AN ARGUS SPECIALIST PUBLICATION

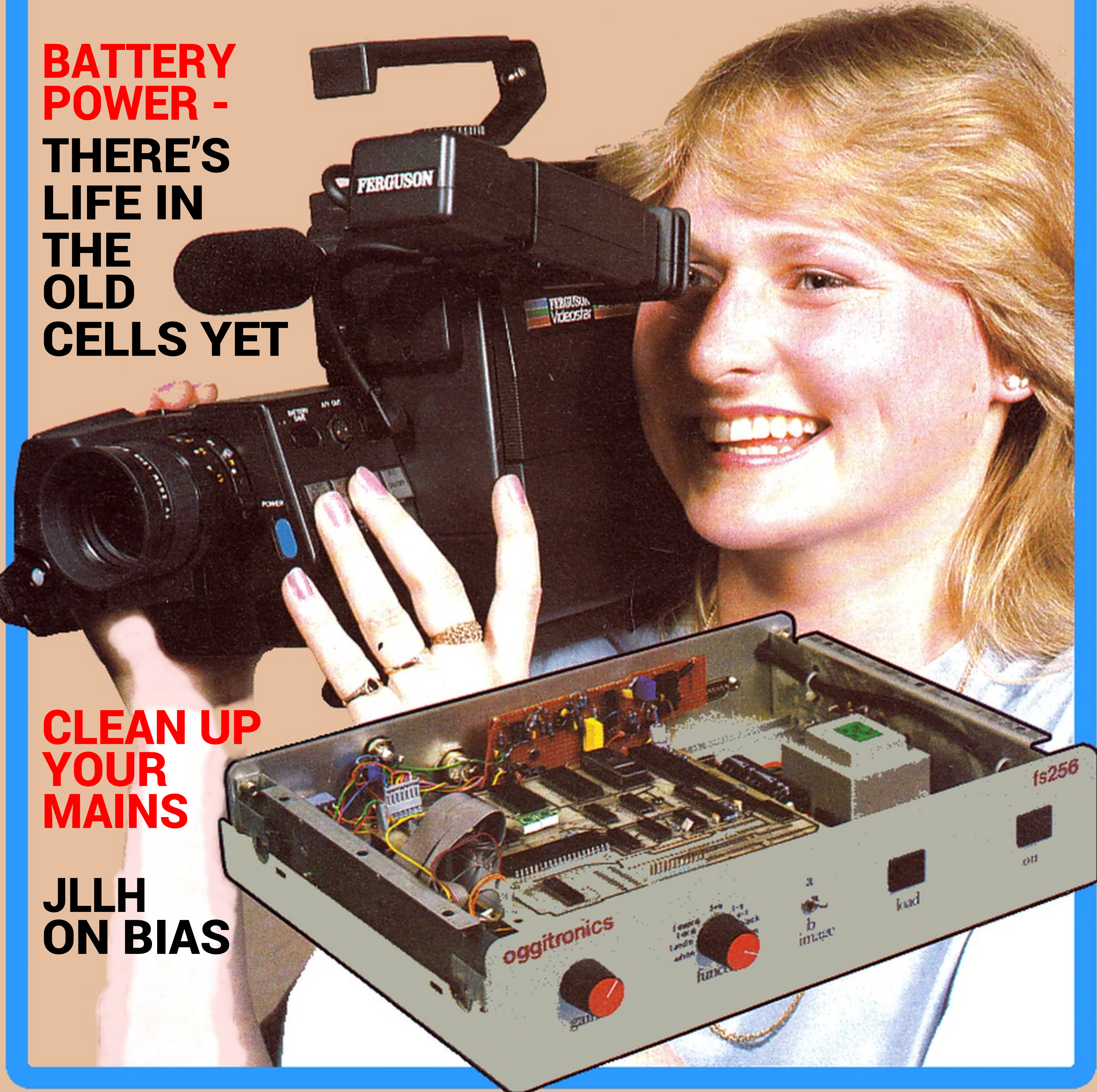
electronics today

INTERNATIONAL SEPT 1986 £1.20

TO BUILD

LOW COST FRAMESTORE

BATTERY POWER - THERE'S LIFE IN THE OLD CELLS YET



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

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.**

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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.**

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

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

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

SAVE £138.00 Usual Price £228.85
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The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full range 45Hz - 20KHz. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W, 1mtr. dB.

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

OMP 19" STEREO RACK AMPS

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

MF200 (100 + 100)W.	£169.00	**Securicor**
MF400 (200 + 200)W.	£228.85	**Delivery**
MF600 (300 + 300)W.	£299.99	**£10.00**

1 K-WATT SLIDE DIMMER

- Control loads up to 1Kw
- Compact Size 4½" × 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 £13.99 + 75p P&P

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

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

POWER RANGE
8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. 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.

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 £29.99 + £3.00 P&P ea.
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10" 200 WATT R.M.S. C10200GP Guitar, Keyboard, Disco.
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB. PRICE £44.76 + £3.00 P&P
15" 200 WATT R.M.S. C15200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £62.41 + £4.00 P&P
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £89.52 + £4.00 P&P.

WEM
5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £22.00 + £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 £32.00 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £36.00 + £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 £47.00 + £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.
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

BSR P295 ELECTRONIC TURNTABLE

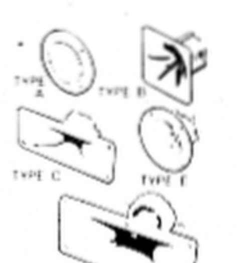
- Electronic speed control 45 & 33⅓ r.p.m. • Plus/Minus variable pitch control • Belt driven • Aluminium platter with strobed rim • Cue lever • Anti-skate (bias device) • Adjustable counter balance • Manual arm • Standard ½" cartridge fixings • Supplied complete with cut out template • D.C. Operation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

Price £36.99 £3.00 P&P

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

PIEZO ELECTRIC TWEETERS - MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 40p P&P.**
TYPE 'B' (KSN1005A) 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) 3½" 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.**

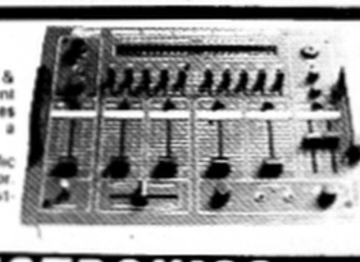
PANTEC HOBBY KITS

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

3 watt FM Transmitter

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

STEREO DISCO MIXER



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

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SWITCHES

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

SUB-MIN TOGGLE

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

SLIDE 250V:

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

PUSH BUTTON 8A with 10mm Button

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

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch Assorted Colours 75p each

ULTRASONIC TRANSDUCERS

40 Khz 475p (pr).

GAS/SMOKE DETECTORS

TGS812 or TGS 813
650p
Holders for above 40p

DIP SWITCHES

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

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way: 2 pole/2 to 6 way. 3 pole/2 to 4 way. 4 pole/2 to 3 way **55p**

ROTARY: Mains DP 250V 4 Amp on/off **68p**

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

WAFERS: (make before break) to fit the above switch mechanism 1 pole/12 way: 2 pole/6 way 3 pole/4 way 4 pole/3 way 6 pole/2 way **65p**
Mains DP 4A Switch to f t **45p**
Spacers 4p. Screen 8p.

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	65p

THUMBWHEEL Mini front mounting switches

Decade Switch Module	320p
B.C.D. Switch Module	350p
Mounting Cheeks (per pair)	95p

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper 24 inches	145p	165p	240p	380p

Female IDC Header Jumper Leads 36 inches long

	20pin	26 pin	34 pin	40 pin
Single ended	160p	200p	260p	300p
Double ended	290p	370p	460p	525p

VERO

VERO BOARDS 0.1"

2½ × 1	30p
2½ × 3¼	96p
2½ × 5	110p
3¼ × 3¾	110p
3¾ × 5	125p
3¾ × 17	420p
4¾ × 17	550p
VO Board	185p
DIP Board	395p
Vero Strip	95p

VERO PINS per 100

Single Ended	55p
Double ended	60p
Wire Wrap S/E	155p
Wire Wrap D/E	255p

VERO TOOLS

Spot face cutters	150p
Pin insertion tool	185p

VERO WIRING

PEN — Spool	380p
Spare Spool	75p
Combs	8p
Pen + Spool + Combs	580p

PHOTO DECs

Veroblock	480p
S Dec	350p
Eurobreadboard	580p
Bimboard	575p
Superstrip S52	1350p

COPPER CLAD BOARDS

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

DALO ETCH RESIST PEN
Plus spare tip **100p**

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

EDGE CONNECTORS

	1"	156"
2 × 6 way		75p
2 × 12 way		160p
2 × 15 way		165p
2 × 18 way	175p	160p
2 × 22 way	200	170p
2 × 23 way	150p	
2 × 25 way	250p	245p
2 × 28 way	180p	
2 × 30 way	280p	
2 × 36 way	300p	
2 × 40 way	320p	
2 × 43 way	400p	
2 × 75 way	600p	

DIL SOCKETS

Pin	Low Prof	Wire Wrap	Turned Pin
8	8p	20p	14p
14	10p	23p	28p
16	10p	40p	28p
18	16p	40p	33p
20	20p	58p	37p
22	22p	60p	39p
24	25p	68p	42p
28	28p	78p	52p
40	30p	89p	72p

ANTEX SOLDERING IRON

C-15W	600p	CS17W	820p
G-18W	620p	XS25W	650p
Spare tips assorted size			100p
Spare elements			245p
Iron stand with sponge			195p

SIL SOCKET 0.1" pitch 20 way 65p

IDC CONNECTORS

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

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	125p	—	—	175p
DIN41612 2 × 32 A + B	200p	—	175p	—
DIN41612 2 × 32 A + C	225p	—	165p	210p
DIN41612 3 × 32 A + B + C	280p	290p	295p	300p

DIL PLUG (Header)

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

RIBBON CABLE price per foot

	Grey	Color
10 way	15p	26p
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	180p

ZIF TEXTOOL DIL SOCKETS

24 pin	550p
28 pin	695p
40 pin	800p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	160p	250p
Female				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	260p	390p
PCB pins	100p	125p	195p	355p
Covers	75p	70p	70p	65p

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

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

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

AMPHENOL CONNECTORS

	IDC	SOLDER
24 way IEEE plug	465p	460p
24 way IEEE skt	485p	480p
36 way Centronics plug	375p	390p
36 way Centronics skt	480p	450p

PANEL METERS

FSD
80 × 46 × 35mm
0–50µA
0–100µA
0–500µA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0–1A
0–2A
0–25V
0–50V
0–300V AC
845p

CRYSTALS

32.768KHz	100
100KHz	400
200KHz	370
455KH	370
1MHz	265
1.008M	275
1.28MHz	450
1.6MHz	200
1.8MHz	345
1.8432M	210
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	95
3.8864M	300
4.0MHz	140
4.032MHz	290
4.19430M	150
4.433619M	100
4.608MHZ	200
4.80MHz	200
5.0MHz	150
5.185MHz	300
5.24288M	390
6.0MHz	125
6.144MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	175
7.68MHz	200
8.0MHz	140
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	170
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	155
16.0MHz	200
18.0MHz	150
18.432M	150
19.968MHz	150
20.0MHz	150
24.0MHz	150
24.930MHz	325
26.69M	150
27.648M	170
27.145M	160
38.6667M	240
48.0MHz	240
100.0MHz	295

RELAYS

Miniature, enclosed, PCB mount

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

DOUBLE POLE Changeover, 8A 30V DC or 250V AC
RL-113 53R Coil 6V DC (5V4 to 9V8) **190p**
RL8-111 205R Coil. 12V DC (10V7 to 19V5) **195p**
RL8-114 740R Coil. 24V DC (22V to 37V) **200p**

ASTEC UHF MODULATORS

Standard 6MHz	375p
Wideband 8MHz	550p

BUZZERS

miniature, solid-state 6V. 9V & 12V	70p
PIEZO TRANSDUCERS FB2720	70p

LOUDSPEAKERS

Miniature, 0.3W- 8 Ohm 2in, 2½in 2¾in, 3in	80p
2½in 40Ω, 64Ω or 80Ω	80p
6" × 4" 8Ω	200p
7" × 5" 8Ω	225p
8" × 5" 8Ω	250p

BT TELEPHONE CONNECTOR

LJU 1/4A	Mini Line Master	435p
LJU 1/6A	Mini Line Slave	295p
LJU 2/4A	Line Master	370p
LJU 2/6A	Line Slave	250p
LJU 3/4A	Flush Master	370p
LJU 3/6A	Flush Slave	240p
LJU 10/3A	Dual Splitter	475p
4 WAY	BT Plug	65p

TRANSFORMERS

3-0-3V, 6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V @ 100mA **130p**
PCB mounting Miniature, Split bobbin
3VA: 2x6V/0.25A; 2x9V/0.15A, 2x12V/0.12A; 2x15V/0.2A **235p**
6VA: 2x6V/05A, 2x9V/0.3A; 2x12V/0.25A; 2x15V/0.2A **280p**
Standard Split Bobbin type
6VA: 2x6V/0.5A; 2x9V/0.4A 2x12V/0.3A; 2x15V/0.25A **250p**
12VA: 2x4.5V/1A3, 2x5V-1A, 2x9V/06A; 2x12V/0.5A; 2x15V-0.4A; 2x20V/0.3A **345p** (35p p&p)
24VA: 2x6V/1.5A; 2x9V/1.2A; 2x12V/1A, 2x15V/08A; 2x20V/0.6A **385p** (60p p&p)
50VA: 2x6V/4A; 2x9V/2.5A; 2x12V/2A 2x15V/1.5A, 2x20V/1.2A; 2x25V/1A; 2x30V/0.8A **520p** (60p p&p)
50VA: Outputs +5V/5A, +12V, +25V, -5V, -12V at 1A **620p** (60p p&p)
100VA: 2x12V/4A, 2x15V/3A. 2x20V/2.5A; 2x25V/2A, 2x30V/1.5A, 2x50V/1A **955p** (75p)
P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

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

100mA TO92 Plastic package

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

ICL7660	245p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	TL497A	165p
LM309K	135p	78H05 + 5V/5V	550p
		78H12+12V/5A	
LM317K	250p		
LM317KP	450p	78HG+5V10+25V/5V 5A	550p
LM323K	450p		
LM337	175p	79HG 5V to-24V/5A	765p
LM723 Var	30p		
78S40	225p		

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	35p
500 pins	100p

ALUM BOXES

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

VIDEO MONITORS

VIDEO MONITORS

- 1431 – MICROVITEC Medium resolution 14" colour TTL Input £176
- 1451 – MICROVITEC High resolution 14" RGB, suitable for 80 column £225
- KAGA Vision II High resolution RGB colour monitor £210
- KAGA Vision III+ Ultra High resolution RGB colour monitor, TEX mode switch allows monochrome tex display £830
- KAGA KX1201G Hires Green Monitor £90
- KAGA KX1202G Ultra Hi-res Green Monitor £105
- KAGA KX1203A Ultra Hi-res Amber Monitor £105
- ZENITH 12" Hi-res monitor, Ideal for word processing as its Green or Amber screen is very restful to read
- ZVM1220 Amber Hi-res £76
- ZVM1230 Green Hi-res £72

All monitors supplied with connecting leads to the BBC MICRO

- Carriage on monitors £7 (Securicor)

CMOS

4000	20
4001	20
4002	20
4006	70
4007	25
4008	60
4009	40
4010	40
4011	20
4012	20
4013	25
4014	50
4015	40
4016	25
4017	40
4018	55
4019	40
4020	40
4021	55
4022	90
4023	20
4024	35
4025	20
4026	90
4027	30
4028	40
4029	45
4030	20
4031	125
4032	65
4033	130
4034	146
4035	70
4036	260
4037	115
4038	75
4039	270
4040	45
4041	55
4042	45
4043	45
4044	50
4045	110
4046	60
4047	50
4048	50
4049	25
4050	25
4051	50
4052	40
4053	60
4054	70
4055	70
4056	70
4057	1000
4059	600
4060	70
4061	500
4062	986
4063	60
4066	25
4067	230
4068	20
4069	20
4070	22
4071	20
4072	20
4073	20
4075	25
4076	60
4077	25
4078	25
4081	20
4082	20
4085	60
4086	60
4089	120
4093	25
4094	70
4095	70
4096	100
4097	250
4098	70
4099	110
4160	95
4161	96
4162	96
4163	96
4174	96
4175	105
4194	105
4408	830
4409	660
4410	725
4411	760
4412	805
4415	590
4419	280
4422	770
4435	850
4440	900
4450	360
4451	360
4490	450
4500	395
4501	40
4502	50
4503	45
4504	100
4505	250
4506	100
4507	45
4508	130
4510	55
4511	55
4512	55
4513	150
4514	85
4515	115
4516	50
4517	275
4518	50
4519	35
4520	50
4521	110
4522	125
4526	70
4527	60
4528	45
4529	60
4530	90
4531	120
4532	65
4534	365
4536	260
4538	60
4539	60
4541	65
4543	65
4548	60
4549	390
4553	210
4554	180
4555	50
4556	50
4557	250
4558	120
4559	340
4560	110
4581	104
4562	350
4566	160
4568	280
4569	175
4572	45
4580	255
4581	125
4582	95
4583	100
4584	40
4585	65
4597	330
4599	155
40085	90
40097	45
40098	42
40100	215
40101	130
40102	100
40103	412
40104	120
40105	220
40106	40
40107	50
40108	325
40109	100
40110	236
40114	240
40161	150
40163	75
40173	100
40174	75
40174	60
40181	220
40182	60
40192	75
40193	90
40194	70
40195	75
40244	150
40245	150
40257	196
40373	220
40374	220
45106	586

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2 Red	12
2 Green Yellow or Amber	14
02 Bi colour Red/Green	100p
Green/Yellow	115p
02 Tri colour Red/Green/Yellow	65
Hi-Brightness Red	56
Flashing red 02 red	55
Square LEDs. Red. Green. Yellow	30
Rectangle Stackable LEDs Red. Green or Yellow	18
Triangular LEDs Red	16
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH ARRAY Ten Segments	
MV57164 Red	225
MV54164 Grn	230

ISOLATORS

ILT4	75
ILD74	145
ILQ74	275
TIL111/2/4	70
ILCT6 Darlington	135
TIL117	125
TIL127	120
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
.8" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625

OPTO

OCP71	120
ORP12	85
ORP61	86
BPX25	250
BPW21	320
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REFLECTIVE Optical Switch	225
SLOTTED Optical Switch similar to RS Components	295

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Epson FX85 Dot matrix Printer	£315
Centronics GLP (NLQ) Printer	£ 99
Tractor feed attachment for GLP	£ 9
KAGA/TAXAN KP810 Printer	£210
KAGA/TAXAN KP910 Printer	£339
Brother HR15 Daisy Wheel Printer	£285

Securicor Carriage on above	£7
Cable for above Printers to interface to BBC Micro	£6
TEX EPROM ERASER with Safety switch Erasers up to 25 EPROMS	£28
Spare UV Lamp (Bulb)	£8

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Designed for Schools and Colleges to teach Z80 Machine code. Menta uses TV for display. Shows STACK & PROGRAM in HEX. Editing facility includes: direct keyboard ASSEMBLER, RS-232 Output DISASSEMBLER. Used to write & debug short machine code routines. Menta is a complete controller with 24 bits of I/D used for ROBOTICS.
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5¼" Disc Drives for the BBC

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

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(Securicor Carriage on drives £7)

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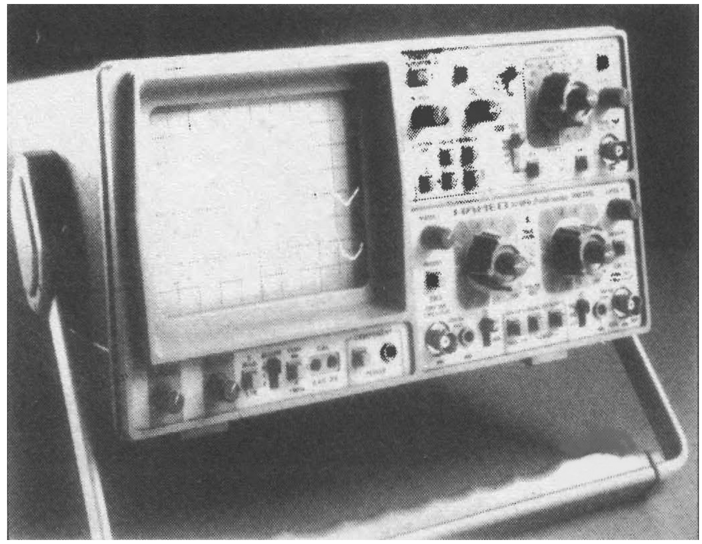


Low-Cost Digital Storage 'Scope

Hameg claim their new oscilloscope costs less than any other dual-channel DSO in the world. The price, including probes, is just £448.00 plus VAT.

The HM205 provides all the facilities usually found on a 20MHz analogue oscilloscope while the storage facility allows slowly-changing signals to be captured and displayed without flicker. Signals with periods of up to 50 seconds can be viewed in this way. Other features include an integral component tester and a 1 kHz/1 MHz calibrator and there is also a two-level graticule illumination system which makes it easier to take photographs of the screen.

The maximum sampling rate of the HM205 is 100kHz and the resolution of the stored image is 1024 x 256 points. The storage facility can be used either in refresh mode, in which the display is updated each time a new sample is taken, or in single-shot mode. Signals stored in single-shot mode remain in memory for as long as the instrument is powered-up, even if the 'scope is used in the meantime to display other signals in analogue form.

An active video trigger allows stable triggering of noisy and distorted TV signals and there is also a variable hold-off control to permit triggering of other complex signals. Three rear-panel BNC sockets provide a Z modulation input and vertical signal and sweep outputs, and an optional add-on unit allows the memory contents to be fed out to a chart or X-Y recorder.

The HM205 is covered by a two-year warranty and will be available from selected Hameg distributors. Hameg Ltd, 74-78 Collingdon Street, Luton, Bedfordshire LU1 1RX, tel 0582-413174.

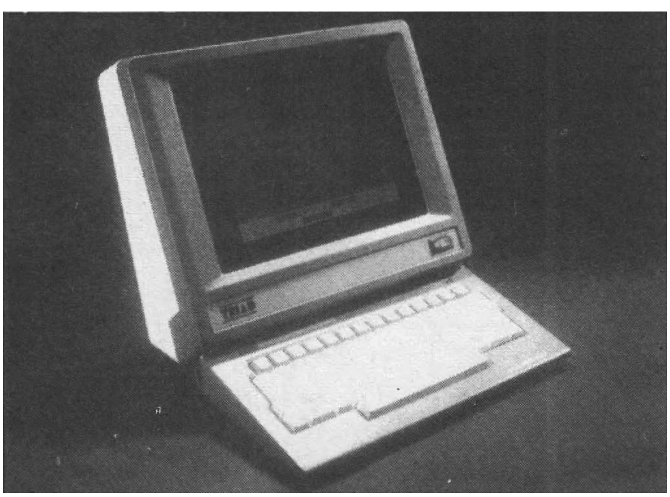
No Boom Yet'

The electronics Industry emerged from the first half of 1986 in better shape than most other sectors of British industry, but is still showing little sign of sustained growth.

Business information company Dun & Bradstreet Ltd report roughly the same number of business failures in the first six months of this year as in the same period last year. Within these figures, company liquidations were slightly down while bankruptcies among individuals, firms and partnerships were 7% higher.

The trend is reflected in a survey by temporary staff specialists Manpower Ltd which shows no improvement in job prospects throughout industry as a whole. However, the picture is a little brighter in the electronics manufacturing sector. Slightly fewer employers plan to increase their staffs than this time last year but only half as many actually expect to reduce their workforce in the next quarter.

Both Manpower and Dun & Bradstreet make the point that these figures have come in spite of encouraging economic indicators such as the fall in Inflation and the drop in interest rates. According to Manpower, the question is at what stage the reductions in employers' costs will be reflected in an increased willingness to take on and retain staff. If the present trend continues, they say, job prospects for 1986 could worsen.



Plasma Display Terminal

The Triad computer terminal from Perdix Components is said to be the first in the world to use a high resolution plasma display.

As well as providing a flat, flicker-free alternative to CRT-based terminals, Perdix say the Triad offers better visibility than existing flat-screen terminals which use LCDs.

The viewing area of the screen is equal to that of an 11" monitor and carries a full 80-column, 25 line display in the orange colour which is fast becoming a European Standard. The display unit measures about 12" square by less than 3" deep and comes with either a separate, full-sized keyboard or in portable form (illustrated above) with an integral keyboard which folds up over the display when not in use.

The Triad's controller board is software-programmable to enable it to emulate many of the industry's terminal standards, with VT-100 and IBM-PC available now and others due shortly. Standard connectors allow easy connection to the host system and to a printer, and there is also an optional on-board modem which meets the relevant European and American standards and operates at up to 1200 baud.

There is considerable concern in some quarters over possible health risks associated with the type of radiation emitted by CRTs. The Triad terminal is free of such risks and as such is expected to be of enormous interest to companies worried about Trade Union opposition to the use of standard VDU technology. In addition, the Triad terminal is said to offer far greater data security than CRT-based terminals because it is almost impossible to bug. This makes it an attractive alternative to the complex screening systems currently employed where security is important

• The desk-top Triad-EX with separate keyboard is available now and the portable Triad-PT will be available shortly. *Perdix* Components Ltd is part of Densitron International, and full Details can be obtained from them at Unit 4, Airport Trading Estate, *Biggin* Hill, Kent TN16 3BW, tel 0959 *71011.*

• Whilst on the subject of flat screen displays, Hitachi have introduced a large, high-contrast, wide-viewing-angle LCD which, they claim, offers over 100% improvement in visibility compared with existing LCDs. The LM585X has a screen area of 220 x 166mm which is comparable to a 10" CRT and its resolution is 640 x 200 pixels. The improvements result from the use of what Hitachi call 'X-Technology' and 'high duty ratio dynamic drive techniques'. Neither is explained in any detail in the press release. The display is compatible with CRT control systems, and Hitachi expect its low power consumption and 12mm depth to make it a popular choice for portable equipment Hitachi Electronic Components (UK) Ltd, 21 Upton Road, Watford Hertfordshire WD1 7TB, tel 0923-46488.

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7400	0.30
7401	0.30
7402	0.30
7403	0.30
7404	0.36
7405	0.30
7406	0.40
7407	0.40
7408	0.30
7409	0.30
7410	0.30
7411	0.30
7412	0.30
7413	0.50
7414	0.70
7416	0.36
7417	0.40
7420	0.30
7421	0.60
7422	0.40
7423	0.60
7425	0.40
7426	0.40
7427	0.32
7428	0.43
7430	0.30
7432	0.36
7433	0.30
7437	0.30
7438	0.40
7439	0.40
7440	0.40
7441	0.90
7442A	0.70
7443A	1.00
7444	1.10
7445	1.00
7446A	1.00
7447A	1.00
7448	1.00
7450	0.36
7451	0.35
7453	0.38
7454	0.38
7460	0.55
7470	0.50
7472	0.45
7473	0.45
7474	0.50
7475	0.50
7476	0.45
7480	0.65
7481	1.80
7483A	1.05
7484A	1.25
7485	1.10
7486	0.42
7489	2.10
7490A	0.55
7491	0.70
7492A	0.70
7493A	0.56
7494	1.10
7495A	0.60
7496	0.80
7497	2.10
74100	1.90
74107	0.50
74109	0.75
74110	0.75
74111	0.55
74116	1.70
74118	1.10
74119	1.70
74120	1.00
74121	0.55
74122	0.70
74123	0.80
74125	0.65
74126	0.55
74128	0.55
74132	0.75
74136	0.70
74141	0.90
74142	2.50
74143	2.70
74144	2.70
74145	1.10
74147	1.70
74148	1.40
74150	1.75
74151A	0.70
74153	0.80
74154	1.40
74155	0.80
74156	0.90
74157	0.90
74159	1.75
74160	1.00
74161	0.80
74162	1.10
74163	1.10
74164	1.20
74165	1.10
74166	1.40
74167	4.00
74170	2.00
74172	4.20
74173	1.40
74174	1.10
74175	1.05
74176	1.00
74178	1.50
74179	1.50
74180	1.10
74181	3.40
74182	1.40
74184	1.80
74185A	1.80
74190	1.30
74191	1.30
74192	1.10
74193	1.15
74194	1.10
74195	0.90
74196	1.10
74197	1.10
74198	2.20
74199	2.20
74221	1.10
74251	1.00
74259	1.50
74265	0.90
74273	2.00
74276	1.40
74278	1.70
74279	0.90
74283	1.05
74285	3.00
74290	0.90
74293	0.90
74298	1.80
74351	2.00
74365A	0.90
74366A	0.90
74367A	0.90
74368A	0.90
74376	1.60
74390	1.10
74393	1.20
74490	1.10
74393	1.20
74490	1.40

74LS SERIES

74LS00	0.24
74LS01	0.24
74LS02	0.24
74LS03	0.24
74LS04	0.24
74LS05	0.24
74LS08	0.24
74LS09	0.24
74LS10	0.24
74LS11	0.24
74LS12	0.24
74LS13	0.34
74LS14	0.50
74LS15	0.24
74LS20	0.24
74LS21	0.24
74LS22	0.24
74LS24	0.50
74LS26	0.24
74LS27	0.24
74LS28	0.24
74LS30	0.24
74LS32	0.24
74LS33	0.24
74LS37	0.24
74LS38	0.24
74LS40	0.24
74LS42	0.50
74LS47	0.80
74LS48	0.90
74LS51	0.24
74LS54	0.24
74LS55	0.24
74LS73A	0.30
74LS74A	0.35
74LS75	0.45
74LS76A	0.36
74LS78	0.42
74LS83A	0.70
74LS85	0.75
74LS86	0.36
74LS90	0.48
74LS91	0.90
74LS92	0.35
74LS93	0.54
74LS95B	0.75
74LS96	0.90
74LS107	0.40
74LS109	0.40
74LS112	0.45
74LS113	0.45
74LS114	0.45
74LS122	0.70
74LS123	0.80
74LS124	1.40
74LS125	0.50
74LS126	0.50
74LS132	0.65
74LS133	0.50
74LS136	0.45
74LS138	0.55
74LS139	0.55
74LS145	0.95
74LS147	1.75
74LS148	1.40
74LS151	0.65
74LS152	2.00
74LS153	0.65
74LS154	1.60
74LS155	0.65
74LS156	0.65
74LS157	0.50
74LS158	0.65
74LS160A	0.75
74LS161A	0.75
74LS162A	0.75
74LS163A	0.75
74LS164	0.75
74LS165A	1.30
74LS166A	1.50
74LS168	1.30
74LS169	1.00
74LS170	1.40
74LS173A	1.00
74LS174	0.75
74LS175	0.75
74LS181	2.00
74LS183	1.90
74LS190	0.75
74LS191	0.75
74LS192	0.80
74LS193	0.80
74LS194A	0.75
74LS195A	0.75
74LS196	0.80
74LS197	0.80
74LS221	0.90
74LS240	0.90
74LS241	0.90
74LS242	0.90
74LS243	0.90
74LS244	0.80
74LS245	1.10
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
74LS257A	0.70
74LS258A	0.70
74LS259	1.20
74LS260	0.75
74LS261	1.50
74LS266	0.60
74LS273	1.25
74LS279	0.70
74LS280	1.90
74LS283	0.80
74LS290	0.80
74LS292	9.00
74LS293	0.90
74LS295	1.40
74LS297	9.00
74LS298	1.00
74LS299	2.20
74LS231	3.70
74LS323	3.00
74LS324	3.20
74LS348	2.00
74LS352	1.20
74LS353	1.20
74LS356	2.10
74LS363	1.80
74LS364	1.80
74LS365	0.50
74LS366	0.50
74LS367	0.52
74LS368	0.50
74LS373	0.90
74LS374	0.90
74LS375	0.75
74LS377	1.30
74LS378	0.95
74LS379	1.30
74LS381	4.50
74LS390	0.80
74LS393	1.00
74LS395A	1.00
74LS399	1.80
74LS445	1.80
74LS465	1.80
74LS467	1.80
74LS540	1.00

74LS541	1.00
74LS608	7.00
74LS610	19.00
74LS612	19.00
74LS624	2.25
74LS626	2.25
74LS628	2.25
74LS629	1.35
74LS640	2.00
74LS640-1	3.00
74LS641	1.50
74LS642	2.50
74LS642-1	3.00
74LS643	2.50
74LS643-1	3.00
74LS644	3.50
74LS645	3.50
74LS645-1	4.00
74LS668	0.90
74LS669	0.90
74LS670	1.70
74LS682	2.90
74LS684	3.00
74LS687	3.50
74C922	5.00
74C923	5.50
74C925	6.50
74C926	6.50

4000 SERIES

4000	0.20
4001	0.24
4002	0.24
4006	0.70
4007	0.24
4008	0.60
4009	0.45
4010	0.60
4011	0.24
4012	0.25
4013	0.36
4014	0.80
4015	0.70
4016	0.30
4017	0.55
4018	0.80
4019	0.60
4020	0.80
4021	0.80
4022	0.70
4023	0.24
4024	0.40
4025	0.24
4026	1.30
4027	0.40
4028	0.60
4029	0.75
4030	0.35
4031	1.25
4032	1.00
4033	1.25
4034	2.50
4035	0.70
4036	2.50
4037	1.10
4038	1.00
4039	2.50
4040	0.60
4041	0.60
4042	0.60
4043	0.60
4044	0.60
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.36
4051	0.65
4052	0.60
4053	0.60
4054	0.90
4055	0.90
4056	0.85
4057	0.80
4059	4.00
4060	0.70
4063	0.90
4066	0.30
4067	2.30
4068	0.25
4069	0.24
4070	0.24
4071	0.24
4072	0.24
4073	0.24
4075	0.24
4076	0.65
4077	0.25
4078	0.25
4081	0.24
4082	0.25
4085	0.60
4086	0.75
4089	1.20
4093	0.30
4094	0.90
4095	0.90
4096	0.90
4097	2.70
4098	0.75
4099	0.90
4501	0.36
4502	0.55
4503	0.45
4504	0.95
4505	3.60
4506	0.75
4507/4030	0.35
4508	1.20
4510	0.60
4511	0.55
4512	0.55
4513	1.80
4514	1.10
4515	1.10
4516	0.65
4517	2.20
4518	0.48
4519	0.30
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.60
4528	0.60
4529	1.00
4531	0.75
4532	0.65
4534	4.50
4536	2.80
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.36
4557	2.40
4558	0.90
4559	3.60
4560	1.80
4566	2.00
4568	2.40
4569	1.70

4572	0.45
4583	0.90
4584	0.48
4585	0.80
4727	1.50
14411	7.50
14412	7.50
14416	3.00
14419	2.60
14490	4.20
14495	4.50
14500	6.50
14599	2.00
22100	3.50
22101	7.00
22102	7.00
40014	0.48
40085	1.20
40097	0.36
40098	0.40
40100	1.50
40101	1.25
40102	1.50
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
40108	3.20
40109	1.20
40110	2.25
40114	2.25
40147	2.80
40163	1.00
40173	1.20
40174	1.00
40175	1.00
40192	1.00
40193	1.00
40194	1.00
40244	1.50
40245	1.50
40257	1.80
40373	1.90
40374	1.80
80C95	0.75
80C97	0.75
80C98	0.75

zif sockets

24	pin	5.50
28	pin	7.00
40	pin	9.00

TTL & ECL

10116	70p
10231	360p

TRIACS

Plastic

3A 400V	60p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A 500V	105p
16A 500V	130p
T2800D	130p
T1206D	50p
T1226D	70

DISCRETE DISPLAYS LEDS

125" RED TIL209	0.12
GREEN TIL211	0.16
YELLOW TIL212	0.20
React LEDs (R/G/Y)	0.30
CXQ (Bi) Colour	1.00
10LED Bargraph: Red	2.25
Green	2.25
0.2" TIL220	0.15
TIL222	0.18
TIL226	0.22
TIL32	0.55
TIL78	0.55
TIL31B	1.20
TIL81	1.20
TIL100	0.75

LINEAR I Cs

AD7581	11.90
ADC0808	11.90
AM7910DC	25.00
AN103	2.00
AY1-5050	1.00
AY3-8010	4.50
AY3-8910	4.90
AY3-8912	5.00
CA3019A	1.00
CA3028A	1.10
CA3046	0.70
CA3059	3.20
CA3060	3.20
CA3080E	0.70
CA3086	0.60
CA3089E	2.50
CA3090AQ	3.75
CA3130E	0.90
CA3130T	1.30
CA3140E	0.45
CA3140T	1.00
CA3146	2.25
CA3160E	1.50
CA3161E	2.00
CA3162E	6.00
CA3189E	2.70
CA3240E	1.50
CA3280G	3.00
D7002	6.00
DAC1408-8	3.00
DAC0800	3.00
DAC0808	3.00
DG308	3.00
HA1366	1.90
ICL7106	6.75
ICL7611	0.95
ICL7650	4.00
ICL7660	2.50
ICL8038	4.00
ICM7216B	22.00
ICM7217	7.50
ICM7555	0.90
ICM7556	1.40
LC7120	3.00
LC7130	3.00
LC7431	3.50
LC7137	3.50
LF347	1.20
LF351	0.60
LF353	0.90
LF355	0.90
LF356N	1.10
LF357	1.00
LM10CLH	4.50
LM301A	0.30
LM307	0.45
LM308CN	0.75
LM310	2.25
LM311	0.60
LM318	1.50
LM319	1.80
LM324	0.45
LM334Z	1.15
LM335Z	1.30
LM336	1.60
LM339	0.40
LM348	0.80
LM349CH	3.80
LM358P	0.50
LM377	3.00
LM380N-8	1.50
LM380N	1.50
LM381AN	1.70
LM382	2.00
LM383	3.25
LM384	2.20

