AN ARGUS SPECIALIST PUBLICATION

electronics today

INTERNATIONAL

APRIL 1985 £1.10

THE FINAL LINK

PLUS

RS232 I/O For The ZX81/ Spectrum

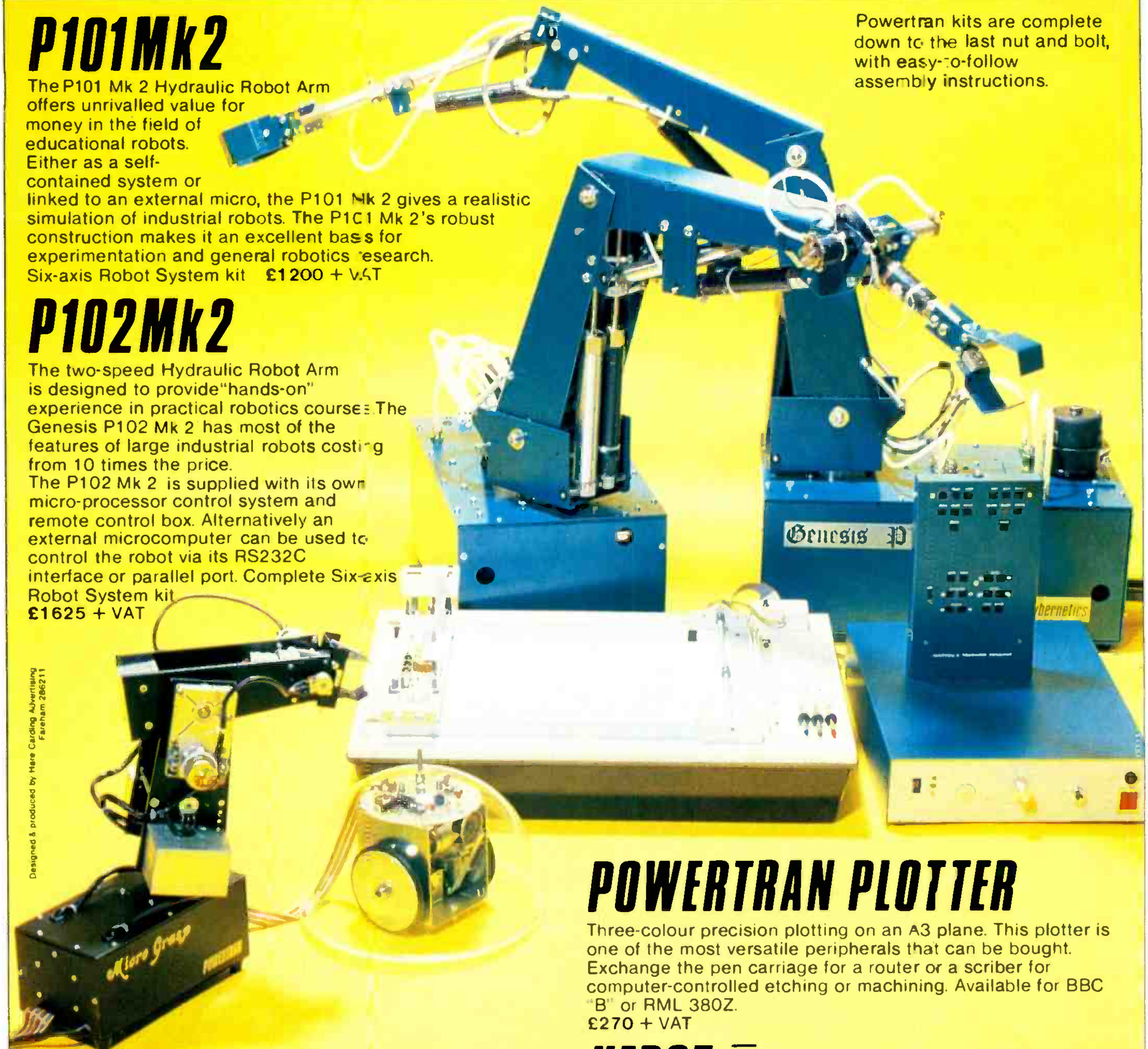
Telephone Call Meter

Electronics For Peace?

The Secrets Of Telecine

AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS..

LEARNING TOOLS



P101Mk2

The P101 Mk 2 Hydraulic Robot Arm offers unrivalled value for money in the field of educational robots. Either as a self-contained system or linked to an external micro, the P101 Mk 2 gives a realistic simulation of industrial robots. The P101 Mk 2's robust construction makes it an excellent basis for experimentation and general robotics research.
Six-axis Robot System kit **£1200** + VAT

Powertran kits are complete down to the last nut and bolt, with easy-to-follow assembly instructions.

P102Mk2

The two-speed Hydraulic Robot Arm is designed to provide "hands-on" experience in practical robotics courses. The Genesis P102 Mk 2 has most of the features of large industrial robots costing from 10 times the price.
The P102 Mk 2 is supplied with its own micro-processor control system and remote control box. Alternatively an external microcomputer can be used to control the robot via its RS232C interface or parallel port. Complete Six-axis Robot System kit
£1625 + VAT

Designed & produced by Hare Carding Advertising Fareham 286211

POWERTRAN PLOTTER

Three-colour precision plotting on an A3 plane. This plotter is one of the most versatile peripherals that can be bought. Exchange the pen carriage for a router or a scriber for computer-controlled etching or machining. Available for BBC "B" or RML 380Z.
£270 + VAT

HEBOT II

With independent control of its two wheels, two-tone hooter, flashing "eyes", retractable pen and four-way collision detectors, Hebot provides an ideal introduction to computer control. Connects to most popular micros.
Complete kit **£95** + VAT
Universal computer interface board kit **£11** + VAT

MICROGRASP

A real programmable robot for the price of a printer! MicroGrasp has four servo-controlled axes and an independent gripper. The robot can be connected to most popular computers via special Powertran adaptors.
Robot kit with power supply **£215** + VAT
Universal interface board kit **£57** + VAT

Access/Visa cardholders – save time – order by phone: 0264 64455.

POWERTRAN
CYBERNETICS LIMITED

Please send me the following kits ____________

I enclose Cheque/Postal Order, value £ ____________
(Don't forget to add V.A.T.)

Name ____________

Address ____________

To Powertran Cybernetics Limited, Portway Industrial Estate, Andover, Hampshire SP10 3ET

Please allow 21 days for delivery. Offers subject to availability. Prices apply to UK only, are exclusive of V.A.T. and correct at time of going to press. Overseas customers - please contact our Export Department.

Access VISA

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FEATURES

PROJECTS

INFORMATION

SWITCHES

TOGGLE: 2A, 250V
SPST 35p DPDP 48p

SUB-MIN TOGGLE

SPST on/off	58p
SPDT c/over	64p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	80p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
4-pole 2 way	220p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A with 10mm Button

SPDT latching	150p
DPDT latching	200p
SPDT moment	150p
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch
Assorted Colours
75p each

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

JUMPER LEADS (Ribbon Cable Assembly)
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 0.1in

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

VQ Board	195p
DIP Board	395p
Vero Strip	95p

PROTO DECs

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

VERO WIRING PEN

+ spool	380p
Spare spool	75p
Combs	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
6" x 6"	100p	125p
6" x 12"	175p	225p

DIL SOCKETS

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

EDGE CONNECTORS

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

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

ANTEX SOLDERING IRONS

C15W	525p;	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

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

ZIF TEXTOOL DIL SOCKETS

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

'D' CONNECTORS

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

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

25 way 'D' CONNECTOR (RS232)
Jumper Lead Cable Assembly

18" long, Single end, Male	475p
18" long, Single end, Female	510p
36" long, Double Ended, M/M	995p
36" long, Double Ended, F/F	£10
36" long, Double Ended, M/F	995p

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	465p	460p
36 way Centronix	450p	475p
24 way Female	480p	450p

PANEL METERS

FSD
60 x 46 x 35mm
0–50µA
0–100µA
0–500µA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0.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	265
1.008M	275
1.28MHz	450
1.6MHz	395
1.8MHz	545
1.8432M	230
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	140
6.5536MHz	225
7.0MHz	150
7.168MHz	200
7.7328MHz	250
7.68MHz	200
8.0MHz	150
8.089333M	395
8.86723M	220
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	200
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- 8Ω

2", 2¼", 2½", 3"	80p
2½" 40Ω 64Ω or 80Ω	80p
6" x 4" 8Ω	200p
7" x 5" 8Ω	225p
8" x 5" 8Ω	250p

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular **£68**
- MICROVITEC 1431, 14" Colour RGB input. Connecting cable incl. **£165**
- MICROVITEC 1451, 14" Medium resolution **£250**
- KAGA 12", Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£259** (car £7)
- KAGA 12", As above but Hi-Resolution **£310** (car £7)
- Connecting Lead for KAGA **£5**

Carriage £7 Securicor

TRANSFORMERS

3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA **130p**
pcb mounting Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **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	79HG − 2.25V to −24V; 5A	685p
LM323K	450p	78S40	225p
LM337	175p		
LM723 Var	30p		
78S40	225p		

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	45p
500 pins	195p

ALUM BOXES

3 x 2 x 1"	85p
4 x 2½ x 2"	100p
4 x 2½ x 2¼"	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

"SPECIAL OFFER"

	1+	1+
2764	425	415
27128	975	965
6116LP	325	315
6464	975	965

CMOS

4000	20
4001	25
4002	25
4006	70
4007	25
4008	60
4009	45
4010	45
4011	25
4012	25
4013	35
4014	60
4015	60
4016	40
4017	60
4018	60
4019	58
4020	80
4042	43
4021	58
4022	67
4023	30
4024	50
4025	22
4026	90
4027	40
4028	50
4029	75
4030	35
4031	130
4032	70
4033	130
4034	146
4035	70
4036	275
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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
4548	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	220
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	198
40373	220
40374	220
45106	586

OPTO

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

OPTO ELECTRONICS

LEDs with clips

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

ISOLATORS

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

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 8 Digits	625
Reflective Switch	225
SLOTTED Optical Switch similar to RS Comp's	295

COMPUTER CORNER

- OL RGB MONITOR, Medium resolution £239
- EPSON RX80 Printer £209
- EPSON RX80 F/T Printer £219
- EPSON FX80 Printer £316
- EPSON FX100 Printer £429
- KAGA/TAXAN KP810 Printer £249
- KAGA/TAXAN KP910 Printer £339
- SEIKOSHA GP100A Printer £122
- BROTHER HR15 Daisywheel £329

Cable for above printers to interface with BBC Micro £7

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

(Securicor Carriage charge on printers is £7)

CALL IN AT OUR SHOP FOR A DEMONSTRATION ON ANY OF THE ABOVE ITEMS. BE SATISFIED BEFORE YOU BUY OR WRITE IN FOR OUR DESCRIPTIVE MICRO PERIPHERALS LEAFLET.

DISC DRIVES

(CUMANA)
DRIVES CASED with PSU & CABLES

- CS100 — Single Cased with PSU, 40 track, 5¼" S/S 100K £119
- CD200 — Twin Cased with PSU, 40 Track, 5¼" S/S 200K £236
- CS200 — Epson Single Cased with own PSU D/S, 40 Track, 5¼" 200K £149
- CD400 — Epson Twin Cased with own PSU D/S, 40 track, 5¼" 400K £280
- **MITSUBISHI 5¼" SLIM LINE DISC DRIVES**
  Double Sided, Double Density, Track Density 96 TPI, Track to track access time 3msec.
- **CS400 MITSUBISHI Single Slimline,** 5¼" Cased with PSU. DSDD. 1 Megabyte (400 K with BBC) £165
- **CD800 MITSUBISHI Twin Slimline,** 5¼" Cased with PSU. DSODD. 2 Megabyte. (800 K with BBC) £339

5¼" DISKETTES (Lifetime Warranty)

- **10 3M Diskettes Single side Double density** £14
- **10 3M Diskettes Double side Double density** £23

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

BBC MICRO WORDPROCESSING PACKAGE

A complete wordprocessing package (which can be heavily modified to your requirements, maintaining large discount). We supply everything you need to get a BBC Micro running as a word-processor. Please call in for a demonstration.

Example Package:
BBC Micro, with DFS Interface, Wordwise, Twin 400K TEC Disc Drives, 12" High-res green monitor, Brother HR15 Daisywheel printer, Beebcalc & Database software on Disc, 10 3M Discs, 500 sheets of paper, 4 way mains trailing socket, manuals and all cables.

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We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, 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.

TOOLTRONICS

MINIATURE TOOLS

PRECISION JEWELLERS' TOOLS

Rustproof Tempered Handles and Blades. Chrome Plated Handles. Swivel Heads for use on Precision work

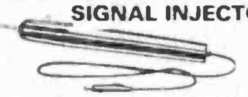
5T21 SCREWDRIVER SET
6 precision screwdrivers in hinged plastic case. Sizes – 0.8, 1.4, 2, 2.4, 2.9 and 3.8mm **£1.75**

5T31 NUT DRIVER SET
5 precision nut drivers in hinged plastic case. With turning rod. Sizes – 3, 3.5, 4, 4.5 and 5mm **£1.75**

5T41 TOOL SET
5 precision instruments in hinged plastic case. Crosspoint (Philips) screwdrivers – H0 and H1 Hex key wrenches. Sizes – 1.5, 2 and 2.5mm **£1.75**

5T51 WRENCH SET
5 precision wrenches in hinged plastic case. Sizes – 4, 4.5, 5, 5.5 and 6mm **£1.75**

SIGNAL INJECTOR



Simple push button operation. Oscillates at 700–1kHz with harmonics to 30MHz. 1.4V p/p output. Impedance 10Ω. Ideal for trouble-shooting with audio equipment. One "AA" penlight battery supplied. O/No VP96 **£2.50**

LOGIC PROBE

Automatic levelling. White LED indication. Minimum width of measuring pulse 30 millisecs. Maximum input frequency 10MHz

Input impedance	100kΩ
Power consumption	40mA maximum
Power supply	4.5–18 V d.c.

ORDER No. VP97 **£10.50**

CURRENT/POL CHECKER

Heavy duty test prods with built-in indicators for testing polarity, indicates whether a.c. or d.c. 3.5V to 400V. O/No VP98 **£3.00**

TESTER

Universal tester with ceramic buzzer. Tests diodes, transistors, resistors, capacitors and continuity. One "AA" penlight battery included.

Test current	Max 2μA
Test voltage	1.2V
Response range	100MΩ
Max voltage	500V
Internal resistance	390kΩ
Length	135mm

£5.00 O/No VP99

CIRCUIT TESTER

D.C. continuity tester for circuit checking on all low voltage equipment and components. Diode checking also possible. Takes two AA batteries. 90cm lead has crocodile clip. Body length 145mm. O/No VP100 **75p**

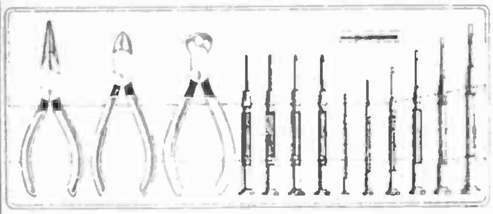
MINIATURE VICE

Miniature plastic and metal vice with strong suction base for portability. Single action to secure or release suction. Plastic jaws with rubber pads 20mm wide, open out to 40mm. Dims. 85 × 65 × 60mm approx. *FANTASTIC VALUE* O/No VP95 ONLY **£1.60**

METRIC & BRITISH MEASURES

Steel tapes in sturdy ABS plastic case. Silk wrist strap. These yellow coated convex tapes have inch and metric graduations. Automatic push button return. 2m long × 13mm wide. O/No VP89 **£1.75**

13 PIECE TOOL KIT AND CASE



13-piece tool set housed in attractive moulded plastic case with clear sliding cover ● 1 off 5" snipe nose "radio" pliers with side cutters ● 1 off 4½" side cutters ● 1 off 4½" end cutters ● 2 off hex "Allen" key drivers 2mm and 2.5mm, 2 off cross-point "Philips" drivers No. 0 and No. 1 (with tommy bar) ● 6 off precision screwdrivers. Sizes from 1mm to 3.5mm ●

ONLY £7.50 ORDER No. VP102

LOW COST CUTTERS/PLIERS – SPECIAL DRIVERS

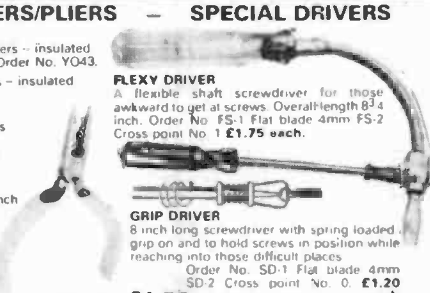
Miniature round nose cutters – insulated handles 4½ inch length. Order No. YO43.

Miniature long nose pliers – insulated handles 5½ inch length. Order No. YO44.

Miniature bend nose pliers – insulated handles 5½ inch length. Order No. YO45.

Miniature end nippers – insulated handles 4½ inch length. Order No. YO46.

Miniature snipe nose pliers with side cutter and sorrated jaws – insulated handles 5 inch length. Order No. YO42.



FLEXY DRIVER
A flexible shaft screwdriver for those awkward to get at screws. Overall length 8¾ inch. Order No. FS-1 Flat blade 4mm FS-2 Cross point No. 1 **£1.75 each.**

GRIP DRIVER
8 inch long screwdriver with spring loaded grip on and to hold screws in position while reaching into those difficult places. Order No. SD-1 Flat blade 4mm SD-2 Cross point No. 0 **£1.20 each.**

ALL AT **£1.55** each

ANTEX SOLDERING IRONS

MODEL	O/NO	PRICE
SX 25 watt	1931	£5.40
CX230 17 watt	1972	£5.30
CX250 15 watt	1948	£5.20

ANTEX ST4 IRON STAND
Chromium plated steel spring – in plastic base insulated, with wiper pad. O/No 1939 **£1.75**

PORTABLE SOLDERING IRON
12volt, 25 watt. Works from car battery. 2 core cable with heavy duty croc clips. O/No 1971 **£5.60**

Ideal outdoor motorist, boat, caravan-owner. SK1 SOLDERING KIT – for miniature work. Kit consists of: 1–15w iron (C240) 3 bits, 3.32", 5/32", 3/16". Solder & heat shunt · Booklet "How to Solder". O/No 1938 **£8.00**

THE THIRD AND FOURTH HAND

…you always need but have never got until now. This helpful unit, with rod mounted horizontally on heavy base, crocodile clips attached to rob ends. Six ball & socket joints give infinite variations and positions through 360° also available attached to rod, 1 2½" dia magnifier giving 2.5 × magnification. Helping hand unit available with magnifier as illustrated. ORDER NO. T402 **£5.50**
Without magnifier ORDER NO T400 **£4.75**

UNIVERSAL STAND

A combined Third & Fourth Hand with magnifier and Soldering Iron Stand, all in one unit. *A must for all who solder and need hands free!* O/No 403 **£5.50**

BI-PAK SOLDER–DESOLDER KIT

Kit comprises: O/No VP80
1 High Quality 25 Watt General Purpose Lightweight Soldering Iron 240v mains incl. 3/16" (4.7mm) bit. 1 Quality Desoldering Pump. High Suction with automatic ejection. Knurled anti-corrosive casing and Teflon nozzle. 3.5 metres of De-Soldering braid on plastic dispenser. 2 yds (1.83mm) Resin Cored Solder on Card. 1 Heat Shunt too tweezer Type.
Total Retail Value over £12.00
OUR SPECIAL KIT PRICE £9.95

AUTOMATIC WIRE STRIPPER

Will clamp 5 different sizes of wire, strip and remove the insulation in one single operation. Accepts wires of dia. 1mm, 1.6mm, 2mm, 2.6mm and 3.2mm. Has hardened steel cutting surfaces, spring loaded insulated handles. O/No 1997 **£5.45**

BA BOX SPANNER SET

Contains one of each size. 0BA, 2BA, 4BA, 6BA, 8BA. Fixed Chrome Vanadium Steel Shaft in Plastic Handle. O/No 2057 **£4.00**

DESOLDERING PUMP

High suction pump with anti corrosive casing & Teflon nozzle. O/No 1936 **£4.50**
Spare nozzle O/No 1937 **50p**

CRIMPING SET

A crimping tool set consisting of a crimping tool suitable for insulated terminals. Supplied with 34 assorted terminals in a plastic tray with hinged, transparent lid. O/No 1966 **£3.75**

PICK-UP TOOL

Spring-loaded "Pearl grip" pick up tool for small components. Four fingers extend to 14mm dia. when plunger is pressed and close up when retracted. Chrome metal. Pocket clip. O/No VP139 **£1.75**

IC EXTRACTION TOOL

IC Extraction is made relatively easy with this tool. The IC is held by specially designed teeth. O/No 2015 **50p**

MAINS NEON TESTER/DRIVER

Has strong transparent handle with insulated screwdriver blade & pen type pocket clip – rated at 500v max. Length 140mm (5½"). O/No 2016 **55p**

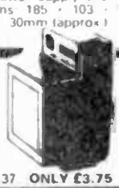
SUB-BOX

A neat swivelling disc provides close tolerance substitution resistors of 36 preferred values from 5 ohms to 1Kohm. Simply fix clips into circuit and swivel until optimum result is achieved. O/No. VP112 **£4.75**

BATTERY TESTER

Tests all types of battery including standard, NICAD, Alkaline, etc. Takes all standard sizes including 6V lantern batteries and watch/hearing aid cells. Also tests fuses and lamps by means of internal 9V (PP3) battery. Can also be used to recharge NICAD batteries by means of external 3-12V d.c. power supply (not included). Dims. 185 × 103 × 30mm (approx.). Full instructions provided. O/No VP101 **£7.00**

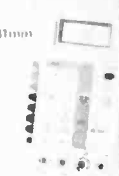
POWER SUPPLY



Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug input – 240V, AC 50Hz. Output – 3, 4.5, 6, 7.5, 9 & 12V DC Rating – 300ma MW88. O/No. 137 **ONLY £3.75**

BRAND NEW LCD DISPLAY MULTITESTER

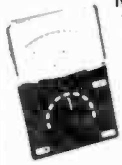
RE 188m
LCD 10 MEGOHM INPUT IMPEDANCE
• 3½ digit • 16 ranges plus hFE test facility for PNP and NPN transistors • Auto zero, auto polarity • Single-handed, push-button operation • Over range indication • 12.5mm (½-inch) large LCD readout • Diode check • Fast circuit protection • Test leads, battery and instructions included



Max. indication	1999 or –1999
Polarity indication	Negative only. Positive readings appear without – sign
Input Impedance	10 Megohms
Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	5 C to 50 C
Power Supply	1 – PP3 or equivalent 9V battery
Consumption	20mW
Size	155 × 88 × 31mm

RANGES
DC Voltage 0-200mV
0-2-20-200-1000V Acc 0.8%
AC Voltage 0-200-1000V
Acc 1.2% DC Current 0-200uA
0-2-20-200mA, 0-10A. Acc 1.2%
Resistance 0-2-20-200k ohms
0-2 Megohms Acc 1%
BI-PAK VERY LOWEST PRICE **£45.00** each
Leather case for 188m **£2.50** EACH

MULTITESTER



1,000 opv including test leads & Battery

AC volts	0-15-150-500-1,000
DC volts	0-15-150-500-1,000
DC currents	0-1ma-150ma
Resistance	0-25 K ohms, 100 K ohms
Dims	90 × 61 × 30mm

O/No. 1322 OUR PRICE **£6.80** ONLY

HT320 MULTITESTER

Facilities for testing transistors. Mirror Scale, leads and batts.

SPEC.

DC Volt	20,000 O P V
AC Volt	8,000 O P V
DC Volt	0-0.1-0.5-2.5-10-50-250-1000v
AC Volt	0-10-50-250-1000v
DC Current	0-50uA-2.5mA-25mA-0.25A
Resistance	2K-20K-2M-20M Ohms
AF Output (dB)	10dB to +22dB for 10v AC
	As a Trans Tester tests Leakage Current (Iceo), DC Current Amplification Factor (Hfe)
Dims	146 × 95 × 55mm

Order No. 1323 **£15.40**

BI-PAK PCB ETCHANT AND DRILL KIT

Complete PCB Kit comprises
1 Expo Mini Drill 10,000RPM 12V d.c. incl. 3 collets & 3 – Twist Bits
1 Sheet PCB Transfers 210mm × 150mm
1 Etch Resist Pen
1 ½lb pack FERRIC CHLORIDE crystals
3 sheets copper clad board
2 sheets Fibreglass copper clad board
Full instructions for making your own PCB boards
Retail Value over £15.00
ORDER NO VP81
OUR BI-PAK SPECIAL KIT PRICE £9.95

RATCHET SCREWDRIVER KIT

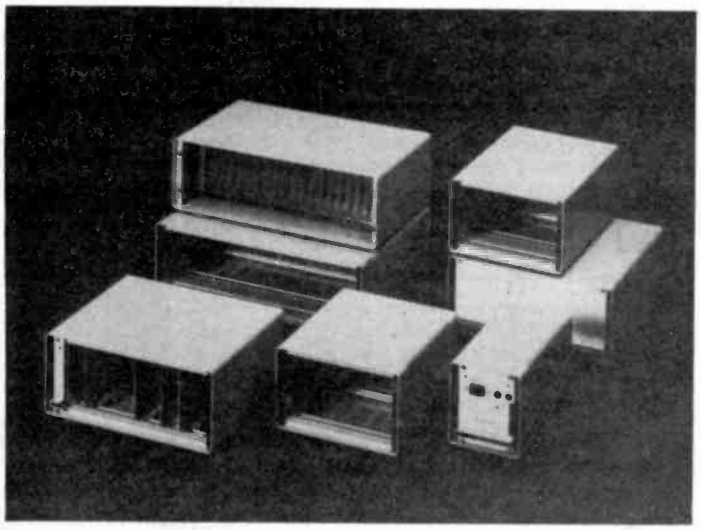
Comprises 2 standard screwdriver blades 5 & 7mm size, 2 cross point size 4 & 6, 1 Ratchet handle 5-in-1 Kit. O/No 329B **£1.45 each.**

BI-PAK

Send your orders to Dept EE2 BI-PAK PO BOX 6 WARE, HERTS
SHOP AT 3 BALDOCK ST. WARE, HERTS
TERMS CASH WITH ORDER. SAME DAY DESPATCH. ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL (0920) 3182. GIRO 388 7006
ADD 15% VAT AND 75p PER ORDER POSTAGE AND PACKING

Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods normally sent 2nd Class Mail.
Remember you must add VAT at 15% to your Total order.
Postage add 75p per Total order.

DIGEST



Eurocard Rack Cases

OK Industries have added eight new 3-unit high card cases to their Elrack range. The cases accept both sizes of Eurocards and all other sub-assemblies designed for use with 19" sub-rack systems but offer constructors a choice of four widths instead of the standard rack width which is usually available.

The new cases are made from aluminium and are supplied in kit form. They are suitable for all sub-assemblies manufactured to DIN 41494, part 5 and accept both 100 x 160mm and 100 x 220mm Eurocards. The top of the enclosure is secured only by the rear fixing screws which allows it to be removed easily for internal access. The four widths available are 101, 203, 304 and 426mm and each can be ordered in depths to suit either 160 or 220mm Eurocards. Prices range from £30.96 to £52.63.

OK plan to extend the range still further in the near future with a series of 4, 5 and 6-unit high card cases in widths of 203, 304 and 426mm. Further details and a full catalogue are available from OK Industries UK Ltd, Dutton Lane, Eastleigh, Hampshire SO5 4AA, tel 0703-619841.

Come And Go At The Same Time

It seems an obvious idea, really, but so far as we know, Norbain are the first to actually produce bidirectional opto couplers. Needless to say, this will probably provoke a mailbag or two of readers' letters along the lines of "When I was knee-high to an EF80, there was a company on the Edgware Road that sold two ORP12s glued to two 12V light bulbs — mind you, you could only go at 2 baud with this set up. . ."

There are two new optocouplers, both using gallium arsenide LEDs with NPN silicon phototransistors for the outputs and designated the OP1 2500 and the OP1 2501. Both devices have an input to output isolation voltage of 1500V with guaranteed minimum current transfer ratios of 12.5% for the OP1 2500 and 20% for the OP1 2501.

Additionally the OP1 2501 has a CTR symmetry of 0.5 minimum and 2 maximum. In terms of a bidirectional optocoupler, CTR symmetry means that the output radiant power from both LEDs will not be identical with the same forward current. This will be reflected in the output waveform which will develop alternate peaks at two different amplitudes.

The power dissipation of the input diode is 100mW derating linearly at 1.33mW/°C above 25°C. The power dissipation of the output transistor on the OP1 2500 is 150mW and 300mW on the OP1 2501, derating linearly at 2mW/°C and 4mW/°C at 25°C respectively. The output rise and fall time of the devices is typically 2μs within an operational temperature range of −55°C to +100°C. Norbain House, Boulton Road, Reading, Berkshire RG2 0LT, tel (0734) 864411.

Advance Buys House Of Instruments

Advance Power Supplies Ltd, the UK power-supply manufacturer formed in April 1984 as a result of a management buy-out of the former Gould Power Conversion Division, has purchased instrument distributor House of Instruments.

Advance sees the move as a major step forward in its expansion and diversification plans, and is moving the existing House of Instruments operation from Saffron Walden to its Bishop's Stortford headquarters. Advance say they are committed to providing continuity for existing House of Instruments customers, and the sales staff are remaining with the company.

For the future, Advance intends to invest considerably in House of Instruments, both in terms of higher stocking levels to ensure speedier service and in completely new product lines and services. Advance Power Supplies Limited, Raynham Road, Bishop's Stortford, Herts, CM23 5PF, tel 0279 55 55.

Bradley Marshall Resurgent

When Bradley Marshall's Edgware Road component shop was severely damaged by a gas explosion next door, it was almost like an old friend dying.

Happily, the company has risen, phoenix-like, in a new shop opposite its old premises. And it's bigger and better, with more space, more components, more staff and a new computer centre.

London's Edgware Road will be even more welcoming to electronics enthusiasts now. Bradley Marshall, 382-386 Edgware Road, London W2 1BN, tel 01-723 4242.

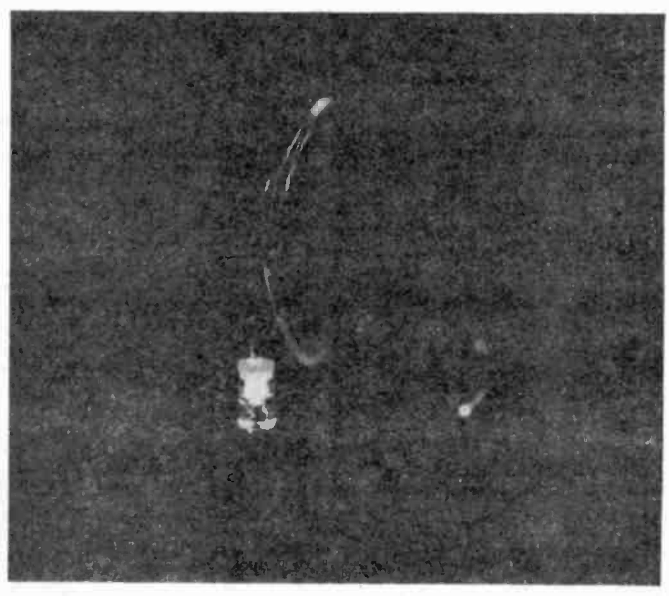
● Monolithic Memories have produced an A2 sized wallchart which lists and compares bipolar PROMs from all of the leading manufacturers. the chart is available upon request from Monolithic Memories Ltd, Monolithic House, 1 Queens Road, Farnborough, Hampshire GU14 6DJ, tel 0252-517431.

LED Along An Optical Guide

AEG-Telefunken have produced a printed circuit mounting LED which has a built-in flexible optical guide which will transmit light for distances of up to 2.0 metres. The device allows front panel indication to be achieved using a board-mounted LED, thus removing the need for off-board wiring, or it could be used with a photo-sensitive detector to form an opto-coupler with very high voltage isolation.

The optical guide will be available in standard lengths of 0.5, 1.0, 1.5 and 2.0 metres but may be cut and polished at an intermediate length to suit the application. The current transfer ratio of the guide is 50% and the LED colours available include red, yellow and green.

AEG-Telefunken (UK) Ltd, 217 Bath Road, Slough, Berkshire SL1 4AW, tel 0753-872120.

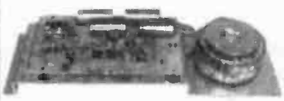


OMP POWER AMPLIFIER MODULES

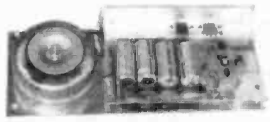
★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE S.A.E. 28p STAMP FOR CURRENT LIST

OMP POWER AMPLIFIER MODULES

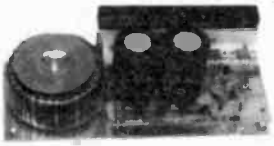
Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market, i.e., Industry, Leisure, Instrumental and Hi-Fi, etc. When comparing prices, NOTE all models include Toroidal power supply, Integral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



OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV at 10K, Size 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.
Three models (Ratings RMS into 4 ohms)
MF200 (100 + 100w) £169.00
MF400 (200 + 200w) £228.85
MF600 (300 + 300w) £274.85
Securicor Delivery £10.00

LOUDSPEAKERS

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

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

POWER RANGE

8" 50 WATT R.M.S. Hi-Fi/Disco. 20 oz. magnet, 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.

12" 100 WATT R.M.S. Hi-Fi/Disco 50 oz. magnet, 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 + £3.00 P&P ea.

15" 100 WATT R.M.S. Hi-Fi/Disco 50 oz. magnet, 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq. 20Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. PRICE £37.49 + £3.00 P&P ea.

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 £9.99 + £1.00 P&P ea.

6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc. 1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.

8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc. 1½" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.

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.**

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

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

SAVE £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

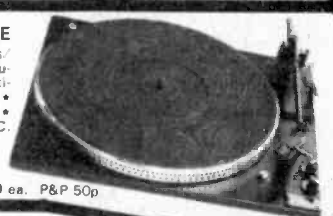
STEREO CASSETTE DECK

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 4⅓" × 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 P295 ELECTRONIC TURNTABLE

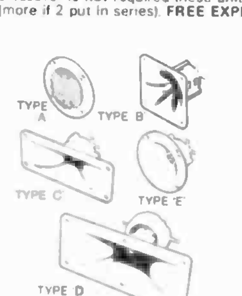


★ Electronic speed control 45 & 33⅓ r.p.m. ★ Plus/Minus variable pitch control ★ Belt driven ★ Aluminium platter with strobed rim ★ Cue lever ★ Anti-skate (bias device) ★ Adjustable counter balance ★ Manual arm ★ Standard ½" cartrige fixings ★ Supplied complete with cut out template ★ D.C. Operation 9-14v D.C. 65mA
Price £36.99 + £3.00 P&P

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

PIEZO ELECTRIC TWEETERS — MOTOROLA

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

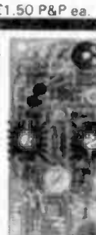


TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £5.39 each + 40p P&P.
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. Price £5.99 each + 40p P&P.
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £6.99 each + 40p P&P.
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. Price £9.99 each + 40p P&P.
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £5.99 each + 40p P&P.
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. Price £3.99 + 40p P&P.

