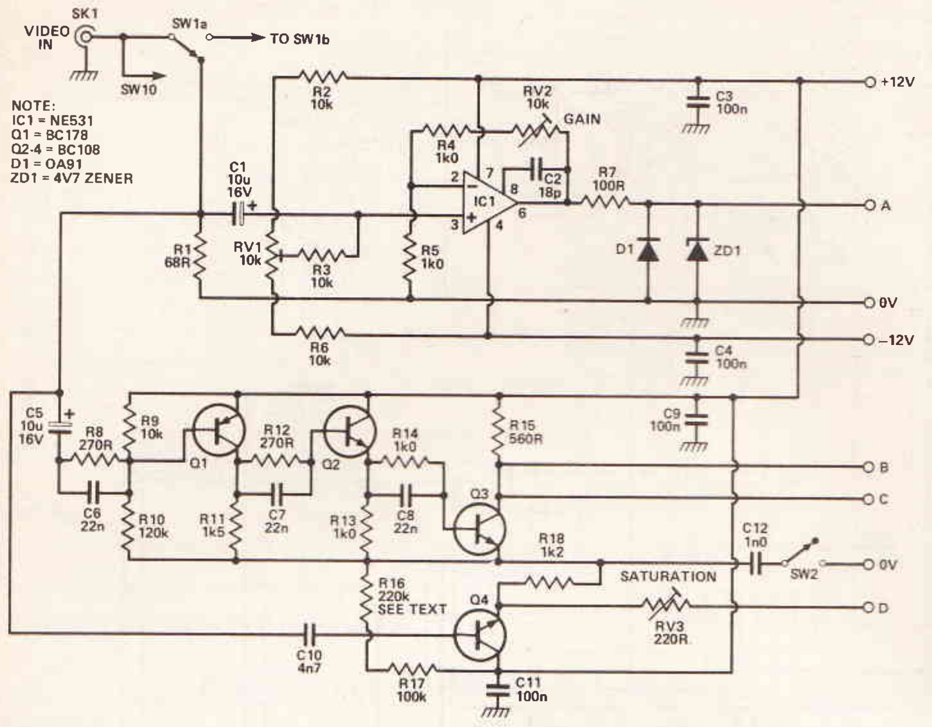


Fig. 8 Circuit diagram of the input amplifier, sync detector and colour filter.

The incoming composite video signal is first terminated by R1 to make it an approximate match for the standard (nominal 75R) video line impedance. The coupling capacitor C1 next isolates the input so that a DC bias (for DC restoration) provided by RV1 can be added before the signal is amplified by IC1, whose gain is adjusted by RV2 between about 1 and 10 to allow for variations in input levels and special 'white out' type effects. The ADC chip cannot tolerate negative voltages on its input, so diode D1 performs the dual function of limiting the maximum negative voltage to some −0.2V and removing the negative going sync pulses — see Fig. 7b. The y (luminance) signal is not affected much by this providing that the bias from RV1 is adjusted so the black level is rought 0V or so as explained under the Setting Up section. D2 is included so that any spikes above 5V cannot get into the ADC. R7 limits the current which can flow into the diodes, protecting both them and the op-amp.

Sync detection is performed by the circuitry around Q1-Q2-Q3. Q1 is biassed so that it is normally turned hard off. When a sync pulse comes along, it drags the base low via the differentiator C5 so that the transistor conducts during the pulse. This signal has not got very sharp edges, however, so R12/C7/Q2 and C8/R14/Q3 perform pulse shaping to improve the square wave edges. Q3 is the sync output device which drives the output circuit and synchronises the ADC's clock.

The chroma signal and some of the high frequency luminance is passed through C10 acting as a high-pass filter. This chroma signal is highly attenuated however, so it is amplified by Q4. Matching the colour output level to the rest of the video signal is fairly important to avoid under- or over-saturation of hues on the final display and to ensure reliable colour burst detection. The colour level is adjusted by RV3, AC coupled to the output by C12 and may be switched on and off by SW2. There is no reason why the saturation level shouldn't be made variable from the front panel with a pot, but note that the leads to such a pot would have to be screened, as do the leads to the colour killer switch SW2.

The ADC chip is the heart of the Video Vandal, so it is worth taking time over a description. The chip is of the 'Flash Converter' type which can manage some 19 million conversions per second. A slightly simplified description of how the chip works follows. The reference voltage on pin 9 is divided into 63 identical segments by a resistor ladder. Each 'rung' of the ladder is connected internally to one input of a window comparator (op-amp), with the other inputs commoned and brought out via a sample-and-hold (S&H) on pin 11. When a voltage is applied to pin 11 and the S&H lets it through, one of the 63 comparators will find its two inputs at the same potential and its output will change state. The 63 outputs are fed into a 1-of-63 to 6-bit converter — probably an array of diodes — and then into an output latch which is clocked at the same rate as the S&H. An extra comparator is included as an over-range indicator, with its input brought out on pin 2. To allow high accuracy, the resistors have to be laser trimmed during manufacture, and this is one reason why the chips are so expensive.

The amplified video signal coming from the input board is fed directly into the input of the ADC, but note R19 which protects the chip from damage by static discharge during assembly and testing. The high value is chosen so that it has no effect upon the input voltage. Pin 9 is the reference input, held at 3.9V by D3 and decoupled by C13. Q5 drives the 'Distortion' LED; although D2 protects the ADC against overvoltage, if the quantitising range is exceeded, distortion in the form of bright whites 'peaking out' will occur. This effect is sometimes useful, though, so the ability to do it by setting the Gain

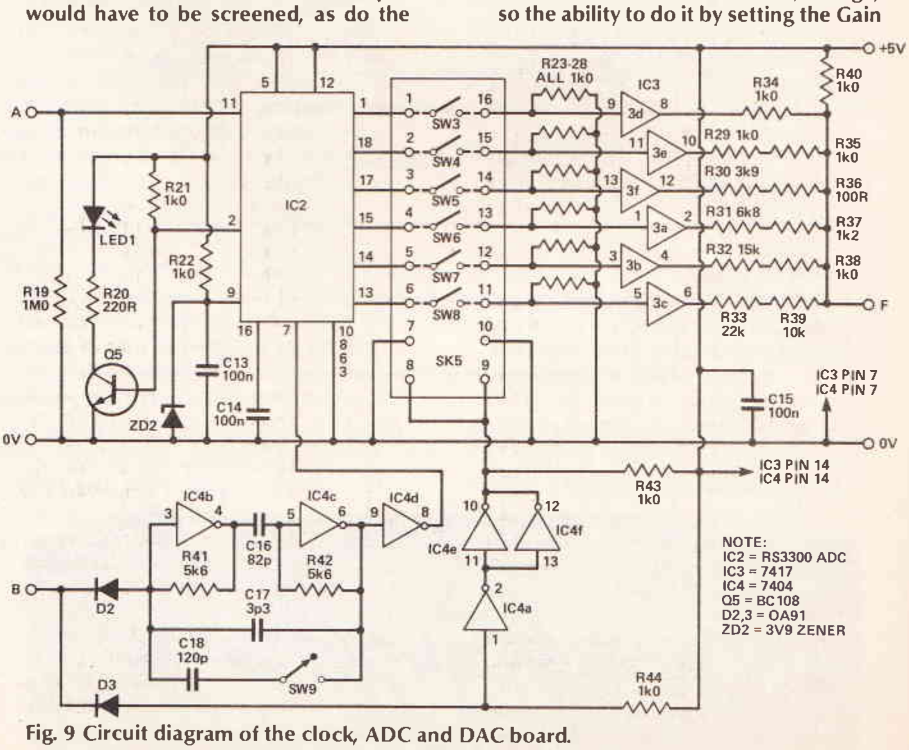


Fig. 9 Circuit diagram of the clock, ADC and DAC board.

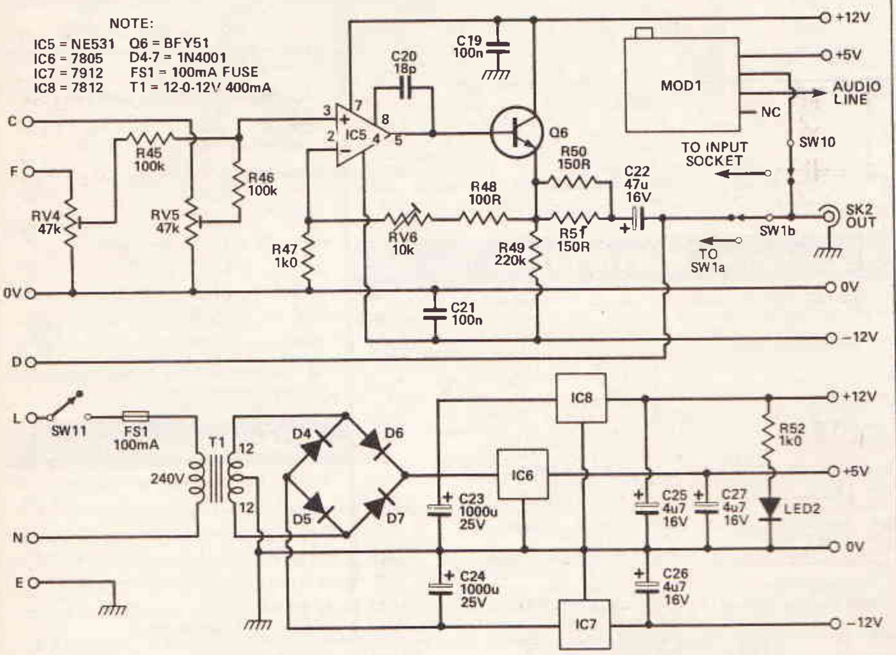


Fig. 10 Circuit diagram of the output amplifier and PSU.

control too high has been left.

The ADC chip is clocked at some 4-8 MHz by the oscillator built around two gates of IC4. It does not run at anything like the highest speed that IC2 can work at because of the need to adjust the frequency of clocking to provide the 'Ribbon' effect (which is nothing more or less than a digital S&H). If this effect is not required then C16 could be reduced to about 10pf, and C17 could be replaced by a crystal to reduce in-band quantisation noise (16 MHz was used in the MK.1 prototype) and C18/SW9 left in situ: this would make most sense as the ADC would work at the highest possible frequency unless specifically required to go slowly. The advantage of using a capacitor rather than a crystal is that it is much cheaper.

If the oscillator was allowed to run free, the 'Ribbon' effect would be completely unstable, so during sync pulses the clock is interrupted by D4 grounding an input. The otherwise unused gates in IC4 are used to provide a TTL sync output to the DATA socket.

'Bit Switches' SW3-8 switch on and off the output bits from IC2 to the Digital to Analogue Converter (DAC), R34-40. The switches provide the variable resolution feature of the Vandal. If all six switches are closed the output is practically the same as the input; with just S1 (most significant bit or MSB) set, the output is literally black and white with no grey between the extremes. If compared with photographic film, this is the electronic equivalent of 'lith' film. Putting different switches on and off creates different effects.

The DAC is of the simplest parallel type known to man — the R-2R ladder. This works by having resistances proportional to the significance of a bit switched in and out, pulling a line up or down proportionally. For example, the MSB is connected via the lowest value of resistor (1K), the next most significant bit via twice that (remember we're working in binary) and the third four times etc. The overall effect is that the output voltage at point F is proportional to the binary number presented to the buffer gate array's inputs. Note that much of the linearity of the circuit is dependent on the DAC; for best results 2% or preferably 0.5% tolerance metal film resistors should be used.

The pull-down resistors R23-28 are included because a floating TTL input — apart from being a bad thing — considers itself to be 'high' (logic 1), and hence is in the wrong state as far as the DAC is concerned where a bit which is 'off' is considered to be grounded.

The output board's function is to recombine the y and sync signals into a composite signal, current amplify them, change from high impedance to 75 ohms, and finally pipe the colour back in again. The y and sync signals are simply added together in a passive mixer (RV4,5) and fed into an op-amp. Q6, which boosts the output current capability, is included in the op-amp's negative feedback loop so that the circuit will theoretically remain linear under all circumstances. R50 and R51 match the output to 75R impedance, with C22 AC coupling the circuit. The colour signal is the last thing which is added to the output because its frequency is higher than can be put through the op-amps without risk of instability. The NFB loop of R48 and RV6 sets the output level.

The power supply which shares the same board is quite straightforward: 12-0-12 VAC from the secondary of T1 is bridge rectified by D6-9 and regulated to +5V and ±12V by ICs 6, 7 and 8.

3. This function requires the use of a computer with suitable software driving it — which is way beyond the scope of this article — but the connections between the computer's port and the DATA socket are of the 6 data bits and the sync pulse.
4. False colour (which should not be confused with the ordinary colour) is created by connecting an RGB monitor (the sort used with Oric, Electron and BBC computers is suitable) to the DATA socket, with the RGB inputs connected to bits 2, 1 and 3 respectively. This creates colours representing brightness, which may be filmed or displayed 'live'. Alternatively, the bits may be connected to a PAL encoder and then recorded or displayed.

THE DATA SOCKET AND BEYOND

The DATA socket is a very important part of the Video Vandal concept. Through this, it is possible to expand the system, as it carries the important 6 data lines along with the sync line, all at TTL levels. Through this socket is is possible to connect computers (for frame grabbing) or with an encoder or RGB monitor it is easy to produce 'false colour' pictures, where the RGB inputs of a monitor (or RGB to PAL encoder) are connected to the three most significant bit outputs so that differing colours represent the brightnesses. For example, green footballers playing on magenta grass with a red ball is a typical output. If there is sufficient interest, an RGB to PAL encoder card will be designed. Other than this, the Vandal could be used as a fast analogue to digital converter for other purposes, which is one reason why it is built on separate boards — if just the ADC/DAC board is built then a stand-alone high speed analogue to digital converter is at your fingertips.

The cheap'n'cheerful Video Vandal should cost around £100-&130 to build: the nearest professional (studio quality) device that the Author has yet found — albeit also a Time Base Corrector — doesn't leave much change out of £17,000!

The author wishes to thank G8BVI for help with various prototype colour pass filters, and Mr. M. Boote of Beaminster School for help and the loan of test gear.

ETI

ELECTRON SPEAKER

Turn your Electron into a chatterbox with this project from John Wike.

As the title suggests this is a project to add a speech unit to the Acorn Electron. It plugs into the rear edge connector, is easy to use and does not interfere with any other devices that are connected.

The system is based on the ubiquitous General Instruments speech processor, type SPO256-AL2. This chip contains all the components necessary to produce 64 speech sounds (or allophones). Associated with it are six other chips for interfacing and audio output.

The board is driven by a short Basic PROCEDURE and 73 bytes of machine code; the latter is easily assembled using the built-in assembler on the Electron. The speech codes are stored in a queue and once the process has started a non maskable interrupt (NMI) routine is used to get data from the queue. This means that the computer can carry on with the rest of the program while the circuit is speaking.

The Hardware

The circuit consists of the speech processor, oscillator, address latch, decoding, and NMI generator. The oscillator circuit is

HOW IT WORKS — HARDWARE

Gates IC1a, IC1b and IC2a decode the address and control lines so that a write operation in the range &C000 to &DFFF will cause the eight least significant bits of the address bus to be latched in IC3. Also address line A12 will be latched in IC6a and a clear pulse will be applied to latch IC6b.

When the circuit is reset the standby (SBY) output of the speech processor (IC5) goes high and latch IC6a, pin 8 goes low, disabling gates IC2b and IC1c. When the computer writes to latch IC3 at address &C001, line A12 will be low so IC6a,8 will go high and IC2b,6 will apply a low level to the address load (ALD) input of IC5. Less than a microsecond later SBY will go low again and IC2b,6 will go high, clocking latch IC6b.

As the outputs of both IC6a and IC6b will now be high, IC1c,3 will go low causing a non maskable interrupt (NMI). In response to this the computer will write to IC3 at address &C0xx and latch IC6b will be cleared, cancelling the NMI via IC1c. Some tens of milliseconds later, SBY will go high again, causing IC2b,6 and ALD to go low. IC5 will load data from IC3, SBY will go low, there will be an NMI and the computer will write to IC3 at a new address &C0yy. When there is no more speech data the computer prevents further interrupts by writing to address &D000. This sets IC6a,8 low and disables IC1c.

Note that because new data is loaded into IC3 as soon as the old data has been loaded into IC5, the speech inflection bits are one step ahead of the actual speech data.

The inflection circuit is based around a voltage controlled oscillator chip, IC4. The control voltage for this is derived via a crude analog to digital converter formed by R3, R4, RV1, RV2 from the latch outputs IC3,9 and IC3,12. The output of IC5 is a pulse width modulated square wave which is passed through filter R5, R6, C4, C5 and volume control RV3 to the audio amplifier IC7.

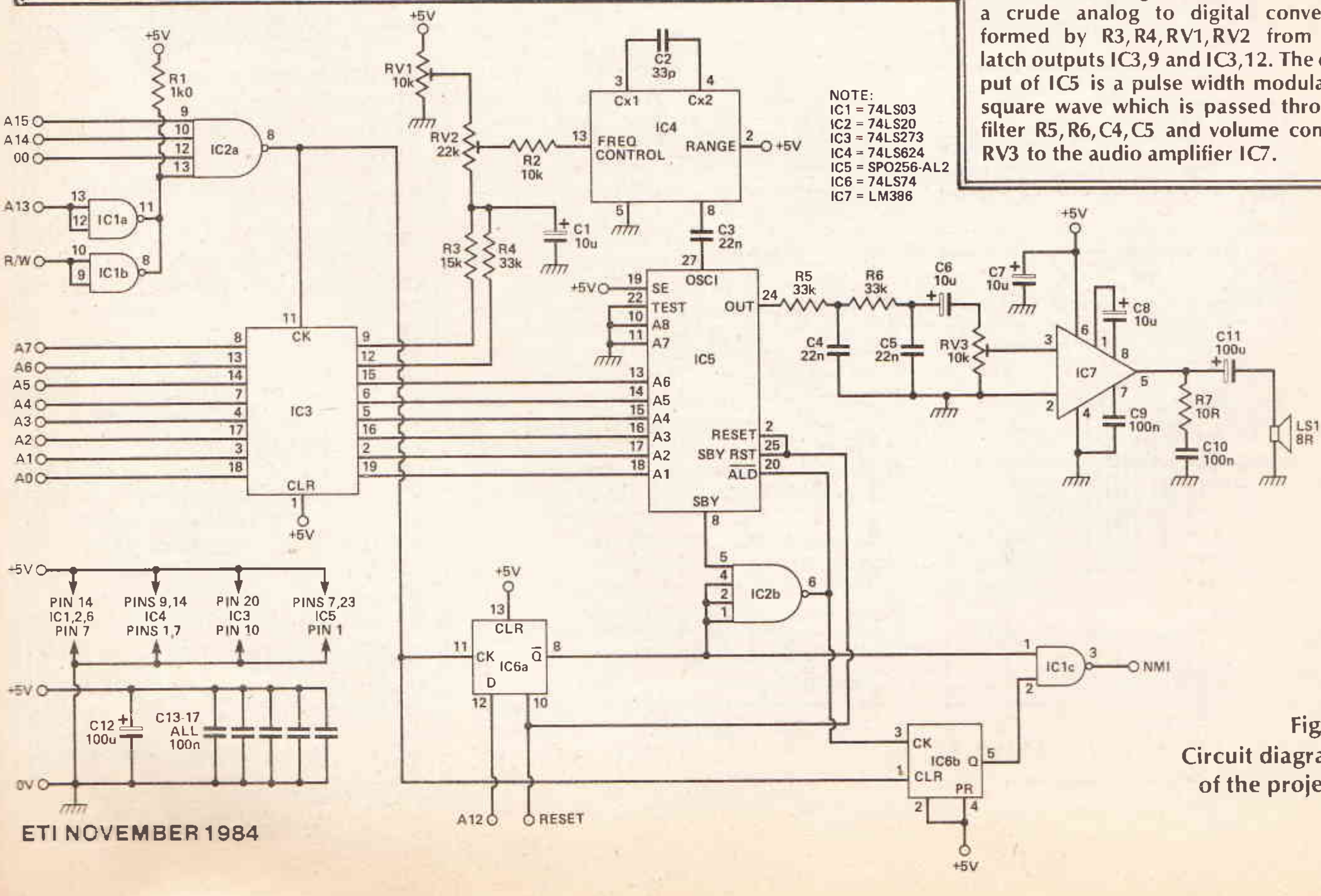
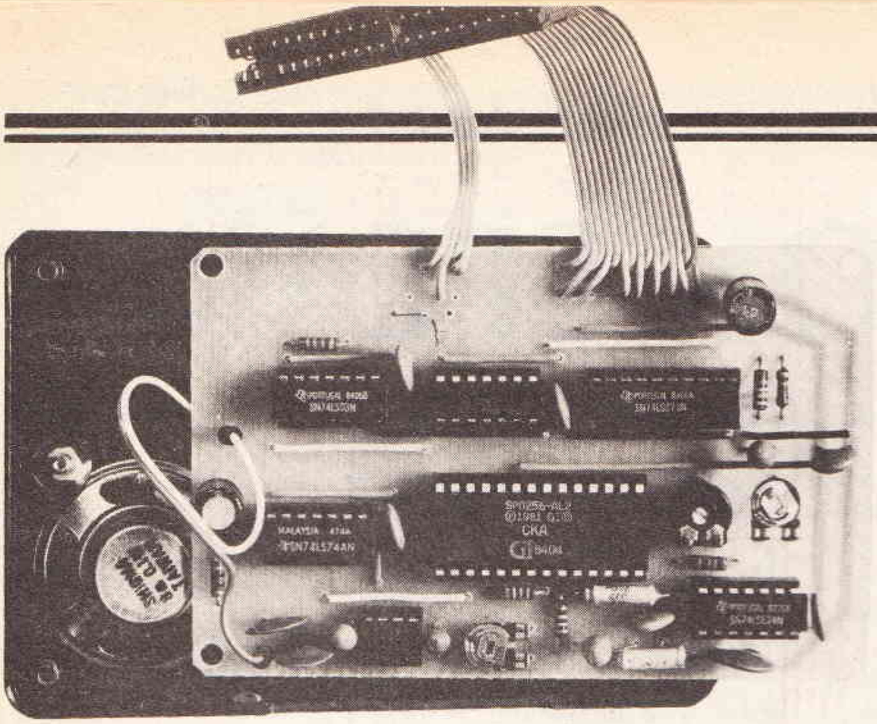
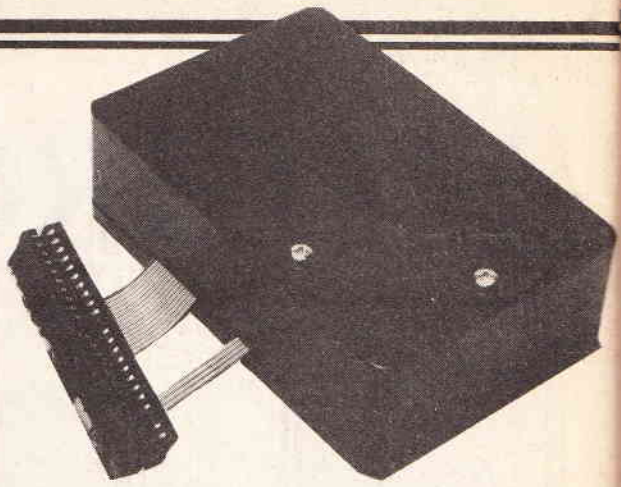