LM386N-1	1.00
LM387	2.70
LM389	1.80
LM391	1.80
LM392N	1.10
LM393	0.65
LM394CH	4.00
LM709	0.36
LM710	0.48
LM711	1.00
LM723	0.60
LM725CN	3.00
LM733	0.65
LM741	0.22
LM747	0.70
LM748	0.30
LM1011	4.80
LM1014	1.80
LM1801	3.00
LM1830	2.50
LM1871	3.00
LM1872	3.00
LM1886	6.00
LM1889	3.00
LM2917	3.00
LM3302	0.90
LM3900	0.80
LM3909	1.00
LM3911	1.80
LM3914	3.50
LM3915	3.40
LM3916	3.40
LM13600	1.50
M51513L	2.30
M51516L	4.50
MB3712	2.00
MC1310	1.50
MC1413	0.75
MC1458	0.40
MC1495L	3.00
MC1496	0.70
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NE565	1.50
NE566	1.50
NE567	1.25
NE570	4.00
NE571	3.00
NE592	0.90
NE5532P	1.80
NE5533P	1.80
NE5534P	1.20
NE5534AP	1.50
OP-07EP	3.50
PLL02A	5.00
RC4136	0.55
RC4151	2.00
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RC4558	0.55
S566B	2.30
S50240	9.00
SAA1900	16.00
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SN76033N	3.00
SN76489	4.00
SN76495	4.00
SN76660	1.20
SPO256AL2	7.00
TA7120	1.20
TA130	1.40
TA7204	1.50
TA7205	0.90
TA7222	1.50
TA7310	1.50
TBA231	1.20
TBA800	0.80
TBA810	0.90
TBA820	0.80
TBA820M	0.75

TBA920	2.00
TBA950	2.25
TC9109	5.00
TCA210	3.50
TCA220	3.50
TCA940	1.75
TDA1010	2.25
TDA1022	6.00
TDA1024	1.10
TDA1170S	3.00
TDA2002	3.25
TDA2003	1.90
TDA2004	2.40
TDA2006	3.20
TDA2020	3.20
TDA2030	2.50
TDA3810	7.50
TDA7000	3.50
TEA1002	7.00
TL061CP	0.40
TL062	0.60
TL064	0.90
TL071	0.40
TL072	0.70
TL074	1.10
TL081	0.35
TL082	0.55
TL083	0.75
TL084	1.00
TL094	2.00
TL170	0.50
UAA1003-9	9.35
UA759	3.20
UA2240	1.20
UAA170	1.70
UCN4801A	4.00
ULN2003A	0.75
ULN2004A	0.75
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ULN2802	1.90
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UPC1185H	5.00
XR210	4.00
XR2206	4.00
XR2207	3.75
XR2211	5.75
XR2216	6.75
XR2240	1.20
ZN404	1.00
ZN414	0.80
ZN419P	1.75
ZN423E	1.30
ZN424E	1.30
ZN425E8	3.50
ZN426E8	3.00
ZN427E8	6.00
ZN428E8	4.50
ZN429E8	2.25
ZN447E	9.00
ZN448E	3.00
ZN450E	7.50
ZN459CP	3.00
ZN1034E	2.00
ZN1040	6.50
ZNA134J	23.00
ZNA234E	9.50

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CPU's

1802CE	6.50
2650A	10.50
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6502A	6.50
6502B	8.00
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6802	3.00
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6809	6.50
6809E	10.00
68B09	10.00
6809E	8.00
68B09E	12.00
68000-L8	36.00
8035	3.50
80C35	6.00

8039	4.20
80C39	7.00
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8085A	3.00
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6551A	6.00
6821	1.50
68B21	2.50
6829	12.50
6840	3.75
68B40	6.00
6850	1.60
68B50	2.50
6852	2.50
6854	6.50
68B54	8.00
6875	5.00
8154	8.50
8155	3.80
8156	3.80
8205	2.25
8212	2.20
8216	1.60
8224	P.O.A.
8226	4.25
8228	5.50
8243	2.60
8250	9.50
8251A	3.25
8253C-5	3.50
8255AC-5	3.50
8256	18.00
8257C-5	4.00
8259C-5	4.00
8275	29.00
8279C-5	4.80
8283	4.50
8282	4.50
8284	4.60
8287	3.50
8288D	9.50
8755A-0/1/2/9	16.00
TMS4500	14.00
TMS9901	5.00
TMS9902	5.00
TMS9911	16.00
TMS9914	14.00
Z80P10	2.50
Z80AP10	2.75
Z80CTC	2.50
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Z80DMA	7.00
Z80ADMA	7.50
Z80ASIO	7.00
Z80BP10	5.00
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RAMS

2016-150	4.00
2101	4.00
2102	2.50
2107B	5.00
2111A-35	4.00
2114-3	2.50
2147	4.00

4116-15	2.00
4116-20	1.80
41256-20	6.00
4164-15 (TI)	3.00
4164-15	2.00
4164-20	2.00
4416-15	3.50
4532-20	2.50
4816AP-3	2.00
5101/5501	4.00
5514/5114	4.00
5516	5.00
6116P-3	1.80
6116LP-3	4.00
6264LP-15	3.75
6810	1.50
74S189	1.80
74S201	3.50
74S289	2.25
93415	6.00
93L422	7.50
93425	6.00

ROMS/PROMS

28L22	4.00
24S10	2.50
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18SA030	2.00
74S188	1.80
74S267	2.25
74S288	1.80
74S387	2.25
82S23	1.50
82S123	1.50
82S129	1.75

EE PROM

2816-30	
2K×8	30.00
9306 256 bits (16×16)	4.00

EPROMS

2516+5V	3.50
2516-35	5.50
2532	4.50
2532-30	5.50
2564	8.00
2708	4.00
2716+5V	3.50
2716-35	5.50
2732	4.50
2732A-2	9.00
2732A-30	6.00
2732A-35	5.00
2764-25	2.00
27C64-25	10.00
27128-25	2.75
27128-30	7.50
27256-25	20.00
27256-30	20.00
TMS2716	5.00

CRT CONTROLLER

CRT5027	18.00
CRT6545	9.00
EF9364	8.00
EF9365	25.00
EF9366	25.00
EF9367	36.00
MC6845	6.50
MC6845SP	6.50
MC6847	6.50
SFF96364	8.00
TMS9918	15.00

CRYSTALS

32.768 kHz	1.00
1.00 MHz	2.70
1.8432 MHz	2.25
2.00 MHz	2.25
2.45760 MHz (S)	2.00
2.5 MHz	2.25
2.662 MHz	2.50
3.12 MHz	1.75

3.276 MHz	1.50
3.5795 MHz	1.00
4.00 MHz	1.40
4.194 MHz	1.50
4.43 MHz	1.00
4.608 MHz	2.00
4.9152 MHz	2.00
5.000 MHz	1.50
5.068	1.75
6.00 MHz	1.40
6.144 MHz	1.44
7.00 MHz	1.50
7.168 MHz	1.75
8.00 MHz	1.50
8.867 MHz	1.75
10.00 MHz	1.75
10.50 MHz	2.50
10.70 MHz	1.50
11.00 MHz	3.00
12.00 MHz	1.50
14.00 MHz	1.75
14.318 MHz	1.75
14.756 MHz	2.50
15.00 MHz	2.00
16.00 MHz	2.00
17.734 MHz	1.50
18.00 MHz	1.70
18.432 MHz	1.50
19.969 MHz	1.50
20.000 MHz	1.75
24.000 MHz	1.50
48.00 MHz	1.75
116 MHz	2.50
PXO1000	12.00

DISC CONTROLLERS

6843	8.00
765A	10.00
8272	12.00
FD1771	20.00
FD1791	20.00
FD1793	20.00
FD1797	22.00
WD2793	27.00
WD2797	27.00
WD1691	15.00
WD2143	12.00

CHARACTERS GENERATORS

RO-3-2513	US 7.50
RO-3-2513	LC 7.00

REAL TIME CLOCK

MC6818P	4.00
MM58174AN	9.90
MSM5832RS	3.50

BAUDRATE GENERATOR

MC14411	7.50
COM8116	6.50
4702B	7.50

KEYBOARD ENCODER

AY-5-2376	11.50
AY5-3600	7.50
74C922	5.00
74C923	6.00

UHF MODULATORS

6 MHz	3.75
8 MHz	4.50
SOUND & VISION 12 MHz	12.00

VOLTAGE REGULATORS
1A FIXED VOLTAGE PLASTIC TO220

+VE			-VE	
5V	7805	0.45	7905	0.50
6V	7806	0.50	7906	0.50
8V	7808	0.50	7908	0.50
12V	7812	0.45	7912	0.50
15V	7815	0.50	7915	0.50
18V	7818	0.50	7918	0.50
24V	7824	0.50	7924	0.50

1A FIXED VOLTAGE PLASTIC TO92

5V 78L05	0.30	15V 78L15	0.30
6V 78L06	0.30	5V 79L05	0.45
8V 78L08	0.30	12V 79L12	0.50
12V 78L12	0.30	15V 17L15	0.50

OTHER REGULATORS

LM309K	1.40
LM323K	3.50
78HO5KC	
5A 5V	5.75
78H12	6.40
78PO5	9.00

SWITCHING REGULATORS

ICL7660	2.50
SG3524	3.00
TL494	3.00
TL497	3.00
78S40	2.50
RC4195	1.50

VARIABLE REGULATORS

LM305AH	2.50	LM723N	0.50
LM317T	1.50	78HGKC	6.50
LM317K	2.40	78GUIC	2.25
LM337T	2.25	79HGKC	6.75
LM350T	4.00	79GUIC	2.50
LM396K	15.00	79MGT2C	1.40

DISPLAYS

FND357	1.00	MAN6610	2.00
FND500/TIL730	1.00	NSB5881	5.70
FND507/TIL729	1.00	TIL311	6.50
MAN74/DL704	1.00	TIL729	1.00
MAN71/DL707	1.00	TIL730	1.00
MAN3640	1.75	MAN6910	1.50
MAN4640	2.00		

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	75p
14 pin	42p	20 pin	60p	28 pin	100p
16 pin	45p	22 pin	65p	40 pin	130p

Turned Pin Low Profile Sockets								
	8 pin	20p	16 pin	30p	20 pin	40p	28 pin	65p
	14 pin	25p	18 pin	35p	24 pin	55p	40 pin	99p

DIODES

BY127	12p	OA200	9p	IN4003/4	5p
OA47	10p	OA202	10p	IN4006/7	7p
OA90	9p	IN914	4p	IN5401/2	12p
OA91	9p	IN4148	4p	IN5403/4	14p
OA95	9p	IN4001/2	5p	IS920	9p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way	50 way
Header Plug	90p	145p	175p	200p	220p	235p
Receptacle	85p	125p	150p	160p	190p	200p
Edge Conn.	120p	195p	240p	320p	340p	390p

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Testing, Testing

A new ·examination in electronics has been established by th Associated Examining Board, an independent self-supporting body which offers a range of testing and training services to industry, commerce and education. The examination will be in line with the series of Basic Tests run by the Board. Subjects in this series include Life Skills, Computer Awareness, the World of Work, Science and Graphicacy-(sic). The electronics test will be classified as a Basic Test (Specialist).

The AEB claim that the syllabus and examination were devised after research showed that employers wanted a test of basic electronics skills for potentia employees. John Day, Secretary General of the AEB, claims that, 'There are various tests available to employers in such things as mechanical aptitude, which are useful, but there is nothing appropriate in the field qt electronics.'

The draft syllabus and trial paper produced by the AEB for consultation bears a resemblance to City & Guilds 214 - a course designed for test engineers. There are, of course, a number of examinations available to educational and training establishments to test the capabilities of students of electronics at all levels. Apart from the City & Guilds tests, there are those held under the auspices of TEC and GCE boards. The AEB syllabus will be taught under four headings: components; electronic systems; measurement, instruments and fault-finding; and safety.

The first examination is scheduled for May, 1987. So far there is no indication of who will recognise the examination at that time. Further details may be obtained from The Associated Examining Board, Stag Hill House, Guildford, Surrey GGU2 5XJ (tel: 0483 506506).

An Italian View

In a recently issued paper titled 'The strategic importance of semiconductors to our societies', Pasquale Pistorio, President of Italian electronics giant SGS, has predicted that 'by 1987 Japan will occupy the three top positions in the list of the world's largest semiconductor suppliers.

Pistorio says that 'this is the result of a war which although not officially declared h� been fought by Japan with the purpose of conquering the worldwide electronic market' He claims that Japanese companies have been allowed to grow by the lack of national and supra-national strategies to support the Eutopean and American semiconductor industries.

The European and American semiconductor industries may continue their retreat into increased specialization, having already given up on memories. Despite (or perhaps because of) the current dispute between Intel and NEC over microcode copyright. the SGS president sees US and European firms handing over the microprocessor market to the Japanese while they fall back on semicustom chips to provide the significant market of the future.

This may enable the Japanese to end up with such a big share of the market that their position will be unassailable. 'If we follow the path of increased specialization,' Pistorio says, 'the semiconductor industry will no longer exist outside of Japan:

For Pistorio, that would mean the end of an electronics industry outside of Japan - and maybe worse. When one no longer controls semiconductor technology,' he says, 'one has relinquished control over one's industrial or technological destiny.'

· The road of advanced niche production leads nowhere unless it is supported by the basic technology and silicon foundry capabilities of 'successful large, broad range, suppliers.' Europe as a whole, concludes Pistorio, must support its semiconductor industry at all levels and across the board if it is to maintain any fndust')' at all.

Fair Hearing

Featurlng heavily at this year's British Music Fair (Olympia, 29th July to 3rd August) are a number of new MIDI products. Akal are exhibiting their latest MIDI compatible mixer - the MG1214 - as well as the AX73 controller keyboard with voice unit and the MPX820 fully programmable 8-channel mixer. Casio introduce a guitar style remote keyboard (the AZ1) with 41 touch sensitive keys and complete control over program change via MIDI. Meanwhile, Rose-Morris are unveiling what they describe as a 'MIDI guitar system from Ovation.' Roland's new MCSOO MIDI recorder is on show and Toa are launching the 04 and 04-E MIDI mixer and expander.

We hope to have a full report next month. In the meantime, among the more interesting products on show are MTR's portable 4-track, described as 'the ultimate in price busting', Rlckenbacker's 5 and 7 string basses and Peavey's fully programmable combo amp witl\MIDI interface.

Clamp It-Damp It

EMC Datacare have introduced a domestic version of their clamp-on interference suppressor. The suppressor is claimed to drastically reduce interference from all sources and is designed to be used with cables up to 9.9mm in diameter. The device consists of a ferrite core pair which just clamps on to the cable, so allowing suppression without having to remove connectors, cut or splice wires or open up equipment casing.

The company is producing two kits: the D918 'professional' version containing 8 core pairs and selling at £23.50 in small quantities and the D91 version with 4 core pairs for £13.95. EMC Datacare invite dealership enquiries and may be contacted at Power Court, Luton, Bedfordshire LU1 3JJ (tel: 0582450747).

• Allan Bradley of component supplier Bradley-Marshall has set up a partnership to distribute Velleman electronics kits. High-Q Electronics has exclusive UK distribution rights to the kits and will be supplying them to all the usual retailers, including Bradley. Marshall themselves. Two new products are to be released shortly - a car alarm kit(K2638) and a Liquid Level Control. Allen Bradley is actively seeking new retailers and can be contacted at High-Q Electronics, 382 Edgware Road, London W2 1EB (tel: 723 5963).

• Spaceheights Ltd of Weymouth announce the publication of two 'practical guidebooks' aimed at manufacturers and professional electronics designers as 'consumer guides' to software that may be relevant to them. They are 'A Practical Guide To The Control of Assemblies, Sub-assemblies, Labour, Materials and VAT on a Personal Computer - With Seven Illuminatiog Case Studies', and 'A Practical Guide To The Analysis of Linear Electronic Circuits on a Personal Computer - With 15 illustrative Case studies'. They are priced, respectively, at £6.99 and £5.99 inclusive and are available from Spaceheights Ltd., 6 Prospect Place, Weymouth DT4 JJY (0305 771974).

• In response to our request for EPROM programming services, we have received a number of replies. Midland Electronics, Sa Gregory Street, Lenton, Nottingham NG7 2LR (tel: 0602 7839369) offer programming from a listing. Ed Turnbull, Hydro Bungalow, Allendale Road, Hexham, Northumberland NE46 2NB (tel: 0434 607264) offers a comprehensive service, induding copying, programming from BBC disk or cassette and manual entry. Unfortunately, we can give n_& further details nor offer any'r assurances as to these services.

• As from next month, we'll be featuring a free readers' ad coupon In every issue. As from the subsequent month, we'll be featuring the free ads as well. The ads are designed for individuals not operating businesses chiefly as a means of selling or exchanging unwanted equipment They will, of course, be subject to a number of conditions ... among which will be a limitation on number of words and the absence of any guarantees on our part Provided people read the conditions on the ad coupon before buying or obtaining goods or services, there should be no problems. We hope the service will be popular and useful.

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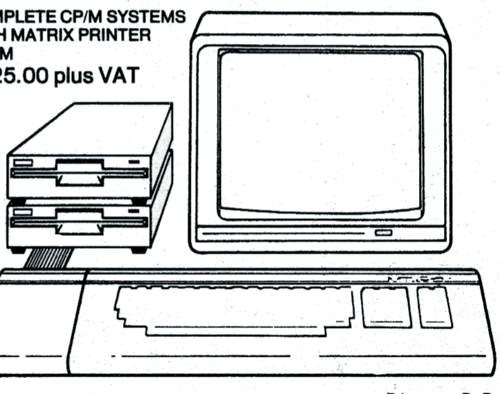

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68000P8	20.00
1793	12.00
1691	12.00
9216	12.00
1770	12.00
8271	45.00
2793	20.00
2797	20.00
L203B/4 ULN2003	0.70
L204B/4 ULN2004	0.70
MC1488	0.58
MC1489	0.58
SN75108	0.90
SN75189	0.70
SN75450	0.70
SN75480	0.99
SN76013	2.70
SN76023	2.80
SN76110	0.90
SN76228	0.90
SN76530	0.70
SN76660	0.70
SN76666	1.00
SN76666N	1.00
ULN2001	0.70
ULN2002	0.70
ULN2002AN	1.10
75109	1.20
75110	1.00
75112	1.60
75113	1.20
75114	1.50
75115	1.50
75121	1.10
75122	1.10
75150P	1.30
75154	1.30
75159	2.20
75160	4.50
75161	4.00
75162	4.50
75172	3.00
75182	1.00
75188	0.80
75189	0.80
75365	1.50
75450	0.60
75451	0.45
75452	0.45
75453	0.55
75454	0.55
75490	4.50
75491	0.60
75492	0.60

MEMORIES

2016AP12	2.95
2114-2	2.90
2716-350 N/S	3.00
2732 450 N/S	2.50
2732A 250	2.75
2764-200	2.50
2764-25	1.75
27C64-25	8.00
27128-200	3.00
27128-250	2.21
27256-25	7.00
4116-3	0.75
27C256-20	15.00
27512-25	36.00
27C512-25	49.00
4164P-15	1.50
41254-15	5.30
41256-15	3.00
41416-15	3.90
4864P-2 150N/S	1.50
50256-12	3.50
6116LP3 150NS	1.75
6116P4 200NS	1.50
HM 58064P-25	18.00
HM6264LP12	3.40
HM6264LP15	3.00
HM62256P-12	63.00
HM65256P-15	17.00
MB85101-A-10	46.00
TC5501P	4.00
TC5514AP3	2.95
TC5516APL2	2.90
TC5517BP	2.95
TC5565PL15	3.55
TMM2018D	6.85
TMM416P-3	2.95
UPD41464C-15	8.00
UPD43256C-15L	55.00

DIL SOCKETS

TP = Turned Pin LP = Low Profile

	LP	TP
8 PIN I.C. SOCKET	0.05	0.20
14 PIN I.C. SOCKET	0.07	0.35
16 PIN I.C. SOCKET	0.08	0.38
18 PIN I.C. SOCKET	0.09	0.43
20 PIN I.C. SOCKET	0.10	0.48
24 PIN I.C. SOCKET	0.13	0.52
28 PIN I.C. SOCKET	0.14	0.55
40 PIN I.C. SOCKET	0.18	0.85
24 PIN ZIF	4.16	
28 PIN ZIF	4.87	
40 PIN ZIF	7.02	

DIODES

AA19	0.08
AA129	0.20
1N4001	0.04
1N4002	0.04
1N4003	0.05
1N4004	0.05
1N4005	0.05
1N4006	0.06
1N4007	0.06
1N4148	0.03
1N5401	0.09
1N5402	0.09
1N5404	0.12
1N5406	0.12
1N5408	0.14
1S44	0.08
1S920	0.07
1S921	0.08
6A600	0.40

74HC & 74HCT

HC00	0.28
HC02	0.28
HC03	0.28
HC04	0.28
HC08	0.28
HC107	0.35
HC109	0.40
HC10	0.28
HC112	0.40
HC113	0.40
HC11	0.28
HC125	0.40
HC126	0.40
HC132	0.70
HC133	0.28
HC137	0.70
HC138	0.70
HC139	0.70
HC14	0.70
HC15	0.70
HC153	0.50
HC158	0.50
HC160	0.80
HC161	0.80
HC162	0.80
HC165	0.85
HC173	0.80
HC174	0.80
HC194	0.80
HC195	0.80
HC240	1.00
HC241	1.00
HC242	1.00
HC244	1.00
HC245	1.00
HC257	0.80
HC266	0.70
HC273	1.00
HC32	0.35
HC390	1.00
HC393	1.00
HC42	0.50
HC51	0.28
HC534	1.00
HC540	2.00
HC541	2.00
HC74	0.50
HC75	0.50
HC85	1.00
HCT240	1.75
HCT241	1.75
HCT244	1.50
HCT245	2.20
HCT640	2.40

CRYSTALS

32.768KHz	0.95
100.0KHz	4.00
1MHz	2.65
1.8432KHz	2.00
2.0MHz	2.10
2.4576MHz	1.90
2.5MHz	1.80
3.0MHz	2.10
3.2768MHz	3.00
3.579545MHz	1.25
3.6864MHz	1.70
4.00MHz	1.20
4.194304MHz	1.30
4.433619MHz	1.00
4.9152MHz	1.20
6.00MHz	1.30
6.144MHz	1.30
6.4MHz	1.50
6.5536MHz	1.50
7.159MHz	1.30
7.3728MHz	1.50
8.0MHz	1.40
10.0MHz	1.70
12.00MHz	1.50
15.00MHz	1.80
16.0MHz	2.00
18.432MHz	1.50
20.0MHz	1.50
32.00MHz	1.50
36.00MHz	1.30
48.00MHz	1.30

VOLTAGE REGS

7805	0.35
7808	0.35
7808CK	0.56
7812	0.35
7815	0.35
7815CK	0.56
7818	0.35
7824	0.35
78L05	0.20
78L08	0.20
78L12	0.20
78L15	0.30
78L24	0.30
7905	0.40
7908	0.40
7912	0.40
7915	0.40
7918	0.40
7924	0.40
79L05	0.33
79L08	0.40
79L12	0.33
79L15	0.40
79L24	.60

CMOS

4000B	0.18
4001B	0.18
4001UB	0.18
4002B	0.18
4002UB	0.18
4006B	0.50
4007UB	0.18
4008B	0.50
4009UB	0.25
40103B	3.00
40104B	0.75
40105B	1.50
40107B	0.40
40108B	2.35
40109B	0.87
4010B	0.25
40110B	1.85
4011UB	0.18
40114B	2.10
4011B	0.18
4012B	0.18
4012UB	0.18
4013B	0.25
40147B	0.85
4014B	0.40
4015B	0.40
40160B	1.25
40161B	1.25
40162B	0.50
40163B	0.50
4016B	0.25
40174B	0.50
40175B	0.50
4017B	0.40
40181B	1.80
4018B	0.40
40192B	0.50
40193B	0.60
40194B	0.60
4019B	0.35
40106B	0.35
40208B	2.10
4020B	0.50
4021B	0.50
4022B	0.50
4023B	0.18
4023UB	0.18
4024B	0.30
40257B	1.50
4025B	0.18
4025UB	0.18
4026B	0.80
4027B	0.25
4028B	0.32
4029B	0.50
4030B	0.18
4031B	1.00
4033B	1.00
4034B	1.10
4035B	0.50
4038B	0.60
4040B	0.45
4043B	0.40
4044B	0.45
4045B	1.00
4046B	0.50
4047B	0.50
4048B	0.30
4049B	0.25
4050B	0.25
4051B	0.50
4052B	0.45
4053B	0.45
4054B	0.60
4055B	0.60
4056B	0.60
4060B	0.50
4063B	0.70
4066B	0.25
4067B	2.00
4068B	0.18
4069UB	0.18
4071B	0.18
4072B	0.18
4073B	0.18
4075B	0.18
4076B	0.50
4077B	0.18
4078B	0.18
4081B	0.18
4082B	0.18
4086B	0.45
4089B	0.95
4093B	0.25
4094B	0.60
4095B	0.75
4096B	0.75
4097B	2.25
4099B	0.75
4502B	0.50
4503B	0.33
4508B	0.90
4510B	0.40
4511B	0.40
4512B	0.40
4514B	1.00
4515B	1.00
4516B	0.40
4517B	2.25
4518B	0.40
4520B	0.40
4522B	1.10
4526B	0.40
4527B	0.50
4532B	0.50
4536B	2.00
4538B	0.60
4543B	0.55
4555B	0.30
4556B	0.30
4584B	0.45
4585B	0.40
4724B	1.00

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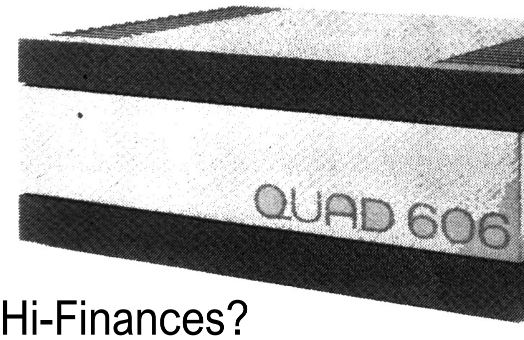

Hi-Finances?

Hi-fi equipment manufacturers Quad are really pushing the boat out in their fiftieth anniversary year. Not long after the introduction of their 306 poweramplifier(see News Digest, April '86 ETI) comes anothernew power amplifier, the Quad 606.

The 606 uses Quad's famous feed-forward error correction or 'current dumping' system and is described as having a similar circuit topology to the 306 'with more of what matters where it matters'. Maximum power output is 180 watts per channel into eight ohms on speech and music (140W on sine waves) and roughly double that amount of power into four ohms. The retail price will be £449.00 including VAT.

Along with the information on the 606 came a glossy, 8-page brochure called" Quad - the first fifty years" which contains a history of the company in pictures. There was no accompanying note to say whether further copies are available ornot, but we expectthey'll send you one if you ask nicely. The address is Quad Electroacoustics Ltd, Huntingdon, Cambridgeshire PE18 7DB, tel 0480 52561.

• Another item of Hi-fi equipment well worth looking out for is the new Mirage system. It consists of a three-way active loudspeaker arrangement in which each drive unit is fed from a separate power amplifier. The amplifiers are fed from an electronic crossover unit which in turn is driven from a control amplifier. The complete system is said to offer extremely high output levels and will cost a lot more than most of us have in our piggy-banks.

Features include the use of balanced connections between units, high overload margins on all inputs and an extremely high signal-to-noise ratio. The X10 electronic crossover includes time delays to correct for phasing in the loudspeakers and both this unit and the C10 control amplifier are fed from an external power supply. The P100 power amplifiers use a four-wire output system which places the loudspeaker connections inside the feedback loop and their rated output is 100Winto8R, 180Winto4Rand 250W into 2R. Completing the line-up are the S10 loudspeakers which have a cabinet volume of 85 litres and feature a 38mm ferro-fluid treated HF unit, a dome midrange unit and a 318MM bass unit.

First samples of the new system should be available by the time this issue goes on sale. We'll let you know if we get our hands on one!

• Following the launch of their 32-bit reduced instruction set computer chip, Acorn have introduced an evaluation system for the device. The kit includes both hardware and software and is available in two versions, one for the BBC and Master series micros and one for the IBM-PC and AT and compatible machines. The BBC/Master version is available now and costs £4,500 plus VAT, and the IBM-PC/AT version will become available during the last quarter of this year. Acorn Computers Ltd, Fulbourn Road, Cherry Hinton, Cambridge CB1 4JN, tel 0223-245 200.

• *Satellite enthusiasts may like* to *know that* Comex *Systems sell a TVRO (television receive only) receiver kit It* consists of *a board and components for the RF, IF, video, control and sound IF circuits and* two *complete modules,* one *a tuneable converter covering 950-1450MHz and the other an IF processor and wideband FM quadrature detector. They can also supply much* of *the necessary add-on equipment For price and other details* contact *them at* Comet *House, Unit 4, Bath Lane, Leicester LE3 5BF, tel* 0533-25084.

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

GET DOWN TO BUSINESS WITH OCTOBER'S ETI

Take The Plunge

In the next ETI, we'll be starting *a short series of supplements to help readers thinking about starting their own businesses. Electronics offers a huge range of opportunities for small businesses - component supply, technical services, design, manufacture. We'll be profiling successful businesses started by hobbyists and trying to fathom the reasons for their* success. *But we'll also offer useful information and advice from experts on legal, financial and technical matters.*

You'll find out how to *organise your business, why you need a business plan, where to get financial backing, how* to *negotiate the law and more. Our a,m is* to *give you enough information* to begin *any new venture you may be considering by the end of the series, and* to *begin it with confidence and a* good *chance of success.*

A Good Buy

We're also announcing the start of a Free Readers' Ads service, to give readers a forum for selling, buying or exchanging equip-ment Watch out for the coupon appearing in next month's issue.

Optical Memory

The CD-ROM is almost with us, but *even* before its arrival the idea that optical storage is restricted to read-only memory is already outdated. This feature examines the whole field of optical storage and looks forward to the CD-ROM in particular.

PLL Digital Frequency Counter

Our project section leads off with a spectacular piece of test equipment, designed by Graeme Durant The counter is fully auto-ranging between 15Hz and 1OM Hz with a four digit display plus range indication. A *frequency multiplier allows updating* to *occur two and a half times* a *second* on *all ranges -invaluable for audio work. We think this design is the equal of commercial designs costing hundreds of pounds and yet the whole thing contains only standard components and can be built for well under £100.*

Plus: News, Reviews, Tech Tips, Read/Write and all our regulars.

THE OCTOBER ISSUE OF ETI ON SALE 5th SEPTEMBER

All the articles listed above are at an advanced stage of preparation, but circumstances beyond our control may prevent their publication.

NEWS: NEWS: NEWS: NEWS:

DIARY

Optical Fibre Telecommunications — August 31st-September 5th
University College of North Wales, Bangor. For details see August '86 ETI or contact the IEE at the address below.

Radio Amateurs' Examination Course — September 3-5th onwards
North Trafford College, Manchester. Preparation for the City & Guilds RAE and the Post Office morse test which can be taken on two evenings a week or as a full day's study each Wednesday. There is also an advanced morse course running on Monday evenings. Enrolment takes place on the above dates at the college, Talbot Road, Stretford, Manchester M32 0XH, tel 061-872 3731 extension 53.

The Evolving Local Telecommunications Network — September 7-12th
Aston University, Birmingham. Vacation School organised by the IEE and designed to bring newcomers to the field of telecommunications equipment design up to date with the conditions and requirements of the existing network. For details contact the IEE at the address below.

Electrical Measurements, DC to VHF — September 7-12th
Imperial College of Science and Technology, London. For details see August '86 ETI or contact the IEE at the address below.

Radio Amateurs' Examination Course — September 8-10th onwards
Paddington College, London. For details see August '86 ETI or contact the college, 25 Paddington Green, London W2 1NB, tel 01-402 6221.

ESSDERC '86 — September 8-11th
University of Cambridge. Conference covering the latest developments in solid state device research. For details contact the Institute of Physics, 47 Belgrave Square, London SW1X 8QX, tel 01-235 6111.

Commodore Horizons Show — September 13/14th
UMIST, Manchester. For details contact Database Exhibitions at the address below.

Television Engineering Course — September 17th onwards
The IBA, London. Series of 29 two-hour lectures to be held on one evening each week at 6.30pm. Covering all aspects of television engineering, the course is aimed both at those new to the industry and those already in it who wish to revise or bring their knowledge up to date. For details contact the Royal Television Society, Tavistock House East, Tavistock Square, London WC1H 9HR, tel 01-387 1970.

People and Computers: Designing For Usability — September 22-16th
University of York. Conference organised by the Human-Computer Interaction group of the British Computer Society. The event features workshops and tutorials to provide practical expertise in the latest techniques as well as an accompanying exhibition and a varied social programme. For details contact the BISL Conference Department, The British Computer Society, 13 Mansfield Street, London W1M 0BP.

Electron & BBC Micro User Show — September 26-28th
UMIST, Manchester. For details contact Database Exhibitions at the address below.

Electromagnetic Compatibility — September 30th-October 3rd
University of York. See August '86 ETI or contact the Institution of Electronics and Radio Engineers, 99 Gower Street, London WC1E 2AZ, tel 01-388 3071.

Sound Comm '86 — October 1/2nd
New Century Hall, Manchester. Exhibition of sound equipment for PA, discos, sound reinforcement, etc. Organised by the Association of Sound and Communications Engineers. For details contact Brenda White on 06286 - 67633.

Addresses
Database Exhibitions, Europa House, 68 Chester Road, Hazel Grove, Stockport SK7 5NY, tel 061-456 8835.

Institution of Electrical Engineers, Savoy Place, London WC2 0BL, tel 01-240 1871.

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ADF13 Rom Cartridge .... £13 (d)
ADF10 Econet Module .... £43 (c)
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ADJ23 Ref. Manual Part II ..... £14.95 (c)
ADJ24 Advanced Ref. Manual . £19.50 (c)

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Multiform Z80 2nd Processor .... £299 (b)
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64K Upgrade Kit for B Plus .... £35 (d)

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Econet Starter kit .... £85 (d)
Econet Socket Set .... £29 (c)
Econet Bridge .... £174 (b)
File Server Level II .... £179 (d)
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10 Stallion Lead set .... £26 (c)
Adv. Econet User Guide .... £10 (d)

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PS400 with psu 1 × 400K/1 × 640K 40/80T DS .... £129 (b)

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PS35 1 with psu .... £121 (b)
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PD35 2 with psu .... £209 (b)

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EPSON
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Optional Tractor Feed .... £20 (c)
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FX80 .... £260 (a)
FX105 (136col) .... £449 (a)
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JUKI 6100 Daisy Wheel ...... £249 (a)
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RS232 Interface + 2K Buffer .... £85 (c)
Ribbon KP810/910 .... £6.00 (d)

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

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

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Printer Leads can be supplied to any length

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PHILIPS BM7522 12" Hi Res Amber Screen .... £79 (a)
Swivel Base for Kaga Monochrome fitted with Digital Clock .... £21 (c)

MODEMS

— All modems listed below are BT approved

SPECIAL OFFER

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

MIRACLE 2000
A world standard modem covering V21, V23 (Bell 103/113/108 outside UK) and including 75, 300, 600, 1200 baud ratings. Optional Auto dial, auto answer cards, complete control from computer keyboard. WS2000 £95 c

GEC DATACHAT 1223:
BABT approved modem complying with CCITT V23 standard. Supplied with software .... £69 (b)

Data Cables for above modems available for most computers.

SPECIAL OFFER

2764-25 ...... £2.00
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Please add carriage 50p unless indicated as follows:
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Serial Test Cable
Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end using a 10 way switch making it possible to produce almost any cable configuration on site.
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Allows an easy method to reconfigure pin functions without rewiring the cable assy.
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Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
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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).**

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

UV ERASERS

All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time .... £47(c)
UV1T as above but with a timer .... £59(c)
UV140 erases up to 14 eproms at a time. £68 (b)
UV141 as above but with a timer .... £88 (b)

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

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

D CONNECTORS

No of Ways

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

EDGE CONNECTORS

	0.1"	0.156"
2 × 6-way (commodore)		300p
2 × 10-way	150p	
2 × 12-way (vic 20)		350p
2 × 18-way		140p
2 × 23-way (ZX61)	175p	220p
2 × 25-way	225p	220p
2 × 28-way (Spectrum)	200p	
2 × 36-way	250p	
1 × 43-way	260p	
2 × 22-way	190p	
2 × 43-way	395p	
1 × 77-way	400p	500p
2 × 50-way (S100conn)	600p	

EURO CONNECTORS

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

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

AMPHENOL CONNECTORS

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

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

GENDER CHANGERS

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24" Single end Male
24" Single end Female
24" Female Female
24" Male Male
24" Male Female

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(grey/metre)

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

DIL HEADERS

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

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READ/WRITE

Mud Slinging

Dear Sir,

As a regular reader of ETI since its inception, I have enjoyed the often outrageous leg-pull articles usually reserved for your April Issue. I read your July feature "JOBS FOR A CHANGE" and wondered . . .

