ELECTRONICS &
Wireless world
January 1985 85p

Floppy discs and systems

Audio amp symmetry

Single-board computers

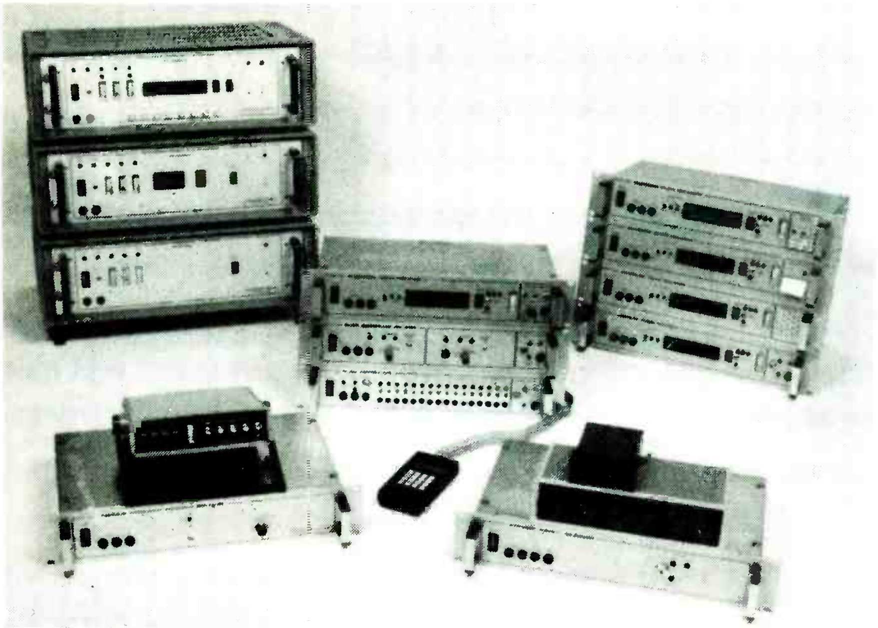
Data exchange

Compact discs

Australia	A$	3.30
Denmark	DKr.	38.00
Germany	DM	7.00
Greece	Dra.	24.00
Holland	DFl.	9.00
Italy	L	4200
Spain	Pts.	370.00
Switzerland	SFr.	8.00
Singapore	M$	7.00
U.S.A.	$	4.00

RADIOCODE CLOCKS LTD

SPECIALISTS IN ATOMIC TIME, FREQUENCY AND SYNCHRONISATION EQUIPMENT



NEW PRODUCTS

- **MINIATURE RUBIDIUM OSCILLATOR MODULE**
  Lower power, fast warm up, optional output frequencies, programmable frequency offsets.
- **RUBIDIUM FREQUENCY STANDARD**
  High performance, compact and rugged instrument. 2U rack or ¼ ATR case options.
- **INTELLIGENT OFF-AIR FREQUENCY STANDARDS**
  Microcomputer controlled instruments, directly traceable to N.P.L., precision ovened local oscillator, comprehensive monitoring and status information, real time synchronisation.
- **LOW COST MSF FREQUENCY STANDARD**
  Instant operation, directly traceable to N.P.L., self-contained portable unit, no scheduled frequency changes, 24 hr transmission, real time synchronisation

- **Off-air frequency standards**
- **Intelligent time systems**
- **Caesium/Rubidium based clocks & oscillators**
- **Master/slave systems**
- **Time code generators/readers**
- **Record/replay systems**
- **Intelligent display systems**
- **Precision ovened oscillators**
- **Time/frequency distribution systems**

Radiocode
Clocks Ltd*

Unit 19, Parkengue,
Kernick Road Industrial Estate, Penryn,
Falmouth, Cornwall. Tel: Falmouth (0326) 76007

(*A Circuit Services Associate Co.)

CIRCLE 37 FOR FURTHER DETAILS.

pantechnic

- design manufacture and supply

POWER AMPLIFIERS
HIGH POWER ASSEMBLIES
CONTROL CIRCUITRY

- for application in

INDUSTRY
PUBLIC ADDRESS
HI-FI

- available

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CUSTOMISED
C A D DESIGNED

tel. 01.361.8715 132 High Road
telex 266 873 New Southgate
PANTEC G LONDON N11 1PG.

CIRCLE 83 FOR FURTHER DETAILS.

BERG LOW PROFILE 14 PIN DUAL IN LINE I.C. SOCKET manufactured from glass filled polyester to UL94V-0. £7 for 100, £31 for 500, £56 for 1000, £256 for 5000, £460 for 10,000, £2100 for 50,000, £3700 for 100,000. Sample 10 sent for £1.20 + 30p p&p (£1.73 inc VAT)

BERG LOW PROFILE 16 PIN DUAL IN LINE I.C. SOCKET as above £8 for 100, £36 for 500, £65 for 1000, £295 for 5000, £530 for 10,000, £2390 for 50,000, £4300 for 100,000. Sample 10 sent for £1.40 + 30p p&p (£1.96 inc VAT)

WIRE CUTTER AND STRIPPER tempered steel blades spring loaded with moulded red P.V.C. handles. Cutting and stripping adjustable up to 6.0mm$_2$. Overall length 135mm, weight 64 grms, 10 for £15, 25 for £34, 50 for £63, 100 for £116, 500 for £525, 1000 for £1000. Sample pair sent for £1.75 + 25p p&p (2.30 inc VAT).

INTERNATIONAL 'POWER ONE' regulated D.C. supply unit A.C. input 100/120/220/240 volt — D.C. output 5 volt at 16.2 amp with +/-.05% regulation for up to 50% load change. Built to very high standard on satin finish aluminium open chassis 14" (W) × 5" (H) × 2½" (D) WT 5.5kg. (Brand new boxed). Price £38.50 + £4.00 p&p (£48.87 inc VAT)

REGULATED D.C. SUPPLY UNIT BY GRESHAM LION. Input 220 volts +/- 10% or 240 volt +/- 10% 125W. Outputs 5 volt/25 amp, 12 volt/10 amp, 15 volt/10 amp, 24 volt/5 amp, 30 volt/4 amp, (set at 5 volt) load regulation. 15% zero to full load. Temp range -10C to + 70C. With remote sensing facility — free standing chassis 10" (W) × 4" (H) × 4½" (D) WT 3.5kg. Brand new boxed complete with handbook. Price £130 + £4.00 p&p (£154.10 inc VAT)

WIRE WOUND RESISTORS manufactured by E.R.G. type 16 ES with a standard tolerance ±5% of nominal resistance value. All values in stock.
3 watt series £3.50 per 100 any one value + £1 p&p (£5.17 inc VAT)
6 watt series £6.50 per 100 any one value + £1 p&P (£8.63 inc VAT)
10 watt series £10.50 per 100 any one value + £1 p&p (£13.23 inc VAT)

ALUMINIUM FOIL CAPACITORS manufactured by Iskra 2.25 MFD 385V A.C. WKG axial type. Body length 40mm x 23mm £25 per 100 pcs, £115 per 500 pcs, £212 per 1000 pcs, £980 per 5000 pcs, £1800 per 10,000 pcs, £4165 per 25,000 pcs. Sample 10 sent for £3.00 + p&p (£4.60 inc VAT)

BRITISH MADE TRANSFORMER input 240V at 50Hz, output 120V-O-12V 1/2 amp with built in thermal overload cutout. P.C. mounting £25 for 10 + VAT, £115 for 50 + VAT, £210 for 100 + VAT, £950 for 500 + VAT, £1700 for 1000 + VAT. Sample sent for £3 + 75p p&p (£4.31 inc VAT).

PAIR OF MATCHED SPEAKERS 4 ohm 3 watts in team finish cabinets with black/chrome facia 7 1/2" × 12" × 5" depth — 1 sample pack (2 spks) £10.00 + £2 p&p (£13.80 inc VAT) 10 packs £9.00 each + £2 p&p (£12.65 inc VAT).

12" VIDEO DISPLAY UNIT (green) complete with frame and P.C.B. incorporating time bases/EHT, etc but minus case and simple power supply unit. Originally designed to be basically compatible with BBC Micro and Commodore computers. Circuit diagram supplied. Price per sample unit £35.00 + £3 p&p (£43.70 inc VAT). Quantity prices on application.

OPEN FRAME AND SHADED POLE MOTORS by well known manufacturers, 240 volt a/c — many uses — price per sample £1.50 + 75p p&p (£2.59 inc VAT), price per 10 motors £1.25 + 75p p&p (£2.30 inc VAT each)

ULTRASONIC BURGLAR ALARM — portable — wooden finish with internal alarm — easily installed — mains/battery option. Provision for window contacts — pressure mat. external horn and bell unit.
Sample units £39.00 + £2 p&p = £47.13 inc VAT each, 5 units £35.00 + £2 p&p = £42.55 inc VAT each, 10 units £33.00 + £2 p&p = £40.25 inc VAT each.

EXTERNAL HORN Sample unit £7.50 + £1.50 p&p = £10.35 inc VAT each, 5 unit £6.75 + £1.50 p&p = £9.49 inc VAT each, 10 unit £6.37 + £1.50 p&p = £9.05 inc VAT each.

TERMS C.W.O. export enquiries welcome. We find it impossible to advertise all we stock. Please telephone, write or telex for further enquiries. Personal callers always welcome.

ELECTRONIC EQUIPMENT CO.

SPRINGFIELD HOUSE,
TYSSEN STREET,
LONDON E.8. 2ND
TEL NO. 01-249-5217
TLX: 8953906 EECO G

CIRCLE 53 FOR FURTHER DETAILS.

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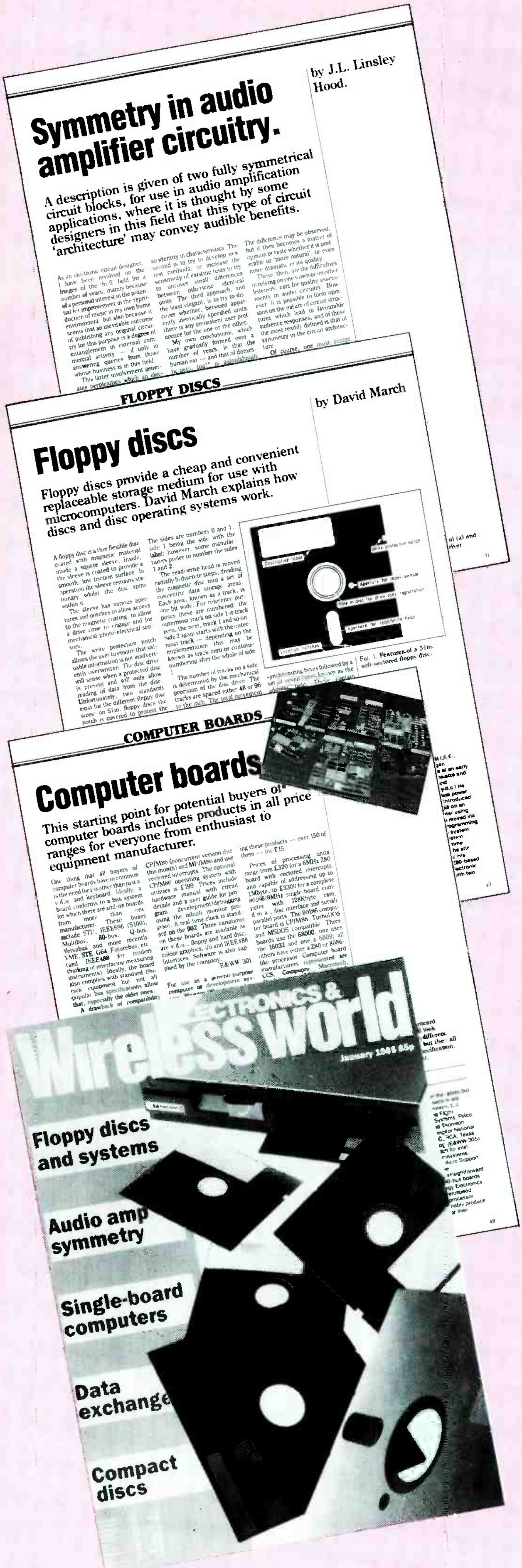
ELECTRONICS & Wireless world

over 70 years in independent electronics publishing

January 1985 Volume 91 number 1587

FEATURES

REGULARS



Front cover, designed by Richard Newport and photographed by Chris Stevens, illustrates the article on floppy discs by D. March, starting on page 43. Disc drive by courtesy of Statacom.

NEXT MONTH

Nigel Cawthorne on the latest international developments in cable television as reported to a Swiss cable and satellite tv conference.

Award-winning design of a combined car window demister and v.h.f. aerial for h.f. reception is detailed by J.D. Last and B. Easter, its developers.

A tutorial series on sampled-data systems — a subject many engineers find difficult — by D.M. Taub presents the theory in a completely new way, specially suitable for use with computers.

An automatic warning device is designed for sending an alarm signal by telephone. Per Anderson gets round the problem of direct connection to telephone lines.

Current issue price 85p, back issues (if available) £1.06, at Retail and Trade Counter, Units 1 & 2, Bankside Industrial Centre, Hopton Street, London SE1. Available on microfilm; please contact editor.

By post, current issue £1.30, back issues (if available) £1.40, order and payments to EEP Sundry Sales Dept., Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Tel.: 01-661 3378.

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01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Computer & Econet Referral Centre

BBC Computers:

Model B: **£320(a)** B+DFS: **£409 (a)**
Model B+NFS: **£389 (a)** B+NFS+DFS **£450 (a)**
ACORN 2nd Processors: 6502: **£175 (a)** Z80: **£352 (a)**
TORCH UNICORN: Z80 Card: **£299 (a)** Z80 Disc Pack: **£699 (a)**
UNICOMM Communications Package: £159 (b)
20 Mbyte Hard Disc+400K Floppy: £1995 (a)

We stock the full range of ACORN hardware and firmware and a very wide range of other peripherals and firmware for the BBC. For detailed specifications and pricing please send for our leaflet.