Fig. 1 Circuit diagram of the project.





in fact voltage controlled. The control voltage is produced by a rough digital to analog converter from the two most significant bits of the speech data. This allows a certain amount of inflection in the output voice. To allow the speech processor to load fresh data as quickly as possible it is necessary to latch each allophone while the previous one is being spoken. This means that the inflection bits will affect the preceding allophone.

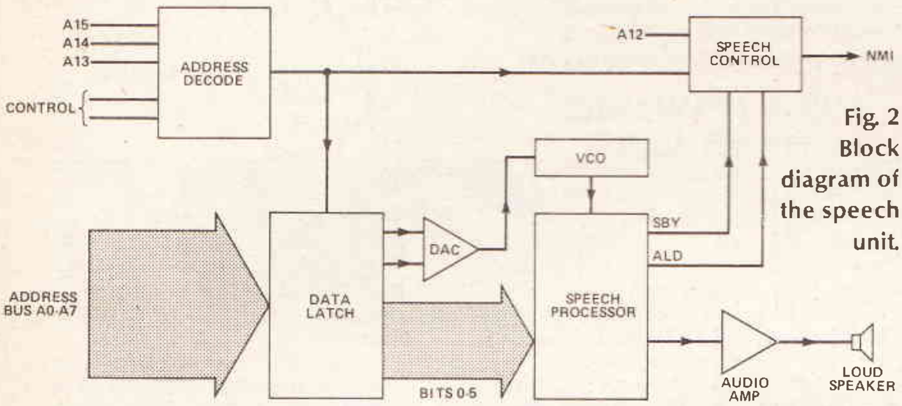


Fig. 2 Block diagram of the speech unit.

BUYLINES

There should be no problems here. The SPO256-AL2 and the box are available from Rapid Electronics, and the PCB is available from the author at 9, Lon-y-Garwa, Caerphilly, Mid-Glamorgan for £6 inc. p&p.

PARTS LIST

RESISTORS (all 0.25 watt 5%)

R1	1k
R2	10k
R3	15k
R4,5,6	33k
R7	10 R
RV1,3	10k
RV2	22k

CAPACITORS

C1,6,7,8	10uF Tantalum
C2	33pF
C3,4,5	22nF
C9,10,13-17	100nF
C11,12	100uF electrolytic

SEMICONDUCTORS

IC1	74LS03
IC2	74LS20
IC3	74LS237
IC4	74LS624
IC5	SPO256-AL2
IC6	74LS74
IC7	LM386

MISCELLANEOUS

Double sided 25 way edge connector; ribbon cable; IC sockets; printed circuit board; 8 ohm 0.1 watt loudspeaker; BICC/VERO plastic box 3" x 4.5" x 1.5".

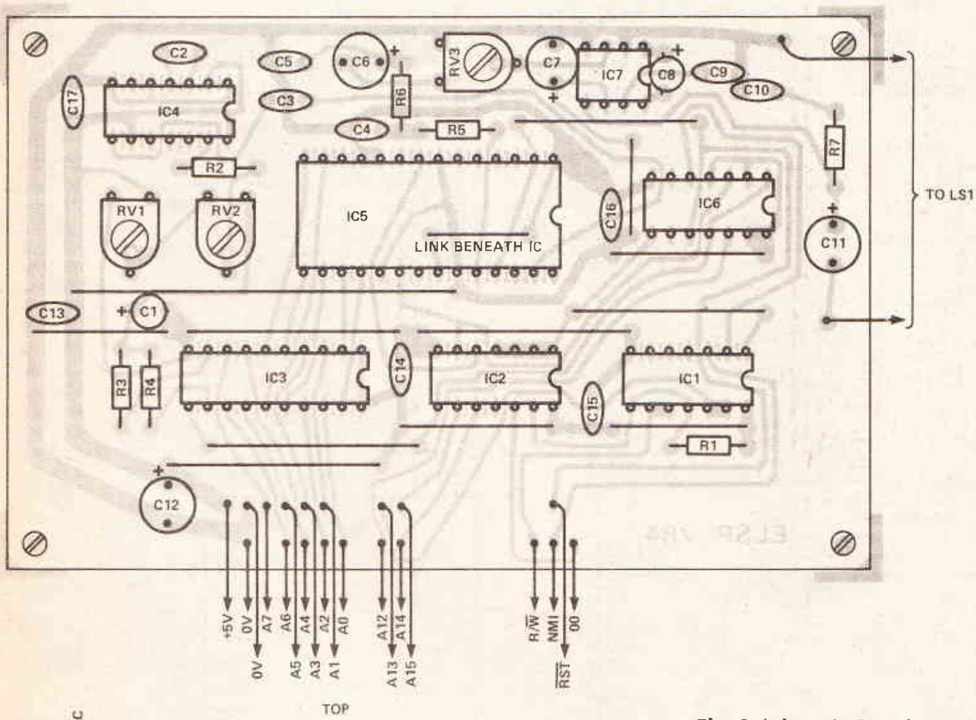


Fig. 3 (above) Overlay diagram.

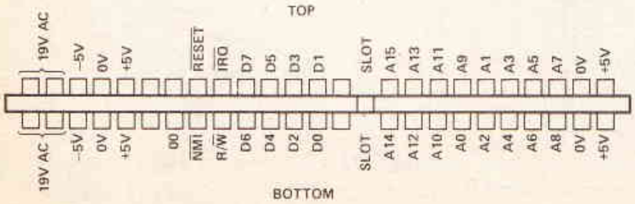


Fig. 4 (left) Connector details.

Fig. 5 The software needed to use the unit.

```
LIST
10 PROCINIT:ONERRORGOTO40
20 DIM Q1% (100),Q2% (100)
30 CLS:PRINT:PRINT:PRINT
40 PROCSPEAK(796)
50 REPEAT:PROCSPEAK(799)
60 PRINT"PLEASE ENTER A NUMBER ";
70 INPUTI%
80 PROCSPEAK(I%+800)
90 UNTILFALSE
95 :

796 DATA4,155,135,173,15,117,132,4,216,70,131,26,154,80,67,18,143,79
797 DATA67,19,196,13,19,132,24,134,67,7,45,7,105,77,167,152,139,131,55,183
798 DATA137,147,136,116,67,0
799 DATA9,45,19,43,3,7,11,2,13,51,3,20,3,11,15,16,1,28,51,0

800 DATA43,60,53,0
801 DATA46,15,15,11,0
802 DATA13,31,0
803 DATA29,14,19,0
804 DATA40,40,58,0
805 DATA40,40,6,35,0
806 DATA55,55,12,12,2,41,55,0
807 DATA55,55,7,7,35,12,11,0
808 DATA20,2,13,0
809 DATA11,24,6,11,0
810 DATA13,7,7,11,0
811 DATA12,45,7,7,35,12,11,0
812 DATA13,48,7,7,45,35,0
813 DATA29,51,1,2,13,19,11,0
820 DATA13,48,7,7,11,1,2,13,19,0
900 DATA57,15,15,11,1,2,33,39,12,12,1,21,0
950 :

1000 DEFPROCSPEAK(X%)
1010 RESTOREX%:A%=0
1020 IFQ%=Q2% Q%=Q1% ELSE Q%=Q2%
1030 REPEAT:READB%:?(Q%+A%)=B%
1040 A%=A%+1:UNTILB%=0
1050 CALLstart,Q%:ENDPROC
1055 :

2000 DEFPROCINIT
2010 point=&8D:lasto=&8F:block=&601
2020 spon=&C000:spoff=&D000
2030 O%=&D00
2040 FORI=OTO2STEP2
2050 P%=O%
2060 [ OPT I
2065 :
2070 .inter PHA
2080 LDAlasto
2090 BNEinter2
2100 LDAspoff
2110 STAspoff
2120 PLA
2130 RTI
2135 :
2140 .inter2 TYA
2150 PHA
2160 LDY#0
2170 LDA(point),Y
2180 JSRstart2
2185 :
2190 INCpoint
2200 BNEinter4
2210 INCpoint+1
2215 :
2220 .inter4 PLA
2230 TAY
2240 PLA
2250 RTI
2255 :
2260 .init LDA#0
2270 BEQstart2
2275 :
2280 .start LDAlasto
2290 BNEstart
2295 :
2300 LDAblock
2310 STApoint
2320 LDAblock+1
2330 STApoint+1
2335 :
2340 LDY#0
2350 LDA(point),Y
2360 TAX
2370 INY
2380 LDA(point),Y
2390 STApoint+1
2400 STXpoint
2405 :
2410 TYA
2415 :
2420 .start2 STAlasto
2430 TAY
2440 LDAspon,Y
2450 STAspon,Y
2460 RTS
2465 :
2470 ]:NEXT
2480 CALLinit:ENDPROC
>
```

The address decoding was designed with two factors in mind. The first factor was that the circuit should not interfere with any add-ons that might use the official extension addressing area (&FC00 to &FCFF). The second factor was a desire to keep the chip count down. It was decided to make the circuit write-only and to address it in parallel with the operating system ROM. The addresses chosen (&C000 to &DFFF) mean that only 3 address lines need decoding and as the computer normally only reads from this area there will be no faulty triggering. The one snag with this is that Acorn have not disabled the ROM during write operations, so any data output by the speech routines would conflict with data from the ROM. This problem was overcome by using indexed addressing to output the data on the address bus. A read followed by a write will latch the lower eight bits of the address bus whilst ensuring that the data bus does not conflict with the contents of the ROM.

When the speech processor is ready to receive more data, an NMI is generated, to be cleared when the new data is latched.

HOW IT WORKS — SOFTWARE

The machine code interface, assembled in PROCINIT (lines 2000 to 2470), uses three zero-page memory locations. The two labelled "point" form a 16 bit pointer into the speech queue, and the one labelled "lasto" stores the last byte output. If "lasto" contains zero then the speech processor is inactive.

There are three entry points into the machine code. Entry at ".init" (line 2260) initialises the system by clearing location "lasto" and the speech data latch.

Entry at ".start" (line 2280) causes the program to halt until the previous speech queue is finished (lines 2280 to 2290). It then examines the parameter block at &601 and loads "point" with the start of the next queue (lines 2300 to 2400). Then a non-zero pause value, ie. 1, is stored in "lasto" and interrupts are enabled by writing to &C001 (lines 2410 to 2460).

Entry at ".inter" occurs only in response to a non maskable interrupt. If "lasto" contains zero then further interrupts are disabled by writing to &D000 (lines 2070 to 2130). Otherwise a byte from the queue is written to the speech latch and "lasto", and the pointer is up-dated (lines 2140 to 2250).

The BASIC section of the test program contains the speech data strings (lines 796 to 900). The main loop (lines 10 to 90) dimensions two queues, Q1% and Q2%, and prompts for a number to be entered. The procedure PROCSPEAK (lines 1000 to 1050) restores a pointer to the correct data string and loads the string into alternate queues. It then calls the machine code with the start of the queue as a parameter.

In order to produce your own speech strings you must first choose each allophone from the table. Then decide on the inflection value (0, 64, 128, or 192) required for each allophone and add this to the *following* allophone, forming them into a DATA statement ending in zero. To produce your sounds use procedure PROCSPEAK (line number of your data).

Writing to addresses in the range &C000 to &CFFF enables interrupts, and the range &D000 to &DFFF disables them.

The audio output is amplified by an IC power amplifier and applied to a small 100mW loudspeaker. The board has been designed to fit with the loudspeaker inside a BICC/VERO 3" x 4.5" x 1.5" plastic box using the box lid screws for mounting.

The Software

The program listed here to test the circuit contains Basic routines, machine code, and sample data strings. Two sound queues are provided so that one can be loaded while the other is being output. These queues obviously have to be long enough to accommodate the longest data string used. When the data has been loaded into a queue a machine code routine is called to set up a pointer into the queue for use by the interrupt routine and to start the speech processor by writing to address &C001.

In Electron Basic, a call to a machine code routine can be followed by several parameters. The locations where the values of these parameters are stored are put into a block of memory starting at &600, and the location of the first parameter is in &601-&602. This facility is used here: the start address of the queue is held in a variable which is given as a parameter to the machine code call. The contents of &601-2 are then used to find the value of the variable which is stored as a pointer.

Each data string must end with a zero, which is used as an end marker. If this would affect the inflection of the last spoken data a pause with the correct inflection bits can be inserted. As each byte is written to the speech board it is also stored in a memory location. When the interrupt routine detects a zero in that location it disables further interrupts by writing to address &D000.

As the NMI routine in the Electron must start at &D00 that is where the machine code is assembled. The assembly is included in the initialisation PROCEDURE because pressing BREAK resets the byte at &D00 to a return from interrupt instruction.

Construction

Construction of this project should present no difficulty. The board is single sided and there are only thirteen links to fit. The use of IC sockets is recommended — do not forget the link underneath IC5. Once all the components have been soldered in, the edge connector can be attached via approximately three inches of 19-way ribbon cable and the loudspeaker can be connected with about four inches of wire. If the board is going to be mounted in a box, a slot must now be made in the side of the box at the point where the ribbon cable will come out.

Setting Up

Having checked **very** carefully for shorted tracks etc, insert all the ICs and connect the board to the Electron. Type in ?&&C013=?&C013 and you should hear a repetitive noise. It is actually an 'ee' sound but do not worry if it is not immediately recognisable. Adjust RV3 to give a suitable volume level out of the speaker. Now type ?&C000=?&C000 and the noise should stop.

If you have access to an oscilloscope, program function key 1 to do ?&C000=?&C000 and function key 2 to do ?&C0C0=?&C0C0, using the *KEY commands. Monitor the waveform on pin 8 of IC4 and you should see the frequency changing when you press the two function keys. Adjust RV1 and RV2 so that the frequency produced by key 1 is as close as possible to 2.5MHz and that from key 2 is as close as possible to 3.5MHz.

If you cannot get to an oscilloscope, program the keys to ?&C013=?&C013 and ?&C0D3=?&C0D3 and adjust RV1 and RV2 to give the best sounding voice and variation. Now try the test program and make any final adjustments. **ETI**

Sound Type	Symbol	Code		Duration	Example	Notes
Silences	/PA1/	00	0	10ms		
	/PA2/	01	1	30ms		
	/PA3/	02	2	50ms		
	/PA4/	03	3	100ms		
	/PA5/	04	4	200ms		
Short vowels	/IH/	0C	12	70ms	sIt	
	/EH/	07	7	70ms	End	
	/AE/	1A	26	120ms	hAt	These vowel sounds can be doubled to lengthen them.
	/UH/	1E	30	100ms	bOOk	
	/AO/	17	23	100ms	AUght	
	/AX/	0F	15	70ms	sUcceed	
	/AA/	18	24	100ms	hOt	
Long Vowels	/IY/	13	19	250ms	sEE	
	/EY/	14	20	280ms	trAy	
	/AY/	06	6	250ms	kIte	
	/OY/	05	5	420ms	vOIce	
	/UW1/	16	22	100ms	tO	
	/UW2/	1F	31	260ms	fOOd	
	/OW/	35	53	240ms	zOne	
	/AW/	20	32	370ms	dOWn	
R-coloured vowels	/ER1/	33	51	160ms	lettER	
	/ER2/	34	52	300ms	fERn	
	/OR/	3A	58	330ms	fORtune	
	/AR/	3B	59	290ms	alARm	
	/YR/	3C	60	350ms	hEAr	
	/XR/	2F	47	360ms	stARe	
Resonants	/WW/	2E	46	180ms	We	(See also /WH/)
	/RR1/	03	14	170ms	Read	
	/RR2/	27	39	130ms	cRane	
	/LL/	2D	45	110ms	Like	
	/EL/	3E	62	190ms	angLE,	squirrEl
	/YY1/	31	49	130ms	cUte,	compUter (Y-sound)
	/YY2/	19	25	180ms	Yes	
Voiced Fricatives	/VV/	23	35	190ms	Vest	
	/DH1/	12	18	290ms	THis	
	/DH2/	36	54	240ms	baTHe	
	/ZZ/	2B	43	210ms	Zoo	
	/ZH/	26	38	190ms	pleaSure,	aZure
Voiceless Fricatives	/FF/	28	40	150ms	Food	These allophones may be used doubly for initial or singly for final positions.
	/TH/	10	29	180ms	THin	
	/SS/	37	55	90ms	veST	
	/SH/	25	37	160ms	SHip	
	/HH1/	1B	27	130ms	He	
	/HH2/	39	57	180ms	Hoe	
	/WH/	30	48	200ms	WHig	(see also /WW/)
Voiced stops	/BB1/	1C	28	80ms	riB	
	/BB2/	3F	63	50ms	Beast	
	/DD1/	15	21	70ms	enD	Usually need 10-30ms silence preceding these.
	/DD2/	21	33	160ms	Down	
	/GG1/	24	36	80ms	Guest	
	/GG2/	3D	61	40ms	Got	
	/GG3/	22	34	140ms	peG	
Voiceless Stops	/PP/	09	9	210ms	Pow	
	/TT1/	11	17	100ms	parTs	
	/TT2/	0D	13	140ms	To	Usually need 50-80 ms silence preceding these.
	/KK1/	2A	42	160ms	Can't	
	/KK2/	29	41	190ms	speaK	
	/KK3/	08	8	120ms	Crane	
Affricatives	/CH/	32	50	190ms	CHurCH	
	/JH/	0A	10	140ms	JudGe	
Nasal	/MM/	10	16	180ms	Milk	
	/NN1/	0B	11	140ms	thiN	
	/NN2/	38	56	190ms	No	
	/NG/	2C	44	220ms	aNGer	

Table 1 The allophones that the unit can generate.