Can there really be a vast 'data base' at the end of that often muddy, weed-infested, single cart-track cul-de-sac so aptly named Green Lane in the tiny village of Marshfield? The thought of hordes of consultants, advisors and peace-loving applicants trying to pass each other in the lane, let alone park as they flock to avoid alleged extortionate rates of registered employment agencies, or rushed to the aid of a post-graduate research worker looking for material for his thesis, really made my eyes water. Could the tiny one-roomed village Post Office survive the volumes of mail that the proposed modus operandi of Exchange Resources would generate?

A point that puzzled me even more is that there appear to be no records to show that Exchange Resources has the necessary license required under the Employment Agencies Act 1973 and Employment Protection Act, 1975, or indeed local planning approval, to operate as a legal entity and so 'advertise' its past and proposed agency achievements in a feature article in ETI.

Once licensed, an agency or business must sign a Certificate of Compliance which is an undertaking to operate within the respective Acts. All aspects of the business, in particular the handling, storage and access to confidential documentation received and generated on behalf of applicants and clients, are regularly inspected by the Area Employment Agency Licensing Office to ensure strict compliance with the Acts. For example it would be illegal to reveal any matters of confidentiality obtained in the conduct of business in an article for ETI, or to feature jobs available, except by formal and competitive advertisements.

At this point I feel that I should make it clear that I have no interests in the employment agency business whatsoever, but am a Director of a Technical Services Division comprising three high technology companies. As with all such companies in this area, we have an interest in cost effective recruitment which we know is a highly personal and confidential process requiring specialist training and experience. We operate in the 'real world' which is quite different from that envisaged by your article.

There are some 300 licensed agencies in the proximity of Exchange Resources contact address and contrary to the ETI article, which contains nothing new whatsoever, all of the services proposed in the article and many more are currently provided for. The facts are that licensed agencies within a 50 mile radius of Bristol, cooperate with each other and with other organisations to provide cost-effective recruitment. Incidentally, in some 40 years of experience I have yet to find a confessed pacifist turn down high remuneration, a company car and other 'perks' because he does not want to be associated with the 'defence industry'.

To cater for the 'smaller client companies' which your article appears to believe are neglected, the Bristol Chamber of Commerce and Industry issues a comprehensive guide on "Successful and Cost Effective Recruitment" prepared through its Small/Independent Business Committee. I enclose a copy for your information.

Cost effective recruitment is time consuming and therefore costly, if the right person is to be selected for the job. The cost of the total process of selection for a typical specialist electronics design engineer position in a major company could be about £1,000. Unfortunately, if the agency selection is not approved by the client the agency stands to lose its costs against operating overheads. You cannot 'shortcut' this process by using a so called 'data base' no matter how large the main frame. The VDU does not permit you to probe the brain of the individual on file for which your client is paying, even if you could keep your records up to date with the varied and nomadic changes of which your applicants fail to inform you.

In the real world, very few clients are prepared to help you overcome 'cash flow' problems of your business or agency with pre-paid service contracts — why should they when they can take 90 days or more credit at your expense by delaying payment of your invoices! Furthermore you need only about ten subcontracted staff who want to be paid on a weekly basis, against your clients contracted terms of monthly payment to find that you need a £30,000 overdraft at the end of 90 days. Which is why you rarely see a Porsche or a Roller parked in front of houses of those entrepreneurs who invested their money in the employment agency business. If you believe that average agency charges of some 12% of placement's annual salary is extortionate then may I remind you that industry and most other business gross profit margins are pitched at 40% of turnover.

It is strange how some people will pluck defence expenditure figures out of the blue without considering the true apportionment. Some four fifths of defence costs are spent on salaries, transportation, administration, buildings and purchases of common user items manufactured outside of the defence industry, without which the whole of the commercial base of this country would collapse. In the electronics industry almost all of the bulk materials are common user items made to specification, and who is to say which BC108 goes to domestic or defence electronics.

Finally, with memories of my 1937 school days when many schools spent many hours winding basket weave variometer inductors destined for home made crystal sets to be distributed by some charity to the far flung outposts of the British Empire — do the people of Eritrea really need three wave band radios to make, when you can buy far eastern made sets for less than £10 in Asmara? Surely *it would be chaper to buy these plus periodic replacement batteries on a charitable basis. Incidently, I seem to recall that the basket weave inductors finished up as the centre piece for ornate native hair arrangements, but there was an even greater demand for two inductors which finished up as an ornate but uncomfortable bra!! So much for the crystal sets.*

Yours Sincerely
A.H.E. Welch, DFC. TD.
Corsham,
Wiltshire

We showed Mr. Welch's letter to Tony Wilson, whose proposals for a recruitment agency operating in the electronics industry formed the subject of the JOBS FOR A CHANGE feature. This is his reply:

I had been expecting the cheap jibes and prejudice contained in Mr Welch's letter. The letter does however have some points worthy of reply, so let's start at the beginning.

Yes, Green Lane can be muddy, and does have weeds (countryside plants and flowers) — and thankfully it isn't yet completely gentrified. There won't be hordes of people visiting this address — as with most agencies there will be other means of communication, and there will be other offices in some of the major cities. The village PO does actually manage to cope admirably with our mail and with that of several large postal businesses (how many PO s have more than one public room anyway?)

Mr Welch really should check his facts much more thoroughly than he does. We had a DoE licence to trade well before the date of his letter, and it is prominently displayed on these premises (which he could easily have checked during his daring venture up Green Lane).

Mr Welch's patronising tone does him no credit; he seems to assume that people who wish to advance from the status quo by using our resources more effectively are complete dupes, incapable of getting anything professional together. I have been trading on my own account since 1976 and am a fellow of the Institute of Quality Assurance. Within the agency there is similar expertise and business experience. We are also being advised by several reputable and successful agencies in the U.K.

There is a very real gap in the market, and I have proof of that from the interest shown by employees, consultants, employers and other agencies — and by our backers. This is the 'real world' Mr Welch, where many many, people are sick of this country's over commitment to so-called defence. They fervently wish to see change, and that change will come about despite resistance caused by fear and self-interest. I am a 'confessed pacifist' whatever you mean by that. What I mean by it is that I am committed to peace and am prepared to take high personal risk to that end. I have repeatedly turned down big remuneration, company cars and perks, and a very well paid career. I still work in defence, despite the sometimes severe problems this cases me and my family, because I believe we need an effective defence and that I have an absolute right to influence it from the inside. I could show you many more people willing to put their money where their mouths are. What risks in your every day life do you take for your beliefs Mr Welch?

The Bristol Chamber of Commerce is one of many local agencies providing good service to the small business person — but they do not provide tailored, flexible services. We intend to do that. We are very well aware of the high costs of staff placement and of the skills and expertise needed. In this respect we have the services of experienced people and organisations throughout the UK. Their services do not come cheaply but we believe that with the right approach we can do the whole job more cheaply than most agencies. I do see 'Porsches and Rollers' belonging to well-heeled agents — some of whom I know very well. If it wasn't so profitable I doubt if there would be 'some 300 licensed agencies' near here, as you claim. General business profit margins may (or may not) be pitched at 40% of turnover, but agencies do not "turnover" a placement's salary, they never even see it, so that is a crass comparison to make. In any case there are agencies which approach or exceed 40% (for example, many office temping agencies).

I'm well aware of the dependence of the commercial sector on defence procurement and the use of services. The degree of that dependance is to do with government priorities — it's not God given or inevitable. We could spend very much less on 'defence' and give more support to industry to make it more competitive, invest in new technologies, R & D, and education and training (even the conservative CBI and Institute of Directors are beginning to recognise this).

In your final paragraph I find your racist assumptions that the people of Eritrea can only deal with technology in your comic book terms, and are only fit for charity and hand outs, particularly objectionable. Their request to us is to provide a beginning for an indigenous technology base, so that they are not dependent on the patronage of you and me forever more. Their country has been ravaged by wars financed by Western, and now Soviet, money. The only way they can regain their own power is to become self sufficient — I will be very pleased if I can help in a small way.

Incidentally, Mr Welch, to help move your education out of the 1930's and to begin to understand the brilliance, courage and resourcefulness of the Eritreans, why not send for more information on the sophisticated social, technical and other systems that have been set up under a state of siege in Eritrea, by Eritreans. Send a request and an A5 SAE to: Eritrean Information Service, 391 City Road, London EC1V 1NE, or 'phone (01) 837 9237.

Tony Wilson BA FIQA

Dear Sir,

I have recently started reading ETI again after a lapse of a few years, due to the increases in subscription price and an excess of articles of the bolt-on computer goody/1001 more-boring-things-to-do-with basic theme, and I have been delighted to see a more intelligent, questioning and rational approach to the problems of the connection between electronics and the 'defence' industry.

I look forward to reading a regular feature on Exchange Resources, and all I can say to those misguided individuals who have cancelled their subscriptions, presumably anxious to retain their cosy cost-plus contract jobs, supported by the hard-earned taxes of hard-working commercial software engineers like myself, is that I hope I can afford to take out a subscription again, if I don't win it in the reader survey!

Yours faithfully,
Alexander Monro
Jericho,
Oxford.

● Around twenty letters have been received in response to the JOBS FOR A CHANGE article, some sent to us at ETI and some sent directly to Exchange Resources. With the exception of the two letters printed here, all of the replies have been from people who either wish to make use of the services offered by Exchange Resources or who are interested in participating in one of the projects mentioned in the article. — Ed.

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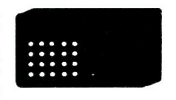

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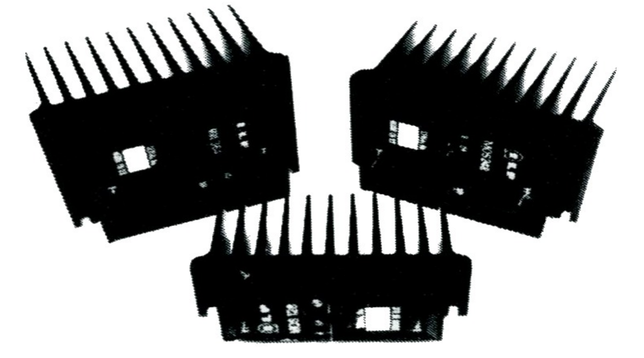

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Type	Output Power Watts (rms)	Load Impedence Ω	Price
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Ideal for Hi Fi, Full load protection integral Heatsink, slew rate 15v/μs

Type	Output Power Watts (rms)	Load Impedence Ω	Price
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HY124	60	4	£17·45
HY128	60	8	£17 45
HY244	120	4	£22·45
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Distortion less than 0.01%

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CHARGE OF THE LIGHT BRIGADE

U2 can be an expert on batteries, with a little help from Andrew Armstrong.

In the design of electronic equipment, the power supply often used to be left until last and then designed almost as an afterthought by the most junior member of the design team. Nowadays, there are specialist engineers and companies concerned only with power supplies, and it is recognised that the choice of power supply can influence the overall equipment design very significantly.

So it is with batteries. Increasing numbers of electronic products need a portable power source, and the correct choice of battery can determine the product's viability. Of course, there have been specialists in the design and manufacture of batteries since they started to be manufactured commercially, but this is a discipline allied to chemistry rather than electronics.

Because chemists design batteries and engineers design the batteries into machinery, the choice of battery type is sometimes less well informed than it might be. The two types of experts do not speak the same language, so it is not surprising if the criteria for choice are imperfectly understood.

Chemistry

A detailed knowledge of the chemistry involved in an electric cell is not necessary for the electronics designer, but a knowledge of what goes into a cell and how it is assembled is useful background information.

The basic idea behind an electric cell is to have two chemicals reacting in an ionic form, such that 'spare' electrons accumulate at one side of the reaction. If the physical construction of the cell is such that the electrons can only return to the other side via an external circuit, then useful energy can be extracted. This effect is illustrated most simply by the reaction used in a mercury cell (Fig. 1).

On the left we see an oxygen ion O— leaving the mercuric oxide cathode and taking with it two electrons from the mercury atom. This oxygen is being attracted towards the zinc anode, which has a greater affinity for oxygen than the mercury.

Once it has left the cathode, the oxygen reacts with a molecule from the water electrolyte to form two hydroxyl ions, OH—. One of these joins with the zinc, and the hydrogen is released, leaving behind its electron. The hydrogen, H—, rejoins the second hydroxyl ion, reforming the water molecule. Now the cathode has lost two electrons, the anode has gained two, and the water is unchanged.

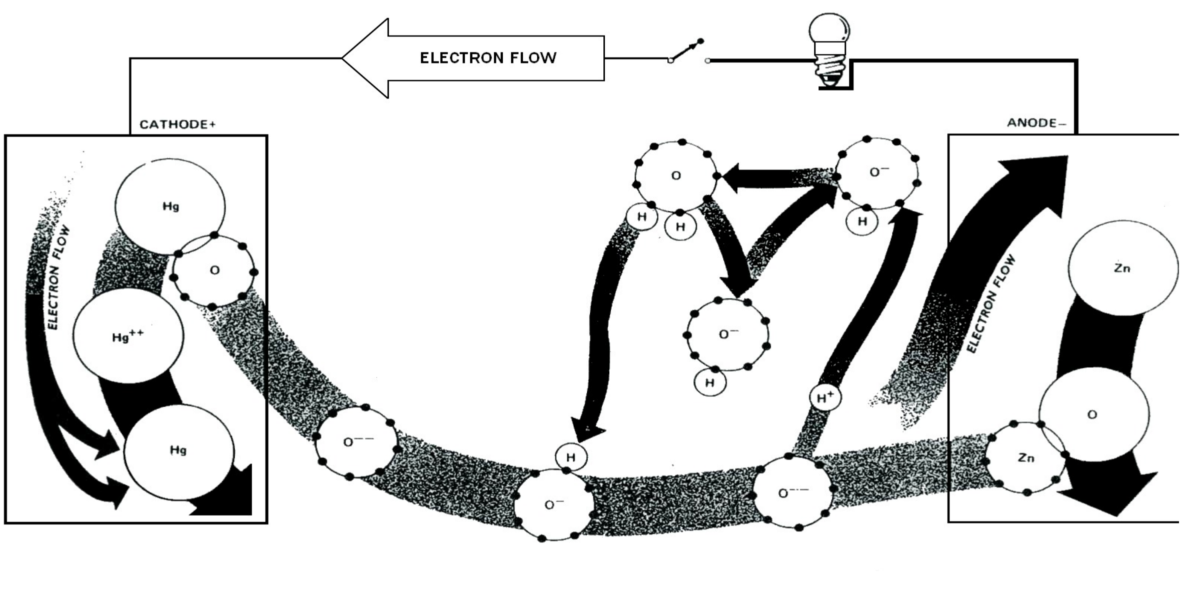
Assuming that no external circuit is connected, this reaction will continue until the electrostatic repulsion between the excess electrons on the anode, and the hydroxyl ions balances the extra affinity of zinc for oxygen compared with mercury. The point at which this occurs determines the EMF of the cell.

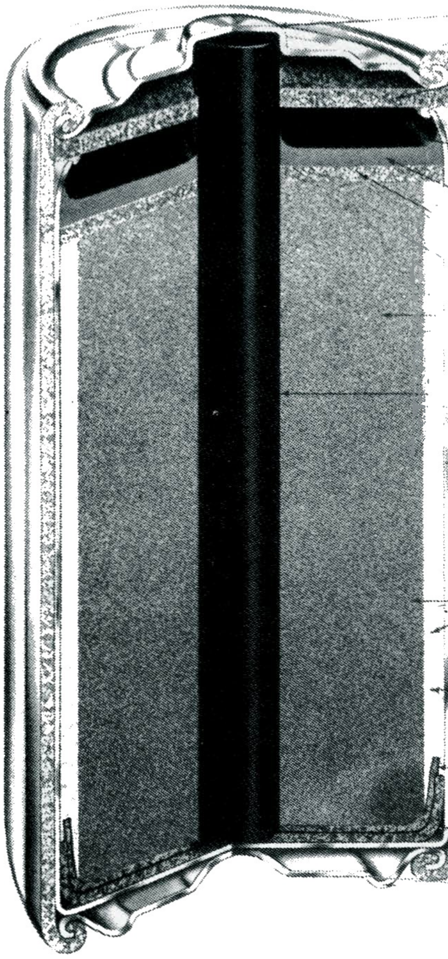
If an external circuit is connected, the reaction proceeds, and the spare electrons on the anode flow through the circuit to replace those missing on the cathode.

It is not easy to give within the scope of this article a deeper explanation. In general, atoms of elements consist of a nucleus containing protons (with one positive charge) and neutrons (with no charge) and a number of electrons equal to the number of protons. Thus, the charges balance.

The electrons are arranged in shells — groupings of similar energy states — and for maximum stability each

Fig. 1 The chemical reaction which takes place inside a mercury cell.





Rg. 2 The internal construction of a zinc-carbon cell

shell should contain its full complement of electrons. Most elements do not have the exact number of electrons to fill all the shells used, so the outer shell (in which the electrons have the highest energy level and are least strongly bound to the nucleus) is often short of a few electrons. Elements combine into chemical compounds to complete their outer shells by sharing electrons.

Why then should oxygen prefer to share two electrons with zinc rather than with mercury? The answer is that zinc has 30 electrons, as against mercury's 80. This means that zinc's outer shell is closer to the nucleus (lower in energy) than that of mercury. If all else is equal, systems try to attain the lowest energy levels (like a ball rolling to the bottom of a hill), which explains the direction of the reaction in a mercury cell.

If you want to know why the electron shells need a specific number of electrons — it beats me. If anyone knows please write and tell me.

Primary Cell Types

In practice cells are more complicated than the mercury cell illustration. Other chemicals are added to assist the reaction, prevent deterioration, etc. We will take a look at some of the main types of cell, beginning with primary (non-rechargeable) cells.

The zinc-carbon cell, illustrated in Fig. 2, is perhaps the most widely used in consumer applications. The anode is made of zinc, the active surface of which is amalgamated with merucry. The zinc electrode forms the outer case of the battery as well, though some manufacturers add an outer steel case.

The cathode is made of manganese dioxide, with a carbon rod to collect the current. The electrolyte is a solution of ammonium chloride (NH_4Cl) and zinc chloride ($ZnCl_2$), which is acidic.

The heavy duty zinc-carbon cell is very similar to the ordinary variety, but the difference is that its electrolyte is zinc chloride only. This gives an increased ability to provide heavy currents, though it has no greater energy storage.

The alkaline-manganese cell uses similar electrode materials, but its electrolyte and construction are different from the zinc-carbon cell. This is illustrated in Fig. 3. The anode is made of powdered zinc, amalgamated with mercury, and the current is collected by a metal collector (the 'nail') instead of a carbon rod. This provides a low internal resistance for the cell.

The electrolyte is potassium hydroxide, an alkaline solution which is highly conductive. The cathode is made of electrolytically-produced manganese dioxide, which is purer and has more oxygen per unit volume than the naturally occurring substance. This means that the energy content of the cell per unit volume is greater than that of the zinc-carbon type.

These are the most commonly used cells, but a number of other types are used where other qualities are needed. Most of these are button cells, designed to meet special

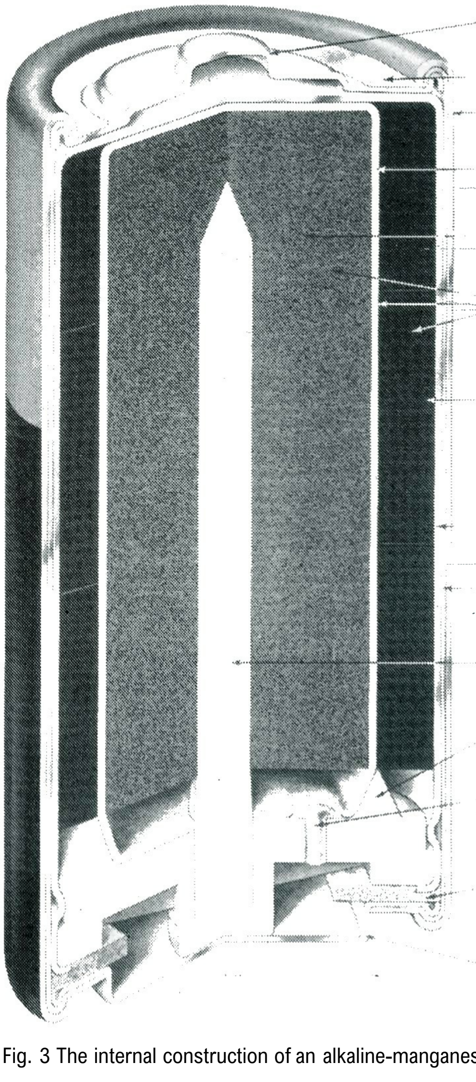


Fig. 3 The internal construction of an alkaline-manganese cell.

needs. The mercury button cell is illustrated in Fig. 4 and its basic chemical reaction has already been described. Its output is 1.3V. A cell with a silver oxide cathode provides 1.6V, and can be used where the extra voltage is needed, or where the environmental effects of disposing of mercury cells are unacceptable. The silver cell is even more expensive than the costly mercury cell.

Zinc-air cells (also illustrated in Fig. 4 to show the relative sizes of the anodes) have been around for some time, but have not turned out to be the panacea which some people initially believed them to be. Their major advantage is that they get their oxygen from the air rather than from an oxygen bearing chemical, so that for a given energy storage they are smaller and lighter than many other types of cell.

They have two main disadvantages. One is that zinc-air cells require air to operate, so they cannot function in a sealed environment. I recall a story circulating at a company where I worked about the zinc-air batteries manufactured by another part of the group. Apprently these had been installed in digital watches in considerable quantities, and all had gone well for a while. After about two months there were complaints that the watches had all stopped working, though when examined they appeared to be working correctly. It was eventually discovered that the battery stopped working when it had used all the oxygen contained in the watch, and restarted when the back was taken off to investigate.

The other difficulty with zinc-air cells is that once the air seal has been removed to allow the cell to work, the electrolyte starts to dry out. Normal cells remain usable for about three months, although some special low drain ones are meant to last three years. Rumour has it that these are not always satisfactory.

The lithium cell has been heralded as a major advance in battery technology. In fact there is not one type of lithium cell but about a dozen variations. Some examples of these are lithium copper oxide, lithium sulphur oxide and lithium thionyl chloride.

The energy per unit weight is high because lithium is a light metal, the third lightest element in the periodic table after hydrogen and helium. Lithium is extremely reactive, which you might think would result in a rapid or explosive self discharge of the cell. What actually happens is that the surface reacts and forms a non-reactive oxide layer which prevents any unwanted reaction. The result is that the cells have a long shelf life, typically ten years.

Secondary Cells

So far all the cells mentioned have been of the primary, or non-rechargeable type. Secondary (rechargeable) cells have been around for some time now, and they are being used more and more. The first widely used rechargeable battery was the lead acid car battery, but this is not practical for use in portable electronic equipment.

When a cell is recharged, current is forced through it in the reverse direction. The oxygen leaves the anode, restoring it to its metallic state, and returns to the cathode. Small primary cells are not capable of this process to a worthwhile degree, because the anode material swells up as it oxidises (just like rust on a car) and its shape is distorted and pieces may break off.

In the **nickel cadmium cell** (NiCad) this problem is largely solved by containing the anode and cathode materials in porous, conductive plates. The individual particles of electrode material can change size without seriously changing the shape of the overall structure, so recharging is possible.

Nickel cadmium cells may be stored in any state of charge, but if they are stored completely discharged for long periods a probelm can arise There is a tendency for crystaline cadmium 'whiskers' to grow towards the opposite plate of the battery. If the cell is charged, then a short circuit will melt the whisker back onto the anode. If there is no charge in the battery this cannot occur, and it is possible to reach the stage where no practical amount of current fed into the cell will remove the whisker. The cell is then of no further use.

Sealed lead-acid cells and batteries are also available and are widely used in industrial emergency lighting and back-up supply systems. They are also to be found in some professional portable tape recorders (for example, the type used by many radio journalists) and are beginning to appear in domestic audio equipment. The Sony Discman II CD player reviewed in ETI recently uses a battery pack of this type.

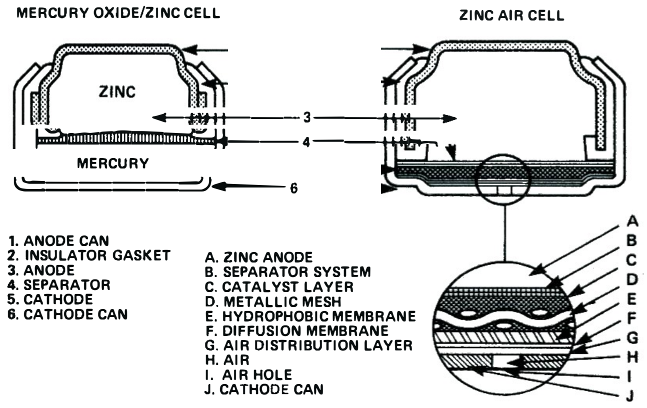


Fig. 4 The internal construction of a mercury button cell (left) and a zinc-air cell (right).

Sealed lead-acid cells have a nominal operating voltage of 2.2V so they cannot be substituted directly for zinc-carbon or manganese-alkaline cells. They come in two types — the flat plate type, normally supplied as 6V or 12V batteries, and the Cyclon cylindrical cell type, normally supplied individually. Both types should be stored in a charged state.

Less commonly available are **silver-zinc rechargeable cells.** These have about double the energy density of NiCads, and a constant voltage over most of the discharge. They are little used in amateur or consumer equipment.

Of more future interest are the new **rechargeable lithium cells,** which provide double the energy density of NiCads, and weigh less. The anode is made of lithium foil and the cathode is made of molybdenum disulphide powder bound to a substrate. The electrolyte — which the manufacturers Molicell do not identify — acts only as a carrier for ions and does not react chemically with the electrode materials.

There appears to be no oxygen involved in the reaction, which is significant. As mentioned above, the lithium electrode in a lithium primary cell forms a non-reactive layer on its surface, which prevents the untimely discharge of the cell. This would also prevent the lithium from being plated back onto the anode, so a rechargeable cell must use a very different system.

The charge retention of these cells is good for a rechargeable type — approximately 10% charge loss over a year is claimed at 22°C. This would remove the need for float charging in some applications.

An interesting characteristic is that the discharge curve is well defined, and the voltage falls from 2.25V to 1.3V predictably (though not linearly) as the cell discharges. This makes a state of charge indicator possible. Unfortunately, it can also cause problems for equipment which requires a constant voltage, so Molicell have developed some voltage converter designs suitable for use with their cells.

Currently these cells are very costly, and it is likely to be a year or two before the price falls enough for anyone to consider using them for consumer applications, but keep your eyes open because they look interesting.

The main reason why an electronics designer should want to consider the subject of batteries seriously is so as to be able to choose a battery for a given application. For this purpose we need to know about the discharge characteristics of primary cells, and both the discharge characteristics and the charging requirements of secondary cells.

Primary Choice

The choice between zinc-carbon and alkaline manganese cells is fairly simple. Fig. 5 shows the relative energy recovered from the two cell types plotted against current drain. This shows a maximum of seven times as much energy from the alkaline-manganese cell, at a fairly high current drain, but much less at very low currents. If cost is the criterion, then the breakeven point is approximately as shown by the dotted line on the graph, and alkaline-manganese cells are more cost effective at current drains greater than that shown.

In practice, this means that ordinary transistor radios could well be powered by zinc-carbon cells, but cassette players, due to the current consumption of the motor, should be powered by alkaline manganese cells.

Another consideration is the shelf life of the battery. In many cases torches are left in a cupboard or glovebox for a long time until needed. For this type of use it might be tempting to choose zinc-carbon cells, because the whole capacity of the cell is unlikely to be required. However, alkaline-manganese cells deteriorate much more slowly than zinc-carbon cells do, largely because of the alkaline electrolyte. Alkaline cells will remain ready for use long after zinc-carbon cells have quietly expired.

If, though, the torch is to be used regularly but for brief periods (for example, by a meter reader), then the use of alkaline-manganese cells gives little or no advantage. Without a sustained heavy current drain the high power capability of alkaline-manganese cells is no advantage, and the regular use means that shelf life is not a problem.

There is one area in which the choice of cell type is clear. It is widely recognised that alkaline-manganese cells are appropriate for use in personal stereos. As I sit here listening to mine, I am contributing to a growing, though as yet unquantified, environmental problem. This cell type contains mercury in an amalgamated form, and there is obviously at least some risk that after disposal this could get into drinking water or even food.

It is likely that without the personal stereo, too few alkaline-manganese batteries would have been used to constitute a problem, but if the present trend continues, the environmental impact will probably require consideration. It is interesting to note that mercury cells, which contain more mercury, are no longer used in Japan.

The choice between primary and secondary systems follows a different set of criteria. Nickel cadmium batteries, the most commonly available secondary system, store about a quarter as much energy as alkaline-manganese cells of the same size. Some of the cells on sale to the public store only about an eighth as much as the alkaline cells, which necessitates irritatingly frequent recharging. They also supply only 1.2V instead of the 1.5V supplied by the equivalent primary system, which can occasionally cause problems. The charge retention of NiCads is also unimpressive, with a self discharge rate of 20% to 30% of the remaining charge each month.

On the plus side, the internal resistance of NiCads is much less than that of alkaline-manganese cells, so with a high current load the available voltage from the NiCads may be higher than that available from alkaline-manganese cells.

In addition there is the obvious advantate that, once the cost of the cells and the charger is paid, recharging is very cheap and considerable savings can be made in applications requiring frequent charge/discharge cycles. There is the proviso here that the equipment must not completely discharge the batteries between recharges.

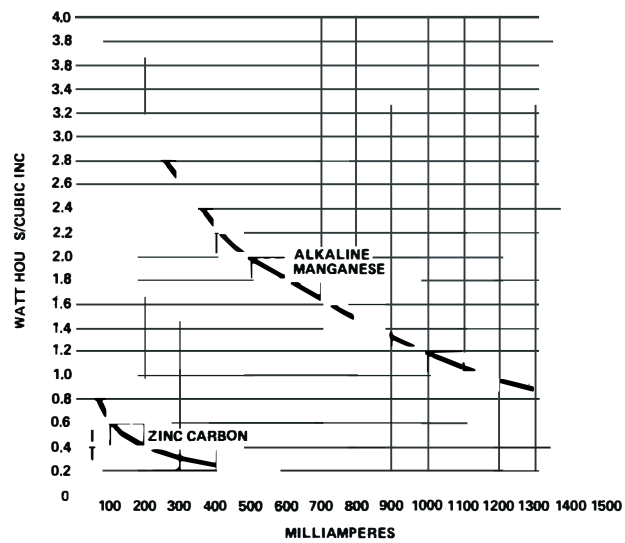


Fig. 5 A comparison of the energy recovered from zinc and alkaline-manganese cells over a range of discharge rates.

Rechargeable Choice

The three varieties of rechargeable cells available to the home user are the NiCad, the flat plate lead acid and the Cyclon-type lead acid. These are all suitable for use in slightly different ways and need to be charged differently. For 'off the shelf' equipment designed to function with ordinary primary cells, NiCads are usually the only choice becuase they come in the same range of sizes as primary cells. If a piece of equipment is to be designed from scratch the choice is no longer so constrained.

For an application requiring a high discharge current and frequent deep discharges, NiCads are almost always the most suitable. The sintered plate cells can routinely be discharged at rates of up to 10C, with pulses of up to 100C. (C is the rate to charge or discharge the rated capacity of the cell in one hour, so 10C would discharge it in 6 minutes provided the capacity is undiminished at this high discharge rate).

Nickel cadmium button cells cannot match this performance, but they can provide high currents and are the only choice for small rechargeable battery packs.

NiCads exhibit a 'memory' effect — if they are repeatedly cycled over a certain fraction of their total capacity they eventually reach a stage at which the voltage on load will fall if any attempt is made to discharge them below this. One deep discharge cycle will remove this effect. The only problem is that the voltage may fall to such an extent that the equipment will not run correctly, and the battery pack may have to be discharged separately using a resistor.

Lead acid cells have a shorter life than NiCads if they are

BIAS REPORT

John Linsley Hood explains the functions of HF bias in tape recorders and offers some hints on selecting and setting an optimum value.

Bias can mean many different things depending on whether one is a politician, a dressmaker, a bowls enthusiast, the owner of a valve hi-fi amplifier, or a tape recordist. With the spread of cassette recorders, we are almost all in this last category, and if our bias is wrong the results we obtain will be poor.

In the tape recording field, bias — or more correctly HF bias — is an AC signal a good bit higher in frequency than the highest audio frequency we are likely to want to record, which is fed into the recording head simultaneously with the desired signal. Its main purpose is to reduce the distortion of the recorded signal, but it has a wide range of other effects too, and it is these which I propose to take a look at.

Unfortunately, there isn't a single best value for the size of this added HF signal, so some sort of compromise has to be made. This must take into account the performance of the machine and the qualities of the tape which is to be used with it.

Up-market tape machines are usually fitted with a control for adjusting the bias, and often incorporate a test tone facility to make it easier to set the bias level correctly. In other machines, the manufacturer will have pre-set the level on some internally-accessible control (usually a trimmer potentiometer) to give the best results with a particular kind of tape. This is fine provided that the setting is right, and that the machine is then used with tape of that type.

However, as I have said, the bias value chosen is a compromise anyway, so let us look at how changes in its level will affect various aspects of a tape machine's performance.

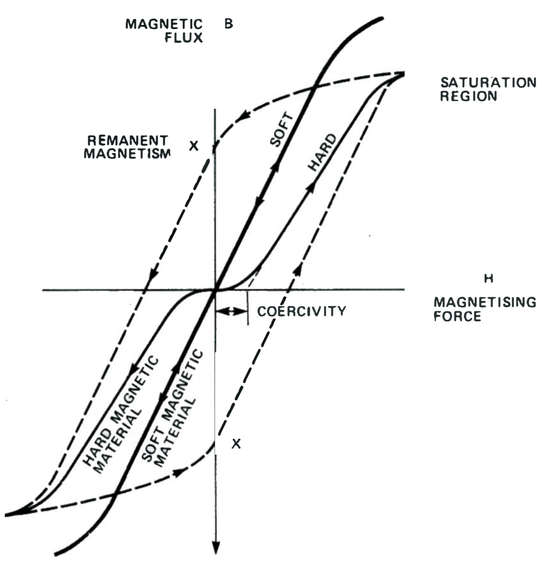


Fig. 1 8-H curves (or soft and hard magnetic materials.

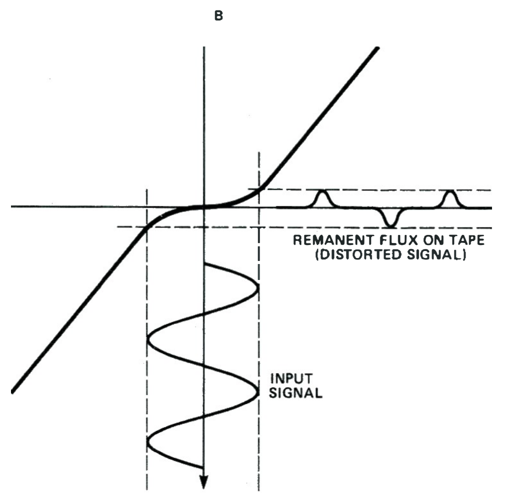


Fig. 2 Distortion of recorded signal due to tape characteristics.

As is fairly well known, magnetic materials respond in a characteristic way to an applied magnetic field (Fig. 1). The magnetising force, H, is plotted against the induced magnetic flux in the material, B, and the result is known as the B-H curve.

The point X (or X') on the vertical axis is what is known as the 'remanent magnetism', or 'remanent magnetic flux' if one is a bit more pedantic. It shows how magnetised the material would be if, as in this case, the applied field H had been strong enough to take the magnetic material into saturation (the condition in which B doesn't get any larger even if H is increased).

Reducing Distortion

There is a big difference here between 'soft' and 'hard' magnetic materials. Soft materials are those which do not retain very much magnetism, such as soft iron and mild steel. Hard magnetic materials retain their magnetism and can therefore be used as permanent magnets; among them are high-carbon steels and some of the special nickel-cobalt-aluminium-iron alloys used in things like loudspeakers.

The difference between the two types of material is shown in the curve of Fig. 1. As well as having a low level of magnetic retention, the soft materials also have a low 'coercivity'. This means that the force which needs to be applied to make them take up magnetism is small.

For recording purposes, we want the tape to retain what we have recorded on it for ever, or at least until we change our minds. For this we need a material with high remanence. It will also be useful if it doesn't pick up unwanted bits of signal from layers of tape below or on

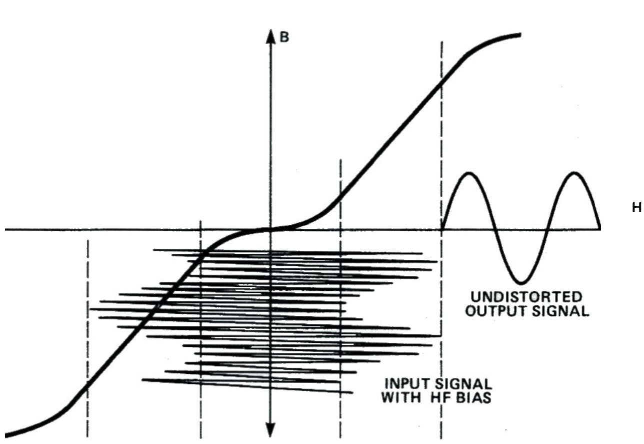


Fig. 3 Use of HF bias to remove distortion.

top of it (the fault known as print through) so it is a good thing if it has a fairly high coercivity.