PRINTERS

EPSON: RX80FT **£225(a); FX80 £315(a)**
FX100 **£435(a);RX100 £345(a)**
KAGA TAXAN:KP810 **£249(a);** KP910 **£359 (a)**
BROTHER:HR15 **£340 (a);.**

ACCESSORIES

EPSON Serial Interface: 8143 **£28** (b); 8148 with 2K buffer **£57** (b).
EPSON Paper Roll Holder **£17** (b); FX80 Tractor Attach **£37** (b); RX/FX80 Dust Cover **£4.50**(d)
EPSON Ribbons; MX/RX/FX80 **£5.00**; MX/RX/FX100 **£10** (d).
JUKI: Serial Interface **£65** (c); Tractor Attach, **£99** (a); Sheet Feeder **£199** (a); Ribbon **£2.50** (a).
BROTHER HR15: Sheet Feeder **£199;** Ribbons — Carbonor Nylon **£4.50;** Multistrike **£5.50** (d);
2000 Sheets Fanfold with extra fine perf. 9.5in. — **£13.50**; 14.5in. **£18.50**(b).
BBC Parallel Lead **£8**; Serial Lead **£7** (d).

BT Approved Modems

MIRACLE WS2000:
The ultimate world standard modem covering all common BELL and CCITT standards up to 1200 Baud. Allows communication with virtually any computer system in the workd, The optional AUTO DIAL and AUTO ANSWER boards enhance the considerable facilities already provided on the modem. Mains powered. **£129(c)** Auto Dial Board/Auto Answer Board **£30 (d)** each. Software lead **£4.50**
TELEMOD 2:
Complies with CCITT V23 1200/75 Duplex and 1200/1200 half Duplex standards that allow communications with VIEWDATA services like PRESTEL, MOCRONET etc as well as user to user communications. Mains powered. **£62 (b)**
BUZZ BOX:
This pocket sized modem complies with V21 300/300 Baud and provides and ideal solution for communications between users, with main frame computers and bulletin boards at a very economic cost. Battery or mains operated. **£52 (c)** Mains Adaptor **£8 (d)**
BBC to Modem data lead **£7**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II .... **£195.00(b)**
Adaptor for 2764/2564 .... **£25.00**

DISC DRIVES

These drives, fitted with high quality JAPANESE mechanisms are supplied in attractive steel cases painted in BBC colour. The drives are fully Shuggart A4000 compatible. All dual drives are supplied with integral power supply whilst singles are supplied with or without power supply. All drives come complete with data & power cables, manual and BBC formatting disc.

1×100K (250KDD unformatted)	40TSS TS55A TEAC	**£100 (a)**
1×400K (1MbDD unformatted)	80TDS TS55F TEAC 40/80	**£155(a)**
2×400K (.5MbDD unformatted)	40TSS TD55A TEAC	**£250 (a)**
2×400 (2MbDD unformatted)	80TDS TD55F Mitsubishi 40/80	**£360 (a)**

CS100 TEC with psu	**£125 (a)**	40/80T Switch Module	**£30 (c)**
CS200 TEC with psu	**£165(a)**	3in. Hitachi 100K 40T	**£105 (b)**
CS400 MITS with psu	**£195 (a)**		

Authorised Distributor
Data Recording Products
3M

3M FLOPPY DISCS

Industry Standard floppy discs with a lifetime guarantee Discs in packs of 10

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

DRIVE ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 28 disposable cleaning discs ensures continued optimum performance of the drives. **£14.50**(c)

Single Disc Cable £6**(d)**	Dual Disc Cable **£8.50**(d)
10 Disc Library Case £1.80(d)	30 Disc Storage **Box £6**(c)
30/40 Disc Lockable **Box £14**(c)	100 Disc Lockable **Box £19**(c)

MONITORS

MICROVITEC 14in. RGB
1431 Std Res **£165 (a);** 1431 Ap std Res PAL/Audio **£210 (a);**
1451 Med Res **£255 (a)**; 1441 Hi Res **£399 (a);**
2031 20in. Std Res **£260(a)**; Plinth for 14in. Monitors **£8.50.**
Microvitec Monitors with TTL/Linear Inputs also available.

KAGA VISION III
Hi Res 12in. RGB **£345 (a);**
Green Screens; KAGA 12G **£99 (a);** SANYO DM 811 112CX **£90 (a);**
Swivel Stand for Kaga Green **£22.50 (b);**
BBC Leads: KAGA RGB **£5** Microvitec **£3.50;** Monochrome **£3.50 (d)**

UV ERASERS

UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays.
It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59 + £2 p&p.**
UV1 as above but without the timer. **£47+£2 p&p**
For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 eproms. UV141 has a built in timer. Both offer full built in safety features UV140 **£61**, UV141 **£79, p&p £2.50.**

PRINTER BUFFER

This printer sharer/buffer provides a simple way to upgrade a multiple computer system by providing greater utilisation of available resources. The buffer offers a storage of 64K. Data from three computers can be loaded into the buffer which will continue accepting data until it is full. The buffer will automatically switch from one computer to next as soon as that computer has dumped all its data. The computer then is available for other uses. LED bargraph indicates memory usage. Simple push button control provides. REPEAT, PAUSE and RESET functions. Integral power supply. **£245** (a).

ATTENTION

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

ACORN IEEE INTERFACE

A full implementation of the IEEE-488 standard, providing computer control of compatible scientific & technical equipment, at a lower price than other systems. Typical applications are in experimental work in academic and industrial laboratories. The interface can support a network of up to 14 other compatible devices, and would typically link several items of test equipment allowing them to run with the optimum of efficiency. The IEEE Filing System ROM is supplied **£282.**

INDUSTRIAL PROGRAMMER

EP8000.
This CPU controlled Emulator Programmer is a powerful tool for both Eprom programming and development work. EP8000 can emulate and program all eproms up to 8KX8 bytes, can be used as stand alone unit for editing and duplicating EPROMS, as a slave programmer or as an eprom emulator **£695**(a)

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

MIN D CONNECTORS

	9 way	15 way	25 way	37 way	50 way
MALE					
solder	60p	85p	1.25p	1.70p	4.00p
angled	1.20p	1.80p	2.40p	3.50p	—
FEMALE					
solder	90p	1.30p	1.95p	2.90p	5.00p
angled	1.60p	2.10p	2.90p	4.40p	—
hood (top/side entry)	90p	85p	90p	1.00p	—

25 way Centronix Type Conn 5.50 pounds
37 way Centronix type Conn 5.50 pounds
IDC 25 way plug 3.85p Socket 4.50p.

TEXTOOL ZIF

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

DIL SWITCHES

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

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 (ZX81)	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

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	275p	
IDC Skt A + C	350p	

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

AMPHENOL CONNECTORS

36-way plug Centronics
Parallel|Solder £5.25 IDC £5.25
36-way socket Centronics
Parallel|Solder £5.50 IDC £5.50
24-way plug IEEE Solder £5 IDC £4.75
24-way socket IEEE Solder £5 IDC £4.75

PCB Mtg Skt
Any Pin 24 way Solder 600p
36 way ZOC 650p

RS 232 JUMPERS

(25 way D)

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

TEST CLIPS

14-pin 375p 16-pin 400p
40-pin £10.30

RIBBON CABLE

(grey/metre)

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

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
24 pin	100p	150p
28 pin	200p	—
40 pin	200p	225p

LINEAR ICs

COMPUTER COMPONENTS

74 SERIES

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	0.36
7423	0.36
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	0.60
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	0.55
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	1.30
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	0.80
74159	1.75
74160	1.10
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
74176	1.50
74179	1.50
74180	1.00
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	0.80
74196	1.30
74197	1.10
74198	2.20
74199	2.20
7474221	1.10
74251	1.00
74259	1.50
74265	0.80
74273	2.00
74276	1.40
74278	1.70
74279	0.90
74283	1.05
74742	3.20
74290	0.90
74293	0.90
74298	1.80
74351	2.00
74365A	0.80
74366A	0.80
74367A	0.80
74368A	0.70
74376	1.60
74390	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
74LS43	1.50
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	0.35
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	0.65
74LS161A	0.75
74LS162A	0.75
74LS163A	0.75
74LS164	0.75
74LS165A	1.10
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	1.00
74LS240	0.80
74LS241	0.80
74LS242	0.90
74LS243	0.90
74LS244	0.80
74LS245	1.00
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
74LS2457A	0.70
74LS258A	0.70
74LS259	1.20
74LS260	0.75
74LS261	1.20
74LS266	0.60
74LS273	1.25
74LS279	0.70
74LS280	1.90
74LS283	0.80
74LS290	0.80
74LS292	9.00
74LS293	0.80
74LS295	1.40
74LS297	9.00
74LS298	1.00
74LS299	2.20
74LS321	3.70
74LS322A	3.90
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	1.40
74LS378	0.95
74LS379	1.40
74LS381	4.50
74LS390	0.60
74LS393	0.95
74LS395A	0.60
74LS399	1.00
74LS445	1.80
74LS465	1.20
74LS467	1.20
74LS490	1.50
74LS540	1.00
74LS541	1.00
74LS608	7.00
74LS610	19.00
74LS612	19.00
74LS624	3.50
74LS626	2.25
74LS628	2.25
74LS629	1.40
74LS640	3.00
74LS640-1	3.00
74LS641	2.00
74LS642	2.50
74LS642-1	3.00
74LS643	2.50
74LS643-1	3.00
74LS644	3.50
74LS645	2.00
74LS45-1	4.00
74LS668	0.90
74LS669	0.90
74LS670	1.80
74LS682	3.20
74LS684	6.50
74LS687	5.50
74LS688	5.50
74LS783	21.00

74S SERIES

74S00	0.50
74S02	0.50
74S04	0.50
74S05	0.50
74S08	0.50
74S10	0.50
74S11	0.75
74S20	0.50
74S22	1.00
74S30	0.50
74S32	0.60
74S37	0.60
74S38	0.75
74S40	0.50
74S51	0.45
74S64	0.45
74S74	0.75
74S85	4.50
74S86	1.00
74S112	1.50
74S113	1.20
74S114	1.20
74S124	5.50
74S132	1.00
74S133	0.60
74S138	1.80
74S139	1.80
74S140	1.00
74S151	1.50
74S153	1.50
74S157	2.10
74S158	2.00
74S163	4.00
74S169	7.00
74S174	3.00
74S175	3.20
74S188	1.80
74S189	2.25
74S194	3.00
74S195	3.00
74S196	3.50
74S200	4.50
74S201	3.20
74S225	5.20
74S240	4.00
74S241	4.00
74S244	5.00
74S251	2.50
74S257	2.50
74S258	2.50
74S260	1.00
74S261	3.00
74S262	11.00
74S283	2.70
74S287	2.25
74S288	2.00
74S289	2.25
74S299	5.50
74S373	4.00
74S374	4.00
74S387	2.25
74S472	4.75
74S473	4.75
74S474	4.00
74S475	4.50
74S570	6.50
74S571	3.00
74S573	5.00

74C SERIES

74C00	0.70
74C04	0.50/ 4069
74C08	0.70
74C10	0.70
74C14	0.50/ 40106 4584
74C20	0.70
74C32	1.00
74C42	1.50
74C48	1.50
74C73	1.00
74C74	1.20
74C76	1.00
74C83	2.00
74C85	2.25
74C86	0.50/40/ 70 4507
74C90	1.90
74C93	1.50
74C95	1.60
74C107	1.00
74C150	5.00
74C151	2.00
74C157	2.50
74C160	1.80
74C161	1.80
74C162	1.80
74C163	1.80
74C173	1.00/ 4076
74C174	1.50
74C175	1.50
74C192	1.50
74C193	1.50
74C194	1.50
74C195	1.50
74C221	2.50
74C244	2.00
74C245	2.25
74C373	2.25
74C374	2.25
74C902	1.20
74C911	9.00
74C912	4.50
74C922	6.00
74C923	6.50
74C925	6.50
74C926	7.50

74ALS SERIES

74ALS00	0.45
74ALS02	0.45
74ALS04	0.50
74ALS08	0.50
74ALS10	0.45
74ALS20	0.45
74ALS32	0.45
74ALS74	0.70
74ALS138	1.50
74ALS139	1.50
74ALS244	4.00
74ALS245	4.75
74ALS573	2.60
74ALS574	4.50
74ALS580	2.60

4000 SERIES

4000	0.20
4001	0.24
4002	0.25
4006	0.70
4007	0.25
4008	0.60
4009	0.45
4010	0.60
4011	0.24
4012	0.25
4013	0.36
4014	0.60
4015	0.70
4016	0.36
4017	0.55
4018	0.60
4019	0.80
4020	0.80
4021	0.60
4022	0.70
4023	0.30
4024	0.48
4025	0.24
4026	0.90
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	0.55
4042	0.50
4043	0.50
4044	0.50
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.35
4051	0.65
4052	0.60
4053	0.60
4054	0.80
4055	0.80
4056	0.85
4059	4.00
4060	0.70
4063	0.85
4066	0.40
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	0.35
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	0.36
4504	0.95
4505	3.60
4506	0.90
4507	0.35
4508	1.20
4510	0.55
4511	0.55
4512	0.55
4513	1.50
4514	1.10
4515	1.10
4516	0.55
4517	2.20
4518	0.48
4519	0.32
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.80
4528	0.65
4529	1.00
4531	0.75
4532	0.65
4534	3.80
4536	2.50
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.50
4557	2.40
4560	1.40
4566	1.40
4568	2.40
4569	1.70
4572	0.45
4583	0.90
4584	0.48
4585	0.60
4724	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	1.30
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
40108	3.20
40109	0.80
40110	2.25
40114	2.25
40117	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	1.80
40374	1.80
80C95	0.75
80C97	0.75
80C98	0.75

DISPLAYS

DL704RED	1.40
DL707RED	1.40
FND357	1.00
FND500/ TIL730	1.00
FND507/ TIL729	1.00
MAN74/ DL704	1.00
MAN71/ DL707	1.00
MAN3640	1.75
MAN4640	2.00
MAN6610	2.00
NSB5881	5.70
TIL311	6.50
TIL729	1.00
TIL730	1.00
MAN8910	2.50
MAN8940	2.50