PANTEC HOBBY KITS

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

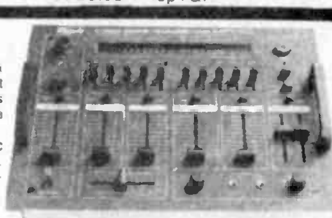
FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt). Price: £8.62 + 75p P&P.
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) Price: £13.74 + 75p P&P.
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). Price: £17.82. Transmitter 80 × 50 × 15mm (9/12 volt). Price: £11.27 P&P + 75p each. S.A.E. for complete list.



3 watt FM Transmitter

STEREO DISCO MIXER

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



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B. K. ELECTRONICS

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

First Digital Recording Console

The first ever digital multi-track sound mixing console is now in full operation. Manufactured by Neve electronics, the digital console was installed at CTS recording studios in West London in just 24 hours with final adjustments taking place between Christmas and the New Year.

Neve claim to have spent some five years researching and developing this new digital console. In addition to collaboration with the BBC, much of the recent work on multi-track facilities was done in conjunction with CTS engineers. Neve says that it has received numerous enquiries about its DSP console from studios and broadcast companies through the world and that it anticipates that over the next decade the digital business will expand to form a major addition to its already growing and developing analogue activity. Further DSP consoles are already in production.

Neve Electronics International Ltd, Melbourne, Royston, Hertfordshire SG8 6AU, tel 0763-60776.

Computer Wars

The battle to the death continues and small black objects continue to hurtle down — in price. In the same week that Acorn suspended dealings in their shares because of financial problems, Sinclair announced a sharp reduction in the price of the Spectrum Plus computer.

The Spectrum Plus will now cost £129.95 including VAT instead of £179.95. At the same time the company announced that they will stop selling the original ZX Spectrum 48K in the UK in order to concentrate on the Spectrum Plus. Owners of the 48K ZX Spectrum may have their machine upgraded to a Spectrum Plus for £30.00 or can purchase a kit and do the job themselves for £20.00. The introductory software six-pack which was previously included in the price of £179,95 will now be available separately at normal prices or at a special price of £14.95 to purchasers of the Spectrum Plus.

Sinclair says that they hope the price reductions will enable them to increase their 44% share in the UK market. The price of the QL remains unchanged at £399.00 including VAT. For Spectrum upgrade kits contact Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS, tel 0276-686100.

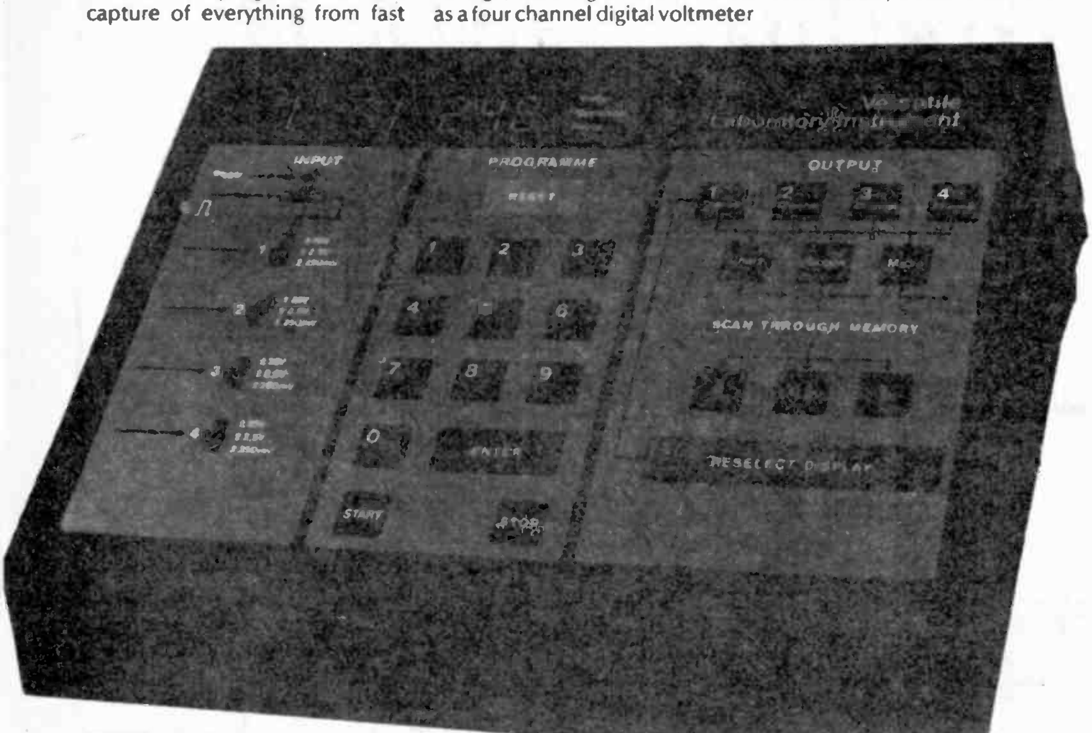
Versatile Data Capture For Laboratories

Data Harvest describe their latest product as a versatile laboratory instrument, or Vela for short. It is designed to record up to four analogue voltage inputs, store them in battery backed-up memory and then reproduce them in analogue form for display on an oscilloscope or chart recorder or in digital form for further processing on a microcomputer.

The four analogue inputs have individually selectable sensitivities of ±25v, ±2.5V and ±250mV and store the recorded data in 1K of CMOS RAM after conversion in an A/D converter whose resolution is 8 bits ±¼ LSB. A TTL-compatible digital input is also provided on a 26 way IDC connector. The unit can be powered from the mains via an adaptor, from an external 8-13V supply or from internal cells, allowing it to be used for data capture 'in the field'. Fifteen programs allow the capture of everything from fast voltage transients with an interval of 30μs between samples to slowly changing biological and other data with sampling interval of up to 999 seconds. A D/A converter with a resolution of 8 bits +½ LSB provides an analogue output for display on an oscilloscope or chart recorder while a TTL-compatible digital output allows the data to be fed to a BBC B, RML 380/480Z, Apple II or PET microcomputer or directly to a Centronics printer.

Vela uses a 6802 microprocessor and has 4K of EPROM for applications software storage. A further 12K of EPROM space is available for software expansion. A two-digit code entered via the keyboard selects the required program and a single key selets the recording channel and output mode. An LED display shows channel, time and voltage, allowing Vela to be used as a four channel digital voltmeter and thus enabling sensor output voltages to be checked before recording. A pulse input is provided to trigger data capture and can also be used as a timing and counting input providing frequency measurement from 1Hz to 15kHz and timed periods from 1ms to 65 seconds. Other possibilities include the storage of recorded data on disc after processing through a micromputer and the generation in conjunction with a micro of complex waveforms and sequences for use in control applications.

Vela measures 300 x 230 x 75mm and weights 2.2kg. It costs £375.00 plus VAT and is avilable from Data Harvest Ltd, 28 Lake Street, Leighton Buzzard, Bedfordshire LU7 8RX, tel 0525-373666. Vela is also available from STC Electronic Services, Edinburgh Way, Harlow, Essex CM20 2DF, tel 0279-26777.



Snail Update

Readers who saw the February News Digest may remember an item describing a microcomputer peripheral called Slomo, a device which slows down a micro so that complex games, etc can be learnt more easily. The address given at the end of the article was that of Cambridge Computing Research Ltd but we have since been told that CCR are in receivership and that no further orders should be sent to them. Slomo is still available from Nidd Valley Micro Products who originally designed it and the price is unchanged at £14.95 inclusive. They can be reached at Stepping Stones House, Thistle Hill, Knaresborough, North Yorkshire HG5 8JW, tel 0423-864488.

● *Electronic Brokers have published a 20-page, two-colour catalogue which describes their range of test and computer equipment. It has sections on oscilloscopes and logic analysers, multimeters, generators, counters and timers powers supplies, line conditioners and EPROM programmers and also describes a range of DEC Tektronix computer equipment. Copies of the catalogue are available from Electronic Brokers Ltd, 140-146 Camden Street, London NW1 9PB, tel 01-267 7070.*

● **Global Specialities Corporation have produced a 12 page catalogue which describes their range of design and test instruments. The catalogue includes power supplies, capacitance meters, function generators and multiplexers and is available from GSC, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ, tel 0799-21682.**

● Marston Palmer's new catalogue describes their full range of aluminium heatsinks, from clip-on types for individual semiconductors up to massive extruded sections. The catalogue also includes accessories such as thermal compound and stand-off pillars and has two pages of notes and formulae to help you select the right heatsink for your application. Marston Palmer Ltd, Wobaston Road, Fordhouses, Wolverhampton WV106 6QJ, tel 0902-783361.

● *Texas Instruments have produced a new catalogue of their technical publications. Brief details are given of all the 41 books in the range, from data books and design manuals to text books aimed at the student, some of which are also available on video. The catalogue includes a price list and order form is available from the Customer Response Centre, Texas Instruments Ltd, Manton Lane, Bedford MK41 7PA, tel 0234-67466.*

● **Instrument Rentals have a wide range of test equipment of various types which they hire out for periods of one week or more. Prices range from £6.00 for an AVO-8 and £7.00 for a 15MHz, dual trace 'scope up to several thousand pounds per week for some of the flashier network analysing gear. For a copy of their new catalogue contact Instrument Rentals (UK) Ltd, Dorcan House, Meadfield Road, Langley, Slough SL3 8AL, tel 0753-44878.**

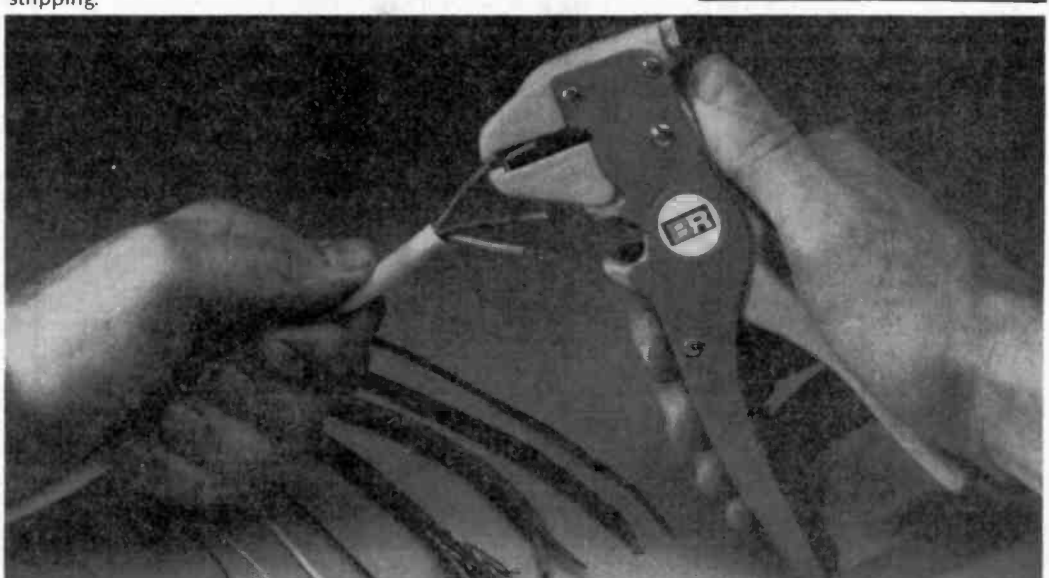
Single-Action Wire Stripper

B & R ELectrical Products have introduced a self-adjusting wire stripper and cutter which will prepare the ends of insulated cables in one movement. The tool accepts most types of solid and stranded wires and the manufacturers claim that it costs only about a third of the price of comparable tools currently on the market.

The TC1017 is robustly constructed and self-adjusting during operation to enable fast and accurate stripping of insulation from most types of solid or stranded insulated wire with outside diameters from 0.5 to 5mm. For particularly hard or soft insulation materials a manual adjustment is provided to alter the force of the blades, but such adjustment is not normally necessary.

The tool operates in one continuous action by gripping the insulating material in its metal jaws, simultaneously cutting through it and removing the insulation by the sliding action of the blades. Moulded into the jaws of the tool are graduations in millimeters and inches to assist measurement of the length of insulation to be stripped. The tool also incorporates a pair of tempered steel cutting blades to enable the wire to be cut and trimmed to length before stripping.

The Model TC 1017 wire stripper costs £4.30 plus VAT (trade price) and is one of a series of new products to be included in the next edition of the B&R telephone and mail order components catalogue. B&R Electrical Products Ltd, Temple Fields, Harlow, Essex CM20 2BG, tel 0279-443351.



Low-Cost Touch Screen

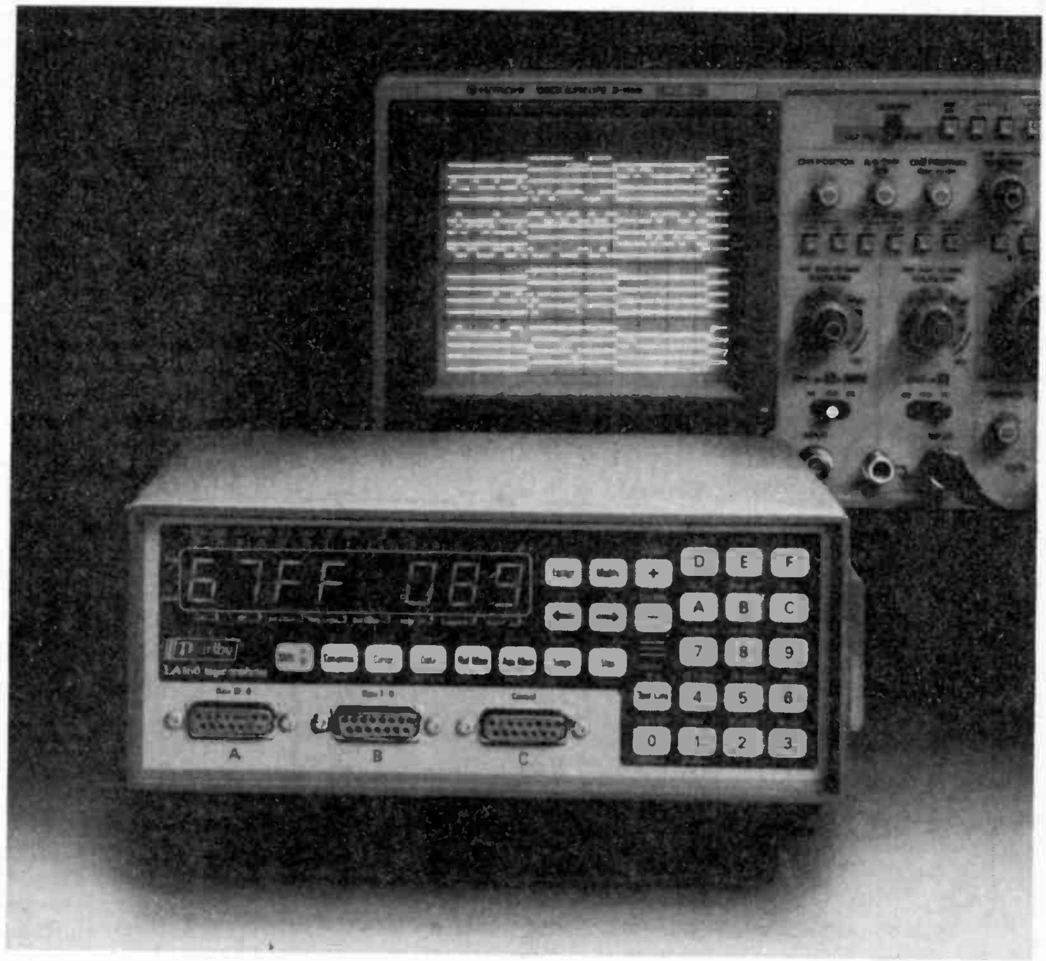
Microvitec have produced a touch sensitive clear screen which fits over their computer monitors and which can be used by the young, the disabled and others who have difficulty with keyboards to enable them to communicate with computers. The screen uses infra-red beams to detect the presence of a finger or a stylus, is inherently safe, and the manufacturers claim that it costs only a fraction of the price of currently available touch screens.

The Touchtech 501 consists of a stand into which metal-cased Microvitec monitors are secured and a screen bezel. The bezel contains a number of infra-red transmitters and sensors which project a network of beams across the screen area. The beams cannot, of course, be seen, but interrupting any of them with a finger or stylus will immediately be detected by the appropriate sensor and the co-ordinates fed to the computer. The information can then be interpreted by the software as required, for example, as a yes or no decision or as a choice between other alternatives.

The Touchtech 501 comes complete with a user's handbook and a diskette containing nine demonstration programs developed by the Government-backed Microelectronics Programme. The complete package is expected to sell for £210.00 plus VAT.

Microvitec PLC, Futures Way, Bolling Road, Bradford, West Yorkshire BD4 7TU, tel 0274-390011.

Low Cost Logic Analyser



Thurlby Electronics have introduced a portable, sixteen channel logic analyser which is claimed to offer high performance but will sell for under £400 excluding VAT in its basic form. Features include a 2000 word memory, comprehensive trigger facilities and an RS423 interface, and Thurlby hope that the low price will encourage organisations to equip each of their engineers with one rather than expecting a number of engineers to share one machine as at present.

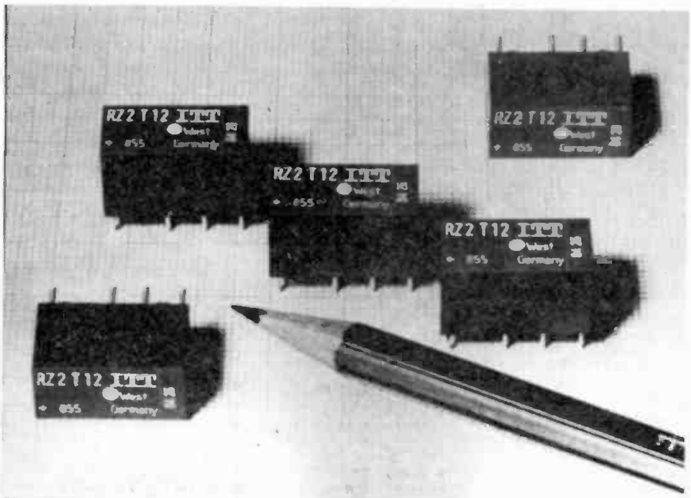
The LA-160A has a maximum clock rate of 10MHz and the LA-160B has a maximum clock rate of 20MHz. Both have sixteen data channels but can be enlarged to 32 channels using a clip-on extender module, whereupon the maximum clock rates become 5MHz and 10MHz respectively. The acquisition memory holds 1999 sixteen bit words and stores 999 before the triggering event and 999 after it. The memory size becomes 1000 32-bit words when the extender module is added. A built-in state domain display shows the data in either binary, octal, decimal or hex form or in a mixed display of binary and hex, and by connecting the unit to a conventional oscilloscope a full, multi-channel timing display can be obtained.

The trigger facilities include 20 bit trigger width, the ability to set the trigger word in any display format, selectable trigger hold-off and a trigger arm input with selectable delay. Data can be captured synchronously or asynchronously using either the clock of the circuit under test or the internal clock which has sixteen selectable frequencies from 1KHz to 10MHz or 20MHz. Two clock qualifiers enable data to be captured selectively, for example on the Read cycle of the microprocessor bus.

The LA-160 is microprocessor controlled via an interactive keyboard with all the set-up information being stored in permanent memory. A non-volatile reference memory is also included. This can be loaded from the acquisition memory or the keyboard and allows reference data to be stored for comparison purposes.

The software facilities include word search, block memory compare, word by word memory compare and stop on equality or non-equality acquisition modes. A built in RS423 interface enables the contents of the acquisition memory to be dumped to a computer. The inputs are fixed at TTL level but optional high impedance variable threshold data pods are available. Other options inlcude an IEEE-488 bus analysis connector and a printer interface for hard copy.

The LA-160 weighs less than 1.8kg (4lb) and is compact enough to fit into a toolkit or briefcase. The 10MHz version (LA-160A) costs £395.00 and the 20MHz version (LA-160B) costs £495.00 the optional extras range in price from £7.50 for a logic grabber set up to £125.00 for the 32 channel extension module, and all prices exclude VAT. For further details and a list of distributors contact Thurlby Electronics Ltd, New Road, St. Ives, Cambridge PE17 4GB, tel 0480-63570.



High Sensitivity Relay

ITT Switches (UK) Ltd claim to have produced the most sensitive single-coil bistable relay available. It only requires a 40mW pulse for 10ms to change it from state to state.

The RZ2T relay has a two-pole changeover configuration and uses bifurcated contacts. Being a bistable type, it will remain in its operated state until a pulse of reverse polarity is applied to move into the other state. The contact bounce time is less than 0.5ms which ITT claim is ten times better than the average performance of similar electromechanical relays. It is housed in a standard DIL PC-mounting case and will withstand most normal PCB cleaning processes except ultrasonic cleaning.

ITT Switches (UK) Ltd, 8 Roberts Way, Wickford, Essex SS11 8DD, tel 03744-66111.

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

ACORN COMPUTER SYSTEMS
BBC Model B Special offer....... **£348** (a) BBC
BBC Model B+Econet .... **£389** (a)
BBC Model B+DFS.......... **£409** (a)
BBC Model B+DFS +Econet .... **£450** (a)

UPGRADE KITS
A to B Upgrade Kit.......... **£65** (d)
DFS Kit.......... **£95** (d)
Econet Kit.......... **£55** (d)
Speech Kit.......... **£47** (d)

ACORN ADD-ON PRODUCTS
Z80 2nd Processor.......... **£352** (a)
6502 2nd Processor.......... **£175** (a)
Teltext Adaptor.......... **£190** (b)
IEEE Interface £282 .... **£282** (b)
Prestel Adaptor.......... **£99** (b)

RH Light pen.......... **£39.50** (c)

BBC FIRMWARE
1.2 Operating System.......... **£7.50** (d)
Basic II ROM.......... **£22.50** (d)
View Word Processor ROM.......... **£48.00** (c)
Wordwise Word Processor ROM .... **£34.00** (d)
BCPL ROM/Disc .... **£86.00** (b)
Disc Doctor/Gremlin Debug ROM **£28** (d)
EXMON/TOOL KIT ROM .... **£28 ea** (d)
Printmaster (FX80)/Graphics ROM .... **£28 ea** (d)
ULTRACALC spreadsheet ROM **£89 ea** (c)

COMMUNICATION ROM
Terml Emulator.......... **£28** (d)
Communicator.......... **£59** (d)
Commstar.......... **£229** (d)

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

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EPSON

RX80FT **£225** (a) RX80T **£215** (a) FX80 **£315** (a) FX100 **£435** (a)

KAGA TAXAN

KP 810 (80col) **£255** (a) KP910 (156col) **£359** (a)
JUKI 6100 **£340** (a) **BROTHER** HR15 **£340** (a)

ACCESSORIES

32K Internal Buffer Parallel **£99** (b)

EPSON
Serial Interface: 8143 **£28** (c); 8148 with 2K **£57** (c)
Paper Roll Holder **£17** (d); FX80 Tractor Attachment **£37** (c)
Ribbons: FX/RX/MX80 **£5** (d) FX/RX/MX100 **£10** (d)
RX/FX80 Dust Cover **£4.50** (d)

KAGA TAXAN
RS232 with 2K Buffer **£85** (c) KP810/910 Ribbon **£6.00** (d)

JUKI 6100
RS232 with 2K Buffer **£65** (c) Ribbon **£2.50** (d)
Tractor Attachment **£129** (a) Sheet Feeder **£129** (a)
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2000 Sheets Fanfold Paper with extra fine perforation
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Labels per 1000's; single row 3½" x 17/16" **£5.25**(d)
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MODEMS

— All modems listed below are BT approved

MIRACLE WS2000:
The ultimate world standard modem coverall all common BELL and CCITT standards up to 1200 Baud. Allows communication with virtually any computer system in the world. The optional AUTO DIAL and AUTO ANSWER boards enhance the considerable facialities already provided on the modem. Mains powered **£129(b)**. Auto Dial Board/Auto Answer Board **£30(c)** each. Software lead **£4.50.**

TELEMOD 2:
Complies with CCITT V233 1200/75 Duplex and 1200/1200 Half Duplex standards that allow communications with VIEWDATA services like PRESTEL, MICRONET etc. as well as user to user communications. Mains powered **£64(b).**

BUZZ BOX:
This pocket sized modem complies with V21 300/300 Baud and provides an ideal solution for communications between users, with main frame computers and bulletin boards at a very economic cost. Battery or mains operated, **£52(c)**. Mains adaptor **£8(d)**.

BBC to Modem data lead £7.

DISC DRIVES

These are fully cases and wired drives with slim line mechanisms of high quality, Shuggart A400 standard interface. Drives supplied with cables manuals and formatting disc suitable for the BBC computer. TEAC 80 track drives are supplied with 40/80 track switching as standard. All drives can operate in single or dual density format.

1 x 100K 40T SS:TS55A .... **£100**(b)
1 x 200K 40/80TSS TS55E.......... **£140**(b)
1 x 400K 40/80TDS TS55F.......... **£145**(a)
2 x 100K 40T SS:TD55A with psu ...... **£250**(a)
2 x 200K 40/80T SS:TD55E TEAC with psu .... **£325**(a)
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CS55A with psu .... **£125**(b)
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CS55F with psu.......... **£169**(b)

3M 5¼" FLOPPY DISCS

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

40T SS DD **£15 (c)** 40T DS DD **£18 (c)**
80T SS DD **£22 (c)** 80T DS DD **£24 (c)**

DRIVE ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives .... **£14.50** (c)
Single Disc Cable .... **£6** (d) 10 Disc Library Case .... **£1.80**(c)
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MONITORS

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1431 Standard Resolution .... **£165 (a)**
1451 Medium Resolution.......... **£240 (a)**
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1431 AP Std Res PAL/AUDIO.......... **£210 (a)**
1451 AP Med Res PAL/AUDIO .... **£280 (a)**
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Above monitors are now available in plastic or metal cases, please specify your requirement.
KAGA Super Hi Res Vision III RGB .... **£340 (a)**
Hi Res Vision II.......... **£235 (a)**
MONOCHROME MONITORS 12":
Kaga Green KX1201 G Hi Res.......... **£99 (a)**
Kaga Amber KX1201 A Hi Res.......... **£105 (a)**
Sanyo Green DM8112CX Hi Res.......... **£90 (a)**
Swivel Stand for Kaga Monochrome.......... **£21 (c)**
All monitors are supplied with leads suitable for the BBC Computer. Spare leads available.

ATTENTION

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

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2764-25 .... **£4.90**
27128-25 .... **£18**
27128-30 .... **£16**
6264-15 .... **£28**
6262LP-15 .... **£31**
6264-12 .... **£35**

GANG OF EIGHT INTELLIGENT FAST EPROM COPIER

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

SOFTY II

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

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All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time.... **£47(c)**
UV1T as above but with a timer .... **£59(c)**
UV140 erases up to 14 eproms at a time **£61(b)**
UV141 as above but with a timer.......... **£79(b)**

CONNECTOR SYSTEMS

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(Speedblock Type)

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

D CONNECTORS

No of Ways

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

TEXTOOL ZIF

SOCKETS 24-pin £5.75
28-pin £8.00 40-pin £9.75

EDGE CONNECTORS

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

EURO CONNECTORS

DIN 41612

2 x 32 way St Pin	230p	275p
2 x 32 way Ang Pin	275p	320p
3 x 32 way St Pin	260p	300p
3 x 32 way Ang Pin	375p	400p
IDC Skt A + B	275p	
IDC Skt A + C	350p	

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

AMPHENOL CONNECTORS

36 way plug Centronics (solder) 500p (IDC) 475p
36 way skt Centronics (solder) 550p (IDC) 500p
24 way plug IEEE (solder) 475p (IDC) 475p
24 way skt IEEE (solder) 500p (IDC) 500p
PCB Mtg Skt Ang Pin
24 way 700p 36 way 750p

GENDER CHANGERS

25 way D type

Male to Male.......... **£10**
Male to Female **£10**
Female to Female.......... **£10**

RS 232 JUMPERS

(25 way D)

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

DIL SWITCHES

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

TELEPHONE CONNECTORS

4 way plug	110p
6 way plug	180p
6 way rt ang skt	160p
Flexible cable	
4 way	50p/m
6 way	72p/m

RIBBON CABLE

(grey/metre)

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

DIL HEADERS

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

MISC CONNS

21 pin Scart Connector **200p**
8 pin Video Connector **200p**

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	1.75
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	80p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p
7443A	100p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150
74LS47	80p
74LS48	90p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/629	140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS153	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	85p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	180p
74LS193	160p
74LS194A	75p
74LS195A	75p
74LA196	80p
74LS197	80p
74LS221	100p
74LS240	80p
74LS241	80p
74LS242	80p
74LS243	90p
74LS244	80p
74LS245	100p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	80p
74LS290	80p
74LS292	900p
74LS293	80p
74LS295	140p
74LS297	900p
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	500p
74LS324/624	350p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS373	90p
74LS374	90p
74LS375	75p
74LS377	140p
74LS378	95p
74LS379	140p
74LS381	450p
74LS390	60p
74LS393	110p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	1350p
74LS626	225p
74LS628	225p
74LS629	140p
74LS640	300p
74LS640-1	300p
74LS641	200p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS6-	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	180p
74LS682	320p
74LS684	650p
74LS687	550p
74LS688	550p
74LS783	£21

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	100p
74S30	50p
74S32	80p
74S37	80p
74S38	75p
74S40	50p
74S51	45p
74S64	45p
74S74	75p
74S85	450p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	550p
74S132	100p
74S133	60p
74S138	180p
4098	75p
4099	90p
74S151	150p
74S153	150p
74S157	210p
74S158	200p
74S163	400p
74S169	700p
74S174	300p
74S175	320p
74S188	180p
74S189	225p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S262	1100p
74S283	270p
74S287	225p
74S288	200p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p
74S472	475p
74S473	475p
74S474	400p
74S475	450p
74S570	650p
74S571	650p
74S573	500p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	60p
4009	45p
4010	60p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	250p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	35p
4051	65p
4052	60p
4053	60p
4054	80p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	90p
4095	80p
4096	90p
4099	90p
4501	38p
4502	55p
4503	36p
4504	95p
4505	360p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	85p
4534	380p
4536	250p
4538	75p
4539	75p
4541	80p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	140p
4561	40p
4566	140p
4568	240p
4569	170p
4572	40p
4583	45p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14416	300p
14419	250p
14490	420p
14495	450p
14500	650p
14599	280p
22100	350p

LINEAR ICs

AD7581	£16	LM723	50p	TBA820M	75p
ADC0808	1180p	LM725CH	300p	TBA920	200p
AM7910DC	£25	LM733	60p	TBA950	225p
AN103	320p	LM741	18p	TCA210	300p
AY-1-5050	180p	LM747	70p	TCA220	350p
AY-3-1270	790p	LM748	30p	TCA270	350p
AY-3-1350	350p	LM1011	400p	TCA940	175p
AY-3-8910	400p	LM1014	150p	TDA1004A	300p
AY-3-8912	450p	LM1801	300p	TDA1010	225p
CA3019A	80p	LM1830	150p	TDA1002	300p
CA3028A	110p	LM1871	300p	TDA1024	110p
CA3046	70p	LM1872	300p	TDA1170S	300p
CA3059	320p	LM1886	600p	TDA2002	325p
CA3080	75p	LM1889	450p	TDA2003	390p
CA3080E	70p	LM2917	300p	TDA2004	320p
CA3086	46p	LM3302	75p	TDA2006	320p
CA3088E	210p	LM3900	60p	TDA2020	320p
CA3089AQ	375p	LM3909	70p	TDA2030	180p
CA3130E	100p	LM3911	100p	TDA2541	225p
CA3130T	130p	LM3914	380p	TDA2593	300p
CA3140E	45p	LM3915	340p	TDA2653	700p
CA3140T	100p	LM3916	340p	TDA3560	600p
CA3160E	100p	LM13600	150p	TDA3810	350p
CA3161E	150p	MB3712	200p	TDA7000	350p
CA3162E	450p	MB3730	200p	TEA102	[illegible]
CA3189E	270p	MC1310P	190p	TL061CP	40p
CA3240E	150p	MC1413	75p	TL062	60p
CA3280G	275p	MC1445	250p	TL064	90p
D7002	£10	MC1458	45p	TL071	40p
DAC1408-8	225p	MC1495	350p	TL072	60p
DAC0800	225p	MC1496	100p	TL074	110p
DAC0808	225p	MC3340P	200p	TL081	30p
DG308	300p	MC3401	50p	TL082	50p
HA1366	190p	MC3403	65p	TL083	75p
ICL7106	675p	MF10CN	340p	TL084	90p
ICL7611	95p	MK50240	900p	TL094	300p
ICL7650	400p	MK50398	700p	TL170	50p
ICL7660	250p	ML920	500p	TLA30C	[illegible]
ICL8038	300p	ML922	400p	UAA1003-1	830p
ICM7216B	£22	MM8221A	300p	UA759	250p
ICM7217	750p	NE531	130p	UA2240	150p
ICM7555	90p	NE544	200p	UAA170	170p
ICM7556	140p	NE555	22p	UCN4801A	350p
LC7120	300p	NE556	50p	ULN2001A	75p
LC7130	350p	NE564	400p	ULN2002A	75p
LC7137	350p	NE565	120p	ULN2003A	75p
LF347	150p	NE566	150p	ULN2004A	75p
LF351	60p	NE567	120p	ULN2068	[illegible]
LF353	90p	NE570	400p	ULN2802	190p
LF355	90p	NE571	400p	ULN2803	190p
LF356N	110p	NE592	80p	ULN2804	190p
LF357	100p	NE5532P	180p	UPC575	275p
LF13331	380p	NE5533P	180p	UPC592H	200p
LM10C	400p	NE5534AP	120p	UPC1156H	300p
LM301A	30p	OP-07EP	500p	UPC1185H	300p
LM307	45p	PLL02A	500p	XR210	400p
LM308CN	75p	RC4136	90p	XR2206	350p
LM310	275p	RC4151	250p	XR2207	375p
LM311	90p	RC4558	60p	XR2211	675p
LM318	150p	S566B	240p	XR2216	675p
LM319	180p	SAA1900	£16	XR2240	150p
LM324	45p	SFF96364	800p	ZN409	180p
LM334Z	115p	SL490	300p	ZN414	100p
LM335Z	130p	SN76013N	300p	ZN419P	175p
LM339	100p	SN76023N	300p	ZN423E	130p
LM348	60p	SN76033N	300p	ZN424E	130p
LM358	90p	SN76115N	210p	ZN425E8	350p
LM358P	50p	SN76477	300p	ZN426E8	300p
LM377	210p	SN76488	300p	ZN427E	600p
LM380N-8	110p	SP0256AL2	700p	ZN428E	450p
LM380	75p	SP8515	750p	ZN429E8	210p
LM381AN	170p	TA7120	150p	ZN440E	750p
LM382	200p	TA7130	140p	ZN446CP	230p
LM383	325p	TA7204	150p	ZN1034E	200p
LM384	220p	TA7205	150p	ZN1040E	650p
LM386N	110p	TA7222	150p	ZNA134J	£23
LM387	120p	TA7310	150p	ZNA234E	950p
LM388	170p	TBA641BX1	400p		
LM391	180p	TBA231	120p		
LM392N	110p	TBA800	90p		
LM393	100p	TBA810	100p		
LM394CH	385p	TBA820	80p		
LM709	36p				
LM710	50p				
LM711	50p				

VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		-ve	
5V	7805	45p	7905	50p
6V	7806	50p	7906	50p
8V	7808	50p	7908	50p
12V	7812	45p	7912	50p
15V	7815	50p	7915	50p
18V	7818	50p	7918	50p
24V	7824	50p	7924	50p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
LM309K	1A 5V	140p
LM323K	3A 5V	350p
78H05KC	5A 5V	540p
78H12	5A 12V	640p
78P05	10A 5V	900p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T		225p
LM350T	10A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	575
78GUIC	1A+VAR	225p
79HGGKC	5A−VAR	675p
79GUIC	1A−VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

OPTO-ELECTRONICS

20L704 Red	140p	MAN4640	200p
DL707 Red	140p	MAN6610	200p
FND357	100p	NSB5881	570p
FND500/TIL730	100p	TIL311	650p
FND507/TIL726	100p	TIL729	100p
MAN74DL704	100p	TIL730	100p
MAN71/DL707	100p	MAN8910	250p
MAN3640	175p	MAN8940	250p

OPTO-ISOLATORS

ILQ74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
ILQ74	220p	6N137	360p
		6N139	175p

LEDS

TIL209 Red	12p	TIL222 Green	18p
TIL211 Green	16p	TIL226 Orange	22p
TIL212 Yellow	20p	MV57164 Red Array (10)	225p
CXO95 (bi-colour)	100p	MV54164 Green Array (10)	225p
TIL220 Red	15p	Rect Leds R.G.Y	30p

COUNTERS

74C925	650p
74C926	650p
74C928	650p
72168	£22
ZN1040	670p

DL704	140p
DL707Red	140p

COMPUTER COMPONENTS

CPU

1802CE	650p
2650A	1050p
6502	350p
6502A	550p
65C02A	£15
6502B	800p
6800	250p
6802	300p
6809	650p
6809E	£12
68B09	£12
68B09E	£16
68000-L8	£36
8035	360p
8039	420p
8080A	420p
8085A	300p
8086	£22
8088	1750p
8748	£18
TMS1601	£12
TMS9980	£12
TMS9995	£12
WD55	£14.50
Z80	280p
Z80A	325p
Z80B	700p
TMS9903	£25
TMS9911	£18
TMS9914	£14
Z80PIO	260p
Z8CAPIO	275p
Z80CTC	260p
Z8CACTC	275p
Z8CDART	650p
Z8CADART	700p
TMS4500	£14
TMS9901	500p
TMS9902	500p
Z8CDMA	700p
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THE FINAL LINK

The loudspeakers are obviously the final link in the hi-fi chain, some would say. Not, others would contradict, the room modifies the sound so must be counted. They're both wrong, as Vivian Capel will demonstrate.