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

TV FRAMESTORE

Would you like to be able to capture a TV picture, then manipulate it with your home computer? We're going to tell you how its done. This project for experimenteers will use a flash-converter ADC with state-of-the-art circuitry to make it possible to use relatively slow DRAMs for the actual storage.

VARIO UPDATE

Following on the success of the original article, Lindsay Ruddock has had a look t some of the points we've been asked about by readers, including improved temperature compensation and some suggestions for 'total energy'.

DIGITAL DELAY LINE

Of course, the other sort of analogue signal you might be interested in storing in a digital form is music. So that's just what we're going to show you how to do in the description of this project. Developed with value for money in mind, this is a high-quality unit with some novel circuitry. It offers percussion and freeze, and a maximum delay time of 1.3 seconds (with 5 kHz bandwidth). The unit can be used to generate a large number of effects, including chorus, flanging, vibrato, pseudo-reverb, slap-back (What? - Ed.), long echoes, single and multiple echoes, etc, etc.

EXPERIMENTER'S DRAM CARD

Phil Walker's been looking for some extra memory of late, and here's the result, a 64K DRAM card. We originally designed the card because of difficulties with reliability and supply of the DRAM controller IC in our original design, but we found that we could do the same job more cheaply than the original anyway!

DISTORTION METER

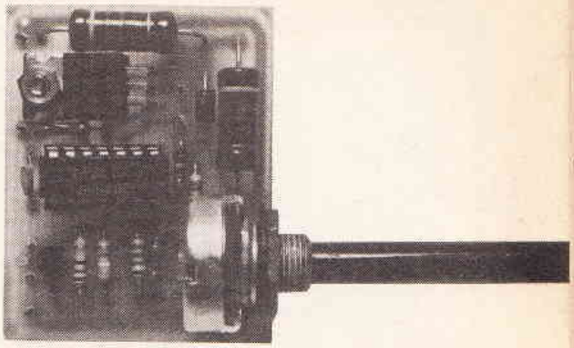
A project here for audio designers and the ilk, here is a relatively simple distortion meter from John Linsley Hood. Using a simple Wein network with a soupcon of feedback to increase the notching, this design works by filtering out the original signal and leaving the distortion behind. The unit also includes a wide-range audio millivoltmeter.

PLUS — SPECIAL SUPPLEMENT: EIGHT PAGES OF TECH TIPS!

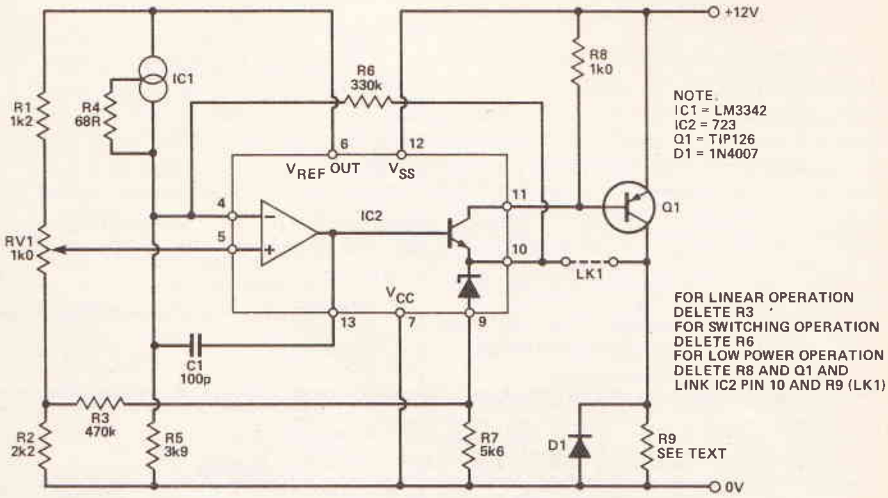
Here's our answer to all those readers who have been contacting us to find out what's happened to the Tech Tip they sent in five years ago. Seriously, we will be presenting eight pages of readers' up-to-the-moment ideas, in an extra eight pages of the magazine. All the more reason for buying the one and only ETI!

ALL THIS AND MORE IN THE NEXT ISSUE, ON SALE NOVEMBER 9th. BE NICE TO YOUR NEWSAGENT AND HE'LL KEEP YOUR COPY FOR YOU.

TEMPERATURE CONTROLLER



The ever popular Phil Walker no longer has any problems keeping his fans under control — not now that he's built himself an ETI Seecon.



This project is intended to be a simple but effective temperature controller. It brings together two readily available devices to make a unit which can act either in a linear mode or as an on/off switching controller. A single small PCB accommodates the complete circuit including a temperature-setting potentiometer, the temperature sensor and and, for applications where only small amounts of heat are required, two large resistors which act as heating elements. It is also possible to mount the sensor away from the PCB and to use the output to drive a fan, an external heating element or any other device which draws a current of a few amps or less from a 10-30V supply.

The Circuit

The temperature sensing element in this project is the LM334Z current source IC. This is programmed by means of a resistor to pass a current of about 1 mA. Due to the nature of the device the current is not greatly affected by the voltage across it but is affected by the temperature. In fact the current increases linearly as the temperature rises and this is used to generate a voltage proportional to the absolute temperature. In order to make use of this effect we have employed a well-known voltage regulator IC, the 723. This gives us several functions in one device which would otherwise have to be provided separately. First it contains a temperature stable voltage reference which is used to supply the temperature sensor and the reference adjusting potentiometer. Second it contains an operational amplifier with a moderately high gain and lastly it has an output transistor capable of passing up to 150 mA.

HOW IT WORKS

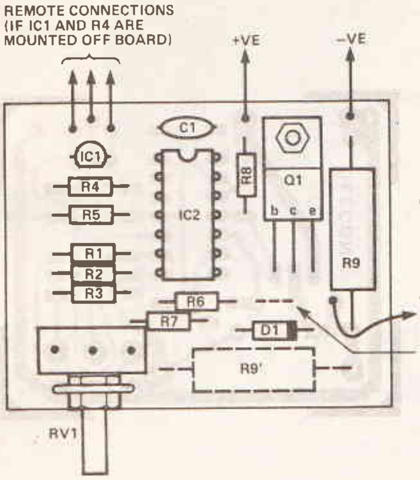
IC1 is an LM334Z adjustable current source. It has a voltage sensitivity of about 0.02%/volt and a temperature coefficient of about 0.33%/°C. The effects of voltage sensitivity are largely eliminated by using a regulated reference to feed it and the temperature setting potentiometer. This reference voltage is obtained from the 723 voltage regulator IC.

The LM334Z is set to pass about 1mA through R5 which thus develops a voltage of about 3.9V with respect to 0V. This is applied to the inverting input of the op-amp inside the 723, IC2. Connected to the reference supply from IC2 pin 6 there is a potential divider network consisting of R1, R2 and RV1. The values in this network are chosen such that the bottom end of RV1 is at about 3.0V while the top end is at 4.5V. These are equivalent to a temperature range of about ±50°C. With suitable changes to R1 and R2 this can be modified at will. The output from RV1 slider is applied to the non-inverting input of the op-amp where it is compared with the output of the sensor circuit. If the temperatue of the sensor is too high the voltage at the inverting input of the op-amp will be higher than that set by RV1 and the ouput of the op-amp will go low tending to turn off the output transistor. This in its turn will turn off Q1 and reduce the power in the load (R9).

To make the regulating effect operate over a defined range, R6 feeds back some of the ouput voltage into the sensor circuit to give an amplifier gain of about 80. The result is that the output at pin 10 of IC2 should change at a rate of about 1V/°C. This will give a regulating range of 6°C when using a 12V supply. (A 1k resistor across the Link A may be needed.) For use as an on/off switching controller R6 should be used instead. A value of 470k should give ±1°C switching window.

The output from the op-amp in the 723 is connected directly to a power transistor capable of handling up to 150mA. For some applications this may be enough and R8 and link A can be shorted. For higher power applications Q1 is used to boost the power handling of the circuit. This device could be as power transistor such as TIP32 with R8 470R and R7 1k5 or, as we have specified, a TIP126 power darlington. These can handle currents up to 5A, but it is not a good idea to run them too close to this limit because of the effects of switch-on surges and the like. It should also be bourne in mind that no heatsinking has been provided on the PCB and this will further limit the maximum safe current the device can handle.

R9 is the actual heating element if mounted on the PCB (two positions for this are provided — either or both can be used) or the load can be remote. If the load is not resistive, D1 should be fitted to absorb switching transients. If the load is remote it may be desirable to mount the sensor near it and pads on the PCB are provided for this. If long leads are used R4 should be mounted close to IC1 and not on the PCB.



PARTS LIST

RESISTORS (¼W 5% unless otherwise stated)	
R1	1k2
R2	2k2
R3	470k (see text)
R4	68R
R5	3k9
R6	330k (see text)
R7	5k6
R8	1k (see text)
R9	see text
RV1	1k0 linear potentiometer
CAPACITOR	
C1	100p
SEMICONDUCTORS	
IC1	LM334Z
IC2	723
Q1	TIP126 (see text)
D1	IN4007
MISCELLANEOUS	
PCB; short length of 16 SWG solid wire; 14-pin DIL socket; nut and bolt to secure Q1.	

The circuit is configured such that increasing temperature tends to reduce the power in the load. To use this in a linear mode feedback can be provided from the output to the inverting input to the op-amp section. The resistor value chosen for this gives about 1 volt per degree Centigrade. For switching mode operation the necessary feed back is provided to the non-inverting input of the op-amp which gives a sharp on-off action. The rate of switching will depend on external factors such as thermal inertia and sensor position, etc.

For low power operation it may be possible to omit the output transistor from the circuit and use the 723 output device only. This is made possible by shorting IC2 pin 10 to R9 using LK1 and replacing R8 with another link.

For wide range operation you may find it necessary to put a resistor of 1k or so across link LK1. The diode D1 is only necessary when inductive loads such as relays or fans are used instead of resistors.

Construction

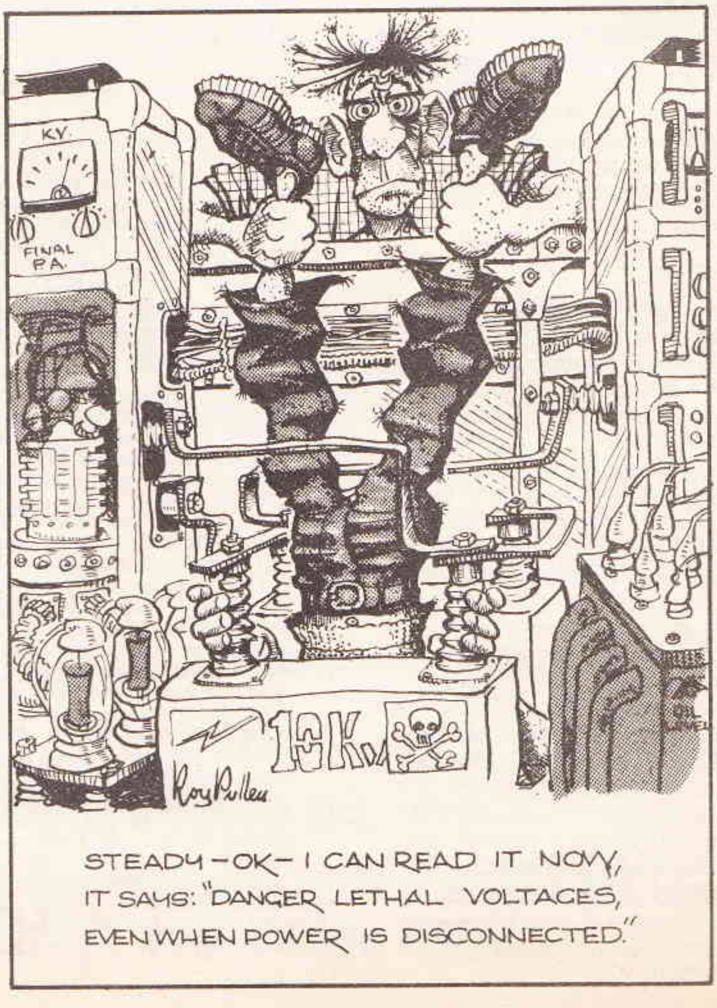
This is quite simple so long as the components are correctly placed. RV1 should be a PCB mounting type and can be secured with a loop of 16 SWG wire soldered into the holes provided. The remaining threaded boss on the potentiometer spindle can be used to secure the whole unit to a panel with an extra nut.

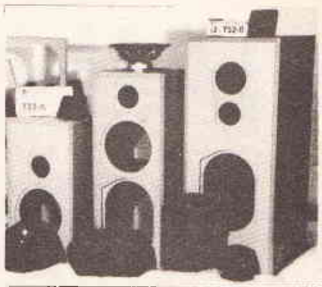
If the unit is to be used for low power then R9 can be mounted on the PCB. Note that R3 or R6 may be fitted but not both. Also, link A may be fitted if Q1 is not used and a 1k resistor used for linear operation or an open circuit for switch mode operation. R8 should be linked across if Q1 is omitted.

If IC1 is to be mounted remotely then R4 should be mounted with it and two wires only connected back to the PCB. **ETI**

BUYLINES

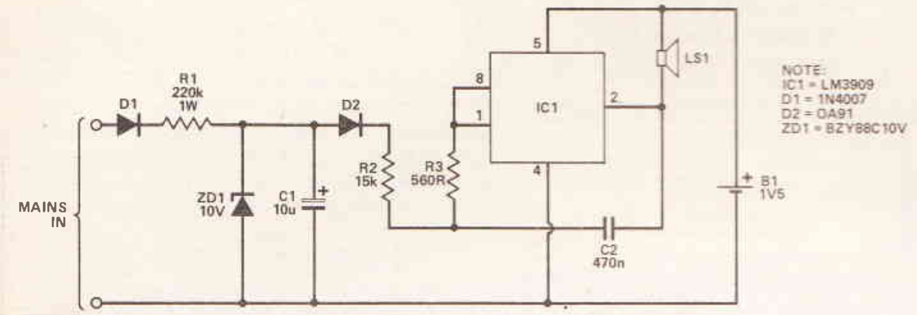
Nothing here to cause any problems — all the devices here are quite widely available. The PCB is, as ever, available through our PCB service.





MAINS FAILURE ALARM

Help! Help! I'm powerless! There are some items around the house or lab that you'd like to say that to you when necessary. The ETI Vogonoff gives them a voice. Design and development by Phil Walker.



This very simple project will continuously monitor the mains supply to any pieces of equipment and let you know if someone pulls the plug or the power goes off for any other reason.

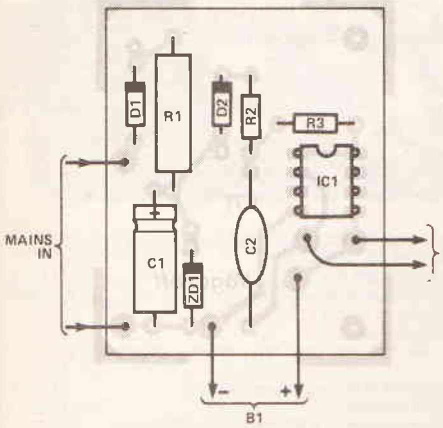
The circuit is very simple and consists mainly of a LM3909 connected up as an oscillator and driving a small loudspeaker. In normal operation it is prevented from oscillating by a small current into C2 from the rectified mains. If this current fails due to the absence of mains input the LM3909 will oscillate and cause a sound to be emitted from the loudspeaker. The power to drive the speaker is obtained from the 1½ volt dry cell which under the normally very low

HOW IT WORKS

The mains supply to be monitored is rectified by D1 and regulated by R1 and ZD1 such that about 10V appears on C1. This produces a current via D2 and R2 into C2 and the input to IC1 such that the input of IC1 is held above its upper switching threshold. Under these circumstances, the output of IC1 is also high so no current flows through LS1.

If the mains input fails, the charge on C1 will leak away until the voltage at the input to IC1 reaches its lower threshold. IC1's output will then switch and go low drawing current through LS1. Due to the internal circuit operation of IC1 and the characteristics of LS1 and C2, the output of IC1 will switch back to the high state after a short time and start continuous ocillation which is heard as a tone from the loudspeaker.

Since the non-operational state of the project draws very little current from the cell it should last a long time before needing replacement



power drain when the circuit is not oscillating will last a very long time.

Possible applications for this device may include monitoring mains supplies to darkroom or other laboratory equipment, tape recorders and record players where prolonged stationary contact would cause flats to develop on pinch rollers, etc, and even as an anti-theft device (although the noise it makes is not very loud).

PARTS LIST

RESISTORS	
R1	220k 1W
R2	15k 0.25W
R3	560R 0.25W
CAPACITORS	
C1	10µF 25V electrolytic
C2	470nF 100V polytester
SEMICONDUCTORS	
IC1	LM3909
D1	1N4007
D2	0A91
ZD1	BZY88C10V
MISCELLANEOUS	
LS1	2.5 in. 64R loudspeaker
B1	1.5 V dry cell prefer alkaline type

PCB: see buylines; box: plastic box 4½ x 3 x 1½ inches approx; wire; grommetts or glands; (nylon) nuts and bolts; 8 pin DIL socket if required.

Construction

The main thing to bear in mind when making this product is that all the circuitry is at mains potential and this must not be accessible from outside of the case. To this end we recommend that you use nylon bolts to secure the circuit board, loudspeaker and battery. Wiring to the outside world should be made with well insulated mains cable through a grommett or cable gland and the cable should be well secured inside the case.

The construction of the PCB should pose no problems so long as the IC and polarised diodes and capacitor are correctly positioned. The dry cell can be permanently wired in place as it should last a very long time. Use an adhesive cable clip to hold it in place.

The loudspeaker could well be glued to the inside of the box with a few **small** holes to let the sound out. We recommend that these holes be covered by some additional insulation if the finished unit is accessible.

BUYLINES

Nothing that we can see in this project should cause any problems here. The PCB is available from your usual friendly source — our own PCB service.

electronics today international
BOOK SERVICE

How to order: indicate the books required by ticking the boxes and send this page, together with your payment, to: ETI Book Service, Argus Specialist Publications Ltd, 1, Golden Square, London W1R 3AB. Make cheques payable to ETI Book Service. Payment in sterling only please. All prices include P & P. Prices may be subject to change without notice.