DISPLAY DRIVERS

9368	4.50
9370	4.50
LM3914	3.50
LM3915	3.50
LM3916	3.50
UDN6118	3.20
UDN6184	3.20
ULN2003	0.90
ULN2004	0.90
ULN2068	2.90
ULN2802	1.90
ULN2803	1.80
ULN2804	1.90
75491	0.70
75492	0.70

OTHERS

2N5777	0.50
BPX25	1.80
BPW21	2.80
OCP71	1.80
ORP12	1.20
ORP60	1.20
ORP61	1.20
SFH205	1.00
TIL32	0.55
TIL78	0.55
TIL31B	1.20
TIL81	1.20
TIL100	0.75

LINEAR ICs

AD7581	15.00
ADC0808	11.90
AM7910DC	25.00
AN103	2.00
AY-1-5050	1.00
AY-3-1270	7.50
AY-3-1350	3.50
AY-3-8910	4.50
AY-3-8912	5.00
CA3019A	1.00
CA3028A	1.10
CA3046	0.70
CA3059	3.25
CA3060	3.50
CA3080	0.70
CA3086	0.60
CA3089	2.10
CA3090AQ	3.75
CA3130E	0.90
CA3130T	1.30
CA3140E	0.45
CA3140T	1.00
CA3146	2.25
CA3160E	0.90
CA3161E	1.60
CA3162E	4.40
CA3189E	2.70
CA3240E	1.50
CA3280G	2.70
CAD70C2	12.10
DAC1408-8	2.25
DAC0800	2.25
DAC0808	2.25
DG308	3.00
HA1366	1.90
ICL7106	6.75
ICL7611	0.95
ICL7650	4.00
ICL7660	2.50
ICL8038	3.00
ICM7216B	22.00
ICM7217	7.50
ICM7555	0.90
ICM7556	1.40
LC7120	3.00
LC7130	3.00
LC7131	3.50
LC7137	3.50
LF347	1.50
LF351	0.60
LF353	0.90
LF355	0.90
LF356N	1.10
LF357	1.00
LF13331	3.50
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	1.50
LM336	1.60
LM339	0.40
LM348	0.60
LM358P	0.50
LM377	2.10
LM380N-8	1.50
LM380N	1.20
LM381AN	1.70
LM382	1.20
LM383	3.25
LM384	2.20
LM386N-1	1.00
LM387	2.70
LM389	1.80
LM391	1.80
LM392N	1.10
LM393	0.85
LM394CH	3.75
LM709	0.35
LM710	0.48
LM711	1.00
LM723	0.60
LM7245CN	3.00
LM733	0.65
LM741	0.16
LM747	0.70
LM748	0.30
LM1011	4.80
LM1014	1.50
LM1801	3.00
LM1830	2.50
LM1871	3.00
LM1872	3.00
LM1886	6.00
LM1889	4.50
LM2917	3.00
LM3302	0.75
LM3900	0.80
LM3909	1.00
LM3911	1.80
LM3914	3.50
LM3915	3.40
LM3916	3.40
LM13600	1.50
MS1513L	2.30
MS1516L	4.50
MB3712	2.00
MB3730	4.00
MC1310P	1.50
MC1413	0.75
MC1445	2.50
MC1458	0.45
MC1495L	2.50
MC1496	0.70
MC3340P	2.00
MC3401	0.50
MC3403	0.65
MF10CN	3.40
MK50240	9.00
MK50398	7.90
ML920	5.00
ML922	4.00
MM6221A	3.00
NE529	2.20
NE531	1.20
NE544	1.90
NE555	0.22
NE556	0.60
NE564	4.00
NE565	1.20
NE566	1.50
NE567	1.25
NE570	4.00
NE571	4.00
NE592	0.90
NE5532P	1.50
NE5533P	1.60
NE5534P	1.80
NE5534AP	1.50
OP-07EP	5.00
PLL02A	5.00
RC4136	0.55
RC4151	2.00
RC4195	1.50
RC4558	0.55
S566B	2.20
S50240	9.00
SAA1900	16.00
SAD1024A	11.50
SFF96364	8.00
SL490	3.00
SN76013N	3.00
SN76023N	3.00
SN76033N	3.00
SN76115N	2.15
SN76477	6.00
SN76489	4.00
SN76495	4.00
SN76660	1.20
SPO256AL2	7.00
SP8515	7.50
TA7120	1.20
TA7130	1.40
TA7204	1.50
TA7205	0.90
TA7222	1.50
TA7310	1.50
TBA641BX1	4.00
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
TCA270	3.50
TCA940	1.75
TDA1004A	5.00
TDA1010	2.25
TDA1022	4.50
TDA1024	1.10
TDA1170S	3.00
TDA2002	3.25
TDA2003	1.90
TDA2004	2.40
TDA2006	3.20
TDA2020	3.20
TDA2030	1.80
TDA2541	4.00
TDA2591	4.00
TDA2593	5.00
TDA2653	7.00
TDA3560	9.90
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
TL430C	1.20
UAA1003-3	9.35
UA759	3.20
UA2240	1.20
UAA170	1.70
UCN4801A	5.50
ULN2001A	0.75
ULN2002A	0.75
ULN2003A	0.75
ULN2004A	0.75
ULN2068	2.90
ULN2802	1.90
ULN2803	1.80
ULN2804	1.90
UPC575	2.75
UPC592H	2.00
UPC1156H	3.00
UPC1185H	5.00
XR210	4.00
XR2206	3.50
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
ZN450E	7.50
ZN459CP	3.00
ZN1034E	2.00
ZNA1040	6.60
ZNA134J	23.00
ZNA234E	9.50

REAL TIME CLOCK

MC6818P	4.50
MM5817AN	8.500
MSM5832RS	3.50

TELETEXT DECODER

SAA5020	6.00
SAA5030	7.00
SAA5041	16.00
SAA5050	9.00

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

OTHER REGULATORS

Fixed Regulators

LM309K	1A 5V	1.40
LM323K	3A 5V	3.50
78H05KC	5A 5V	5.40
78H12	5A 12V	6.40
78P05	10A 5V	9.00

VARIABLE REGULATORS

LM305AH		2.50
LM317T	TO-220	1.50
LM317K	TO3	2.40
LM337T		2.25
LM350T	10A+VAR	4.00
LM396K	10A+VAR	15.00
LM723N		0.50
78HOSKC		5.40
78HGKC	5A+VAR	5.75
78GUIC	1A+VAR	2.25
79HGKC	5A-VAR	6.75
79GUIC	1A-VAR	2.50

SWITCHING REGULATORS

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

OPTO-ISOLATORS

ILD74	1.30	TIL111	0.70
ILQ74	2.20	TIL112	0.70
MCT26	1.00	TIL113	0.70
MCS2400	1.80	TIL116	0.70
MOC3020	1.50	6N137	3.60
		6N139	1.75

LEDS

0.125"		0.2"	
RED TIL209	0.12	TIL220	0.15
GRN TIL211	0.16	TIL222	0.18
YEL TIL212	0.20	TIL226	0.22
Rect LEDs (R/G/Y)	0.30		
CXQ (Bi Colour)	1.00		
10 LED BarGraph: Red	2.25		
Grn	2.25		

COUNTERS

74C925	6.50
74C926	6.50
74C928	6.50
72168	22.00
ZN1040	6.70

CPU

1802CE	6.50
2650A	12.00
6502	3.50
65C02	15.00
6502A	5.50
6502B	8.00
6800	2.50
6802	3.00
6809	6.50
6809E	12.00
68B09	12.00
68B09E	16.00
68000-L8	36.00
8035	3.60
8039	4.20
8080A	4.20
8085A	6.50
8086	22.00
8088	17.50
8748	P.O.A.
TMS1601	12.00
TMS9980	12.00
TMS9995	12.00
WD55	14.50
Z80	2.80
Z80A	3.25
Z80B	8.00
8287	4.25
8288D	11.00
8755A	24.00
TMS9903	25.00
TMS9911	18.00
TMS9911	14.00
Z80P10	2.60
Z880Ap10	3.25
Z80CTC	2.60
Z80ACTC	3.25
Z80DART	6.50
Z80ADART	8.00
Z80DMA	8.00
TMS4500	14.00
TMS9901	5.00
TMS9902	5.00
Z80ADMA	9.00
Z80ASIO	9.00

SUPPORT DEVICES

2651	12.00
3242	8.00
3245	4.50
6520	3.00
6522	3.50
6522A	5.50
6532	5.20
6551A	1.58
68B21	2.20
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	4.00
8156	4.00
8205	2.25
8212	2.20
8216	1.60
8224	3.00
8226	3.00
8228	4.20
8243	2.90
8250	9.50
8251A	3.50
8253C-5	3.70
8255AC-5	4.00
8256	16.00
8256	24.00
8257C-5	4.00
8259C-5	5.00
8271	P.O.A.
8275	29.00
8279	6.50
8284	7.50
8282	4.50
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2102	2.50
2107B	5.00
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2114-3L	2.50
2114-4L	2.00
2147	3.20
4027-3	3.00
4116-15	2.00
4116-20	1.75
4118-3	5.00
4164-15	5.50(TI)
4164-15	5.00
41256-20	25.00
4164-20	4.50
4416-15	5.00
4532-20	2.50
4816AP-3	2.00
5101/5501	3.70
5516	6.50
6116P-3	5.00
6116LP-3	5.50
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6514-45	2.50
6810	1.60
74S189	2.25
74S201	3.50
74S289	2.25
93415	6.00
93L422	9.50
93425	6.00

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28L22	4.75
24S10	2.50
18S030	2.00
18SA030	2.00
74S188	1.88
74S287	2.25
74S288	1.80
74S387	2.25
74S473	4.75
74S474	4.00
74S570	6.50
74S571	3.00
74S571	3.00
74S573	5.00
82S23	1.50
82S123	1.50
82S129	1.75

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2516-35	5.50
2532	4.50
2532	5.50
2564	6.50
2708	3.00
2716+15V	3.50
2716-35	5.50
2732	4.50
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2732A-30	6.00
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27256-25	60.00
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27128-30	16.00
TMS2716	5.00

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CRT5037	12.00
CRT6545	9.00
EF9364	8.00
EF9365	30.00
EF9366	30.00
EF9367	36.00
MC6845	6.50
MC6845SP	7.50
MC6847	6.50
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TMS9918	30.00
TMS9927	14.00
TMS9928	20.00
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AM25LS2538	3.50
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AM26LS32	1.20
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DAC80-CB1-V	28.00
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DS8830	1.40
DS8831	1.50
DS8832	1.50
DS8833	2.25
DS8836	1.50
DS8838	2.25
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MC1489	0.60
MC3446	2.50
MC3459	4.50
MCS3470	4.75
MC3480	8.50
MC3486	2.25
MC3487	2.25
MC4024	3.25
MC4044	3.25
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MC14412	7.50
75107	0.90
75108	0.90
75109	1.20
75110	0.90
75112	1.60
75113	1.20
75114	1.40
75115	1.40
75121	1.40
75122	1.40
75150P	1.20
75154	1.20
75159	2.20
75160	5.00
75161	3.50
75162	4.00
75172	3.00
75182	0.90
75188	0.60
75189	0.60
75365	1.50
75450	0.80
75451	0.50
75452	0.50
75453	0.70
75454	0.70
75480	1.50
75491	0.65
75492	0.65
8T26	1.20
8T28	1.20
8T95	1.20
8T96	1.20
8T97	1.20
8T98	1.20
81LS95	1.40
81LS96	2.20
81LS97	1.40
81LS98	2.20
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9602	3.00
9636A	1.60
9637AP	1.60
9638	1.60

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8272	26.00
FD1771	20.00
FD1791	20.00
FD1793	20.00
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FD1797	22.00
WD2793	36.00
WD2797	32.00
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2.00MHz	2.25
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2.45760Mhz(S)	2.50
2.5MHz	2.50
2.662MHz	1.75
3.276MHz	1.50
3.5795MHz	1.00
4.00MHz	1.50
4.194MHz	2.00
4.43MHz	1.00
4.608MHz	2.50
4.9152MHz	2.50
5.00MHz	1.50
6.00MHz	1.40
6.144MHz	1.40
7.00MHz	1.50
7.16MHz	1.75
8.00MHz	1.50
8.867MHz	1.75
10.00MHz	1.75
10.50MHz	2.50
10.70MHz	1.50
11.00MHz	3.00
12.00MHz	1.50
14.00MHz	1.75
14.31MHz	1.60
14.756	2.50
15.00MHz	2.00
16.00MHz	2.00
17.734MHz	2.00
18.00MHz	1.70
18.432MHz	1.50
19.969MHz	1.50
20.000MHz	1.75
24.000MHz	1.50
48.000MHz	1.75
116MHz	2.50
PXO1000	12.00

LOW PROFILE SOCKETS BY TI

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 TI

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16 pin	45p	22 pin	75p	40 pin	130p

TURNEO PIN LOW PROFILE SKTS.