The human ear makes all the other links in the hi-fi chain seem crude in construction and design. An understanding of these fascinating instruments with which we have been endowed can help us identify the important characteristics of the sounds that we hear. This in turn can shed light on the art of sound reproduction and hi-fi. The ear is divided into three sections, the outer, middle and inner ear; each section has its own specific function.

The Outer

The outer ear consists of the appendage known as the **pinna**, and the ear canal terminating in a diaphragm stretched across it, known as the **ear-drum**. The pinna is provided not merely for decoration or even to protect the ear from the intrusion of foreign bodies, though it does both to a certain extent. Its convolutions produce reflections which follow the direct sound into the canal with minute delays, hence with phase differences.

The reflections differ according to the angle of incidence of the sound, so the resulting phase differences serve as a code to identify direction. The auditory section of the brain decodes this information instantly to locate the position of a sound source.

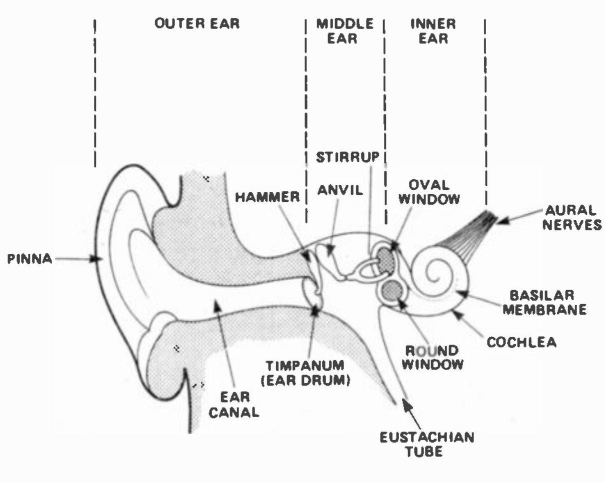


Fig. 1 Our hearing system showing the three main sections: the outer, middle and inner ear.

It is commonly believed that source location is due entirely to volume and phase differences existing between the two ears. If this were so, our sound location would be limited to the front horizontal plane, as it is with conventional stereo systems. However, as we have the facility of all-round location with vertical identification as well, there is evidently more involved. This can be demonstrated by plugging one ear and trying to identify the direction of a sound source. It is still possible, though the sense of direction is reduced.

The amount of phase difference generated by there being a path difference between direct and reflected sound depends on two things: the path difference itself and the wavelength of the sound concerned. The first of these will depend on the dimensions of the pinna convolutions, and if these are small in comparison to the wavelength, the phases difference will be quite small and probably undetectable. So, logically, we will get best sense of sound location with higher frequencies where the wavelengtyh is comparable to the pinna convolutions.

At mid-to-low frequencies, the wavelength of the sound becomes comparable to the head's size, so comparison of phase between the two ears may help location here. At lower frequencies, it would take pinnas (or possibly heads) of literally elephantine proportions to give good directional sense, and the practical problems in carrying around that lot must outweigh any advantages for everyone except the elephants themselves. However, this is not a major problem, as the majority of low-frequency natural sounds do have higher frequency components that we can locate satisfactorily.

The Middle Ear

The directional-encoded sound travels down the ear canal to the ear-drum, or **timpanum** as it is also called, which vibrates in response. The next section, the middle ear, has the function of impedance matching and dynamic range compression. The well-known rule which applies in electronics as well as mechanics is that to transmit the maximum amount of energy from one unit to another, impedances must be similar. Electrical impedances are matched between amplifier output stages and loudspeakers by transformers, and the mechanical impedance offered by the road wheels of a car is matched to the engine torque by the gearbox.

In the case of the ear, minute air pressure variations acting on the ear-drum make this a low impedance member, whereas the fluid-filled inner ear which converts the vibrations to neural signals is of a higher impedance. Matching is accomplished by three interjoined bones termed the **hammer, anvil** and **stirrup.** The first two of these are a pair of pivoted levers that produce a leverage ratio of nominally 3:1, and the stirrup, or **stapes** as it is also called, communicates the motion of the second lever to the window of the inner ear.

The three bones are held in position by tiny muscles. These can cause the pivot position to change and they can also stiffen to cause a decrease in the amount of movement. Hence these can reduce the sensitivity of the whole ear progressively as the input sound level increases. This enables the ear to handle an enormous range of sound levels, the loudest being 10^{12} times larger than the faintest. We can accommodate all the natural sounds we are likely to ever encounter — from the rustling of leaves to a nearby thunderclap — but we can have problems with man-made sounds such as the explosions, jet engines and machine tools, to name but a few.

If the middle ear were a completely sealed cavity, differences of atmospheric pressure would cause the ear-drum to be stretched inward or outward depending on the atmospheric pressure. This would displace the three connecting bones and upset the sound compression. The **eustachian tube** connects the middle ear to the back of the throat, and so maintains atmospheric pressure on the inner surface of the ear-drum.

Inner Ear

The final bone of the trio, the stirrup, transmits the sound vibrations to the window of the inner ear. This is shaped like a snail's shell hence its name, the **cochlea.** It is really a long tube rolled up in a spiral. To understand what it does we will imagine that it is unrolled as depicted in Fig. 2. A horizontal membrane divides the tube into an upper and lower compartment along its entire length except at the end where there is a short gap. The membrane is termed the **basilar membrane,** the upper compartment the **scala vestibuli;** the lower one, the **scala tympani;** and the end gap, the **helicotrema.**

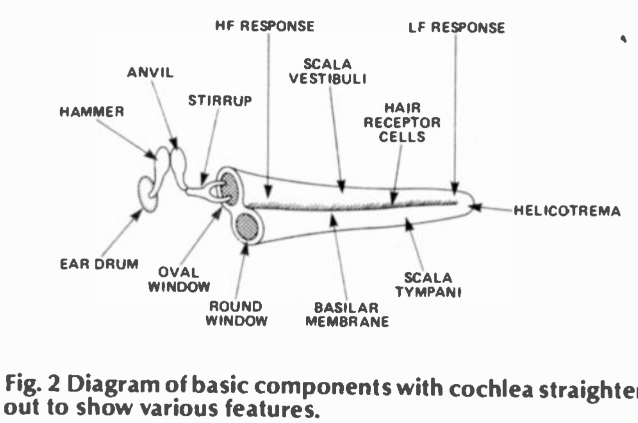


Fig. 2 Diagram of basic components with cochlea straightened out to show various features.

The whole tube is filled with fluid and is sealed at the far end so that a complete path is formed along one half, through the helicotrema and back along the other half. The top half or scala vestibuli has at its entrance a diaphragm termed the **oval window,** while the bottom one, the scala tympani, is termined at another diaphragm, the **round window.**

When pressure variations are communicated to the upper oval window by the stirrup, they travel along through the fluid to the far end, down through the helicotrema gap and back along the lower chamber to the round window. As fluid is incompressible, the round window serves to absorb the pressure variations and dissipate them to he air in the middle ear.

Now as those vibrations travel along the upper chamber they pass through thousands of very sensitive hair cells on the upper surface of the dividing membrane. These are linked to the nerve fibres that are connected to the auditory part of the brain,and their movements produce the neural signals along the fibres.

Total length of the membrane averages 31mm, and frequency response is distributed along its length; the region near the entrance is sensitive to the high frequencies, and the region near the end to low frequencies. The audio spectrum is divided into 24 bands with 1/3 octave spacing, each with its own nerve path to the brain. Centre frequencies of each band start at 50 Hz for band 1 up to 13.5 kHz for band 24.

Cut-off outside each band is not sharp but gradual, especially on the high side, although it is steeper on the low. Thus there is some overlap which fills in should any band become inoperative for any reason. Each band occupies a definite position along the basilar membrane with physical spacings of 1.3mm; spacings are termed **barks,** one bark being the space from one band to the next.

Frequency Response

The frequency response of the 'typical' ear is shown in Fig. 3. As can be seen, the response is by no means level, and varies considerably with absolute sound intensity.

The figure shows the levels at which pure tones of given frequency appear to equal the loudness of a 1kHz

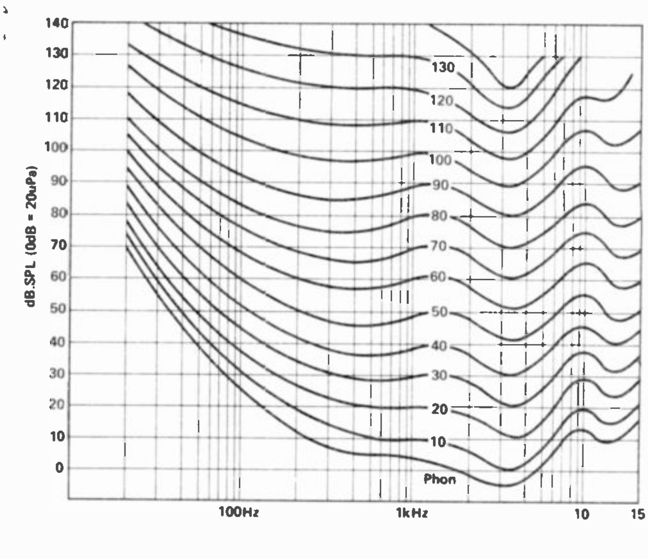


Fig. 3 Equal loudness contours. These show the amount of sound pressure required to produce sensations of equal loudness at various frequencies and volume levels. They are therefore the inverse of a frequency response curve.

reference tone, averaged over a large group of people in the 18 to 25 age range; these curves are now accepted as an international standard.

The most sensitive region at all sound levels is around 4kHz, with lifts in response at around 400 Hz (for higher sound levels) and 12 kHz. The response at very low levels to bass and treble is comparatively much lower than at the higher levels, in particular on the bass end. This explains why some amplifiers have loudness controls to lift the bass response at low sound levels, to make the overall sound more 'natural' (or so the manufacturers say...).

As with most other abilities, there is a decline in the sensitivity of our hearing with age. Over the age of 30, the high frequency response falls off at an increasing rate (Augh! — Ed.), and at 60 the response is some 15dB down at 3kHz as compared to the age of 20. At 6kHz. the response is even lower, at around 25dB down. This progressive losss of sensitivity is known as **presbycusis.**

Warning Quo Fans!

Permanent damage can be inflicted on your ears by over-exposure to loud sounds. Short periods of over indulgence produces a temporary loss of sensitivty, after which your hearing will recover. However, if you listen to such a sound for long enough, permanent damage will occur, and the 'safe' time depends on the level of the sound.

There are maximum permitted times for which workers in the UK can be exposed to industrial noise, and these could be used as a guide; the starting point is at sound level of 90dB, which is permitted for up to 8 hours. From this, the maximum permitted time halves for each additional 3dB; so for 93dB, 4hrs max is allowed; 96dB, 2 hrs; 99dB, 1hr; 102dB, ½hr; 105dB, ¼hr; 108dB, 7½mins; 111dB, 3¾mins.

Damage can be greater if the noise contains impulsive components caused by percussive sources. However, irrespective of the frequency or nature of the noise which produced the damage, the effect is always the same, a reduction in sensitivity centred around 4 kHz, ie. the frequency region for speech. Lower and higher frequencies are less affected if at all. As the damage increases with further exposure, the band of affected frequencies broadens until it sometimes reaches down to 1 kHz.

The effect of listening to loud rock music can now be appreciated. Unlike classical music where loud peaks are interspersed with quieter passages, rock music is usually reproduced at a continuously high level, often at well over 100 dB. Furthermore, the percussive beat adds its toll. So be warned!

Listening Levels

What volume level then, should orchestral music be reproduced? If too quiet it lacks colour and interest, while if too loud, as is more often the case, it is unnatural. One reason for this, even if the amplifier can handle the peaks without stress, is those aural response curves. The frequency balance is distorted at very high levels just as much as at low ones. For optimum fidelity, the sound pressure level at the ears should be about what it would be in the concert hall.

What sort of levels could we expect there? A lot depends on the acoustics, the size hall and the position of the listener. Taking Bristol's Colston Hall as an example, from a centre position in the 11th row, considered among the best, peaks of 86 dB were measured during an orchestral concert. On another occasion, in the 9th row and with a different orchestra, 90 dB was clocked. From a similar position, during a large scale orchestral and choral work, a peak of 94 dB was recorded.

Those peaks were rare and momentary. The quietest passages were pianissimo strings which measured 45 dB and were just audible. Woodwind solos were in the 60 dB range, while most of the orchestral playing was in the 60-80 dB region. Thus, a dynamic range of some 45 dB from quietest to loudest is called for which is well within the range of hi-fi producers, in fact many exceed this unnecessarily.

If you are keen on getting the level right, a sound level meter should be used. Not all are expensive, some are available without the sophisticated of professional instruments, quite reasonably. However, if you feel indisposed to shell out for even one of these, a few common sound pressure levels might help to get things in perspective. Soft whisper at 1 metre, 45 dB; normal conversation at 1 metre, 65 dB; vacuum cleaner at 1 metre, 75 dB; cruising motor coach inside, 70 dB; whistling kettle at 1 metre, 85 dB; pneumatic drill at 1 metre, 110 dB.

Decibels

We've been using the term 'decibel' or 'dB' for some time in the article, so it's about time we said what it is. It expressed a logarithmic ratio between two quantities. In the case of sound pressure levels, it is between the one being expressed and a reference which is the accepted threshold of hearing, 20 μPascals, or 200 μdynes/cm^2. Being logarithmic, it more closely expresses the perceived sound levels, because of the ear's sound level compression. A difference of 1 dB is the absolute minimum that can be detected, but usually it needs some 3 dB difference before a change of level is perceived. Doubling the sound pressure level produces a 6 dB increase in the logarithmic scale, but a subjective doubling of the sound level requires an increase of some 10 dB which is three times the actual level.

Identifying Sounds

How is it then that we can identify sounds, especially musical instruments that are playing the same note? The standard explanation is that we do it by means of harmonics and overtones.

When a string or column of air in an instrument vibrates, in addition to the fundamental vibration, there are harmonics at twice, three times, four times and so on the fundamental frequency. As well ss these various parts of the instrument body vibrate at resonant frequencies which may be harmonically unrelated to the note being played. All these harmonics and overtones produce a characteristic pattern or **formant** which is different for each instrument and gives it its special tone.

Harmonic analysis reveals that the pattern changes considerably with some instruments between their lower, middle and upper registers. The flute for example has few if any harmonics in its upper register, being perhaps one of the purest toned of instruments, yet in its lower range it can have up to ten. The bassoon has an upper register that is fairly conventional, with strong fundamental and a series of harmonics of diminishing amplitude, but its middle compass has a weak fundamental with the second harmonic actually stronger, and the following ones irregular in strength. The low register is different again with a very weak fundamental and harmonics increasing in amplitude as high as the fifth.

Also, many instruments have a quite different harmonic pattern when played softly to when played loudly; the piano is an example. Yet, with all this we can

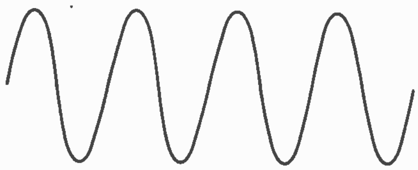


Fig. 4 Formant of glockenspiel: a pure tone with low harmonic content; very difficult to identify without starting transients.

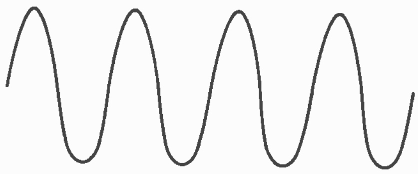


Fig. 5 Piano played pp: mainly second harmonic with fundamental as seen from broader negative half-cycles.

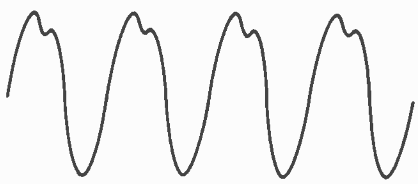


Fig. 6 Piano played mf: stronger second harmonic with others, mainly even.

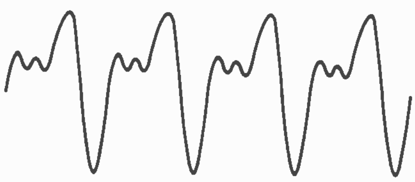


Fig. 7 Trumpet: stronger harmonic content whan piano note but not dissimilar, when starting and finishing sections removed. Harder sound than piano.

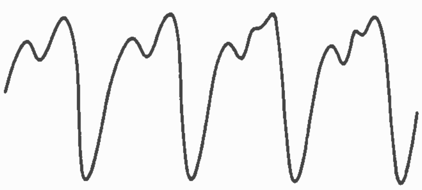


Fig. 8 French horn: mellower tone then trumpet, but similarity in waveform can be seen.

Fig. 9 Clarinet: distinctive pattern consisting of strong fundamental with strong odd harmonics in large number.

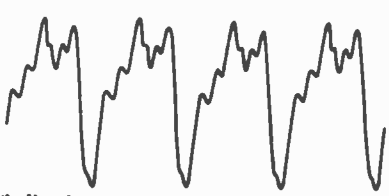


Fig. 10 Violin: large number of harmonics both odd and even gives rounder, less incisive tone than clarinet. Yet without starting and finishing portions, it is difficult to distinguish them (even the violinist had it wrong).

still recognise the instruments whatever their register and level.

Clearly something else must be responsible for giving the characteristic sound in addition to harmonic content. Another factor which has been suggested is the 'shape' of the sound, that is the way it starts, decays, and finishes. Percussive instruments produce very steep starting transients, but quickly decay to inaudibility. The attack of the bow on stringed instruments is quite different and the notes can be sustained or even increased in volume at the will of the player, and the cessation is abrupt as the bow is lifted. Wind instruments also have a characteristic start and can be sustained or increased. Further complications are vibrato, in the case of strings, whereby the performer makes small rapid changes of pitch to give expression, and tremulo with some wind instruments such as the flute, which is mainly amplitude variations.

Experiment

To test the validity of this theory, I set up an experiment with the cooperation of a small amateur orchestra. Six instruments were chosen that were unalike in tone: trumpet, French horn, B-flat clarinet, glockenspiel, violin, and piano. Each instrument played in turn an ascending scale of C-major starting at middle C. Each note was played deliberately and slowly, with no vibrato or tremulo and duly recorded on a reel-to-reel tape-recorder.

Next, each note was 'topped-and-tailed'; that is the start and finish were edited out leaving only the middle portion, and the order of the instruments re-arranged.

Finally, members of the orchestra, members of a choir that frequently performed with it, and some hi-fi enthusiasts were asked to try and identify the instruments from the doctored recording. Each participant had an answer sheet and was asked to put the name of each instrument down as it was heard. They were asked not to guess, but put down only if they thought they knew the identity of the instrument, and also not to put the final one or two down by process of elimination. If they were not sure they were asked to leave the space blank. All we told which instruments were being played but not their order. Some participants were the original players.

In view of this knowledge and familiarity with the sound of the instrument, one would expect a high score. In fact only 25% got all the answers right, and no instrument was correctly identified by all participants. A breakdown of the correct answers was: trumpet 65%, horn 85%, clarinet 85%, glockenspiel 85%, violin 45%, piano 70%.

The trumpet was not too difficult, but it sounded strange and foxed 35%; the horn was, to my ears, unmistakable — even so, 15% got it wrong. The clarinet was much more difficult, but was given away by a slight breathiness on a couple of notes; without this, fewer would have got it right.

In spite of its high score, the glockenspiel was very difficult. It was given away by a slight tinkle on one note due to insufficient chopping of the starting transient when editing. The effect was of a pure clear tone very much like the flute. The violin was also difficult, many confusing it with the clarinet and vice-versa. It was even mistaken for the trumpet and piano in some answers.

A most peculiar effect was given by the piano, and 30% failed to get it right. The sound was more like a mellow brass instrument! All participants said that the test was difficult, and many, though giving the right answers, said they were not entirely certain.

So, the conclusion is that starting transients in particular, and the decay and termination in addition, play an important part in the recognition of musical sounds. This emphasizes the need of good tranisent response and avoidance of transient distortion in amplifiers and speaker systems. On the other hand, a perfectly level response in the upper region, though desirable, is of less importance because the harmonics that fall in this region vary so much in amplitude. This is possibly the reason why many speakers, though having a rocky-looking treble response, sound perfectly acceptable. large peaks though, should be avoided for another reason as we shall see.

Listening Fatigue

A strange effect this, and often unsuspected. After a spell of listening to recorded music, various symptoms may arise. These can range from a mild feeling of having heard enough, to feelings of unease and actual irritation. It may not be actually associated with the sound heard, but these nevertheless are the cause.

So what causes listening fatigue? Distortion is certainly one of them. Even harmonics generated by the reproducing equipment, although related as harmonic distortion are harmonious with the fundamentals and can be tolerated in quite large doses. Odd harmonics are dissonant, and small amounts can be unpleasant. Crossover distortion, inherent with simple class-B output stages, consists mostly of third harmonics. Although reduced to very low levels by sophisticated design, it can still have an effect, even if to a lesser extent.

Another cause is intermodulation distortion. Here, harmonically unrelated spurious frequencies are generated by the interaction of two signal frequencies. Complex waveforms consisting of many frequencies can generate an abundance of spurious ones, and nearly all discordant. This too can result in fatigue.

A further cause is excessive high-frequency response. Peaks in the treble can over-emphasize the natural harmonics of the musical instruments. The effect may be an apparent brilliance which is not unpleasant, but even stimulating to start with, yet can soon produce fatigue symptoms.

Holophony

A couple of years ago (in July 1983) we published an article on Holophony, and for fuller information you should look there. However, since that article was published, the editor has had a chance to discuss the holophony with the inventor, Hugo Zucarrelli. The basis of his theory is that the ear actually emits a sound of its own, which interferes with the incoming sound. This interference pattern is decoded by the cochlea, which, with sound travelling in opposite structure as a sonic interferometer.

As readers will guess, reactions to this sort of theory have ranged from polite disinterest to noisy dismissal. This hasn't been helped by the somewhat disappointing results on the holophony demonstration record, or Hugo Zucarrelli's rather secretive attitude towards his invention. However, he certainly convinced the editor that the standard explanation for how we locate sound sources is inadequate.

Over-efficient loudspeaker tweeters, spurious oscillation in cross-over networks, and tweeters that beam sound directly at the listener can all be responsible. Boomy bass can be fatiguing, though this is less heard nowadays than it used to be.

Some interesting experiments were conducted at Kings College, Cambridge, by Dr G Cross in the early part of the last decade, on listening fatigue. It was found that valve amplifiers produced less fatigue than transistor ones. At that time crossover distortion was more pronounced with the then current transistor designs, whereas many valve amplifiers operated in class-A. However, another possible contributing factor is the extended HF response of transistor amps compared to that of valves. Transient distortion is another amplifier defect that could have an aural effect. It is caused by delay in the negative feedback signal reaching an earlier controlled stage, so that it is too late to reduce sudden transient signals. The result is an overloaded stage and severe distortion. However, because it passes quickly it may not be consciously noticed.

Dr Cross also found that fatigue was produced when the reproducing system was upgraded. This was explained by a frame of reference being established by the inferior equipment. If used for a period, this is taken as 'normal'. This difference in performance of the new system, say an improved HF response, violates the established frame of reference. In time, the new system itself becomes accepted as the norm, but during the adjustment period, fatigue symptoms can be encountered.

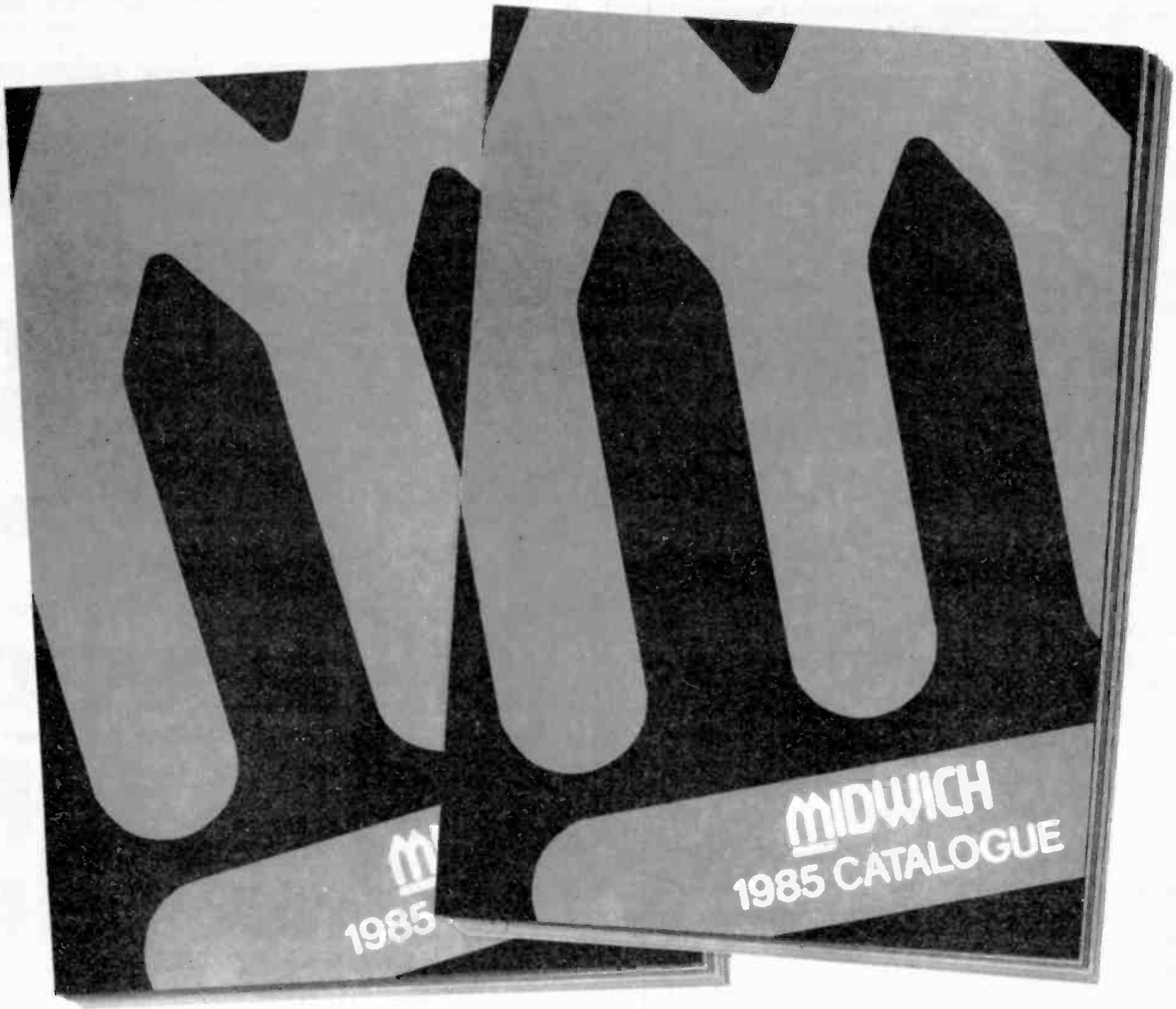
Yet another effect could be described as the 'new equipment anxiety syndrome'. This is possibly more likely with hi-fi enthusiasts than with listeners who buy equipment just to listen and enjoy the music. Enthusiasts tend to be very critical, so having spent much time and effort evaluating different products, then finally taking the plunge and acquiring a particular outfit, there is anxiety, conscious or unconscious, as different favourite records are played, lest the new purchase be found wanting in some respect.

This could explain why those folk who are constantly changing their equipment never seem to get any real enjoyment from it, and so make yet another change — they are in a constant state of anxiety!

Listening fatigue though is not brought on only by *reproduced* sounds. Dr Cross's research was intially stimulated by the fact that some lecturers at the college were holding students' attention while others with the same material and teaching techniques were not. It was found that the voices of the unsuccessful ones were in fact producing listening fatigue which affected attention and also retentivity of students.

One interesting fact that came to light was that female voices were less likely to produce fatigue than male. Apart from the possibility of the students being predominantly male, hence more likely to be attentive to a female speaker, a possible explanation for this is the harmonic content of the female voice. Although the female voice is pitched higher than the male, it has fewer harmonics, hence a purer tone. The male voice, though deeper, has more harmonics and therefore extends higher in the overall frequency spectrum. As we have previously seen, an excess of high frequencies, or prominent harmoncis can result in fatigue.

We do not know all the mechanisms and psychological effects that are involved between the outer ear and the sensations of sound produced in the brain, but the outline here presented should help us appreciate the equipment with which we have been endowed and how it relates to reproduced sound in our homes.



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RS232 I/O FOR ZX81 OR SPECTRUM

Designed for use with either the ZX81 or the spectrum, this project is for those whou would like to be able to communicate with printers and other computers. Design and development by Peter Moore in conjuction with Newtech (Micro) Developments Ltd.

This RS232 interface provides a wide range of software programmable baud rates and a true positive/negative voltage swing at its output. The facility is provided for a 'ready' signal from external equipment to be read by the computer and the interface provides its own 'ready' signal for external equipment. The interface plugs into the rear edge connector of your ZX81 or Spectrum and a rear edge connector is provided so that further periperhals can be plugged in behind.

Pin	Function
1	'Ready' line input
2	'Ready' line output
3	0V/GND
4	Serial output (TX)
5	Serial input (RX)

Table 1 Connections to SK2

Construction

All the components used in this project are mounted on a single sided fibreglass PCB. There are fifteen links to be made on the PCB not counting the pads marked A, B and C. These pads are used to select either an active high (logic 1) or active low (logic 0) ready signal from the RS232 interface: if you link A to C the ready out signal will be active high; linking A to B will select an active low signal. Decide which you require and solder a link accordingly.

Solder the remaining fifteen links in position; note that three of these are located *beneath* ICs 1, 2

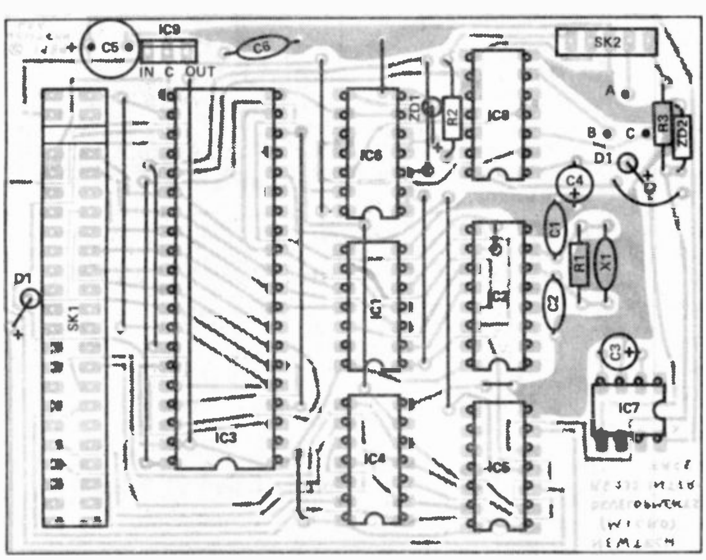


Fig. 1 Overlay diagram of the interface board

PARTS LIST

RESISTORS (all ¼W 5%)	
R1	10M
R2,3	1k0
CAPACITORS	
C1,2	56p
C3,4	10µ 16V electrolytic
C5	220µ 16V electrolytic
C6	100n ceramic
SEMICONDUCTORS	
IC1	74177
IC2	4702B
IC3	AY-3-1015
IC4,5	74LS32
IC6	74LS00
IC7	7660
Ic8	1488
IC9	7805
D1,2	1N4148
AC1,2	BZY88C4V7
MISCELLANEOUS	
X1	2.4576 crystal
SK1	23 + 23 way ZX81 Spectrum edge connector
SK2	5 way 0.1" PC plug and in-line socket

PCB; rear edge connector strip; IC sockets: 1 off 40 pin, 1 off 16 pin, 5 off 14 pin, 1 off 8 pin; wire, solder, etc.

and 3; you may wish to solder these on the copper side of the board, in which case use insulated wire.