BEGINNERS GUIDE

Beginner's Guide to Basic Programming Stephenson	£5.35
Beginner's Guide to Digital Electronics	£5.35
Beginner's Guide to Electronics	£5.35
Beginner's Guide to Integrated Circuits	£5.35
Beginner's Guide to Computers	£5.35
Beginner's Guide to Microprocessors	£5.35

COOKBOOKS

Master IC Cookbook Hallmark	£10.15
Microprocessor Cookbook M. Hordeski	£7.70
IC Op Amp Cookbook Jung	£14.25
PLL Synthesiser Cookbook H. Kinley	£7.70
Active Filter Cookbook Lancaster	£13.40
TV Typewriter Cookbook Lancaster	£11.15
CMOS Cookbook Lancaster	£11.85
TTL Cookbook Lancaster	£10.95
Micro Cookbook Vol. 1 Lancaster	£15.30
BASIC Cookbook K. Tracton	£6.00
MC6809 Cookbook C. Warren	£7.25

ELECTRONICS

Principles of Transistor Circuits Amos	£8.50
Design of Active Filters with experiments Berlin	£11.30
49 Easy to Build Electronic Projects Brown	£6.00
Electronic Devices & Circuit Theory Boylestad	£13.20
How to build Electronic Kits Capel	£3.55
How to Design and build electronic instrumentation Carr	£9.35
Introduction to Microcomputers Daglecs	£7.20
Electronic Components and Systems Dennis	£15.00
Principles of Electronic Instrumentation De Sa	£11.40
Giant Handbook of Computer Software	£12.95
Giant Handbook of Electronic Circuits	£17.35
Giant Handbook of Electronic Projects	£11.75
Electronic Logic Circuits Gibson	£5.55
Analysis and Design of Analogue Integrated Circuits Gray	£30.25
Basic Electronics Grob	£11.30
Lasers — The Light Fantastic Hallmark	£7.70
Introduction to Digital Electronics & Logic Joynson	£5.25
Electronic Testing and Fault Diagnosis Loveday	£7.85
Electronic Fault Diagnosis Loveday	£6.25
Essential Electronics A-Z Guide Loveday	£7.50
Microelectronics Digital & Analogue circuits and systems Millman	£12.70
103 Projects for Electronics Experimenters Minis	£8.30
VLSI System Design Muroga	£34.10
Power FETs and their application Oxner	£9.40
Practical Solid State Circuit Design Olesky	£25.00
Master Handbook of IC Circuits Powers	£12.85
Electronic Drafting and Design Raskhodoff	£22.15
VOM — VTVM Handbook Risse	£8.50
Video and Digital Electronic Displays Sherr	£28.85
Understanding Electronic Components Sinclair	£7.50
Electronic Fault Diagnosis Sinclair	£4.50
Physics of Semiconductor Devices Sze	£17.35
Digital Circuits and Microprocessors Taub	£32.00
Active Filter Handbook	£7.60
Designing with TTL Integrated Circuits Texas	£15.20
Transistor Circuit Design Texas	£15.20
Digital Systems: Principles and Applications Tocci	£12.95
Master Handbook of Telephones Traister	£10.00
How to build Metal/Treasure Locators Traister	£6.00
99 Fun to Make Electronic Projects Tymony	£8.50
33 Electronic Music Projects you can build Winston	£6.95

COMPUTERS & MICROCOMPUTERS

BASIC Computer Games Ahl	£6.35
From BASIC to PASCAL Anderson	£9.95
Mastering Machine Code on your ZX81 T. Baker	£7.25
UNIX — The Book Banaham	£8.75
Z80 Microcomputer Handbook Barden	£10.95
Microcomputer Maths Barden	£11.90
Digital Computer Fundamentals Barter	£9.90
Visicalc Book. APPLE Edition Bell	£15.55
Visicalc Book. ATARI Edition Bell	£15.55
Introduction to Microprocessors Brunner	£23.00
Programming your APPLE II Computer Bryan	£9.25
Microprocessor Interfacing Carr	£7.70
Microcomputer Interfacing Handbook A/D & D/A Carr	£9.50
Musical Applications of Microprocessors Chamberlain	£28.85
30 Computer Programs for the Home Owner in BASIC D. Chance	£9.25
Microcomputers Dirkson	£9.30
APPLE Personal Computer for Beginners Dunn	£9.50
Microcomputers/Microcomputers — An Intro Gioone	£11.80
Troubleshooting Microprocessors and Digital Logic Goodman	£9.25
Getting Acquainted with your VIC 20 Hartnell	£8.50
Getting Acquainted with your ZX81 Hartnell	£5.95
Let your BBC Micro Teach you to program Hartnell	£7.90
Programming your ZX Spectrum Hartnell	£8.50
The ZX Spectrum Explored Hartnell	£6.95
How to Design, Build and Program your own working Computer System Haviland	£9.30
BASIC Principles and Practice of Microprocessors Heffer	£7.15
Hints and Tips for the ZX81 Hewson	£5.25
What to do when you get your hand on a Microcomputer Holtzman	£9.95
34 More Tested Ready to Run Game Programs in BASIC Horn	£7.70
Microcomputer Builders' Bible Johnson	£12.40
Digital Circuits and Microcomputers Johnson	£14.55
PASCAL for Students Kemp	£7.20
The C — Programming Language Kernighan	£18.20
COBOL Jackson	£9.25
The ZX81 Companion Maunder	£9.50
Guide to Good Programming Practice Meek	£6.40
Principles of Interactive Computer Graphics Newman	£13.95
Theory and Practice of Microprocessors Nicholas	£11.35
Exploring the World of the Personal Computer Nilles	£12.95
Microprocessor Circuits Vol. 1. Fundamentals and Microcontrollers Noll	£9.80
Beginner's Guide to Microprocessors Parr	£5.35
Microcomputer Based Design Peatman	£11.30
Digital Hardware Design Peatman	£9.80
BBC Micro Reavealed Ruston	£9.45
Handbook of Advanced Robotics Safford	£14.45
1001 Things to do with your own personal computer Sawusch	£8.50
Easy Programming for the ZX Spectrum Stewart	£7.15
Microprocessor Applications Handbook Stout	£34.40
Handbook of Microprocessor Design and Applications Stout	£37.60
Programming the PET/CBM West	£17.80
An Introduction to Microcomputer Technology Williamson	£8.20
Computer Peripherals that you can build Wolfe	£12.40
Microprocessors and Microcomputers for Engineering Students and Technicians Wooland	£7.10

REFERENCE BOOKS

Electronic Engineers' Handbook Fink	£56.45
Electronic Designers' Handbook Giacoletto	£59.55
Illustrated Dictionary of Microcomputer Technology Hordeski	£8.45
Handbook for Electronic Engineering Technicians Kauffman	£27.50
Handbook of Electronic Calculators Kauffman	£35.00
Modern Electronic Circuit Reference Manual Marcus	£44.00
International Transistor Selector Towers	£10.70
International Microprocessor Selector Towers	£16.00
International Digital IC Selector Towers	£10.95
International Op Amp Linear IC Selector Towers	£8.50
Illustrated Dictionary of Electronics Turner	£12.95

VIDEO

Servicing Home Video Cassette Recorders Hobbs	£12.95
Complete Handbook of Videocassette Recorders Kybett	£9.25
Theory and Servicing of Videocassette Recorders McGinty	£12.95
Beginner's Guide to Video Matthewson	£5.35
Video Recording: Theory and Practice Robinson	£14.40
Video Handbook Van Wezel	£21.90
Video Techniques White	£12.95

Please send me the books indicated. I enclose cheque/postal order for £......... Prices include postage and packing

I wish to pay by Access/Barclaycard. Please debit my account.

5 2 2 4

4 9 2 9

Signed ....

Name ....

Address ....

ETI KNITE-LITE

A figment of flippant foollery for functional fantasy fans, fully fabricated by Phil Walker.

For some reason there seems to be a requirement for computer-controlled cars and alien robots to be endowed with roving red eyes. Well, this offering from the cybernetic cavern of the ETI workshop will enable all and sundry to share in the excitement. Now you too can upgrade your latest creation with the roving red-eye look from the ETI stable.

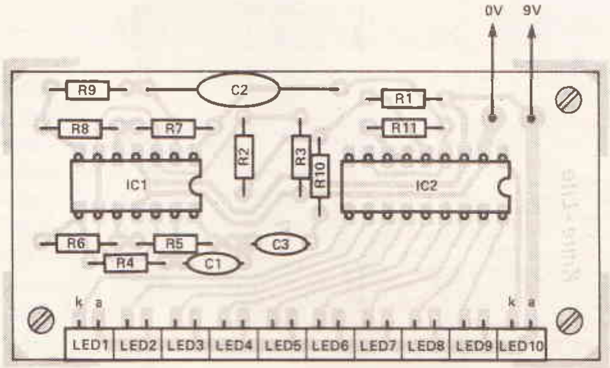
The Circuit

In principle this is very simple. The display consists of ten red LEDs driven by an LM3914 linear bar-graph IC. This IC also contains a voltage reference source and all the necessary comparators to control the display.

In order to produce the smooth to-and-fro sweep two sections of a quad operational amplifier have been configured as a triangle wave generator. The ouput from this is applied to the lower end of the voltage reference and comparator chain while the other end of the comparator chain is connected to the upper end of the voltage reference.

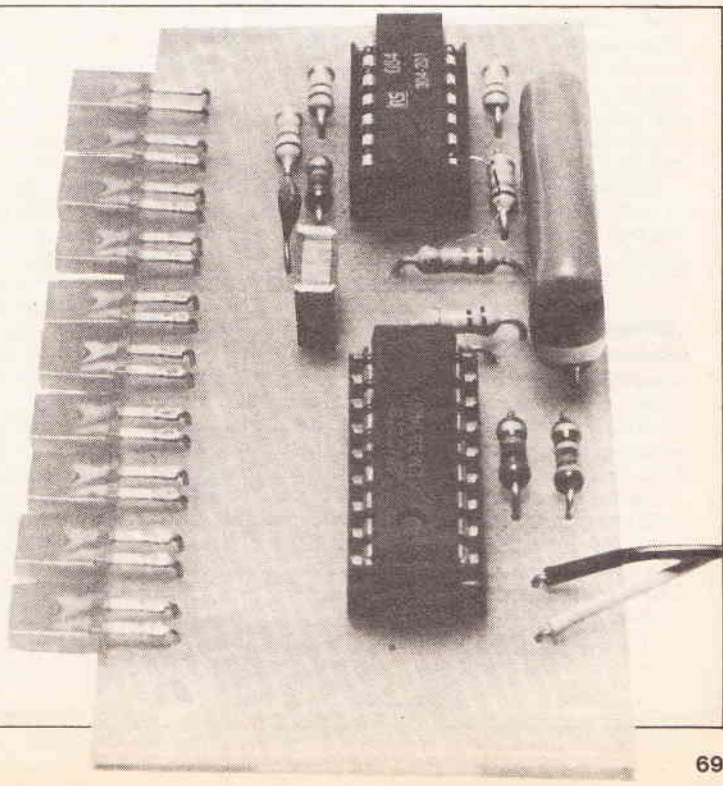
This means that the reference voltage is sitting on top of the triangle wave generator and is being swept up and down past a reference applied to what is normally the signal input pin. This produces the basic back and forth sweep on the display.

As it stands so far the display would be jerkey so some method



PARTS LIST

RESISTORS		SEMICONDUCTORS	
R1	82k	IC1	TL084
R2,4,10	15k	IC2	LM3914
R3,6,8	100k	LED1—10	Rectangular red LED
R5,11	1k0		
R7	18k		
R9	3M3		
CAPACITORS (ceramic or polycarbonate)		MISCELLANEOUS	
C1	1n0	PCB (see buylines); battery: PP3 size 9V; battery clips; SPST switch if required; box: optional 4½ x 3 x 1½ or larger if to contain battery as well.	
C2	1µ0		
C3	68n		



BUYLINES

Nothing here to cause any problems; the square LEDs used in the prototype were obtained from Rapid Electronics, but lots of other suppliers sell them. The two ICs are quite widely available, too, and the PCB is available from our PCB service.

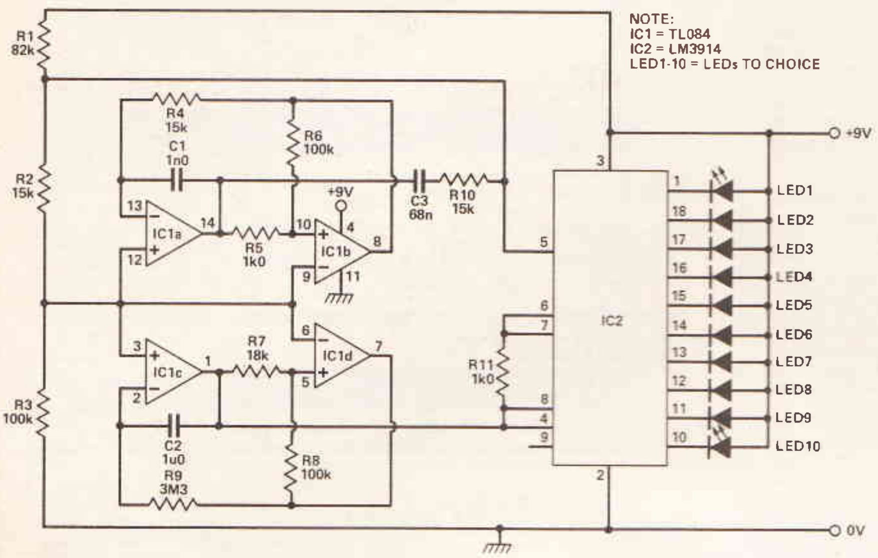
of smoothing out the transition between adjacent LEDs is necessary. This is done by connecting up the remaining two sections of the quad op-amp to form another triangle wave generator operating at a much higher frequency. The ouput from this is mixed with the reference voltage to smear the display over two or three LEDs at a time. This makes the display much smoother and more realistic.

Construction

The construction of this project is quite simple as all the components are mounted on the PCB. Make sure, however, that you get both the ICs the right way round and do not confuse anode and cathode connections on the LEDs. If you want to mount them off the board it should make no difference to the circuit operation.

The type of box used for the project is entirely up to you, but we suggest one large enough to hold a PP6 or PP9 size battery to power the circuit for a day or so (continuous operation). Although the circuit does not draw a large current (about 20mA) it is a good idea to fit a switch in the battery lead.

The circuit should operate with supply voltages from 6 volts to 20 volts but some adjustments will have to be made to several resistor values if you want to vary the supply voltage from the intended 9V. This is caused by the fact that the amplitude and frequency of the two oscillator circuits is dependent on the supply voltage. Frequency effects can be countered by changing the capacitor values but amplitude changes especially in the sweep oscillator are much more difficult to remove. **ETI**



HOW IT WORKS

The principles of operation governing this project are quite straightforward but unfortunately the practice is a little more obscure

The main work in the project is done by the LM3914 IC. This is a bar-graph display driver which contains a voltage reference, graded comparator string and current-limited output drivers. There is also some internal logic which enables the user to have either a dot or bar mode display. In this application we use only the dot mode so pin 9 which selects the mode is left open circuit.

The on-chip voltage reference source is not referenced to 0V and can be floated within the supply rail boundaries (with some restrictions). We must note however that the current drawn from the reference supply also determines the LED driver output current. In this cicuit R11 sets the LED current to about 12 or 13mA.

The circuit is configured such that the 1.25V reference of the LM3914 sits on top of the sweep ramp generated by IC1c and IC1d. The resistor ratios and capacitor value used in this circuit are selected to provided a triangular wave sweep of about 2 seconds with a peak-to-peak value of about 1.2 volts. The amplitude is set by R7/R8 while the frequency is determined by R9 and C2.

The configuration of IC1c and IC1d is that of the integrator and Schmitt trigger. IC1c and C2 form the integrator. If the ouput of IC1d is high then current will flow through R9 into C2 (the input current to IC1c can be ignored). As this happens, the input side of C2 is kept at the reference voltage supplied by the R1,2,3 divider chain by the action of IC1c. This causes the output of IC1c to go linearly in a negative direction.

At some stage the output voltage from IC1c via R7 will pull the input of IC1d slightly negative overcoming the effect of the positive output of IC1d via R8. This will cause the output of IC1d to go to the negative rail very rapidly. Now current will be drawn out of C2 via R9 and the output of IC1c will ramp in the positive direction. This will continue until the output of IC1c can pull the input of IC1d positive and switch its output positive also. The whole cycle will repeat indefinitely.

As the output of IC1c ramps up and down the lower end of the voltage comparator chain in the LM3914 to which it is connected is also driven. In addition the upper end of the chain also goes up and down but 1.25 volts more positive. This is set by the floating voltage reference.

As the whole comparator chain is ramped up and down, it passes the fixed voltage from R1,2,3 divider chain. This causes the dot display to sweep to and fro along the LEDs. This is equivalent to holding the bottom end of the comparator chain fixed and sweeping the input terminal instead, but it overcomes the need for a low impedance R1,2,3 divider chain. The signal input needs less than 50nA bias current while the comparator input impedance is only about 10k and would take 120μA; some other means of setting the LED current would be necessary.

The voltage actually present at pin 5 of the LM3914 is about 0.6 volts more than the reference to the oscillators. This means that the input seen by the LM3914 is alway in the comparator range and gives the correct display.

The display given by the circuitry described so far is not as smooth as it might be as the transition between one LED and the next is quite abrupt. To overcome this another oscillator similar to the first is configured around IC1a and b. This operates in exactly the same way as the other but at a much higher frequency. Its output "wobbles" the reference voltage seen by the LM3914 via R10/C3 such that the dot mode display is "smeared" across two or three LEDs and the transitions are much smoother. There is some interaction between the two oscillators but this is not visually obvious.

SPECTRUM STAGE LIGHTING INTERFACE

Would you like to computerize your scene changes, or light your living room? Richard Neep could have the project for you.

The stage lighting unit, published in January, February, April and May of 1983 is still giving cause for interest, if readers' letters are anything to go by (perhaps it's just that we forgot to tell you the specs of some of the transformers at the time . . .). The design presented here will interface a Sinclair Spectrum home-computer to the unit.

This project replaces the keyboard and memory of the original project and is directly compatible with the autofade units. Using the computer has several advantages over the original control system. The data can be stored on tape instead of relying on battery backed-up RAM, the lighting changes can be more sophisticated; and the whole system can be made more user friendly. This last point is perhaps the most important; data can be entered in plain, ordinary decimal and displayed on the TV monitor rather than in octal on the LED display on the original.

First, we shall look at the hardware, then we shall give some notes on the necessary software; finally, we shall look at other uses.

Ins And Outs

The Spectrum has a very large capacity for control applications, there being potentially 65,535 input or ouput locations. Some of these are reserved by the machine for the keyboard, tape interface, printer, etc. There are further limitations in that the Spectrum is happier if only one of the lower five address lines goes low at any one time, which, as we've seen before (Spectrum Control Port, p44, ETI October) means that projects are best designed to use output addresses which are one less than multiples of 32.

If these numbers are written out in binary, it can be seen that the lower five address bits are all high. The next four address bits, A5 to A8, are used to decode the 16 outputs of the interface. Extrapolating, this method can provide up to 2048 such outputs.

The actual circuit of the decoder is quite straightforward. When an OUT command is processed by the Spectrum, the $\overline{IORQ}$ and $\overline{WR}$ lines are taken low. The circuit is designed so that when the lowest five address lines go low, the next four address lines (A5 to A8) will be used to point to one of the autofade units. This autofade unit will then latch in the buffered and slightly rearranged data on the Spectrum's data bus.

The re-arrangement of the data was found to be less hassle than writing software to do the re-arranging. The autofade units use bits D0 to D2 to determine the final light-level from the controlled lamp, while bits D3 to D7 are used to determine the fade speed (how quickly the light changes from the old level to the new one). The authors of the original had decided to reverse the significance of the bits, ie D3 is the most significant of the speed bits, whereas D2 is the most significant of the final level bits.

Software Options

The software to accompany this project is largely a matter of personal taste and is best tailored to individual requirements. On the Spectrum, the format of the OUT command is: OUT (address), (value), where the value is a number between 0 and 255, ie a single byte written in decimal.

In the stage lighting unit, the eight bits of the byte are split into two sections; as already mentioned, the top five bits (D7 to D3) are used to control the fade speed, but with D7 as the LSB and D3 the MSB. However, the connections to these bits are reversed on the interface PCB, making D7 the MSB and D3 the LSB so far as the software is concerned. The lower three bits, D0 to D2, control the final brightness, with D2 the MSB.

The light level and fade speeds would obviously be most conveniently entered into the computer as decimal numbers, and stored in an array. Therefore a routine is needed to combine the two decimal numbers and produce a single number between 0 and 255.

The use of the five bits for the fade speed means that there are a total of 2^5 or 32 different fade speeds, from 0 to 31 decimal. Three bits for the final light level means 2^3 different level settings, from 0 to 7. If required, it would be a simple enough matter to write a routine which allows these to be entered as percentages and then scales the percentages to the nearest equivalent whole number in the range 0 to 31 or 0 to 7, as appropriate.