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BC107/8	18p
BC109C	20p
BC169C	18p
BC172	18p
BC177/8	30p
BC179	20p
BC182/3	15p
BC184	16p
BC187	30p
BC212/3	16p
BC214	18p
BC237	16p
BC327	16p
BC337	16p
BC338	16p
BC461	40p
BC477/8	36p
BC516/7	50p
BC547B	20p
BC548C	18p
BC549C	16p
BC557B	18p
BC559C	24p
BCY70	30p
BCY71	36p
BD131	75p
BD132	80p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	40p
BF256B	50p
BF257/8	40p
BF337	36p
BFR39	32p
BFR40	32p
BFR79	32p
BFR80	32p
BFR96	180p
BFX29	45p
BFX30	45p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFX89	180p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	30p
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BU105	190p
BU108	250p
BU109	225p
BU126	150p
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BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ413	250p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	150p
MJE3055	120p
MPF102	40p
MPF103/4	40p
MPF105	40p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	30p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	40p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP55	180p
TIP120	75p
TIP121	75p
TIP122	80p
TIP125	75p
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ZTX752	70p
2N697	35p
2N698	45p
2N706A	36p
2N708	36p
2N918	45p
2N930	30p
2N1131/2	50p
2N1613	36p
2N1711	36p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	30p
2N2484	30p
2N2646	50p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	12p
2N3053	36p
2N3054	60p
2N3055	55p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	16p
2N3704/5	16p
2N3706/7	16p
2N3708	16p
2N3773	200p
2N3819	40p
2N3823	30p
2N3866	90p
2N3902	700p
2N3904	18p
2N3906	18p
2N4036	65p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	60p
2N5459	30p
2N5460	60p
2N5485	36p
2N5875	250p
2N5883	375p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1939	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	200p
3N140	200p
3N141	200p
3N201	200p
3N204	200p
40290	250p
40361/2	75p
40595	120p
40673	90p
40871/2	100p

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OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
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1N4005	6p
1N4006/7	7p
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1N5403/4	14p
1N5404/5	14p
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2A 400V	45p
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3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

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8A500V	95p
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12A500V	105p
16A400V	220p
16A500V	130p
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TIC206D	60p
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TIC246D	110p

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8A600V	180p
12A400V	160p
16A100V	180p
16A400V	180p
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CIRCLE 59 FOR FURTHER DETAILS.

See-through computers

Our future is quite obviously going to be computer-shaped. Those of us who are not comfortable with computers will clearly be at a considerable disadvantage in the day-to-day business of living: not only engineers and workers in much of industry will need an easy familiarity with computers, but those of us whose involvement is only tenuous also need to cultivate some kind of *entente* with them.

But, relatively speaking, personal computers are in their infancy and are unlikely to remain for long in their present form. In a few years — it would take a reckless man to specify how many — writing Basic programs on a qwerty keyboard will, one hopes, be a thing of the past, like the quill pen. Computers will be unnoticed aids to life, as is the telephone.

With that in mind, it does seem that the style of introduction of computers into schools has been somewhat ill-considered. Computing ought not, surely, to be a subject in isolation from the rest of education. Computing is a nonsense unless it is seen in relation to the other facets of a full education. Admittedly, until computers are made "user-friendly" to an as yet unseen extent, or a pupil is intent on pursuing a career in the computer field, the fundamentals have to be learned. But they should not get in the way of the studies, displacing and obscuring them and causing the purely mechanical business of operating the machine to be the object.

A number of schools do regard the computer as a means, rather than the end. One teacher who is in charge of computing in his school says "I'd rather not have that particular job. Until computers are about as obtrusive and obstructive as a blackboard, they're nothing but a damn nuisance". One hesitates to cite McLuhan yet again as a source, but his remark about media and messages is certainly on target in this context.

It may be that one is unduly pessimistic. Perhaps some pupils can adapt to the use of computers and will accommodate developing types of machine as they occur with no more thought than they apply to the use of a new ball-point, but indications are that a great number become either mesmerized or bogged down when faced with a keyboard and v.d.u.

In the early stages of education, perhaps it would be more effective to present computed results as a *fait accompli*, the computing having been done by a teacher — the computer then becomes an aid to teaching rather than learning. Pupils' interest in the classroom computer could then be allowed to evolve naturally and become a consuming passion, without having been a barrier to the learning of mathematics,chemistry or geography.

It is inevitable that computers will eventually play their proper role and be 'transparent' to teacher and taught, and the quicker that state of affairs comes about, the better.

DOMESDAY DISCS

To celebrate the 900th anniversary of the Domesday Book, The BBC are to compile a new book which will be published on interactive videodisc. Two LaserVision discs will contain the equivalent of two million pages of facts, figures, text and maps as well as some 85 000 photographs. This is claimed to be he equivalent of two full sets of the *Encyclopaedia Britannica*.

The £2.5M project is being financed by BBC Enterprises, the DTI and Philips Electronics who will be working with the BBC to produce a new player, able to cope with the discs which will be marketed under the BBC name.

The information is to be collected by channeling all text and pictures from every community in the country through a local volunteer school. An editorial board of experts will also guide the selection of data from national sources. There is to be a national photographic competition to allow anyone to submit pictures.

The project was the idea of BBC producer Peter Armstrong, who is planning a series of tv programmes to celebrate the ninth centenary of the Book. He decided that a modern equivalent was needed for comparison and that the latest technology should be used. Out of this came the idea of a "peoples' database", where the local communities would be able to build their own portrait of life in their areas. The 10 000 schools will enter the information on their computers and store it on floppy discs which will be sent to the BBC. There will be plenty of facts and figures but it was thought to be important that there was also freely written text to give more feeling to the project. The local information will be supplemented by data from national sources, Ordnance Survey maps, graphics and collections of photographs on various general topics.

Peter Armstrong commented on the choice of videodisc as a medium: "As an alternative to tape or cassette recorders, the videodisc has not caught on because you can't record on the disc. However, in its interactive form it offers a more exciting prospect.

"I believe that interactive video is an important aspect of the BBC's future and that in the 1990s people will want to interact with their tv screens. If the BBC is to remain true to its Charter obligation to educate and inform then it must pioneer these new forms of technology."

The discs, and players, are to be ready by Michaelmas (September 29th) 1986, the anniversary of the completion of the original Domesday Book.

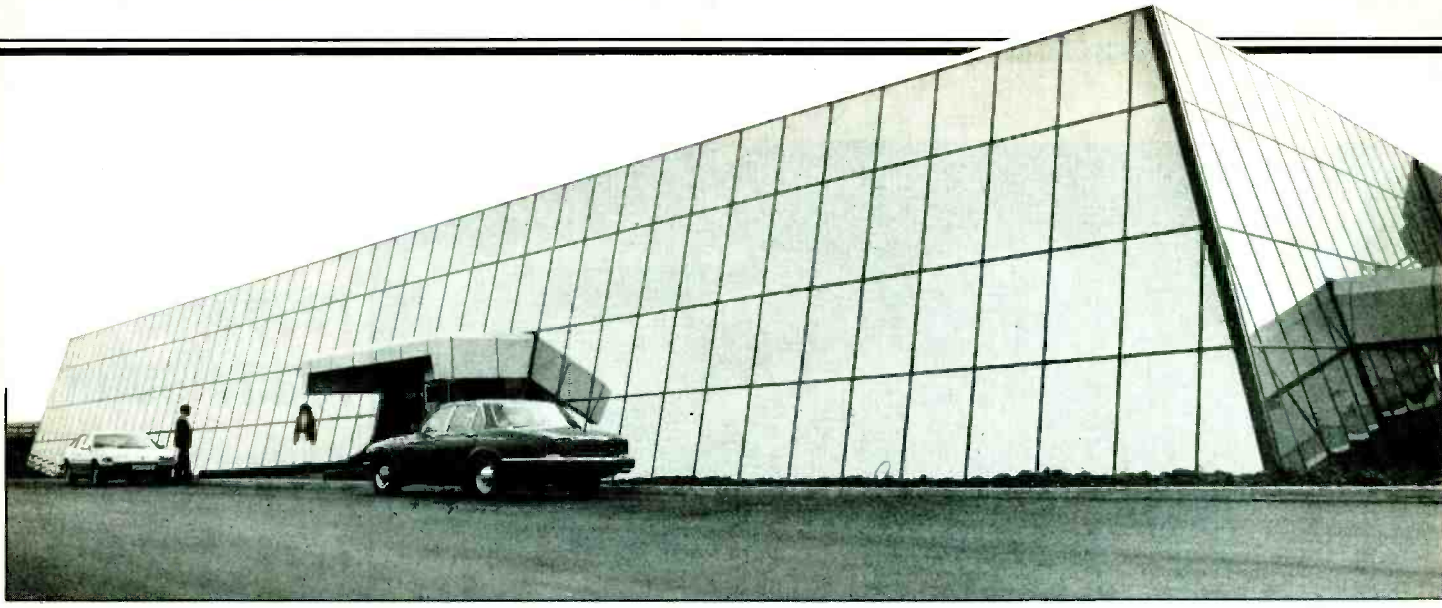
•At Compec, Acorn were demonstration their interactive videodisc system which also uses the Philips LaserVision discs. Such systems use a constant angular velocity to the disc to allow the laser pick-up to access the information at random under computer control. For sequential showing of a continuous programme the system uses a constant linear velocity so that the disc spins faster when pick-up is nearer the centre. The programme on display at Compec was about railways and with text and moving pictures demonstrated how a token interchange system was used on a single track railway. Questions to the pupil were answered through the computer keyboard.

Satellite link for famine convoy

A communications link to the Sahel 84 convoy was provided by Inmarsat. The convoy, consisting of 26 trucks and support vehicles travelled 5 000km through north-west Africa from Nouadhibou, Mauritania to Agades, Niger, visiting areas of drought and famine-stricken populations.

The mission was organized by French and Luxembourg tv networks, supported by the French and International Red Cross, Unicef and other aid organizations. Protein tablets, medical supplies and other emergency aid was distributed. As there were no communications links in the areas crossed and because of the humanitarian nature of the mission, Inmarsat provided access to their Marecs A satellite, designed for shipping communications in the Atlantic.

As well as transmitting the day-to-day arrangements and logistics for the convoy, the satellite link was used for news reports by journalists.



This extension to the Allen Clarke Research Centre at Caswell will house Plessey's microelectronics research laboratory. It will be used to extend the company's research in silicon integrated circuits towards the sub-micron architecture and in computer-aided design for v.l.s.i.

Some news from Sweden

The Swedish government is to invest 40% of the £4.5M needed to develop gallium arsenide semiconductor integrated circuits. The research is the responsibility of Rifa, an Ericsson company who have already produced GaAs transistors and diodes and believe there is a great future in the four-times-faster-than-silicon chips. Ericsson-Rifa will be supplying the rest of the funds.

Protection of information

The Swedes have a 'personnummer', similar to the British National Health number or Driving Licence number which is based on the owner's date of birth. The number is required in indentification for almost any transaction; cashing a cheque, borrowing library books, medical treatment or even enrolling as a student or club member. As many of these processes are increasingly computerized, there has grown increasingly unease on the possibility of invasion of privacy. A parliamentary committee has been set up to investigate the conflict between public access to information and the need for national security of public records.

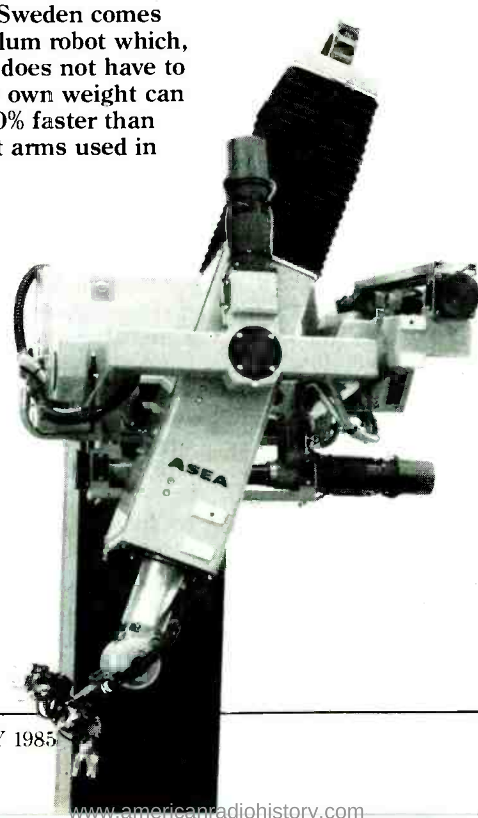
Computerized football pools

Esselte Security systems in Stockholm has developed a micro-controlled system for checking and handling football pools and lottery coupons. Coupons may be read into the system from remote terminals. The total bets and number of coupons are calculated and the system can calculate immediately the total amounts due to winners and commissions to agents etc. Electronic transfer of cash will provide 'instant prizes'. Sweden has a daily numbers game as well as weekly and bi-weekly pools which can be dealt with by the new system. Its modular design allows it to be adapted for any other game or betting system that may arise.

Talking document reader

A multi-language system has been developed by Infovox in Danderyd, Sweden, which can read computer texts and automatically convert them into speech; synthesized, but natural sounding, they claim. The language may be selected from English, French, Spanish, Italian, German and Swedish and plain or phonetic text can be entered directly. The rate of delivery of speech may be controlled and also the pitch. The hardware includes two serial interfaces with buffers, a control program independent of any language, a language-specific program, a user lexicon with battery back-up, synthesizer circuits, amplifiers and loudspeakers and a real-time clock. There is a large pronunciation dictionary and further words, abbreviations or irregular words can be programmed in by the user. The system may also be used for reading telex messages and proof reading. In telecommunications it can form an information service between telex, teletex, videotex and other electronic message services. It may also be used to provide spoken commentary to computer-aided learning and for training in speech, reading and writing. It can provide a voice to those unable to speak and can read texts or provide a talking computer to the visually handicapped.

Also from Sweden comes this pendulum robot which, because it does not have to support its own weight can be up to 50% faster than other robot arms used in assembly.



Nordic DBS chooses C-MAC

The Nordic Council of Ministers (Finland, Iceland, Norway and Sweden) have decided to go ahead with a direct broadcasting by satellite tv and radio service using the C-MAC/Packet system, developed in the UK by the IBA. Broadcasting will start in 1987 using an experimental satellite, Tele-X. The initial phase will be for two or three satellite channels each of which will accomodate a tv picture, tv stereo sound, commentator channels and two radio channels in stereo. At the same time, a committee of representatives from the four countries have recommended a system with two Nordsat satellites relaying and four tv channels to be launched in 1989 and fully operational in 1990. The C-MAC system has been selected for use by the EBU, but only the UK and now the Nordic states have officially adopted it.