Next insert and solder the two diodes D1 and D2 and Zener diodes ZD1 and ZD2, making sure they are the right way round. Solder resistors R1 (10M) and 2 and 3 (1k0).

Now insert and solder the IC sockets one at a time taking care to ensure that all pins are soldered and that there are no solder bridges across any of the PCB tracks.

Solder IC9 in position taking care to mount it with the flat, all-metal side facing the nearest edge of the PCB. Insert and solder capacitors C1 to C6: C3, 4 and 5 are electrolytics, so be careful to get the polarity right on these. Insert the solder crystal X1 and 0.1" PC plug SK2.

Finally, insert the edge connector and solder it, leaving a gap of 5mm between the body of the connector and the PCB surface.

If you wish to be able to plug further peripherals in behind your RS232 interface you will need to solder the ege connector strip (supplied in the kit) to the rear of the PCB behind SK1. Place the edge connector strip between the pins of SK1 (see Fig. 2) and, with a pair of pliers or pincers, gently squeeze the two rows of pins together so that they touch their corresponding tracks on the edge connector stip. Make sure that the key edge connector strip is at the same end as the key of SK1 and then solder the edge connector strip into position taking care not to allow solder to flow back onto the copper side of the PCB.

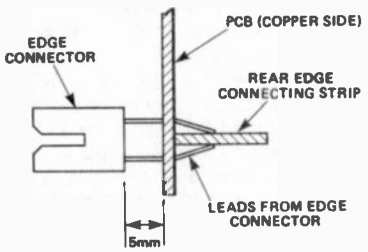


Fig. 2 Connecting the rear edge connector.

Before inserting the ICs, make a final check of all your soldered joints and make sure there are no solder bridges across any of the PCB tracks. Carefully insert the ICs making sure that they are the right way round, in the right sockets (!) and that no IC pins become bent under their respective ICs.

You can check that your RS232 interface is working correctly by temporarily connecting SO and SI directly together; data sent to the RS232 board to be transmitted should appear at the RS232 input port.

Programming

The RS232 interface provides software control over the transmission/reception baud rate, the number of data bits per character and the number of stop bits appended. Programming is accomplished by means of a data byte written to the interface board's status port (see Table 2). A logic 1 in bit D7 (TSB) will select two stop bits while logic 0 will select 1 stop bit.

NB2	NB1	Bits/char
0	0	5
0	1	6
1	0	7
1	1	8

Table 3 NB1 and NB2 programming. Note that the Bits/char figure excludes stop and start bits. A combination of two stop bits and five bits per character will result in 1½ stop bits.

NB1 and NB2 select the number of data bits per character (see Table 3). Where the number of data bits per character is five and the number of stop bits selected is two, 1½ stop bits will be appended. To select (for example) two stop bits, eight bits per character at 1200 baud: $1111\ 1011_2 = FB_{16} = 251_{10}$ (D4 is unused and can be either 0 or 1).

Three bits read from the RS232 interface's status port indicate the current state of the UART and the equipment it is communicating with (by means of the ready line) DAV is the UART **data available** flag; this will be logic 1 when data (which has not yet been read by the computer) has been received by the UART. DAV connects to

IC3 is an AY-3-1015 UART (Universal Asynchronous Receiver/Transmitter). One of the most useful devices ever produced, it is designed to interface serial to parallel and parallel to serial data channels.

The AY-3-1015 consists of two main sections: a transmitter, which converts parallel data latched into the IC into serial form, adds start and stop bits and transmits the data from its serial output, and a receiver which converts serial data appearing at the serial input to parallel data.

The UART requires a clock signal sixteen times the required baud rate; IC2 is a programmable baud rate generator which, in conjunction with crystal X1, R2, C1 and C2, supplies a range of software programmable baud rates.

UART flag TBMT (Transmitter Buffer Empty) is at logic 1 when the UART can receive further data to be transmitted in serial form. The state of TBMT and the ready input line RDY (for transmitting data) and DAV (Data Available) for receiving data are read into the computer by a read from the status port (A6=0).

When such a status read operation is made, the output of IC4d is taken to logic 0; this line is taken to IC5c (whose output is connected in open collector fashion to D6), IC5c then communicates the current state of the ready input to the computer data bus. IC4d's output is also connected to the SWE (Status Word Enable) input of the UART; when SWE is taken to logic 0, DAV and TBMB (which are tri-state outputs) are enabled and pass the current UART status to data bus line D0 and D7 respectively.

Data to be transmitted in serial form is latched into IC3 by DS being strobed to logic 0. When IORQ, A7 and WR are at logic 0, DS will be taken low latching the data on the data bus into the UART. The UART converts this data into serial form adding start and stop bits (no parity — NP is connected to Vcc) and outputs it to the UART serial out (SO) line.

IC8 is an RS232 line driver IC which inverts the serial data providing approx + 9 volts for a logic 0 input — 9 volts for logic 1. IC8 is powered from the + 9 volt line from the computer; it also requires a negative supply of similar

D3	D2	D1	D0	Baud rate
0	0	1	0	50
0	0	1	1	75
1	1	1	1	110
0	1	0	0	134.5
1	1	1	0	150
0	1	0	1	200
1	1	0	1	300
0	1	1	0	600
1	0	1	1	1200
1	0	1	0	1800
0	1	1	1	2400
1	0	0	1	4800
1	0	0	0	9600

Table 4 Baud rate selection.

D7	D6	D5	D4	D3	D2	D1	D0
TSB	NB2	NB1	not used	Baud rate selected			

Table 2 Significance of bits used to program the interface.

HOW IT WORKS

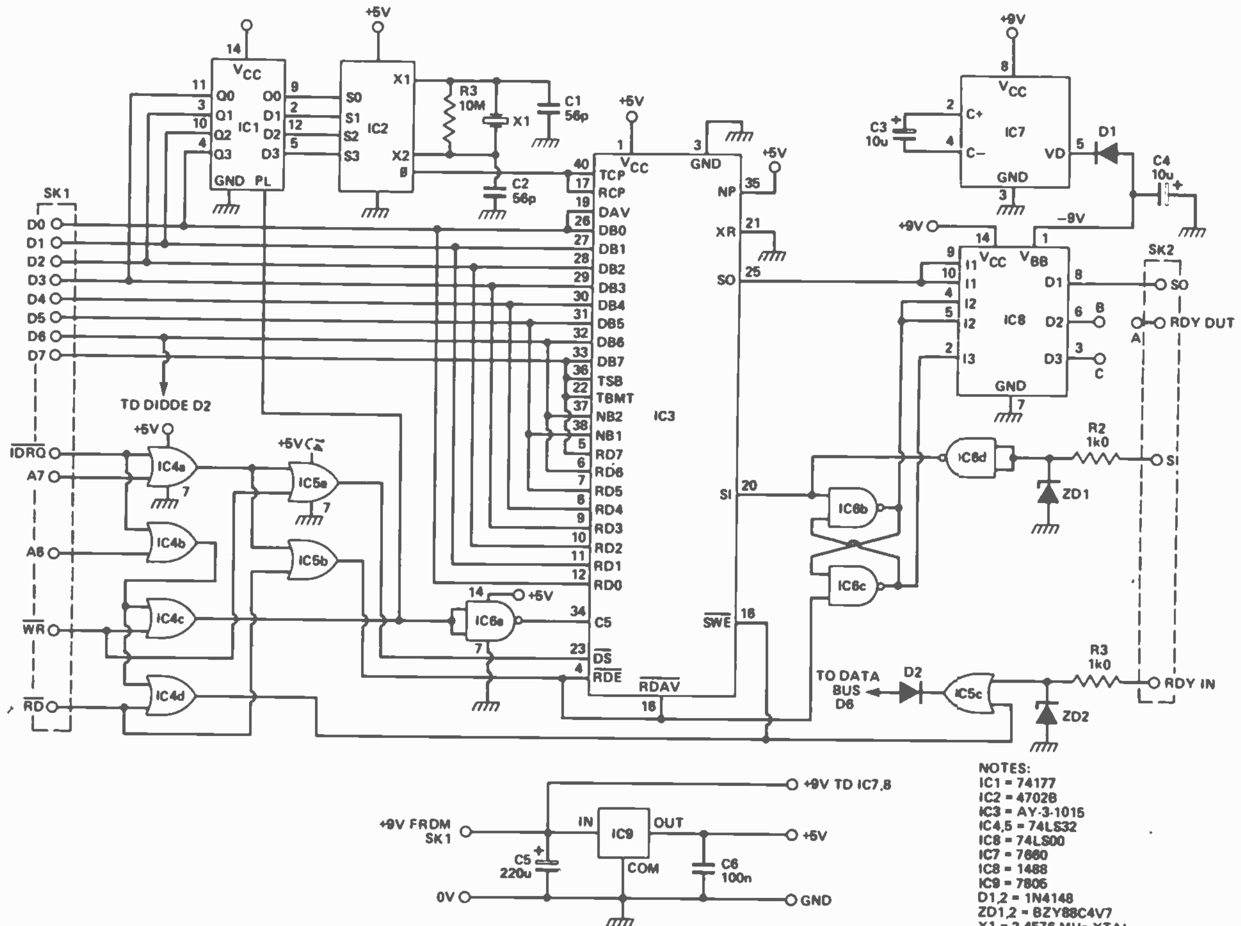


Fig. 3 Circuit diagram.

voltage. IC7 is a voltage converter IC (also powered from the 9 volt line) which produces a negative voltage at its output (C4 *is* shown connected the right way round with its positive lead connected to GND).

Serial data appearing at the RS232 interface's serial input is clipped to TTL levels by ZD1 and R2; IC6d buffers and inverts this signal before sending it to the UART's serial input. The start bit of data received at this point is a logic 0; data arriving at the UART serial input resets the latch formed by IC6b and c to indicate a 'not ready' state to the equipment transmitting data to the interface board. When data is read from the UART (by taking RDE, Read Data Enable, to logic 0) this latch is set once again indicating 'ready' (ie that the UART can receive further serial data). Both outputs of the latch are made available to provide a choice of active high or active low indication, selected by means of a wire link on the PCB.

Indication to the computer that the UART has received a byte of data is supplied by the UART's DAV (Data Available) flag. This line will be at logic 0 except when the UART is holding data received from its serial input. When the UART is read by the computer DAV is reset by RDAV (Reset Data Available) being taken to logic 0 together with RDE (Read Data Enable) which places the data received by the UART onto the data bus.

The number of data bits, stop bits and the baud rate are programmed by a wire operation to the status port. IC1 is a quad latch IC whose inputs are connected to data bus lines D0-D3. Data is latched into IC1 by a negative strobe in its PL (Parallel Load) input (due to IORQ = A6 = WR = 0) supplied at the output of IC5a; this line is also inverted by IC6a to provide a positive strobe for the CS (Control Strobe) input of the UART. This strobes the required number of bits per character and number of stop bits (the data on TSB, NB2 and NB1) into the UART.

data bus line D0 during status read operations.

TBMT is the UART **transmitter buffer empty** flag and is at logic 1 when the UART can receive further data for transmission. TBMT is connected to D7 during status read operations.

The ready line (RDY IN) indicates the state of the devices with which the RS232 board is communicating: depending on this piece of equipment, RDY will be either 0 or 1 when further data can be transmitted. RDY connects to D6 during status read operations.

Spectrum Programming

Two IN/OUT port addresses are used by the RS232 Board:
OUT 65471 is the (status out) program port;
IN 65471 is the status input port;
OUT 65407 is the data output port;
IN 65407 is the data input port.

Before being used to transmit and receive data, the UART should be read (to reset DAV if necessary and also the ready output line) and the required baud rate, number of data bits per character and number of stop bits required should be written to the status port, eg:

```
10 PAUSE 1 : LET A=IN 65407
20 OUT 65471, x
```

where x is the UART programming data.

The subroutines listed in Fig. 4 could be used for data input/output operations. An alternative

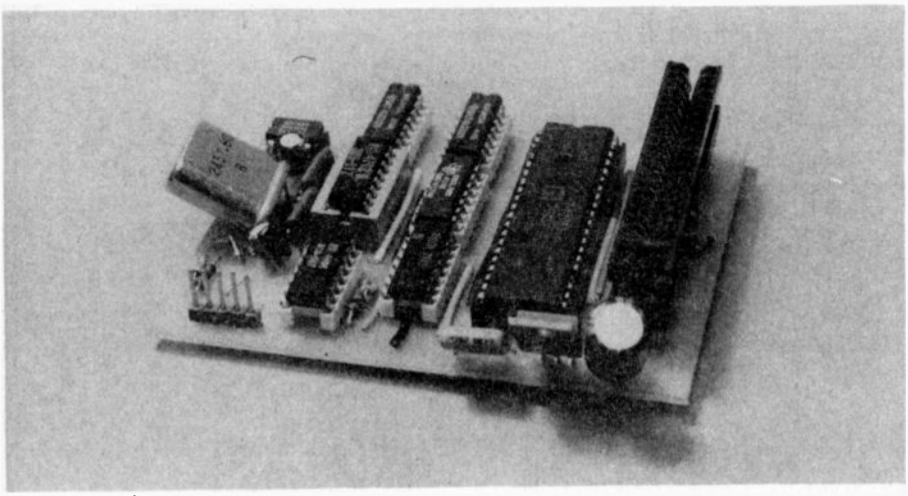
```
1ØØØ REM Spectrum subroutines - input data
1Ø1Ø PAUSE 1: LET a=IN 65471: IF a/2=INT (a/2) THEN GO TO 1Ø1Ø:
REM loop if DAV=Ø
1Ø2Ø PAUSE 1: LET a=IN 654Ø7: RETURN
1Ø3Ø REM Outputting data
1Ø4Ø PAUSE 1: LET a=IN 65471: IF a<192 THEN GO TO 1Ø4Ø: REM loop
 if RDY or TBMT =Ø
1Ø5Ø OUT 654Ø7,n: RETURN


1Ø35 REM Alternative line 1Ø4Ø
1Ø4Ø PAUSE 1: LET a=IN 65471: IF a<128 OR a>191 THEN GO TO 1Ø4Ø
```

Fig. 4 Spectrum subroutines.

```
   1 REM Program to output at string of data to a printer
 1ØØ INPUT i$: LET i$=i$+CHR$ 13: REM i$ ends with carriage retu
rn
 11Ø FOR f=1 TO LEN i$: LET n=CODE i$(f)
 12Ø GO SUB 1Ø3Ø: NEXT F: GO TO 1ØØ
```

Fig. 5 Spectrum program to output a string of data to a printer.



line 1040 is given where the ready line from the equipment with which the RS232 Board is communicating is active low (logic 0). Fig. 5 gives an example of a short program which will output a string of characters typed into the Spectrum to a printer.

ZX81 Programming

Since the ZX81 has no IN and OUT commands, three short machine code routines are used (see Fig. 6). Before being used to transmit and receive data, the UART should be read (to reset DAV if necessary and also the ready output line) and the required baud rate, number of data bits per character and number of stop bits required should be written to the status port, eg:

10 POKE 16545, x
15 RAND USR 16544

where x is the UART program data.

To read data in from the RS232 input port use:

LET A=USR 16514

The subroutine checks the state of DAV and, if DAV=1, inputs the data and returns it in variable A. Since it is highly undesirable (from the user's point of view) for the computer to enter a machine code loop (if DAV is 0), the subroutine returns whether or not new data has been received; if it has, A will return holding a number greater than 255, otherwise A will of course) be less than 256.

Fig. 7 gives a BASIC subroutine that could be used to wait for the input of a byte of data.

To output data to the RS232 port, use:

POKE 16540, x
LET A=USR 16528

where x is the data to be output.

As before, the subroutine does not cause the computer to enter a loop if TBMT and/or RDY is inactive. The number returned in A will be less than 256 if the data has been output, otherwise A will be greater than 255.

Fig. 7 also gives a short BASIC subroutine that could be used to output data.

```
1       REM xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (reserve
                                                  37 bytes)
1Ø      FOR F = 16514 TO 1655Ø
15      PRINT F ,
2Ø      INPUT N
25      PRINT N
3Ø      POKE F , N
35      NEXT F

16514    1     LD BC,nn      Entry point for data input
16515  191     c             status port
16516    1     b
16517  237     In r , (c)
16518  12Ø     r = A
16519  2Ø3     Bit b,r
1652Ø   71     b=DØ, r=A
16521  2ØØ     RET Z
16522    5     DEC B
16523   14     LD C,n
16524  127     data port
16525  237     In r,(c)
16526   72     r=C
16527  2Ø1     RET
16528    1     LD BC,nn      Entry point for data output
16529  191     c             status port
1653Ø    1     b
16531  237     In r,(c)
16532  12Ø     r=A
16533  246     OR,n
16534   63     n             mask
16535  254     CP,n
16536  255     n             test for TBMT = Rdy = 1
16537  192     RET NZ
16538    5     DEC B
16539   62     LD A,n        data to be output
1654Ø    Ø     POKEd
16541  211     OUT (n),A
16542  127
16543  2Ø1     RET
16544   62     LD A,n
16545    Ø     POKEd  UART program data.
16546  211     OUT (n),A     program UART
16547  191     n
16548  219     IN (A),n
16549  127     n             clear DAV
1655Ø  2Ø1     RET
```

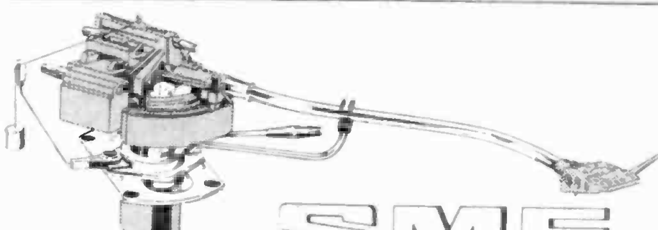
Fig. 6 ZX81 BASIC machine code subroutine, with a program to get it into the memory. If RDY is active low, data for 16536 should be 191.

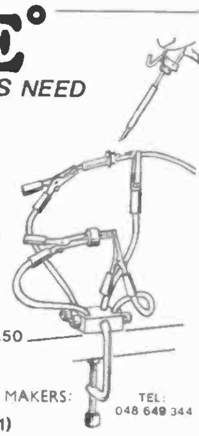
```
1ØØØ   REM INPUT DATA SUBROUTINE
1ØØ5   LET A = USR 16514
1Ø1Ø   IF A   255 THEN GOTO 1ØØ5
1Ø15   RETURN
1Ø2Ø   REM OUTPUT DATA SUBROUTINE - N HOLDS DATA BYTE TO BE OUTPUT
1Ø25   POKE 1654Ø , N
1Ø3Ø   LET A = USR 16528
1Ø35   IF A   255 THEN GOTO 1Ø3Ø
1Ø4Ø   RETURN
```

Fig. 7 ZX81 machine subroutine.

BUYLINES

All components used in this project with the exception of the PCB are readily available from electronic component suppliers. The PCB is available from Newtech (Micro) Developments Ltd. for £5.80. Newtech also supply a full kit of parts for the project at £28.95 and will also supply the RS232 interface built and tested and mounted in a case for £33.95. These prices are all inclusive. You can find Newtech at 1, Courtlands Road, Newton Abbot, Devon TQ12 2JA.





THE REAL COMPONENTS

As a preamble to a discussion on the nasties of transistors, John Linsley Hood reveals that the carbon diode (more accurately, the coke diode) pre-dated germanium and silicon types.

When I was about nine years old, my grandfather gave me an old crystal radio to play with. This was one which he had made for himself, and used during the 1920s. My own reaction was that if it had worked once, it should work again, so I took it all to pieces, and cleaned it most carefully and put it back together, and indeed it did work again, though the 'crystal' was a bit decrepit and it needed a lot of patience to find a workable spot for the 'cats whisker'.

This set me to experimenting to see if I could find any useful substitute for the now rather eroded lump of lead sulphide, and I found in due course that a piece of domestic coke would work quite well. The reason why a crystal and 'cats whisker' works at all is shown in Fig. 1, and, surprisingly this forms the foundations for the whole of present day semi-conductor electronics.

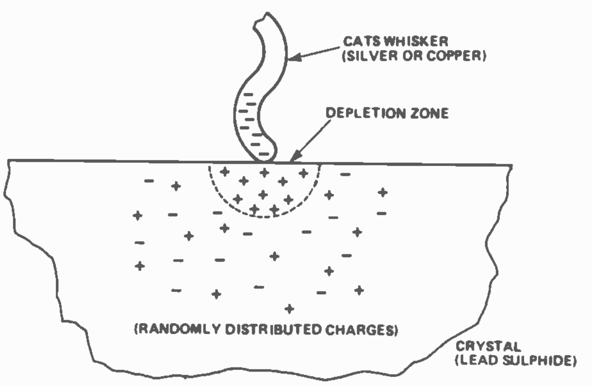


Fig. 1 Generation of a depletion zone at point of contact between a metal cat's-whisker and lead sulphide crystal (greatly magnified in dimensions).

At a junction between a conductor (the copper or silver wire 'cats whisker') and a semiconductor (the occasional small areas on a crystal of lead sulphide, or, in my case coke), a 'depletion zone' will arise in which electrons from the semiconductor will be absorbed by the conductor, leaving a region empty of electrons surrounding the point of contact. Current can now pass from the conductor into the semiconducting —now empty— region, but not conversely, unless a fairly high potential is applied; the junction acts as a rectifier.

In the case of a metal/semiconductor junction, the current vs. voltage characteristics of such a junction are as shown in Fig. 2 with the bit of the graph just around the origin expanded. This kind of characteristic is helpful if it is to be used as a detector in a crystal radio, since the voltages available at the rectifier are extremely small, virtually just what comes out of the aerial wire multiplied by the Q of the aerial tuned circuit; so any kind of 'dead space' around the zero voltage point on the graph would cause the signal to be lost.

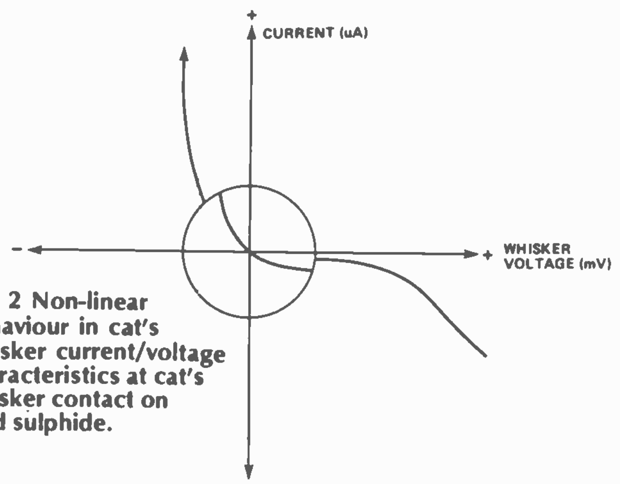


Fig. 2 Non-linear behaviour in cat's whisker current/voltage characteristics at cat's whisker contact on lead sulphide.

This type of crystal/cats whisker diode was employed during the war years when small very high frequency rectifier diodes were needed for use as detectors (ie. rectifiers) at the input of centimetric radar receivers. Since it was not possible at that time to amplify the RF signals at those frequencies, all that could be done was to demodulate the RF input from the aerial, and then amplify the resultant relatively low frequency pulse signals.

The type of construction employed is shown in Fig. 3, and the semiconductor employed was a tiny chip of as nearly as possible single-crystal silicon. If the surface was carefully cleaned and etched, almost any point on it would work, and the 'whisker' could be kept in place with a filling of some hard wax, provided that this didn't seep between the metal whisker and the crystal surface.

So far as I was concerned, my experiments with crystal radios were a dead end, and as soon as pocket money and circumstances allowed, I moved up to thermionic

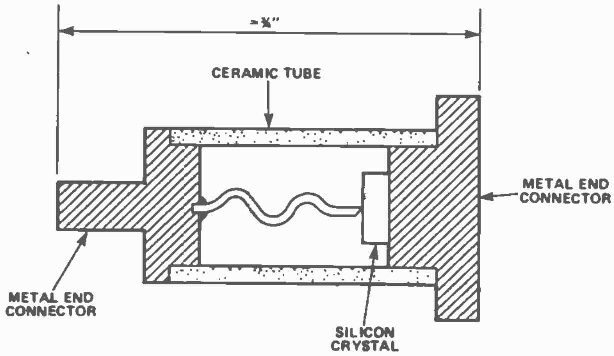
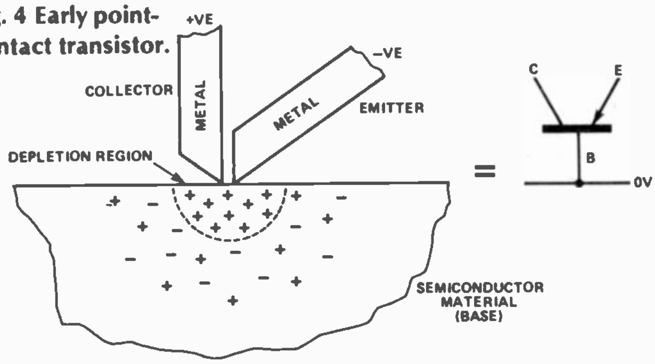


Fig. 3 War-time British 'Schottky' diode style radar signal rectifier and mixer.

valves — nice shiny things, whose glass envelopes could be polished, and which always worked if their filaments were intact. These were much more predictable than crystals and cats whiskers, and they could be used to amplify signals which crystals could not.

However, in the USA, Shockley and his colelagues at the Bell Telephone Labs. had not forgotten the crystal diode, and were actively considering the ways in which this could be made to amplify. Their approach was that shown in Fig. 4.

Fig. 4 Early point-contact transistor.



Point Contact Transistors

This type of device operated on the principle that a region of semiconducting material — by which I mean things which are neither metallic (and therefore good conductors) nor insulating (materials like germanium, silicon, and some forms of carbon, are examples) — depleted of electrons by its contact with a conductor, would allow an input of electrons, but would now allow an outflow.

However, Shockley and his colleagues, Bardeen and Brattain, reasoned that if two-point contact diode 'whiskers' were very close together, then current injected into the semiconductor by one metal point, and which would only need a low potential to achieve this forward conduction, might be swept up by the, other, reverse-biassed diode and cause a current to flow in this where previously there had been none. The advantage of this would be that a relatively high voltage, several volts perhaps, could be applied to the **collector** whereas only a fraction of a volt would be required at the **emitter** — as the forward-biassed point was named.

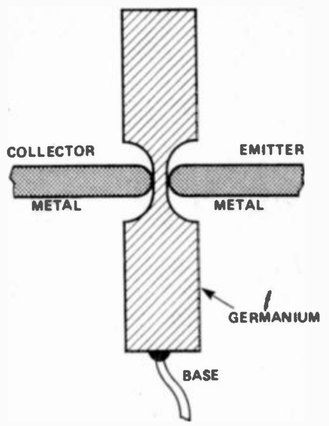
Happily, the idea worked, and because the main characteristic of such a point contact device was that the resistance of the input electrode was low, whereas that of the output, reversed-bias electrode was high, the device was known as a **transfer resistor** (it transferred the current from a low resistance circuit to a high resistance one) or **transistor** for short.

The proportion of current which was actually transferred from one electrode to the other was known as **alpha** (α), and this was a measure of the skill in getting the points close together. Ideally it would be unity, which would imply that all the electrons emitted would be collected. Curiously, though, it could sometimes be higher than this if the interaction of the injected electrons with the base material caused new electrons to be generated.

For this type of transistor to work, the base material would have to be one having a deficiency of free electrons in its structure. Nowadays we would refer to this as P-type material.

Junction Transistors

Understandably, the kind of transistor which Shockley and his colleagues first developed would have been very tiresome to try to manufacture on any sort of commercial scale, so the scheme shown in Fig. 5 was used instead, in which a slice of germanium was etched away from both sides by jets of hydrofluoric acid until the two cavities almost met. Point contact wires could then be applied from either side and would be separated by a region which was as narrow as the thickness of the residual base material.



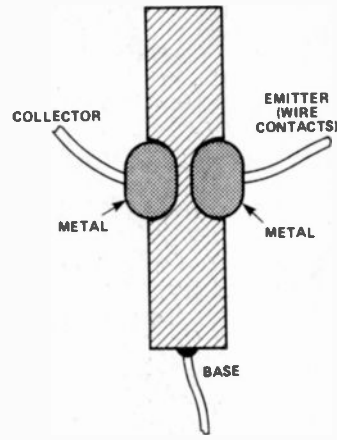
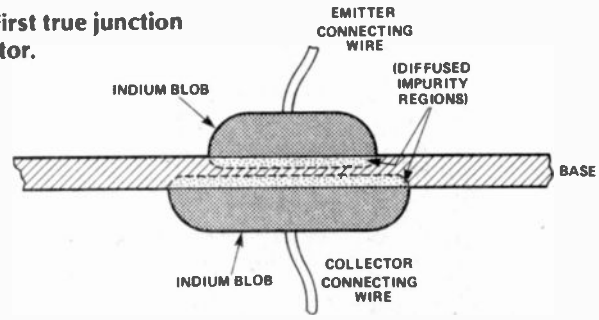


Fig. 5 (left) Commercial point-contact transistors.

Fig. 6 (right) Improved point-contact transistors offering greater immunity to mechanical shock.

This was better, but still a bit awkward to make and not very shock proof. The answer to this was to replace the wire point contacts with deposited blobs of metal, as shown in Fig. 6. If these were made of Indium, this would diffuse into the P-type base, causing an N-type region which would work just as well as a metallic whisker contact. The final development of this system came with the structure shown in Fig. 7, where the base was just a thin layer of mono-crystalline germanium 10 to 20 thous. thick, with indium blobs applied to either side, and then heated to cause it to diffuse inward.

Fig. 7 First true junction transistor.



The closer the two diffusion layers got together the higher the current gain would be, so it was a matter of some skill in the making of such devices to stop just in time. If the two inward diffusing regions met in the middle — like Aunt Emily's shingles — the result would be a defunct device. As an extension of this, if the user allowed the device to get hot, the diffusion would continue, and the transistor's current gain would get higher and higher, until finally it would short-circuit.

Silicon would be a better material to use from the point of view of its thermal stability, but it had not been favoured in the earlier transistor types because of the difficulty of obtaining high current gains. Speaking from the point of view of a traditional two-sided diffused junction transistor, current gains in the common emitter mode (β) of 50-100 could be obtained with germanium, but only in the range 15-25 with silicon.

This difficulty was resolved when the **planar** form of transistor construction was invented by the Fairchild Instrument Corporation. This is shown in Fig. 8.

Planar Transistors

These employ a thin wafer of very high purity monocrystalline silicon as the substrate, doped with a suitable trace quantity of some impurity. For example boron will give a P-type result, and arsenic will make an N-type material. These impurities can be diffused into the crystal slice, from one side only (the term planar is supposed to imply this), and if a normally N-type substrate is diffused with sufficent P-type impurity, through some sort of vapour resistant diffusion mask, the result will be a P-type area, as shown in Fig. 8. If the wafer is then masked again to give a smaller area, an N-type impurity could be diffused into the middle of this region, to give a transistor of the kind shown in Fig. 9.

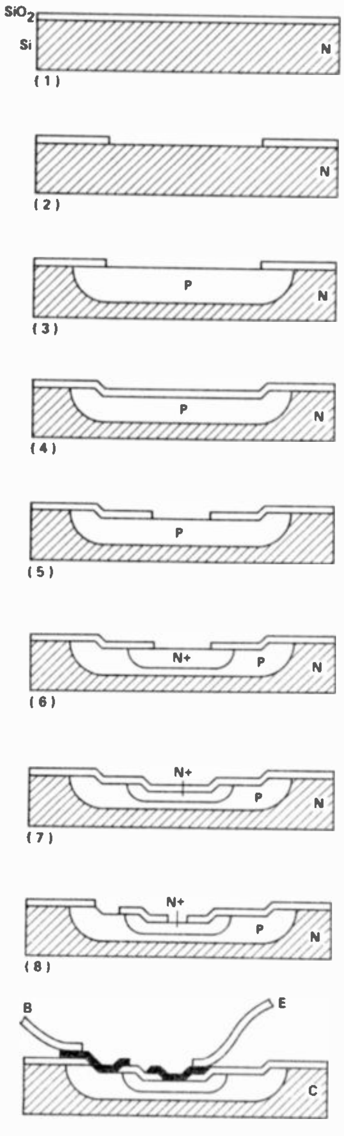
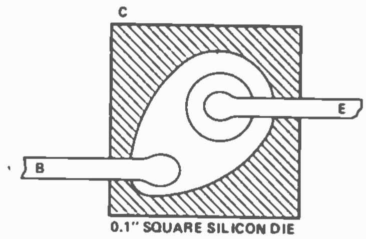


Fig. 8 Stages in the manufacture of a silicon planar transistor. Many would be made simultaneously on a single slice of silicon.

Because the effective base region, the P-type sandwich filling between the two N-layers can be made very thin by careful control of the diffusion process, current gains of 400-500 are feasible. Moreover, if the device becomes hot, both regions will diffuse — if they do at all — in the same direction, so the problem of them meeting head-on is lessened.

However, the main advantage of this kind of construction is that it is possible to make many hundreds of transistors at a time on a single thin wafer of silicon. Nowadays these can be 5 or 6 inches in diameter, so, with a transistor occupying a chip probably only 0.1" square, the possible output per wafer can be visualised. This has brought the cost of such devices down dramatically, so that to a manufacturer who buys in bulk, small signal transistors will not cost much more than 1p each.

Fig. 9 Typical diffusion lay-out for small-signal silicon planar transistors.



Epitaxial Planar Transistors

These are a development of the basic planar construction of Fairchild, with the difference that a thin layer of monocrystalline material is grown onto the surface of the wafer, as in Fig. 10, before the selective diffusion processes are begun, to arrive at the cross sectional structure shown in Fig. 11. This has the advantage that the base region is now formed in the epitaxially grown layer, and this will have just one impurity element, not two.

Fig. 10 Composite (two-layer) crystal slice used in epitaxial base transistor manufacture.

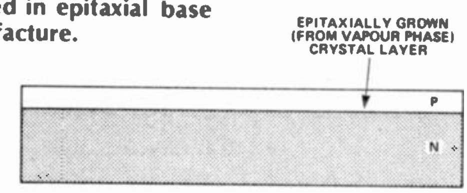
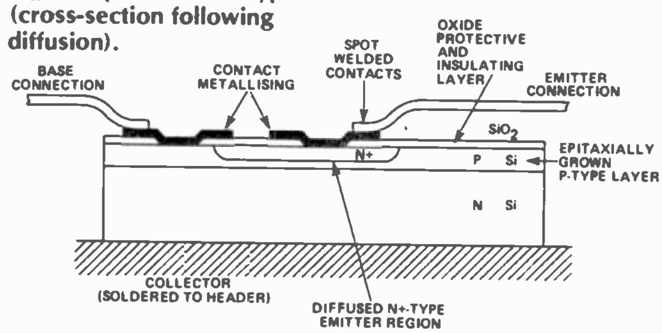


Fig. 11 Epitaxial base type transistor (cross-section following diffusion).



This is advantageous because the breakdown voltage of a transistor is determined by the base region, and a singly-doped layer will have better characteristics than a doubly-doped one. Also the emitter base junction will have better characteristics because the emitter will now have only two diffused — added — impurities instead of three.