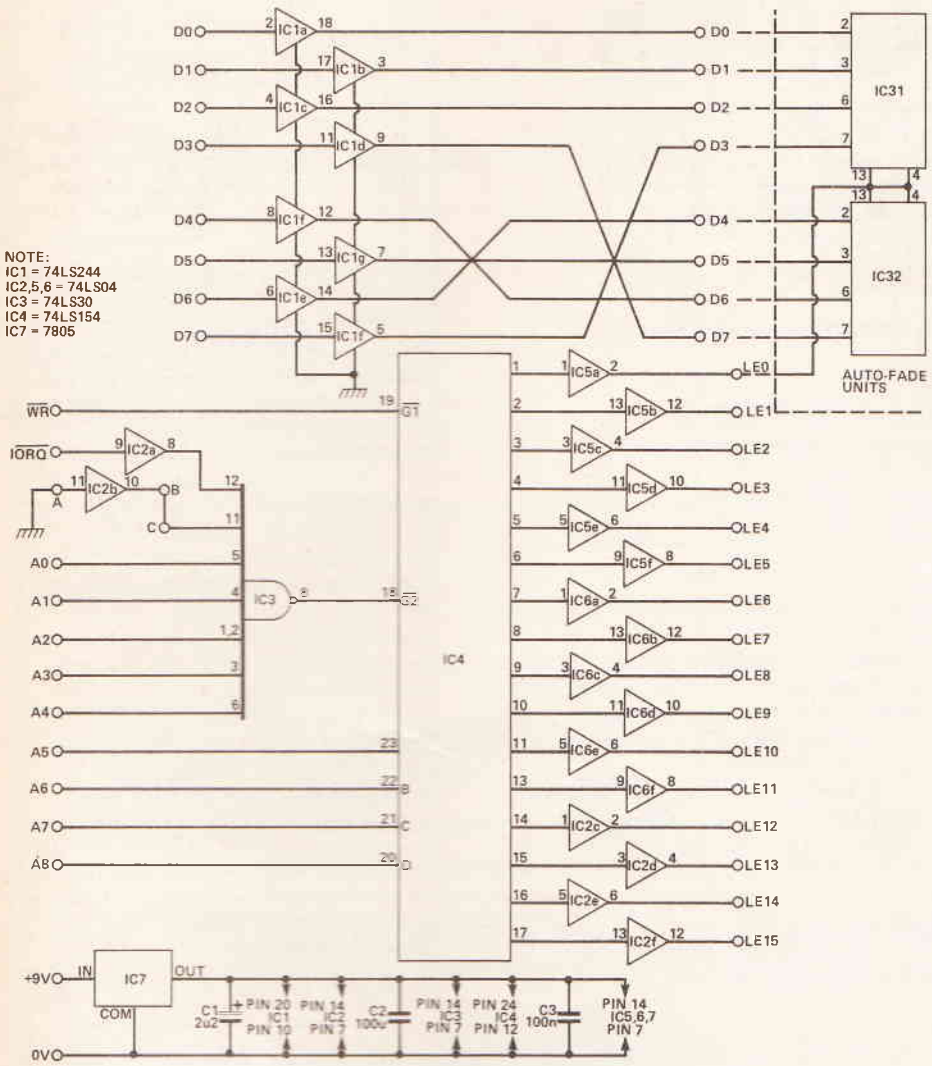
The next step is to combine the two numbers into one; this can be achieved by multiplying the fade speed by 8 and adding the light level. A worked example would perhaps make this clearer.

Suppose we wish to fade to a light level of 45% at a speed of 85%. First, convert to the scaled 3-bit (level) and 5-bit (speed) components:

speed: 85% x 31/100 = 26.35; truncated to 26; binary 11010

level: 45% x 7/100 = 3.15; truncated to 3; binary 011

Next multiply speed by 8:
speed: 26 x 8 = 208; binary 1101000
(Note: it is vital that the truncation is carried out before the multiplication, otherwise the fractional



HOW IT WORKS

The data lines are buffered by IC1a-h, then crossed to change the order. This is made necessary by the auto-fade units in the orginal stage-lighting units have the data for the fade speed (D3 to D7) back-to-front, ie D3 is the most significant bit and D7 the least. It is, of course, generally easier ot cross a few tracks than it is to write complicated software. The buffered data is then fed to all the autofade units in the main stage lighting unit; D0 to D2 control the final brigtness of the controlled light.

IC4 is a 4-to-16 line decoder; when the two gate inputs G1 and G2 are low, the output line pointed to by address inputs A, B, C, D will go low (all outputs are normally high). This is used to select which of the auto-fade units is to latch in the data on the data lines.

Gating of the decoder is performed by IC2a and IC3; the WR line is taken directly to one gate input of IC4, as this is the narrowest of the signals from the Z80. IORQ is inverted then NANDed with the address lines A0 tp A4; this is then used to provide the input to the other gate input on IC4.

The power for the circuit is derived from the unregulated 9V supply available on the Spectrum edge connector; a 7805 regulates the 9V to the required 5V.

Fig. 1 Circuit diagram; note that IC30 and 31 are on the fader boards of the main unit.

part of the speed will throw up non-zero digits in the lower three bits after multiplication.

Next, add the two numbers:

speed:	208	binary: 11010000
level:	+3	binary: 011
combined:	211	binary: 11010011

This is the final result; looking at the first five bits, 11010, this is 26 decimal or 84% of 31. (31 is the maximum speed). The final three bits are 011 which is 3 decimal or 43% of 7 (7 is the maximum brightness).

The rest of the software depends on the individuai preferences of the user and the speed of operation required. Two programs have been written by the author, one of which is fast but gives limited information suitable for rock band or disco applications; the other program is slower for traditional theatre use, and gives pretty coloured bar-graphs of the light levels for each scene.

Other Uses

Dare we say it, but this port could fairly simply be converted to an output-only control port. All that would be necessary would be to have a number of pairs of four-bit latches, like ICs 31 and 32 in Fig. 1, all wired in parallel to the data lines, but with their individual latch lines going to different latch enable outputs from the interface.

Individual bits on the data bus can be controlled quite easily. The general rule is that if you wish to control the nth bit on the data bus, you multiply 0 or 1 (as appropriate) by 2^n. The numbers generated in this way can just be added together to take the number to be OUTput. So, to put 1 on the bit 0, 1 on bit 2 and 1 on bit 3, the sum is

$$1 \times 2^0 + 1 \times 2^1\ 0 \times 2^3 + 1 \times 2^3$$
$$= 1 \times 1 + 1 \times 2 + 0 \times 4 + 1 \times 8$$
$$= 1 + 2 + 0 + 8$$
$$= 11$$

11 in binary is 1011, which is what is required.

Up to sixteen latch pairs can be driven this way, giving a grand total of 128 on/off switches!

Construction

Construction of this project should be quite straightforward. We have designed the PCB so that the Spectrum edge connector can sit directly on the PCB.

We suggest commencing construction of the PCB by inserting and soldering all the IC sockets. It will then be fairly easy to locate all the wire links, of which there are 20, all in the supply lines. After soldering the wire links, insert and solder the capacitors and SK1.

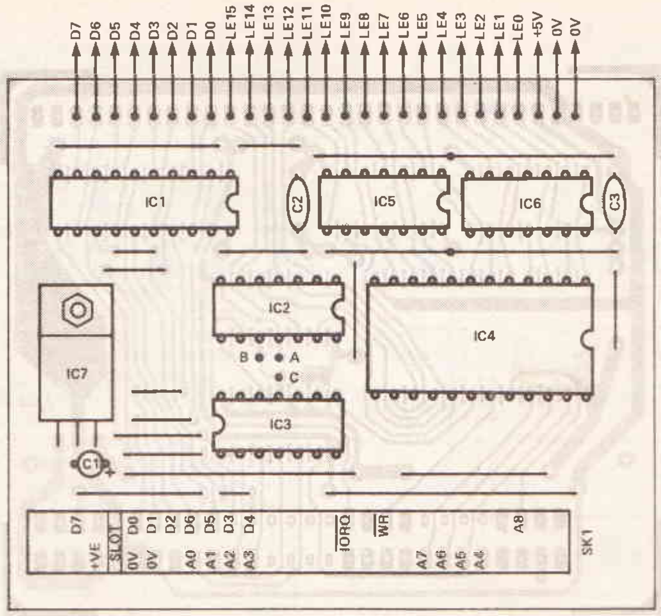


Fig. 2 Overlay diagram of the PCB.

We suggest the next stage as a check against shorts on the PCB. Plug in the board and check that your Spectrum works correctly with the board in position; if it does not, switch off immediately and look for the fault. If it does, insert and solder IC7, and repeat, this time checking for 5V across all the supply line decoupling capacitors and the appropriate IC socket pins.

Finally, insert the remaining ICs and test again; try outputting data in the relevant address range, to check that this does not cause any faults.

When linking up to the stage lighting unit, you can use ribbon cable and just parallel all the data and latch enable lines, if you used the PCBs as printed with the original articles, as all the latch selection was done with links on the PCB. Alternatively, you could use ribbon cable for just the data bus, and single wires to the relevent latch enables.

Before using the light unit in anger, we would suggest performing OUTs to the latches and checking that the correct data arrives at them (don't forget that the data bus is twisted). **ETI**

PARTS LIST

CAPACITORS

C1	2μ2 16V tantalum bead
C2,3	100n ceramic

SEMICONDUCTORS

IC1	74LS244
IC2,5,6	74LS04
IC3	74LS30
IC4	74LS154
IC7	7805

MISCELLANEOUS

PCB; Spectrum edge connector; ribbon cable, wire, solder, etc.

BUYLINES

Nothing here should cause any problems; the PCB will be available through our PCB service.

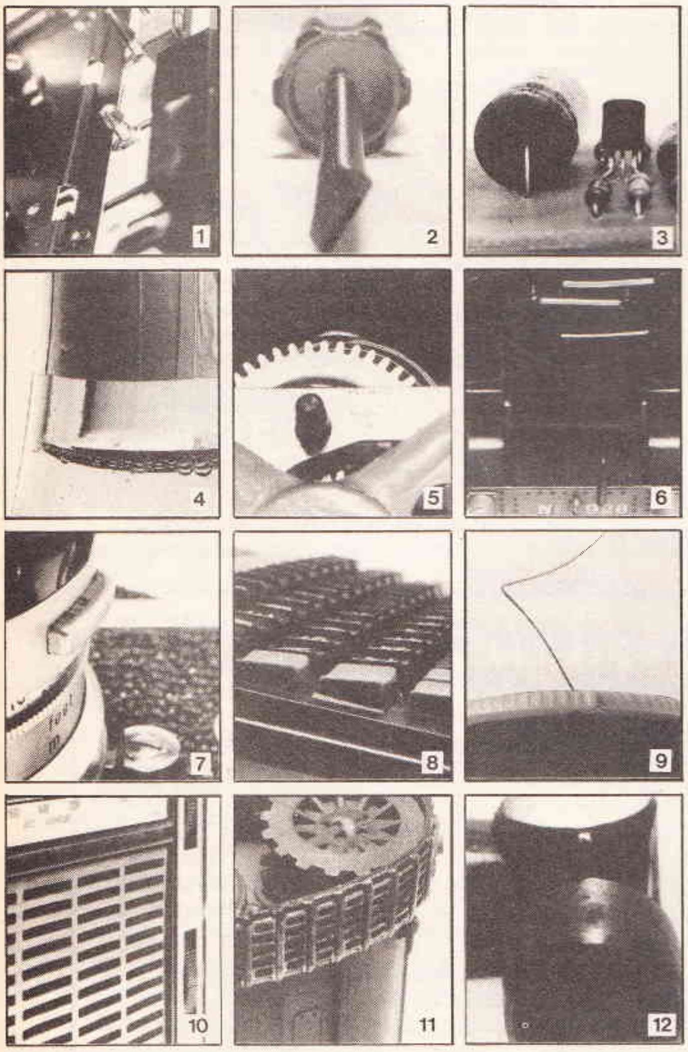
The Prizes:

You could win £2,500 to be spent on a dream holiday of your choice for you and your family!

Second prize — a complete Canon portable video outfit worth £1,300.

Third prize — a BBC Model B micro computer plus software worth £450.

Fourth prize — Minolta X700 camera with a 50mm lens and flashgun, worth £280.



How to enter:

Just identify the twelve objects pictured opposite....

HINT — the Argus Specialist Magazines listed below might give you a clue:

- Electronics Today International
- Personal Computing Today
- Movie Maker
- Your Model Railway
- Clocks
- Home Computing Weekly
- Beatbox
- Ham Radio Today
- Electronics
- 35mm Photography
- Model Cars
- Woodworker
- Games Computing
- Photoplay Movies and Video
- ZX Computing
- Military Modelling
- Hi-Fi Now!
- Winemaker
- Citizens' Band
- Model Boats
- Video Today
- Popular Crafts
- Which Video?
- Your Commodore

and write your (one-word) answers in the spaces provided on the coupon. For instance, if you think that number 9 is a record, write 'record' in the space next to 9 on the coupon and so on. Then tell us in up to 20 words why **MAGAZINES MAKE IDEAL HOLIDAY READING.** Complete the coupon in BLOCK LETTERS, and send it to: *DREAM HOLIDAY COMPETITION, Argus Specialist Publications Ltd., No 1 Golden Square, London W1R 3AB*, to reach us no later than 31st December 1984.

Competition rules

1 The competition is open to all UK and Eire readers except employees of Argus Specialist Publications Ltd., their printers and distributors

2 As long as an original coupon from the magazine(s) of your choice is used for each entry there is no limit to the number of entries per person. Photocopied coupons will not be accepted.

3 All entries must be postmarked before 31st December 1984

4 The prizes will be awarded to the first four entrants who identify the twelve objects correctly and whose completed sentence is judged the most apt and original.

5 No correspondence will be entered into about the competition results; the judges' decision is final.

6 Winners will be notified by post and the results will be published in a future issue of this magazine.

The 12 objects are

1.	2.	3. ....
4.	5.	6. ....
7.	8.	9. ....
10.	11.	12. ....

Magazines make ideal holiday reading because *(up to 20 words)* ....

....

NAME *(BLOCK LETTERS)* ______________________ AGE *(if under 18)* __________

ADDRESS ____

Send to **DREAM HOLIDAY COMPETITION,** Argus Specialist Publications, No 1 Golden Square, London W1R 3AB.

PERPETUAL PENDULUM

More attractive than magnetic sculptures, more swinging than a Newton's cradle, Damon Hart-Davis describes the latest thing in executive toys.

There is no such thing as perpetual motion. However, this project attempts to mimic it with the help of a little electronics and a magnet or two. It was constructed as the 'project' element of an A/O examination in electronics, and it was hoped that the swinging motion might hypnotise the examiners into giving the designer a high mark.

The basic principle behind the project is quite simple: a magnet swings on the end of a piece of cord. At the centre of the swing is a coil with some electronics. The magnet causes a small voltage to appear across the coil, and this is detected by the electronics. The electronics then causes a pulse of current to flow through another coil on the same bobbin, which administers a 'kick' to the pendulum and keeps it going.

To make the motion of the pendulum more interesting, other permanent magnets can be placed around the PCB containing the electronics and coil; this will deflect the pendulum swing from being regular, making it random, and to some minds, more interesting.

The Circuit

The circuit is quite straightforward; IC1 forms the input detector, and Q1 switches on with a sufficiently large output from IC1. IC2 a and b form a monostable, IC2 c inverts the output from the monostable and Q2 drives the 'kick' coil.

The main problem with this circuit will be its tendency to oscillate. The two coils on the same core constitute a transformer, and although the coupling between the coils isn't very good

HOW IT WORKS

When the pendulum moves away from the coil, a voltage is induced in L1 such that the R1 end goes negative with respect to OV. The amplitude of the induced voltage varies according to the speed of swing of the pendulum and the distance between it and the iron core of the coil, but will be of the order of 10mV.

Because the output coil L2 is wound on the same core as the sensor coil there is a risk of the higher amplitude output pulses being coupled back into the input and causing oscillation. To reduce this risk, the circuit has been arranged so that such induced voltages will be positive with respect to OV. Diode D1 will then conduct and prevent the voltage rising above its forward conduction value. R1 is included to limit the current which flows under these conditions; without it, L1 and L2 would appear as a transformer with a shorted output, and this would cause the transistor driving L2 to get very hot.

R2, R3, C1 and IC1 form an inverting amplifier with a gain of 100. C1 limits the bandwidth of the amplifier and therefore helps to prevent instability and oscillation. The output of the stage is fed to the circuit formed by R4, R5 and Q1, a switch whose action is largely independent of the supply voltage. This converts the analogue output of the op-amp, which varies in level according to the stimulus, into a logic signal switching quickly and cleanly between logic high and low states.

The output of Q1 is then fed to a monostable multivibrator formed by IC2a, IC2c, C2 and R6. The monostable is triggered when Q1 collector goes low, whereupon the output will go low for 0.2 seconds and then return to the high state. This delay further reduces the risk of the circuit as a whole oscillating and also ensures that the output pulse is of long enough duration to drive the pendulum well away from the coil. Without it, the pendulum might well move around the coil in a small circle rather than swinging across it.

IC2b is used to invert the output of the monostable before feeding it to the coil driver transistor, Q2. R8 is included to limit the current flowing through the coil and the collector circuit of Q2 should the coil have a resistance of less than about 400R. D2 protects the transistor against high back-EMFs generated when the current through the coil is removed.

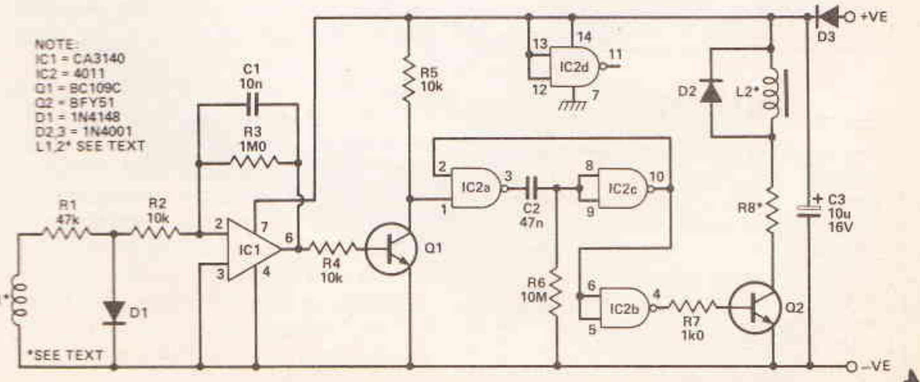


Fig. 1 Circuit diagram of the perpetual pendulum.

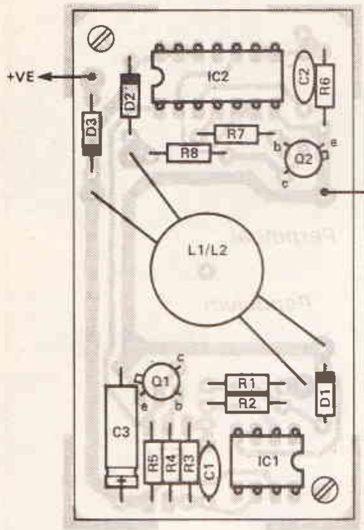
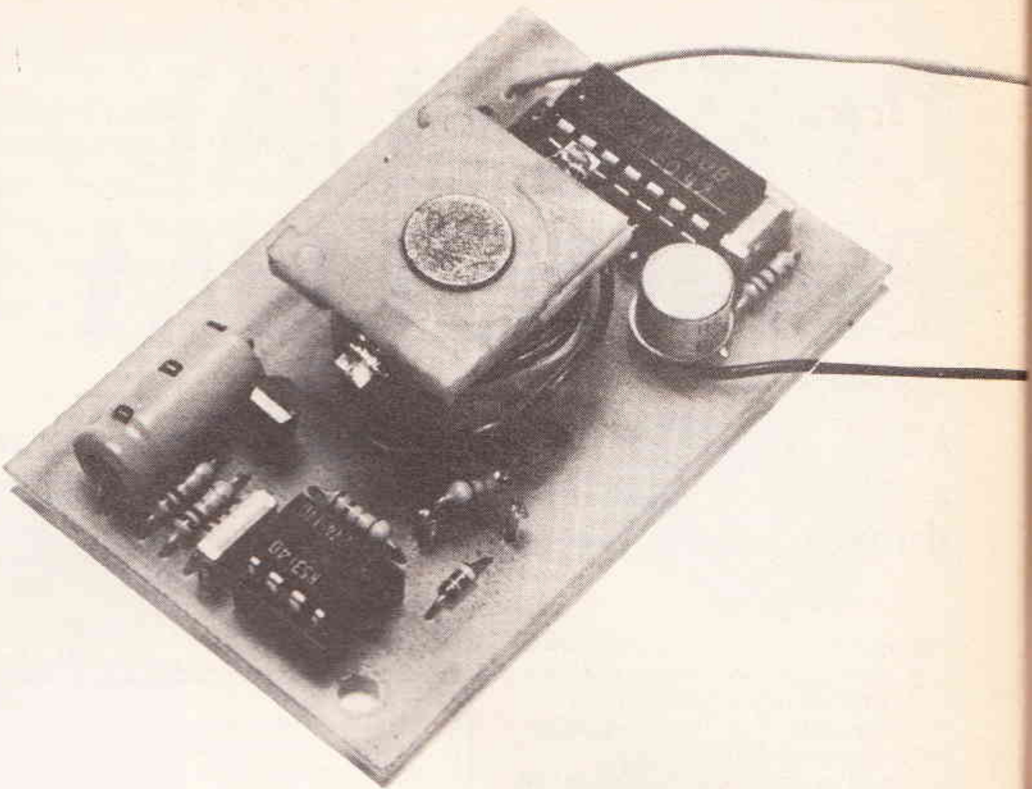


Fig. 2 Component overlay diagram for the PCB.