Unfortunately, this will lead to the kind of B-H curve shown in Fig. 2, which has a flat bit at the middle where all the small signals will lie. If we try to record on this, by pulling the tape over the gap in an electromagnet to which we are feeding our desired audio signal, the result will be both small and very distorted, like an amplifier with a bad case of crossover distortion.

A solution was found to this problem fairly early on in the days of tape recordings. It was to superimpose a high frequency sinewave signal on the desired audio input, so that the composite signal looked like that in Fig. 3.

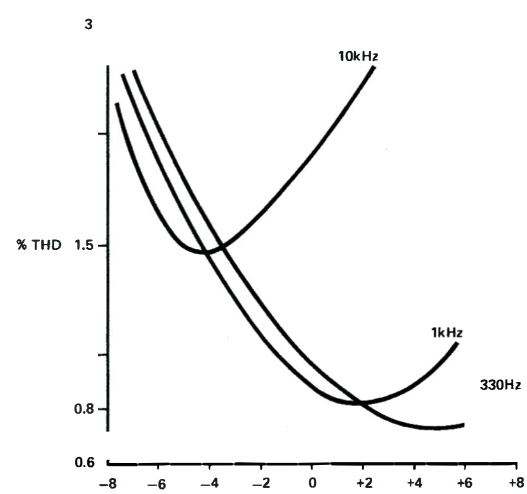


Fig. 4 Variation of THD with HF bias for different signal frequencies.

The way in which this works is really not fully understood, but one theory is that as the tape is drawn away from the recording head, the HF magnetic flux decays more rapidly than that due to the lower frequency signal, so that it is only the wanted signal which remains.

The snag with this theory is that it has been found that high frequency audio signals will also act as a bias input, reducing the need for the other bias signal. Another theory is that all the composite signal is recorded, but that the very high frequency bit disappears because the length of the little magnets induced in the tape coating is so short that they demagnetise themselves, leaving only the lower frequency signals which we want. Whatever the explanation, it works.

The optimum value of bias to give the lowest distortion will vary from one make of tape to another, but usually the best value won't be too far away from that which is best for other things. A minor snag is that less bias is usually required to give the lowest distortion on, say, a 10kHz signal, than would be needed for a 330Hz or 1kHz signal. This is shown in Fig. 4.

It is sensible to choose the value which is best at the lower frequencies because the distiortion introduced in tape recordings is mostly third harmonic (provided that it is not of the crossover type caused by gross underbiasing). The third harmonic of 10kHz is 30kHz, which will not be reproduced or audible anyway, whereas the

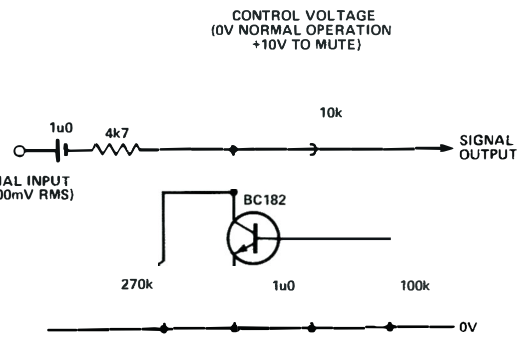


Fig. 5 A simple signal muting circuit.

third harmonic of 1kHz is 3kHz, which is near the ear's most sensitive region.

A modest degree of under-biasing will lead to an increase in third harmonic distortion, due to the lack of straightness in the middle of the B-H curve. Too much bias will also lead to an increase in distortion since it will push the signal voltage swing towards the point at which the B-H curve flattens out, and this flattens off the tops of the reproduced sinewaves.

As an aside, while we are dealing with distortion, the maximum recording level (usually indicated as +3 or +4 on the recording level meter) is generally chosen as the value which will give 3% THD using the makers' preferred tape. Better tape materials will allow more output for the same THD.

Noise

Noise in tape recorders comes from two different sources: electronic noise in the replay or microphone amplifiers (the record amplifier usually has a decent-sized signal to work on and shouldn't cause problems) and that due to the tape.

In commercial equipment, the audio channel is normally muted when the tape is at rest so the user doesn't hear any hiss. In modern equipment, this is done by a transistor switch of the kind shown in Fig. 5. This would be a simple addition to DIY gear.

Tape noise is basically due to the random nature of the distribution of the tiny permanent magnets (known as domains) throughout the tape, and has an effect similar to graininess in a photographic enlargement. In a perfect world, a clean tape would consist of microscopically small domains, uniformly distributed in such a manner that they all cancelled each other out.

In practice, they are large enough to generate an audible signal as they individually pass over the replay head

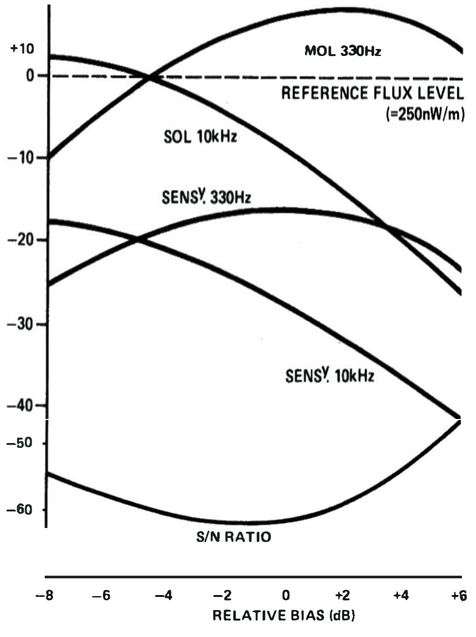


Fig. 6 The effects of bias on the characteristics of ferric cassette tape.

and they are random in their distribution, which means that there is a finite possibility that they will gather into clumps having a significant magnetic moment.

Sadly, the bias signal and its accompanying audio signal will tend to exaggerate this clumping, which means that the noise tends to increase with bias and also with audio signal. This causes what is known as modulation noise or 'noise behind the signal', which decreases when the signal disappears.

Since the recorded output from the tape increases with bias at lower values, the normal curve of signal-to-noise ratio shows a dip in the modulation noise curve as a function of bias. This is shown in Fig. 6, where I have plotted the way in which the various tape characteristics change as the bias is altered.

The notional mid-point on the bias graph is usually chosen to give the flattest practicable fequency response in cassette recorders, or the lowest THD value in higher-speed reel-to-reel machines.

Sensitivity and Maximum Output Level

The major and most conspicuous feature of bias adjustment is the way in which the sensitivity changes at various frequencies as the bias value is increased. It simply is not possible to choose, in the case of cassette machines, a value which is best for both HF and LF signal components.

Because the use of the best setting for HF would mean that a lot of other qualities would be a lot worse, it is usually accepted that HF output must be sacrificed. The normal practice is to choose a setting which will lead to the replay output at 10kHz being 10dB lower than that at 1kHz when both are recorded at the same signal level.

The replay amplifier equalisation characteristics are then adjusted to give a reasonably flat frequency response from the recorder. So, if the bias settings are incorrect for the tape that is being used, the HF response will either be peaky or poor depending on the direction of the error.

Also, as can be seen from the graph of Fig. 6, the bias setting affects both the low frequency maximum output level (the value at which there is 3% THD) and the high frequency saturation output level (the output level beyond which one cannot get). The inability of standard ferric tapes to provide high outputs at HF is probably the major failing of the cassette recorder as a hi-fi medium. Both chrome and ferro-chrome (dual layer) tapes are better in this respect as Fig. 7 shows, but not by a lot. The major advantage from the use of chrome-type tapes is the fact the they are replayed at a 70us time-constant. This means less replay HF boost than with ferric types and gives a better signal-to-noise ratio.

Setting The Bias Level

If our cassette recorder has a built-in facility for setting the optimum value of bias then there is no problem. Most machines don't have this facility, but it isn't difficult to locate the bias control and to build a small signal generator for use as a signal input. A suitable device which will provide a choice of at least two spot frquencies is shown in Fig. 8.

This will run from a single 9V battery, and will provide a stable output of about 0.5V RMS at a range of frequencies which can be chosen by the constructor. I have indicated appropriate component values. At least two such output frequencies, for example 330Hz and 8kHz, are needed to give a useful set-up range, but more could be used by switching capacitance values if the user wished.

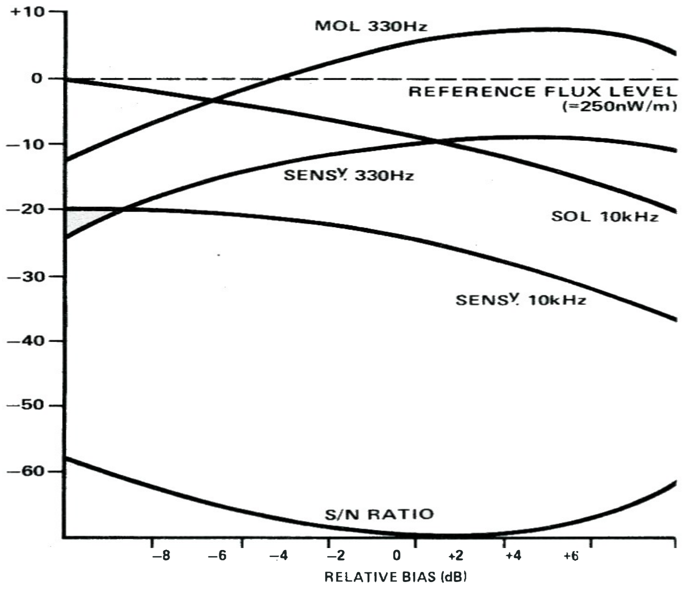


Fig. 7 The effects of bias on the characteristics of chrome cassette tape.

The actual value of THD generated by the oscillator is not very important provided that is small in tape terms. In this circuit I have used a pair of back-to-back germanium diodes to provide output stabilisation in an op-amp Wien-bridge oscillator. This gives about 0.5% THD, and is a lot less expensive than the use of a vacuum envelope thermistor which would be needed were very low THD values required.

The design of the little oscillator is such that it will not be affected very much by AC fields, so an inexpensive plastic box will make an entirely suitable housing.

If you already have a sine wave generator of reasonable quality you may not need to use the circuit shown

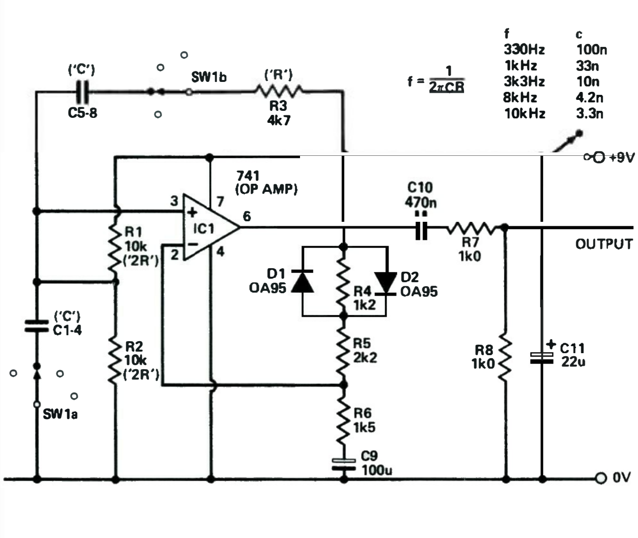


Fig. 8 Circuit diagram of a simple spot frequency oscillator.

here. However, it is far more convenient to be able to switch rapidly between frequencies rather than having to tune a dial and it also ensures that you always use the same few frequencies for each stage of the testing.

There are several ways of using the test oscillator depending upon whether you wish to fiddle with the bias setting on your recorder or not. If not, the best approach is to obtain a quantity of different blank tapes and find out which one best suits the existing bias level of your machine. To do this, record a series of test tones at different frequencies on each tape and then note on the VU meter which tape gives the most uniform response on playback. You could also use the VU meter to determine which recording level results in the most uniform response on playback.

If you do not mind finding and adjusting the bias level control then you can attempt to set the machine up to give optimum performance with your preferred brand and type of tape. The most reliable way of doing this is probably to obtain a number of identical blank tapes and to record the test tones at the beginning of each. Use a different bias setting for every tape and write on it what that bias setting is (if your bias control is not calibrated you will have to find some way of marking its positions). Replay the tapes and note which one gives the most uniform readings on the VU meter, then set the bias control to the setting used to record that tape.

As a final thought, it has been suggested by one manufacturer that different types of music have different output spectra and will therefore require different bias settings for optimum performance. The theory is that rock, pop and vocal music will be handled best at standard bias settings while orchestral music, which has its highest signal levels in the low-to-middle frequency range, will sound better at about 15% above the standard bias setting. Electronically synthesised music, which has a very wide sound bandwidth, will be handled best at about 15% below the standard bias level. Equipment made by the manufacturer in question incorporates a switch to select bias levels above and below a pre-set standard.

ETI

MICRO-COMPUTER AIDED CIRCUIT DESIGN

Non-linear analysis doesn't frighten the micro. But, says Julian Burt, watch out for the transform scene.

When we design circuits we make many simplifying assumptions about component behaviour. One major simplification is the assumption of linearity. We freely use Ohm's Law, E (or V) = I.R, to describe the operation of a resistor although this implies complete linearity which, in practice, is impossible to achieve.

There are several sources of non-linearity for even the simple resistor: the capacitance and inductance of the carbon spiral it may be made of, the effects of temperature and so on. Some components have particularly non-linear responses — for example, diodes (Fig. 1). The diode can, if biased correctly, be regarded as linear only for very small signal fluctuations. In general, a diode's response when forward biased follows an exponential law:

$$I = I_s(e^{qV/KT} - 1),$$

where I_s is the reverse or saturation current, e is the base of natural logarithms (2.7183), q is the charge on an electron (1.6 x 10^{-14} coulombs), V is applied voltage, K is Boltzmann's constant (1.38 x 10^{-23} Joules/°Kelvin and T is the absolute temperature in Kelvin.

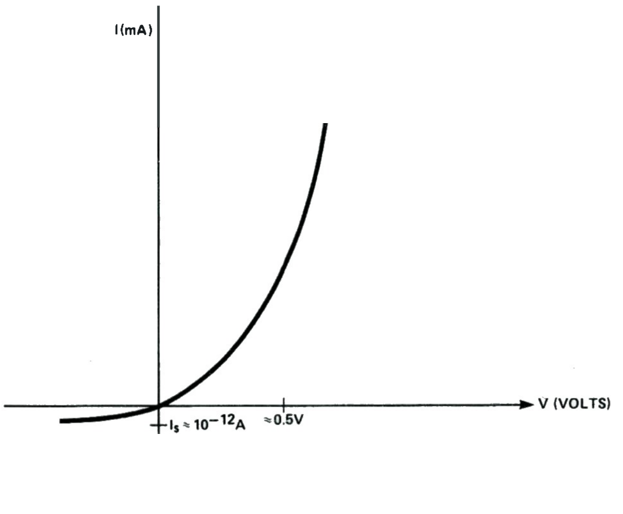
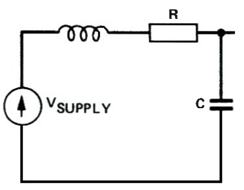


Fig. 1 Typical diode characteristic.

Suppose we wished to find the voltage across the diode in Fig. 2. Since we are talking about a DC supply we can make the simplifying assumptions that, eventually, the inductor will appear as a short circuit and the capacitor as an open circuit. The whole circuit can be redrawn (Fig. 3) so that the supply voltage is shown to be equal to the voltage across the resistor plus the voltage across the diode (Kirchoff's Laws). The voltage across the resistor can be obtained from Ohm's Law since we know

Fig. 2 Simple circuit for non-linear analysis.



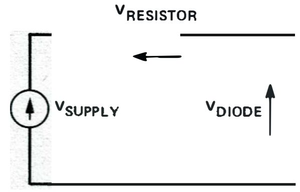


Fig. 3 The circuit of Fig. 2 under DC conditions.

that the current through the resistor is equal to the current through the diode which, in turn, is given by the diode equation above.

Alternatively, we can rearrange the diode equation to solve it for the voltage across the diode. In this case, we would find that:

$$V_d = (KT/q)\log_e((I/I_s)+1)$$

and I would be given by Ohm's Law as the supply voltage minus the diode voltage all divided by R.

This is a very simple circuit. Yet solving the equations involved is not a straightforward matter, involving, as it does, exponential or logarithmic expressions. Imagine the complexity of a circuit with several diodes or a transistor or two.

The Numerical Solution

There are two basic techniques for solving non-linear equations without resorting to the calculation of complex exponentials or logarithmic expressions. The first is graphically, which is impractical for use on a micro-based system, and the second is by means of a numerical algorithm.

The commonest numerical method is the Newton-Raphson method in which an initial guess at the solution is refined by means of a formula derived from a Taylor series:

$$X_n = X_{n-1} - (f(X_{n-1})/f'(X_{n-1}))$$

where
X_n is the n^{th} approximation to the solution,
$f(X)$ is the equation to be solved, and
$f'(X)$ is the first derivative of $f(X)$.

This method is perfectly acceptable for single variable equations but becomes considerably more complex as more and more dependent variables are introduced. For instance, if we have two unknowns, X and Y, such that

$$f_1(X,Y)=0 \text{ and } f_2(X,Y)=0 \text{ and}$$

$$X_n = X_{n-1}+X \text{ and } Y_n = Y_{n-1}+Y$$

where X and Y are very small compared to X_n and Y

then expanding Newton's method means that we will have the problem of solving a partial derivative matrix or Jacobean.

The Jacobean would have to be recalculated and inverted for every consecutive approximation, so making solution a slow process. Newton's method converges to an accurate solution with surprising speed, but the time taken to calculate each Jacobean and its inverse is a major drawback.

Several attempts have been made to find an alternative method with a similar speed of convergence in which Jacobeans do not have to be explicitly calculated. These methods are still being developed and one of the most practical ways to evolve so far is Broyden's method.

Broyden's method is a streamlined version of the Newton-Raphson method in which the inverted Jacobean which provides the successive solution to the approximations is not calculated. Instead, an approximation to the inverted Jacobean is updated using already known values of the functions involved in the orginal equations. Also, Broyden's method incorporates a 'damping factor' to ensure that successive approximations actually do converge to the solution. Perhaps its major advantage is that it can be described in a reasonably simple eight step algorithm.

The Transfer Function

The transfer function of a network is an algebraic expression that relates the output of the network to its input (Fig. 4). It is found by taking the Laplace transform of the impulse function, h(t). The input of the circuit or network is described by $V_i(t)$ in the time domain. Its output is $V_o(t)$. The impulse function is that function in the time domain which converts $V_i(t)$ to $V_o(t)$. In the simplest cases the circuit might be an amplifying block or a potential divider and h(t) would be a straightforward linear function.

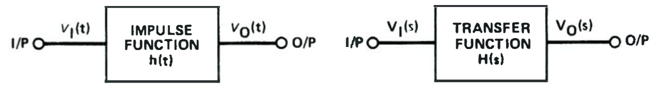


Fig 4 The transfer function describes the circuit behavior in the frequency domain and can be derived from the impulse function of the time domain.

The Laplace transform of a function, h(t), is given by the formula:

$$F(s)=\int_0 h(t)e^{-st}dt$$

where 's' is a variable describing a complex frequency, $\sigma+2\pi fj$ (σ can be thought of as a damping factor and f the frequency).

The transfer function F(s), will relate the output to the input of the circuit or network under investigation, but this time in the frequency domain. At first glance, this may seem like a long-winded and pointless technique for circuit analysis. Actually, Laplace transforms greatly reduce the mathematics involved in analysis — in simple terms, by removing the differential equations that describe a circuit in the time domain. (Also, tables of Laplace transforms are widely available).

Consider the response of a capacitor and an inductor. For a capacitor, the time domain equation

$$v(t)=(1/C)\int_0^t i(t)$$

becomes $V(s)=(1/sC)I(s)$ and an inductor's $V(t)=L\, di(t)/dt$ becomes $V(s)=sLI(s)$. We can also show how a transfer function, H(s), can be used to generate time domain response, gain and phase frequency responses and the phase and group delays of a circuit.

From Time To Time

The time domain response can be found simply by reversing the process of calculating the Laplace transform — in other words, by using the inverse transform. The general formula for the inverse Laplace transform is known as the Bromwich integral:

$$f(t)=(1/2\pi j)\int_{c-j\infty}^{c+j\infty} F(s)e^{st}ds.$$

Precisely because s is a complex quantity, this integral can often be evaluated by straightforward numerical means. In particular, if we assume that F(s) takes the form P(s)/Q(s) where P(s) and Q(s) are polynomials and Q(s) is of a degree at least one higher than P(s), then it can be shown that f(t) is equal to the sum of the residues of $F(S)e^{st}$ at all poles. A pole, in this context, being a value of s such that F(s) equals infinity or, bearing in mind the ratio of polynomials above, it is one root of Q(s) or one actual value of s that satisfies the equation Q(s)=0.

The residues of a function can be found in a number of ways. The concept itself, like poles, is actually defined mathematically by reference to Laurent's theorem which gives a way of expanding a function in the complex plane. If the function has simple (first-order) poles, p_i, such that s tends towards p_i for each i, then each residue can be found by multiplying F(S) by s-p_i and evaluating the result as s tends towards p_i.

Since the function F(s) is assumed to be equal to P(s)/Q(s) and since we can rewrite Q(s) as $(s-p_1)(s-p_2)\ldots(s-p_n)$, it is possible to show by means of partial fractions that

$$F(s)=\sum_{i=1}^{n} K_i/(s-p_i)$$

where K_i is the i^{th} residue of F(s). Listing 1 will calculate these residues for any function with simple poles, on the assumption that P(s) is a similar polynomial to Q(s) giving rise to zeroes, rather than poles, of F(s). (There will be fewer zeroes than poles.) The routine is a direct translation from FORTRAN and may seem to be rather inefficient.

Once the residues have been found it is easy to work out the inverse transform by applying the formula mentioned above. Since f(t) is equal to the sum of the residues of F(s) e^{st} at all poles and since e^{st} has a positive value at all poles, f(t) is equal to

$$\Sigma \quad K_i e^{pit}.$$

Listing 2 gives the time domain response of a circuit between times TSTART and TSTOP calculating the output of a circuit under transfer function f(t) at intervals of TINC. It is important to choose a suitable value of TINC, especially for step function responses, as oscillations may be missed if TINC is too large. A good program would allow TINC to be redefined and the response recalculated as required.

```
1850 DEF PROCTRESP
1860 PROCRESID
1870 NO =INT(1+(TSTOP-TSTART)/TINC)
1880 FOR I=1 TO NO
1890 RESP ( I ) =0
1900   NEXT I
1910 T = TSTART
1920 FOR I=1 TO NO
1930 FOR J=1 TO M
1940 EPR=EXP (T*P ( 1, J) ) *COS (T*P (J, 2) )
1950 EPI=EXP(T*P(J,1))*SIN(T*P(J,2))
1960 PROCcomplex(RK(J,1),RK(J,2),EPR,EPI,3)
1970 RESP(I)=RESP(I)+outreal
1980   NEXT J
1990 T=T+TINC
2000   NEXT I
2010 ENDPROC
```

Listing 2 Routine to calculate the time domain response of a transfer function. (Response magnitude is stored in the array RESPwith NO as the number of responses evaluated).

Delays, Delays

The transfer function, F(s), is a complex quantity — a function of the complex variable s. In the first article of this series, we showed how the magnitude and phase change represented by a complex number can be found through the modulus and argument of the number. By evaluating F(s) for different frequencies we can obtain a set of complex numbers which will describe a circuit's response. By setting s equal to $2\pi fj$, (ignoring the damping factor), it is possible to work out the gain and phase response of a circuit from F(s). Still assuming our transfer function has simple poles the gain or modulus of F(s) is equal to the product of the moduli of the zero terms $(s-z_i)$ divided by the product of moduli of the pole terms $(s-p_k)$, all multiplied by a constant, A, the gain factor. Listing 3 is a routine that will do the job. It will also find out

```
1590  DEF PROCRESID
1600  FOR I=1 TO M
1610  S(1)=P(I,1):S(2)=P(I,2)
1620  ZM(1)=1:ZM(2)=0
1630  PM(1)=1:PM(2)=0
1640  IF N=0 GOTO 1700
1650  FOR J=1 TO N
1660  PROCcomplex(S(1),S(2),Z(I,1),Z(I,2),2)
1670  PROCcomplex(ZM(1),ZM(2),outreal,outimag,3)
1680  ZM(1)=outreal:ZM(2)=outimag
1690  NEXT J
1700  FOR J=1 TO M
1710  IF (J-I)=0 GOTO  1750
1720  PROCcomplex(S(1),S(2),P(J,1),P(J,2),2)
1730  PROCcomplex(PM(1),PM(2),outreal,outimag,3)
1740  PM(1)=outreal:PM(2)=outimag
1750  NEXT J
1760  PROCcomplex(ZM(1),ZM(2),PM(1),PM(2),4)
1770  PROCcomplex(G,0,outreal,outimag,3)
1780  RK(I,1)=outreal:RK(I,2)=outimag
1790  NEXT I
1800 ENDPROC
```

Listing 1 A routine to calculate the residues of a simple pole transfer function (Z is the zeros array with N values, Pis the poles array with M values, G is the gain constant of the transfer function, and the residues are stored in array RIO.

the phase shift by subtracting the sum of phase contributions of each pole term away from the sum of the contributions of each zero term.

Listing 3, of course, requires a frequency specification. We could plot the modulus of F(s) and its argument against $2\pi f$ on a graph to show the frequency response of the circuit. This means that we could actually assess the transfer function of a circuit from a graph of its frequency response.

The transfer function can also be used to calculate phase and group delays in a circuit. If a sinusoidal input is applied to a network it will be found to have suffered a phase change at the ouput (assuming the network is not purely resistive). The phase change corresponds to a delay in passing the signal through the network. This is known as phase delay and is given by the formula: −arg(F(w))/w, where w is a frequency and arg(F(w)) is the argument of F(s) at the frequency w.

Group delay is given by the similar formula: −d(arg(F(w)))/dw, where we are, of course, talking about differentials. Calculating phase delay is clearly a simple matter of dividing phase shift as calculated above by the frequency at which it is calculated. Group delay could be calculated somewhat more elaborately by means of numerical differentiation — calculating the phase shift at two close frequencies and dividing the difference between the phase shifts by the difference in frequencies. Unfortunately, these differences must be very small for the calculation to be accurate and the computer (especially, a micro) introduces round-off errors which will upset the results.

There is a better method which involves substituting $2\pi fj$ for s and utilising some crafty complex arithmetic. The result is that group delay can be shown to be given by the real part of

$$\sum_{k=1} 1/(s-p_k) - \sum^{m} 1/(s-z_i)$$

with s equal to $2\pi fj$.

Listing 4 extends Listing 3 to include the computation

```
1340  DEF PROCFVAL
1350  S(1)=0:S(2)=2*PI*FR
1360  ZM(1)=1:ZM(2)=0
1370  PM(1)=1:PM(2)=0
1380  IF N=0 GOTO 1440
1390  FOR I=1 TO N
1400  PROCcomplex(S(1),S(2),Z(I,1),Z(I,2),2)
1410  PROCcomplex(ZM(1),ZM(2),outreal,outimag,3)
1420  ZM(1)=outreal:ZM(2)=outimag
1430  NEXT I
1440  FOR I=1 TO M
1450  PROCcomplex(S(1),S(2),P(I,1),P(I,2),2)
1460  PROCcomplex(PM(1),PM(2),outreal,outimag,3)
1470  PM(1)=outreal:PM(2)=outimag
1480  NEXT I
1490  PROCcomplex(ZM(1),ZM(2),PM(1),PM(2),4)
1500  PROCphasemod(outreal,outimag)
1510  HMOD=G*modZ
1520  HLMOD=20*LOG(HMOD)
1530  PHI=phaseZdeg/2*PI*FR
1540 ENDPROC
```

Listing 3 Routine to calculate frequency domain gain and phase shift. (FR is the frequency at which responses are calculated. HMOD is the gain at FR, HLMOD the gain in decibels and PHI the phase at FR).

```
1000  DEF PROCFVAL2D
1010  W=FR*2*PI
1020  S(1)=0:S(2)=W
1030  ZM(1)=1:ZM(2)=0
1040  PM(1)=1:PM(2)=0
1050  GDC(1)=0:GDC(2)=0
1060  IF N=0 GOTO 1150
1070  FOR I=1 TO N
1080  PROCcomplex(S(1),S(2),Z(I,1),Z(I,2),2)
:A=outreal:B=outimag
1090  PROCcomplex(ZM(1),ZM(2),outreal,outimag,3)
1100  ZM(1)=outreal:ZM(2)=outimag
1110  PROCcomplex(1,0,A,B,4)
1120  PROCcomplex(GDC(1),GDC(2),outreal,outimag,2)
1130  GDC(1)=outreal:GDC(2)=outimag
1140  NEXT I
1150  FOR I=1 TO M
1160  PROCcomplex(S(1),S(2),P(I,1),P(I,2),2)
:A=outreal:B=outimag
1170  PROCcomplex(PM(1),PM(2),outreal,outimag,3)
1180  PM(1)=outreal:PM(2)=outimag
1190  PROCcomplex(1,0,A,B,4)
1200  PROCcomplex(GDC(1),GDC(2),outreal,outimag,1)
1210  GDC(1)=outreal:GDC(2)=outimag
1220  NEXT I
1230  PROCcomplex(ZM(1),ZM(2),PM(1),PM(2),4)
1240  PROCphasemod(outreal,outimag)
1250  HMOD=G*modZ
1260  PHI= phaseZdeg
1270  GD=GDC(1)
1280  PD=GD
1290  IF FR<>0 PD=PHI/W
1300  ENDPROC
```

Listing 4 Extended version of Listing 3 giving group delay (GD) and phase delay (PD). (Note: all routines use routines given in first article).

of phase and group delays. These calculations are most useful in analysing the real behaviour of filters and determining to what extent they depart from the ideal 'brick wall' response for both large and small frequency changes.

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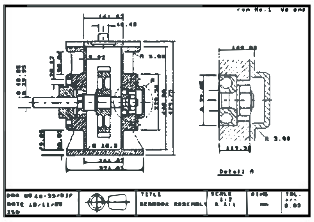

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HARDWARE DESIGN CONCEPTS

Mike Barwise continues his series on the general considerations brought to bear on peripheral design with some particular thoughts...

Last month, we introduced some of the central ideas in the field of buffer design. Now it's time to turn our attention to an actual type of circuit. This implementation requires two pointers to a single storage array. One pointer is used for storing data from the host, and the other is used for writing data to the printer. Whereas in our first buffer the array had a finite start and end, we now allow the buffer to wrap around, so that the next byte loaded after the highest RAM address is the lowest again.

A good analogy to the mechanism is that of a clock face with two independent hands (Fig. 1). The array addresses are distributed clockwise around the face. One hand points to the current storage location to be written to from the host (loaded), and the other hand points to the current location to read out to the printer (unloaded). This clock is like the Kiddie Clock used in infant school to teach time of day, with one major exception: neither hand is ever allowed to overtake the other. If either hand catches up with the other, it must wait until it has been left behind again before advancing further.

The buffer in Fig. 1 is 12 Kbytes in length, and currently contains about 8K of valid data.

This is like the Kiddie Clock used in infant school, with one major exception: neither hand is ever allowed to overtake the other.

In the operational direction (notional clockwise) the storage pointer will always be in advance of the output pointer. In the special case when there are no characters to pass on to the printer, the input/output pointer *difference* will be one byte, otherwise it is the actual number of bytes waiting for pass-on plus one. This difference is the crucial factor: the absolute value of either pointer is practically immaterial, so long as the buffer can wrap around and the pointers are preserved when transferring control between read and write operations.

The resulting device is a *software semi-synchronous FIFO.* Transfers from the host are requested asynchronously, and synchronized by the buffer CPU's interrupt to its internal operations.

If the buffer has free space, a READY flag is presented to the host, indicating that data may be passed to the buffer. At this time the buffer will be either sending characters to the printer, updating its output flag as it goes, or idling with no characters to send and an output pointer difference of one.

Writing a byte into the host interface port causes an interrupt to the buffer CPU. This cancels the READY flag, stops idling or sending to the printer, and *saves its current output pointer.* The character is read from the host interface, and stored according to the current value of the storage pointer, which is then updated and saved. The output pointer is restored before return from the interrupt.

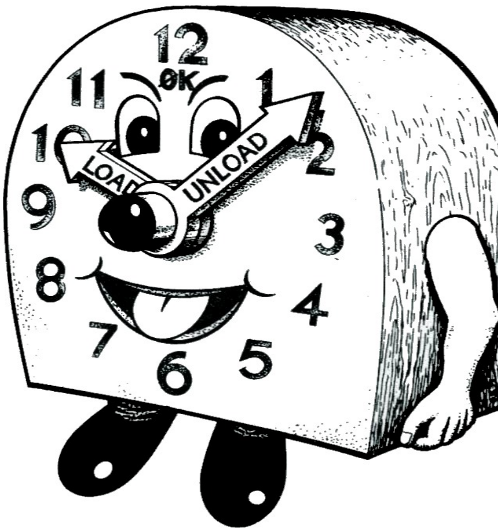


Fig. 1 The Kiddie Clock analogy.

On return from the interrupt, the input/output pointer difference must be greater than one, as a character has been loaded into the buffer. The output routine therefore sends characters to the printer until either the input/output pointer difference is one again, or another interrupt occurs, whichever happens first.

If at any time the buffer is almost full, the READY flag is cancelled until the buffer is free to acquire more data. It is important that the flag is cancelled while there is still room for several characters, to cover any potential confusion at the interface due to the asynchronicity of the host and buffer processors. It is also a good idea to allow the buffer to partially empty before re-allowing the READY flag. Typical parameters for this hysteresis are: almost full with the greater of 16 bytes or 1/256 of the buffer size to spare, and half full (half empty if you're pessimistic) before re-allowing the READY flag. The capacity point at which the buffer starts accepting characters again is worth experimenting with: the greater the hysteresis, the less efficient the buffer, but there must be sufficient to prevent it acting as a single character drop-through port, as a burst transfer of several bytes is more efficient for the host than one character at a time.

Buffer Ports — Input And Output

Now for the buffer's ports to the outside world. Forget about peripheral interface chips — we will use good old-fashioned TTL (or CMOS!). This is not just prejudice: the job to be done is very simple, and for practical purposes requires no modifications when changing mating equipment. If programmable interfaces were used, timings and sequences of operations would have to be performed by software, which is feasible but unnecessary.

The commonest printer interface is the Centronics parallel standard, and this is the interface I have chosen for our printer buffer. Readers with serial printers could append a parallel to serial converter to the output of the buffer.

The Centronics interface uses a minimum of eight data lines and three control lines: data strobe ($\overline{STB}$), acknowledge (ACK) and BUSY. Optional lines can provide detailed information on printer function status (for example, paper end) but we will ignore these, as they are rarely implemented on home micros, and they only define BUSY status in more detail.

> *Forget about peripheral interface chips - we will use good old fashioned TTL.*

Data strobe, STB, is a negative-going pulse supplied by the host computer to the printer or buffer to indicate that a new data byte has been loaded into its printer port data register (PPDR). Acknowledge, $\overline{ACK}$, is a negative-going pulse supplied by the printer or buffer to the host computer to indicate that it is finished with the data byte in the PPDR, and the host computer is allowed to supply the next byte. BUSY is an active high state line which indicates that the printer or buffer is not ready for the next data byte yet. BUSY is high from just after $\overline{STB}$ until either just before or during $\overline{ACK}$, and under certain fault conditions (for example, no paper, off line). The host computer must only supply data while BUSY is low.

There are two modes of operation using these three control lines: *busy poll,* where $\overline{ACK}$ can be ignored, and *handshake,* where the printer can be supplied by the host micro with data under interrupt.

In *busy poll* mode, the host generates a $\overline{STB}$ after loading its PPDR with a byte. It then sets up a loop which repeatedly checks BUSY until it goes low. At this time it is assumed that the printer is free for the next character. This is a very common mode of operation on the earlier home micros which are not interrupt driven.

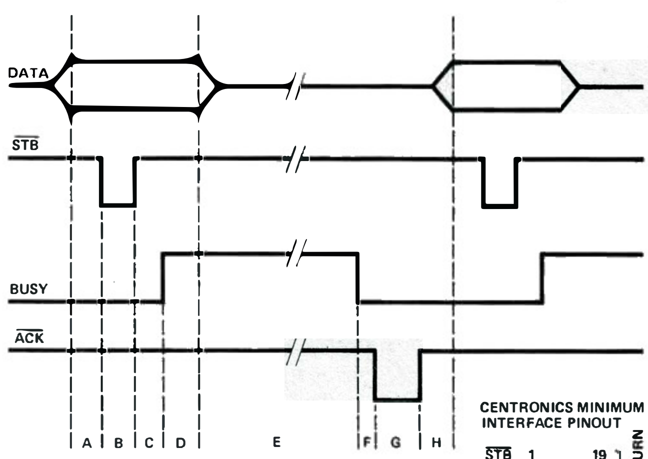
In *handshake* mode, there are two methods of control. The most interesting is the use of the $\overline{ACK}$ to generate an interrupt to the host. The service routine does a quick check of BUSY (not polling, but just 'are we busy now?') and, if not busy, supplies the next character to the printer. Other tasks can be carried on in the foreground subject to suitable host software, but it should be noted that the *first* character of a printing job cannot be supplied under interrupt, as the $\overline{ACK}$ which causes the interrupt is a *reply* to a $\overline{STB}$.