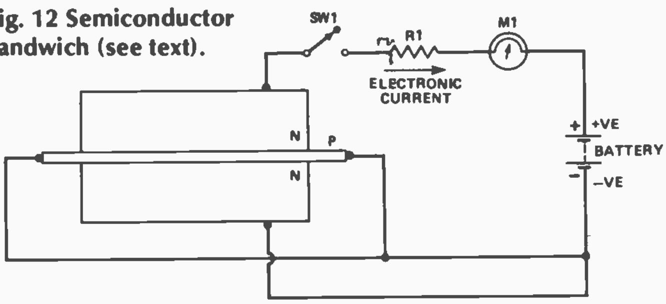
Most modern small-signal transistors are of the **epitaxial base** type, because they are easier to make in good yields, and are as good or better in performance. There is also a small advantage in the noise characteristics of epi-base devices, in comparison with straight double-diffused planar ones, which is an added bonus.

Junction Transistors — How Do They Work?

The method of operation of the common base (ie, base connected to the common or 0V line, and the input signal applied to its emitter) point-contact transistor, sketched above in Fig. 4, is fairly easy to grasp; however, the way in which a common emitter junction transistor works is very much more difficult to visualise, or explain in any manner which would both be simple and also would reconcile the several physical concepts now accepted by the solid-state physicists. However, it is possible to offer a modem which doesn't take too many liberties with the accepted theories, and yet is fairly easy to follow. This is as follows.

Consider the semiconductor sandwich which I have sketched in Fig. 12, made from two layers of N-type semiconductor material, on either side of a thin slice of P-type. Now if a good connection is made to the P-type material (and for good transistor performance this is very necessary) and this is connected to the battery at the same point as the lower N-type slice, then the N-type region at the bottom of the diagram and the P-type region in the middle of the sandwich will be at the same potential. There is therefore no incentive for electronic current to flow from the (electron rich) N-type zone into the P-type (electron deficient) middle layer, so this remains short of mobile electrons, and when switch SW1 is closed, no current flows through the load resistor (R1) or the meter.

Fig. 12 Semiconductor sandwich (see text).



However, if the voltage on the P-type layer is gradually increased by a potentiometer, as shown in Fig. 13, eventually the forward bias on the middle layer will become high enough for electrons to be attracted from the lower — let us call it the emitter — N-type region into the middle P-type slice. If this layer is thin then most of these will be drawn across this region into the top N-type zone — which I propose to call the collector — and current will flow in the load resistor and meter.

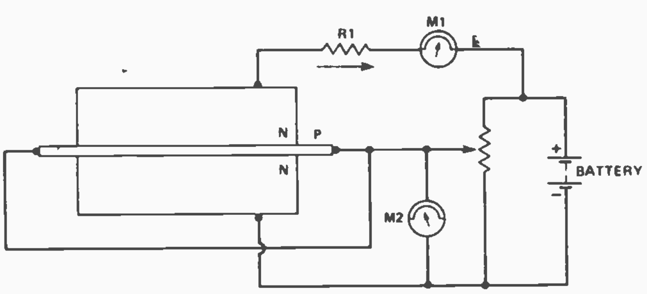
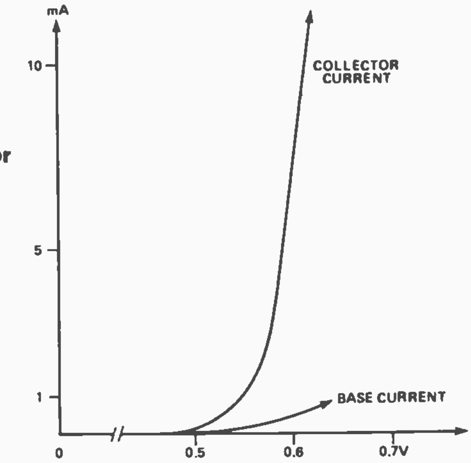


Fig. 13 Semiconductor sandwich with voltage applied to the P-type layer.

The amount of current which will flow in the P-type region, which I propose to call the base, will be the difference between the number of electrons leaving the emitter region, and the number which is promptly swept up by the positively charged collector region. If all of them were to be lost to the collector, there would be no current flow in the base at all. I am not sure what would happen then!

The way in which the current flow in the collector circuit varies, as the voltage applied to the P-type base region in the middle of the sandwich is increased from 0V upwards, is shown in Fig. 14. and I have shown the

Fig. 14 Collector and base currents in silicon junction transistors.



base current flow in the same diagram. Conventionally, the ratio of total current to base current (I_e/I_b) is known as the **current gain** or beta (β).

Several important conclusions can be drawn from this model. The first of these is that the thinner the base region, the higher the current gain will be. Also, since the only thing which stands in the way of current flow from the emitter to the collector is the thin base region, the thinner this is, the lower the collector-emitter breakdown voltage will be, though this also depends on the doping levels and extent of unwanted impurities in the three regions. Nevertheless, a transistor with a high current gain is likely to have a lower c-e breakdown voltage than a transistor with a low beta.

Another point which can be inferred from Fig. 12 is that if the base region is open circuited, leakage currents from the base region into the collector will cause the base to have a positive voltage, and will consequently cause an amplified emitter-collector leakage flow. So, make sure that the base circuit return path resistance is not too high. Also, since leakage currents get worse with temperature, if the device is going to get hot, it will need a lower base circuit resistance for a given overall collector leakage current level. Because transistors with high current gains require less base current for a given collector output current, and for a given base voltage, the input impedance, as seen at the base of the transistor, increases directly as the current gain is increased, and this makes such high-beta transistors useful in high impedance, low signal level circuitry.

The kind of device I have sketched, in crude form, in Figs. 12 and 13 is an NPN device (though in practice it would be made in the forms shown in Figs 8/9 or 11). The same sorts of argument are appropriate if one credits **holes** (places where electrons should be but aren't) with the same qualities and ability to move as positive electrons. For all practial purposes this is true, but the 'holes' move much more slowly, and they can become trapped or detained in unwanted impurities or crystal lattice defects, leading to delayed responses in operation — particularly noticeable in pulse propagation systems.

Because PNP transistors have an N-type base region, where all the movement of charge is by electrons, PNP transistors usually have a lower noise level than NPN ones, and would usually be preferred for low signal level audio input circuits.

I will talk about some of the less common aspects of transistor operation later in this series, and also show how circuit calculations are done with the Y, Z and H parameters. However, next month I propose to take a closer look at small signal and power transistors, and their uses and limitations.

ETI

BUZBY METER

Here's a project for all our readers who have contributed to that great national charity — British Telecom. Design and development by Nick Payne.

You stare blankly at a telephone bill which baldly delares "4077 units — £205.30" and you wonder how it all happened. You use a neighbour's phone and are uncertain whether to leave 10p or £5 or something in between. You may be a hesitant speaker on the phone worrying about how much it must be costing, which might, in fact, be surprisingly little or maybe, for business purposes, you would like to charge the cost of a call to a certain account.

From all these situations the Telephone Call Meter, sometimes known as the "Buzby Meter" described below can rescue you.

Overview

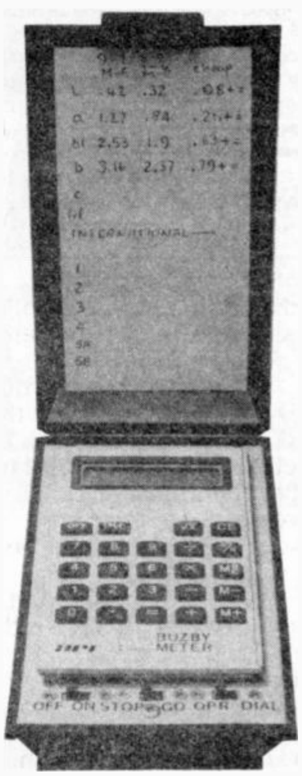
This device is an aid to checking the cost of telephone calls. Before a call is made, an amount equal to the cost of a small time interval (7.5 seconds) of the call is entered on the keyboard and the cumulative cost of the call is shown on the display, incrementing every 7.5 secs. For convenience a list of the most used rates is attached to the device.

The device uses the auto-constant feature available on most calculators. It consists of an electronic calculator plus timing circuit, which operates on the auto-constant key of the calculator.

As an example, a call to a certain town might cost 2.6p every 7.5 secs. Before the call is made 2.6 + = is entered on the keyboard. When the called party answers, the timer is started and 2.6 is added to the display every 7.5 secs, giving the true cost of the call as it progresses. The "+" key actuates the auto-constant in the add mode.

The circuit of Fig. 1 shows the timer circuit operating a CMOS analogue switch is in parallel with the "equals" key which causes the constant to be added.

Furthermore, the timer circuit automatically takes account of the



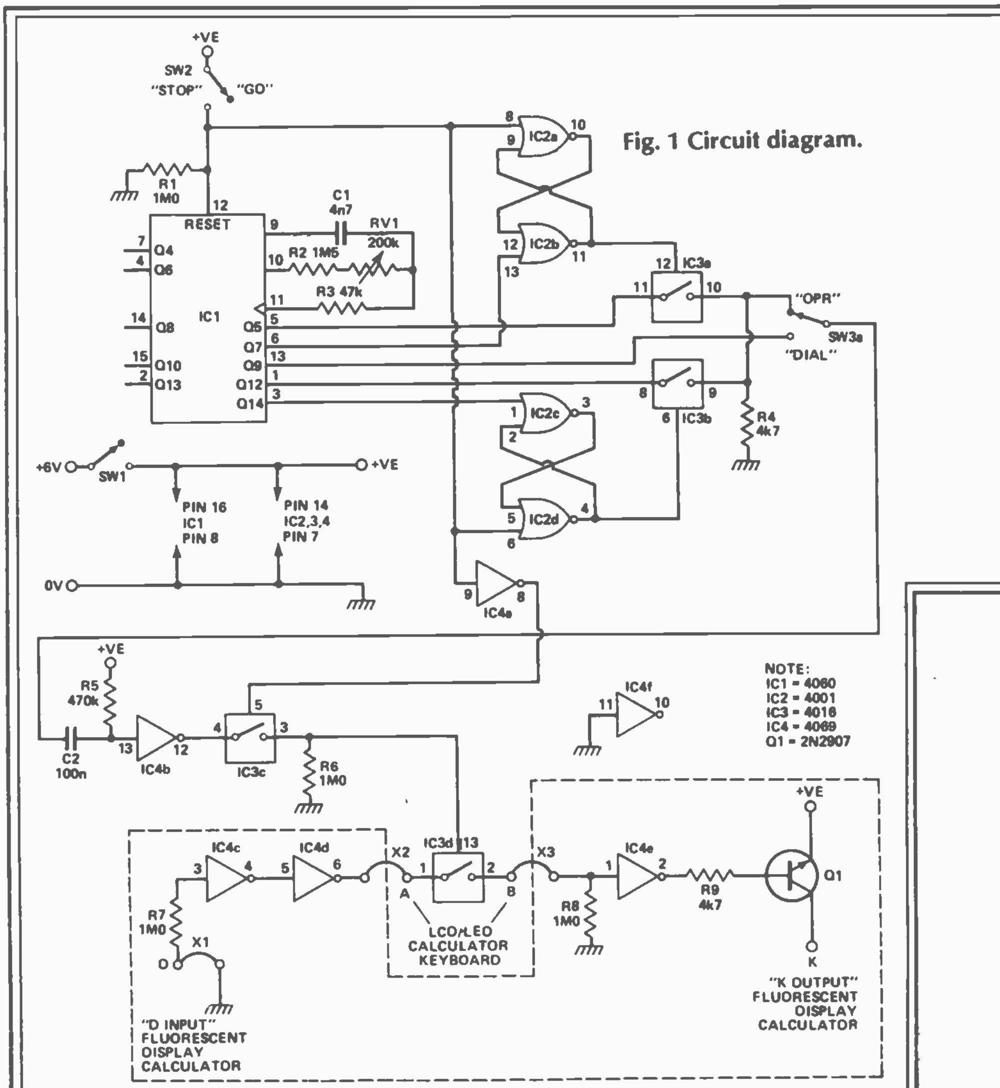


Fig. 1 Circuit diagram.

HOW IT WORKS

Referring to Fig. 1, IC1 is a 4060 CMOS oscillator ripple counter. The frequency of operation is controlled by C1, R1, R3 and RV1. It is trimmed to 68.2Hz ± 1% by RV1, setting the accuracy of the timer.

The A9 output cycles at 68.27/512Hz or once every 7.5 secs. With the switch SW3 set at DIAL, this waveform is fed into the monostable formed by IC4b, R5 and C2. Negative edges on the Q9 waveform are converted into negative-going pulses of 50ms duration. For the timer to run, SW2 is open, putting a low level on the reset input of IC1 and high level on the output of IC4a. This turns on CMOS analogue switch IC3c.

The positive going pulses are therefore switched through to IC3d. IC3d is wired in parallel with the "equals" key on the calculator keyboard, so that when it is pulsed on, the calculator chip responds by incrementing the displayed value.

When the telephone call is finished, the user resets the counter to prevent further incrementing of the display by closing SW2. Reset will force all counter outputs low. If Q9 is high before reset, resetting will present a negative going edge causing it to output a pulse. This pulse is prevented from reaching the calculator by the output of IC4a going low, turning off switch IC3c. R6 pulls the output of IC3c low when it is off. The feature for calculating the 3 minute minimum charge imposed on some operator calls is performed by the two latches formed by IC2a with IC2b and IC2c with IC2d and analogue switches IC3a and IC3b. The user sets SW3 to "OPER". Refer to Fig. 2 for detailed timing of waveforms.

During reset, latch IC2a/b is set so that IC4b output is high and latch IC2c/d is set so that IC2d output is low. Therefore, switch IC3a is on and IC3b is off. R4 pulls the output of the switches low when they are both off.

When the reset is removed and the counter starts, 2 cycles of 2.13 Hz from Q5 passes through IC3a to the monostable, thus pulsing IC3d twice, causing the calculator to add the initial displayed quantity to itself twice, effectively multiplying it by 3. This now represents the 3 minute minimum charge.

Q7 goes high after approximately one second resetting latch IC2a/b and turning off switch IC3a. This prevents any further pulses from Q5 reaching the monostable. After 2 minutes Q14 goes high resetting latch IC2b/c closing switch IC3b. This allows Q12, which next goes low after 3 minutes, to be fed through to the monostable, incrementing the displayed quantity at the end of 3 minutes and thereafter every minute.

The circuit will run off any voltage between 3 and 18 and would normally run off the same voltage as the calculator. However, the RC oscillator clocking IC1 is less stable when the supply voltage is less than 4V. Substituting a 74HC4060 and 74HC4016 for IC1 and IC3 would improve performance with a 3 and 4V supply. A solar powered calculator may work here if the solar cells have enough excess power in normal light. At 4 to 5 V a 4066 is better than a 4016 for IC3. The supply rails to the calculator chip must lie inside the rails to the timing circuit for proper operation of switch IC3d. Supply current is approximately 70μA at 6V. The device will normally be 1% accurate at room temperature, which is the accuracy the clock can be trimmed to.

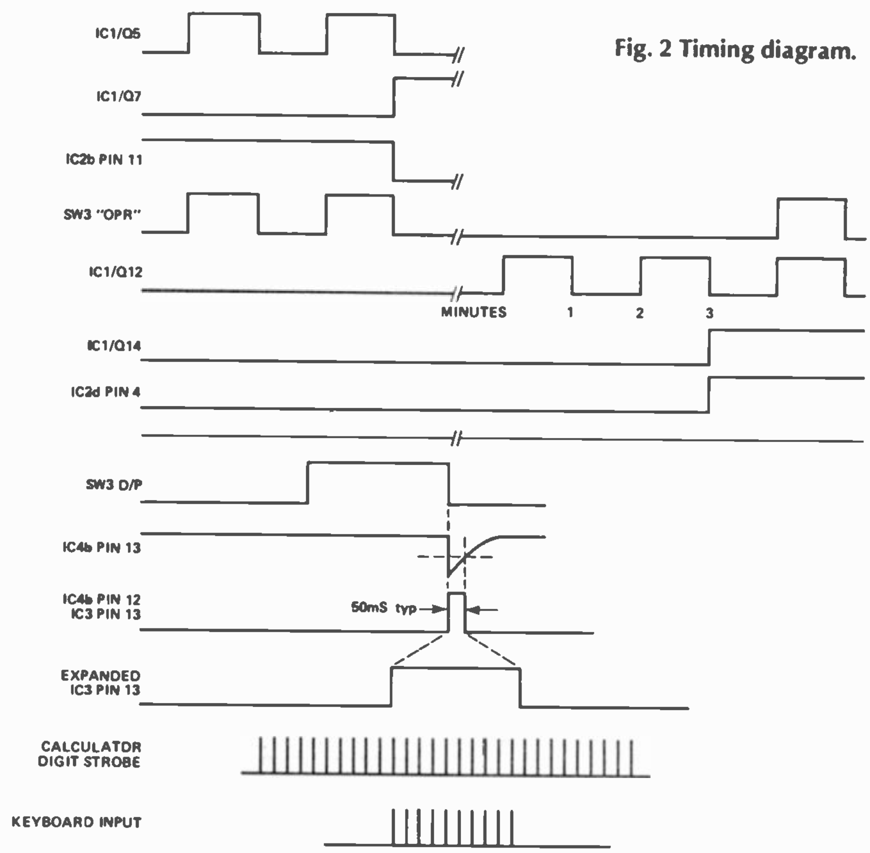


Fig. 2 Timing diagram.

3 minute minimum charge imposed on some operator connected calls. The 3 minute minimum feature is activated by a switch. Also the device operates as a normal electronic calculator when the timer is not running.

Connecting The Calculator

To find if your calculator is suitable for this conversion, first it must have an auto-constant. This typically works as follows:- pressing 1 +=== causes the display to go 1,2,3, etc each time the = key is pressed. In this case = is the auto-constant key with 1 being the constant. Your calculator may work slightly differently, but if you cannot get it to work in this fashion at all, it is not suitable. Otherwise make a note of which is your auto-constant key. This is the one which the timing circuit is connected to.

With the calculator switched off, open the back and find the leads that go from the keyboard to the chip. Keep the auto-constant key depressed, find with an ohmmeter which two of the leads are connected, and which are not connected when the key is released. On some calculators any impedance below 50k is considered a connection. Do not use a X10k range on the ohmmeter or the chip may be damaged.

If you have an LCD or a modern LED calculator that is all that is needed, these two leads can be connected either way round to the output of the timing circuit. However, older LED and all flourescent display calculators have a negative bias rail of typically 30V generated by a DC-DC converter (see Fig. 4). In this case, with the calculator switched on, check which of the two keyboard leads selected above has the most negative voltage. This is the "D" lead. Better still with a

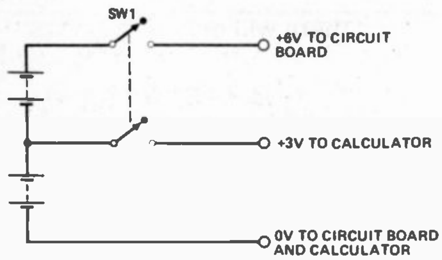


Fig. 3. Power supply when using a 3V calculator (typical for LCD types).

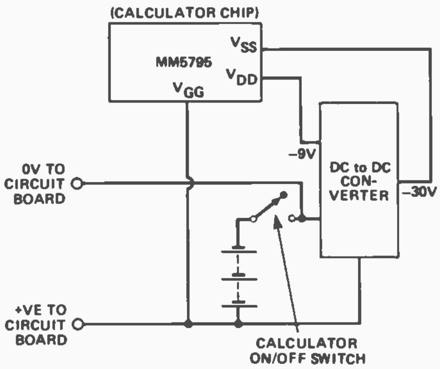


Fig. 4 Power supply when using a fluorescent display calculator such as National Semiconductor 200.

'scope, the "D" lead will be seen to have negative going pulses on it, while the other lead, the "K" lead, will be floating. In this case add the extra circuit shown inside the dotted box in Fig. 1. (X2, X3, R7-R9, Q1).

Mounting And Power Supply

With a larger calculator, there is probably room for the timing circuit somewhere inside the case and room for the switches on the front panel. For the smaller slimline calculator it is better to mount everything in a fliptop box, e.g. Vero 75 — 3018C. Fig. 5 shows this method of mounting.

In the author's version, and APF M1920 calculator was used. the two button cells are removed and two lengths of wire approximately 30 SWG, 8" long are connected to the + and − pads. Two more pieces are connected with great care (the pc pads are small) across the = key. A piece of masking tape can provide temporary strain relief for the four wires. The soldered joints should be kept low and smooth to avoid shorting to the back of the case.

Drill a small hole in the back of the calculator to allow passage for the four wires, and carefully remove all burrs. A matching hole should be drilled in the front panel of the flip-top box, along with holes for switches SW1-3, and any holes necessary to give access to the screws which hold the calculator body together. Glue the calculator case back to the panel of the flip-top box (or bolt it to the panel, if there's room inside the calculator case for the screw heads). Do make sure all the holes line up before the glue sets!

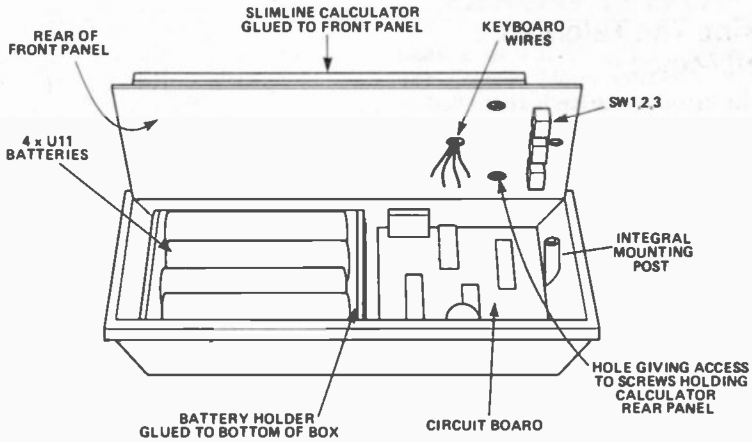


Fig. 5 Mounting of LCD slimline calculator to front panel of flip-top box.

Feed the four wires from the calculator through the appropriate hole, then screw the calculator body onto its case back; make sure you pull the four wires through as the calculator body comes together.

The power supply is wired as Fig. 3 because 3V is not enough to run the circuit board; this is got around by soldering a 3V tap onto the battery holder. On the circuit board connect the two keyboard leads from the calculator to points A and B. Leave out links X2, X3 and R9 and Q1 but put in link X1.

Fluorescent Display Calculators

For an older LED display or a fluorescent (green) display calculator all components on the printed circuit board except X1 must be mounted. In this example a National Semiconductor 200 type calculator was used (for information on this chip MM5795 and calculators in general, refer to National Semiconductor MOS/LSI Databook 1977 Edition). The 'D' input which is the most negative keyboard line is connected to R7 and the 'K' output, the floating input to the chip is connected to Q1 collector. See Fig. 4 for power connections; in general the +V line to the circuit board should go to the most positive point found in the calculator, while the 0V should go to a point not more than 15V negative of this point. With luck you can use the calculator on-off switch to switch the circuit board as well.

Hand-held calculators of this type are too thick to mount on top of the front panel of a fliptop box, but can be clamped underneath with a cut-out for the keyboard and display. Also take the opportunity to mount bigger batteries then those that fit inside the calculator.

Trouble-Shooting

If nothing seems to work, first check that all components are correctly inserted and there are no dry joints or solder bridging of tracks. Then check the power is supplied to the board. Check the oscillator IC1, C1, R2. R3 and RV1 with a 'scope, signal tracer or audio amplifier. Then check the countdown chain Q4-Q14 (the outputs change slowly enough to be seen with a voltmeter). Check the rest of the circuitry with SW3 in the 'DIAL' position, referring to Fig. 2. C2 and R5 set the pulse length to the keyboard. If your calculator is slow it may not see this pulse. Try increasing C2 or R5.

	Peak (9-1, M-F)	**Standard** ((8-9, 1-6, M1-F)	**Cheap** (all other times)
L	0.45	0.34	0.08+=
a	1.35	0.90	0.34+=
b1	2.25	1.69	0.67+=
b	2.70	2.03	0.84+=

Table 1 Figures to enter to get the costs.

Using The Telephone Call Meter

If the meter is mounted in a fliptop box, you have a convenient place (in the lid) to glue the call charges. The machine works by adding on the charge for 7½ seconds of the call. Although telephone charges are reckoned by 4.7p message units, the length of which vary by the distance being called and the time of day, reckoning the call in 7½ second chunks does not lead to any great inaccuracy. For a b-rate trunk call (over 35 miles) at peak rate you get 15 secs for 4.7p. Therefore 7½ seconds costs
4.7 x 7.5/15p = 2.35p
= 2.70p (inc 15% VAT)

To use the machine for such a call, set the OPR/DIAL switch to DIAL, key in 2.70p +=, dial the call and when the called party answers set the STOP/GO switch to GO. The display will show 2.70 and every 7½ seconds it will increment 5.4, 8.1, 10.8 etc. When the call ends, switch to STOP and the display will stop incrementing and there will only be a one or two pence error in the displayed quantity.

A partial list of call charges appears on Table 1. They are worked out by dividing 40.54 by the number of seconds for one unit (40.54 = 4.7 x 7.5 secs + 15% VAT) The final thing to do is to adjust RV1 until the calculator increments exacly once every 7.5 secs.

If the 3 minute minimum charge feature is not required leave out R4, IC2 and SW3, but ground pins 6 and 12 of IC3.

PARTS LIST

RESISTORS (¼W 5%)	
R1,6,7,8	1M0
R2	1M5
R3,4*	47k
R5	470k
R9*	4k7
RV1	200k (or 220k) submin preset
CAPACITORS	
C1	4n7
C2	100n
SEMICONDUCTORS	
IC1	4060
IC2*	4001
IC3	4016
IC4	4069
Q1*	2N2907
MISCELLANEOUS	
SW1*	SPST (or DPST, see text) slide or toggle
SW2	SPST slide or toggle
SW3*	SPDT slide or toggle

Box (Vero 75-3018C or 75-3019J or similar); calculator; battery holder; wire, PCB, etc.

*May not be needed — see text.

BUYLINES

Nothing here should cause any problems. The PCB is as ever available through our PCB service.

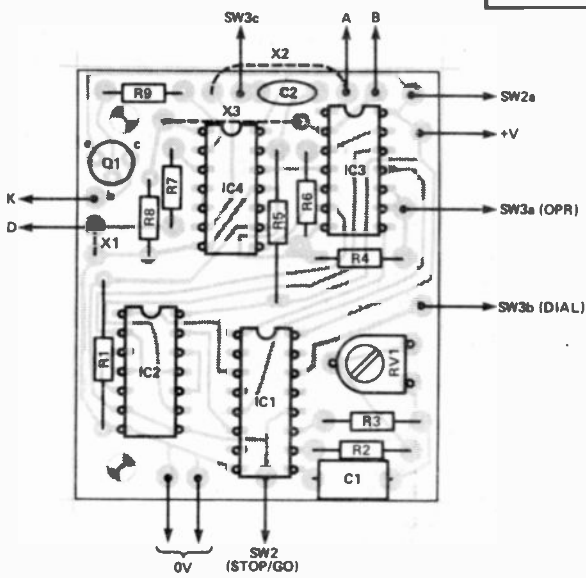


Fig. 6 Overlay diagram.

NEXT MONTH

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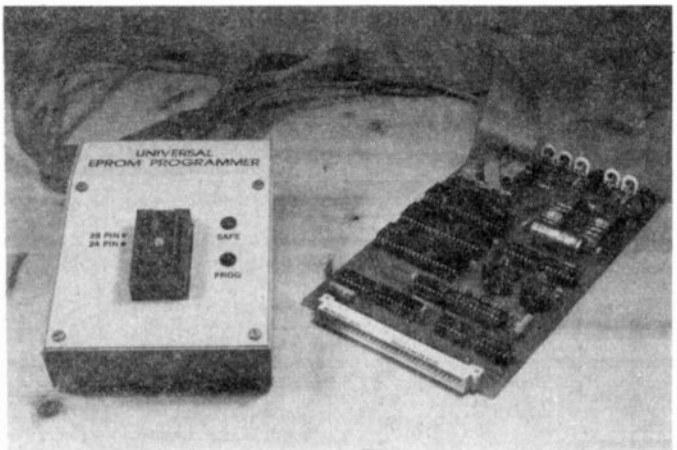
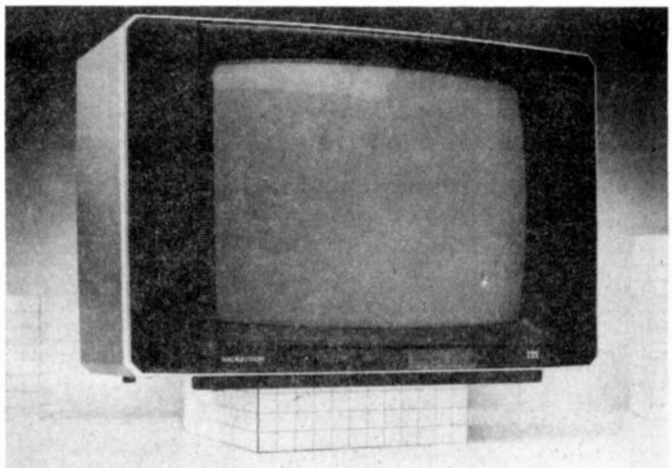
UNIVERSAL EPROM PROGRAMMER Mk II

When the Universal EPROM programmer was published in August 1983, it was capable of programming all the EPROMs commonly available on the amateur electronics/small business market, and a few more besides. Since then, technology hasn't stood still, and nor have we! We present the Mk II version, which will be capable of programming the newer EPROMs now in circulation. Readers who have built the earlier version need not despair, because an upgrade for this will also be described.





DIGIVISION

The TV signal is sent in an analogue fashion — so what's the point of using digital signal processing in a TV? Vivian Capel investigates ITT's Digivision D1000, which has been seven years and £20 million in the making.

STEREO SIMULATOR

Finally, just in case you thought we'd gone completely digital, here's an audio project. It's a natty little device which can give you pseudo-stereo from a mono source, and it can also give spatial stereo as well. And it's small enough to be used as an internal add-on in a variety of audio gear.

DIGITAL SCOREBOARD

So you really would like your name up in lights? Sorry, but we can't help just yet — but here is a project that will your score up in lights. The modular approach of this design makes it quite flexible, and it can be controlled either by thumb-wheel switches or from a computer I/O port.

6802 EVALUATION BOARD

Here's a project that's been designed for people who would like to break into the world of machine code and microprocessors. It's based on the 6802 which is a version of the 6800 with one or two extra bits (no pun intended) added.

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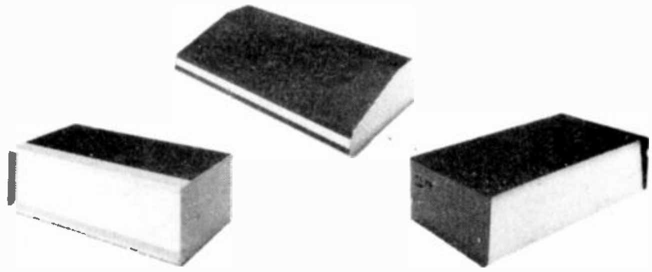

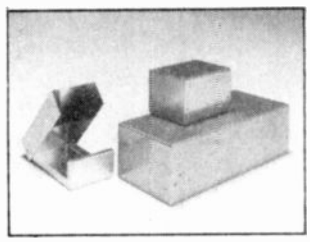

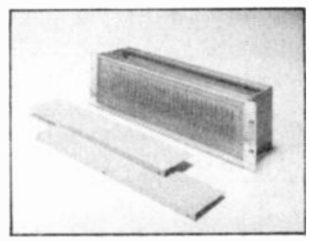

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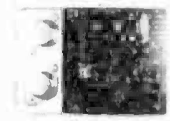
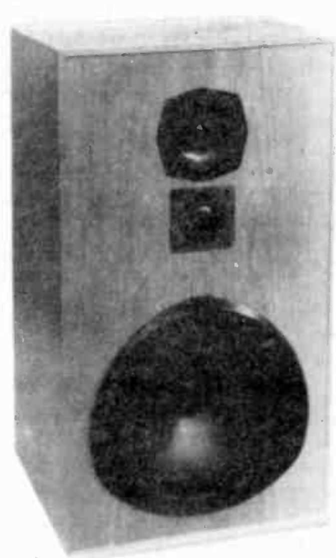
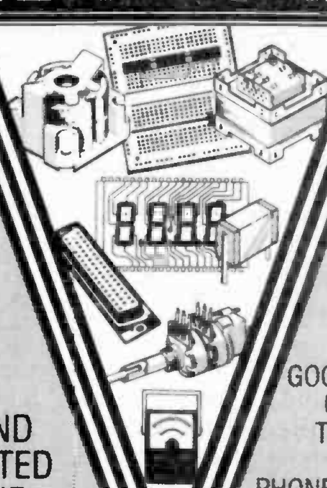






TELECINE

Ever wondered how 35mm Cinemascope feature films are processed for presentation on television? Andrew Armstrong takes a look behind the scenes.

Almost everyone watches feature films on television from time to time. These are the films which you might have seen at the cinema a year or two ago, and they were probably produced on 35mm colour film. Some pre-recorded video cassettes are also made from feature films, and in both cases the film is then viewed in a way not intended by the person who made it. Whether the dramatic material is as well suited to presentation on a small screen as on a large screen is often open to debate, but the technical quality of the programme is usually as good as we would expect it to be had the film been made specifically for television.

Colour Television

Before making any further reference to films, let's refresh our memories on the subject of colour television.

The television picture is built up by means of an interlaced raster scan, illustrated in Fig. 1. In Britain a 625 line frame is used, built up from two 312.5 line fields. Fifty fields per second are transmitted, forming twenty five complete frames. This method gives a reasonable compromise between vertical resolution and flicker, within the limits of the transmission bandwidth used.

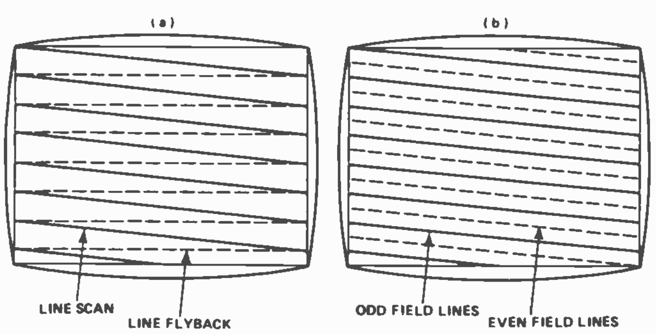


Fig. 1 a) the odd field of a single frame of video is scanned by a TV camera and b), the odd and even frames combined to make up an interlaced raster.

As with the black and white system, colour television relies on the persistence of vision of the eye to prevent the viewer observing the scanning process which builds up the picture — it all happens too fast. The colour perception of the eye is also fooled into seeing that which is not there. The eye seems to assess the colour of the light it receives by evaluating the proportional stimulation of cells which respond to red, green, and blue light. The frequency response is sufficently broad for there to be an overlap of response between red and green, and green and blue.