PARTS LIST

RESISTORS (all ¼ W, 5%)

R1	47k (see text)
R2,4,5	10k
R3	1M
R6	10M
R7	1k
R8	as required to bring coil resistance up to approximately 400R

CAPACITORS

C1	10n ceramic
C2	47n ceramic
C3	10u, 16V axial electrolytic

SEMICONDUCTORS

IC1	CA3140
IC2	4011
Q1	BC109C or BC182L
Q2	BFY51 or 2N3053
D1	1N4148
D2,3	1N4001

MISCELLANEOUS

L1,2	see text

PCB; sockets for ICs if desired; permanent magnet; case, battery or PSU, etc.

BUYLINES

The only item here which might present any problems is the relay used for L1/L2. Ours was rescued from a fruit machine and had a 48V, 10k ohm coil, but we have not been able to locate a supplier for these. Most constructors should be able to find something in the junk box which would work reasonably well, but if you really are stuck then try one of the 24V open relays available from Maplin and other suppliers.

(it isn't meant to be) it will probably be enough to cause problems. The gain of the detector is 100, which is tapered off at higher frequencies by C1. The remainder of the circuit is nominally digital, but digital circuits have a nasty habit of behaving like analogue ones just when you don't want them to.

Construction

Assembling the PCB should present no problems and the only points to watch here are the usual ones, such as getting the ICs and the transistors the right way around and not inserting these components until after the resistors and capacitors have been soldered.

The coil used in the prototype for L1 consisted of an 'open' type relay rated at 48V, 10k. The relay was stripped of its contacts and swinging arm to leave just the coil, plastic bobbin and iron core. Two hundred turns of 36 SWG enamelled copper wire were then wound on top of the existing coil to form L2. The rating of the relay coil is not too critical and it is probable that most coils with a large number of turns and a resistance of a few k ohm or more would do. Room has been left on the PCB for resistors in series with both L1 and L2, and it may be necessary to experiment with different values of resistance to get the circuit to work correctly.

As explained in the How It Works section, it is important for correct operation that the two coils are wired in the correct sense relative to one another. The voltage induced in L1 must be positive with respect to 0V when L2 is pulsed and negative with respect to 0V when the pendulum is moved away from it. It should be possible to find the correct arrangement by experiment, and no damage can be done by getting it wrong at a first attempt. If you have access to an oscilloscope or a reasonably high impedance millivoltmeter, you can determine the correct arrangement by connecting up L2 and determining the polarity of the voltage across L1 when Q1 collector is temporarily shorted to ground.

Choice of case for the project is left very much up to the constructor. The prototype was installed in a clear plastic box with the supply leads taken out to an external PSU, but it could just as easily be built as a self-contained unit with its own 9V battery. The current consumption varies with the supply voltage but is of the order of a few milliamps with peaks of 10-16 mA when a pulse is delivered to L2. This is a little high for sustained operation from a PP3 and if you intend to leave the device on continuously you should use either a PP9 or a mains power supply offering between 5 and 15V.

ETI

Ex Stock Integrated Circuits

74LS00	70p	2732	495p
74LS04	82p	2764-250	640p
74LS08	60p	611P3	675p
74LS20	45p	TC5516	750p
74LS27	40p	4164	500p
74LS32	70p	7400	30p
74LS157	70p	7404	40p
74LS244	225p	7416	45p
74LS373	210p	7407	225p

Variety of TTL & 74LS items in stock—please 'phone your enquiry.

*Please add 50p for p&p + 15% VAT to all orders.

Export—No VAT. p&p at cost.

Government & Educational Establishments' Official Orders Welcomed

NEW CATALOGUE AVAILABLE: PLEASE SEND S.A.E.

DEALERS ENQUIRIES WELCOME

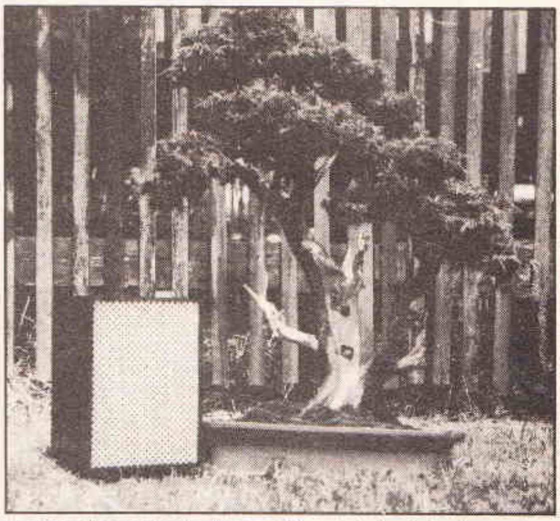
Cambridge Microcomputer Centre

The Peripheral Centre of East Anglia

153-4 East Road, Cambridge CB1 1DD
Telephone (0223) 355404 Telex 817445

Prices subject to change without notice.

Bonsai

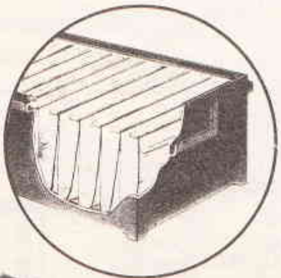


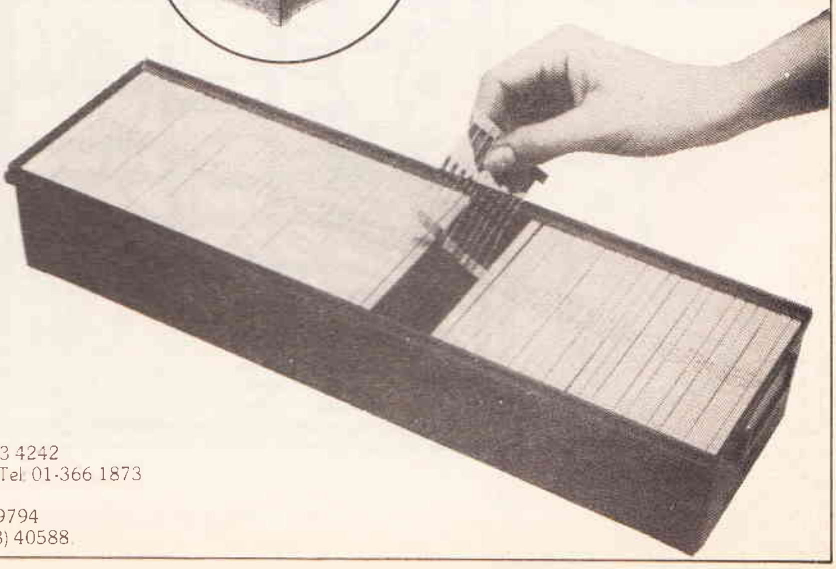
Bonsai is a Japanese technique for miniaturising trees whilst preserving all their natural characteristics. This is exactly what we have done with our new British invented and manufactured loudspeaker.
Based on a newly developed single full range driver the diminitive "Musician Bonsai" has all the qualities of the best, large multi way systems without some of their vices.

For details please contact:
Merseyside Acoustic Developments Ltd.,
Merseyside Innovation Centre,
131, Mount Pleasant, Liverpool, L3 5TF.
Tel. 051-709-0427

Two Hundred Year Old Bonsai Tree By Courtesy Of: TOKONOMA NURSERY.

Component MINI FILE





For
Electronic and other small parts.
A large variety of components can easily be kept well organized.
60 storage pockets per unit.
Unit size:
L400 W125 H77mm.
Material: Injection-moulded in impact resistant polystyrene.
4 and 6 Drawer Steel cabinets available.
The 6 Drawer cabinet, practical for field service, has lock and carrying handle.
Recommended prices (excluding V.A.T.):

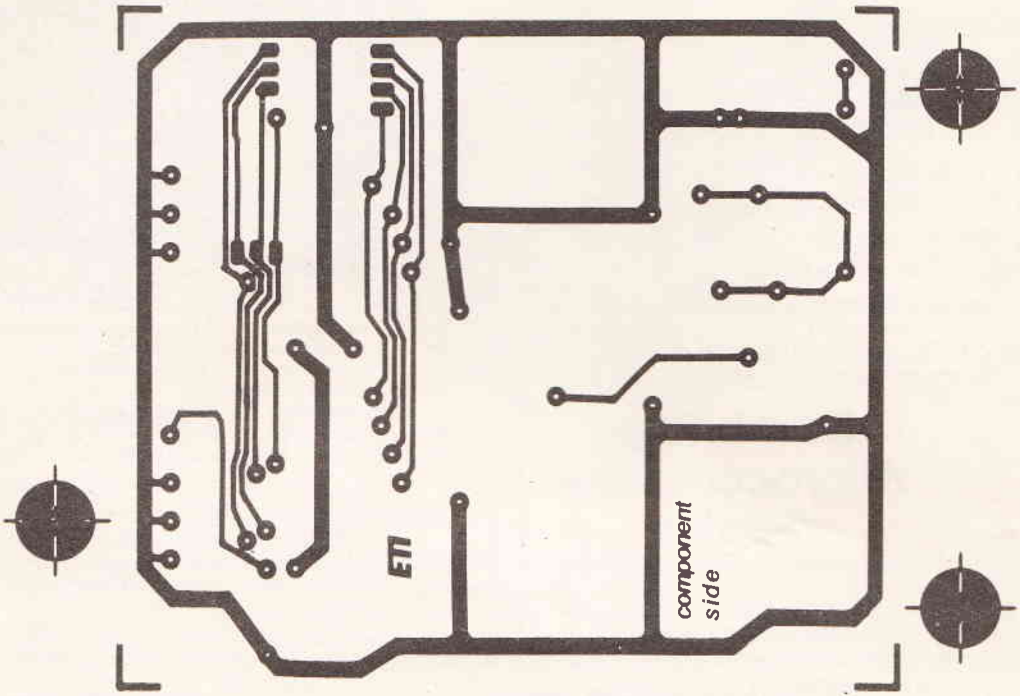
6 drawer cabinet with lock and handle	£92.00
4 drawer cabinet with lock and handle	£59.00
Single drawer	£11.00

Typical Minifile applications:

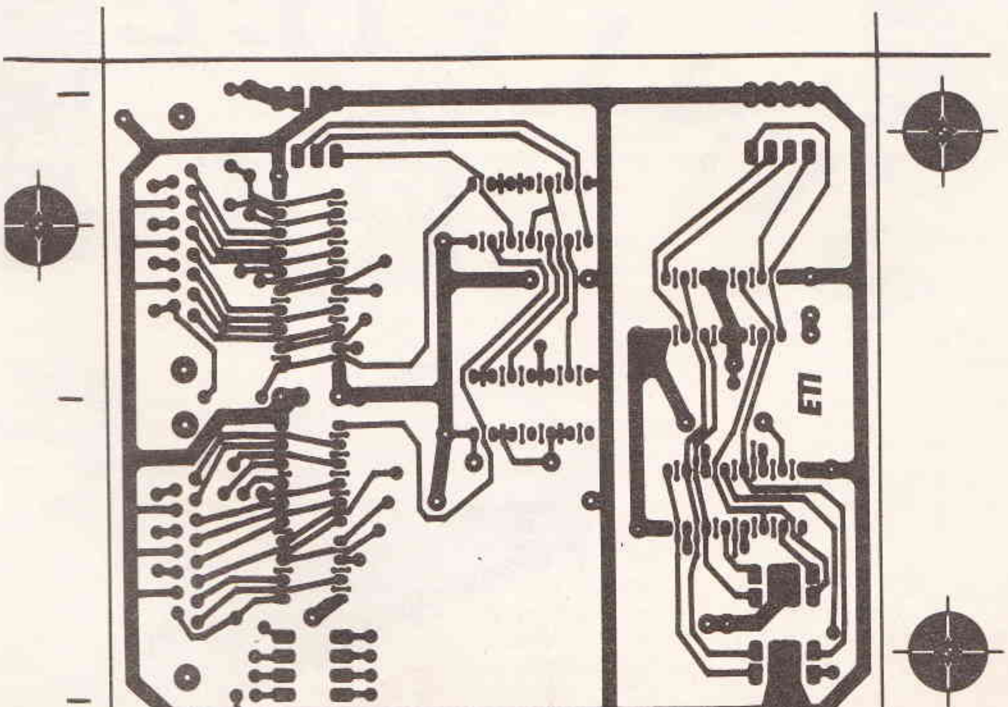
R & D Departments	Prototype Kits
Production Test & Rework	Service Departments
Field Service Engineers	The Electronic Hobbyist
Repair kits for computers	CNC- machines.

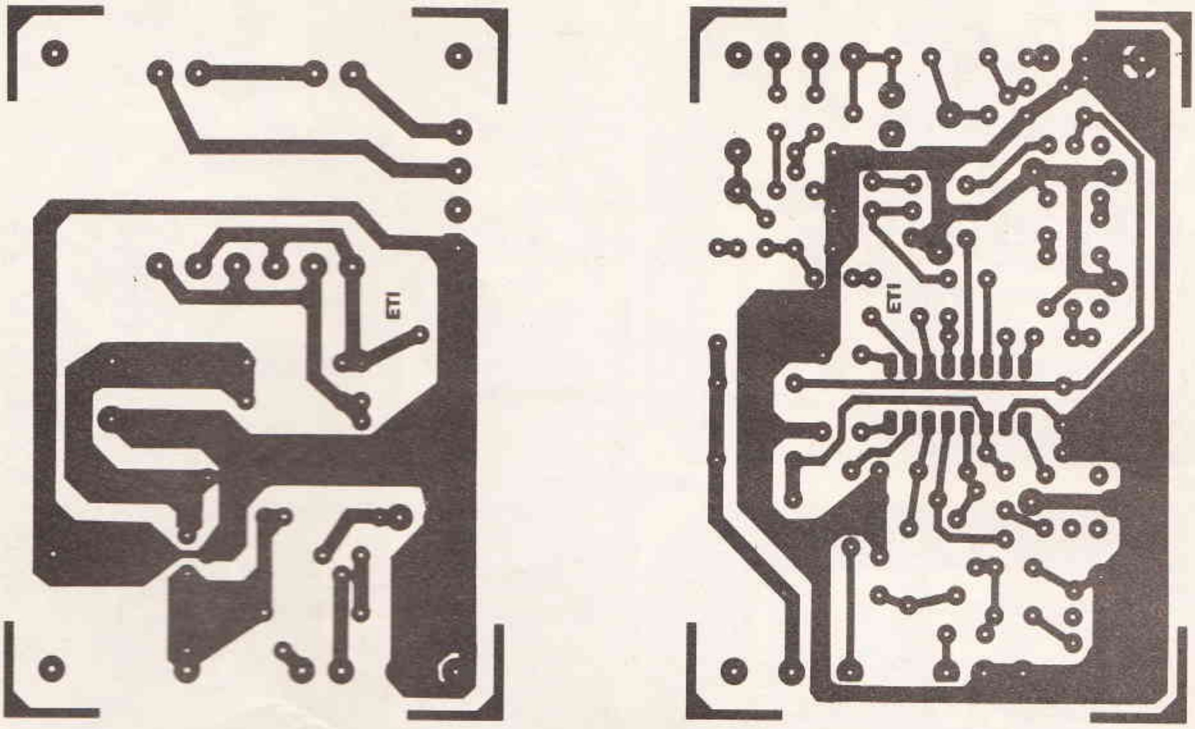
Stocked by:
Bradley Marshall, 325 Edgware Road, London W2 1BN. Tel: 01-723 4242
Enfield Electronics, 208 Baker Street, Enfield, Middlesex EN1 3JY. Tel: 01-366 1873
Henry's, 404-406 Edgware Road, London W2. Tel: 01-724 0323
TK Electronics, 11-13 Boston Road, London W7 3SJ. Tel: 01-579 9794
Watford Electronics, 33/34 Cardiff Road, Watford, Herts. Tel: (0923) 40588.

FOIL PATTERNS

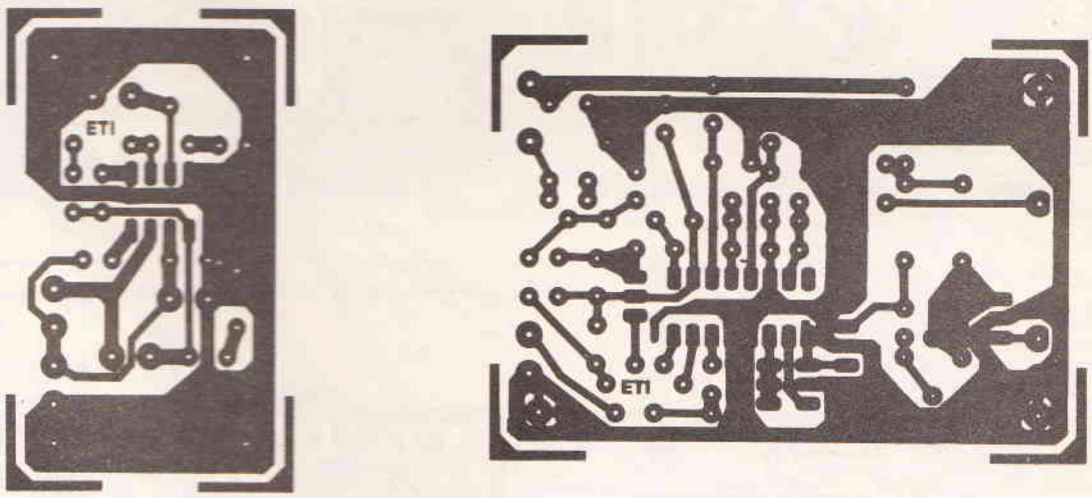


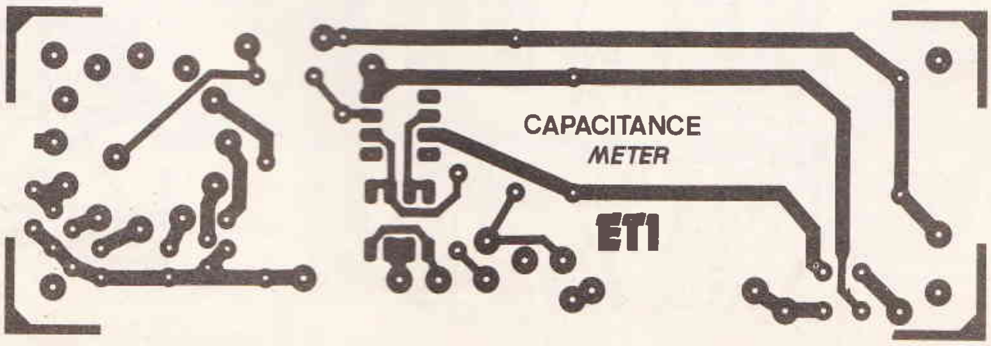
The top and bottom foils of the control port I/O board.