TV by telephone

A system for transmitting slow-scan tv pictures over the telephone has received approval for connection to the BT telephone network. The Philips Slow Rate Transmission (SRT) system is thus the first to offer long-range remote video transmissions for security, surveillance and many other applications. The system features auto-dial, auto answer and line-status monitoring and overcomes the drawback of previous systems when the line connection drops out after three minutes. In a typical application, an alarm triggers the system which will then dial the remote control centre and transmit digitized pictures. This can, of course prevent the mobilization of security procedures in the case of false alarm. Alternatively the system may be dialled by a controller, calling up pictures from the camera on site. There are facilities for dividing the monitor screen into four and viewing complete pictures from four different cameras.

Interim approvals for telecom equipment

Prompted, no doubt, by the ever-increasing back-log of apparatus waiting to be approved by the BABT, the DTI has announced that an interim approvals scheme has been adopted. Those wishing to take advantage of the scheme must still apply for approval in the normal manner. At the same time they may indicate that they also wish to apply for interim approval. Apparatus will then given the essential safety tests and, if the complexity warrants it, limited field trials. The manufacturing facilities will need to be inspected for safety aspects unless the maker is already producing approved equipment. Then the applicant must sign a declaration that the apparatus will conform to all the necessary standards. Having been granted interim approval, the supplier will be allowed to release a limited quantity of the equipment on to the market and further batches may be released as the full approval testing is proceeding. If, however, any of the subsequent test indicate a failure all the supplied apparatus will need to be modified, free of charge to the user. The interim scheme will cost about £520 in addition to the existing approval charges.

Eprom programmer listings

Readers requesting the eprom programmer list have received copies of the SC84 character-generator instead. Those who sent us their names and addresses on a separate slip will receive the correct listing as soon as we have it; would other readers please write to us again?

B.T.G.– link between research and manufacture

Following on from the demise of the National Enterprise Board, which is being stripped of all its assets, the BTG has outlined its future role; to act as a broker between public-sector and academic research and the commercial exploitation of the technologies developed. To achieve this they will offer to take responsibility for patenting or otherwise protecting advances in technology from the public sector sources and provide finance for the development of the technology to the point where it may be taken up by industry. They will also provide a licencing scheme for the transfer of that technology to commercial industry and offer project finance to help licencees launch their products on the market. They will take a share of the licence fees which will be the BTG's source of income for future investment. Their traditional role of financing new developements in industry and the launching of new companies, especially in the areas of new technology, will continue but on a strictly commercial basis so that the BTG will be, as it has been hitherto, self-financing and profit making.

In order to fulfil its aims, the BTG plans to invest some £15M a year. The role of technology transfer will be augmented by supporting university contract research and development or consultancy work. 'Campus Investments' will specialise in providing finance for academic spin-off and start-up companies. With this in mind, a second Academic Enterprise Competition has been set up for academic researchers who are involved in setting up companies to exploit their research results. 42 Universities have agreed that the leaders of BTG-funded research will be designated BTG Research Fellows. All this will be backed up by a computer database of current research and companies seeking solutions to technological problems in the hope that some of these will find mutual agreement.

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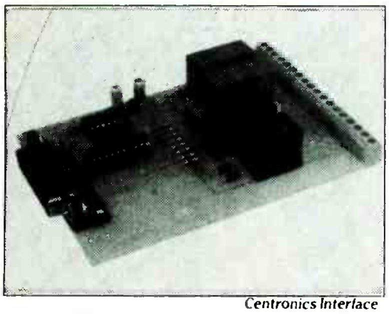

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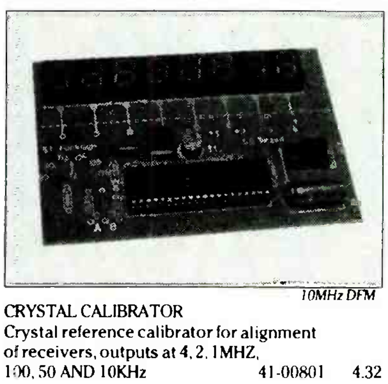

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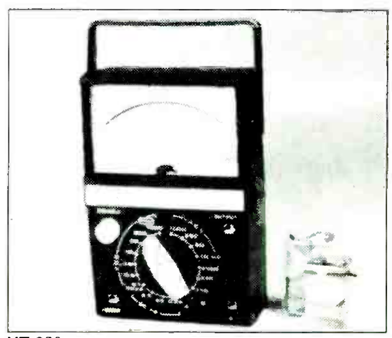

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TBA530Q	1.10
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AC176K	0.31
AC187	0.25
AC187K	0.28
AC188	0.25
AC188K	0.37
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BC108A	0.11
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BC109	0.10
BC109B	0.12
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BC114	0.11
BC116A	0.15
BC117	0.19
BC119	0.24
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BC143	0.24
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BC148A	0.09
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BC149	0.09
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BC159	0.09
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BC171A	0.10
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BC172	0.10
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BC184LB	0.09
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BC208B	0.13
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BC213L	0.09
BC214	0.09
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BC214L	0.09
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BC251A	0.12
BC252A	0.15
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BC301	0.30
BC303	0.26
BC307B	0.09
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BC328	0.10
BC337	0.10
BC338	0.09
BC347A	0.13
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BC547	0.10
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BC557	0.08
BC557B	0.08
BC558	0.10
BCY33A	1.60
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BD116	0.60
BD124P	0.59
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BD707	0.90
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BF119	0.65
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BF173	0.22
BF177	0.38
BF178	0.26
BF179	0.34
BF180	0.29
BF181	0.29
BF182	0.29
BF183	0.29
BF184	0.28
BF185	0.28
BF194	0.11
BF195	0.11
BF196	0.11
BF197	0.11
BF198	0.16
BF199	0.14
BF200	0.40
BF241	0.15
BF245	0.30
BF259	0.28
BF257	0.28
BF258	0.28
BF259	0.28
BF271	0.26
BF273	0.18
BF336	0.34
BF337	0.29
BF338	0.32
BF355	0.37
BF362	0.38
BF363	0.65
BF371	0.25
BF394	0.19
BF422	0.32
BF457	0.32
BF458	0.36
BF459	0.36
BF467	0.68
BF595	0.23
BF597	0.25
BFR39	0.23
BFR40	0.23
BFR41	0.28
BFR81	0.25
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BFR90	1.50
BFR91	1.75
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BFT43	0.35
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BFX29	0.30
BFX84	0.26
BFX85	0.32
BFX86	0.30
BFX88	0.25
BFY50	0.21
BFY51	0.21
BFY52	0.25
BFY90	0.77
BLY48	1.75
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SKE5F	1.45
TIP29	0.40
TIP29C	0.42
TIP30C	0.43
TIP31C	0.55
TIP32C	0.42
TIP33B	0.95
TIP34B	0.95
TIP41A	0.45
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TIP47	0.65
TIP120	0.60
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2N3703	0.12
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2SC2028	1.15
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2SC2078	1.45
2SC2091	0.85
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2SC2166	1.95
2SC2314	0.80
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2SD234	0.50
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BA145	0.16
BA148	0.17
BA154	0.06
BA156	0.15
BA157	0.30
BAX13	0.04
BAX16	0.06
BB105B	0.30
BT151	0.79
BY126	0.10
BY127	0.11
BY133	0.15
BY164	0.45
BY176	1.20
BY179	0.63
BT182	0.55
BY184	0.35
BY199	0.40
BY206	0.14
BY208-800	0.33
BY210-800	0.33
BY223	0.90
BY298-400	0.22
BY299-800	0.22
BYX10	0.20
BYX36-150R	0.20
BYX38-600R	0.60
BYX55-600	0.30
BYX71-600	1.10
BZY95C30	0.35
CS4B	4.50
CS10B	8.45
OA47	0.09
OA90	0.05
OA91	0.06
OA95	0.06
OA202	0.10
IN21DR	5.00
IN23B	5.00
IN23C	5.00
IN23ER	5.00
IN23WE	5.00
IN4001	0.04
IN4003	0.04
IN4004	0.05
IN4005	0.05
IN4007	0.06
IN4148	0.02
IN4448	0.10
IN5401	0.12
IN5402	0.14
IN5403	0.12
IN5406	0.13
IN5407	0.16
IN5408	0.16
ITT44	0.04
ITT923	0.15
ITT2002	0.10

ZENER DIODES

BZX61 Series	0.15
BZY88 Series	0.10

LINE OUTPUT TRANSFORMERS

DECCA 100	7.95
DECCA 1700 MONO	9.95
DECCA 1730	8.95
DECCA 2230	8.25
GEC 2040	8.95
GRUNDIG 1500	15.45
GRUNDIG 5010-6010, 2222.5011-6011	13.45
ITT CVC20	8.20
ITT CVC30	8.25
PHILIPS G8	8.50
PHILIPS G9	8.99
PHILIPS G11	13.39
PYE 725	10.95
RBM T20A	12.40
TANDBERGE 90°	11.15
TELEFUNKEN 711A	11.15
THORN 1590	9.50
THORN 8000	9.20
THORN 9000	9.95
THORN 9800	22.40
THORN MAIN TRANSFORMER 3000/3500	9.70

NEW BRANDED CATHODE RAY TUBES

A1865/20	65.00
AW36.11	25.00
CME822W	19.00
CME822GH	25.00
CME1428GH	45.00
CME1428W	39.00
CME1523GA	39.00
CME1523W	39.00
CME1431GH	39.00
CME1431W	39.00
CME202GH	45.00
CME2024W	45.00
CME2325W	45.00
CME3126GH	45.00
CME3128GH	45.00
CME3128W	45.00
CME3132GH	45.00
CME3155W	45.00
CRE1400	25.00
CV429	89.00
CV1450	35.00
CV1526	19.00
CV2185	15.00
CV2191	19.00
CV2193	15.00
CV2328	65.00
CV5119	85.00
CV5320	85.00
CVX389	55.00
D9-110GH	39.50
D9-120	45.00
D10-210GH	45.00
D10-210GH68B	65.00
D10-210GH72	65.00
D10-230GH	35.00
D10-230GM	35.00
D10-293GY/90	55.00
D13-27GH	49.50
D13-30GH	49.50
D13-33GM	49.00
D13-47GH/26	55.00
D13-47GH/34	55.00
D13-51GL/26	85.00
D13-51GM/26	85.00
D13-450GH/01	55.00
D13-471GH/26	55.00
D13-550GH	65.00
D13-600GM	59.00
D13-610GH	59.00
D13-610GM	59.00
D13-611GH	59.00
D13-611GM	59.00
D13-630GH	59.00
D14-120GH08	65.00
D14-150GH	75.00
D14-150GM	75.00
D14-172GH/84	59.00
D14-172GR	55.00
D14-172GV	55.00
D14-173GH	55.00
D14-173GM	53.00
D14-173GR	55.00
D14-181GH/62	65.00
D14-181GH/98	65.00
D14-181GJ	55.00
D14-181GM	53.00
D14-181GM50	59.00
D14-182GH	59.00
D14-182GM/98	65.00
D14-200BE	89.00
D14-200GA/50	85.00
D14-200GM	75.00
D14-210GH	75.00
D14-270GH/50	75.00
D14-310W	110.00
D14-320GH	85.00
D14-320GH/82	85.00
D14-340GH/KM	45.00
D14-340KA	45.00
D16-100GH	65.00
D16-100GH/65	69.00
D16-100GH/67	65.00
D16-100GH67A	75.00
D16-100GH/79	69.00
D16-100GH/79A	75.00
D16-100GH97	65.00
D18-130GH	65.00
D18-160GH	69.00
D21-10GH	65.00
D21-10GJ	69.00
D21-10LD	69.00
DG7-5	55.00
DB7.6	35.00
DB7-36	55.00
DG7.32	45.00
DG13.2	45.00
DH3-91	55.00
DH7.91	45.00
DP7.5	35.00
DP7.6	35.00
DN13.78	35.00
F15.101LC	49.00
F16-101GM	55.00
F16-101LD	55.00
F21-130GR	55.00
F21-130LC	55.00
F21-131GR	79.00
F31-10GM	65.00
F31-10GR	65.00
F31-10LC	65.00
F31.10LD	65.00
F31-12LC	65.00
F31-12LD	65.00
F31-13GR	65.00
F31.13LD	65.00
F31-13LG	65.00
F41-123LC	160.00
F41-141LG	160.00
F41-142LC	185.00
M7-120W	19.00
M14-100GM	45.00
M14-100KA	55.00
M14-100LC	45.00
M17-151GVR	175.00
M17-151GR	175.00
M19-100GY	55.00
M19-100W	45.00
M19-101GR	55.00
M19-103W	55.00
M23-110GH	55.00
M23-111W	55.00
M23-111GH	55.00
M23-111LD	55.00
M23-112GM	55.00
M23-112GV	55.00
M23-112GW	55.00
M23-112KA	55.00
M23-112LD	55.00
M23-112W	55.00
M24-120GM	59.00
M24-120GR	59.00
M24-120LC	59.00
M24-120WAR	59.00
M24-121GH	55.00
M24-121LC	59.00
M24-121WA	59.00
M28-11LA	49.00
M28-12GH	55.00
M28-12LC	55.00
M28-13LC	49.00
M28-13LG	49.00
M28-13GR	49.00
M28-13WA	49.00
M28-131GR	55.00
M28-132GM	55.00
M28-133GH	55.00
M31-100GH	55.00
M31-101GH	55.00
M31-182GR	55.00
M31-182GV	53.00
M31-183W	55.00
M31-184W	65.00
M31-184GH	65.00
M31-184P31	65.00
M31-185GH/VR	69.00
M31-186W	69.00
M31-190GH	55.00
M31-190GR	55.00
M31-190LA	55.00
M31-190W	59.00
M31-191GH	59.00
M31-191GR	59.00
M31-191GV	55.00
M31-191W	59.00
M31-192W	59.00
M31-195GH	59.00
M31-210GH	59.00
M31-220W	59.00
M31-270GY	65.00
M31-271P31	65.00
M31-271GW	65.00
M31-271W	65.00
M36-12W	75.00
M36-141LA	75.00
M36-141LG	75.00
M36-141W	75.00
M36-170LG	75.00
M38-100GR	65.00
M38-101GH	65.00
M38-103GR	65.00
M38-113GH	65.00
M38-120W	65.00
M38-120WA	65.00
M38-121GR	65.00
M38-121GHR	65.00
M38-121LA	65.00
M38-121WA	65.00
M38-122GW	65.00
M38-140LA	65.00
M38-141LA	65.00
M38-142GR	65.00
M38-142LA	65.00
M38-340P31	65.00
M38-341GR	65.00
M38-341P31	65.00
M38-344P39	65.00
M40-120W	59.00
M43-12GM/01	65.00
M43-12LG/01	65.00
M44-120LC	65.00
M44-120GR	65.00
M47-25GR/22	65.00
M50-120GH	65.00
M50-120GR	65.00
M50-120GV	65.00
M50-120LC	65.00
M61-120LC	75.00
M61-120W	75.00
S6AB	45.00
SE4/D/P7	45.00
SE42BP31AL	55.00
SE42BP31	55.00
SE52AP31AL	55.00
SE5FP31	55.00
T937	65.00
T948N	65.00
T948H	65.00
V3191	59.00
V4150LC	55.00
V4254B	65.00
V4274GH	65.00
V4283W	65.00
V5002LD	65.00
V5004GR	59.00
V5004LD	59.00
V6001GH	65.00
V6006GH	65.00
V6007DP31	59.00
V6007GW	65.00
V6008GW	59.00
V6008W	65.00
V6034WA	59.00
V6048CLA	59.00
V6048F	65.00
V6048J	49.00
V6052GH	65.00
V6052GR	65.00
V6064BLA	65.00
V6064BP31	55.00
V6064CLA	55.00
V6069GH	55.00
V6070P31	49.00
V7016A	65.00
V7030	59.00
V7031GH	59.00
V7031/67A	59.00
V7035A	49.00
V7037GH	45.00
V8004GR	65.00
V8006GH	65.00
V8010A	65.00
2BP1	9.00
3BP1	13.50
4EP1	30.00
3WP1	18.50
3H/0BM	55.00
5BP1	9.00
5BHP1	30.00
5BHP1FF	30.00
5BHP31	30.00
5CP1	10.00
6EP7/S	39.00
13BP1	13.50
13BP4	17.50
17DWP4	25.00
32J/1085	69.00
88D/89B/89D/89L	15.00
1273	39.00
1564	39.00
1844	45.00
9442E1	80.00
95447GM	75.00
95449GM	75.00
7709631	78.50