The alternative method of operation in *handshake* mode is to use STB and $\overline{ACK}$ to toggle a hardware flip-flop in opposite directions, and to poll its output as a pseudo-BUSY signal.

Figure 2 is a diagram of representative timing relationships for the Centronics interface. The stated minima and maxima are approximate, but the interface should function normally in most cases if they are adhered to. A safety margin of say 50% applied to all timings should guarantee operation without problems.

The buffer input interface (Fig. 3) consists of a data register (74LS374) and a control flip-flop. It is advantageous to use an edge triggered flip-flop to improve the sequential timing of the interface. As edge triggered flip-flops are not readily available, a D-type (74LS74) is used in conjunction with a monostable (74LS221).

In normal operation, the $\overline{STB}$ from the host micro trips the monostable (IC2a) which generates a negative going pulse. As soon as this is low, the D-type (IC3a) is reset, taking its $\overline{Q}$ output high to indicate BUSY to the host. Simultanteously, the Q output of IC3a drives the interrupt line of the buffer microprocesor.



A	DATA SETUP TO $\overline{STB}$	1uS MIN
B	$\overline{STB}$ WIDTH	1uS MIN
C	$\overline{STB}$ TRAILING TO BUSY	0·1uS
C+D	DATA HOLD FROM $\overline{STB}$	1uS MIN
E	BUSY DURATION	100uS - FULL LINE PRINT + RTN TIME
F	$\overline{ACK}$ FROM BUSY TRAILING	1uS MAX
G	$\overline{ACK}$ WIDTH	5uS MIN
H	$\overline{ACK}$ TRAILING TO DATA	0·1uS

CENTRONICS MINIMUM INTERFACE PINOUT

		GND TWISTED PAIR RETURN
$\overline{STB}$	1	19
D0	2	20
D1	3	21
D2	4	22
D3	5	23
D4	6	24
D5	7	25
D6	8	26
D7	9	27
$\overline{ACK}$	10	28
BUSY	11	29

Fig. 2 Centronics interface timings and pin-out.

When the monostable pulse ends, its rising edge clocks the data on the interface cable into the buffer data register (BDR-IC1). The duration of the monostable pulse guarantees that data are stable at the BDR, allowing for the propagation delays of the host PPDR and the Centronics cable, but is less than the interrupt service time of the buffer processor read routine. If the processor is very fast, it may be necessary to introduce a wait at the start of the interrupt service routine: either an absolute wait or a poll of a register bit driven by the output of IC2a.

Either way, when you know the BDR holds a valid byte, it is read and stored by the buffer processor as discussed previously. When all housekeeping is finished, any $\overline{WRITE}$ to DECODE 1 causes a negative-going pulse which clocks the D-type (IC3a) back to its previous state cancelling BUSY, and simultaneously trips the monostable (IC2b) which generates an ACK to the host micro. The buffer software can then return to its previous task of outputting characters to the printer.

The output port of the buffer is shown in Fig. 4. There is considerable freedom in the design of this port, depending on the mode of operation you can decide to use. The primary invariable is the data output register (DOR-IC4) and the STB generator (IC5a, b).

Data are latched into the DOR on the trailing (rising) edge of the write cycle of your software STORE instruction — DECODE 2. The same rising edge trips the first monostable (IC5a) which provides a delay dictated by the Centronics protocol (Fig. 2, D). The trailing edge of this pulse trips the second monostable (IC5b) which generates the STB signal to the printer.

A read status port (IC6) reflects the state of the Centronics BUSY line to the buffer processor, and (optionally) a flip-flop (IC3b) similar to the input port flip-flop may be used to generate a second signal (NOT READY), toggled by the write to the DOR and the Centronics ACK. Both signals must be low to allow data transfer.

Note the inverse sense of the D-type operation: it is RESET by the leading signal (STB), and SET by the trailing signal (ACK). This is to allow the general RESET line of the buffer microsystem to clear the ports to a READY state on initialisation without using extra logic gates, by using the D-type PRESET inputs.

Of course you could use compatible CMOS logic throughout instead of the suggested TTL.

Use Of Interrupts

I do not recommend trying to run both input and output of the buffer under interrupt. The critical data direction (input) should be run under interrupt, and the output to the printer should be under polled transfer. The reduction in the output rate as a result of this will scarcely be noticed.

When the buffer is temporarily full, the buffer micro simply returns from interrupt without writing to the ACK generator of the input port. As soon as the buffer has free space, the foreground output program can generate the ACK, thus resetting BUSY.

It will be necessary to control the interrupt masks in addition if you use a maskable interrupt which is *level* sensitive (for example, the 6502 IRQ signal), as the interrupt line will remain low for the whole period between STB resetting IC3a and ACK clocking it again.

If the processor is very fast it may be necessary to introduce a wait at the start of the interrupt service routine.

Alternatively, it is quite feasible to use an edge triggered interrupt (for example, the 6502 NMI signal), so long as it is pointed at a null routine during initialisation and extended BUSY periods, as a precaution against noise triggered false interrupts.

The third option is to stay with a maskable level triggered interrupt, and interpose a 10μs monostable, edge triggered by the output of IC3a. This will provide a long enough low pulse to register as a valid interupt, but will then lock out further interrupts until ACK has occurred.

Next on my list is stand-alone arithmetic processing. This covers both straight maths and data encryption/decription. Quite a lot has appeared in ETI recently on this last, so you might like to refresh your memory (if it's dynamic!) in time for next month.

Fig. 3 Centronics interface input port.

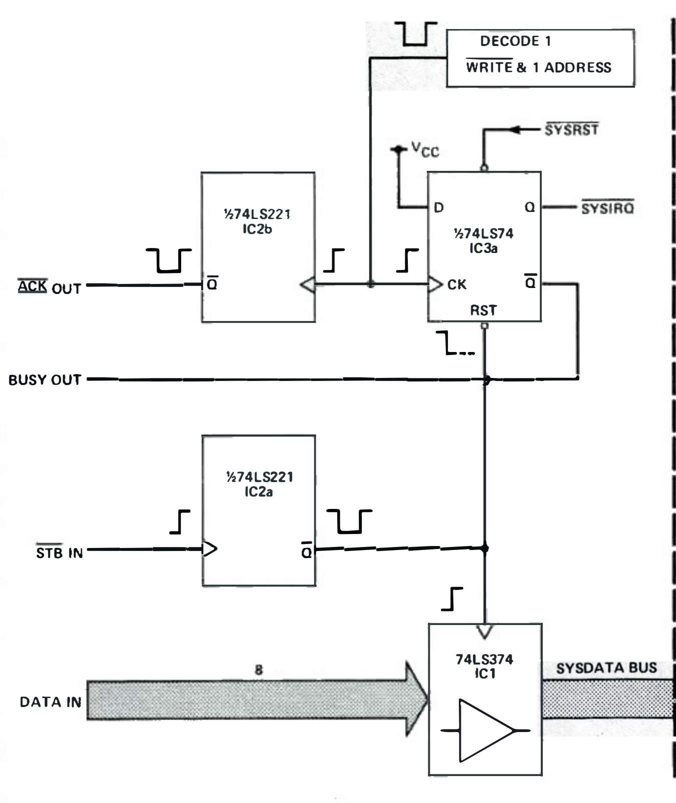
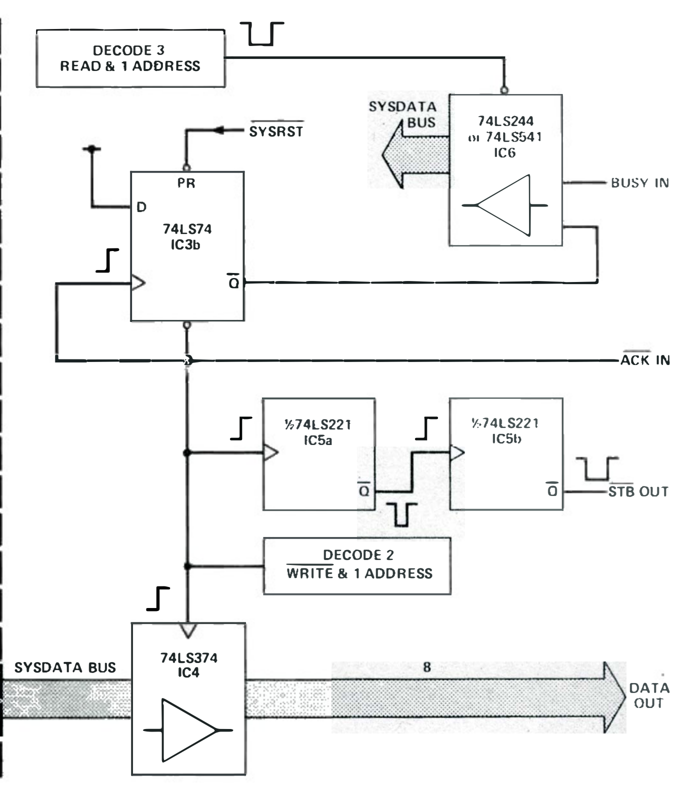


Fig. 4 Centronics interface output port.



LOW COST FRAMESTORE

Want to grab some of the action. Need a frozen frame for the hot weather. Dan Ogilvie of Oggitronics has the wherewithal - an affordable video frame store with all the trimmings allowing storage and processing of medium resolution images.

Over the next few issues of ETI we will cover the design and construction of an affordable video framestore that can capture and process video images, whether they be from cameras, video tape recorders or broadcast in real time. A full kit of parts will be available for the construction of the PCB, or the plated through hole PCB can be purchased alone for those wishing to make their own way. A cased, tested and complete framestore is also available for those whose feet tend to be level with their head for the greater proportion of the time.

The techniques of interfacing the framestore to a microprocessor will be explained by means of an example in the form of an add-on RS232 interface which provides a comprehensive, albeit slow, access to the store. Again a kit of parts and PCB will be made available. Finally some EPROMs will be available with some simple and not so simple image processing algorithms in them to run on the MPU board.

Decision Time

At the outset, some decisions had to be made as to how much memory and what type to use, what resolution is satisfactory and affordable and, generally, what to include and what to leave out of the specification. To appreciate the decisions that were made, it's useful to have some idea what the incoming video looks like.

Video is sent as a sequence of lines of information, each one slightly below the previous one and each lasting 64 microseconds, of which 52 µs is visible. The other 12µs is time used to get the trace back to the beginning of the next line.

In all, 625 lines are sent to describe the complete image. They are sent in two goes, 312½ each time, the half ensuring the second lot lie in between, or 'interlace' with, the first lot. Each lot is called a field, 312½ lines of 64µs each, lasting a total of 20ms. The two fields together are called a frame. About 575 of the 625 lines are visible, the others being blanked during flyback, when the spot gets back to the beginning of a field.

Figure 1 illustrates what the composite video signal looks like. There are two obvious parts to it. The first is down the bottom of the signal (about 0.3V of it usually) and is the synchronizing information.

This consists of 4 µs pulses to mark the beginning of each line and longer pulses to mark the beginning of each field. Within the field pulse is information which enables us to determine which field is which within a frame.

Although a monochrome signal would not have it, I've shown where the colour burst pops up. This performs the same job as the line and field syncs for the colour decoder. On top of the sync signals and about 0.7V in amplitude is the video itself. Where the syncs stop and the video starts (on the back porch) is defined as black. As the video signal approaches 0.7V, it would appear progressively whiter.

Memories

To store one video image, we are going to break it up into little packets (pixels), which represent the brightness of the image at each point on a notional screen and hold them in a digital memory. The more pixels there are in memory, the better the reconstituted image will look.

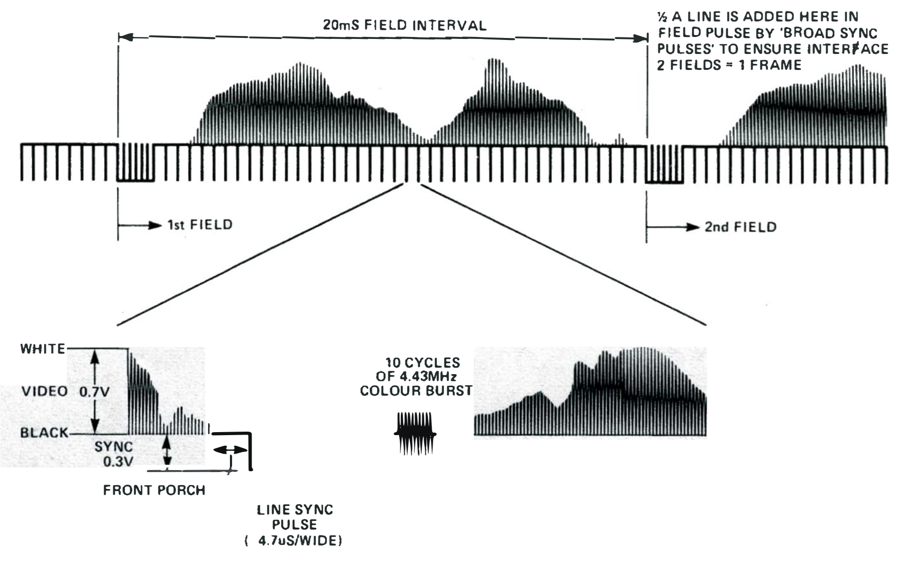


Fig. 1 The video signal.

To make full use of memory ICs, we must choose the number of pixels to be stored with care. Nearly all memories store 2^n bits of information. We could store 575 x ½, or 287½ lines per field. The nearest power of 2, gives 256 (2^8) lines. No real problem here, 64 μs are available to store each line and this is plenty of time for modern RAMs.

How many pixels per line should be stored? Well what about 256 again? Sounds reasonable, doesn't it? This means that one image will be composed of 256 x 256, or 64K, pixels. The pixels will require a certain number of bits to represent brightness levels, all of which means a fair amount of memory which could turn out quite expensive. Cost indicates dynamic RAM.

What should the access time of the RAM be? To make full use of the RAM, we should only store what is known as the active period of the line, the 52 μs that doesn't comprise fly back. So each pixel is 52/256 μs or 203ns wide. Let's call it 200ns and use a 5MHz sample clock — nice round numbers.

Just a small snag here though — 200ns is too fast for dynamic RAM. The popular 64Kx1, 150ns DRAM actually requires 260ns to access it, allowing time between accesses for the DRAM to settle down a little (the precharge time). One way around this is to store two successive pixels temporarily in a register and then present them to two dynamic RAMs (one for each pixel). Now 400ns are available for storage, which is plenty, and the slight increase in hardware complexity is negligible.

As far as accuracy is concerned, one factor overrides all. As I only have 200ns to convert a signal level video into a binary number, a parallel or flash converter must be used. Until recently, a 4 bit (16-level) flash converter could cost £40 or so — the 6-bit (64-level) device being over £100. To our rescue comes STC's recently introduced 8-bit combined ADC and DAC in a single package costing about £40 complete. The IC will be looked at in more detail next month — suffice to say that the price is a result of plastic packaging and anticipated high volume production for television and video equipment.

Unfortunately, to use more than four bits the amount of hardware (including memory) would have to be doubled, most TTL ICs being four or eight bits

The framestore showing an *untreated image.*

wide. To keep costs down. It was decided to use four bits with an option to expand this later.

Although we're only using four-bits, since two RAMs are required for each storage operation we still need eight RAMs altogether. Having settled on DRAM and having 400ns available for an access, it was decided to use a read-modify-write cycle instead of a conventional read or write cycle.

By delaying the application of the write pulse, the DRAM will assume it is in a read cycle and will present the information at its Q outputs — that is, at the address requested. We take this information and display it. We also send it to an arithmetic processor which has access to the data waiting to be written into memory. The output of the arithmetic unit is then presented to the D inputs of the DRAM after any required processing. This enables the frame store to do things like add or subtract previous and present information before writing it into RAM.

Another simple benefit is that an image is still displayed even if continuously writing into the store. To do this with static RAM would require a read followed by a write cycle: 300ns in total, which is too long. A read-modify-write cycle for DRAM takes only 25ns longer than a conventional read or write cycle. Also, 8Kx8 static RAM (the most cost effective at the moment) uses common I/O pins so that the read information must be latched and held for the arithmetic logic unit (ALU) — which means more hardware.

In the actual circuit (Fig. 2), the hardware to interface to DRAM allows a simple upgrade to 256Kx1 memories (by adding one address like) which enables up to eight, fields to be stored. Also, since the contents of the DRAMs are being read all the time, the stored image is always viewable and the DRAMs can be refreshed automatically in the read-modify-write cycle as long as the address present when row address strobe ($\overline{RAS}$) goes low is the lowest order byte of the full address. This changes 128 times a line or 256 times every 128 microseconds.

The DRAMs are not accessed during the flyback period when nothing is being stored. This represents 312½-256 = 56.5 lines per field or 56.5 x 64μs, which is 3.616ms. This is the longest time the DRAMs are required to hold data without refresh. This is too long for some DRAMs which require 128 cycle refresh every 2ms. DRAMs which only need a 256 cycle refresh every 4ms present no need to worry about refresh at all. The last row to be refreshed will have to wait 3.616ms plus 128μs, or 3.744ms, which is fine.

However, 2ms DRAMs will probably work if used at room temperature or thereabouts so that

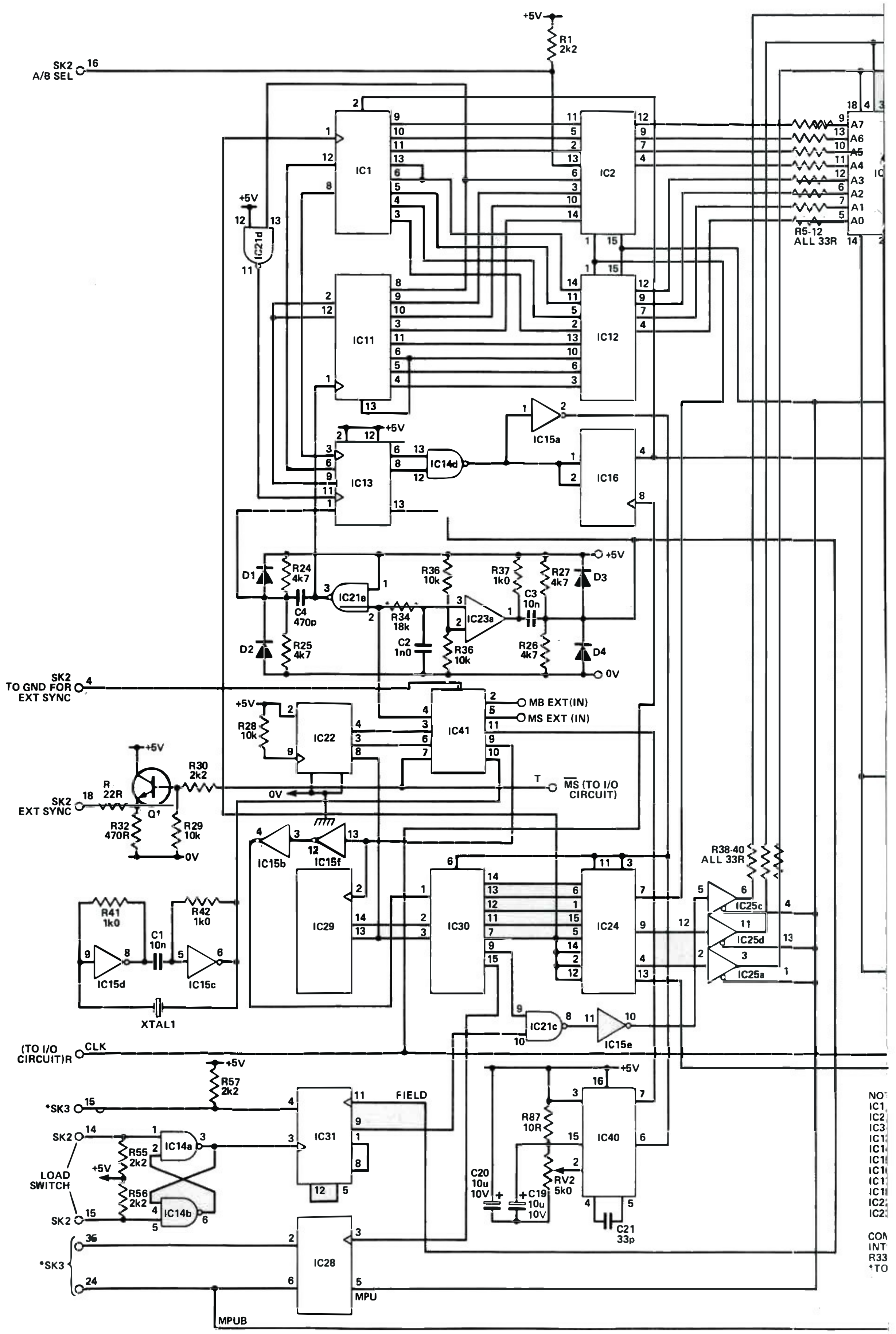
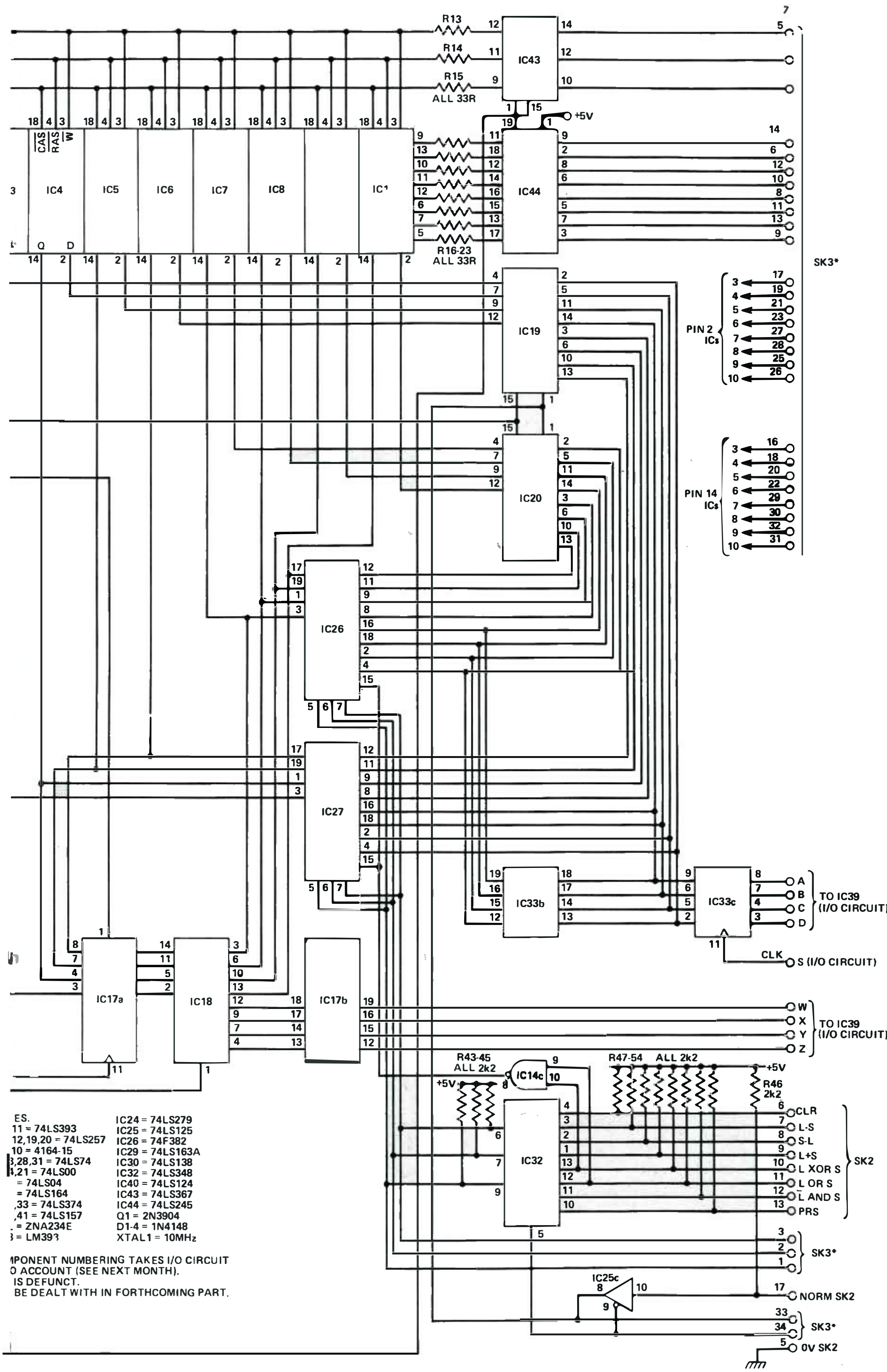


Fig. 2 The circuit diagram for the logic section of the framestore.



ES.
11 = 74LS393
12,19,20 = 74LS257
10 = 4164-15
3,28,31 = 74LS74
4,21 = 74LS00
= 74LS04
= 74LS164
,33 = 74LS374
,41 = 74LS157
. = ZNA234E
3 = LM393

IC24 = 74LS279
IC25 = 74LS125
IC26 = 74F382
IC29 = 74LS163A
IC30 = 74LS138
IC32 = 74LS348
IC40 = 74LS124
IC43 = 74LS367
IC44 = 74LS245
Q1 = 2N3904
D1-4 = 1N4148
XTAL1 = 10MHz

MPONENT NUMBERING TAKES I/O CIRCUIT
O ACCOUNT (SEE NEXT MONTH).
IS DEFUNCT.
BE DEALT WITH IN FORTHCOMING PART.

the tiny capacitors used to hold the charge representing a one or zero bit do not discharge quickly. If you already have eight 2ms RAMs (Hitachi, Motorola or Toshiba, for instance) socket them and try them out. If you are buying RAMs from scratch, get Texas or Samsung or any other 4ms devices. The kit will supply the correct RAMs.

Just A Wee DRAM

Those who are familiar with DRAMs may skip this bit (as it is the last section this month, this has distinct attractions). To save on packaging, 64Kx1 DRAMs receive the 16 address bits required to select one of 65536 (216) locations as two bytes into the RAM. A write enable pin, two supply pins (watch out — they're the opposite way round to everything else on this earth!) and separate data in and out pins (D and Q) mean we can fit a 64Kx1 RAM into a 16 pin package. Pin one is unused (a little lie here, since it can be used for an auto refresh function) and allows a simple fourfold expansion to 256K.

To access the DRAM, the first (and lower) eight bits are set up and $\overline{RAS}$ is taken low (see Fig. 4). This initiates the cycle and latches the first address byte. After the RAS address hold time, the address is changed, by the LO line here, and $\overline{CAS}$ taken low to latch the high order byte. After the $\overline{CAS}$ address hold time (45ns), we no longer need to hold the address steady and can do with it as we will. $\overline{CAS}$ also turns on the data output drivers. Some 150ns after $\overline{RAS}$ or 100ns after CAS, whichever is the later, valid data appears on Q, representing the information at the location latched in. This is sent to the ALU and some function performed to combine it and the incoming converted ADC data. The output of the ALU is then sent to the data input of the RAM.

If the RAM is to be read as in a normal display access cycle, the output data is just latched so it is ready for the digital-to-analogue converter. The access cycle is then terminated by taking $\overline{RAS}$ and $\overline{CAS}$ high. The RAM may now no longer be accessed until the precharge time has elapsed (100ns). During this time the data that was read is automatically written back into the location from wherever it was destructively read. Hence the lack of an additional refresh requirement.

Should we wish to write new information in to the RAM, once the ALU had valid data we need only take write ($\overline{W}$) low for at least 45ns to write new data in on its falling edge. The cycle terminates as before.

Next month we'll deal with the ADC/DAC circuit and complete the description of the framestore. The parts list, buylines and details of where to purchase the kit will then be covered, along with construction and connection details.

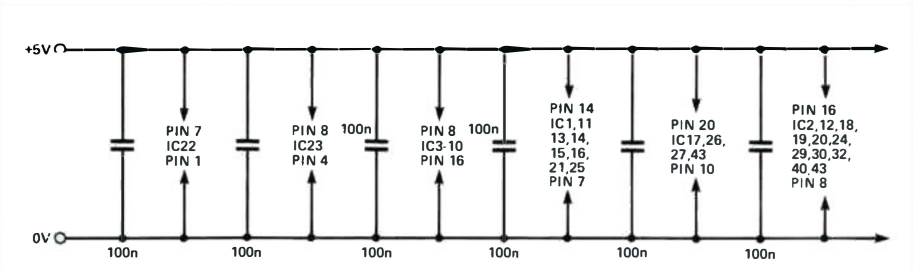
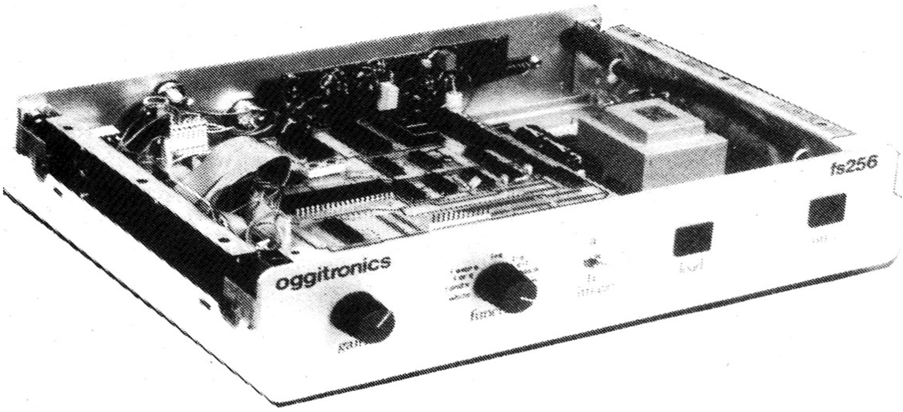


Fig. 3 Power connections to the logic section.



Inside the framestore.

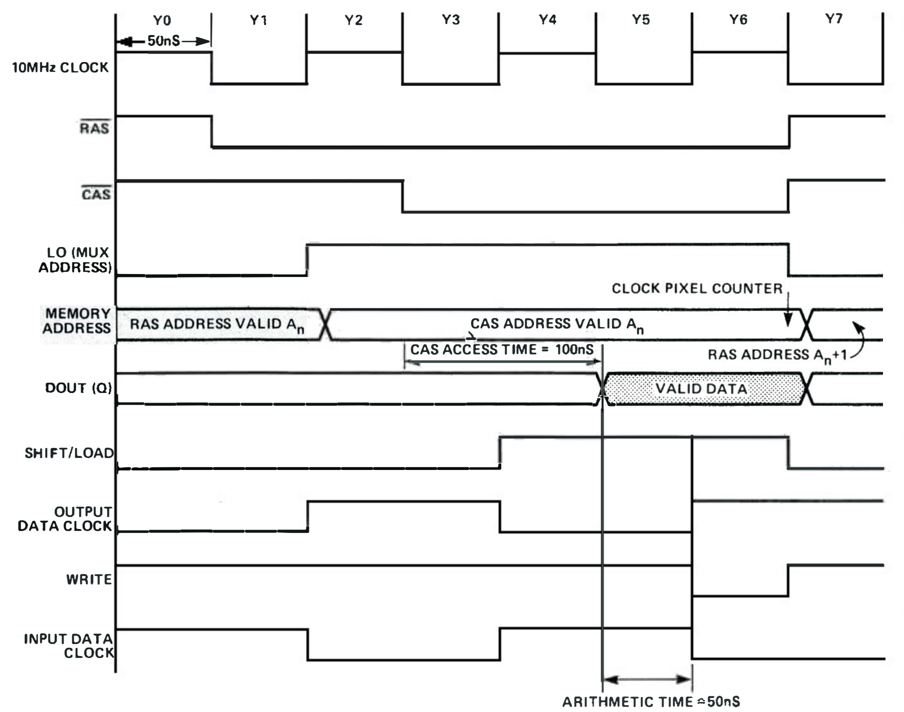


Fig. 4 Dynamic RAM timing diagram.

HOW IT WORKS

The master oscillator is formed from two TTL inverters (IC15b, c — Fig 2) and a 10MHz crystal (XTAL 1). (An option is also provided to feed in an external clock signal). This is fed via two further delay gates (IC15 a, d) and a binary counter (IC29) to the select inputs of a 3-to-8 mulitplexer (IC30). The outputs from this consist of a series of negative going pulses in order from YO to Y7 repeating continuously. These pulses are used to set and reset the four RS latches of IC24. The outputs from these form the RAS and CAS signals for the DRAMs and the multiplexing signals for the output data and the addresses.

The 2.5MHz from IC29 clocks IC22, the sync pulse generator. This chip (actually designed to produce test patterns) generates a mixed sync and mixed blank signal. In external sync mode these signals are generated from the incoming video signal. The mixed sync output is fed directly to the output mixer stage and is also buffered by Q1 to provide a 75R drive to the sync input of a camera if required. The mixed blank output is fed via an inverter and differentiating network (IC2 and associated components) to IC13, pin 1. This resets the flip-flop at the end of the blanking period of every line (start of the display period or active line period), enabling the pixel counter IC1.

IC1 counts the Y7 pulses from IC30 until 128 have elapsed whereupon the Q4 ouptut on pin 8 goes high, clocking IC13, pin 32, and resetting the counter. Only 128 addresses are counted because two pixels are stored in each location.

The mixed blank output of IC22 is integrated and level detected in a comparator, IC23. This detects the field pulses in the mixed blank output. Similarly this pulse is differentiated, clears IC13, pin 13 and enables the counter IC11. When 256 lines have been counted the Q4 output on IC11, pin 8, returns low and clocks pin 11 of IC13 via IC21d. This resets the line counter.

The outputs of the line and pixel counters are presented to IC2 and IC12, which are 2-to-1 multiplexers. The select signal on pin 1 of the two multiplexers presents the lower address bits for latching into the DRAMs with $\overline{RAS}$ and then switches them over to present the remainder of the address for latching by CAS. The upper address bit is used to select one of the two halves of the DRAM, allowing two images to be stored. The multiplexed address lines drive the DRAMs, IC3-10, via 33R resistors. These help to prevent damaging negative overshoot of the address and control lines caused by the steep edges and high capacitance of the DRAM inputs. Pin 15 of ICs 2 and 12 allow the addresses to be tri-stated. The $\overline{RAS}$, $\overline{CAS}$ and $\overline{W}$ inputs of the DRAM can also be tri-stated via IC25. This allows external memory access. ICs 3 to 6 store the 4 bits of one pixel, and ICs 7 to 10 store the 4 bits of the adacent pixel.

The data from the DRAM is clocked into a 4-bit wide parallel in, serial out shift register formed by latch IC17 and the 2-to-1 multiplexer IC18. The shift/load signal is provided by pin 13, IC24. In the latter part of the DRAM cycle the multiplexer selects the data from the DRAM and the clock pulse latches in both pixels of data. The multiplexer then connects IC17 as two 4-bit wide latches, clocking the two pixels out sequentially to the DAC whilst the RAM is accessing the next two pixels of information.

The data from the ADC is clocked into IC33. Two sequential pixels are stored before being presented to the DRAM. The data may be passed from IC33 unmodified via multiplexers IC19 and IC20. This occurs if the NORM input of the function switch is grounded (pin 1 of the multiplexers). Alternatively the data from IC33 is presented to two arithmetic logic units (ALUs), IC26 and IC27, each operating on one pixel of the latched data. The other input to the ALU is from the appropriate RAM chip's output.

A read-modify-write cycle is used by the DRAMs. This allows them to present the previous stored data before rewriting occurs. The output data from the RAMs is presented to the ALUs together with the corresponding-new-incoming data. The output from the ALU is sent to the RAM via IC19 and IC20. The function of the ALU is selected by IC32. This chip provides a 3-bit binary code in response to grounding one of its eight inputs. The 'unmodified/ALU' select line and the ALU function can be tri-stated if required to allow external control.

The write signal to the RAM is derived from IC30. The load switch is debounced by IC14 and the leading edge of the pulse is latched into one half of IC31. The Q output of this is sent to the D input of the second half which is clocked by field pulses from IC23. An integral number of fields is therefore always stored, although no distinction between first and second field is made, either being stored. The load enable output gates pulses from IC30, pin 9, which are sent to the RAM via tri-state buffer, IC25b, and a damping resistor. An external load input can be provided by momentarily grounding pin 4 of IC31. Holding this pin low continuously loads new data into the RAM so that the TV monitor shows a digitized live image.

IC28 synchronizes external accesses to the RAM by, for example, an MPU, ensuring no conflict with the precharge or other critical timings. No refresh is provided for the DRAMs. By presenting the least significant address lines to the RAMs on the RAS clock edge, reading the RAMs ensures that all 256 cycles are refreshed within the 4ms requirement. Incidentally, IC22 also provides crosshatch, dot and greyscale outputs that can be used in setting up the framestore or monitor.

THE ETI MAINS CONDITIONER

Paul Chappell gets your mains supply into trim.

The domestic mains supply in this country bears about as much relationship to a 240V sine wave as the Sinclair C5 does to a motor car. Transient spikes of 200V or more above the peak mains voltage are common, and RF noise is present in copious quantities, both of which can degrade the performance of sensitive electronic equipment. Hi-fi enthusiasts will be familiar with the effects, which range from the obvious and annoying cracks and pops to more subtle effects — a general feeling that the sound reproduction is not quite as perfect as it could be. As for computers, there is nothing more frustrating than having a program crash for no apparent reason, or finding vital data corrupted.

The ETI Mains Conditioner has been designed to remove the irregularities and leave your supply clean and relatively unpolluted. A voltage dependent resistor absorbs most of the energy from transient spikes, and a filter removes the remaining RF noise. The PCB is small enough to fit inside just about any hi-fi amplifier or tuner. With home computers and other equipment where space is limited, it can be built into a small plastic box and connected in series with the mains lead.