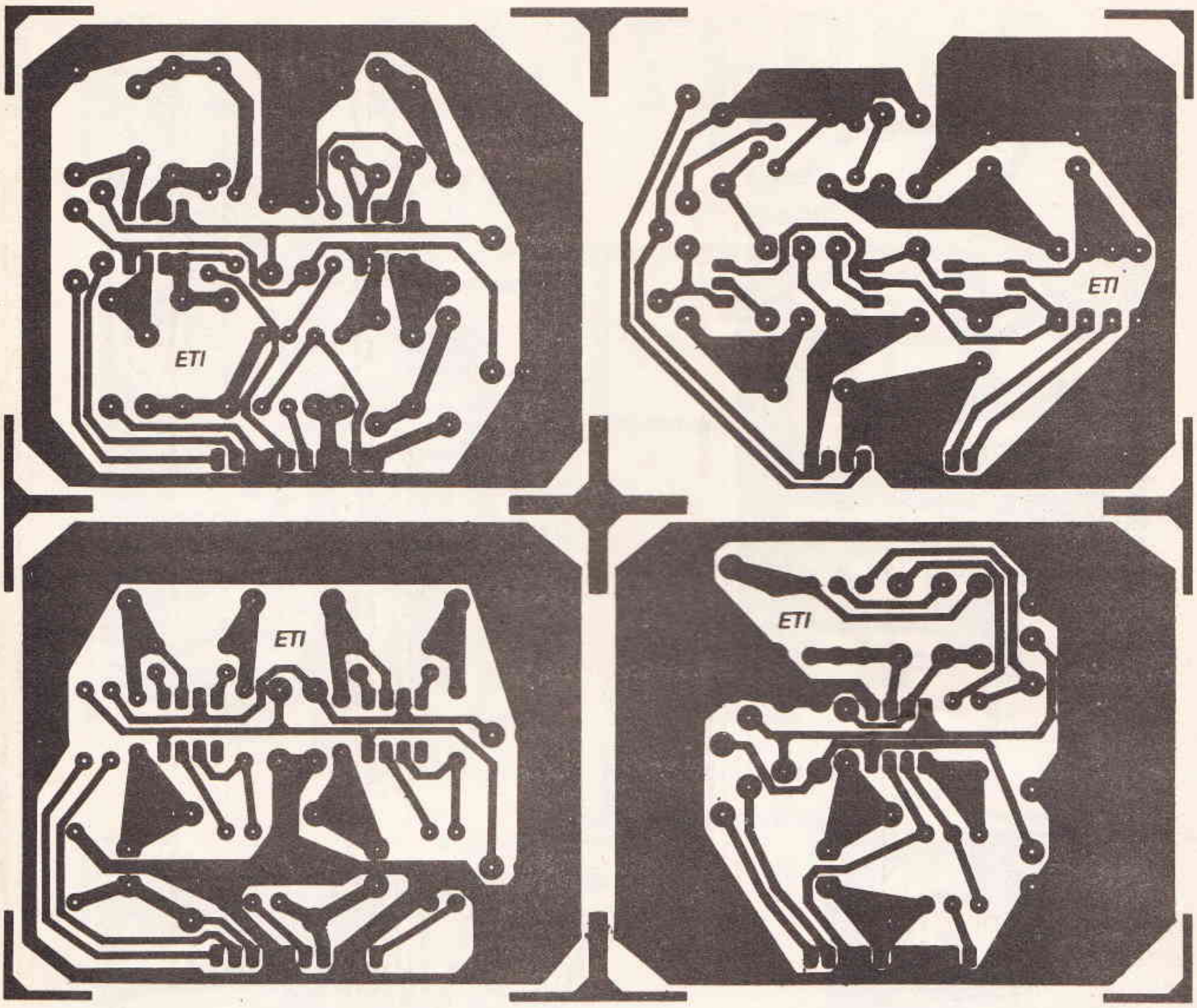


These four boards are for the AM/FM radio.



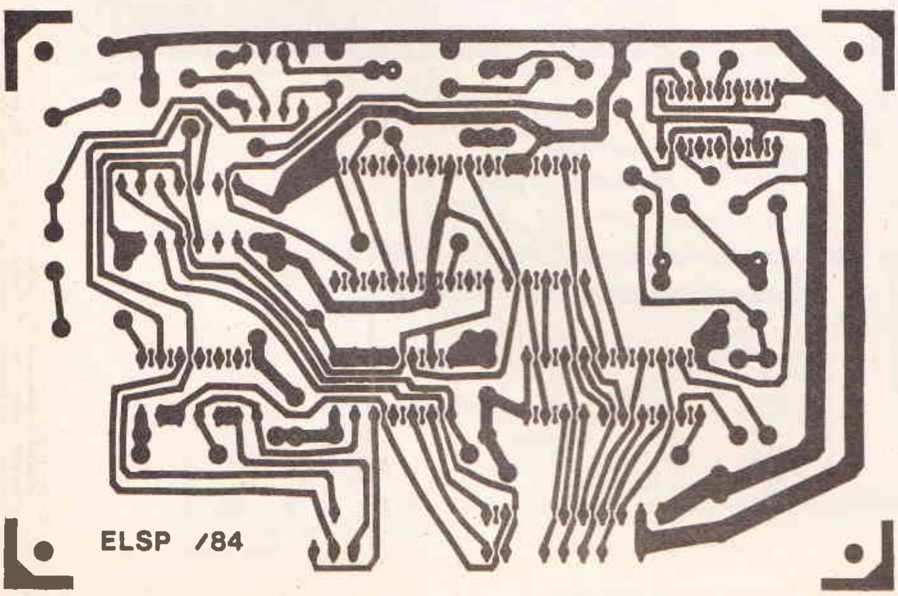


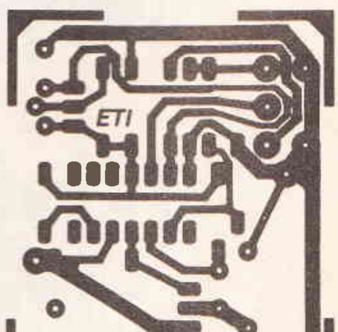
The capacitance meter board.



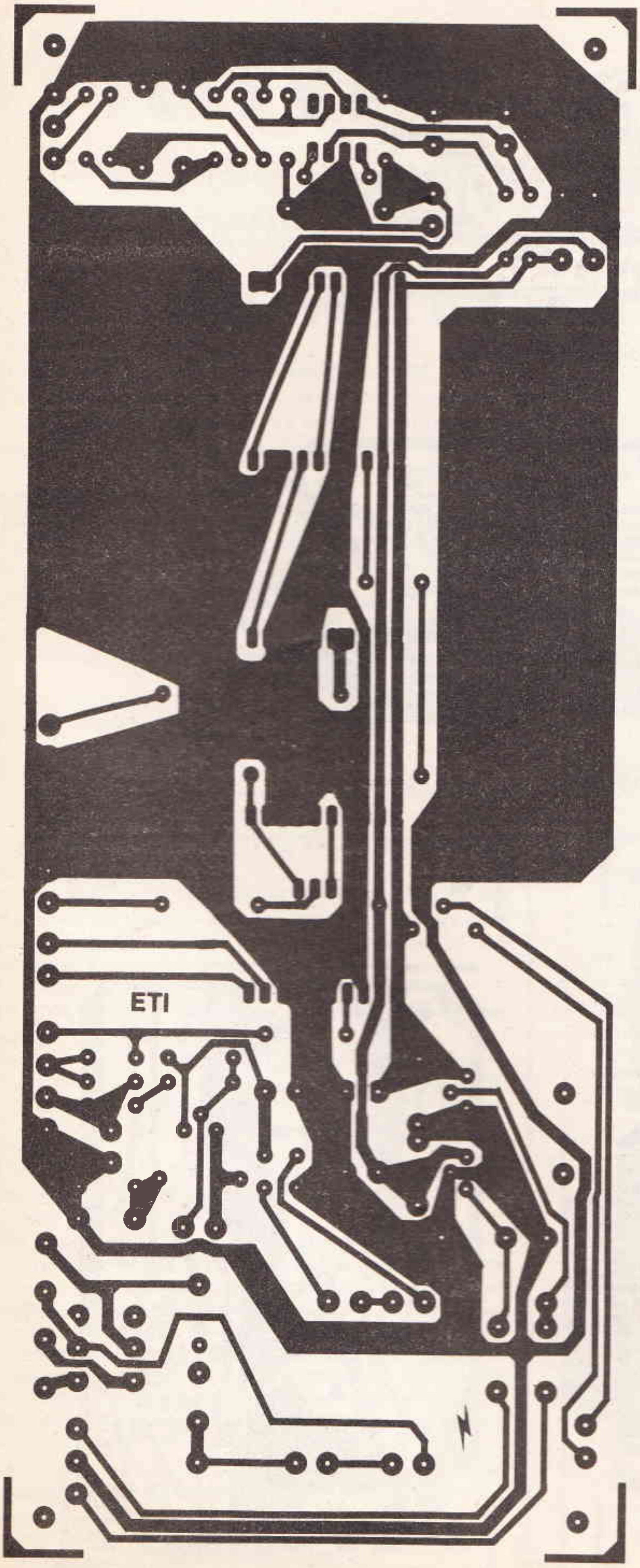
The mother board and four of the plug-in module boards for the active loudspeaker. ▶

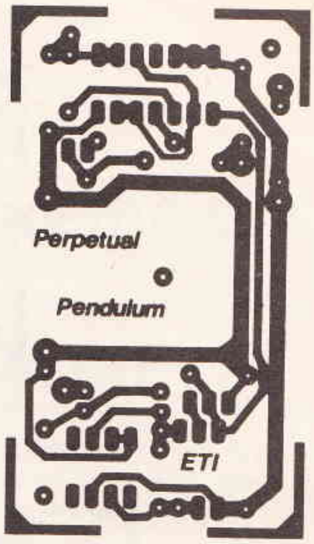
The foil pattern for the Electron speech board.



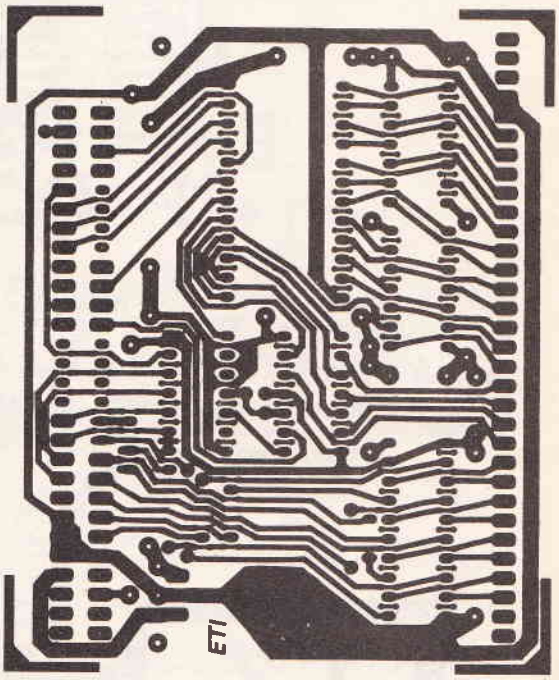


The temperature controller foil pattern.

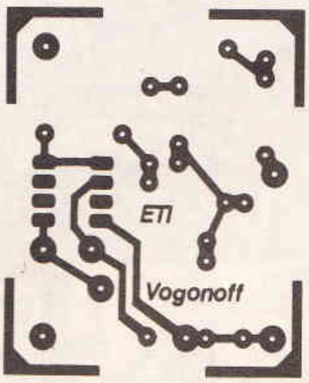




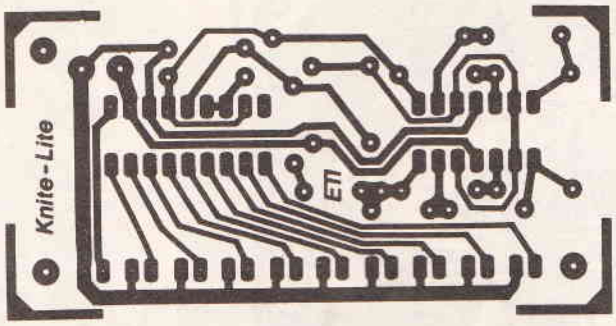
The Perpetual Pendulum foil pattern.



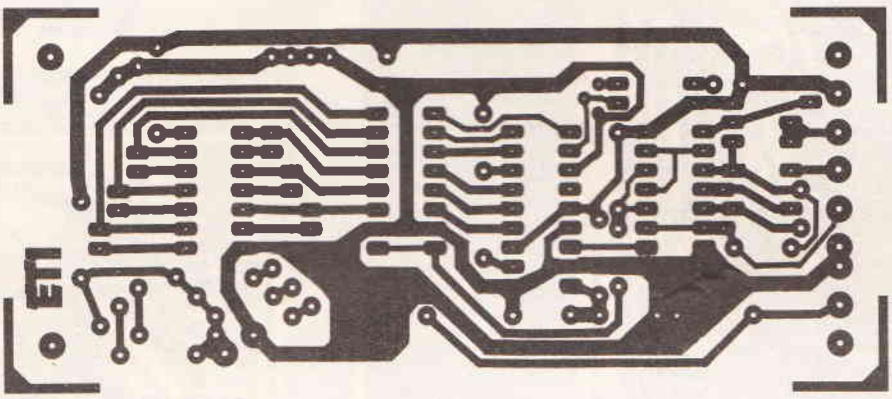
The foil pattern for the Stage Lighting Interface.



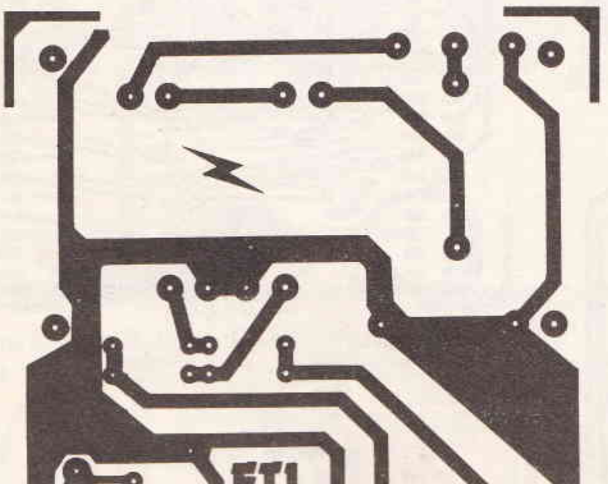
The pattern for the mains failure alarm.

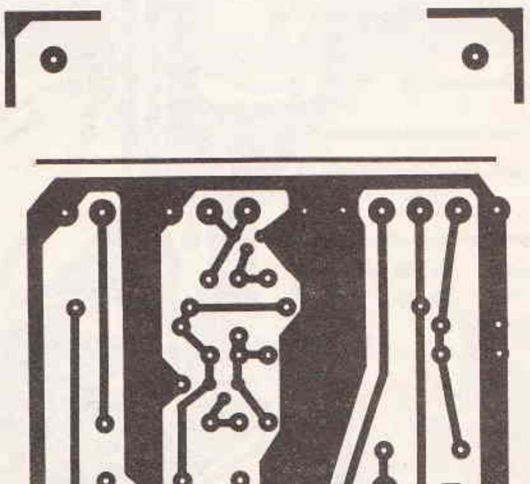


The Knite Light foil pattern.



These three boards are for the Video Vandal.





ATTENTION ALL WRITERS . . .

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

We want to hear from you!

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

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

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

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

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.

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
- ☐ E/844-2 Mains Borne RC (Rcvr) 3.70
- ☐ E/845-1 Auto Light Switch......... 4.01
- ☐ E/845-2 ZX81 EPROM Prog. 10.53
- ☐ E/845-2 Mains Born RC (Trans)..... 5.07
- ☐ E/845-4 Centronics Interface 4.09
- ☐ E/845-5 Vario 6.62
- ☐ E/845-6 Midi Drum Synth 3.59
- ☐ E/846-1 Oric EPROM Bd 19.58
- ☐ E/846-2 Spectrum Joystick....... 3.30
- ☐ E/847-1 Warlock Alarm.......... 8.19
- ☐ E/848-1 Joystick Interface........ 3.07
- ☐ E/848-2 EPROM Emulator 9.11
- ☐ E/848-3 Infrared Transmitter..... 3.70
- ☐ E/848-4 Infrared Receiver........ 3.98
- ☐ E/848-5 CMOS Tester 4.60
- ☐ E/849-1 EX42 Kybd. Interface...... 3.82
- ☐ E/849-2 Bansheee Siren 3.19
- ☐ E/849-3 Dry Cell Charger.......... 2.80
- ☐ E/8410-1 Echo Unit 3.92
- ☐ E/8410-2 Digital Cassette........ 9.80
- ☐ E/8410-3 Disco/Party Strobe 4.80
- ☐ E/8411-1 AM/FM Radio (4 bds) 13.02
- ☐ E/8411-2 Control Port-control bd ... 12.15
- ☐ E/8411-3 Control Port-I/O bd........ 6.33
- ☐ E/8411-4 Capacitance Meter.......... 3.55
- ☐ E/8411-5 Video Vandal (3 bds)...... 12.10
- ☐ E/8411-6 Temperature Controller 2.88
- ☐ E/8411-7 Mains Failure Alarm........ 2.54
- ☐ E/8411-8 Knite Light 3.25
- ☐ E/8411-8 Stage Lighting Interface 3.73
- ☐ E/8411-10 Perpetual Pendulum 3.14

How to order: indicate the boards required by ticking the boxes and send this page, together with your payment, to: ETI PCB Service, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB. Make cheques payable to ETI PCB Service. Payment in sterling only please. Prices subject to change without notice.

Total for boards	£....................
Add 45p p&p	0.45
Total enclosed	£....................

PLEASE ALLOW 28 DAYS FOR DELIVERY

Signed ....

Name ....

Address ....

....

ELECTRONICS TODAY INTERNATIONAL CLASSIFIED

Lineage:
40p per word (minimum 15 words)
Semi Display: (minimum 2 cms)
£11.00 per single column centimetre
Ring for information on series bookings/discounts
All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request)

01-437 0699

Send your requirements to:
Will Fox
ASP Ltd.,
1 Golden Square,
London W1.

ALARMS

ALARMS ADE

FREE BOOKLET on BURGLAR ALARMS with
LOWEST U.K. DIY PUBLISHED PRICES
PHONE OR WRITE FOR YOUR COPY
051-523 8440
AD ELECTRONICS
217 WARBRECK MOOR
AINTREE, LIVERPOOL L9 OHU

A1 INTRUDER ALARMS

Wholesale Alarm Suppliers
Latest D.I.Y. & Wholesale Published Catalogue.
Write off for your copy
86 Derby Lane, Old Swan, Liverpool 13
Tel: 051 228 3483 or 051-220 0590

ALARM EQUIPMENT

Complete door entry phone kit	**£39.50**
2 Zone B.S. panel	**from £38.50**
Single zone B.S. panel	**£33.50**
Complete CCTV kit	**£235.00**

(Prices + VAT & Carriage)
Send for full list of fire and security equipment.
VICTOR SECURITY CENTRES LTD
Hambletonian Yard, West Row
Stockton-on-Tees, Cleveland TS18 1BB
Tel: 0642 608500

BURGLAR Alarm Equipment. Please visit our 2,000 sq. ft. showrooms or write or phone for your free catalogue. C.W.A.S. Ltd., 100 Rooley Avenue, Bradford BD6 1DB. Telephone 0274 731532.

KNIGHT ALARM SUPPLIES
Wholsalers of intruder and fire alarms, C.C.TV., door entry, emergency lighting, nursing call equipment.
- External PIR/controllers ....**from £60.00** + VAT
- Digital key pads ....**from £19.00** + VAT

CATALOGUE AVAILABLE
349 Kirkstall Road, Leeds LS4 2HD
Tel: (0532) 795-079

SOFTWARE APPLICATIONS

CORTEX SOFTWARE

For the Powertran Cortex computer
FORTH — Supplied in two 2564 eproms. Totally standalone supports cassette, 5.25" & 8" discs. Price £35.00 inclusive.

DISCS — Forth utilities, use with above eproms, contains editor, assembler, and utilities. Price £30.00 inclusive.

AUTO-BOOT DISCS
FORTH — Use the Basic 'BOOT' command to download the Forth system, the Forth eproms are not required. Price £55.00 inclusive.