ELECTRO-OPTICAL

95025	25.00
9558B	25.00
9677M	22.00
P4231BAM	19.00

WIREWOUND RESISTORS

4 Watt	5R6-10K	0.20
7 Watt	R47-22K	0.20
11 Watt	1R5-15K	0.25
17 Watt	1R-15K	0.30

VALVE AND CRT BASES

B5D	5.50	B13B	0.50
B7G	0.15	B14A	3.00
B7G SKTD	0.25	12PIN CRT	0.95
B8G	0.70	NUVISTOR	2.95
B8H	0.70	OCTAL	0.35
B9A	0.25	SK610	35.00
B9A SKT	0.40	UX5	1.75
B9G	0.75	UX7	1.75
B10B	0.20	CANS	0.30

EHT MULTIPLIERS

ITT CVC20	6.35
ITT CVC30	6.35
PHILIPS G8 550	6.96
RANK T20A	6.91
THORN 3000/3500	7.57
THORN 8500	5.80
THORN 9000	8.00
UNIVERSAL TRIPLER	5.45

REPLACEMENT ELECTROLYTIC CAPACITORS

DECCA 30 (400-400/350V)	2.85
DECCA 80/100 (400/350V)	2.99
DECCA 1700 (200-200-400-350V)	3.55
GEC 2110 (600/300V)	2.25
ITT CVC20 (200/400V)	1.80
PHILIPS G8 (600/300V)	2.25
PHILIPS G9 (2200/63V)	1.19
PHILIPS G11 (470/250V)	2.35

VARICAP TUNERS

ELC1043/05 MULLARD	8.65
ELC1043/06 MULLARD	8.65
U321	8.25
U322	8.25

POTENTIOMETERS

STANDARD VERTICAL POTS	0.12
MIN. VERTICAL POTS SANDARD	0.12
HORIZONTAL POTS	0.12
MIN. HORIZONTAL POTS	0.12
CONVERGENCE PRE-SETS	0.30
SLIDERS LOG	0.48
SLIDERS LINEAR	0.48

PUSH BUTTON UNITS

DECCA, ITT, CVC20 6WAY	7.95
ITT CVC5 7 WAY	10.19
PHILIPS G8 (550) 6 WAY	14.49

20MM QUICK BLOW FUSES

100MA	8p each
200MA — 5AMP	5p each

20MM ANTI SURGE FUSES

100MA — 800MA	15p each
1A — 5AMP	12p each

SPARES & AIDS

FOAM CLEANSER	0.79
FREEZE IT	0.82
SOLDA MOP	0.64
SWITCH CLEANER	0.79
WD40	1.25
PUSH PULL MAINS SWITCH (DECCA, GFC, RANK, THORN ETC.)	1.02
PYE IF GAIN MODULE	6.99
ANODE CAP (27kV)	0.69

PHONE 0474 813225 3 LINES

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SELECTRON HOUSE, WROTHAM ROAD MEOPHAM GREEN, MEOPHAM, KENT DAI3OQY

TELEX 966371 PM COMP

A SELECTION FROM OUR STOCK OF BRANDED VALVES

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A1834	7.50
A1998	11.50
A2087	11.50
A2134	14.95
A2293	6.50
A2599	37.50
A2792	27.50
A2900	11.50
A3042	24.00
A3283	24.00
AC/HL/DD	4.00
AC/THI	4.00
ACT22	59.75
AH221	39.00
AH238	39.00
AL60	6.00
AN1	14.00
ARP12	0.70
ARP34	1.25
ARP35	2.00
ATP4	2.50
AX50	5.50
AZ11	4.50
AZ31	2.50
BL63	2.00
BS450	67.00
BS810	55.00
BS814	55.00
CIK	19.00
C3JA	21.00
C6A	9.00
C1108	54.95
C112G	70.00
C1134	32.00
C1148A	115.00
C1149/1	130.00
C1150/1	135.00
C1534	32.00
CCA	2.60
CC3L	0.90
CL33	2.00
CV Nos Prices on request	
D63	1.20
DA41	22.50
DA42	17.50
DA90	4.50
DA100	125.00
DAF91	0.70
DAF96	0.65
DC70	1.75
DC90	1.20
DCX4-1000	12.00
DCX4-5000	25.00
DET16	28.50
DET18	28.50
DET23	35.00
DET24	39.00
DET25	22.00
DET29	32.00
DF91	0.70
DF92	0.60
DF96	0.65
DF97	1.00
DH63	1.20
DH77	0.90
DH79	0.56
DH149	2.00
DK91	0.90
DK92	1.20
DK96	2.50
DL35	2.50
DL63	1.00
DL70	2.50
DL73	2.50
DL91	1.50
DL92	0.95
DL93	1.10
DL94	2.50
DL96	2.50
DLS10	13.50
DLS16	10.00
DM70	1.95
DM160	2.75
DY51	1.50
DY86/87	0.65
DY802	0.72
E55L	42.00
E80F	18.50
E81L	12.00
E82CC	3.50
E83CC	3.50
E83F	5.50
E86C	9.50
E88C	7.95
E88CC	3.50
E90CC	7.95
E90F	7.95
E91H	4.50
E92CC	3.95
E99F	6.99
E130L	19.95
E180CC	6.50
E182CC	9.00
E180F	6.50
E186F	8.50
E188CC	7.50
E1T	15.00
E280F	19.50
E283CC	10.00
E288CC	13.50
E810F	18.50
E88CC Siemans Special	5.95
E1148	1.00
E1524	6.95
EA50	1.00
EA76	1.95
EA79	1.95
EABC80	0.70
EAC91	2.50
EAF42	1.20
EAF801	3.50
EB34	1.50
EB41	3.95
EB91	0.60
EBC33	2.50
EBC41	1.95

EBC81	1.50
EBC90	0.90
EBC91	0.90
EBF80	0.65
EBF83	0.65
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	2.50
EBL21	2.00
EC52	0.75
EC70	1.75
EC80	9.50
EC81	7.95
EC86	1.00
EC88	1.00
EC90	1.10
EC91	5.50
EC92	1.75
EC93	1.50
EC95	7.00
EC97	1.10
EC8010	12.00
ECC32	3.50
ECC33	3.50
ECC35	3.50
ECC81	1.15
ECC81 Special Quality	1.95
ECC82	0.55
ECC82 Philips	1.95
ECC83	0.65
ECC83 Brimar	1.35
ECC83 Philips	1.95
ECC84	0.50
ECC85	0.60
ECC86	2.75
ECC88	0.85
ECC91	2.00
ECC180	0.72
ECC189	0.78
ECC801S	3.50
ECC803S	3.50
ECC804	0.60
ECC2000	12.00
ECF80	1.15
ECF82	1.15
ECF86	1.70
ECF200	1.85
ECF202	1.85
ECF801	0.85
ECF804	6.00
ECF805	2.50
ECF806	10.25
ECH3	2.50
ECH4	3.00
ECH35	2.15
ECH42	1.00
ECH81	0.65
ECH83	0.78
ECH84	0.69
ECH2000	1.50
ECL80	0.60
ECL82	0.65
ECL83	2.50
ECL84	0.74
ECL85	0.69
ECL86	0.80
ECL805	0.69
EF37A	2.00
EF39	1.10
EF41	3.50
EF42	3.50
EF50	2.50
EF55	4.95
EF71	1.50
EF72	1.20
EF73	1.00
EF80	0.55
EF83	3.50
EF85	0.50
EF86	2.25
EF86 Special Quality	3.15
EF89	0.85
EF91	1.50
EF92	2.15
EF93	0.95
EF94	0.85
EF95	1.50
EF97	0.90
EF98	0.90
EF183	0.65
EF184	0.65
EF730	1.80
EF731	3.50
EF732	3.50
EF800	11.00
EF805S	13.50
EF806S	14.50
EF812	0.65
EFL200	1.50
EH90	0.72
EK90	0.72
EL32	0.95
EL33	4.00
EL34	2.25
EL34 Mullard/Philips	4.50
EL36	1.50
EL37	9.00
EL38	4.75
EL41	3.50
EL42	2.00
EL81	6.95
	5.95
EL84	0.75
EL85	4.50
EL86	0.85
EL90	1.50
EL91	6.00
EL95	0.70
EL153	12.15
EL183E	3.50
EL18P	3.50
EL360	6.75
EL500	1.40
EL504	1.40
EL509	5.25

EL519	6.95
EL802	3.65
EL821	8.50
EL822	12.95
EM1	9.00
EM4	9.00
EM80	0.70
EM81	0.70
EM84	1.65
EM85	3.95
EM87	2.50
EN10	8.00
EN32	13.50
EN91	1.10
EN92	4.50
ESU150	14.95
ESU872	25.00
EY51	0.80
EY81	2.35
EY83	1.50
EY84	5.95
EY86/87	0.50
EY88	0.55
EY91	5.50
EY500A	1.50
EY802	0.70
EZ35	0.75
EZ40	2.75
EZ41	2.75
EZ80	0.75
EZ81	0.75
EZ90	1.50
F6064	2.95
FW4/800	2.95
G55/1K	9.00
G180/2M	9.00
G232 Mullard	3.95
G240/2D	9.00
G400/1K	14.00
GC10B	17.50
GC10D	17.50
GC10/4B	17.50
GC10/4E	17.50
GC12/4B	17.50
GD86W	6.00
GDT120M	5.00
GE10	9.00
GN4	6.00
GN10	15.00
GR10G	4.00
GS10C	16.50
GS10H	12.00
GS12D	12.00
GT1C	14.00
GT1C S/S	13.00
GTE175M	8.00
GTR150W	1.00
GU20	35.00
GU50	17.50
GXU1	13.50
GXU3	24.00
GXU50SS	14.50
GY501	1.20
GY802	1.00
GZ30	1.00
GZ31	1.00
GZ32	1.00
GZ33	4.50
GZ34	2.15
GZ34 U L	3.95
GZ37	4.50
HAA91	1.00
HABC80	0.90
HBC90	0.75
HBC91	0.80
HF93	0.75
HF94	1.50
HK90	1.05
HL2K	3.50
HL23DD	4.00
HL41	3.50
HL42DD	3.50
HL90	0.70
HL92	1.50
HL133/DD	3.50
HR2	4.00
HY90	1.00
HVR2	3.00
JP9-7A	60.00
K3118	85.00
KR6/3	45.00
KT8C	7.00
KT33C	3.50
KT36	2.00
KT44	4.00
KT45	4.00
KT61	4.00
KT63	2.00
KT66 OSRAM	10.50
KT66 USA	6.90
KT66 GEC	14.95
KT77 Gold Lion	9.50
KT81	7.00
KT88 USA	9.00
KT88 Gold Lion	
KT67	9.00
KTW61	2.50
KTW62	2.50
KTW63	2.00
KTZ63	2.50
L63	1.50
L102/2K	6.95
L120/2K	12.00
LB7-20	95.00
LS9B	6.95
M502A	60.00
	85.00
M537A	60.00
M5143	155.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	5.50
M8099	5.00
M8100	5.50
M8136	7.00
M8137	5.50