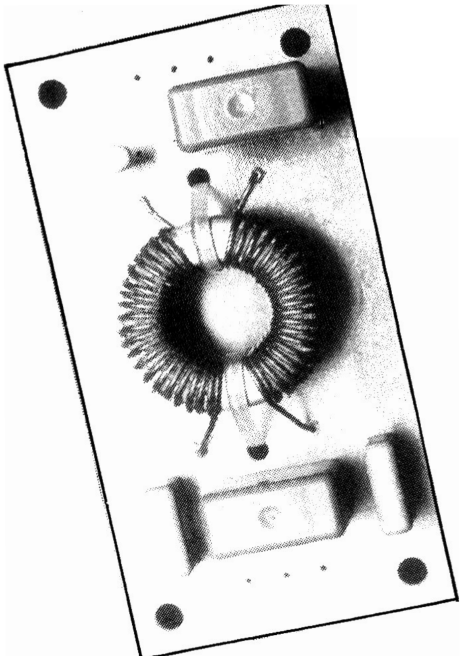
Construction

The circuit is built according to the component layout shown in Fig. 1. The toroid is wound with two coils, each consisting of 20 turns of 22SWG enamelled copper wire. Be sure to wind the coils in the direction shown in the diagram, otherwise the filter will not work correctly.

If you use a nylon coated toroid, the coils can be wound straight onto it. An uncoated toroid will have to be insulated first — a few coats of polyurethane varnish should be enough. The toroid can be held temporarily in place by twisting the wires together behind the PCB, then fixed firmly to the board by means of two thin cable ties through holes AA and BB. After adjusting the coils so that the turns are evenly spaced, the whole assembly can be given another coat of varnish. Finally, the leads should be trimmed and soldered to the PCB. Most modern 'enamelled' wire is coated with a substance that will melt with the heat of a soldering iron, and is self-fluxing. The melting point may be fairly high, so the solder joint will probably take longer than usual.

Please be sure to use the capacitor types specified for this project. Connecting capacitors across the mains can cause fires and potentially lethal electric shocks under fault conditions. Class X capacitors must be used for connection between 'live' and 'neutral', and class Y devices must be used for connections to mains earth. These capactitors are designed so that any failure that may occur will not have disastrous results.

The circuit as it stands is suitable for equipment drawing up to 5A, limited by the wire gauge of the toroid winding. The PCB will accommodate a larger toroid and heavier gauge wire if you wish to increase the rating.



PARTS LIST

RESISTORS	
R1	**220k ½W**
VDR1	**Metal oxide varistor, rated 275V AC working, 26J.**
CAPACITORS	
C1, C2	**10n 250V AC, class X.**
C3, C4	**4n7 250V AC, class Y.**

MISCELLANEOUS
Ferrite toroid, 22SWG enamelled wire, cable ties, PCB.

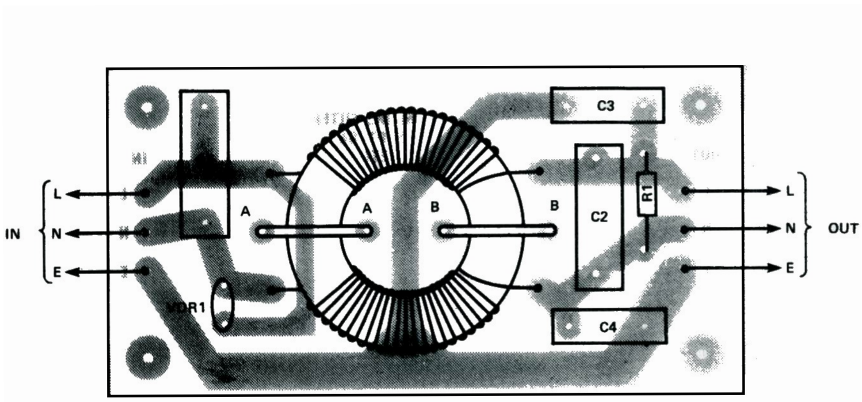
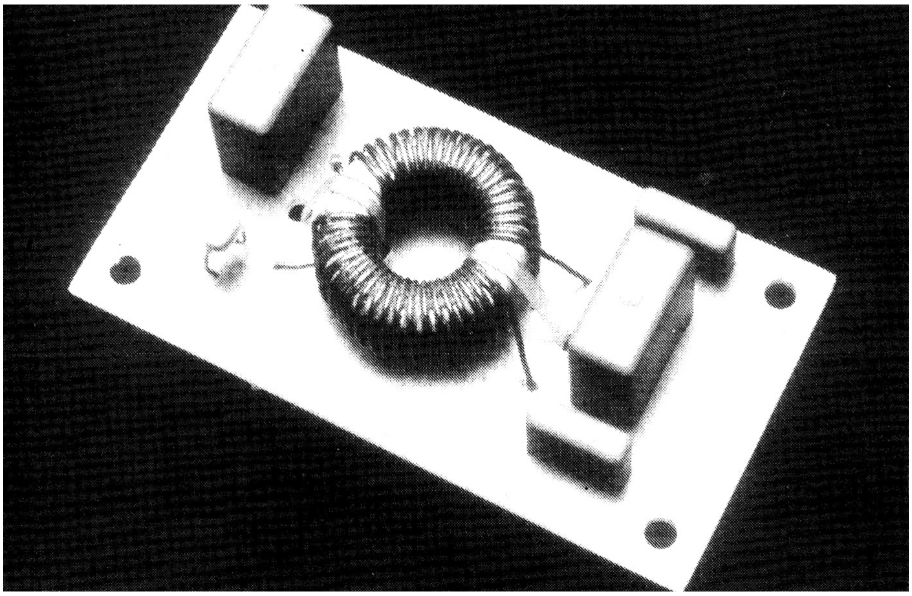


Fig. 1 Component overlay.


The completed mains conditioner - note missing resistor, R1.

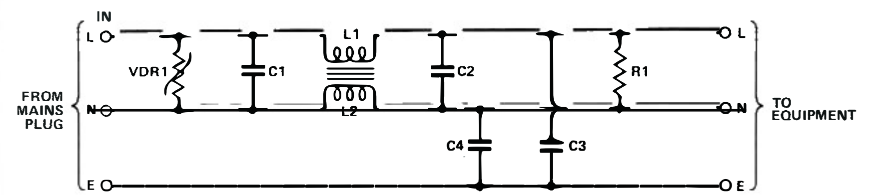


Fig. 2 Circuit diagram.

HOW IT WORKS

The VDR is rather like a bi-directional zener diode. It has a high resistance until the voltage across it reaches the varistor voltage, 430V for the device used in this project, above which point the resistance drops rapidly to a very low level, removing most of the energy from transient spikes and limiting the maximum volt-age. For the length of a pulse — a few µs — the varistor will absorb large amounts of energy and pass currents of several hundred amps, if necessary.

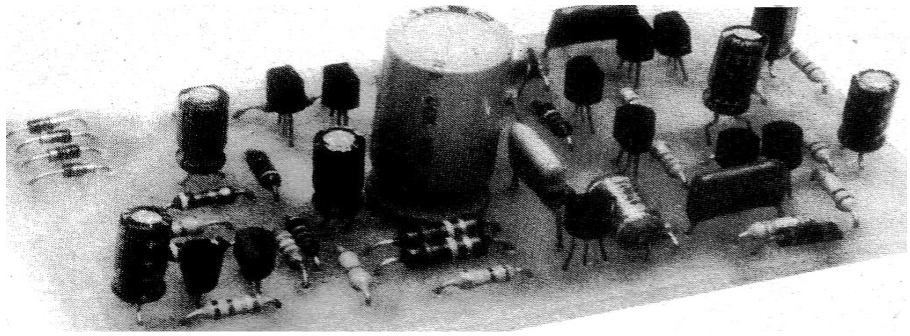
The inductive element of the filter is wound with two coils in opposite directions on the same core. Equal currents flowing in opposite directions through the two coils, as will be the case with the normal mains current, will have no net magnetic effect on the core. Any un-balanced current flow due to noise on the line will see the full inductance of the coils, and will be attenuated by the filter.

BUYLINES

A suitable VDR is available from Maplin (see their ad in this issue) under the name of 'mains transient suppressor', order code HW13 P. Class X and Y capaci- tors are available from the same source. A suitable toroid is type 59-64001401 from Cirkit, who also advertise in ETI. A complete set of parts for the project is available from Specialist Semicondutors, who also have an ad in this issue.

EXPERIMENTAL PRE-AMPLIFIER

Following on from last month's valve preamplifier design, Jeff Macaulay looks at possible explanations for the difference between valve and semiconductor amplifier performance and describes a transistor preamplifier which puts his conclusions to the test.



A great deal of debate has been entered into recently about the use of negative feedback in audio equipment. The negative feedback protagonists argue that the use of overall feedback allows cheap and nasty parts to give a good performance, the negative feedback linearising the load line. The anti-feedback lobby insists that it is far better to design the stages to be linear without the use of negative feedback.

The fly in the ointment as far as the latter argument is concerned is that most of the devices presently available are far from linear without the use of negative feedback. The exceptions to this rule are triode valves and FETs. These however have low voltage gains. On top of this valves are expensive and difficult to use, and suitable FETs are just awkward to obtain.

This appears to leave us back where we started with a choice of either op-amps or transistors. Suitable op-amps for audio preamps are a bit of a thorny topic. The choice is between ultra-low-noise devices with no real slew rate or high slew rate devices with relatively high noise. Transistors seem to have gone out of favour lately, and having heard some of the preamplifier designs that used them it's not surprising! The typical two transistor magnetic cartridge equaliser used to run out of overload and consequently distort terribly at the slightest provocation. This would be particularly noticeable to those whose record collections contain direct cut records.

When I first tried to build a good preamplifier I didn't expect to hear much difference between it and my existing circuit which used a TL072 op-amp. The sound, however, was a revelation — the stereo image, the dynamics and the detail rendition all improved enormously.

This was gained only through the use of valves, and it naturally led me to wonder whether the same improvement might be obtained from solid state circuitry?

Now we all know of those who insist that the valve is the pinnacle of audio development and cannot be surpassed. I for one don't hold these views and feel that a rational reason must be sought. One possible reason is that all the stages in valve equipment operate in class A, and because of the high impedances employed are not loaded by the other circuit elements.

Furthermore, because of the highly linear nature of valves, the distortion generated is minimal even without the use of negative feedback. In a preamplifier the actual signal voltages present at the anodes are very small compared with the output swing capacity. In consequence each stage is working optimally without loading the next.

Compare that to an op-amp circuit in which the output

VALVE PREAMPLIFIER UPDATE

First, we got it wrong last month when we said that the kit for the valve pre-amplifer doesn't include a case. Bewbush Audio have since informed us that it does! Our apologies to anyone who was misled by this.

Second, since publishing the article we have come up with a few further suggestions for component sources. Barrie Electronics tell us that they can supply a suitable transformer for the preamplifier. Known as the V1 it has a mains primary and secondaries giving 250-0-250V at 80mA, 6.3V at 3A and 6.3V at 2A tapped to give 5V at 1A. The cost is £10.51 inclusive of VAT and postage and the address is unit 211, Stratford Workshop, Burford Road, London E15 2SP, tel 01-555 0228. We have also discovered that Marco Trading can supply multi-section, high-voltage capacitors. Their address is given in the Buylines section.

Finally, Graham Nalty's company, Audiokits, can supply a complete kit of high quality parts for the valve preamplifier. A sheet containing prices and some suggested improvements can be obtained from them at the address given in this month's Upgradeable Amplifier article.

operates in Class B and the frequency response has been deliberately rolled off to prevent instability when feedback is applied. To compound matters the feedback loop itself loads the output stage so that even if it doesn't run out of drive capacity the output sees non-linear loading.

One of the troubles with valve circuitry is that the only linear devices available, triodes, have low voltage gain. If we were to compare a transistor and a valve both working from a typical valve HT voltage of, say, 250V, we would find that the valve would have a smaller output voltage swing because of its anode resistance and a much smaller voltage gain. However, the valve would probably offer the lower distortion figure. If we can find a way to reduce the distortion of the transistor stage, we should obtain a performance equal to that of the valve circuit.

In fact we can do rather better than just equal the valve's performance. Applying a little local negative feedback to a transistor will produce a stage that is non-microphonic, requires no heater voltage and has a better output swing and distortion performance than a valve with a comparable input impedance.

All this by the simple expedient of adding an emitter resistor! of course this raises another question: if it's so simple how come nobody has done it before? Well for starters getting economically-priced transistors that would work at that kind of line voltage was very difficult until recently. Another reason is that we are all indoctrinated into thinking of transistors as low voltage devices. After all, that's their real advantage compared with valves.

Equalisation

Having decided to use transistors with local feedback as the basis for the design, all that remains is to decide how to equalise for the most important signal sources.

Despite their technical superiority, most people do not as yet use CD players as their main music source. Instead most of us, myself included, will be using the vinyl disc for some time to come. In consequence most attention will be focussed upon the disc EQ stage.

In modern valve preamps, the types that are raved about by the pundits and which cost an arm and a leg, EQ is done passively. This has the drawback of insertion loss but the EQ obtained can be more accurate than that obtained from an active filter. This is especially true of the HF rolloff which in active designs doesn't continue indefinitely because non-inverting feedback amps cannot have a gain of less than unity. One of the consequences of this is to make such designs more prone to pick up interference.

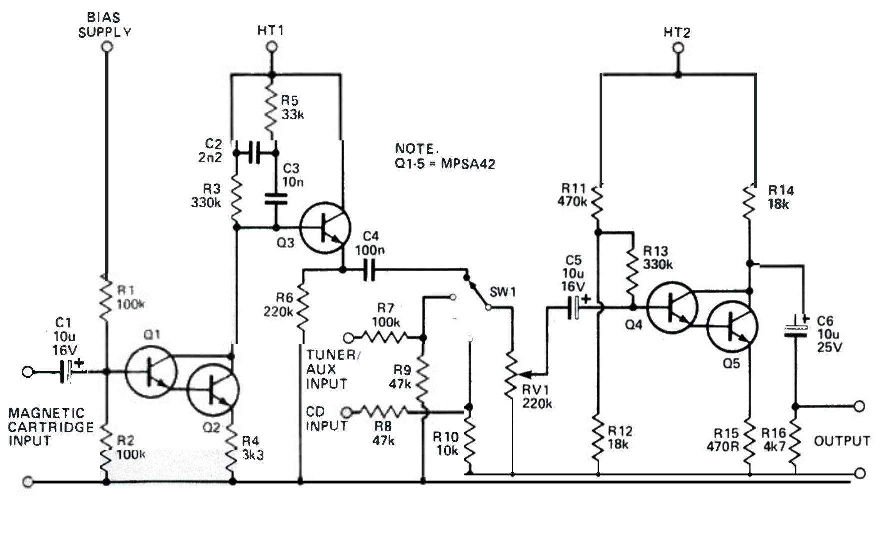


Fig. 1 Circuit diagram of one channel of the experimental preamplifier.

Input Stage

In this design a somewhat different approach has been used. The input signal is turned into a signal current and this is applied to a passive network for the EQ.

The input voltage is turned into an output current because the input voltage is developed across the emitter resistor. This provides a pure current drive at the collector. In fact it is more convenient to make the collector load the equalisation network.

Fig. 1 shows the circuit diagram of the preamp. Instead of using a single transistor a Darlington pair configuration is used. This has the advantage of having a much higher current gain than a single transistor and thus increases the input impedance to several tens of megohms.

Base bias for the pair is obtained from the bias network R17 and R18. To set the required input impedance to 50k for correct loading of the cartridge, R1 and R2 are also used. C7 effectively removes any noise or ripple voltages from the line which might otherwise be amplified by the transistors. The cartridge is coupled into the base of Q1 by C1 which isolates the base from any DC present. A voltage identical in amplitude to the input appears at the emitter of Q2 across R4.

The resulting current is fed from the collectors of Q1 and Q2 to the filter network R3, R5, C2 and C3. At low frequencies, below 50Hz, the gain is set at 100 by the ratio of R3 to R4. Above 50Hz the response falls off at 6dB/octave until 500Hz due to the shunting effect of C3 and R5. From 500Hz to 2150Hz the response is again flat, and thereafter another 6dB/octave rolloff occurs due to the shunting effect of C2.

Q3 is connected as an emitter follower presenting a high impedance to the filter network but a low impedance drive at its emitter to the volume control. The stage as it stands has an overload capability of 40dB with reference to a 5mV input and is therefore effectively overload proof. Even the most energetic direct-cut discs have not managed to overload the prototype.

Other Sources

So much for magnetic cartridges, what about the other sources? Most other sources normally encountered are flat and don't require any kind of equalisation. Generally speaking there are only two other major signal sources to be catered for, CD and tuner. The tuner input has a sensitivity of 100mV for 500mV out and an input impedance of 100k. CDs generally have a much

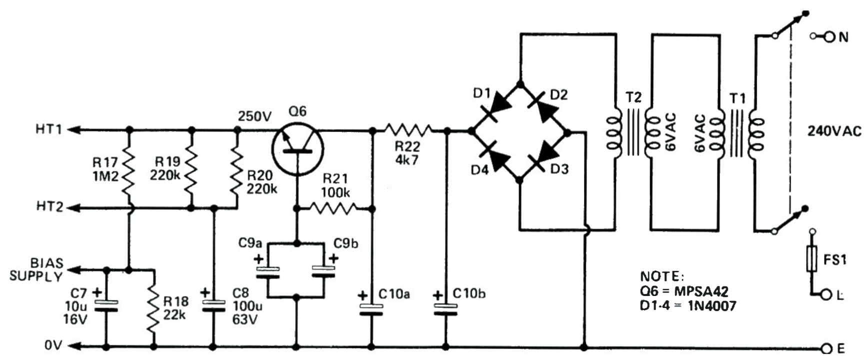


Fig. 2 Circuit diagram of the experimental preamplifier power supply. Note the use of two 6V mains transformers in series to produce a cheap 240V:240V transformer.

higher output level, up to 2V maximum. In any event the sensitivity of this input has been set at 200mV in for 500mV out. Having the volume control at this point in the circuit allows an infinite input overload figure on both inputs.

The line preamp consists of the two transistors Q4 and Q5. These are again used in the Darlington pair arrangement but there is nothing to be gained by employing high voltage lines here. Instead the 250V line voltage is reduced to 50V by the decoupling network consisting of R19, 20 and C8.

A low output impedance is achieved by gain dumping. That is to say that R16 shunts the collector load resistor R14. Overall voltage gain from the stage is set at the ratio of R16 to R15. R11 and R12 provide base bias for the pair whilst the input impedance is set at 330k by the value of R13.

Obtaining a high voltage with low ripple is not the easiest of tasks. However, since the current consumption of the preamplifier is only some 3.5mA the problems are somewhat simpler to solve than those posed by a valve preamp.

HT transformers are expensive and hard to obtain. There are a few companies producing mains isolating transformers (giving a 240V isolated output from a 240V mains input) but these usually have high VA ratings and are therefore large and costly. It would also be possible to use one of the HT transformers recommended for last month's valve amplifier and simply ignore the low-voltage heater windings. The other obvious method of producing HT, an inverter, is not really feasible in audio equipment because of the RF hash radiated by the switching circuitry.

One solution is to use a pair of standard 6V mains transformers back to back. The mains voltage is applied to the primary of T1, the secondary of which is connected directly to the secondary of an indentical transformer, T2. Thus the stepped down mains voltage is stepped up again to appear on T2's primary. An incidental advantage of this method is that we obtain double isolation from the mains.

The HT voltage is full wave rectified by the bridge rectifier, D1 to D4 inclusive. C10b smoothes the raw DC from the rectifiers and this is fed to the RC smoothing circuit formed by R22 and C10a.

At this point the ripple voltage across C10a is about 1mV. However this is not really low enough and further smoothing is required. This is achieved by means of the capacitance multiplier formed by R21, C9 and Q6.

This circuit, also called a gyrator, is a very efficient way of reducing ripple voltages. It works as follows. R21 and C9 form a filter which effectively removes the ripple. The resulting smooth DC is applied to the base of Q6. At Q6's emitter an equally smooth voltage is obtained but at a very low impedance. Because of the transistor's gain, the preamplifier sees an effective capacitance of some 8000μ!

Construction

No case has been specified for this project, so it is up to the constructor to choose something suitable and then work out the appropriate mounting hole positions, etc.

When the holes are all drilled, deburr them, clean down the case and then paint it as required. Allow the paint to dry for some time (overnight if possible), then apply a light coat of varnish and leave to dry again. This is to make it easier to apply the lettering since most rub-down transfers adhere better to varnish than they do to paintwork. Use Letraset or a similar lettering system and when complete, apply another coat of varnish for protection.

The case can now be put aside to dry thoroughly while the PCB is assembled. This should cause no problems at all if Fig. 3 is followed carefully, but take the usual care with the transistors, diodes and electrolytic capacitors, all of which must be inserted into the board the right way around if they are to work correctly. If you have decided to use a 250-0-250V HT

BUYLINES

A complete kit of parts for the experimental preamplifier (including PCB and case, etc) can be obtained from Bewbush Audio, 47b Elmer Road, Middleton-on-Sea, Near Bognor Regis, Sussex PO22 6DZ. The price is £24.95 and the order code is kit HTP1. Those who prefer to find their own parts should not have too much difficulty with most of the components but the transistors, the transformer and the capacitors might present a problem. The transistors are available from a number of suppliers but not all of them trouble to list the device in their catalogues. Two companies who do are Cricklewood and Marco Trading. If you decide to use two 6V transformers as suggested in the text you will have a wide choice of potential suppliers. If you prefer to pay a little more and use a single transformer, try the RS Components type 196-072 or the one mentioned in the Valve Preamplifier Update over the page. We do not know of anyone who stocks 100+100u/320V capacitors as specified here, but Marco Trading have a large range of multisection capacitors including a fairly cheap 100u + 100u + 100u + 150u + 150u 320V type which might be suitable. Their address is The Maltings, High Street, Wem, Shropshire SY4 5EN, tel 0939-32763. The PCB will be available from our PCB Service, see page 60.

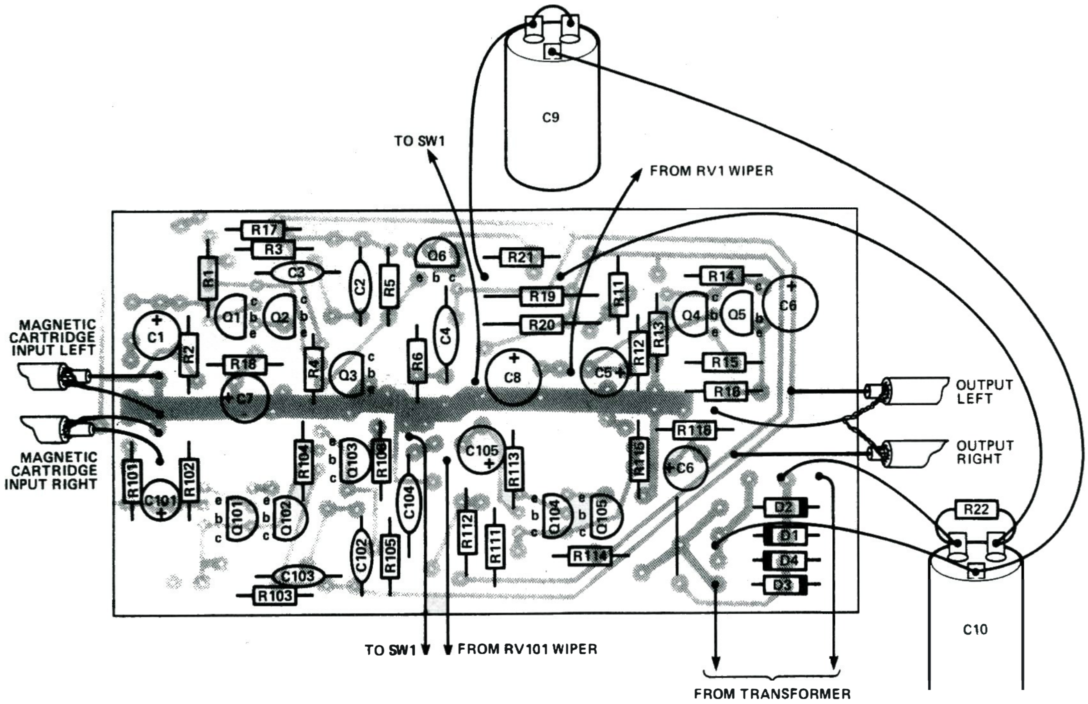


Fig. 3 Component overlay for the preamplifier PCB. This board carries both right and left channels, the right channel component numbers being the left channel numbers plus 100.

PARTS LIST

RESISTORS (all ¼W, 5% or better unless otherwise stated)

R1, 2, 7, 21, 101, 102, 107	100k
R3, 13, 102, 113	330k
R4, 104	3k3
R5, 105	33k
R6, 106	220k
RB, 9, 108, 109	47k
R10, 110	10k
R11, 111	470k
R12, 14, 112, 114	18k
R15, 115	470R
R16, 22, 116	4k7
R17	1M2
R18	22k
R19, 20	220k ½W 5%
RV1, 101	220k single-gang logarithmic potentiometer

CAPACITORS

C1, 5, 7, 101, 105	10u 16V radial electrolytic
C2, 102	2n2 polystyrene
C3, 103	10n polyester
C4, 104	100n polyester, 250V working
C6, 106	10u 25V radial electrolytic
C8	100u 63V radial electrolytic
C9, 10	100u + 100u 320V electrolytic

SEMICONDUCTORS

Q1-6, 101-105	MPSA42
D1-4	1N4007

MISCELLANEOUS

FS1	1A 20mm fuse and panel-mounting holder
SW1	3-pole, 4-way rotary switch (one section not used)
SW2	DPDT mains toggle switch (or substitute potentiomenter with internal DP switch for RV1 or RV101)
T1, 2	6V 1A mains transformers (see text)

PCB; case; PCB mounting pillars; input and output sockets; knobs; nuts, bolts, etc.

transformer in the circuit, don't forget to leave out diodes D2 and D3 and connect the ends of the HT winding to the anodes of D1 and D4. Check and board carefully for errors and dry joints.

You can now install the board, the transformer(s) and the other major components into the case and wire them up. R7-10 and R107-110 should be mounted on the back of the input selector switch, SW1, and the connections between the switch, the potentiometers and the PCB should all be made using screened cable. Bear in mind that quite high voltages are present and use sleeving where appropriate to reduce the risk of shocks and accidental short circuits.

Testing should be a simple matter of connecting the preamplifier to the mains and providing a suitable input source and a means of monitoring the output. With luck, it will work first time. If not, begin by checking that the power supply is giving an output (check at the emitter of Q6) and then work through from the input with a suitable signal present. The power supply has quite a low output impedance and can deliver a nasty shock, so take particular care when probing around within the preamplifier while it is switched on.

When the preamp is tested and working, the only remaining task is to connect it up to the rest of your system and check for hum-loops. It is most likely that your existing equipment will already be earthed, and using a separate earth on the preamplifier will merely give rise to hum. In this case, simply disconnect the mains earth to the preamplifier.

UPGRADABLE AMPLIFIER

Graham Nalty leaves no tone unturned in his quest for the perfect preamplifier.

Having covered the disc inputs of the Virtuoso preamplifier in the first few articles in this series, we now come to the heart of the system and the big question — do we want tone controls, filters or any other form of signal processing? If a particular facility is essential then it must be included, but it must be borne in mind that every additional switch, capacitor, resistor, wire or active circuit will degrade (or rather distort) the sound from the preamp. Using the best quality components you can afford will limit this distortion, but even the best circuitry will have some effect on the sound.

For this reason, I shall describe two options. The first provides all the usual facilities including MC/MM disc input switching, two flat and two tape inputs, stereo/mono switching, bass and treble tone controls and standard volume and balance controls. The second, 'minimalist' option has just the absolute minimum facilities, a special feature of which is the use of separate volume controls for each channel. The advantage of this arrangement is that the signal only passes through one potentiometer in each channel instead of the two used in a normal balance and volume arrangement. A further advantage is that this makes it possible to further upgrade the preamp by using 23 position gold-plated switched attenuators. This upgrade will not be covered in the present series of articles but may be described at a later date.

BUYLINES

Complete kits of parts for -the· tone board and the output board will be available from the author at 6 Mill Close, Borrowash, Derby DE7 3GU. The tone board costs £29.60 for the standard version and £89.40 for the fully-upgraded version, while the output board costs £11.60 for the standard version and £29.00 for the fully-upgraded version. All prices are inclusive of VAT and postage and cover all components for one (mono) board including the PCB. The PCBs will also be available without components in stereo pairs. The cost is £10.00 for two tone boards and £6.00 for two output stage boards. A case for the complete preamplifier is also available and costs £49.00 inclusive. It is drilled and labeled ready to accept the modules described in this series of articles. Two versions are available, one with provision on the front panel for tone con-trols and one without. Please specify which you require when ordering.

Setting The Tone

A good tone control should:-

1) raise and lower high frequencies without affecting the low frequencies,

2) raise and lower the low frequencies without affecting the high frequencies, and

3) offer a flat frequency response at a defined position.

As we have already used passive circuitry for the RIAA equalisation in the disc amplifier, we might consider a passive tone control.

The circuit of Fig. 1 is a switched treble cut circuit. It meets our requirement for a defined flat response, but when it is expanded to include boost and cut at both bass and treble frequencies a large number of components are needed.

The most popular form of tone control is the shunt feedback network shown in Fig. 2. If Z1 and Z2 were replaced with a linear potentiometer and its wiper connected to the amplifier input, the overall gain would be x 1 with

OOPS!

A little confusion crept into the description of shunt and series feed-back equalisers in last month's Upgradeable Amplifier article. In columns two and three on page 47, references to shunt feedback arrangements both in the text and in the illustration captions should read series feedback, and vice versa.

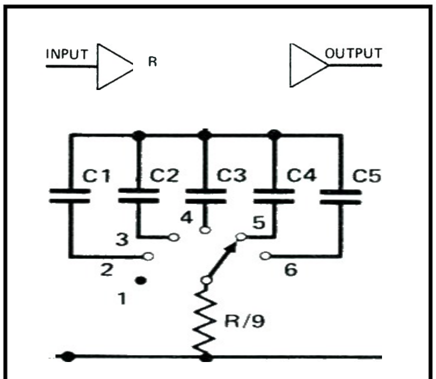


Fig. 1 A switched tone control providing treble cut. When the switch is in position 1, the response will be flal

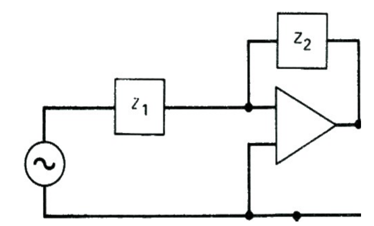
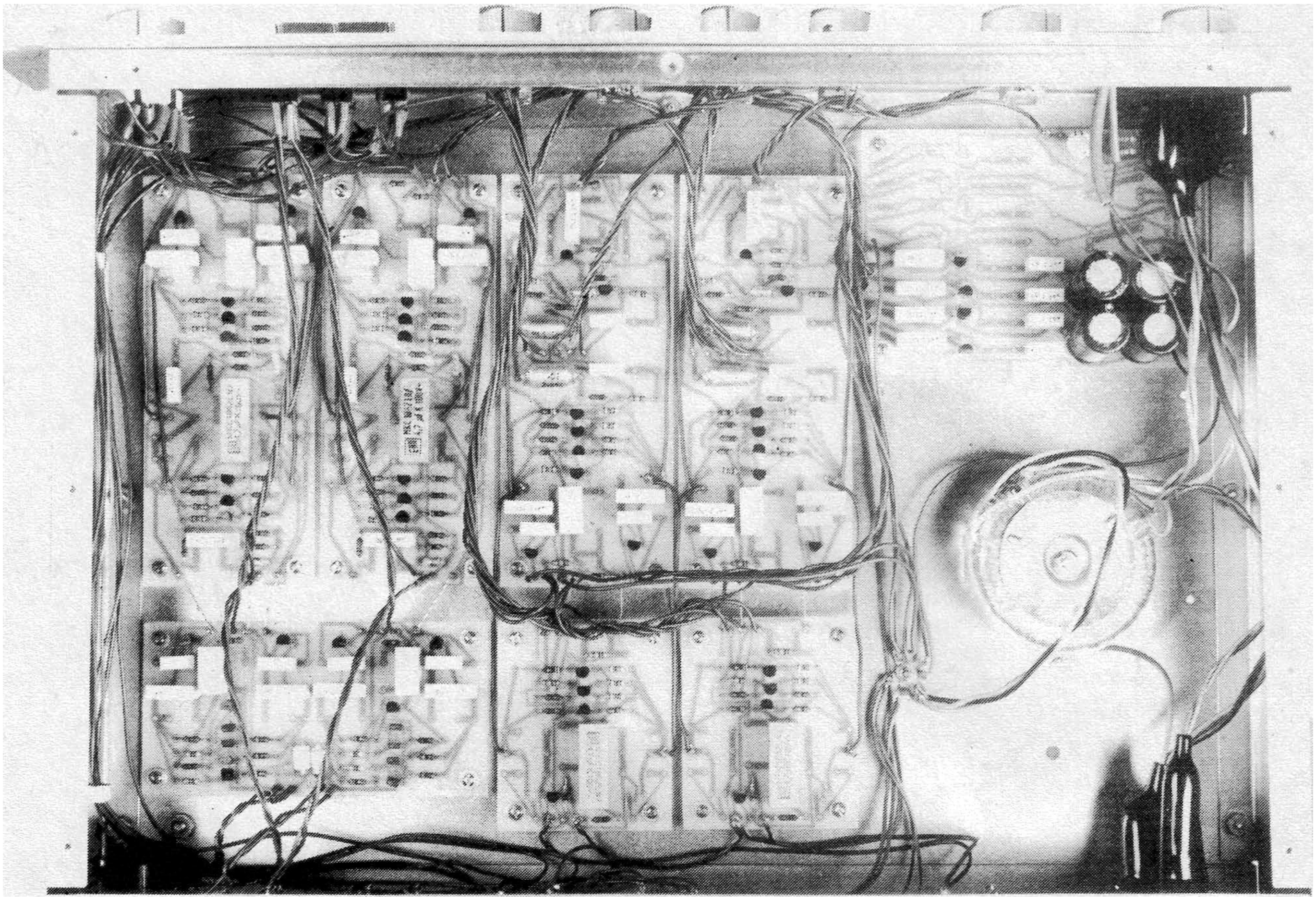


Fig. 2 a basic shunt-feedback tone control.



Internal view of the complete Virtuoso preamplifier in its standard form. The two sets of tone and output boards can be seen in the middle of the case.

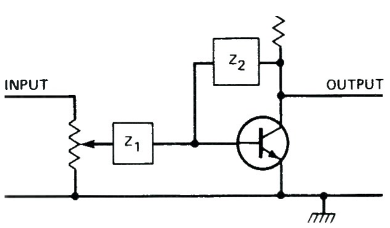


Fig. 3 Unless the input and output networks offer the correct impedance match, the shunt feedback circuit will not have a flat-response position.

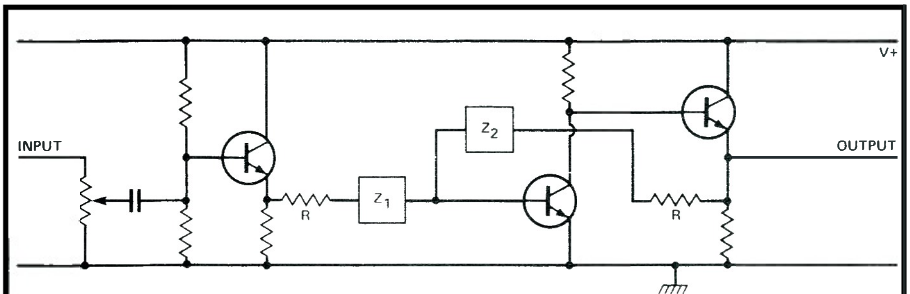


Fig. 4 A shunt-feedback tone control in which the input and output impedances are adjusted by buffers to ensure a flat response in the center position.

the potentiometer at its centre position. If we added a frequency selective network with equal value components either side of the wiper the potentiometer would control the gain, but at the centre position the gain would be x 1 at all frequencies. The arrangement therefore includes a position at which the frequency response is flat.

Unfortunately this is not so easy to achieve in practice. Fig. 3 shows a shunt feedback tone control. This circuit does not give a flat response at the centre position of the tone controls. The impedance seen by the amplifier is not Z 1 & Z2, but (Z1 + potentiometer impedance) and (Z2 + collector resistance). To ensure a flat response at the centre position, it is necessary to control the input and output impedances to which the tone control network is connected.