If, for example, a spectrally pure yellow light (a sodium street lamp is a good approximation) is shone into the eye, the green and red cells are both stimulated. The shade of yellow is determined by the proportional stimulation of the two types of cell. So far as the eye is concerned, the same colour is present if a mixture of red and green light in the right proportions is used instead of a single yellow light. This is how colour television achieves the effect of colour.

There is always a problem because not everyone's eyes work in exactly the same way. Different people need slightly different proportions of primary colours (red, green, or blue lights) in order to produce the illusion of a certain spectral colour. The proportions are also affected by the precise wavelengths of the primary colours which are used. For this reason the choice of coloured dyes for film or light emitting phosphors for television is of great importance.

System Difference

The frame rate used for film is different from that used by any major television system in the world. Most film is taken at 24 fps (frames per second) but the television system in Britain works on 25 frames per second. This is close to the right speed, but American television gives worse problems with a rate of 30 fps.

Even if one were to run the film through a projector at the appropriate frame rate and televise the image directly, there would still be one major problem. The frame blanking period of the television system is much shorter than the time required to pull the next frame of film into view in the projector.

The sequence of operation in a projector is, approximately: 1) a shutter cuts off the light; 2) a claw, engaged with sprocket holes in the film, pulls the next frame into view; 3) the shutter uncovers the light source, so that the frame is visible. While the film frame is displayed it must be completely stationary or else it will appear blurred. Therefore a mechanical settling time is needed.

The result is that this means of televising a film, using a projector, screen, and television camera, would give black areas at the top and bottom of the picture. This occurs quite simply because the television camera is scanning while there is no image on the screen. If the phase of the projector and the television camera were to drift, there would be a black band moving up or down the picture, rather like a severe form of the effect observed on a television set whose main smoothing capacitor is failing.

The eye, of course, has no trouble with projected image, any more than it does with the scanning of the spot generating the raster in a television picture. In each case, the operation takes place faster than the eye can detect, being averaged out by the persistence of vision. The time taken for the eye to respond is normally assumed to be about 1/16th of a second, though this varies from person to person and is less around the periphery of vision than in the central area.

There are other points of incompatibility between film and television, and these generally show up the inadequacies of television. First, the contrast range which can be reproduced on film is very much greater than available from a television set. This is particularly true in a well lit room where a mid-grey area may appear to be black: anything dimmer than mid grey will be indistinguishable.

Another difference is in the primary colours used. Different film stocks use different sets of primary colours, but none of them are the same as the ones used in colour television. This causes both mild desaturation (alteration of the colour towards a neutral grey of the same brightness) and a change of hue (colour).

The aspect ratio (the ratio between the height and width) also differs between film and television. This applies most seriously to cinemascope films. The frame of a cinemascope film is the same shape and sized as that of an ordinary film, and in fact there is no mechanical difference. The difference is in the anamorphic camera lens used, which compresses the image horizontally. In this way, the breadth of the scene filmed is greater compared with its height than the width of the film frame compared with its height.

Telecine Systems

The above incompatibilities demand a special piece of equipment to convert from film to television. One intractable difference, which no conversion equipment can alter, is that the ordinary television system in this country cannot approach the clarity and detail of even a fairly ordinary quality film. Small details, clear on the film, simply show up as blurs on a domestic television. With this reservation, a good telecine machine can provide television pictures which go a long way towards doing justice to the film.

A number of different methods of film to television transfer have been used, but many of them are variations on a theme. There are three main methods.

The first, and least useful method, is to use a projector, screen, and television camera. In order to avoid the problem of black bands across the picture, very long persistence camera tubes are used so that the image persists during the time that the screen is blanked to move to the next frame. This delay causes streaks to be invisible behind moving objects. Due to the differences between three coloured channels, the streaks are normally multicoloured. This effect is present to some extent in all the home video cameras I have seen.

The long persistance camera technique has been (and may still be) used at some small TV stations in the USA, and is employed in the telecine adaptors available for home video use. It is not widely used.

Flying Spot Scanner

Many variations of this idea have been used, and for a long time it has been the major basic technique. The method is to display a television raster on a small cathode ray tube, and focus the image of the raster on to the film. The light passes through the film and then through red, green, and blue dichroic colour splitters and into photomultipliers, which give an electrical output proportional to the light of each colour which passes through the film. This is illustrated in Fig. 2.

If these RGB (red, green & blue) signals are fed to an RGB video monitor, together with the synchronisation signals used to generate the original raster, a television picture of the film frame being scanned will be seen.

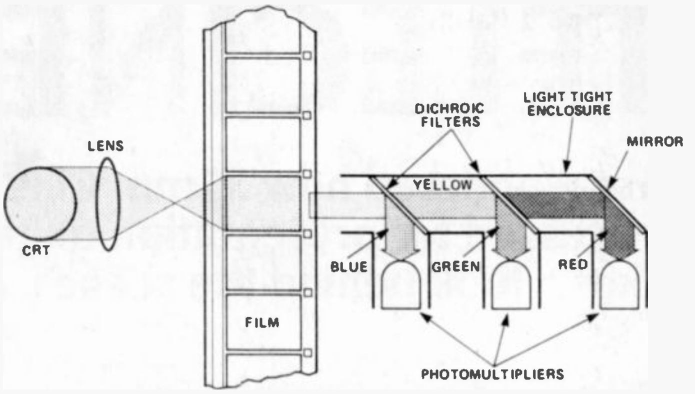


Fig. 2 The light passing through a colour film is directed through a series of dichroic filters to select the colours fed to the photomultipliers.

This method displays a single stationary film frame. To televise moving film, a method must be found to produce a stable picture. Most of these involve moving the image of the raster to track the movement of the film, by various electronic or optical means. One novel modern method used is to scan the film frame only while it is in a suitable position, and to store the television picture digitally to be read out at normal television rate. This means, of course, that the scanning for storage is carried out at a faster rate than normal television scanning, and in a non-interlaced manner.

Charge Coupled Devices

This led logically to the third major technique of televising film, which uses CCD (charge coupled device) line arrays to digitise the film line by line as it passes by. The digital signal generated is stored in a frame store and then read out at the normal television rate.

This technique has recently become very widespread. Two of the major telecine manufacturers, Marconi and Bosch, make only CCD based machines, while another major producer, Rank Cintel, makes both flying spot and CCD type telecine machines.

Flying Spot Variations

A flying spot scanner without a frame store must track the film movement with the image of the raster.This has not always been accomplished electronically. One idea which was tried was the hologon, a multi-faceted prism made to spin so as to present a new face to each film frame. Its angles are such that the image of the raster is deflected to follow the film movement. Several machines of this type have been used at the BBC for many years.

A difficulty in the use of this system is that movement of a heavy, spinning, block of glass must be matched to the television synchronisation signals so that the optical changeover from one facet to the next occurs during the frame blanking period. Because high quality pictures are required, this is more difficult than the control of the heads in a video cassette machine. The film, of course, also has to be synchronised in a similar manner, so there are two sources of mechanical error which must not add up to a noticeable picture disturbance.

Hopping Patch

In many ways, it is easier to move an image on a CRT than to move it optically. Hopping patch is so called because the patch on the CRT hops between two locations, which correspond to the positions of the film frame the first and second time it is scanned.

The movement of the film is in the opposite direction to the direction of scanning, so the resultant raster is half the size that would be required to scan a stationary frame. Figure 3 illustrates this.

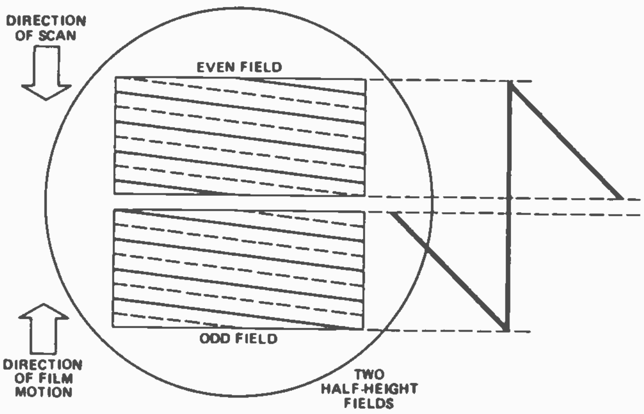


Fig. 3 The 'hopping patch' system. The odd field is scanned first, then the scanning spot jumps up one frame height and carries out the even field scan. The vertical scan waveform is shown to the right.

This system still requires the film to be in the correct place at the correct time, but this is easier than synchronising a prism as well. It also has its own special problems. Because of the interlaced method of producing a television picture, alternate lines on the picture are scanned by the two rasters. If the positioning of each raster relative to the other is not very accurate, the picture details will not match between the two halves and a very visible jitter will result.

This applies to every part of each raster, so a deviation of more than half a television line width from the correct rectangular shape will cause an effect on the picture that would make some viewers seasick.

Film Tracking

Instead of forcing the film to be in the right place to be scanned at the right time, an electronic film tracking system can be used. This determines which of the film frames passing nearby is best placed to be scanned for the next field, and scans it. The position of the film is sensed by optical sprocket hole detectors or by the use of shaft encoders on sprocket wheels. This means that any small disturbances in the control of the film position will not contribute to jitter on the picture. The attendant disadvantage is that the rasters do not always occur at exactly the same place on the CRT, so the job of keeping the shape and positioning accurate is more difficult.

The film tracking method does have an attractive spin-off, which is that the precise film speed no longer matters so far as providing a good picture is concerned. This would allow a film to be played at 24 fps instead of 25 fps, on a British television system. A film can be streched or compressed by a few percent to fit the standard programme times. In order not to upset those with perfect pitch, or even just good hearing, audio pitch correctors are available. These devices use memory to treat the sound rather in the way a frame store treats the video. This can result in some parts of the sound waveform being cut out, or played twice, but this is not normally noticeable.

Some Current Machines

Almost all of the telecine machines sold for professional uses nowadays incorporate framestores. The one exception to this is a new machine, shown for the first time at the IBC Exhibition in Brighton this year, by Independent Cine Equipment. This particular machine uses a film tracking technique to avoid the cost of a framestore, and to provide superior performance in those situations where a framestore is a liability rather than an asset. An illustrative example of a film tracking system is shown in Fig. 4.

The performance of this particular machine is probably comparable with that of some of the better known and more highly priced machines, but it does not offer computer controlled special functions. It is likely that, given the decreasing cost of memory, the extra cost of a frame store in an 'all singing, all dancing' machine would not be very significant.

Digiscan

The most widely sold flying spot telecine is the Rank Cintel Mk III C. This is available in a version using a hopping patch and a version using a frame store and a single patch position. The hopping patch option offers

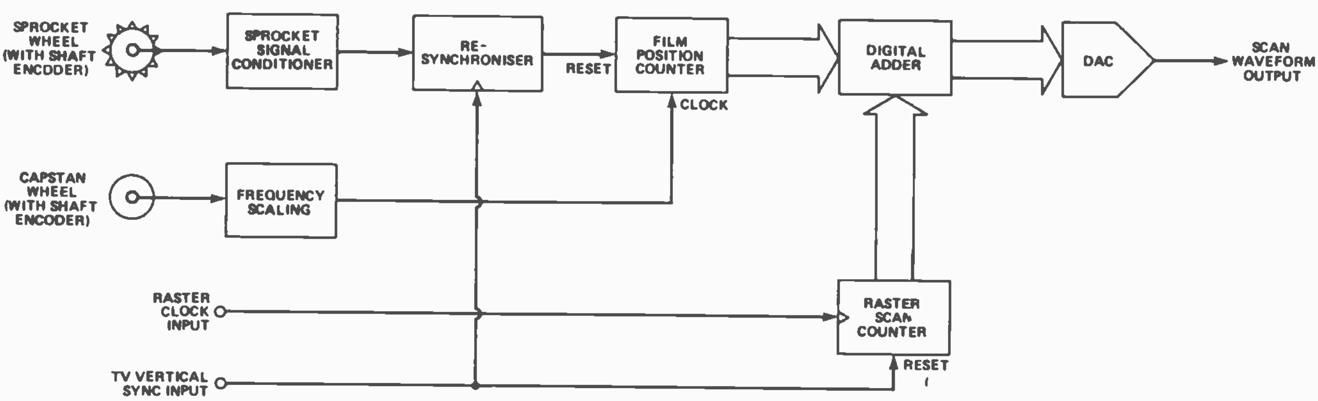


Fig. 4 A simplified film tracking scheme. The resynchroniser resets the film position counter one film frame backwards on the first TV vertical sync pulse, following a sprocket wheel pulse which indicates that the next frame is in view. The composite signal (raster plus film motion) is generated digitally, so analogue drift is not a problem.

operation only at standard film speeds, but it does offer a higher resolution than the frame store version which is limited by the number of memory locations used. An ordinary domestic television set would not show any difference but broadcasters seem to prefer hopping patch machines.

The frame store version (named Digiscan) offers variable speed operation, because regardless of film speed, there is always an up to date picture stored in the frame store. There is also a digital picture enhancement system which, though it cannot produce resolution that is not there in the first place, can greatly improve the appearance of a picture. One method of doing this is illustrated in Fig. 5, were a video edge is artificially sharpened to make the outline of an object appear crisper.

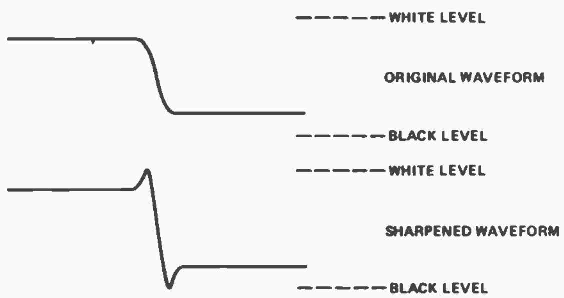


Fig. 5 Edges may be made to appear sharper than they are on the video signal by adding overshoot and speeding the transition. No more detail is generated, but it fools the eye into perceiving a very crisp image.

The enhancement shown is carried out on a single video line, and would only sharpen vertical lines on the picture. A frame store allows the comparison of a picture line with the one before or after it, so that differences can be emphasised, thus sharpening horizontal lines.

There is another great advantage with the Digiscan telecine. Because the film frame is scanned from top to bottom rather than in an interlaced manner, there is no chance that the position of the two interlaced fields finally displayed will not match up correctly even if the geometry of the scanning is imperfect.

Colour Correction

Any system of transferring film to video must take account of the higher contrast available on film, and the differences in the primary colours used. The effect of the higher contrast on the film is that, without any form of correction, large picture areas would appear on the television as completely black or completely white. The signal range must be compressed (referred to as gamma correction) in order to provide a better representation of the film picture. The gamma law is

Antilog(Gamma*Log(signal))

and may result in a gain in the dark areas several hundred times the gain in the light areas.

The gamma law must be correct for each colour, or else the hue will be affected by the brightness. The hue of near black and near white must also be adjusted to compensate for differences in film stock, and even for different scenes. Typically this correction is controlled by three joysticks, with three overall level controls. Thus, the operator may turn the stem of the joystick to adjust the amount of gamma correction used, and adjust the position to determine how this is shared between the red, green, and blue signals.

In addition to requiring the correct gamma for each colour individually, the gamma of each colour may need to be modified by the signals from the other two colours to compensate for the mismatch between the coloured dyes used in the film and the colours used for colour TV. On some types of film stock it can be impossible to achieve natural colours unless this process (referred to as masking) is carried out. Most machines have several preset masking matrices for different film types.

This vigorous correction has several consequences. The first is that there is too little dynamic range in an ordinary frame store to permit the correction to be carried out after storage. If this were tried, then areas which had to be amplified substantially would have the size of the minimum digital step of brightness similarly increased. Distinct stepped brightness levels would be clearly visible.

For this reason, the correction in the Digiscan system is carried out before the signal is digitised. The only problem here is that the digital store is not updated while the film is stationary, so in order to colour correct a scene the operator has to keep running the film back and trying again.

A computer control system is available to take account of the different colour correction needed for different scenes. This stores the correction settings for each scene, and applies them at the appropriate frame number.

Many other facilities are available, including an XY zoom system which will allow the operator to zoom in on any part of the film frame. A subset of this system allows the machine to televise cinemascope films. A portion of the picture width is enlarged to fill the whole screen, and the operator can pan the displayed portion across the frame. The degree of horizontal enlargement is chosen to alter the tall thin images to realistic proportions.

If the panning has not been done quite carefully enough, the viewer may begin to feel like a sepectator at a tennis match. You may occasionally notice the picture panning across to the person speaking just when he finishes what he was saying and someone on the other side of the picture speaks.

A cinemascope film may, instead, be shown with a blank above and below it on the television screen, to reduce the height to a realistic level, but this is not so common.

CCD Machines

There are several manufacturers of CCD type machines. They provide different facilities and are suitable for different applications.

One of the generic differences between flying spot and CCD telecines is that the CRTs used for flying spot scanners have the highest output in the green region, and well down in the blue and red regions. Because of this, the signal to noise ratio of the red and blue channels of a CRT based machine is normally unimpressive. On the other hand, the high output and better spectral response of the projector lamps used on CCD machines gives a good signal to noise ratio on all channels.

A major selling point of Rank Cintel's ADS1 is the facility to detect dirt and scratches on the film. This is possible because the light from the filament lamps used to illuminate the film, unlike the light from a CRT, contains a lot of infa-red. The dyes used on films are transparent to infra-red light, so only the dirt and

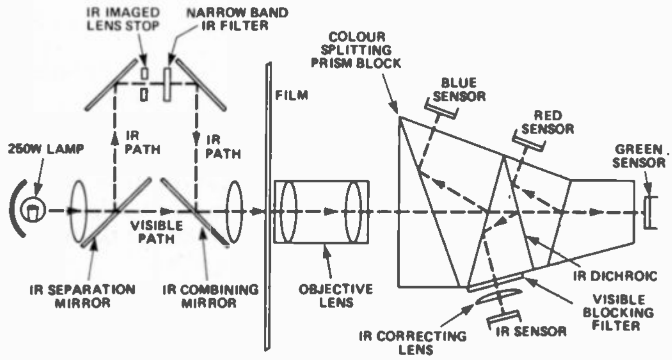


Fig. 6 The infra-red dirt detection system of the Rank Cintel CCD telecine.

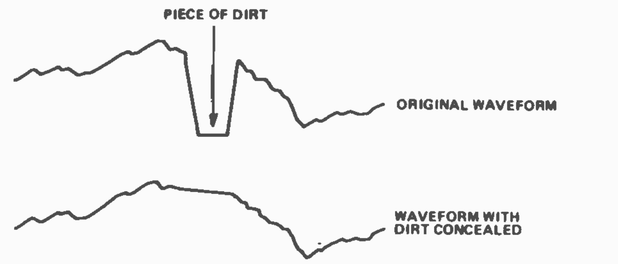


Fig. 7 The concealment of the piece of dirt is carried out by joining the ends of the waveform on either side of it. The slight loss of detail on the picture is rarely detectable.

scratches show up under this wavelength. A special channel is used to detect such blemishes, as illustrated in Fig. 6. Note the extra long optical path length and the special stop for the infra-red, because the focal length of the lenses is very different at this wavelength.

Once the scratch has been detected, it must be concealed. To do this, the video signal must be delayed to allow the concealment circuitry to work. The concealment circuitry is digital and generates a ramp from just before the scratch until just after it, neatly joining up the video waveform. This is illustrated in Fig. 7.

The ADS1 telecine carries out its colour correction by means of analogue circuitry before the frame store. It is very similar to the Digiscan machine in this respect.

The Marconi telecine machine does not offer dirt concealment. One of its special features is that it carries out the colour correction digitally. The block diagram of Fig. 8 illustrates this.

A normal frame store has too few bits to permit the extreme 'black stretch' which is often needed to gamma correct a film. Such is the case with this machine as well, but the DAC digitises the signal to an accuracy of 11 bits. The processing carried out to this accuracy makes good use of look-up tables — a more pedestrian method of processing would not be fast enough.

In the logarithmic conversion, and again in the multiplication, an extra bit is added in the processing to avoid rounding errors. The signal is truncated from 13 bits to 8 bits in the antilog lookup table, and the resultant signal is stored in luminance and colour difference stores.

A German company, Bosch, make a CCD based telecine called the FDL 60. One of its major features is that, in televising cinemascope films, the entire width of the picture may be displayed on a monitor, with border lines superimposed to show which part of the picture is to be broadcast to fill the TV screen. This

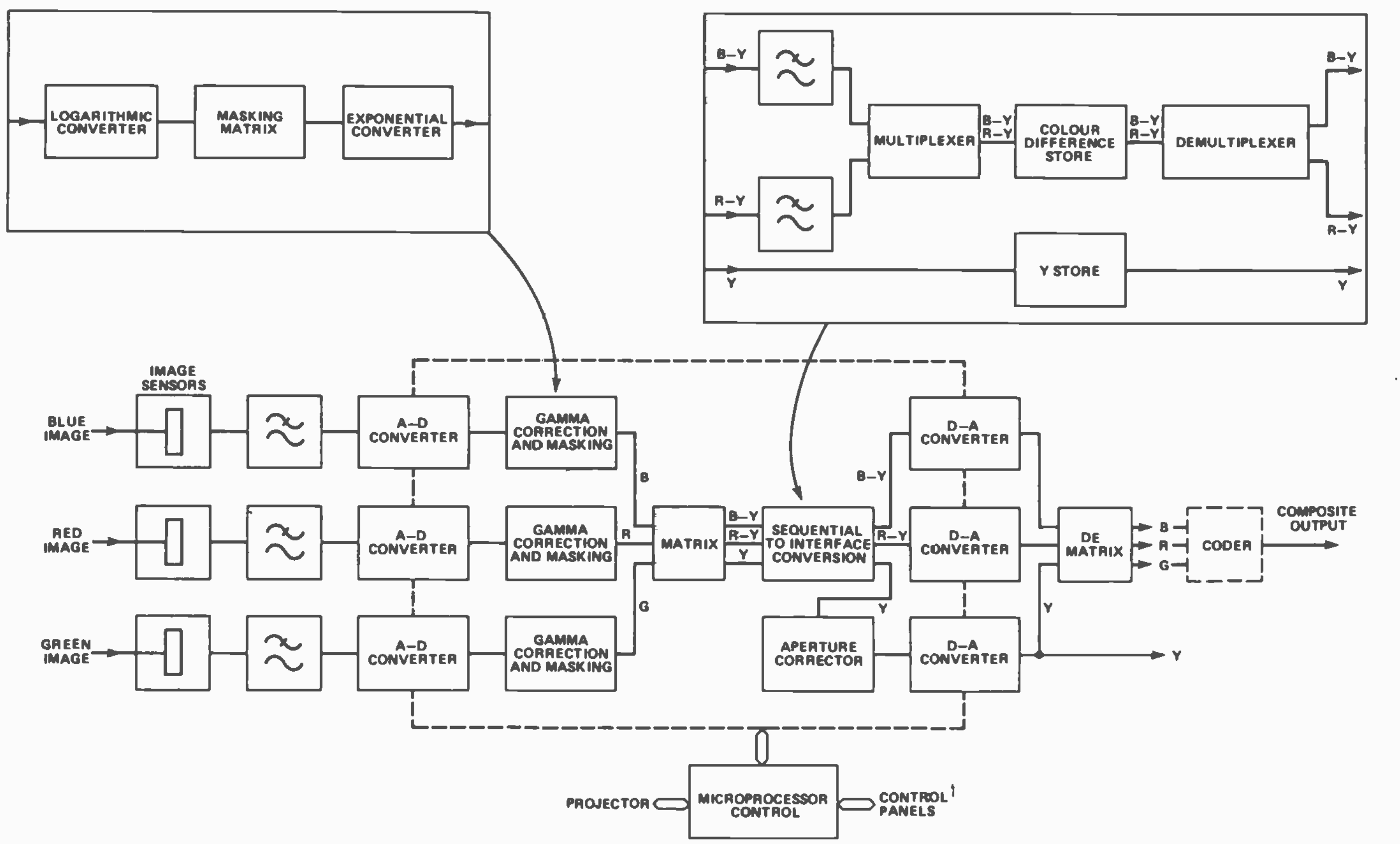


Fig. 8 The Marconi digital colour control system. The filters before the ADCs prevent 'aliasing' — an optical beat between detail on the film and the discrete positions of the optical sensors in the CCD line array.

makes it easier for the operator to pan appropriately. The panning information is stored in a control computer, and used to control the machine 'live'.

The FDL 60 also features a grain reducer which does a very good job of hiding film grain, so a 16mm film can look almost as good as 35mm film. The grain reduction relies on the fact that the grain produces very rapid changes in picture content, which can safely be ignored in a slowly changing scene. If too much correction is used, the grain corrector will try to correct for movement in the scene. The picture would then resemble that obtained from a TV camera using a slow response tube.

Applications

There are two main applications for telecine machines in broadcasting. The obvious use is on-air transmission of films. The films used tend to be made specially for television, so the quality is uniform.

The somewhat limited dynamic range available from CCD machines is quite suitable for this type of film. The reliability and freedom from the need for constant readjustment of CCD machines thus make them desirable for on-air use.

Films which are not specifically made for television do not often have such an ideal characteristic, and are often processed and transferred to tape before broadcast. A flying spot scanner is preferred for this post production work. The ability to zoom, by altering the raster size, with no loss of resolution, and the higher contrast range which can be accommodated, all contribute to its popularity.

The Future

It would appear that the use of film in television is increasing, despite the use of, for example, electronic news gathering equipment. One might imagine that, as videotape based systems become more compact and convenient, film will finally decline as a medium for television.

This may not happen so soon as some people think, for two reasons. First, improvements in film still continue, so that smaller gauge films can be used to give the required quality. Second, when high definition television is introduced, film will be able to meet the picture standards while videotape systems may have a struggle at first.

The next question is — what type of telecine? Although CCD machines are improving, the resolution is limited by the number of elements in the line array, and further improvements are desirable even for present TV standards. It is very likely that the flying spot telecine will enjoy a renaissance if high definition is introduced in the forseeable future.

One might go further, and suggest that a telecine with a frame store is unlikely, at first, to meet with approval from broadcasters, and that a hopping patch system will be used. In this case, it might well be that the limitations of the basic system will mean that some kind of "film tracking system" will be used on machines for this purpose. Thus events have almost gone full circle, because the technical literature on film tracking for flying spot systems goes back for at least twenty years.

DIGITAL FRAMESTORE

In this final part, we give the remaining PCB overlay, the Buylines and some details on picture manipulation. Design and development by Dan Ogilvie.

In this section I hope to explain one further method of image enhancement that can be performed on any computer and can produce some very useful results such as edge detection or noise filtering.

Let us for example consider how we might perform a high-pass filter function on our stored image. The simplest way to filter the picture would be an LCR network on the front end before we stored it. This is simple in theory, but variable filters at 6MHz are difficult to design. If we wished to extend the filtering to include low-pass or band-pass filters more switchable elements would have to be added and the design would become increasingly difficult and complex.

Another approach some readers may have encountered would be to take the Fourier transform of the picture, and then to choose just the required coefficients before applying the inverse transform to restore the filtered version of the image. 'Taking a Fourier transform' is just the mathematical equivalent of splitting the signal into its consituent frequencies, the 'coefficients' referred to being the sizes of the different frequency components. Once a signal is split into its component parts this way, we can perform any filtering function we like, no matter how complex. It does not matter that the function we might choose does not have an 'analogue' (LCR) counterpart. Two examples will illustrate how powerful this method can be.

The transmission of television pictures entails a high bandwidth because of the amount of information that has to be sent. This applies also to the storage of information where the large amount of memory (in this case about 393K bytes for one image) means optical discs offer the Hobsons choice.

Any technique to reduce the amount of memory required to represent an image is worthwhile. Some simple methods can be used effective on documents or similar (one bit data) or on some images with little detail. But for any image with detail these techniques are of little use. However by examining the Fourier coefficients and running complex selection routines to select only those necessary to retain picture detail we can reduce the memory requirements dramatically. There are stores of a complex 24 bit colour (8 bits of red, green and blue) being reduced to one bit with little observed degredation of the image! Further reductions are possible if a degree of degredation is considered acceptable.

One further example is the removal of motion blur from a picture — for example, a photograph of a race horse passing by, taken with a stationary camera. Simplistically, if we could examine the Fourier coefficients we should be able to identify the coefficients associated with the race horse's velocity and remove it from the spectrum, leaving the image without the blur.

Fourier analysis certainly offers

BUYLINES

No particular problems should be experienced with any of the components in the framestore. As was stated, the DRAMs used were Motorola MCM6664L20. In view of the number used it is well worthwhile shopping around for the best price. STC should offer a competitive price and accept Access and Barclaycard (tel. 0279 26777).

The ADC/DAC are obtainable from MCP Electronics Ltd, Alperton, Wembley, Middlesex HA0 4PE, tel. 01-902 5941. The full type numbers are ADC-TDC 1014CJ7 and DAC TDC 1016J5C8. They have a minimum order of £25, which will not be a problem in this case!

The crystal is a special and was obtained from IQD Ltd, North Street, Crewkerne, Somerset TA18 7AR, tel. 0460 74433.

The TTL is standard. The 74F devices can be obtained from Hi-Tech Components, Gilray Road, Diss, Norfolk (tel. 0379 4131), or STC amongst others.

The PCBs will be available from the ETI PCB Service; six memory and one each of the control and ADC/DAC card are required.

The TA6993W used in the external sync circuit will have to be shopped around for. It is an RCA device. Try Macro Marketing (06286 4422) or STC.

us a lot in terms of the range of picture enhancements, but unless you have indeterminable patience or a PDP11 to hand, I do not think these techniques can be applied; I would certainly be interested in hearing from anyone who is attempting it.

Let us look at a technique that can be performed on images and is within the scope of our home micro.

The techniques discussed above would be performed in the frequency domain, ie, we would be manipulating coefficients of terms that represented all the frequencies present in the image. We could however manipulate the image in the spatial domain. In other words, by looking at the adjacent pixels to the one we are operating on and only changing it dependent on its own and the local pixel value we can perform a number of techniques similar to those we saw at first in the frequency domain.

The technique itself is called convolution. It is the spatial equivalent of Fourier analysis. Mathematically, it is sometimes possible to convert a Fourier operator to a convolver but generally speaking convolution is not so flexible.

Convolution takes each point on the screen, and from this and the immediately adjacent pixels, it generates a new pixel value. How this works and what it is capable of is probably best demonstrated by an example.

Fig. 19a shows a section of an image which is boring, absolutely flat and dark grey in tone. Fig. 19b shows a convolver. How it is used is as follows: the central term in the convolver ('9' in this case) is placed over the pixel to be operated on, and the pixel and the surrounding pixels are multiplied by the equivalent terms in the convolver, as shown in Fig. 19c. All the resultant terms are added up to form the new pixel value, as shown in Fig. 19d. In this case the new pixel value is exactly the same as the old value. (Note to the mathematically-minded — this is not true matrix multiplication, thank Heaven!)

Let us suppose that a little further to the right of the same image there is an increase in the brightness, spreading over a couple of pixels, Fig. 19e. Applyimg the same convolver gives the values in Fig. 19f. Notice the extent to which the edge has been enhanced, the pixels adjacent to the edge being turned to reference black (−10 would appear as 0) and very nearly peak white (60, peak white is 63). If a threshold were imposed of, say, 32, so that every below 32 in pixel value were made 0 and every thing above 32 were made 63, this convolver would have successfully picked the outline of the objects in the image in peak white on a black background.

This is one example of a convolver, which is 3 x 3 in size. There are a large variety of convolvers around, by no means all of them 3 x 3 in size. They perform a number of filtering routines — for example, the example shown could be considered the equivalent of a high-pass filter or differentiator — and some other quite 'intelligent' image manipulation functions.

(a)

LINE No. \ PIXEL No.	23	24	25	26	28	29	30
110	10	10	10	10	10	10	10
111	10	10	10	10	10	10	10
112	10	10	10	10	10	10	10
113	10	10	10	10	10	10	10
115	10	10	10	10	10	10	10

(b)

$$\begin{vmatrix} -1 & -1 & -1 \\ -1 & +9 & -1 \\ -1 & -1 & -1 \end{vmatrix}$$

(c)

$$\begin{vmatrix} 10 & 10 & 10 \\ 10 & 10 & 10 \\ 10 & 10 & 10 \end{vmatrix} \bullet \begin{vmatrix} -1 & -1 & -1 \\ -1 & +9 & -1 \\ -1 & -1 & -1 \end{vmatrix} = \begin{vmatrix} -10 & -10 & -10 \\ -10 & +90 & -10 \\ -10 & -10 & -10 \end{vmatrix}$$

(d)

$$8 \times (-10) + 90 = 10$$

(e)

LINE No. \ PIXEL No.	29	30	31	32	33	34	35
110	10	10	10	20	30	30	30
111	10	10	10	20	30	30	30
112	10	10	10	20	30	30	30
113	10	10	10	20	30	30	30
114	10	10	10	20	30	30	30
115	10	10	10	20	30	30	30

(f)

LINE No. \ PIXEL No.	29	30	31	32	33	34	35
110	10	10	−20	+20	60	30	30
111	10	10	−20	+20	60	30	30
112	10	10	−20	+20	60	30	30
113	10	10	−20	+20	60	30	30
114	10	10	−20	+20	60	30	30
115	10	10	−20	+20	60	30	30

Fig. 19 (a) Digitised section of a flat image; (b) a convolver; (c) applying the convolver to one pixel; (d) the result of applying the convolver — back to square one; (e) a section of image with a change of brightness; (f) the convolver applied to this section.

This is unfortunately all the detail on image manipulation that I can justify here. Books on image processing tend to be very expensive and very heavy going. The one that I have found the easiest to get along with is 'Digital Image Processing' by Rafael Gonzalez and Paul Wintz, published by Addison Wesley Publishing in 1977. Perhaps it is high time that someone wrote a book aimed at the home micro user, as there are now a number of vision systems knocking around besides the framestore described in these articles.

Editorial Note

Far be it for us to discourage anyone from building an ETI project, but a few words on this framestore are needed. From the start, this project was conceived as being for experimenters, and by this, we mean someone with enough experience of electronics to fully understand a system of this complexity.

We hope that all our readers will have gained some insight into the techniques involved in storing and manipulating a TV picture, but, as this framestore uses an awful lot of expensive devices, some of them operating at very high speeds, we would expect relatively few readers to build it.

We sttrongly advise potential builders to be certain of their ability to de-bug a large digital system such as this before they begin. If you're not certain of your ability — or if you don't have access to the necessary test gear (say at least a 20MHz dual-beam 'scope) — leave it alone until you are fully ready to have a go.

One final factor we would mention is that we are having difficulty finding someone to replace our former projects editor, Phil Walker, so our ability to answer technical enquiries will be severely limited for th foreseeable future.

We're sorry if this all sounds so negative. However, it's distressing for us — as it must be for the readers concerned — to find a batch of enquiries from people who'll never get their piece of dream hardware to work because they are well out of their technical depth.