M8161	6.50
M8162	5.50
M8163	5.50
M8190	4.50
M8195	6.50
M8196	5.50
M8204	5.50
M8223	4.50
M8224	2.00
M8225	3.50
ME1401	29.50
ME1402	29.50
ME1501	14.00
MH4	3.50
MHLD6	4.00
ML4	4.50
MS4B	5.50
MU14	1.50
MZI-100	125.00
N37	12.50
N78	9.85
OA2	0.85
OA2WA	1.50
OA3	2.50
OB2	0.85
OB2WA	1.25
OC2	2.50
OC3	1.50
OD3	1.70
OM4	1.00
OM5B	3.00
OM6	1.75
ORP43	2.50
ORP50	3.95
ORP93	12.00
P61	2.50
P41	2.50
PABC80	0.50
PC86	0.75
PC88	0.75
PC92	3.50
PC97	1.10
PC800	1.10
PC900	1.26
PCC84	0.40
PCC85	0.54
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.65
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	0.40
PCF200	1.80
PCF201	1.80
PCF800	0.40
PCF801	1.35
PCF802	0.60
PCF805	1.25
PCF806	1.00
PCF808	1.25
PCH200	1.50
PCL82	0.85
PCL83	2.50
PCL84	0.75
PCL85	0.80
PCL86	0.85
PCL800	0.80
PCL805	0.90
PD500	3.50
PD510	3.65
PE1-100	69.00
PEN25	2.00
PEN40DD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	0.95
PL21	2.50
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.78
PL88	1.00
PL95	1.75
PL302	1.00
PL345	12.50
PL500	1.10
PL504	1.15
PL508	1.75
PL509	4.85
PL519	4.95
PL802	5.95
PL802T	3.50
PL820	2.95
PL5557	29.50
PY32	0.60
PY33	0.50
PY81	0.70
PY82	0.70
PY83	0.70
PY88	0.65
PY500A	1.95
PY800	0.79
PY801	0.79
QB3-300	54.95
QE03-10	3.50
QE08-200	145.00
QF40	65.00
QP25	1.00
QQE03-12	6.50
QQE03-20	27.00
QQV02-6	19.50
QQV03-10	5.50
QQV03-10 Mullard	9.50
QQV03-20	25.00
QQV03-20B	32.00
QQV06-40A	27.50
QQV07-50	63.50
QQZ03-20	42.50
QQZ06-40A	45.25
QS75.20	1.50
QS75/40	3.00
QS92/10	5.00

QS95/10	4.85
QS108/45	4.00
QS150/15	6.95
QS150/30	1.15
QS150/45	7.00
QS1200	3.95
QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	2.00
QS1210	1.50
QS1211	1.50
QS1212	3.20
QS1213	5.00
QS1215	2.10
QS1218	5.00
QU37	9.50
QV03-12	4.95
QV05-25	1.75
QV06-20	29.50
QV08-100	145.00
QV2-250	45.00
QY3-125	49.50
QY4-250	65.00
QY4-400	71.95
R10	4.00
R16	12.00
R17	1.50
R18	2.50
R19	2.50
R20	1.20
R1169	55.00
RG1-125	4.95
RG1-240A	14.50
RG3-250A	3.50
RG3-1250A	35.00
RK2K25	62.50
RG4-1000	10.00
RK-20A	12.00
RL16	1.50
RPL16	12.00
RPY13	2.50
RPY43	2.50
RPY82	2.50
RR3-250	15.00
RR3-1250	35.00
RS613	45.00
RS685	54.95
RS688	52.15
S6F17	5.95
S6F33	28.95
S11E12	38.00
S30/2K	12.00
S104/1K	10.00
S109/1K	15.00
S130	5.95
S130P	5.95
SC1/800	5.00
SC1/1100	6.00
SC1/1200	5.00
SC1/1300	6.00
SC1/2000	9.00
SD6000M	45.00
SP2	1.50
SP41	5.00
SP42	3.00
SP4B	4.95
SS501	35.00
ST11	1.50
STV280/40	11.95
STV280/80	19.95
SU42	4.95
TB2.5/300	85.00
TB2-300	45.00
TB3/2000	3.95
TBL-2-300	275.00
TD1-100A	25.00
TD03-10F	35.00
TD3-12	4.00
TDD4	5.50
TP25	1.50
TSP4	7.00
TT11	1.50
TT15	34.95
TT21	45.00
TT22	45.00
TT100	57.00
TTR-31MR	65.00
TY2-125A	85.00
TY4-400	70.00
TY8--600W	365.00
TYS2/250	375.00
U18-20	2.75
U19	11.95
U24	2.00
U25	0.90
U26	0.90
U37	9.00
U41	6.95
U50	2.00
U82	3.00
U191	0.70
U192	1.00
U193	0.65
U251	1.00
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	2.95
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	2.50
UCH42	2.50
UCH81	0.65

UCL82	1.75
UF41	1.15
UF42	1.15
UF80	0.80
UF85	1.20
UF89	2.50
UL44	3.50
UL84	0.85
UU5	3.50
UU7	8.00
UU8	9.00
UY41	3.50
UY85	0.70
V235A/1K	250.00
V238A/1K	295.00
V240C/2K	225.00
V241C/1K	195.00
V2464A/2K	315.00
V339	3.50
V453	12.00
VLS631	10.95
VP4B	4.50
VP133	2.00
VR75/30	3.00
VR101	2.00
VR105/30	1.50
VR150/30	1.15
VT52	2.50
VU29	4.50
VU39	1.50
W21	4.50
W77	5.00
W729	1.00
W739	1.50
X24	1.00
X66/X65	4.95
X76M	1.95
XC24	1.50
XC25	0.50
XFW47	1.50
XFW50	1.50
XG2-6400	135.00
XG5-500	22.50
XL1-5V	1.50
XL628FT	7.50
XNP12	2.50
XR1-1600A	49.50
XR1-3200A	79.50
XR1-6400A	99.50
Y503	25.00
Y65	6.95
Y602	12.00
YD1100	75.00
YJ1060	265.00
YL1020	29.00
YL1070	130.00
YL1071	135.00
YL1290	65.00
Z77	1.20
Z302C	12.00
Z359	9.00
Z505S	15.00
Z520M	4.00
Z521M	8.00
Z700U	3.00
Z749	0.60
Z759	19.85
Z800U	3.00
Z803U	18.95
ZA1000	12.50
ZA1001	1.50
ZA1002	1.50
ZC1040	8.00
ZM1005	8.00
ZM1020	8.95
ZM1021	8.00
ZM1023	7.95
ZM1041	14.00
ZM1082	9.00
ZM1084	10.00
ZM1177	9.00
ZM1202	55.00
ZM1263	4.00
ZM1612	3.00
1A3	4.50
1AC6	1.20
1B3GT	1.95
1B22	10.00
1B24	14.95
1B35A	29.50
1BC2A	2.50
1C1	2.50
1C5GT	2.50
1D5	2.50
1FD1	2.50
1G3GT	2.50
1K3GT	2.50
1L4	0.60
1L6	1.50
1LA6	1.00
1N2	4.50
1N5GT	2.50
1P28	25.00
1S2	0.55
1S5	0.70
1T4	0.70
1U5	1.00
1X2B	1.40
1Z2	8.95
2B7	1.50
2B22	69.50
2C21	1.00
2C39A	23.50
2C39BA	39.50
2C40	37.00
2C42	29.50
2C51	0.75
2C53	32.00
2CY5	1.50
2D21	0.95
2D21W	2.50
2E26	7.95
2J42	93.00
2K25	24.95
2K25 Raytheon	75.00

2K26	95.00
3A/107B	12.00
3A/108A	9.00
3A/109B	11.00
3A/110B	12.00
3A/141K	11.50
3A/147J	7.50
3A/167M	10.00
3A2	3.95
3A3A	3.95
3A4	1.10
3AL5	0.95
3AT2	3.35
3B2	3.00
3B4	7.00
3B7	4.50
3B24	10.00
3B26	24.00
3B28	12.00
3BZ6	1.50
3C4	1.00
3C45	24.00
3CB6	1.50
3CN3A	2.50
3CS6	0.95
3CX3	2.50
3CY5	1.50
3D6	4.50
3D21A	29.50
3D22	19.50
3E22	49.50
3EH7	1.95
3EJ7	1.95
3W4GT	2.50
4B551B	115.00
4-65A	59.00
4687A	9.50
4-250A	65.00
4B32	35.00
4BQ7A	1.75
4BZ6	1.95
4C27	25.00
4C28	25.00
4CB6	1.95
4CX250B I.T.T.	37.50
4CX250B EIMAC	49.00
4CX250B tested ex equipment	9.50
4CX250BM EIMAC	75.00
4CX250K EIMAC	95.00
4CX125C EIMAC	125.00
4CX350A	71.50
4D26	75.00
4GS7	2.25
4GV7	2.25
4J52	75.00
4JC6A	2.95
4X150A	25.00
5A/102D	9.50
5A152M	9.00
5A163K	10.00
5A170K	6.25
5A-180M	9.00
5A-206K	10.00
5AMB	2.15
5ANB	1.20
5AR4	2.00
5AU4	1.50
5B8	2.50
5B.110M	10.00
5B-254M	14.50
5B-255M	19.50
5B-256M	9.00
5B-257M	9.00
5B-258M	14.50
5C22	89.50
5R4GB	2.80
5R4GY	2.80
5T4	5.95
5U4G	1.95
5U4GB	2.50
5V4G	1.25
5Y3GT	1.95
5Z4GT	0.85
6/30L2	0.70
6A/203K	9.00
6A7	4.95
6A8G	1.50
6AC7	2.00
6AF4A	2.50
6AF9	4.15
6AG5	1.50
6AG7	1.95
6AH6	2.50
6AJ4	2.00
6AJ7	2.00
6AK5	1.50
6AK6	2.50
6AL5	0.60
6AM4	3.25
6AM5	6.00
6AM6	1.50
6AN5	2.65
6AN8A	2.65
6AQ5	1.50
6AQ8	0.85

6AR8	3.95
6AS5	1.50
6AS6	2.50
6AS7G	4.50
6AT6	0.75
6AT8	1.75
6AU4	2.00
6AU6	0.95
6AV6	0.75
6AW8A	2.50
6B8G	1.50
6BA6	0.95
6BA7	4.50
6BA8A	3.50
6BC8	1.00
6BD4	1.50
6BD6	2.50
6BE6	0.72
6BF5	1.60
6BG6G	3.00
6BH6	1.95
6BH8	1.50
6BJ6	1.20
6BK4	4.00
6BK7A	1.95
6BM8	0.58
6BN4	1.65
6BN6	1.65
6BN7	4.50
6BN8	2.35
6BQ5	0.75
6BQ7A	0.72
6BL7GTA	3.95
6BL8	0.65
6BL8	1.15
6BR5	0.70
6BR7	4.95
6BR8	2.15
6BR8A	2.15
6BS7	5.50
6BW4	1.50
6BW6	5.35
6BW7	1.50
6BW8	4.00
6BX6	0.48
6BX7GT	3.50
6BZ6	2.50
6BZ7	2.95
6C4	1.10
6C5	1.95
6C6	2.50
6C8G	1.50
6C11	2.50
6C15	2.50
6C18	2.50
6CA4	0.60
6CA7	3.50
6CB5	3.95
6CB6	1.95
6CD6GA	4.50
6CF6	1.50
6CH6	6.95
6CL3	3.95
6CL6	3.25
6CL8A	2.00
6CM5	1.60
6CM7	2.95
6CS6	0.75
6CW4	6.50
6CY5	1.00
6DC6	2.35
6DK6	1.15
6DQ5	4.95
6DQ6B	2.50
6DW4	2.15
6EA4	4.95
6EA7	2.50
6EA8	2.50
6EB8	1.75
6EM5	2.50
6EM7	2.50
6EU7	1.95
6EU8	1.75
6EV7	2.95
6EW6	1.50
6EW7	4.50
6F1	2.00
6F5	4.95
6F6G	2.00
6F7	5.50
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
6F21	2.50
6F22	0.70
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F32	1.25
6F33	17.00
6FG5	1.95
6G6G	5.50
6GH8A	0.80
6GK5	1.50
6GK6	1.95
6GS7	2.15
6GV7	2.50
6GW6	2.50
6GW8	0.80
6H1	9.50
6H3N	1.10
6H6	1.35

6H6GT	1.95
6HS6	4.95
6J4	2.15
6J4WA	3.15
6J5	2.50
6J6	0.65
6JB6A	3.95
6JE6C	4.95
6JU8	2.50
6JS6C	4.95
6J7	4.15
6K7G	0.70
6K8	3.95
6KD6	5.50
6KM8	2.50
6KT8	2.95
6L1	2.50
6L15	3.15
6L19	3.95
6L6GC	2.95
6L6GC(GE)	3.95
6L6GT	1.50
6LD20	0.60
6LF6	4.50
6LJ8	2.50
6LQ6	4.95
6N7	2.50
6N7GT	2.50
6P15	1.50
6P25	4.00
6P26	4.00
6P28	2.00
6Q7	1.20
6Q7GT	1.20
6R7G	3.15
6S4A	1.50
6S7	1.10
6SA7GT	1.35
6SC7	1.50
6SG7	1.35
6SH7	1.35
6SJ7GT	1.20
6SK7	1.35
6SK7GT	1.35
6SL7GT	0.85
6SN7GT	1.35
6SQ7	1.35
6SS7	1.95
6U4GT	1.75
6U8	1.15
6U8A	1.50
6V6GT	1.15
6X2N	1.00
6X4	1.50
6X5GT	1.00
6X5GTY	1.00
6X8A	2.25
7A6	4.50
7A7	2.00
7AD7	1.75
7B7	2.50
7C6	2.50
7E7	2.50
7AU7	1.50
7J7	5.50
7Y4	2.50
8B8	2.50
8B10	2.50
8BQ5	1.95
8FQ7	1.95
10D2	1.25
10DE7	2.50
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E3	55.00
12A6	3.95
12AD6	1.50
12AG8	1.50
12AL5	1.00
12AT6	0.95
12AT7	1.15
12AT7WA	2.50
12AU6	1.50
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AY7	3.95
12AZ7A	1.95
12B4A	3.50
12BA6	1.50
12BE6	1.95
12BH7A	2.50
12BL6	1.75
12BY7A	2.75
12BZ6	4.95
12CA5	1.95
12CX6	1.20
12DQ6B	3.50
12DW4A	3.50
12DW7	2.50
12E1	17.95
12E14	28.00
12GN7	3.95
12HG7	4.50
12HG7A	4.50
12J7GT	3.50