CDOS — Adds file support to Cortex Basic, named program and data files. Includes format and configure utilities. Price £50.00 inclusive.
Disc orders, please state 5.25" or 8" s.a.e. with all enquiries to:-

LOMBARD SYSTEMS
18 Lombard Street, Lidlington
Bedford MK43 0RP

USE ETI CLASSIFIED SECTION TO SELL YOUR PRODUCT/SERVICE

Either fill in the coupon or phone

01-437 0699

HOME GUARD SYSTEMS

If you want professional alarm/C.C.TV/Door entry/security lighting equipment or DIY kits at genuine trade prices don't delay phone today for our free illustrated catalogue.
Tel: 01-651 2449
Freepost, South Croydon
Surrey CR2 9PU
(no stamp required)

SECURITY Alarm Systems

FREE COMPREHENSIVE CATALOGUE!
- *LOWEST DISCOUNT PRICES*
- *HIGHEST QUALITY EQUIPMENT*
- *FREE DIY DESIGN GUIDE*
- *FULLY ILLUSTRATED*
- *MICROCHIP CIRCUITRY*
- *QUICK DESPATCH SERVICE*
- *FULL INSTRUCTIONS*

SEND SAE OR PHONE
C-TEC SECURITY, Dept E.1,
60 Market St, Wigan WN1 1HX
Telephone (0942) 42444
Trade Enquires Welcome

FOR SALE

100W AMPLIFIER — £9.95 built or use the same board for 50W, 150W, 200W into 4 or 8 ohms etc., by using alternative output transistors & P.S.U. S.A.E. for full details to ESS Amplification, Unit 11, Argyle St., Hull.

BARGAIN PACKS our speciality. Send S.A.E. for details plus free samples. Projek Electronics, 44 Mathie Crescent, Gourock PA19 1YX.

ELECTRONIC ORGAN KEYBOARDS and other parts being cleared out as special offer. Elvins Electronic Musical Instruments, 40A Dalston Lane, London E8. 01-986 8455.

POWERTRAN CORTEX Computer. Basic unit. Most IC bases fitted for optional extras (RS232, discs). £220 o.n.o. Bedford (0234) 766111 evenings) weekends except Friday.

POWER AMPLIFIERS 200 watts £12.95 . . . case plus controls and sockets . . . tested. Glass/PCB . . . 4 x MJ3001/TO3 output. 100+100W . . . (MRP £38.40 plus data . . . KIA-8 Cunliffe Road, Ilkley LS29 9DZ.

FOR SALE

EPROMS — Texas TMS 2716 JL/45 Triple Rail 100 new, offers. Telephone: Basingstoke 68465.

KITS

TIME WRONG?
MSF CLOCK is ALWAYS CORRECT — never gains or loses, SELF SETTING at switch-on, 8 digits show Date, Hours, Minutes and Seconds, auto GMT/BST and leap year, also parallel BCD for computer, receives Rugby 60KHz atomic time signals, built-in antenna, 1000Km range, £79.70, get the TIME RIGHT.
Fun-to-build kit (ready made to order) includes ALL parts, printed circuit, case etc, by-return postage, list of other kits.
CAMBRIDGE KITS
45 (TL) Old School Lane, Milton, Cambs.

MICRO BUG
140mm x 370mm. Extremely sensitive, powerful. Operates from 1.5V battery ready built tested only **£9.95** (in kit form **£7.50**).
Also available Automatic Telephone Recorder built tested **£11.95** (in kit form **£8.50**).
All fully guaranteed. Send cash, cheque or P.O. to:
SHAH ELECTRONICS
11 Livingstone Road
Southall, Middlesex
UB1 1TH

METRONOME KIT. Easy to assemble complete with box. You need only a soldering iron and wire cutters. £6.50 including p&p and VAT. Hunt Electronics, PO Box 57, Derby DE6 6SN.

ECOLIGHT (ETI July 84) full kit as per article. £21.05. P.C.B. only £4.50. GP Electronics, 87 Willow Tree Ave., Durham DH1 1DZ.

LINSLEY HOOD DESIGNS
LOW DISTORTION AUDIO SIGNAL GENERATORS

A0 113 Kit	**£25** (p.p. £1)
A0 149 Kit	**£32** (p.p. £2)

Super Hi-Fi Amplifier (ETI)
P.C. Boards from **£4**
Send S.A.E. for further details:
TELERADIO ELECTRONICS
325 Fore Street, London N9 0PE
Tel: 01-807 3719

PRINTED CIRCUITS Make your own simply, cheaply and quickly! Golden Fotolac light-sensitive laquer - now greatly improved and very much faster. Aerosol cans with full instructions, £2.50. Developer 35p. Ferric Chloride 60p. Clear acetate sheet for master 15p. Copper-clad fibreglass board, approx. 1mm thick £2.00 sq. ft. Post/packing 75p. White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall.

MINIATURE FM TRANSMITTERS. Frequency 60-145 MHz, range ½ mile S.G.F.-P.C.B. All componentsd. Full instructions. 9-12V operation, broadcast reception. Super sensitive microphone. Pick-upo on FM radio. £6.95 inc; or ready built £8.95: Same day despatch — Zednith Electronics, 21 Station Road Industrial Estate, Hailsham, E. Sussex BN27 2EW.

WANT RESULTS?

THEN USE

ETI CLASSIFIED

SITUATIONS VACANT

AUDIO ENGINEER REQUIRED. Experienced in servicing all types of hi-fi, radio cassettes and in-car entertainment. Phone Ian on 01-249 4814.

COMPONENTS

UNAVAILABLE COMPONENTS? If we can't get them nobody can. Quote without obligation or charge. Quote or order period approx 2 weeks. No order is too small. Rickman Components, South Ronaldsay, Orkney KW17 2TW. Phone 085683-430.

PHONE OR WRITE for VAT inclusive price list. eg 7805 voltage regulator 38p. HUNT ELECTRONICS, PO Box 57, Derby DE6 6SN (0283) 703071.

IRISH READERS

MAIL ORDER COMPONENTS

Top quality components
Great prices
Return-of-post service

Write or phone for free price list

WAVEFORM ELECTRONICS
12 Effra Road, Rathmines, Dublin 6.
Phone (01) 0001 if England 987507
Mail order only please

AERIAL AMPLIFIERS improve weak television reception. Price £6.70. S.A.E. for leaflets. Electronic Mailorder, Ramsbottom, Lancashire, BL0 9AGH.

COMPONENTS

BUMPER BOX OF BITS

WOW! We've got so many components in stock, we can't possibly list them all — So buy a box. In it you'll find resistors, capacitors, displays, switches, panels with transistors, diodes, IC's etc., coils, pots... and so on. All modern parts — guaranteed at least 1000 items, minimum weight 10lbs. ONLY £8.50 inc. 48 page catalogue 50p.

ELECTRONICS WORLD
1e Dews Road, Salisbury, Wilts SP2 7SN

Betatran Electronics Supplies

Toroidal transformers primary 250V secondaries 0-40, 0-40V, 0-50, 0-50V, 0.55, 0-55V, 0-70, 0-70V at 300VA £17.55, 500VA **£24.70,** 625VA **£30.50. Can Electolytics 63V, 6800uF SA 2£4.35.** 10,000uF 7A **£5.45.** 100V 6800uF 8A **£6.23,** 4700uF 8A **£5.50.** 3300uF 7A **£4.20.** 2200uF 7A **£3.00. Computer Grade 10,000uF 15A £14.69.** MOS-FETs 2SJ 50/2SK 135 **£8.50.** 2SJ83/2SK 227 **£8.20** price per pair. 35A 200V bridge rectifiers **£3.25.** VAT inclusive £1.00 p&p under £7.00. Full spec. many more. Resistors, capacitors, trasnistors, heat sinks, amplifiers, speakers, transformers, etc. Send 4 x 9 self addressed envelope for large list.

Laver St., Cavendish, Suffolk CO10 8AP. Tel: 0787 280639.

2764's! (350ns) Thousands must go only £7.50 each (+V.A.T.). Ideal for BBC etc. Also bulk eprom copying service (any type/quantity considered). DG Sharp (Computer Services), 49 Main St., Bothwell, Glasgow, G71 8ER.

TRANSISTOR/I.C. SALE

2716 EPROM £1.25
2116 16K RAM £2.00
MJE 3055 10 for £1.75
TIP 29/30/31/32A
10 ANY MIX £1.80
BD 135/137/139 20p
100 mixed, coded transistors. All types SS/Tower £2.
SAE for List. 50p carriage all orders.
J. WRIGHT
27 Broomhill Drive
Glasgow G11 7AB

DIODES IN4001 2½p. IN4005 3p. IN5400 7p. IN5404 9p. IN5408 12p. IN4148 1½p. BZY88C Zeners 4½p.
RESISTORS ¼ watt ½p.
Minimum 100 off and 50p carriage.
Webb Electronics
41 Winwick Street, Warrington WAS 2AS
Tel: 54174

PLANS 'N DESIGN

AMAZING ELECTRONIC plans, lasers, gas, ruby, light shows, high voltage teslas, van de graph surveillance devices, ultrasonics, pyrotechnics, new solar generator, 150 more projects, catalogue. S.A.E. Plancentre, Bromyard Road Industrial Estate, Ledbury HR8.

REPAIRS

MICRO-COMPUTER repairs. ZX Spectrum, VIC 20, C64 Pets, Commodore computers, printers and floppy disk. Phone Slough (0753) 48785. Monday to Saturday.

WANTED

WANTED Electronic test equipment, large computers, large quantities of Printed Circuit Boards, anything considered, good prices paid: "C" House, Stanhope Rd., York Town Ind. Est., Camberley, Surrey. 0276-28208.

SERVICES

JBA ELECTRONICS

Manufactures to design or specifications. One offs, small batch prototypes. Analogue digital electronic equipment. Complete electronic service — no job to small.

1st Floor, 4a Lion Yard
Brecon, Powys, South Wales
Tel: (0874) 611177

PRINTED CIRCUIT BOARDS manufactured to your specification. Quality, Quick service. Competitive Prices. COPPER-CLAD fibreglass boards cut to size. 1mm thick £1.80 sq. ft. 1.6mm £2.20 sq. ft. Postage 75p. Mondo Circuits Ltd. 35 Grosvenor Road, Twickenham. Middx. Tel: 01-891 5412.

P.C.B. DESIGN & LAYOUT, manually taped artwork professionally produced at competitive prices. James Gledhill. Tel: 01-674-8511.

FREE PROTOTYPE of the finest quality with every P.C.B. artwork designed by us. Competitive hourly rates, and high standard of work. Halstead Designs Limited. Tel: halstead (0787) 477408.

WIRES 'N CABLES

THE SCIENTIFIC WIRE COMPANY
811 Forest Road, London E17
01-531.1568

ENAMELLED COPPER WIRE

SWG	1lb	8oz	4oz	2oz
8-34	3.63	2.09	1.10	88p
35-39	3.82	2.30	1.26	93p
42-43	5.20	2.91	2.25	1.60
44-47	8.56	5.80	3.49	2.75
48	15.96	9.58	6.38	3.69
SILVER-PLATED COPPER WIRE				
14-30	9.09	5.20	2.93	1.97
TINNED COPPER WIRE				
14-30	3.97	2.41	1.39	0.94

Prices include P&P and VAT. Orders under £2 add 20p. Dealer inquiries welcome.

EQUIPMENT

EPROM COPIER — STAND ALONE 2716-27128 .... **£175.00**
TELEPHONE CONVERSATION RECORDER **£75.00**
2 LINES INTO 1 ANSWERING MACHINE Switching Unit **£30.00**

From L.K.F. Systems Ltd
St. Albans. Tel: 55084

BOOKS

PARAPHYSICS JOURNAL (Russian translation); psychotronics, kirlianography, heliphonic music, telekinetics. Computer software. S.A.E. 4 x 9", Paralab, Downton, Wiltshire.

TURN YOUR SURPLUS transistors, IC's etc into cash. Contact Coles Harding & Co., 103 South Brink, Wisbech, Cambs. Tel: 0945 584188. Immediate settlement.

SCOPES

Repaired & recalibrated, all makes, all models.
Scopex Safgan, Older TEK, TQ
MENDASCOPE LTD
Otter House
Western Underwood, Olney
Bucks MK46 5JS
Tel: Bedford (0234) 712445

BOOKS EXCHANGE SERVICE

BOOKS WANTED FOR CASH

Have you got technical books you no longer need? OR Do you need to read up on a new topic? Then EXCHANGE BOOK CLUB can help YOU!
We buy and sell previously read books on electronics and computing.
For list of currently available titles and details of our guaranteed buy back plan SAE please to:-
JAMES ELECTRONICS, P.O. Box 2 Rothwell, Leeds LS26 0UY

MISCELLANEOUS

AGENTS

Wanted to Sell Computer Software for most computers. We now have the Dialog Electronics Part I in stock, Pools Winner & Course Winner. We can supply business software, games anmd computer ad ons. Phone (0288) 4179 up to 9pm most nights for your free list and details about our agents.

WANT TO BUY SELL SWOP? *JUST FILL IN THE COUPON OVERLEAF* *OR* **PHONE 01-437-0699**

MISCELLANEOUS

IMPROVE YOUR PROSPECTS

with skills that all employers want. Train the easy way with modern home study courses from Ideal Schools.

MODERN ELECTRONICS

Takes you from the beginning right up to C & G 224 course and BTEC national Level.

COMPUTER PROGRAMMING

Learn BASIC with a Spectrum included if you wish.

IDEAL

For a free booklet write today to:
IDEAL SCHOOLS
(Ref. ETO 1)
Freepost, Glasgow
G1 4BR

GENERAL

SEND FOR
FREE
CATALOGUES & PRICE LISTS

Project cases for wah-phase chorus/flanger & graphic eq.

Computer leads, video & audio leads

Plus many more items.

SOLA SOUND
18 Barton Way Croxley Green
Rickmansworth, Herts

ELECTROMART

ESSEX

R JONES ELECTRONICS
267 Rectory Rd., Grays, Essex
Tel: (0375) 33158 — *24hr answer phone*
Components, IC's, Full After Sales Services
Electronic repairs — Industrial & Domestic
Open 9-5.30pm 6 days a week.

LANCASHIRE

ETESON ELECTRONICS
E•E•
15B Lower Green,
Poulton-le-Fylde, Blackpool
Tel: (0253) 885107
Open: 9.30am-12.30, 1.30-5.30. Closed Wed & Sun.
Electronic Component Specialists.

MERSEYSIDE

PROGRESSIVE RADIO
93 Dale Street. Tel 051 236 0982
47 Whitechapel, Tel 051 236 5489
Liverpool 2
'THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9.30-5.30

S. WALES

STEVE'S ELECTRONIC SUPPLY CO. LTD.
45 Castle Arcade, Cardiff
TEL: 0222 41905
Open: Mon-Sat 9-5.30
For components to computers

YOU CAN BE SURE OF THE SHOPS IN **ELECTROMART**

Phone **ASP** on **01-437 0699** for details

ELECTRONICS TODAY INTERNATIONAL

CLASSIFIED ADVERTISEMENT — ORDER FORM

If you have something to sell now's your chance! Don't turn the page — turn to us!

Rates of charge: 40p per word per issue (minimum of 15 words).

and post to **Electronics Today International, Classified Dept., 1 Golden Square, London W1.**

Please place my advert in **Electronics Today International** for...... issues commencing as soon as possible.

I am enclosing my Cheque/Postal Order/International Money Order for: (delete as necessary) £...... (Made payable to A.S.P. Ltd)

VISA

OR Debit my Access/Barclaycard
(Delete as necessary)

We welcome Access

All classified advertisements must be paid for in advance.

Please use BLOCK CAPITALS and include post codes.

Classification ....

Name (Mr/Mrs/Miss/Ms) ....
(delete accordingly)

Address ....

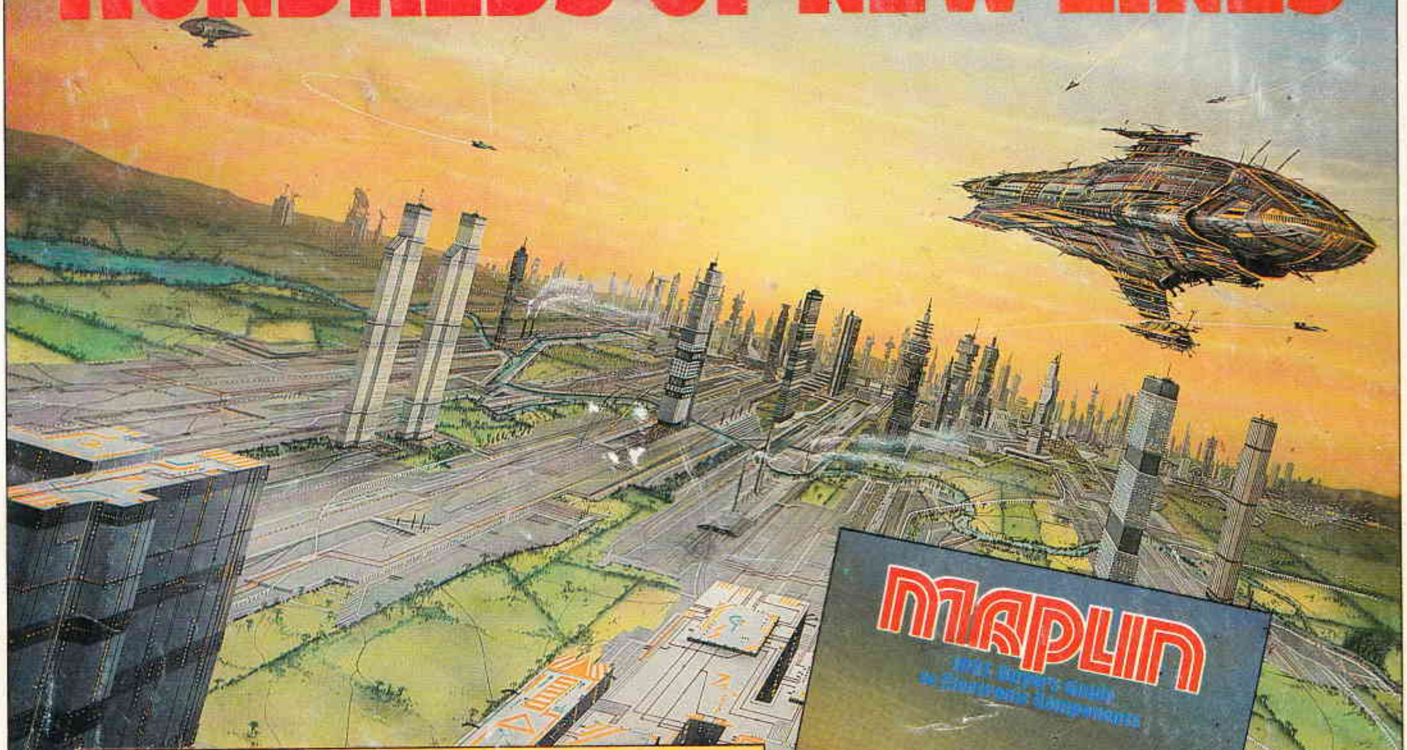
....

Signature .... **Date** ....

Daytime Tel. No. ....

ADVERTISERS INDEX

HUNDREDS OF NEW LINES



The amazing Maplin Catalogue is here again! The new edition is packed with hundreds and hundreds of new electronic components to bring you right up to date with all the latest developments. As all home constructors agree (and a good many professionals too) the Maplin Catalogue is the one essential piece of equipment they really need. And now with all our **prices on the page** the Maplin Catalogue is better value than ever.

On Sale From 10th November 1984.

Pick up a copy as soon as it's published at any branch of W.H. Smith or in one of our shops. The price is still just £1.35, or £1.75 by post from our Rayleigh address (quote CA02C).

Post this coupon now for your copy of the 1985 catalogue.
Price £1.35 + 40p post and packing. If you live outside the U.K. send £2.40 or 11 International Reply Coupons.
I enclose £1.75.

Name ....

Address ....

....

.... ETI 11/84

MAPLIN
ELECTRONIC SUPPLIES LTD

Maplin Electronic Supplies Ltd. Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR.
Tel: Southend (0702) 552911. •Shops at: 159-161 King Street, Hammersmith, London W6. Tel: 01-748 0926. •8 Oxford Road, Manchester. Tel: 061-236 0281.
•Lynton Square, Perry Barr, Birmingham. Tel: 021-356 7292.
•282-284 London Road, Westcliff-on-Sea, Essex. Tel: 0702-554000.
•46-48 Bevois Valley Road, Southampton. Tel: 0703-25831. All shops closed all day Monday.