PARTS LIST — CONTROL CARD

RESISTORS		C3	68p s.mica	IC4	74F04PC	IC26, 27	74LS138N		
R1	560R	C4	33p s.mica	IC5	ZNA134J	Q1, 3, 5, 7	2N2369A		
R2, 3, 14, 15	4k7	C5	100n ceramic	IC6	74F163	Q2, 4, 6	2N3906		
R4	470R	unmarked capacitors	all 100n ceramic	IC7	74LS138				
R5, 9	10k			IC8	74LS08				
R6, 8, 10-13	3k3			IC9	74LS20N				
R7, 16, 19	1k0			IC10, 17	74LS74N	**MISCELLANEOUS**			
R17, 20	220R			IC11-14	74LS151N	L1	single turn 18SWG enamelled wire		
R18, 21	22R	**SEMICONDUCTORS**		IC15	74LS193				
R22-26	2k7	IC1, 28	74F74PC	IC16	74LS32N	X1	25.625 MHz crystal		
CAPACITORS		IC2	74LS04N	IC18	74LS00N				
C1, 2	100p s.mica	IC3	74LS374N	IC19-25	74LS193N	PCB, wire, etc.			

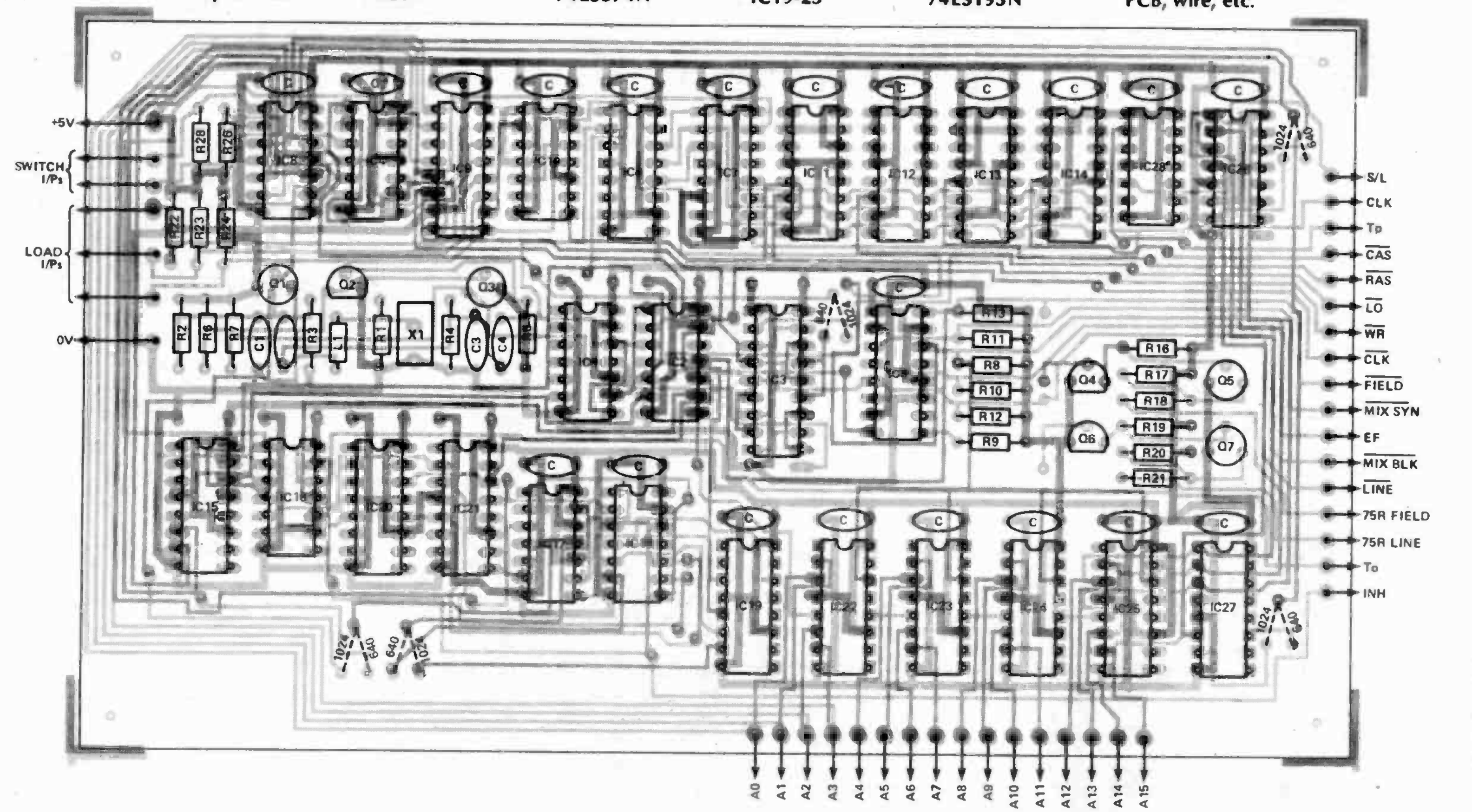
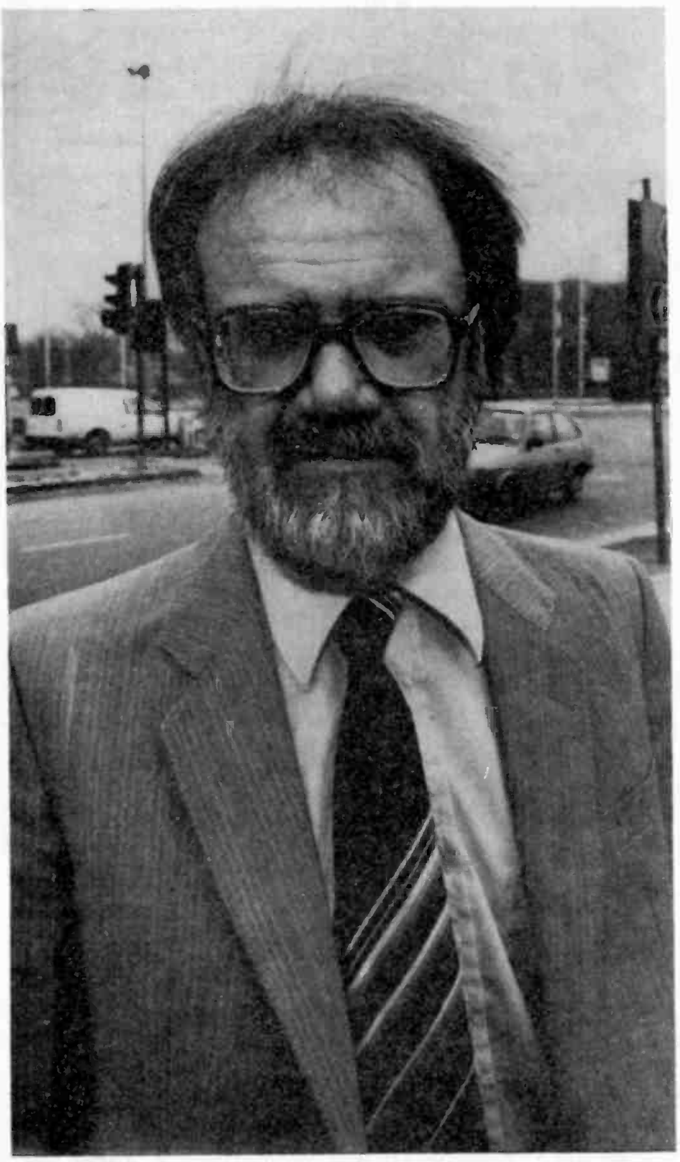


Fig. 20 The final overlay, of the control card. Just a few things have changed between this overlay and the original circuit diagram published back in December '84. Firstly, the downward-pointing arrow close to pin 8 IC1 should have been labelled ($\overline{CLK}$). The resistors around the inputs to IC8a and b and IC9a should be labelled R22 to 26. Finally, there were two devices marked IC17a: the one next to IC7 (top right on page 63, Dec '84) has here become IC28; however, there is no reason why the unused half of IC1 should not be used for this purpose, if an alternative PCB lay-out were used.

ELECTRONICS FOR PEACE?

Electronics for Peace describe themselves as a network of people connected with electronics who share a concern for the military implications of their profession. ETI has been talking to their co-ordinator, Tony Wilson, to find out more.



Tony Wilson is an independent reliability engineer who has worked on commercial space projects and the UK Chevaline programme. He is currently engaged in work on military land systems. He has been a member of Electronics for Peace since the group was formed and has recently become their co-ordinator, giving up much of his time to writing and speaking on the group's behalf. He has written a number of articles on various aspects of defence and technology which have been published in a wide range of trade and other technical journals. His skills in publicity seeking seem to have been recognised by the TOBIE awards committee who have nominated him as one of the three finalists for the title of Electronics Personality Of the Year. The result will be announced at a special ball to be held as part of the All Electronics/ ECIF show in April. We visited Tony at his Wiltshire home to ask him about his views and the objectives of Electronics for Peace.

When and where was EfP founded?

In October 1982, in Bracknell. Tim Williams and Steve Holmes had a letter published in Wireless World asking for people who were interested, and around twenty five got together as a result. I was one of them.

And has the membership grown since then?

It's been at between two and three hundred for the last eighteen months or so but I think it's going up a bit now.

Do people have to be employed in the electronics industry before they can become members?

We're open. So long as people are interested and concerned about the way things are, that's sufficient. At the same time, it's important that we're seen to have a certain level of expertise, so it's good that many of us do work in the industry and know what we're talking about.

Do many of your members work in the defence industry?

Our members cover a very wide field but are mostly engineers working in electronics or computing. I don't know exactly how many work in defence, I haven't analysed it, but I would think maybe 20%.

Do those who work in defence openly criticise the system?

I don't know of anyone in EfP who actually criticises the system from the inside in quite the same way that I do and gets away with it. There is somebody who started at a defence establishment and objected to working on military things, and he was thanked and booted out. But most people don't speak out. It's very difficult.

But you do speak out and your employers know your views.

Yes, they do. They open their magazines and they see my face and what I've written. When I first joined EfP I thought that it would be incompatible with my job, but now I think it's very good that I'm seen to criticise the system from inside. It gives me credibility. It also gives people inside the opportunity to do the same thing themselves, because there's this great fear when you're under the Official Secrets Act of opening your mouth at all, and that's absolutely wrong. People should be allowed to criticise any system that they're in, but they seem unable to do so. I've been there and I know what that feels like.

You say that you thought being a member of EfP might be incompatible with your job: did you think that you might lose your job?

I'm always prepared for that possibility.

Your promotional literature refers to ". . . the appalling unreliability of modern complex weapons systems . . .". Your work involves trying to make weapons more reliable. Given your views, doesn't that create a conflict of interest?

In a better world than the one we live in now I wouldn't see any problem in working to make our weapons more reliable, because we wouldn't have so many of them, we'd only have enough to defend ourselves. In the world we're in at the moment it is a bit of a problem, but then I have to make the best of the situation.

Current complex weapons are not reliable. In two or three weapons generations' time, when design and manufacturing and other techniques have improved, they will be ultra reliable. They will be as reliable as the public seems to think they are now, and when the commanders actually think they are that reliable they'll want to use them. One of the things that stops people using their weapons at the moment is that they know they won't work very well.

So the risk of war may increase as weapons improve. Does that make you more concerned to get your message across now?

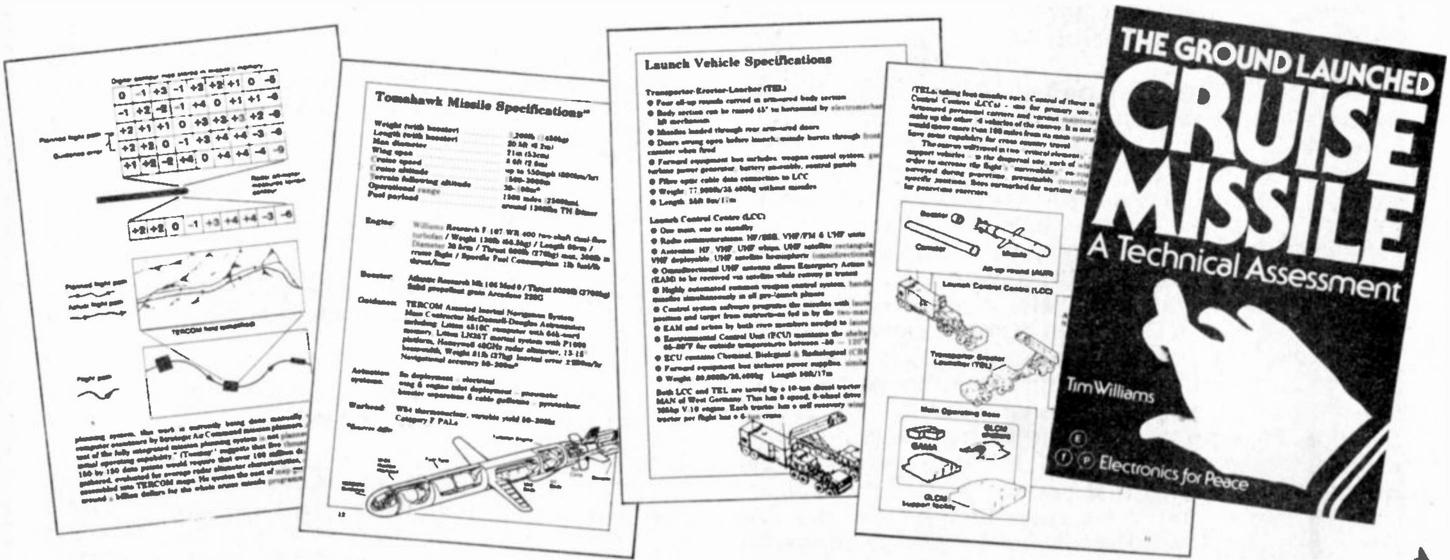
We haven't got long, I'm sure of that.

You spoke of a better world in which we had only as many weapons as we needed to defend ourselves. Were you thinking particularly of nuclear weapons or of all weapons?

To my mind, nuclear weapons are no worse than some of the conventional weapons we are now developing. It's the weapons themselves — weapons of mass destruction — that we're against. We need to bring down the amount of armaments we have, and we need to bring down the influence we have on the third world in selling armaments and encouraging them to use them. We also need to bring down the amount of military funding and orientation within our own industry. They're the three main aims of EfP in the long term.

What are EfPs other aims?

To bring together electronic engineers who are concerned about the military implications of their profession, to provide technical information for people working in the field of nuclear and conventional disarmament and to encourage the development of socially useful applications of electronics.



So you don't have to believe in unilateral nuclear disarmament or anything like that in order to become a member?

I'd be happy if there were anarchists and unilateralists talking to people who drive nuclear submarines. We want to open up the debate, to cut out the paranoia and make it clear that we're just people and that we have a cross section of views, instead of this left and right business.

So how is EfP related to the rest of the peace movement?

We're making a conscious effort to get a cross section of people in, people of all points of view, and I'm not sure that that's what other peace movement organisations are intending to do. That's probably one difference. We want to remain politically unaligned, and that's probably another difference between us and, say, CND who seem to get tied up with the Labour party. We want to provide very good technical information to everybody, not just the peace movement but to everybody, so we have to keep some distance in order to be credible.

So you see yourselves more as providers of information than as a group that's going to sit down in front of cruise missile transporters?

We're not involved in demonstrations or direct action. If individuals want to protest in that way then they're free to do it, but not under the banner of EfP.

What practical steps have you taken in pursuit of your aims?

We researched and published a booklet called "The Ground-Launched Cruise Missile: A Technical Assessment" (reviewed in ETI January 1984 — Ed.). That was very well received and is about to be re-published. We want to keep up a steady flow of booklets and leaflets explaining modern weapons and other war systems and their implications for the UK and the world. Some of the topics we'd like cover are the effects of EMP and means of protecting against it, the link between arms spending and the crisis in the third world, the damaging effects of heavy military investment on commercial investment in research and development, and the effects of the Official Secrets Act on our economy and our freedom.

We're also keen to provide material for people working in peace education in schools, colleges and other organisations. Peace education involves ensuring that students and pupils are presented with as wide a variety of points of view as possible, with undistorted and complete statements of fact on a variety of subjects. These should include national and world defence and militarism, third world issues, racism, multi-national companies, etc. people can then be encouraged to put their own point of view, join in the debate and make their own minds up. We want to be able to provide advice and information, to help plan sessions, to provide speakers who can talk about their personal experiences of the industry or about positive aspects of technology, and to help produce high quality software and text books on relevant topics.

That's an ambitious program because we only have a few people working in this field at the moment, but we've already achieved quite a lot. Three first year polytechnic communications study students produced a tape/slide presentation on EfP, we've given a talk and developed a fantasy based on space and related concepts, we've discussed personal experiences of the industry with sixth form girls, given talks to around 100 electronics students on engineering and morality, talked about aspects of technology to 11 and 12 year olds and worked with a peace education working party to produce a PE programme and resources.

And what about the future?

I want to see EfP getting involved in arms conversion intiatives, in developing means whereby industrial plant and human and other resources currently used for military purposes may be switched over to work which is socially useful. It's not a case of moral extremism, of unreasonable demands for the removal of all military capacity. There's no reason why there shouldn't be a gradual change of emphasis from the military use of particular resources to a commercially sound mixture of military and civil projects, with the military content perhaps forming less than half of the total. With this sort of balance the two can benefit each other, whereas at present the military side is all too often dominant and causes gross inefficiency in the execution of the civilian work. I'd like to see more co-operative working, between individuals and small companies, and education, which is my personal interest. I'm sure others in EfP have got their own priorities. But the arms conversion thing, I think we should be fairly big on that soon. I've put a proposal into the GLC Arms Conversion Council and I'm pretty hopeful that they'll take at lease some of it up.

Are there any particular questions you'd like people to ask themselves after reading this?

What sort of world do you want for yourself and are you happy with what's going on? Do you believe that you could influence the world to be a better place? Do you really regard your job as part of your life, because, if not, you're dead for much of the time. Is that what you want to happen? If not, you've got to take part in deciding what you want to see in the world and doing something about it. Our actions and inaction directly affect the state of this nation and of the world, whether we acknowledge it or not. People starve in Ethiopia largely because the US and UK governments disapprove of the politics opf their government, and because we allow them to get away with it. We in the UK have a parmilitary police force which can easily gain access to records on every individual — because we allow them to get away with it. You may think that 1984 has passed: it hasn't, it's only just begun, but only if we allow it. My own life has changed incredibly since I decided to take responsibility for myself rather than sit back and let politicians, bureaucrats and business people screw things up in my name. I also enjoy life very much more now.

Tony Wilson and Electronics for Peace can be contacted at Townsend House, Green Lane, Marshfield, Chippenham, Wiltshire SN14 8JW, tel 0225-891710.

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CCD DELAY LINE EFFECTS BOARD

The man and his puns have gone, but the echoes linger. Phil Walker describes an add-on CCD delay line effects board for the ETI "Sonneti" combo.

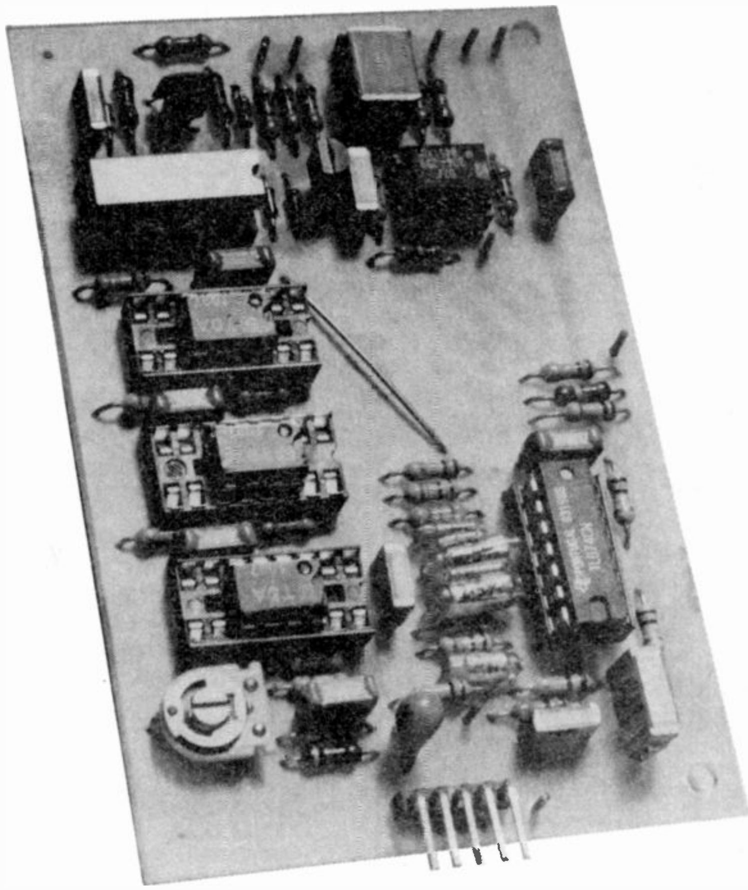
This echo unit was designed as an add-on for the "Sonneti" combo unit published in last month's ETI. It fits neatly into the space available and is wired to suit the unused effects board connector on the combo pre-amplifier PCB. It draws its power from the combo's regulated supply, but there is no reason why it could not be built as a separate unit or installed in another amplifier provided the appropriate supplies are available and the signal levels are correct.

The Circuit

The input from the pre-amplifier section arrives via the plug at IC2a which acts as a mixer to combine it with a proportion of the output signal. The combined signal then passes via a low-pass filter whose cut-off frequency is about 8kHz. This filter was found to be essential to avoid aliassing in the delay line devices.

The signal then enters the first of the three bucket brigade delay line chips. This is either a TDA1022 device with 512 stages or a newer TDA1097 device with 1536 stages. Note that the PCB is laid out to take either device but R31 may need to be adjusted if the TDA1022 device is used since it has a loss of about 4dB per stage as opposed to a nominal 0dB for the TDA1097. For one 1022 R31 is 68k, for two it is 47k and for three it is 33k. This will not give exact compensation but should prove adequate. In our prototype the two devices were mixed quite successfully.

The output from the delay devices is passed via another low-pass filter to remove most of the switching noise which might otherwise upset the main amplifier. The signal then passes to



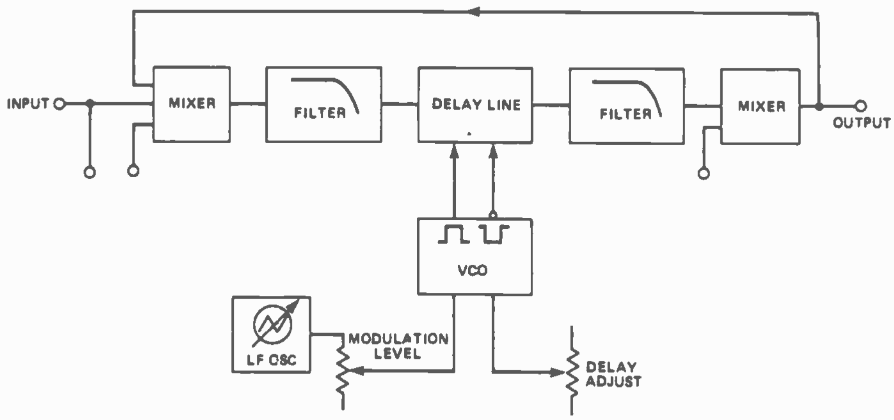


Fig. 1 Block diagram of the effects board.

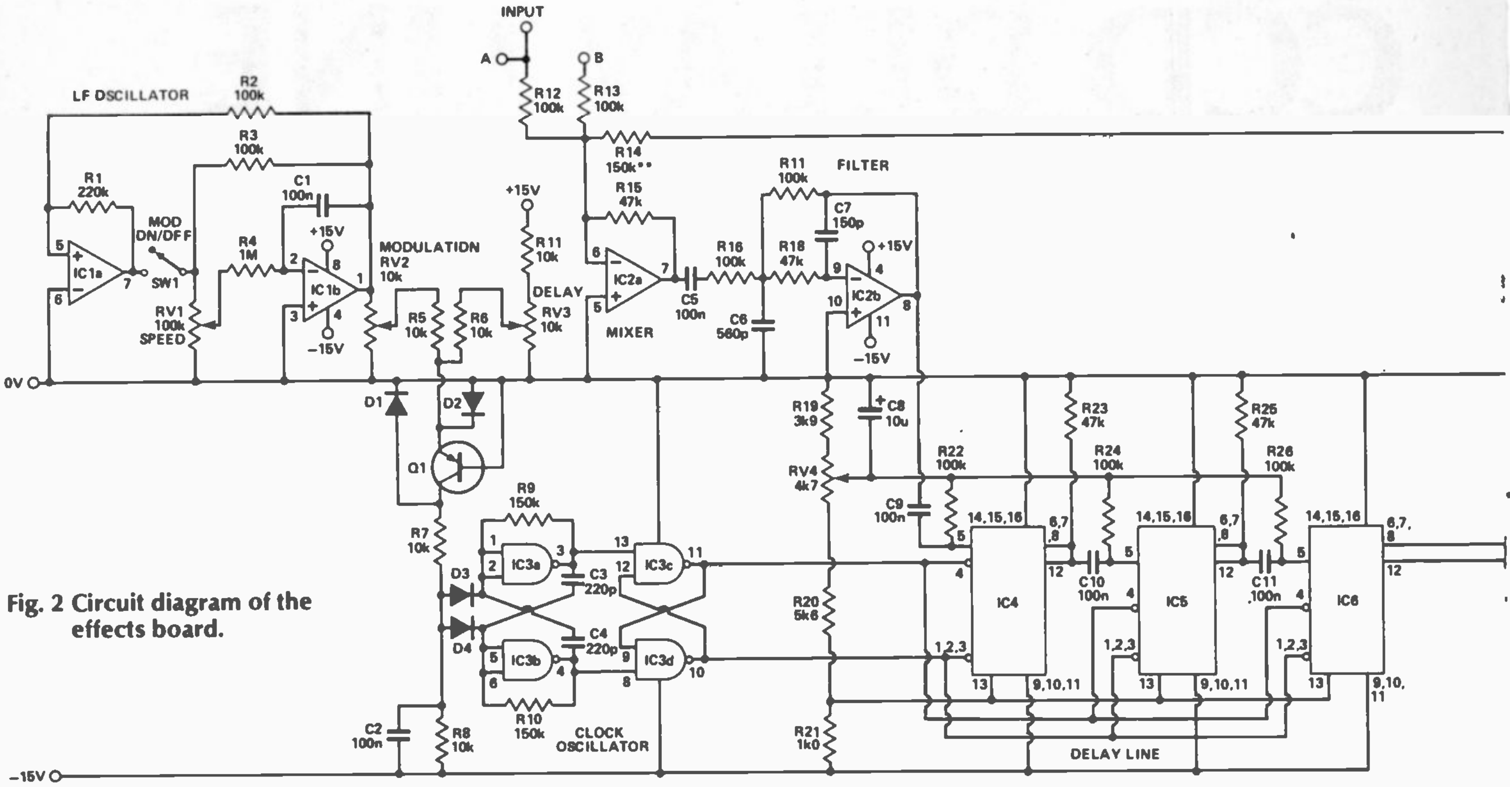


Fig. 2 Circuit diagram of the effects board.

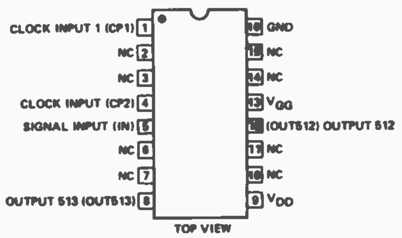


Fig. 3 Pin connections of the TDA1022.

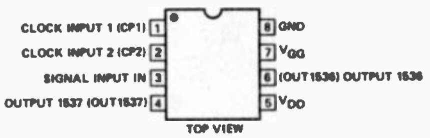


Fig. 4 Pin connections of the TDA1097.

another mixer stage and then to the output pin on the plug. There are extra input points on both mixers (marked A, B and C) to allow the more adventurous to try other effects.

In order for the delay devices to work properly they must be supplied with a two phase, non-overlapping clock signal. This is generated by IC3 and drives all the devices in parallel. The minimum frequency of this clock determines the maximum delay obtainable from the unit and should not be less than about 30kHz in this design. The maximum frequency of the clock generator should not exceed 100kHz for 1097 devices or

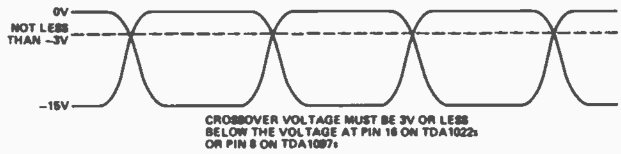


Fig. 5 Clock signal requirements for the CCD delay line ICs. These are supplied by IC3C and d in the circuit above.

300kHz for 1022s. The minimum clock frequency limit is determined by the input filter.

Since the bucket brigade delay line devices work by sampling the input signal they are subject to the rules of sampling theory. The main requirement is that the clock frequency must be greater than twice the highest input signal component. Since we cannot be sure what the input signal contains, a

PARTS LIST

RESISTORS (0.25W 5% carbon film)

R1	220k
R2,3,12,13,15,16,17,22,24,26,28,29,31,32,33	100k
R4	1M0
R5,6,7,8,11	10k
R9,10,14	150k
R18,23,25,27,30	47k
R19	3k9
R20	5k6
R21	1k0
RV1	100k linear potentiometer
RV2,3	10k linear potentiometer
RV4	4k7 miniature horizontal preset

CAPACITORS (miniature PCB mounting polyester unless otherwise stated)

C1,2,5,9-12,16-19	100n
C3,4	220p miniature ceramic
C6,13	560p polystyrene or ceramic
C7,14	150p polystyrene or ceramic
C8	10μ 25V tantulum bead
C15	1μ0

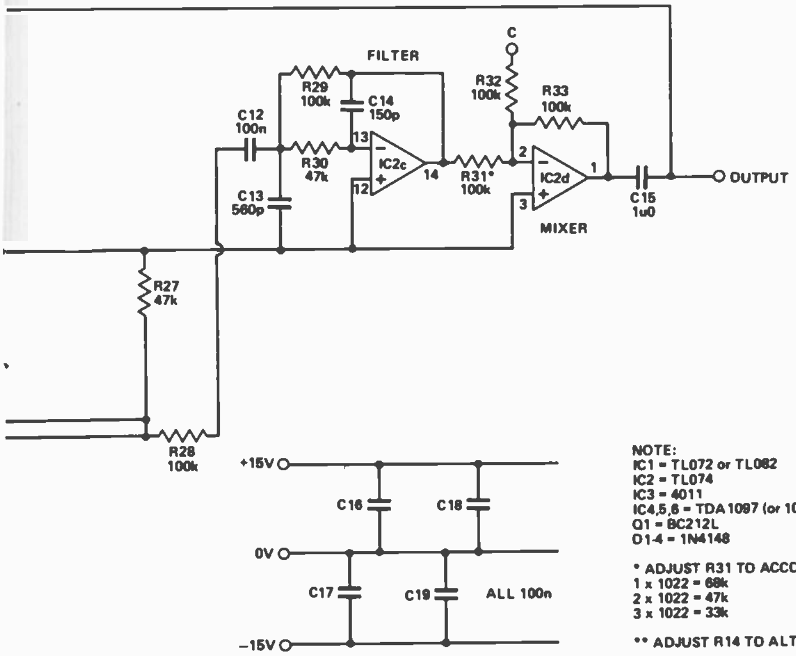
SEMICONDUCTORS

IC1	TL0072 or TL082
IC2	TL074
IC3	4011B
IC4,5,6	TDA1022 or TDA1097
Q1	BC212L
D1-4	1N4148

MISCELLANEOUS

SW1	single pole on/off switch — could be part of RV1 if desired

PCB; DIL IC sockets — 1 off 8 pin, 2 off 14 pin and 3 off 16 pin; 5-way right angle PCB plug; 20 off vertical PCB mounting brackets and nuts and bolts to suit; 3 off control knobs; wire, terminal pins, etc.



NOTE:
IC1 = TL072 or TL082
IC2 = TL074
IC3 = 4011
IC4,5,6 = TDA1097 (or 1022)
Q1 = BC212L
D1-4 = 1N4148

* ADJUST R31 TO ACCOMODATE TDA1022
1 x 1022 = 68k
2 x 1022 = 47k
3 x 1022 = 33k

** ADJUST R14 TO ALTER REVERB TIME

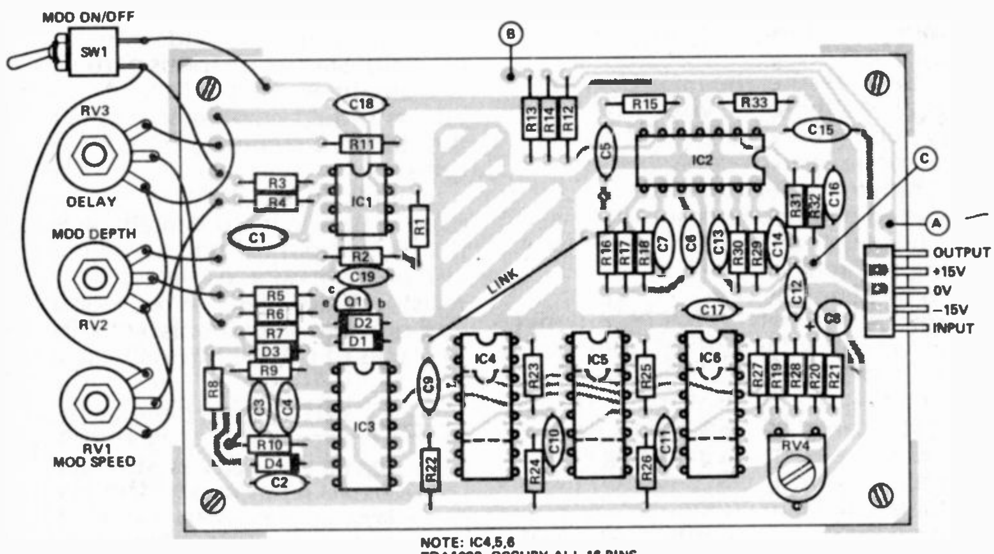
low pass filter has been included to block frequencies higher than 8kHz. The rather simple nature of the filter does not allow a sharp cut-off and some signal will get through even at 16kHz, but the amount will be small enough to ignore.

If we did not comply with the sampling frequency rule mentioned above, frequencies above half the sampling frequency would appear as lower frequencies at the output. For example:

$$f_{sample} = 30kHz,$$
$$f_{signal} = 21kHz,$$
$$f_{output} = 9kHz$$

Also, the output signal would often not have any musical relation to the input signal and would usually sound unpleasant.

For those who wish to experiment with chorus, phasing and flanging the PCB also contains a low frequency triangle wave



NOTE: IC4,5,6
TDA1022s OCCUPY ALL 16 PINS
TDA1097s OCCUPY CENTRAL 8 PINS ONLY

Fig. 6 Component overlay of the effects board.

HOW IT WORKS

IC2a acts as a virtual earth mixer to combine the input signal with a proportion of the output. This mixture then passes to IC2b which is connected as a low pass filter with a cut-off frequency of about 8kHz. This filter is necessary to avoid problems with aliassing whereby high frequency components of the signal would be transformed into lower, non-harmonically related output frequencies.