The circuit of Fig 4, which is derived from a couple of designs I built many years ago from published circuits (Refs 1, 2.), achieves this by using the low impedance of emitter followers. A special feature of this, and of the circuit actually used in the Virtuoso preamplifier, is DC coupling of the tone network. This means that there are no blocking capacitors to add their distortion to the circuit and affect the

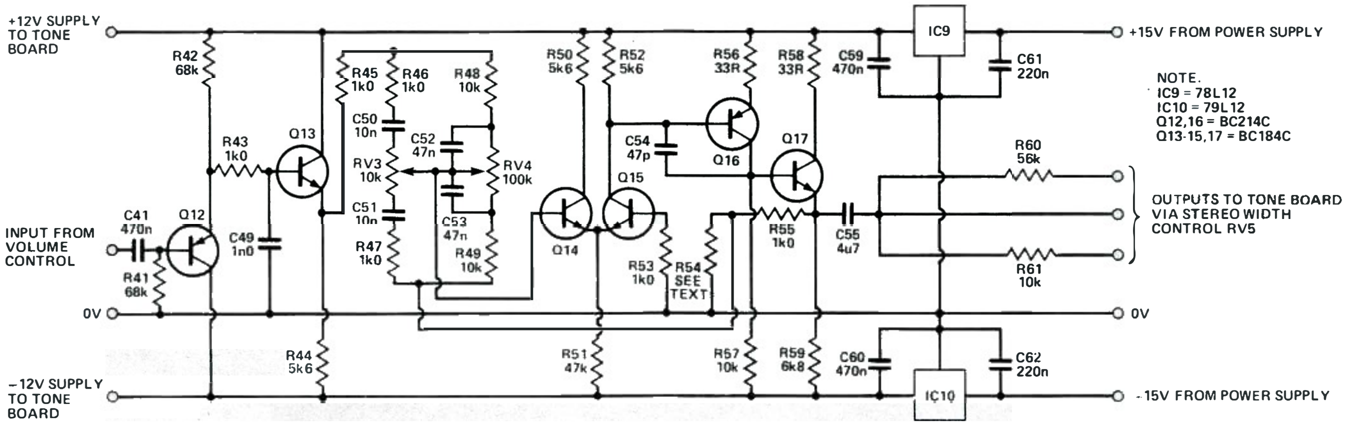


Fig. 5 The tone control circuit in its standard form. The component numbering follows on from that of the earlier modules in this series, but a number of parts used during development have been excluded, leaving gaps in the sequence.

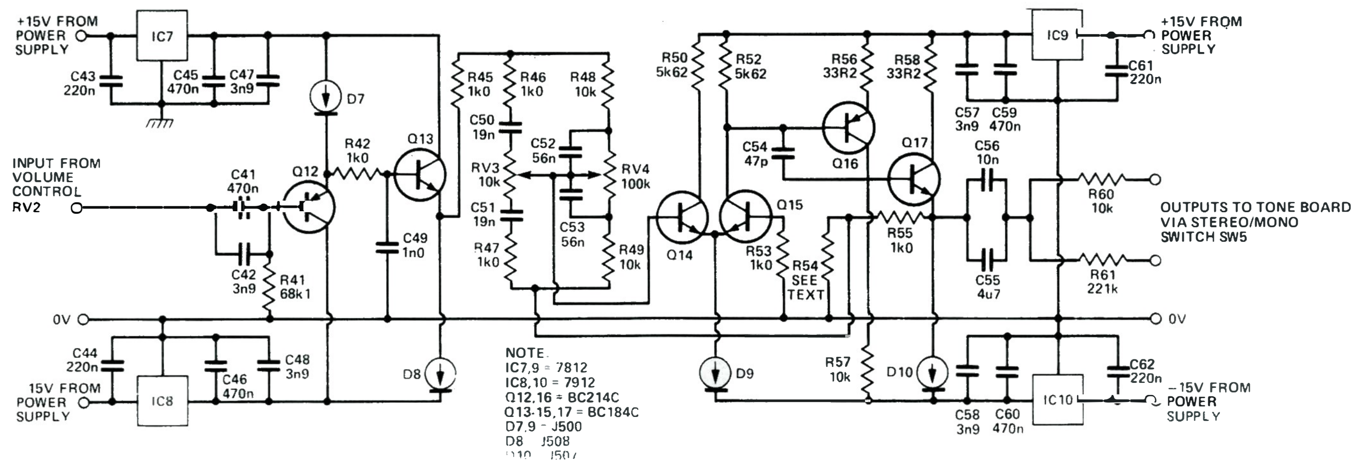


Fig. 6 The tone control circuit in its fully-upgraded form.

HOW IT·WORKS - TONE BOARD

The tone amp consists of emitter followers Q12 and Q13 which provide a low impedance output. Two emitter followers are used to obtain a DC level very close to 0V. A supersonic filter made of R43 and C59 separates the emitter followers to prevent supersonic oscillation in the tone amp. The tone control frequency shaping network comprises R45 - R48 and C50 - C53 and is varied by treble control RV3 and bass control RV4.

The amplification in the tone stage is provided by Q14 - Q17. This arrangement is similar to that used in previous circuits but has an additional output emitter follower for low impedance and an additional capacitor, C54, to maintain stability. The tone amplifier can amplify the signal if required (for example, to drive directly an inverting power amplifier). This is achieved by using R54 and R55 to give output gain as shown in Table 1 whilst maintaining the same resistance as R45.

Stereo image control is carried out by RV5 and R60 - R65 as described in the text.

R54	R55	Gain
1k1	11k	11
1k2	6k2	6
1k5	3k0	3
2k0	2k0	2

$$\text{Gain} = \frac{R54 + R55}{R54}$$

Table 1. Values of R54 and R55 to give various levels of gain in the tone amplifier.

response at very low frequencies.

The only disadvantage in using a shunt feedback tone control is that the phase of the music signal is inverted. Many music lovers and hi-fi enthusiasts regard the preservation of correct phase as an essential element of high fidelity reproduction and claim to be able to detect a difference in the nature of the sound when the phase is reversed. To provide correct phase, a shunt feedback output amplifier follows the tone amplifier.

This output amplifier is a very useful building block for increasing the versatility of the preamp. It can be used as a unity gain buffer for tape outputs, an inverting amplifier for bridged power amplifiers or to provide a reverse phase output for the preamp.

With the circuit already chosen

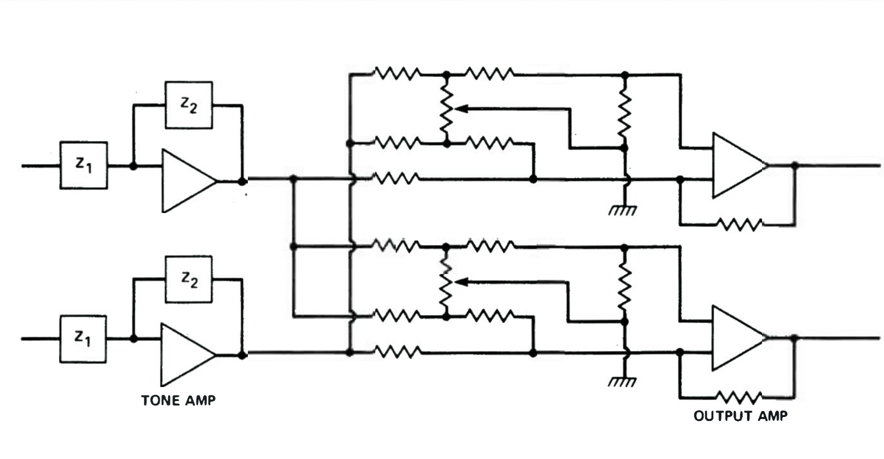


Fig. *7* A simple stereo width control.

for the tone and output amplifiers, it is fairly simple to provide a crude stereo image width control with just a few extra resistors and a dual linear potentiometer. This is achieved by feeding the other channel into the inverting and non-inverting inputs of the buffer amplifier in different amounts, and is illustrated in Fig. 7.

The circuit suffers from the disadvantage that, as the image control is widened, centre stage information is attenuated. At the centre position the amounts of the other channel fed into each input is equal and they cancel each other out to give a stereo signal in both channels. With the control

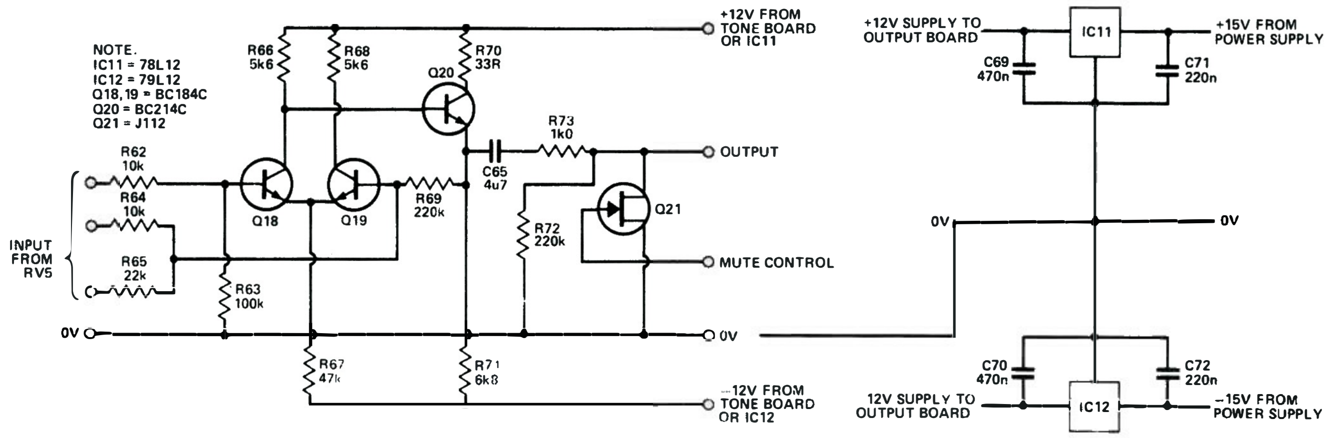


Fig. 8 The circuit of the output stage in Its standard form. When used with tone controls, the output stage draws its power from the 12V regulators on the tone board. When used without tone controls, the output board must be fitted with the IC regulators shown here.

HOW IT WORKS OUTPUT BOARD

The output amplifier is based on Q18-Q20. It functions as an inverting amplifier when used with the tone board or as a non-inverting amplifier coupled directly to the volume control if the tone amp is omitted. The basic, three-transistor gain stage is similar to that used elsewhere in the upgradeable amplifier and its operation has already been described. The output mute is provided by R73 and Q21. When the amplifier is switched on the gate of Q21 is at 0V and Q21 acts as a low resistance between drain and source, attenuating the signal at R73. A control circuit in the power supply enables the gate voltage to rise slowly to about -8V at which point the FET becomes open circuit and allows the signal to pass with negligible effect. Regulators IC11-IC12 are fitted as required to provide a clean, low Impedance power supply.

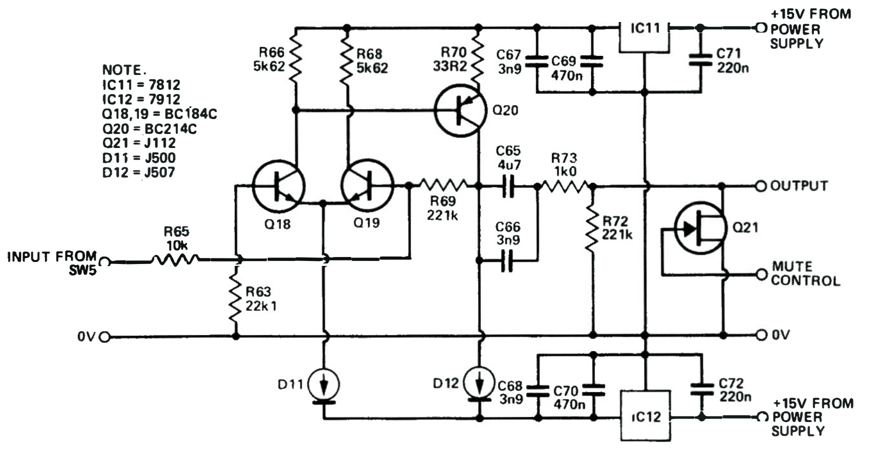


Fig. 9 The circuit of the output stage in its fully-upgraded form. Note· that this version of the board has its own regulators and is therefore not dependent on a tone board for its power supply.

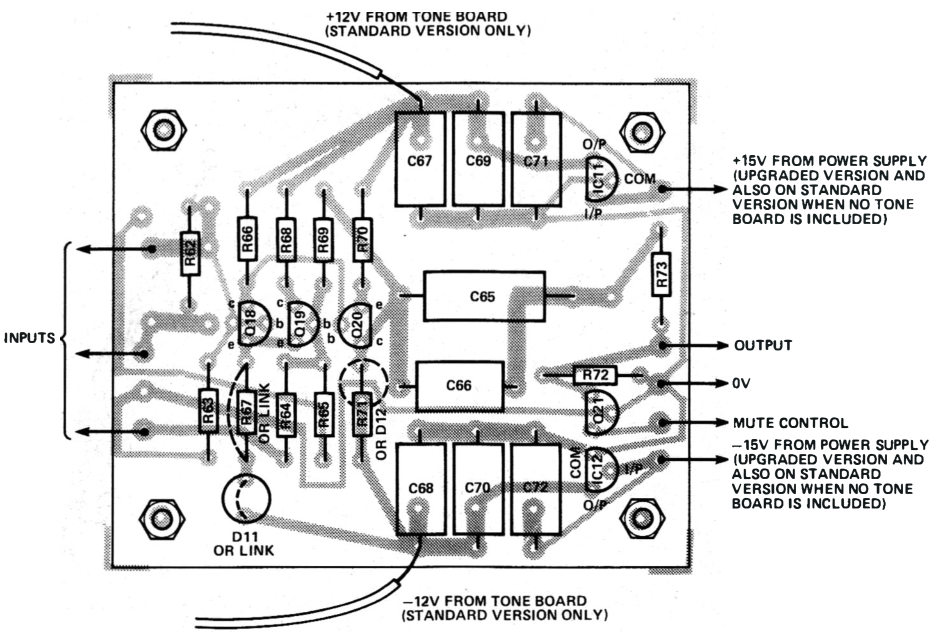


Fig. 10 Component overlay for the output board. See the parts list and the notes accompanying Figs. 8 and 9 regarding the two regulator ICs.

fully anticlockwise, the amount of the other channel fed into each non-inverting input is zero, whilst the amount of the other channel fed into each inverting input is the same as the first channel, giving a mono signal. This arrangement is used in the standard version of the preamplifier only, a simple mono/stereo switch taking its place in the upgraded version.

A final but essential part of the design of a high quality preamplifier is the output muting circuit which prevents switch-on and switch-off transients from reaching the loudspeakers. There are three ways of achieving this:-

a) slow charge and discharge power supply
b) output muting by controlled attenuator
c) output muting by relay.

A controlled attenuator, such as the FET used in the Virtuoso, requires a much simpler power supply than a relay and is used for that reason.

Construction

The component overlay for the output board is shown in Fig. 10 and the overlay for the optional tone control board in Fig. 11. These overlays apply to both the standard and fully-upgraded versions, the difference being that some of the components shown

PARTS LIST- OUTPUT BOARD

RESISTORS	Standard Version (all 1% metal film unless otherwise stated)	Upgraded Version (all Holco H8 0.5% 50 PPM/°C unless otherwise stated)
R62, 64	10k	
R63	100k	22k1
R65	22k	10k
R66, 68	5k6	5k62
R67	47k	see D11
R69, 72	220k	221k
R70	33R	33R2
R71	6k8	seeD12
R73	1k0	1k0
CAPACITORS		
C65	4u7 polyester	4u7 polycarbonate
C66, 67, 68		3n9 or 4n7 polystyrene
C69, 70	470n polyester*	470n polycarbonate
C71, 72	220n polyester*	220n polycarbonate
SEMICONDUCTORS		
IC11	78L12*	7812
IC12	79L12*	7912
Q18, 19	BC184C	BC184C
Q20	BC214C	BC214C
Q21	J112	J112
D11	see R67	J500
D12	see R71	J507

MISCELLANEOUS
PCB; PCB pins, 7 off; 4 off transistor pads for upgraded version only.

All of the components listed above (including the PCB) are for one channel only. Two of each will be required for stereo.

*These components will only be required if a standard version of the preamplifier is built without tone controls.

PARTS LIST - TONE BOARD

RESISTORS	Standard Version	Upgraded Version
	(all 1% metal film unless otherwise stated)	(all Holco H8 0.5%, 50 PPM/°C unless otherwise stated)
R41	68k	68k1
R42	68k	see D7
R43, 45, 46, 47, 53, 55	1k0	1k0
R44	5k6	see D8
R48, 49, 57	10k	10k
R50, 52	5k6	5k62
R51	47k	see D9
R59	6k8	see D10
R60	56k	10k
R61	10k	221k
RV 3	10k dual gang linear potentiometer	10k dual gang linear potentiometer, Bourns 91A conductive plastic
RV4	100k dual-gang linear potentiometer	100k dual-gang linear potentiometer, Bourns 91A conductive plastic
CAPACITORS		
C41, 59, 60	470n polycarbonate	470n polycarbonate
C42, 47, 48, 57, 58		3n9 or 4n7 polystyrene
C43, 44		220n polycarbonate
C45, 46		470n polycarbonate
C49	1n0 polystyrene	1n0 polystyrene
C50, 51	10n polystyrene	19n extended foil polystyrene
C52, 53	47n 5% polyester	56n extended foil polystyrene
C54	47p polystyrene	47p polystyrene
C55,	4u7 polyester	4u7 polycarbonate
C56		10n polystyrene
C61, 62	220n polyester	220n polycarbonate
SEMICONDUCTORS		
IC7		7812
IC8		7912
IC9	78L12	7812
IC10	79L12	7912
Q12, 16	BC214C	BC214C
Q13-15, 17	BC184C	BC184C
D7	see R42	J500
D8	see R44	J508
D9	see R51	J500
D10	See R59	J507

MISCELLANEOUS
PCB; PCB pins,10 off for standard version,8 off for upgraded version; 6 off · transistor pads for upgraded version only.

All of the components listed above (including the PCB) are for one channel only. Two of each will be required for stereo.

Test Points	Test Voltage
Output IC7, IC9, IC11 — ground	12V
Output IC8, IC10, IC12 — ground	−12V
Emitter Q12 — ground	0.6V
Emitter Q13 — ground	less than 0.1V
Emitter Q14 — ground	−0.6V
Emitter Q18 — ground	− 0.6V
Across R50, R66	0.7V
Across R56, R70	0.1V
Emitter Q17 — ground	less than 0.1V
Collector Q20 — ground	less than 0.2V

Table 2 Test voltages at various points around the two circuits.

are omitted on the standard version board or replaced with components of another type. Full details are given in the parts list. If you are a particularly experienced constructor your may decide to build a partially-upgraded version, but if you are at all unsure it is better to choose one version or the other and stick to it.

Having decided which version to build, and whether to build the tone board or not, begin construction by installing the PCB pins for the flying-lead connections. These should be tapped lightly through the board from below and then soldered. Next install the resistors and then the semiconductors. Note that R67 (standard version) and D11 (upgraded version) each have their own set of holes, and that a link must be inserted in place of whichever component you are not using. The capacitors, some of which are physically very large, are best left until last. Note that several hole positions are provided for the tone control capacitors, C50-53, allowing different types and sizes to be used.

The output board can be tested simply by connecting it to a suitable power supply and applying a signal to the input. A ±12V regulated supply should be used to test the standard version but the upgraded version has its own ±12V regulators and can be powered from any regulated or unregulated supply of between ±15 and ±25V. The operation of the muting transistor, Q21, can be checked by applying a negative voltage to its gate when the stage is passing a signal.

The tone board will have to be connected up to potentiometers RV3 and RV4 before it can be tested. Both versions of the board include regulators so any supply of between ±15 and ±25V can be used to test them. Connect an input source and monitor the output by connecting it to another amplifier. If all is well, you should find that the controls behave in the normal fashion.

References

1. Quilter, P.M. Low distortion tone control. Wireless World, April 1971.
2. Ellis, J. N. High quality tone control. Wireless World, August 1973.

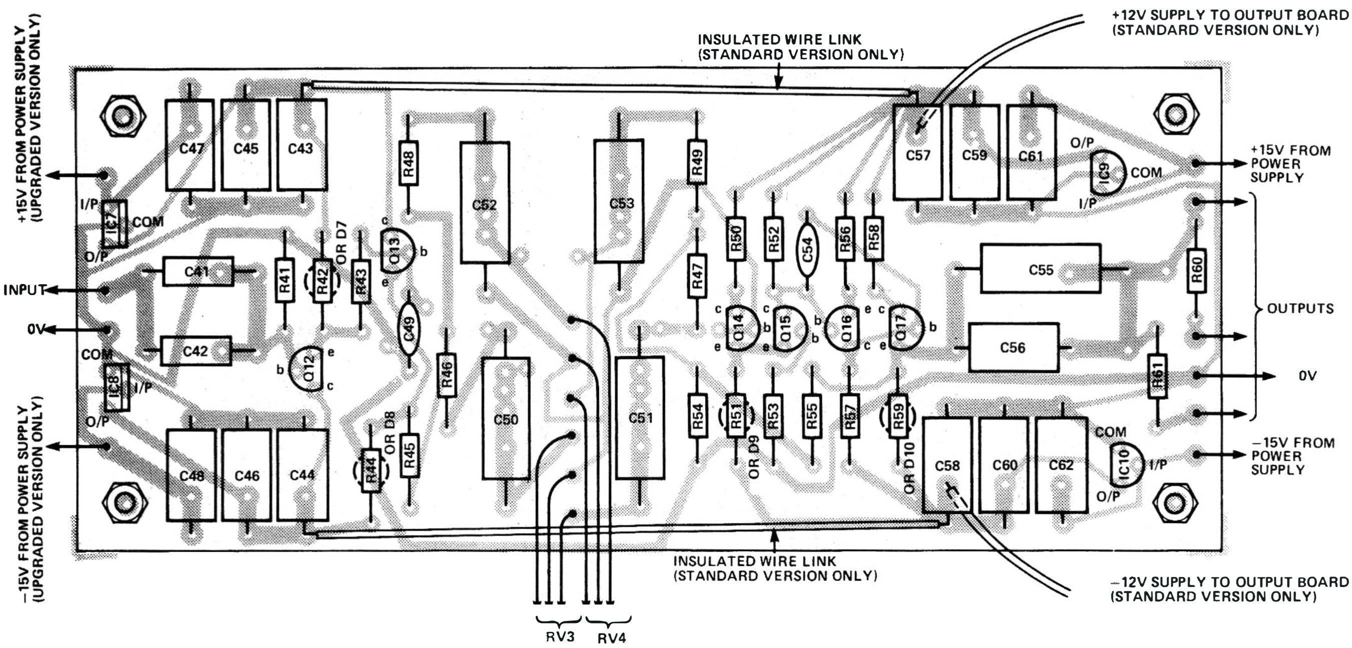


Fig. 11 Component overlay for the tone control board.

The final article in this series will describe the construction of the power supply board and the wiring and assembly of the complete Virtuoso preamplifier.

TECH TIPS

Variable Pulse Burst Generator

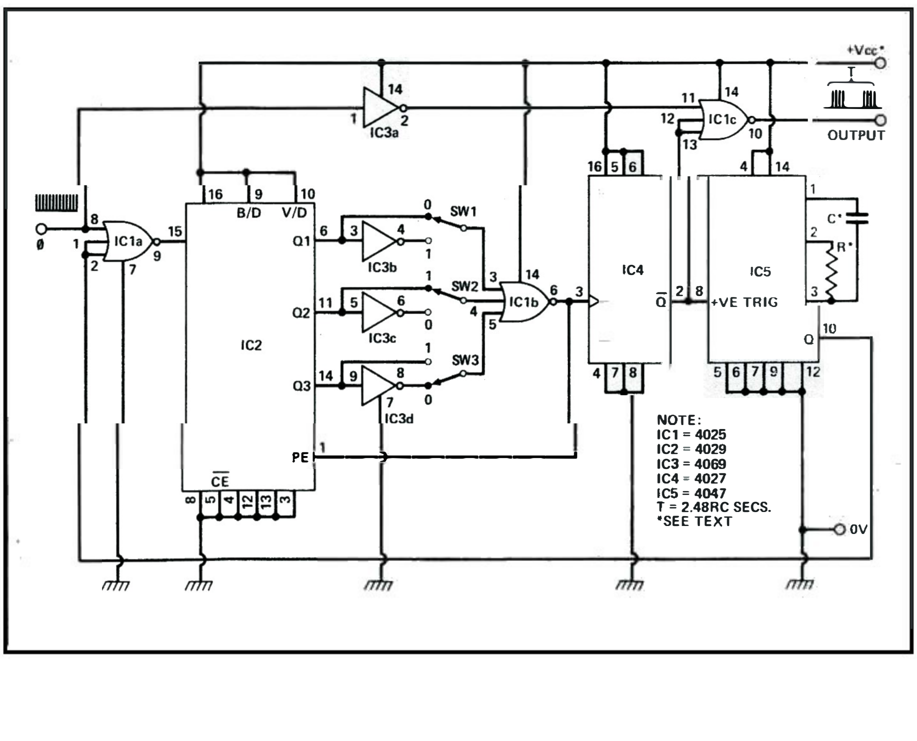
L. Robertson
Aberdeen

This circuit will produce bursts of from 1 to 8 pulses from a clock input depending on the setting of the three switches, SW1, 2 and 3 (See Table 1), with a delay between each burst determined by the 4047 monostable, IC5.

For example, if bursts of 4 pulses are required, the switches are set so that SW1-0, SW2-0 and SW3-1 are fed to the 3-input NOR gate, IC1 b. The input pulses are counted into the 4029 binary counter, IC2, via IC1 a. After the fourth input pulse all the gates on IC1 b will go low causing a positive going pulse to reset the counter via the reset enable pin. This pulse also sets the 4027 flip flop, IC4, setting Q high and thereby holding the circuit output low through IC1 c. Only the first four input pulses in this case will pass through to the output.

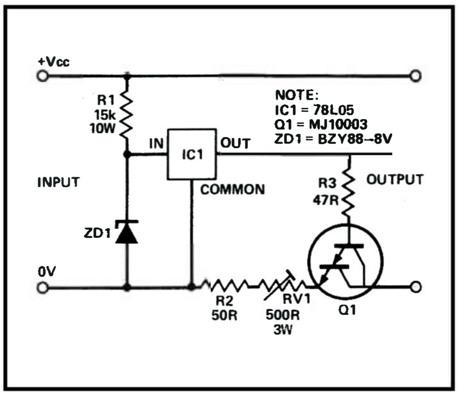
The positive edge of Q also triggers IC5 whose output will go high for a period, T, equal to 2.48 RC seconds, where R is between 1 0k and 1 M0 and C is greater than 1 n0 and is non-polarised and a low leakage type. This disables the input to IC1 a so that no more pulses can go to the counter as long as the monostable is active. At the end of the monostable period, IC5's out-put goes low, IC1 a is enabled and the cycle repeats.

Pulses in burst	SW3	SW2	SW1
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8	0	0	0



High Voltage Constant Current Source

E. Hunter Dundee



The circuit described here provides a constant current source adjustable up to a current of about 60mA and at a voltage of up to 350V. The resistor, R1, and the zener diode, ZD1, provide 8V at the input of the regulator, a 7805, with respect to its common line. This is high enough to ensure that the regulator has sufficient voltage to work with and low enough to keep dissipation to a minimum.

The regulator tries to maintain 5V between its output and its common pins and this voltage is applied to the transistor Q1's base-emitter circuit. The base-emitter voltage of Q1, which is a Darlington device, is about 1V5 when Q1 is on. If the collector current begins to increase through a load attached across the output of the circuit, then the voltage developed across resistors R2 and RV1 will increase. Thus, the voltage on the transistor's emitter rises with respect to the 7805 common pin. While the transistor is biased into conduction, the voltage on its base will be forced to rise. Since the 7805 maintains a constant 5V across its output and common pins, the voltage across R3 will, therefore, drop — ensuring a reduction in base current which counteracts the initial rise in collector current. The same process applies should collector current try to decrease.

The variable resistor, RV1, gives adjustment of the current and the fixed resistor, R2, limits the maximum available current. The variable resistor should be a 3W wirewound type to cope with the power dissipated in it.

A Darlington transistor was chosen because its higher gain maintains a more constant current. The one used in the circuit is rated at 400V and 150W at 25°C, so it is well within its safe operating area. Nevertheless, it should be provided with a heat sink to minimize the effects of temperature rise if more than a few milliamps are required. The circuit values can easily be modified to suit different voltages and currents, provided component ratings are not exceeded.

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OOPS!

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

Digibaro (February 1986)
Capacitors C1, C3, C5 and C7 should be 470u 25V types as shown on the circuit diagram, not 47u 25V types as stated in the parts list. We have also been told that one of the companies mentioned in Buylines, Hawke Electronics, no longer supply the MPX100a pressure transducer. The other company recommended, Macro Marketing, should still be able to help.

LED5 on Fig. 7, page 28, the component overlay, is shown as having 16 pins. It should have 18 pins and be extended rightwards to the two pads shown. In the author's prototype the LED displays used were both MAN6710 2-digit types, LED4 having pins 16, 17 and 18 removed.

RS232-Centronics Converter (March, 1986)
On the circuit diagram (Fig. 2, p. 53), pin 11 of IC2d should be marked pin 13. Pin 10 of IC3 is missing and should be shown connected to ground. Pin 9 of IC7f becomes pin B and vice versa. Also, in Table 1, the figure '8' in column SW1b should be a zero and the '8' belongs in the 'DATA BITS' column. The specification of 74LS121 and 74LS07 is wrong, since LS types do not exist for these devices. They should be replaced with standard TTL. Finally, some confusion seems to have been generated over XTAL1. Although not mentioned in the text, a simple calculation should demonstrate that XTAL1 needs to be 6.144 MHz to produce the baud rates shown.

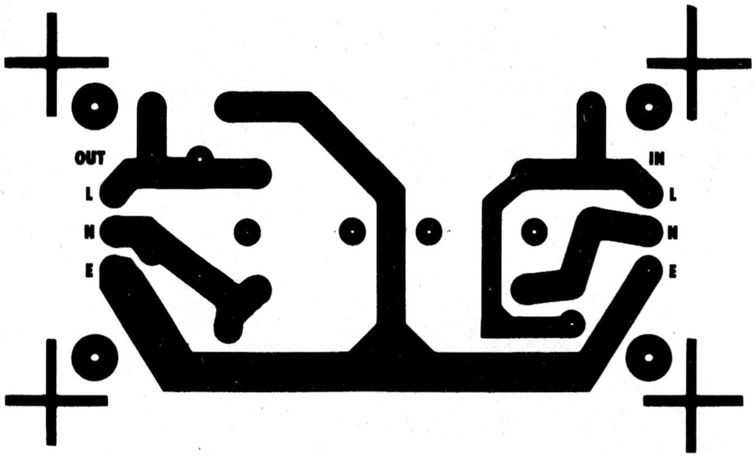
Microlight Intercom (May, 1986)
In Fig. 1 (p.29) the link between pins 2 and 3 of PL3 is not shown. C13 is shown as a polarised capacitor. The battery check contact on SK1 should be shown as normally closed. the PCB foil pattern on p.59 is shown as from the component side. It should be reversed. The miniature loudspeakers mentioned in the article cost £2.50 each, not per pair as incorrectly noted in Buylines, p.32. The author of the article suggests that it may be advisable to insert a suitable capacitor between R9 and IC3, pin 3.

Baud Rate Converter (May, 1986)
In Fig. 4 (p. 35), some confusion has crept in to the ins and outs of the circuit diagram. IC6a and IC5c need to be turned round and pins 20 and 25 of IC2 swapped round. In Fig. 5 (p.36), D4 and D3 are shown the wrong way round on the overlay. This could of course lead to the destruction of C10 as well as the presence of a second +12V rail instead of the required −12V. In Fig. 6 (p.37), SK4.3 and SK3.3 must be swapped over. In the Parts List, C10 should be 1000uF, not 100uF.

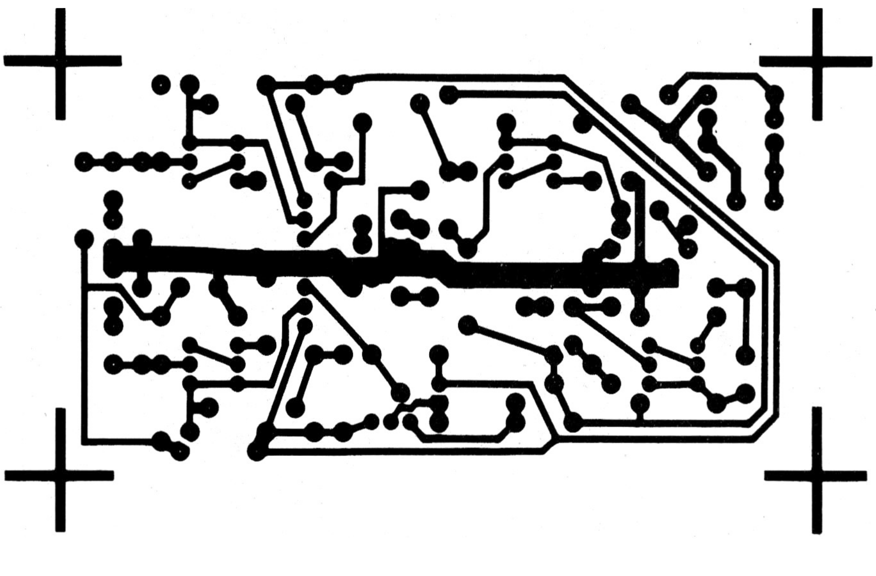
RF Oscillators (June, 1986)
Fig. 12 (p.23) does not, in fact, show a working oscillator. For a series fed arrangement, take the link from CV1a,b junction to R3 and Q1 emitter junction and not 0V, remove C1 and move C2 to shunt R2. For a shunt-fed arrangement, break the link between L1 and Vcc and take Q1 collector to Vcc via a 4k7 resistor.

Speaking Alarm Clock (August, 1986)
In the circuit diagram, Fig. 2 (p.53), diode D3 and resistor R14 should be in parallel not series as shown. The link from IC10, pin 1, to battery positive should be removed.

PCB FOIL PATTERNS

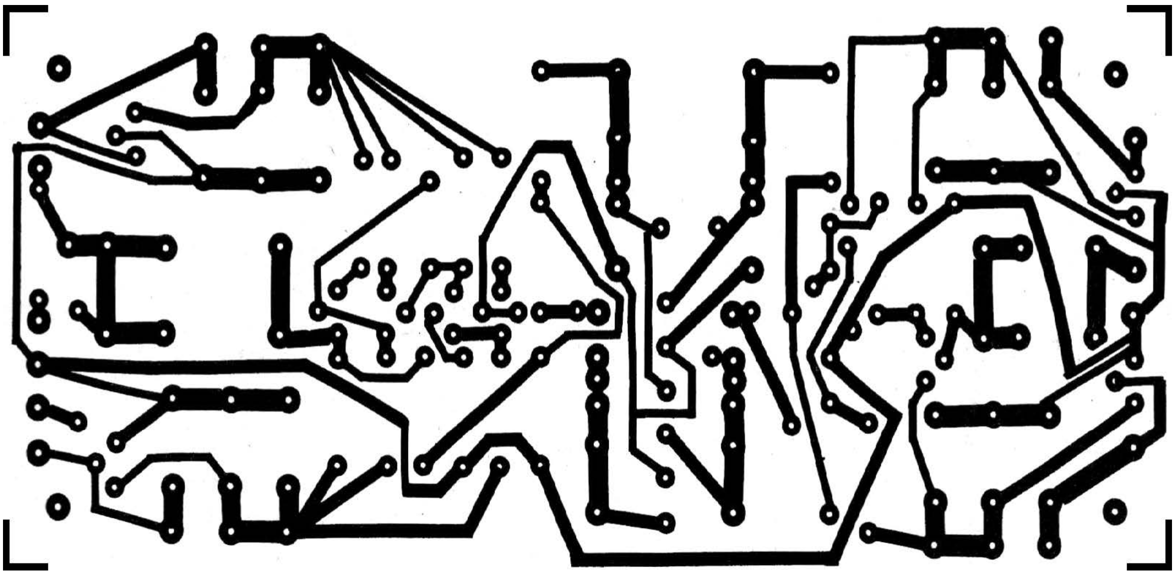


The Mains Conditioner foil pattern.

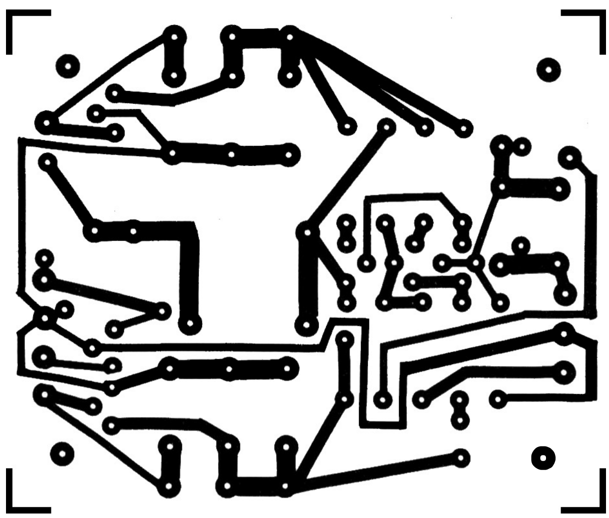


The Experimental Preamplifier foil pattern.

PCB FOIL PATTERNS



The foil pattern for the Upgradeable Amplifier tone control board.



The foil pattern for the Upgradeable Amplifier output board.