The output from IC2b passes to IC4, 5 and 6, the three bucket-brigade delay line devices. Their signal input pins are biassed by R22, 24 and 26 from the voltage at the wiper of RV4. This voltage is by-passed by C8 to prevent interaction and signal feedback. The signal is AC coupled by C9, 10, 11 and 12 and DC conditions at the outputs of the delay chips are satisfied by R23, 25 and 27. An additional bias signal is tapped off the RV4 divider chain by R20 and 21 to feed IC4, 5 and 6.

The output signal from the delay devices is passed to IC2c which is connected as another low-pass filter. Its purpose is to remove most of the high frequency switching noise generated in the delay line. After this the signal passes to IC2d which is connected as another virtual earth mixer.

The high frequency, two-phase, non-overlapping clock signal needed to drive the delay devices is generated by IC3. IC3c and d ensure that the outputs cannot be low simultaneously while IC3a and b provide a symetrical square wave oscillator. By means of D3 and D4 the frequency of oscillation can be varied.

Q1 and its associated resistors and potentiometers allow the voltage applied to D3 and 4 to be varied and thus alter the clock frequency and hence the delay time. D1 and D2 are fitted only as protection for Q1 and may not be necessary. RV3 allows the steady state delay time to be altered while RV2 regulates the amount of modulation applied from the low frequency oscillator.

IC1 is the low frequency oscillator. IC1b is connected as an integrator while IC1a acts as a Schmitt trigger. In normal operation with SW1 closed, when the output of IC1a is positive a current determined by RV1 and R4 will flow into C1. IC1b will prevent the inverting input from going high by ramping its output pin negative. When it reaches about −7.5V (set by R1 and R2) IC1a will switch rapidly so that its output is negative. This will reverse the current flowing in RV1 and R4 and the output of IC1b will ramp in a positive direction. When it reaches about +7.5V IC1a will change state again and the process will continue.

If SW1 is opened then the oscillator action will cease and the output of IC1b should slowly settle to about 0V because of the action of R3. Note that R3 has no effect until SW1 is open.

generator which can be used to modulate the frequency of the clock oscillator and thus vary the delay of the unit. This facility together with the extra mixer inputs should prove quite interesting. It may be found for these effects that one TDA1097 or up to three TDA1022s are better than several TDA1097s. In this case the input link should be moved to eliminate the IC4 and 5 positions as necessary.

Construction

Begin assembling the PCB by installing the wire link and, if you intend using them, the IC sockets and the right-angle PCB plug. The ICs can, of course, be soldered directly to the board if you prefer but we would recommend sockets for IC4, 5 and 6 at least because these devices are expensive and sensitive to static. The PCB plug is only necessary if you are building the unit for use with the "Sonneti".

Continue assembly by soldering the resistors and capacitors into place and finally install the diodes, the transistor and the ICs. If you do not require the variable frequency oscillator section you can omit IC1. The TDA 1022s are sixteen pin devices and will occupy the whole of the IC4, 5 and 6 socket areas but the TDA1097s are 8 pin devices and should be connected to the middle eight pins only as shown on the overlay.

The delay line PCB should fit comfortably into the space between the "Sonneti" preamplifier board and the mains wiring screen, but you may find it necessary to move the preamplifier along a little to make room. If you have used a case other than the one specified and find you are short of space, one solution might be to take the mains switch and indicator outside of the case proper and mount them on the blank section of the front panel at the right hand end. That will leave plenty of room inside for the delay line board and also clear a section of front panel for the controls. Alternatively, the controls could be mounted in the middle of the panel between and just below the input sockets.

The PCB should be positioned with the component side facing forward and then pushed into the connector on the "Sonneti" preamplfier board. The wiring to the three potentiometers and the switch is not critical but it should

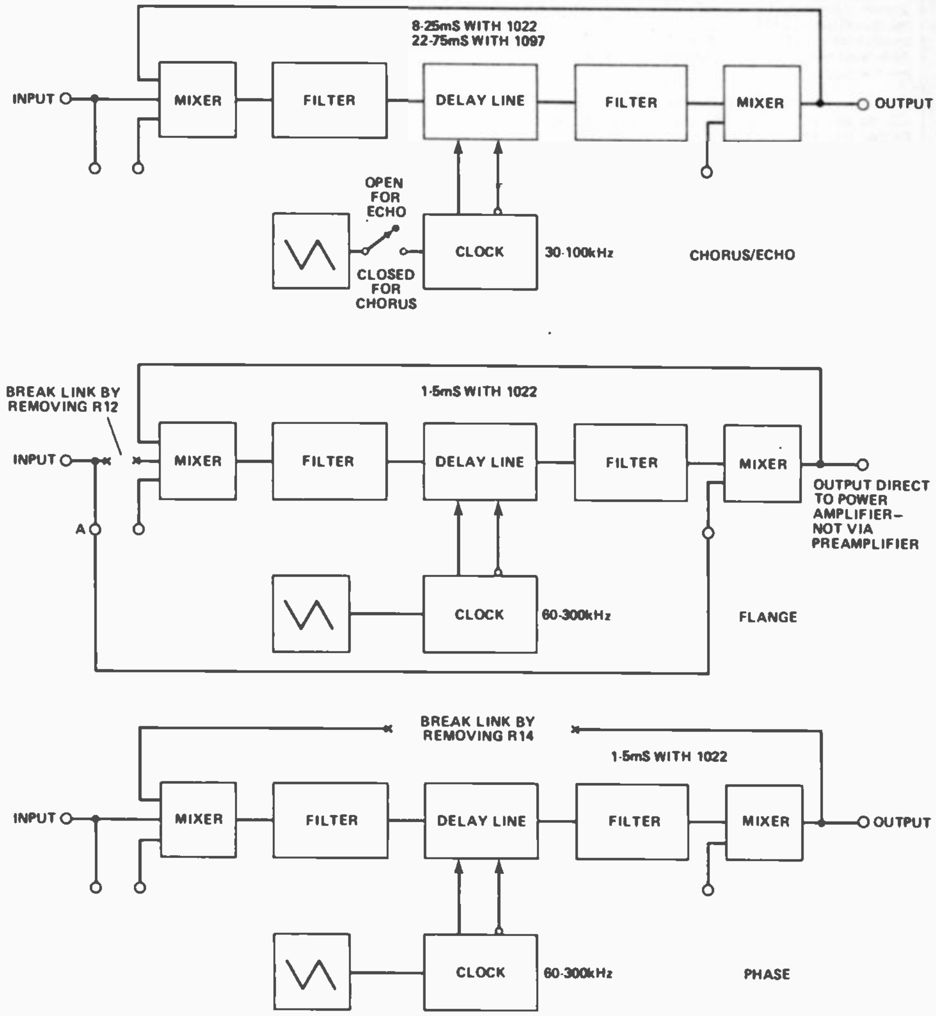


Fig. 7 Connection arrangements for echo/chorus, phase and flanger effects.

be kept away from the mains wiring. The two PCBs are very close together when the connector has been pushed home and it may be found that there is not sufficient clearance for the two adjacent mounting brackets. A little bit of filing should cure the problem.

Begin testing the board by carrying out a thorough visual check, including the wiring to the potentiometers and the switch, then remove the delay line ICs and switch on the power supply. Check that the oscillator is working correctly and that all appears to be generally well (i.e., no smoke!). Switch off, set RV4 to mid travel and insert the delay line ICs. Switch on again and you should find that the unit is working. If any distortion is present, adjust RV4 until it goes. If you are using the delay line as a self-contained unit or in a piece of equipment other than the "Sonneti", make sure that the input signal level is less than 1.5V RMS because too high an input level will also cause distortion.

Experimental Effects

As designed, the unit can produce an echo effect with TDA1097s or a shorter echo with TDA1022s. For a chorus effect it would be advisable to use TDA1022s and increase the clock frequency with RV3. The LF oscillator should be used to modulate the delay. Both of these effects should be obtainable with the standard connection to the pre-amp.

For phase and flanging effects it may be necessary to take the output direct from the unit. It may also be necessary to adjust the resistor values in the mixer stages and provide variable gain controls in places to get the best effects.

ETI

BUYLINES

The TDA1022 is widely available and Crickelwood supply the TDA1097. The remaining semiconductors and all of the other components are perfectly standard and should present no problems. The PCB is available from our PCB Service.

1984/85 CATALOGUE

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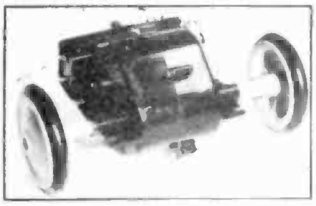

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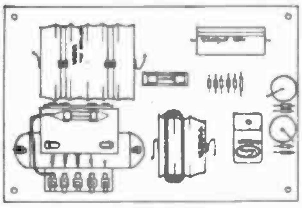

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Fruitless Wait

Dear Sir,

It is about time that the ETI team realised that there are other computers that deserve attention besides the BBC, the Electron, the Spectrum and the ZX81. How about doing a project for the Apple II for a change? Or is it too upmarket for you?

I for one have got increasingly fed up with you just doing everything useful for the above mentioned machines but totally disregarding the Apple. Maybe you could produce a version of the Electron speech board for the Apple, or a morse decoder (I'm particularly surprised that this hasn't been done if the ETI editor is indeed a ham), or even an EPROM programmer. It's infuriating when people come up to you and say "Your Apple can't do that" or "in order to do it from BASIC we have to go into machine code".

So come on ETI, forget the brand new machines and help the old ones catch up. If you can't, who will?

Yours sincerely,
Ian Topliss
Chelmsford

We'd love to help, but the solution is not as simple as you seem to imagine. Whenever we publish a major computer project we promptly receive hundreds of letters from people who want a version suitable for their machines, and given the wide range of microcomputers owned by our readers this is an impossible task. It would mean that for months after the appearance of such projects we would have to sacrifice new designs to make room for the modifications, and since most of our technical authors only have one machine the modifications would have to be developed 'in house', using up large quantities of our Project Editor's valuable time.

We have published designs for use with a wide range of microcomputers in addition to those you list, including the Ace, the Atom, the ZX80, the Sharp MZ80K and the Microtan 65, but it is inevitable that the designs we present will reflect the popularity of individual machines among our readership and that the less popular machines will receive little or no coverage. However, we will be looking carefully at the results of the recent Readers' Survey to see how trends in computer ownership are changing, and we always welcome innovative designs whatever machine they are intended for. So why not have a go at designing something yourself and let us have a look at the end result?

As to your comment about the ETI editor, he is indeed a radio amateur (callsign G1HRT) but ETI has a sister magazine called Ham Radio Today and projects related specifically to amateur radio are usually presented there rather than in ETI.

STOP PRESS! The assistant editor has just passed his RAE (with a distinction and credit, no less, just like his Ed.) but has yet to get his callsign.

The Apple — Neglected? By Us?? Well . . .

Walking Into The History Books

Dear Sir,

I read with great concern that you will soon be losing your Project Editor, Phil (pun-man) Walker, whose technical brilliance is matched only by his overloaded sense of humour.

Even though you are not in the habit of doing so, I think a brief resume of Mr. Walker coupled with a teensy photograph would be in order. This is absolutely necessary for my ETI hall of fame cabinet (I also need to locate him about projects that didn't work!).

Congratulations Mr. Walker (and ETI) for your excellent work. We appreciate it on this side of the globe too!

Sincerely yours,
Edwin Kinyanjui
Nairobi

Phil Walker has, alas, already departed, and he will not be an easy act to follow. As for publishing a resume of his career, the only aspects of it we are sufficiently familiar with are the bits he used to tell us about after the office Xmas party, and we're not going to publish things like that! We hope that the picture published in last month's News Digest pages looks good in your hall of fame.

Please send your letters for this page to: The Editor, Electronics Today International, ASP Ltd, 1 Golden Square, London W1R 3AB. And please note that *any* letter we receive is liable to turn up on this page unless it is clearly marked 'Not for publication'.

READ/WRITE

David Versus A Goliath Tank?

Dear Sir,

The review of the UK defence industry, under the title "System Failure" in ETI January 1985, brought out many relevant facts but also demonstrated the fundamental truth that different observers almost inevitably see a given situation in quite different ways.

Take, for example, the unfortunate Belgrano incident. Would it have been sensible to use an expensive Stingray in circumstances where an older type of torpedo was available and clearly adequate for the task? There are situations of conflict in which a stone and a catapult would be just as effective as the latest Armalite rifle, and there are circumstances in which the catapult would be useless. For that matter, so might the rifle . . .

The nominal object of defence development is to support the growth of technologies which will cope with increasingly difficult combat situations. A new weapon creates a new threat, and calls for an effective countermeasure. A very large proportion of the total defence expenditure is accounted for by that sort of activity. Unfortunately, those who hold the purse strings, under pressure from the services, prefer to place orders for specific equipment which may be outdated by the time it is ready. The cost of research is paid for out of overheads, or from 'private venture' funding (i.e., out of profits!).

A particular difficulty in defence work is that it often calls for performance characteristics which arise nowhere else. Storage life may be important, and immunity from magnetic and radiation fields. This pushes up the cost, and makes adequate testing of specialised components more difficult.

Where the only possible test is a test to detruction, 'type testing' is the only option. Make a hundred copies of a certain device, test ten of them successfully, and you will have greater confidence that the other ninety will work. That is only valid, however, if the ten and the ninety are made as a single batch, by identical methods and with identical pre-testing schedules.

The overall characteristics of a device are usually agreed by the purchasing agency and the supplier as a starting point. The supplier is then likely to sub-contract parts of the work on the basis of specifications drawn up to define each part precisely. There is usually a "fitness for use" clause which is intended to mop up anything that was left out of the specification, but the ploy rarely works.

An interesting example of this was a unit for use in civilian aircraft. Everything worked perfectly until ground pressurisation tests were carried out. Then the increased pressure pushed in the side of a metal can until it touched internal circuitry. Who would have though of specifying a test at atmospheric pressure plus? The expectation was that pressure would be more commonly below atmospheric.

The sub-contract specifications can be the weakest link in the whole chain, and administering them can call for expertise on a par with that provided by the subcontractor.

The same piece of aircraft equipment also illustrates the proposition that 'preventative maintenance' meant work which prevented the equipment working properly. In early service, there was continual trouble until the maintenance staff were persuaded to leave well alone. When that was done, the equipment received the acolade of being "the most reliable piece of aircraft equipment ever made".

On the commercial side, it is true that 'cost plus' has given way (nominally) to 'fixed price', but matters have gone even further. It was normal for the MOD to retain rights of control over foreign sales of a product. Under some contracts they now yield that right, and the supplier is then justified in reducing his charges in the expectation of profiting from foreign sales.

The commercial haggling before an order is placed can be intense, especially if American competition is involved, and the pressures that are created can have an adverse effect on the validity of the technical claims which are made.

Back in the nineteen-fifties, a Technical Director remarked that his company's profits depended on development contracts rather than on manufacturing activities. This could still apply in some areas. Perhaps it should, since it is the research and development work that really matters.

Anyone who has worked in both commercial and military manufacturing and compares them — and most people stay on the side of the fence they know best — is aware of a vast difference of approach. A commercial company may cut corners, relying on the experience of their engineers to safeguard them from catastrophe. In a military manufacturing environment there is a profound distrust of engineering judgement, and a second line of defence in which Quality Assurance excercises control too many decisions. The control is mandatory for defence contracts, but it is no more effective in some cases than the blind leading the lame.

The furore over IC testing is an example of this. The ICs are said to have been tested to the 'wrong' specification, which was the normal standard version rather than one cooked up by people who know only a limited amount about the product, basing their requirements on an arbitrary set of rules.

This, perhaps, is the key to extended development timescales. There is a standard development cycle for electronic equipment, but it can be shortened, at risk, if a commercial approach is adopted. Quite probably, however, there will then be a demand for work to be repeated 'in the proper way', even if the result is entirely satisfactory.

One point was not covered in the original article. A high proportion of all ICs are partially or wholly made in Malaysia, Taiwan or Hong Kong. How could equipment using these devices be made in wartime? A sea/air blockade would cut off supplies only too easily.

Yours sincerely,

Bill Horne
Greenock

SERVICE SHEET

Enquiries

We receive a very large number of enquiries. Would prospective enquirers please note the following points:

● We undertake to do our best to answer enquiries relating to difficulties with ETI projects, in particular non-working projects, difficulties in obtaining components, and errors that you think we may have made. We do not have the resources to adapt or design projects for readers (other than for publication), nor can we predict the outcome if our projects are used beyond their specifications;

● Where a project has apparently been constructed correctly but does not work, we will need a description of its behaviour and some sensible test readings and drawings of oscillograms if appropriate. With a bit of luck, by taking these measurements you'll discover what's wrong yourself. Please do not send us any hardware (except as a gift!);

● Other than through our letters page, Read/Write, we will not reply to enquiries relating to other types of article in ETI. We may make some exceptions where the enquiry is very straightforward or where it is important to electronics as a whole;

● We receive a large number of letters asking if we have published projects for particular items of equipment. Whilst some of these can be answered simply and quickly, others would seem to demand the compiling of a long and detailed list of past projects. To help both you and us, we have made a full index of past ETI projects and features available (see under Backnumbers, below) and we trust that, wherever possible, readers will refer to this before getting in touch with us.

● **We will not reply to queries that are not accompanied by a stamped addressed envelope** (or international reply coupon). **We are not able to answer queries over the telephone.** We try to answer promptly, but we receive so many enquiries that this cannot be guaranteed.

● Be brief and to the point in your enquiries. Much as we enjoy reading your opinions on world affairs, the state of the electronics industry, and so on, it doesn't help our already overloaded enquiries service to have to plough through several pages to find exactly what information you want.

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ETI should be available through newsagents, and if readers have difficulty in obtaining issues, we'd like to hear about it.

Backnumbers

Backnumbers of ETI are held for one year only from the date of issue. The cost of each is the current cover price of ETI plus 50p, and orders should be sent to: ETI Backnumbers Department, Infonet Ltd, Times House, 179 The Marlowes, Hemel Hempstead, Hertfordshire HP1 1BB. Cheques, postal orders, etc should be made payable to ASP Ltd. We suggest that you telephone first to make sure there are still stocks of the issue you require: the number is (0442) 48432.

We would normally expect to have ample stocks of each of the last twelve issues, but obviously, we cannot guarantee this. Where a backnumber proves to be unavailable, or where the issue you require appeared more than a year ago, photocopies of individual articles can be ordered instead. These cost £1.50 (UK or overseas surface mail), irrespective of article length, but note that where an article appeared in several parts each part will be charged as one article. Your request should state clearly the title of the article you require and the month and year in which it appeared. Where an article appeared in several parts you should list these individually. An index listing projects only from 1972 to September 1984 was published in the October 1984 issue and can be ordered in the same way as any other photocopy. If you are interested in features as well as projects you will have to order an index covering the period you require only. A full index for the period from 1972 to March 1977 was published in the April 1977 issue, an index for April 1977 through to the end of 1978 was published in the December 1978 issue, the index for 1979 was published in January 1980, the 1980/81 index in January 1982, the 1982 index in December 1982, the 1983 index in January 1984 and the 1984 index in January 1985. Photocopies should be ordered from: ETI Photocopies, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB. Cheques, postal orders, etc should be made payable to ASP Ltd.

Write For ETI

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

Trouble With Advertisers

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

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If you exhaust the above procedure and still do not obtain a satisfactory response from the supplier, then please drop us a line. We are not able to help directly, because basically the dispute is between you and the supplier, but a letter from us can sometimes help to get the matter sorted out. But please, don't write to us until you have taken all reasonable steps yourself to sort out the problem.

We are a member of the mail order protection scheme, and this means that, subject to certain conditions, if a supplier goes bankrupt or into liquidation between cashing your cheque and supplying the goods for which you have paid, then it may be possible for you to obtain compensation. From time to time, we publish details of the scheme near our classified ads, and you should look there for further details.

OOPS!

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

EPROM Card (June 1984)
On the circuit diagram, Q2 base is shown connected to +25V, but should be connected to +5V. Q3 should not be connected to 0V, but only to point a. The capacitor connected between +25V and 0V is C5 and should be 2μ2 35V tantalum bead. Switch connected across C4 is SW1 on overlay. Increase R8 to 2k7 if using suggested PSU. (R8 OK for 24V).

Spectrum Joystick Interface (June 1984)
The PCB and the circuit diagram do not agree; the circuit diagram is correct, and all PCBs sent out by the PCB service should have been amended. IC3 is 74LS241, as correctly stated in the parts list but incorrectly given in the footnote to the circuit diagram.

CMOS Tester (August 1984)
C3 and C2 are reversed on the overlay: C3 is the electrolytic and C2 the polyester. R33 is 100K, not 1 M as given in the parts list, and RV1 is a 1 M horizontal skeleton preset. R1-16 are two, eight-resistor SIL packages, the component labelled C14 on the overlay is SK1, and the connections to D2 shown in Fig. 3 are reversed. On the circuit diagram, the eight lines connecting SW9-16 to the inverters are shown in reverse sequence. Some of the inverters have been given the wrong designations; the correct sequence, reading down from the top, is:- IC1f, IC2a, IC2b, IC1e, IC1d, IC1c, IC1b, IC1a, IC2c, IC2d, IC2e, IC3d, IC3a, IC3b, IC3c, IC2f. Finally, the pin numbers are missing from ICs 3e and f; the input of IC3e is pin 11 and its output pin 12, and the input of IC3f is pin 14 and its output is pin 15. The PCB is correct in all respects.

Sharp Joystick Interface (August 1984)
Some of the inverter pins are incorrectly labelled on the circuit diagram. Pins 11 and 10 are shown reversed on IC1b, pins 9 and 8 are shown reversed on IC1c, and the output of IC4d is pin 10, not pin 20. Note that a number of the inverters have been incorrectly shown as non-inverting buffers.

AM/FM Radio (November 1984)
In Fig. 2, the oscillator and IF sections should be shown connected to ground; the PCB is correct. In Fig. 4, C31 should be 10n to give the 75us deemphasis shown in Fig. 3, but 4n7 has been found to give a brighter midrange. R38 in Fig. 5 should, of course, be 820k rather than 280k and it and the bottom end of C38, C44 etc should be shown connected to ground. In the construction section on page 25, four pieces of 8mm plywood are mentioned but in fact only three are needed — the fourth side is the front panel. See also the note in December News Digest regarding availability of the inductors.

Digital Control Port (November 1984)
The second sentence in the "Testing" section on page 30 should include the words 'without any ICs in place'. In the second paragraph of that section, the check for +5V should be made on pin 3 of IC101, not IC1. At the bottom of the first column on page 31, the last sentence should finish with B3 = 0.

Video Vandal (November 1984)
In Fig. 8 on page 54, R16 and R17 should be shown connected to the base of Q4, and C12 and SW2 should be in the D output line rather than the 0V line. It may also be beneficial to add a diode across R3 with its anode connected to the slider of RV1. In Fig. 10, R52 and LED2 are shown connected across the +12V supply but it is better to place them across the −12V supply so as to even-up the dissipation in the ICs.

VCDO (March 1985)
RV2 should be 10k (right in parts list, wrong on circuit diagram).

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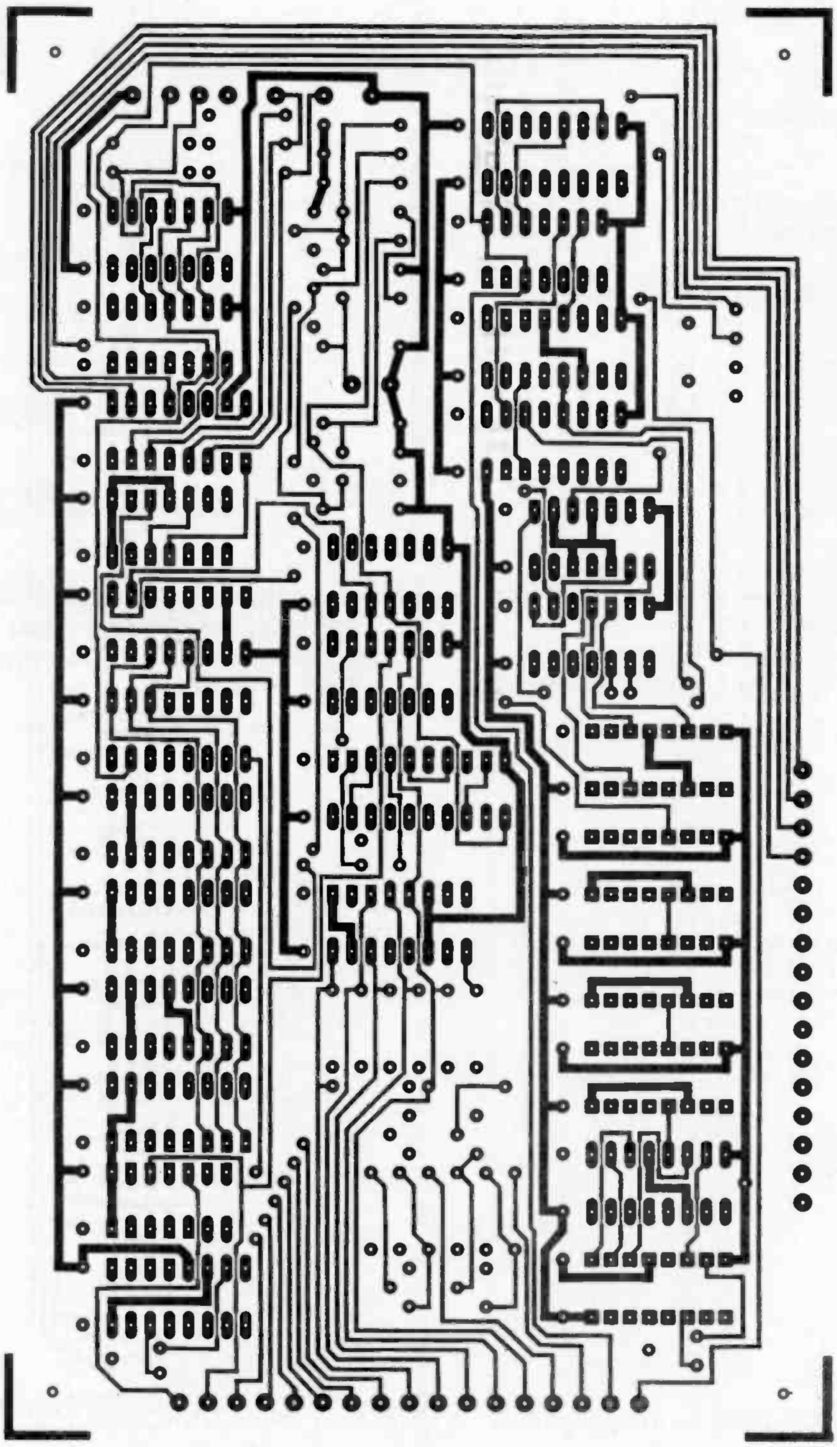
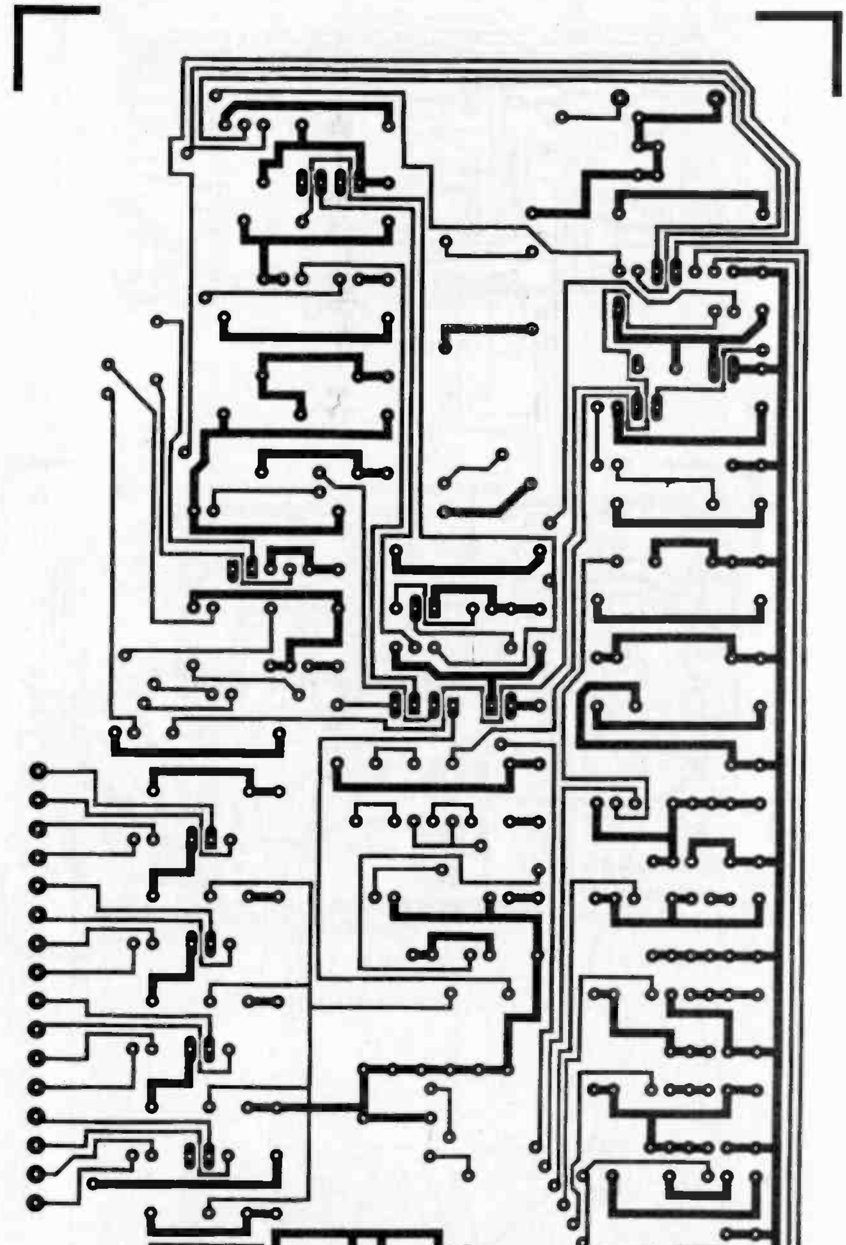
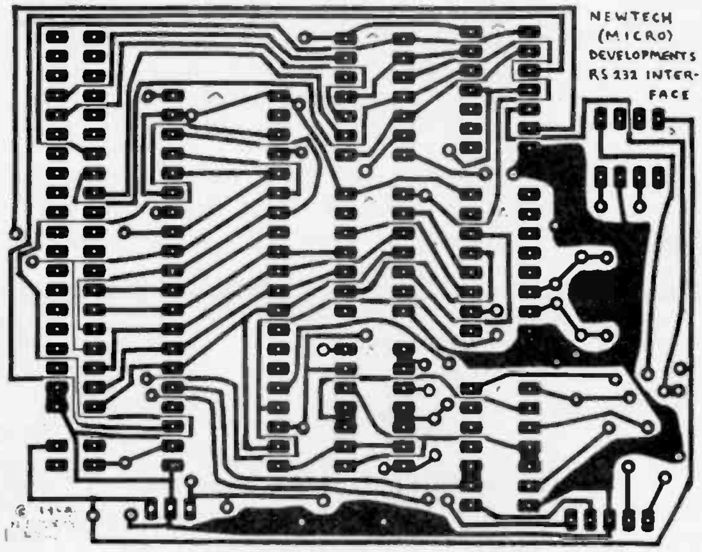


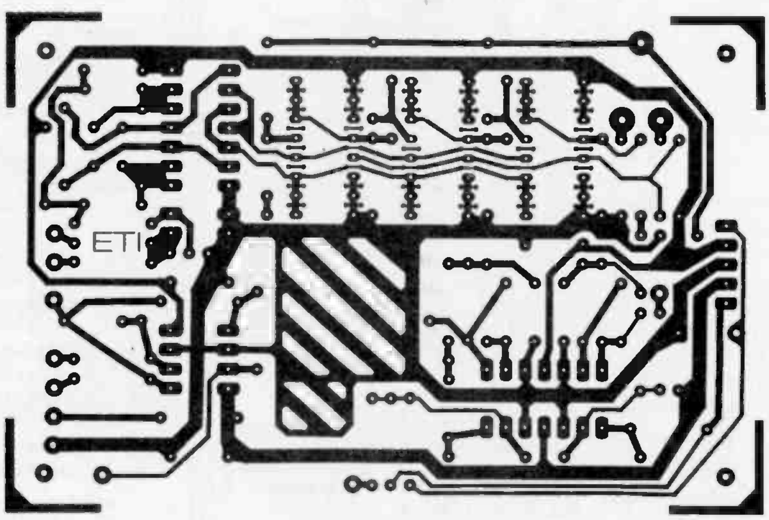
The solder side of the Framestore control card.



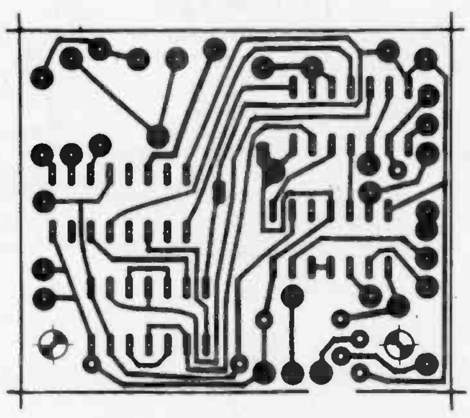
The top foil pattern for the Framestore control card.



RS232 Interface foil pattern.



CCD Delay Line foil pattern.



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The MCS-1 will take *any* sound, store it and play it back from a keyboard (either MIDI or lv/octave). Pitch bend or vibrato can be added and infinite sustain is possible thanks to a sophisticated, looping system.

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The MCS-1 gives you many of the effects created by top professional units such as the Fairlight or Emulator. But the MCS-1 doesn't come with a 5-figure price tag. And, if you're prepared to invest your time, it's almost cheap!

Specification

Memory Size: Variable from 8 bytes to 64K bytes.

Storage time at 32 KHz sampl ng rate: 2 seconds.

Storage time at 8 KHz sampling rate: 8 seconds.

Longest replay time (for special effects): 32 seconds.

Converters, ADC & DAC: 8 bit companding. Dynamic range: 72 dB.

Audio Bandwidth: Variable from 12 KHz to 300 Hz.

Internal 4 pole tracking filters for anti-aliasing and recovery.

Programmable wide range sinewave sweep generator.

MIDI control range: 5 octaves.

+1/V/octave control range: 2 octaves with optional transpose of a further 5 octaves.

Digital Delay Line

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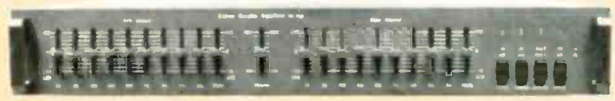

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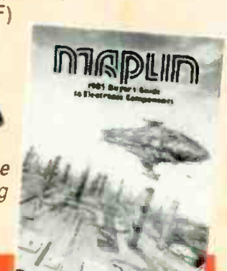

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