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E8402-5	Modular Pre-amp Tone Main Mono	F
E8402-6	Modular Pre-amp Tone Filter, Stereo	F
E8402-7	Modular Pre-amp Balanced Output	F
E8402-8	Modular Pre-amp Headphone Amp	F
E8404-2	Mains Remote control Receiver	F
E8405-1	Auto Light Switch	F
E8405-2	ZX81 EPROM Programmer	N
E8405-3	Mains Remote Control Transmitter	H
E8405-4	Centronics Interface	F
E8405-6	Drum Synth	F
E8406-1	Oric EPROM Board	O
E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
E8406-4	AD Buffer/Filter/Tone	H
E8406-5	AD Headphone Amp	F
E8406-6	AD Preamp PSU	K
E8406-7	AD Power Amp	H
E8406-8	AD Power Amp PSU	J
E8406-9	AD Stereo Power Meter	F
E8406-10	AD Input Clamp	C
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E8408-2	EPROM Emulator	N
E8408-3	Infrared Alarm Transmitter	E
E8408-4	Infrared Alarm Receiver	F
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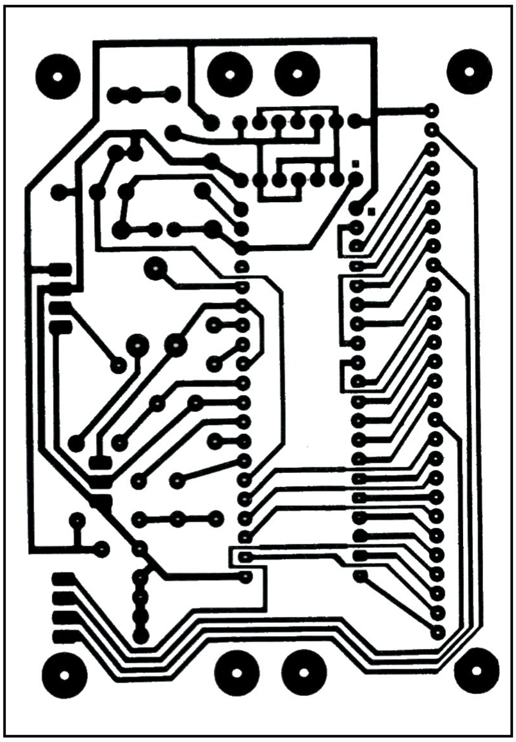
E8409-2	Banshee Siren Unit	F
E8410-1	Echo Unit	F
E8410-2	Digital Cassette Deck	N
E8410-3	Disco Party Strobe	H
E8411-5	Video Vandal (3 boards)	N
E8411-6	Temperature Controller	D
E8411-7	Mains Failure Alarm	D
E8411-8	Knite Light	D
E8411-9	Stage Lighting Interface	F
E8411-10	Perpetual Pendulum	E
E8412-1	Spectrum Centronics Interface	F
E8412-4	Active - 8 Protection Unit	F
E8412-5	Active - 8 Crossover	F
E8412-6	Active - 8 LF EQ	F
E8412-7	Active - 8 Equaliser	F
E8501-3	Digital Delay (2 boards)	T
E8502-1	Digital Delay Expander	N
E8502-2	Data Logger	J
E8503-1	Combo Preamplifier	F
E8503-2	THD Meter mV & oscillator bds (2 boards)	K
E8503-3	THD Meter Mains PSU	F
E8504-1	Framestore Memory	M
E8504-3	Framestore Control	N
E8504-4	Buzby Meter	E
E8504-5	CCD Delay	F
E8505-5	Stereo Simulator	F
E8506-1	Audio Mixer Main	J
E8506-2	Audio Mixer PSU	F
E8506-3	Audio Mixer RIAA	D
E8506-4	Audio Mixer Tone Control	D
E8506-5	EPROM Prog MKII	O
E8508-1	RCL Bridge	N
E8508-2	EX42/BBC Interface	E
E8508-3	EPROM Emulator	L
E8509-1	Spectrum	F
E8509-2	Direct Injection Box	E
E8510-9	Sunrise Light Brightener	K
E8511-1	MTE Waveform Generator	H
E8511-2	Millifaradometer	H
E8511-3	Cymbal Synth	J
E8511-5	Chorus Effect	H
E8511-7	Enlarger Exposure Meter	F
E8511-8	Switching Regulator	E
E8511-9	Second Line of Defence	M
E8512-1	Specdrum connector	F
E8512-2	MTE Pulse Generator	H
E8511-3	Specdrum	L
E8601-2	Walkmate	L
E8601-3	MTE Counter-timer	M
E8602-1	Digibaro	O
E8603-2	Programmable Logic Evaluation Board	H
E8603-3	Sound Sampler Analogue Board	R
E8604-1	JLLH PA PSU	H
E8604-2	Matchbox Amplifier	C
E8604-3	Matchbox Amp Bridging Version	C
E8604-4	MTE Analogue/Digital Probe	M
E8605-1	Microlight Intercom	E
E8605-2	Baud Rate Converter	M
E8605-3	Baud Rate Converter PSU Board	G
E8605-4	Portable PA	H
E8606-1	Midi-CV Converter Board	H
E8606-2	Midi-CV Converter PSU	D
E8606-3	Troglograph	F
E8606-4	80m Receiver	H
E8606-5	Sound Sampler	R
E8607-1	Direction	E
E8607-2	Upgradeable Amp, MC stage (Stereo)	G
E8607-3	BBC Motor Controller	F
E8608-1	Digital Panel Meter	G
E8608-2	Upgradeable Amp, MM stage (mono)	H
E8609-1	Mains Conditioner	E
E8609-2	Experimental preamp	F
E8609-3	Upgradeable amp, Tone board (mono)	H
E8609-4	Upgradeable amp, Output board (mono)	F

BOARDS AVAILABLE



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THE COLOUR BROWN

Andrew Armstrong reports from the consumer front-line. Are brown goods getting better or just more colourful?

'Pop up to town' said the invitation from Marantz. The invitation was to visit their part of what used to be the Audio Trade Fair. This is a disparate, not to say dissipated, event which takes place at a number of separate venues in the inner London area.

It is interesting to check up on advances in the field of electronic consumer products from time to time. At this show, some of the 'advances' were risible, a few were technically interesting, and most were a bit *ho hum.* In short the show, like the goods, was brown.

Because of its geographical proximity to the offices of ETI, the first port of call was the Grundig exhibition. The people at Grundig, who are partly owned by Philips, seemed to be most excited about their 'flatter, squarer tubes' (on television, that is). This seems to be the most important advance in the domestic market. I am not sure about the subjective effect of the tube being flatter, but it does seem sensible to have a squarer tube to make use of all the picture information transmitted and not lose the corners as with older designs.

On the business front, Grundig were offering a 'competitive' telephone answering machine at £350. Two of the special features are remote access, controlled by a user-settable seven-bit code to prevent your competitors from listening in, and that it uses the same tape cassettes as their dictaphones. This allows the businessman to leave dictation for his secretary without leaving his girlfriend's flat!

Back on the television front, two developments were noticeable.

There is now a TV with video recorder built in. The VCR is removable, and both TV and recorder can work independently. This uses a picture enhancement technique called CTI (colour transient improvement), which reduces the inevitable smearing of colours caused by narrow chrominance bandwidth. I am still waiting for someone to produce a colour set which makes use of most of the luminance resolution currently transmitted. That would reduce the justification for introducing High Definition Television.

Grundig had one or two interesting things, such as a small and deceptively simple satellite receiver. The works which matter are in a metal cased module, which is only repairable by the factory. The dish which goes with it has two head amps, for X and Y polarisation, instead of the usual circular polarisation. Electronic switching selects the best signal. This should gain the odd dB or so. The overall noise figure quoted is a creditable less than 2.2dB, and the RRP for the whole works comes to £1750.

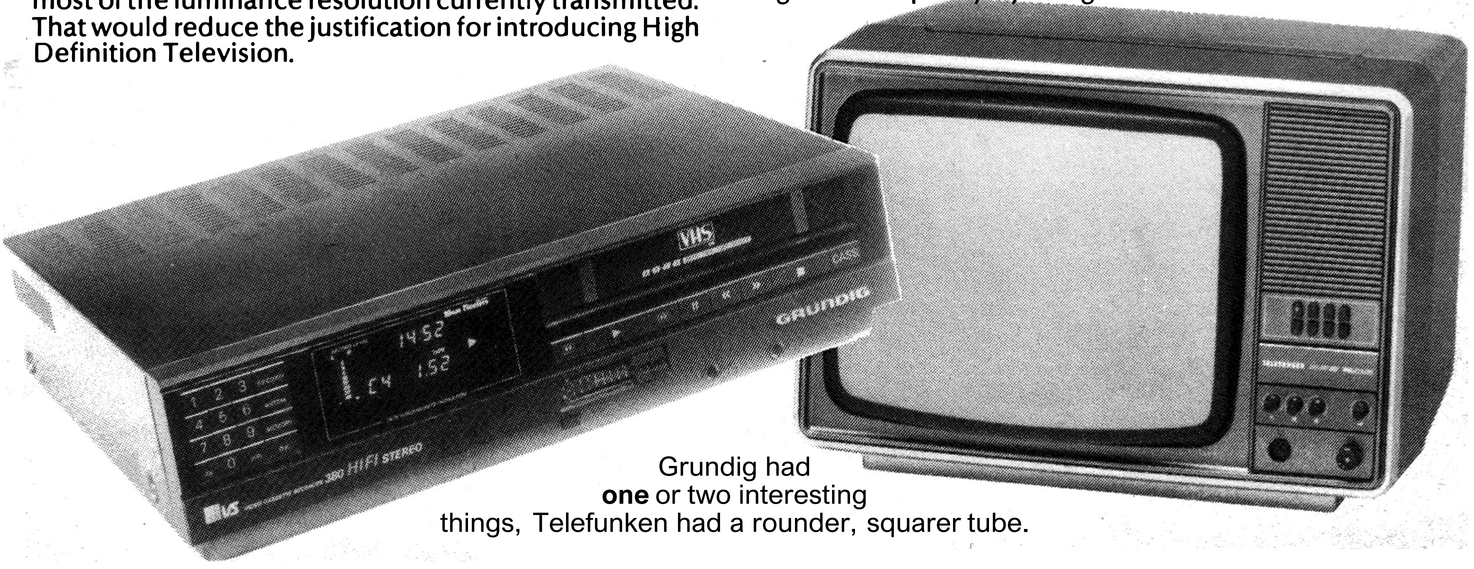
Squarer But Not Flatter

Telefunken, in the same hotel, were showing televi-sions with squarer, but not flatter screens. Apparently, Telefunken believe that the picture looks better on con-vex screens. Not to worry, if the picture or the pro- gramme fails to please — just press a button and the remote control unit lights up! A great boon if you are watching TV in the dark. We are told that their video recorders were 'In a transitional phase — new models will be out in September.' I think that sums it up adequately.

Now on to the next hotel, where there were several more exhibitors.

Black And Brown

Marantz were showing more black goods than brown ones. Their main stock in trade is high quality audio equipment. They have introduced a 16-bit, 4 times over-sampling CD player— the only other people to aspire to these levels, as far as I know, are Philips. The CD65, as it is designated, also provides a digital output to allow the use of an external digital-to-analogue converter (DAC). When pressed the technical man said that the 16-bit specifica-tion of the CD65 is genuine and linear, but that it is still possible to gain extra quality by using an external DAC



Grundig had **one** or two interesting things, Telefunken had a rounder, squarer tube.

with very superior components around it. The DAC unit is likely to retail at about the same price as the CD65, whose RRP is £349.

Still on the subject of digital audio, Marantz expect to introduce a digital audio recorder next year. The quality should be similar to that of the compact disc player, and the machine will use a rotary head. Apparently standards have been agreed. Watch this space next year for more details.

Marantz have also introduced another Dolby surround sound processor. They introduced the idea for the first time last year, and they appear to be pressing forward with it. Apparently, 35mm feature films often have front and rear channel information encoded on them, and this is carried over to prerecorded videocassettes. Dolby labs licence the decoding circuitry just as they license the use of Dolby B and C noise limiter circuits.

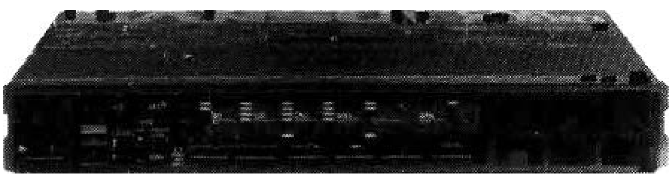
Just to confuse matters, Sansui have also introduced a surround sound processor, reputed to be of similar quality to the Marantz offering. The Sansui version does not, however, use the official Dolby decoding circuit, although the way it works is similar enough to sound more or less right.

Sansui had a neat looking car CD player on display. This is expected to retail for £434 including VAT. This is only for the player, of course. You also need an amplifier. The amplifier which they recommend costs £93, so the whole system is likely to cost more than many living room hi-fis.

Car CD players are very attractive up to the moment when you see the price tag. Remembering that the acoustic environment of a car is not ideal for the appreciation of music, the main justification of having one must be to listen to your CDs without first having to record them on to cassette.

It may come to pass that, if the real price of CDs ever comes down, and more people own more of them, then car CD players will be widely used.

My main impression of the show was that brown goods manufacturers are trying to come up with new gimmicks to persuade people to replace or upgrade their present domestic entertainment facilities. This search for ways to revitalise the market was neatily illustrated by one of Tatung's innovations — a wide range of different coloured cases for one of their television models.



In-Car entertainment from Sansui :- 47+47W amplifier, a seven band graphic equalizer and 'a three spot beam laser CD player!

ALF'S PUZZLE

Last Christmas, Alf promised to make some decorations for the ETI offices. True to his word, he's done it. The fact that he presented us with his LED nativity scene in August is hardly worth mentioning.

The circuit that Alf used is shown in Fig. 1. To save the bother of calculating lots of resistor values, his idea was to connect the entire LED string via a single 220R resistor to a variable power supply, and to turn up the voltage until all the LEDs lit at a reasonable brightness. As he didn't have quite enough LEDs to complete his pattern, he connected another 220R resistor in place of one of them. What do you think happened as Alf turned up the supply voltage? Did some LEDs light before others? Did all the LEDs light eventually? If you're not sure, why not try it for yourself?

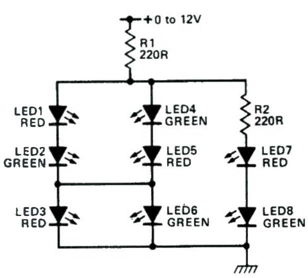


Fig. 1 Alf's LED array.

The answer to last month's puzzle:

The circuit is a kind of dual rectifier - one output is the part of the waveform above the average voltage, the other is the waveform below the average voltage (Fig. 2). If the current drawn by the op-amp for its own internal circuitry is constant, any current drawn from the output will increase the voltage drop across R2 since it must come from the posi-tive supply. This will leave the voltage across R3 constant Conversely, any current supplied to the input will result in an increase of voltage across R3, leaving the voltage across R2 constant.

A more sensible circuit to achieve the same result is shown in Fig. 3. Once again, imbalances in the supply currents are caused by the variation in current through R1, but the input is at a much higher impedance and there is no fiddly setting up to do. The performance of the circuit will depend very much on the characteristics of the chosen op-amp. Its supply current should be independent of supply voltage, and the current drawn from the output should have as little effect as possible on the current required by the remainder of the circuit.

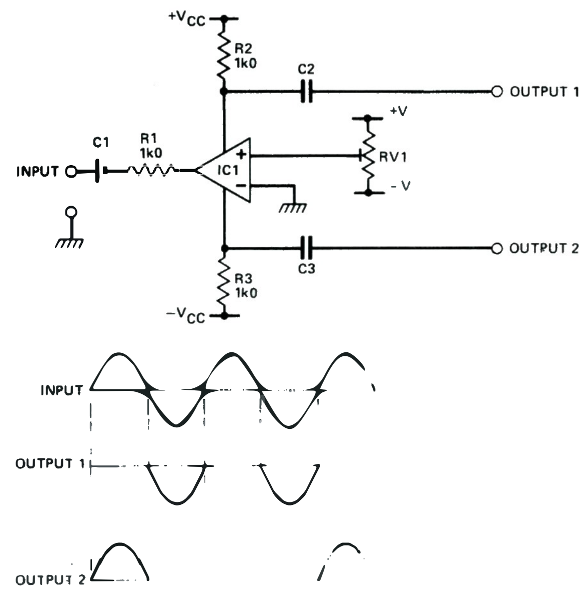


Fig. 2 Last month's solution.

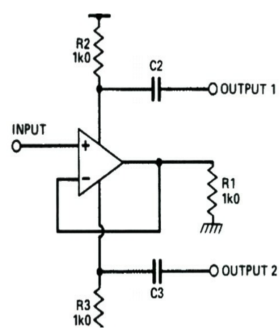


Fig. 3 A better version of the circuit in last month's puzzle.

July Competition Results

The July puzzle was sent in by Henry Earle, who came to some odd conclusions when thinking about the circuit of Fig. 4. The energy stored by a capacitor depends on the charge and the final voltage reached. If the switch in Fig. 4 is closed, a certain amount of charge will be transferred from the supply to the capacitor, and this charge and the final voltage reached will be the same no matter what the value of the resistor. Mr. Earle reasons that since the quantity of charge transferred and the work done in transferring it, is the same for any value of R, it must also apply when R is zero. In other words, no matter what the value of R, the energy from the supply must equal that stored by the capacitor, and must all be recoverable. Yet the resistor has current flowing through it whilst the capacitor is charging, and so must dissipate some heat. Could this be the basis of a free room heater?

The flaw in the argument is apparent when we consider what would happen if the switch was closed with no resistor in series with the capacitor. From an abstract circuit theory point of view, we are forced either to allow that infinite current will flow at the instant the switch is closed, or else to introduce some other element into the circuit — an inductor, perhaps, which we can justify in terms of the inductance of the capacitor's leads. From a practical point of view I would suggest that the outcome would be a heating and possible welding of the switch contacts if the power supply had extremely low internal resistance, or else dissipation of heat in the supply itself — most likely a combination of the two. The point is that the question was posed back to front: the problem is not where the extra energy comes from when the resistor is present, but how the surplus is disposed of when it is absent. Our competition winner — George Andronov of Northfield, Birmingham — suggests that the extra energy would be lost as electromagnetic waves, with the capacitor and inductance of the leads acting as a tuned circuit.

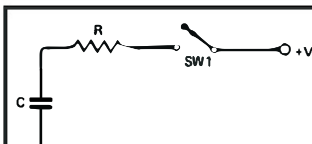


Fig. 4 Full to capacity!

SCRATCHPAD

by Flea-byte

Quote of the month comes from a British Telecom press release singing the praises of their Voicebank messaging system. 'Britain's business people,' chirps the release, 'can spend up to seven working days a year waiting to talk to someone on the telephone.' Ain't it the truth! I sometimes spend that long trying to get through to directory inquiries.

Wages of Sin

Those of you concerned for the welfare of former Thorn-EMI chairman, Peter Liaster, will be pleased to hear that the company's latest financial report shows that Laister was paid a £420,000 golden handshake when he and Thorn parted over some unpleasantness. This compares very favourably with the £95 m Laister paid for In mos when the Government offloaded it. Unlike Laister, Inmos continues to lose Thorn-EMI money, despite Thorn's new management.

The Wages of Sinclair

With his optimism as yet undimmed, Sir Clive Sinclair (known affectionately as 'the knight on the tiles') has bounced back with yet another new company, Anamartic, to handle the wafer scale integration project. Anamartic are looking for £6m to develop a proposed wafer scale silicon RAM disk by 1987 and, with Sinclair apparently taking a well-advised back-seat, they might get it — despite WSI's history of failure. If they do get the money it will be no testament to Sinclair's scientific genius, nor to his business acumen, but to the profound equation that greed plus lack of technical education produces financial backing.

OPEN CHANNEL

Only a few days after I write this column the Monopolies Commission is due to issue its findings about the proposed GEC takeover of Plessey. I foresee that it will conclude the takeover to be sound and not of such a type as to give GEC a monopolistic control of the telecommunications market in Britain.

That is not, however, to say that the takeover is right on other grounds. There is a strong case which argues that many Plessey jobs (and for that matter some at GEC) will have to go in the process — simply because GEC will not wish to have duplicated jobs within the new organisation. Figures in the order of tens of thousands of job losses have been suggested (albeit by Plessey-sponsored consultants), and even if these figures are high, by say 50% or so, there will still be many redundancies. And personnel directly employed by GEC will not be the only victims of the takeover. Many smaller businesses who supply raw materials to Plessey will also suffer.

Job losses will not be entertained lightly by the Government which, at this stage in its electoral timespan, will be looking towards the next election with a view to improving, reducing, or even simply stemming the rise in unemployment figures. The Monopolies Commission reports directly to the Department of Trade and Industry, which is to give its final decision regarding the proposed takeover somewhere around the time when you are reading this issue of ETI.

So, although I foresee the Monopolies Commission giving the OK to the takeover, I also foresee the DTI saying "no". For Plessey's sake, or more correctly for its employees sake, I hope this to be the case.

After these forecasts of impending telecommunications events, I'm going to give a long range forecast on another event (one of my favourite topics of discussion) — satellite television. Over recent months' I've chronicled the comings and goings of direct broadcast satellite (DBS) television systems, satellite master antenna television (SMATV) systems and anything else of any consequence to the potential user.

Stereovision

At the present time DBS does not exist in Great Britain, and is still a long way off. Arguments about satellite costs, suppliers and controllers have caused general disarray among potential broadcasters, leaving many decisions yet to be taken. SMATV does exist, however, and has been 'adopted' by many television equipment suppliers as a satellite television system which individual customers (ie, the likes of me), will be interested in purchasing. Nearly two dozen channels are available via fairly low-powered satellites, giving a wide range of music, film and general entertainment programmes for the viewer. The low-powered transmissions require a consequently large dish aerial (about 1.5 metres in diameter) for adequate reception, compared with the 0.6 metre dishes envisaged for DBS transmission reception.

Costs, unfortunately, are prohibitive to most potential viewers. Aerial and decoding equipment to allow users to receive transmissions from one SMATV satellite and display them on an existing 625-line television receiver start at around £1000. To receive transmissions from more than one satellite a complex controllable aerial and more complex decoder will set you back up to twice this price.

Satellite television systems have three potential advantages over existing terrestrial television systems: (1) by using the wider bandwidth available to satellite television channels, increased definition can be obtained – higher quality pictures are the potential result; (2) again using the higher bandwidth, stereo sound of improved quality is potentially available; (3) a greater number of channels is available. Depending on your point of view and the nature of the programmes transmitted on these channels, this last may not be such an advantage at all — who wants wall-to-wall Dallas?

The first advantage of higher definition is only an advantage if users are prepared to replace their existing television receivers with ones capable of displaying the higher definition pictures. This, of course, means extra cost which users might not think desirable.

The second advantage – stereo high quality sound – is, in fact, now possible via terrestrial television. The BBC and the IBA have recently agreed a system of digitally encoding the stereo sound signal and transmitting it along with the ordinary television signal. Thus existing television receivers can be used: at most a simple decoder is required fo feed the stereo sound signal to a hi-fi system. It is envisaged that the system will be operational nationwide by the early 1990s — possibly before DBS systems!

All this adds up to my third forecast of the month. Because DBS has not yet got off the ground and because of the high costs involved in satellite television systems, terrestrial television has still got a long life left. There may even be enough life left in the old dog to fight off DBS once and for all. DBS may simply be remembered by future generations as the 'pie in the 1980's sky'.

Keith Brindley

REVIEWS-BOOKS

1986 IC MASTER

Hearst Business Communications, Inc. Price: £80.00

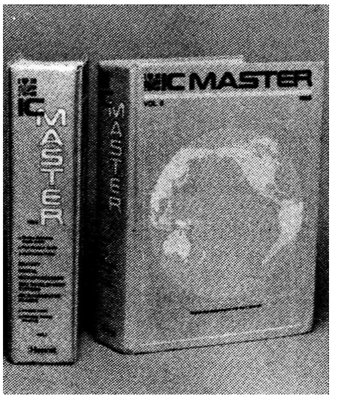
Available from: J.B. Tratsart Ltd., Dept. ET-R, 154a Greenford Road, Harrow, Middx. HA1 3QT

It must be every designer's dream to have at their fingertips information about all currently available ICs. I don't know if anyone has ever added up the number of ICs in production; my own estimate is around 120,000 type numbers, representing perhaps 30,000 different types. To produce a guide with, say, a page or so of data on each, selection tables, functional and electrical equivalents, and enough information to be able to complete a design without referring to any other source, would be such a huge task that nobody has yet attempted it.

There are a number of references which give a certain amount of information about a range of ICs, from the outrageously expensive and virtually useless D.A.T.A. books (our set of five IC references cost £250 and has not been referred to once, with any success, during the past year) to the much less ambitious Towers guides, and the Babani book reviewed below.

The IC Master claims to be a complete guide to currently available ICs. The publishers are cautious enough not to claim that it includes *all* current ICs — it doesn't — but if you want information on devices made by the 70 or so manufacturers represented, it's hard to find an IC that has been overlooked.

A 200 page index, with about 400 entries per page, lists all the ICs included. The index is in dictionary order, so the 7400 comes



before the 741, for instance, because 0 comes before 1 in the 'alphabet'. It's a bit confusing at first, if you're used to numerical order, and you may think an IC has been missed when in fact you're looking in the wrong place, but it doesn't take long to get used to.

Another means of finding your way around the directory — if you're looking for an IC to do a particular job — is the functional index, which points you to the section listing the type of IC you are interested in.

The IC data itself is in general sections: digital, microprocessor, interface, linear, and so on. The sections are broken down into sub-sections, so the linear section includes amplifiers, comparators, phase locked loops and regulators, among others and these are further subdivided according to the IC characteristics — so op-amps are classed as high speed, high voltage, low drift, wide band, and so on.

The information given about each IC is meagre, but in general is enough to enable designers to choose a group of devices that would be suitable for their purposes. Beyond the tables, further information about certain ICs is provided at the whim of the manufacturers, so there is fairly comprehensive data on a few ICs and little or nothing about others.

Other sections of interest include a guide to part numbers, so that IC codes can be interpreted. The manufacturers logos can also be a useful first step in identifying unknown ICs. The application note directory lists sources of detailed information on ICs, and is interesting to browse through if you are searching for ideas on how to proceed with a design project. The manufacturers and distributors directory, giving 'phone numbers of manufacturers and their agents and distributors, is invaluable for following up other information.

My first test of the IC master was to search the index for some of the less common ICs used in ETI projects or just mentioned over the past year — the Am6072 companding DAC, the WD2002 DES data encryption IC and the L165 power op-amp. All were included, which was an encouraging start — although there were some errors.

The index in each case pointed to an entry in a table of similar devices — the Am6072 for example, was listed alongside the DAC 86 and 88 and the AM6070. Information about the ICs included settling time, linearity error, logic compatibility and dissipation — enough to allow a decision on whether or not it would be worthwhile to send for a full data sheet.

My next test was to look for an IC for a particular function. One of our contributors had recently been bemoaning the unavailability of high speed A-to-D flash converters, so I wondered what the IC Master would come up with. A quick scan through the A-to-D converters section gave a number of possible devices, of which the AD9000 seemed the most suitable. The manufacturers' directory gave the UK number for Analog Devices, and one phone call later I knew the price, and a data sheet was on its way. The whole process took about ten minutes.

I can thoroughly recommend the IC master — despite its limitations (it is only 5,000 pages long after all!) it is a genuinely useful reference, and by far the best book of its type that I have come across.

Paul Chappell

LINEAR IC EQUIVALENTS AND PIN CONNECTIONS

Adrian Michaels. Price £4.95

Bernard Babani (publishing) Ltd., The Grampians, Shepherds Bush Rd., London W6 7NF

Much less ambitious than the IC Master, this book gives equivalents and pin-out diagrams for a selection of ICs from 24 manufacturers. The most striking thing about the list of manufacturers is the omissions — no Ferranti, with their popular range of A/D and D/A converters; General Instrument doesn't get a look in (where is their ubiquitous AY-3-8910 sound generator IC, for instance?), and the only Japanese companies represented are NEC and Toshiba — how about Sanyo, Panasonic, Hitachi, and the rest?

Flicking through the pages in search of ICs from recent ETI projects — the Am6072, CMP01, L165, and so on — I was disappointed in every case, although the manufacturers (Advanced Micro Devices, Precision Monolithics and SGS, respectively) are all included, and the Am6072 certainly has a pin-equivalent in the Precision Monolithics DAC88.

The equivalents table, on the whole, sticks to second source products — that is to say, situations where two or more manufacturers, by agreement, produce exactly the same IC. The information is fairly detailed, in the sense that versions of the same IC with different package styles and temperature ranges are listed individually with their exact equivalents, but the same information could have been given far more concisely in the form of a list of manufacturers' codes. The equivalents table could then have contained only the generic device types, and the resulting space saving of two thirds of the book could have been used to include a few of the common ICs that have been overlooked...

The pin-out diagrams are of varying degrees of usefulness according to the type of device — for an op-amp, for instance, you could probably get by on knowing which pins the inputs, output and power rails were connected to. For more complex ICs, the pin-outs can be completely baffling — one diagram in particular has the following pin labels: 'Input 2', 'Input2', (that's not a misprint, by the way — there really are two Input 2s, and two Input 1s too, for that matter), 'Node', 'Q', 'Strobe', 'XFR', 'APU', and so on... If you'd just found this IC in a mixed bag from PIK-A-PUKKA-PAK, I doubt if you'd be any the wiser about how to use it.

The most infuriating thing about the book is that the author has apparently got fed up with filling in the column which points to the pin-out diagrams for the listed ICs. Far too often to be forgiven — for several ICs on every page, in fact — the reader is referred to the section in which the pin-out diagram appears, and left to guess which of the dozens of diagrams shown there is the right one.

The one redeeming feature of this book is the price — £4.95. However, if you're looking for a low cost IC reference, it would be well worth your while to scrape together the extra few pounds for the infinitely better Towers' Selector.

Paul Chappell

THE MICROWAVE DEBATE

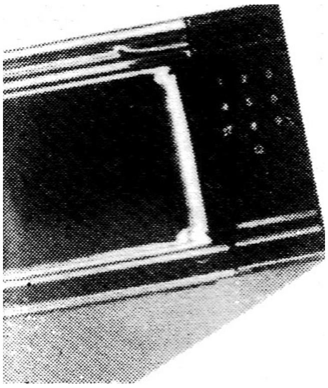
Nicholas H. Steneck

The MIT Press,
Massachusetts Institute of Technology,
Cambridge, Massachusetts 02142, United States of America

ISBN 0-262-19230-6
Price: £29.95

When microwave ovens first appeared in this country the question of safety concerned a lot of people. Articles on the subject appeared in both the specialist and popular press and not a few writers expressed grave doubts, but industry sources and others were quick to dub such views 'alarmist'. Safety standards were stringent, they insisted, and provided microwave ovens were used correctly there was no danger. With time this view seems to have prevailed. What public debate there was has sub-

The Microwave Debate
Nicholas H. Steneck



sided and the only questioning of safety standards and emission levels which takes place now is in the pages of specialist technical journals.

The situation in America, as described by Nicholas Steneck in this book, is very different. Initial public scepticism there has not abated. Rather it has increased, fuelled by articles such as the first product review on microwave ovens by the American Consumers Union which had 'Not Recommended' stamped across each page. The objection was based not on any concrete evidence of health risk but on the fact that they could not find an expert prepared to state unequivocally that there *wasn't* a health risk.

Public consciousness of microwave hazards has also developed on another front. The American cable television companies use satellite links to exchange and 'network' their programmes, and this involves the use of microwave ground stations generally known as uplink facilities. The highly de-centralised nature of the cable television system has led to a number of applications to build uplink facilites in small rural townships. The inevitable planning inquiries have formed a strong focus for public attention and led, in many cases, to the formation of citizens' action groups to oppose the applications.

The fears which lie behind this opposition have very little to do with such obvious dangers as burns and other heating effects. Medical opinion is generally agreed upon the level at which tissue heating is likely, and the safety standards have been set well below this level. What has so worried the American press and public is the possiblity that RF and microwave energy might be capable of introducing biological changes other than through tissue heating.

The evidence for this is described in detail by Steneck. It suggests that long-term exposure to low-levels of microwave and RF radiation can cause cataracts, blood disorders and mental and personality problems. Those responsible for setting safety standards in America have generally dismissed such studies as being faulty either in methodology or in underlying assumptions, but their own research has not always been well received either. A series of studies designed to prove conclusively that low-level microwave radiation is not harmful drew similar criticisms regarding methodology and objectivity and led to considerable disagreement among experts.

The 'official' line continues to be that levels of microwave radiation too low to cause heating effects in the body do not have any effect on health, but the dissenting view has proved strong enough to sway some courts. Workers have been awarded damages for loss of health as a result of exposure to microwave radiation, even though the medical profession do not recognise this as an occupational illness, and citizens' action groups have successfully opposed the building of microwave stations on health grounds even where the operators have been able to prove that their emissions will be well within the official limits.

Steneck chronicles blow and counter-blow in this debate, moving from events which took place within the military establishment during the early years of microwave research through to a period just a few years ago when the latest revision of the safety standards was published. His stance is that of a historian rather than a scientist and he avoids getting caught up in unnecessary technical description. This is wise since he is aiming the book as much at politicians, historians and sociologists as he is at scientists and engineers. At the same time, the rigour with which he tackles all aspects of the material is sufficient to ensure that technically-inclined readers are unlikely to feel short changed.

He is at pains not to take sides in such a contentious matter, and this is evident throughout the book. Neither side in the dispute escapes without criticism. This is admirable, but there are moments when the delicate balancing act becomes almost too much to sustain and is reflected in a tortuous mass of qualifications and guarded criticisms. One becomes obsessed with trying to find out which side Mr. Steneck himself favours and longs for a little more candour. This aside the book is written in a relaxed and accessible style and we can readily forgive him the occasional Americanism such as "... has gotten much stronger...", or "... will likely get worse...".

Good as it is, though, one can't help wondering how many people will be prepared to pay almost £30.00 for this book. At the moment, I suspect, not that many. However, if the advent of cable television or some other service leads to the widespread use of microwave ground stations on this side of the Atlantic, we may find community groups springing-up to fight them in the same way as their American counterparts. If so, this book will provide a useful summary of the debate so far and a valuable source-book for further discussion.

Ian Pitt

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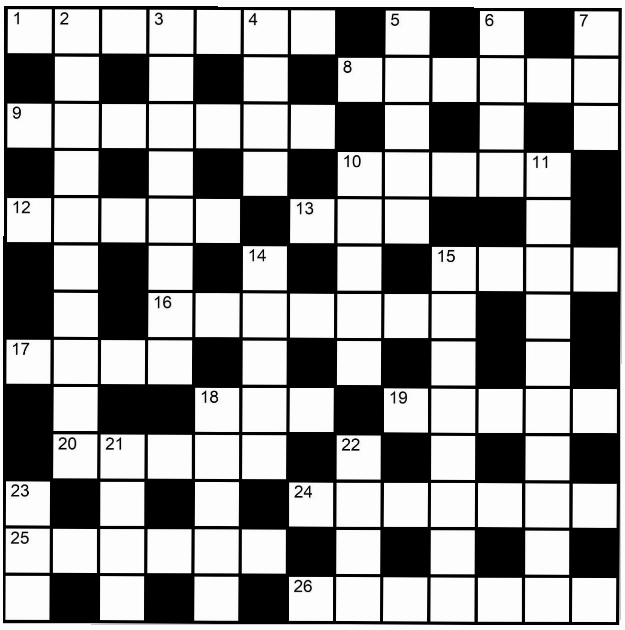

CROSSWORD No. 8

ACROSS

1) Describes two waves of the same frequency which peak and trough at the same time (2, 5).
8) Low voltage, high current sparking (6).
9) Not in focus (7).
10) A computer language (5).
12) Microsoft's disk operating system (5).
13) Describes an imperfect soldered joint (3).
15) As regards current, the opposite of source (4).
16) Disconnect from the power supply (7).
17) ---- ceramic, a type of capacitor (4).
18) A logic gate type (3).
19) The company who manufacture the 520ST microcomputer (5).
20) A second fainter image on a television screen (5).
24) It moves across the scale of a meter (7).
25) Unwanted noise from a radio receiver (6).
26) Computer software package for aiding the design and debugging of further software (7).

DOWN

2) Found in 5 down maybe, but holding no characters (4, 6).
3) A frequency which is multiple of a fundamental frequency (8).
4) ---- rate, the speed at which the output of a circuit can change given a theoretical instantaneous voltage change at the input (4).
5) A storage area in computer memory set aside for keeping tabulated data or strings (5).
6) Acronym for hi-fidelity (2-2).
7) Automatic Gain Control (1, 1, 1).
10) Unwanted open circuit in, say, a copper track on a PCB (5).
11) Describes the multi user, multi task version of the CPM operating system for 16 bit micros (10).
14) Record the number of occurrences of an event, such as a pulse (5).
15) A predefined symbol marking the beginning or the end of a sequence of data (8).
18) Universally-accepted table of codes for characters stored and processed by computers (1, 1, 1, 1, 1).
21) Device which reads or records information on a magnetic medium (4).
22) Microprocessor input/output channel (4).
23) Single side band (1, 1, 1).

Solution to Crossword No. 7

ACROSS

1) Dielectric
7) Hack
8) Word
9) Audio
10) Knob
11) Inch
12) Probe
13) REM
15) Rain
16) Hole
17) THD
19) Radon
20) Boom
21) Data
22) Diode
23) Mast
24) Beta
25) Reed Switch

DOWN

1) Dew Light
2) Eurocard
3) Clamping Diode
4) Radio Channels
5) Choke
6) Octode
13) Resonant
14) Mismatch
18) Heater
19) Radar

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