12K5	1.00
12K7GT	0.60
12K8	1.10
12SA7GT	1.00
12SG7	4.75
12SH7	1.00
12SK7	1.00
12SJ7	0.60
12SN7GT	1.85
12SR7	1.50
12SQ7GT	1.50
13D3	3.20
13D7	3.20
13D9	3.20
13DE7	2.50
13DR7	2.95
13EM7	3.50
14S7	1.00
17DW4A	2.95
17EW8	0.95
17JZ8	4.50
18D3	1.60
19AU4GT	2.50
19G3	17.00
19H4	23.95
19H5	33.50
19Q6	9.00
20A2	10.50
20D1	0.70
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.95
20P5	1.15
21LU8	2.50
24B1	39.50
25L6GT	1.75
25BQ6	1.75
29C1	19.50
30C17	0.40
30C18	1.48
30F5	0.95
30FL1	1.00
30FL2	1.35
30FL12	0.95
30FL13	1.10
30FL14	1.25
30L1	0.45
30L15	0.60
30L17	0.60
30P4MR	1.00
30P12	1.00
30P18	0.60
30P19	1.00
30PL1	2.50
30PL13	0.60
30PL14	1.75
31JS6A	5.50
33A/158M	19.50
35A5	4.50
35L6GT	2.00
35W4	0.70
35Z3	1.85
38HE7	4.50
40KD6	5.50
42	6.95
47	6.00
50A5	1.50
50C5	0.95
50CD6G	1.15
50EH5	1.50
50JY6	2.95
52KU	2.00
53CG	15.00
61SPT	4.50
75B1	3.50
75C1	2.50
83	8.50
84	3.00
85A1	6.50
85A2	1.50
90AV	10.00
90C1	2.70
90CG	13.50
91AG	9.00
92AG	19.50
92AV	12.50
95A1	6.50
108C1	1.50
150B2	6.95
150C2	1.50
150C4	2.15
155UG	25.00
185BT	1.50
274A	15.00
307	5.00
328A	15.00
388A	17.50
425A5	8.00
431U	2.00
572B	35.00
705A	8.00
708A	8.00
715A	6.00
715C	45.00
725A	275.00
803	14.95
805	39.00
807	1.60
810	45.00
811A	12.95
813	18.50
813USA	45.00

829B	14.50
833A	60.00
866A	4.50
872A	27.50
873	60.00
884	5.50
930	9.95
931A	13.95
954	1.00
955	1.00
958A	1.00
1299A	0.60
1619	2.50
1625	3.00
1626	3.00
2050W	4.50
2050	3.95
3545	4.00
404A	10.95
927	15.00
1927	25.00
4313C	4.00
4328D	9.00
5642	9.50
5651	2.50
5654	1.95
5663	1.95
5670	3.25
5672	4.50
5687	4.50
5692	3.50
5696	2.75
5704	3.50
5718	6.15
5725	2.50
5726	1.50
5727	1.95
5749	2.50
5750	1.85
5751	2.95
5763	4.95
5814A	3.25
5829WA	6.50
5636	5.50
5678	7.50
5840	3.50
5842	11.00
5847	10.95
5879	8.50
5886	13.95
5894	39.50
5899	4.50
5963	1.75
5965	2.25
6005	1.85
6012	16.00
6021	3.65
6057	2.50
6058	3.95
6059	3.75
6060	2.25
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	4.75
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146B	7.95
6157	2.50
6158	3.20
6201	6.45
6205	6.95
6211	2.50
6267	2.25
6350	2.00
6360	4.50
6386	14.50
6545	8.50
6550A	9.00
6688	6.50
6870	11.50
6887	9.50
6883B	9.95
6973	5.95
7025	2.50
7027A	4.50
7032	2.00
7059	2.50
7167	3.95
7189	2.35
7193	7.50
7199	6.15
7233	7.95
7239	17.50
7247	2.95
7360	10.50
7462	15.00
7475	5.00
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7551	6.95
7558	9.45
7586	11.00
7587	26.95
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7609	47.00
7733	5.50
7788	18.50
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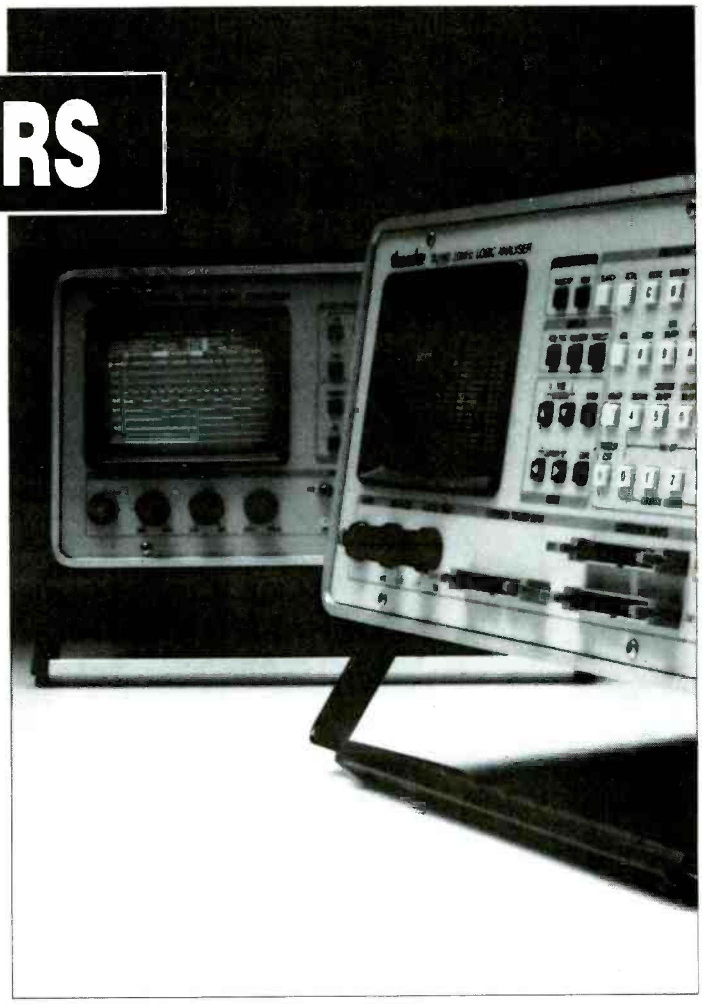
LOGIC ANALYSERS



TA2080
8 channels, 20MHz, timing and state. 252 byte data and reference memories. 23 bit triggering with trigger delay by events and/or clocks. Compare and search facilities. Composite video output. Microprocessor disassembly (Z80, 6800 and 6502) and RS232 option.

TA2160
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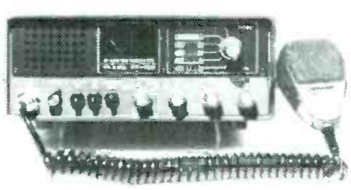
HF SSB TRANSCEIVER



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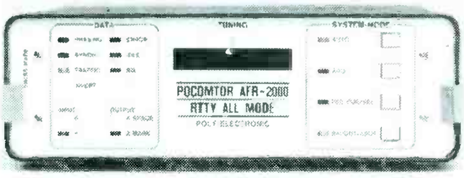

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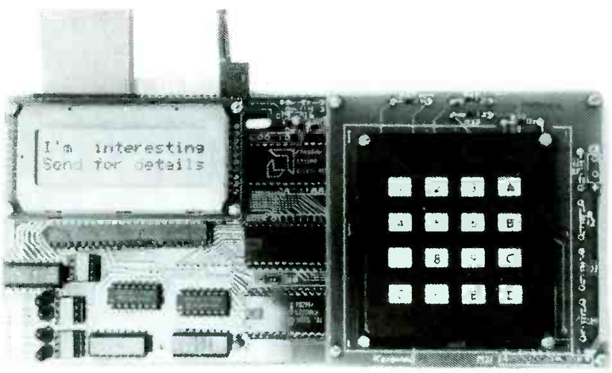

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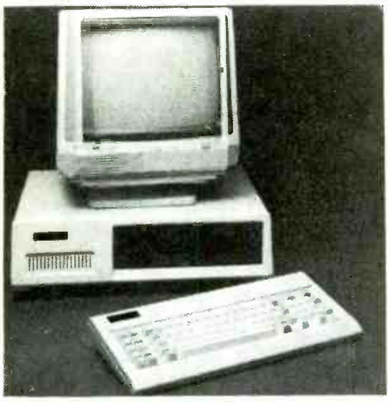

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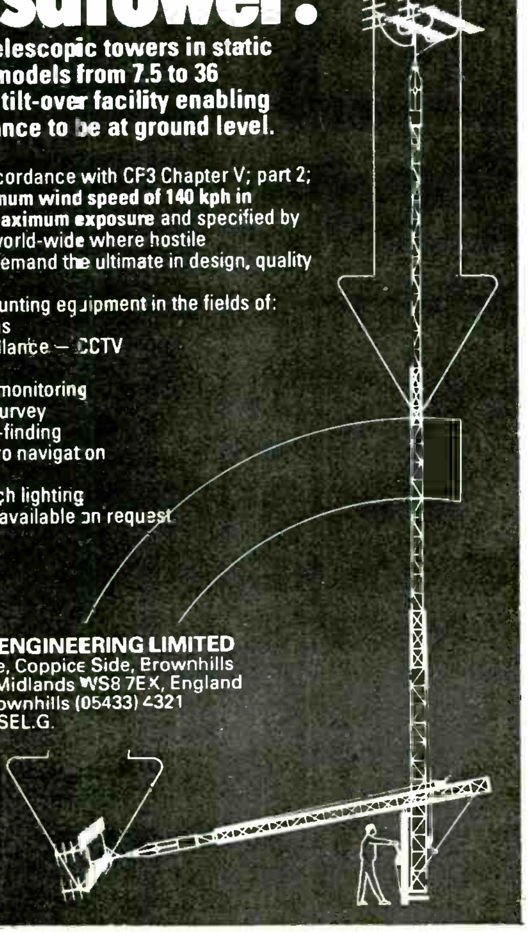

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AC127	0.15
AC128	0.15
AC128K	0.23
AC141K	0.23
AC142K	0.22
AC153K	0.23
AC176	0.18
AC176K	0.20
AC187	0.15
AC187K	0.20
AC180	0.17
AC188K	0.23
ACY18	0.48
ACY19	0.48
AD142	0.60
AD149	0.45
AD161	0.22
AD162	0.22
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.22
AF239	0.22
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BA148	0.10
BA154	0.06
BA157	0.12
BB101	0.13
BB103	0.16
BB105B	0.18
BB205B	0.24
BC107	0.07
BC108	0.07
BC109	0.07
BC115	0.10
BC118	0.11
BC140	0.19
BC141	0.19
BC142	0.19
BC143	0.19
BC147	0.05
BC148	0.05
BC149	0.05
BC157	0.05
BC159	0.05
BC182	0.06
BC182L	0.06
BC183	0.06
BC183L	0.06
BC184	0.06
BC184L	0.06
BC212	0.06
BC212L	0.06
BC213	0.06
BC213L	0.06
BC214	0.06
BC214L	0.06
BC237	0.07
BC238	0.07
BC300	0.16
BC301	0.18
BC302	0.18
BC303	0.18
BC327	0.06
BC382	0.06
BC337	0.06
BC328	0.06
BC557	0.06
BCY32	1.50
BCY33	1.50
BCY34	1.50
BCY42	0.20
BCY56	0.16

BCY70	0.16
BCY71	0.16
BCY72	0.16
BD115	0.26
BD124P	0.50
BD124	1.10
BD128	0.35
BD131	0.25
BD132	0.25
BD135	0.20
BD136	0.20
BD137	0.20
BD138	0.20
BD139	0.20
BD140	0.20
BD144	0.90
BD150	0.30
BD157	0.38
BD158	0.38
BD166	0.30
BD175	0.30
BD177	0.30
BD179	0.32
BD181	0.45
BD201	0.33
BD202	0.38
BD203	0.42
BD204	0.42
BD222	0.31
BD225	0.31
BD232	0.31
BD237	0.21
BD238	0.24
BD433	0.28
BD437	0.28
BD535	0.38
BD536	0.38
BD537	0.40
BD538	0.40
BDX32	1.00
BDX65	0.80
BF180	0.16
BF181	0.18
BF183	0.20
BF184	0.20
BF185	0.20
BF194	0.05
BF195	0.05
BF196	0.06
BF199	0.06
BF200	0.16
BF257	0.18
BF258	0.18
BF259	0.18
BF336	0.20
BF337	0.20
BF338	0.20
BF362	0.30
BF422	0.21
BF458	0.19
BF459	0.19
BFX29	0.20
BFX84	0.20
BFX85	0.20
BFX87	0.15
BFX88	0.15
BFY50	0.14
BFY51	0.14
BFY52	0.14
BFY56	0.25
BYF57	0.25
BFY64	0.25
BR100	0.14
BSX19	0.15
BSX20	0.15
BSX21	0.16
BSX26	0.16
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BT106	0.90
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BU126	0.70
BU204	0.75
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BU208	0.75
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BU326	0.85
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BU407	0.75
BU408	1.00
BU500	1.10
BU526	0.80
BY126	0.06
BY127	0.08
BY133	0.08
BY164	0.22
BY176	0.85
BY179	0.35
BY182	0.32
BY184	0.32
BY187	0.32
BY196	0.20
BY206	0.11
BY207	0.11
BY223	0.72
BYX10	0.15
CA270	0.40
CA3086	0.25
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CA3240	0.90
C106D	0.23
MC1327	0.70
MJ2500	1.00
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MJ2955	0.55
MJ3000	1.15
MJ3001	1.15
MJE29A	0.30
MJE30A	0.30
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MJE350	0.80
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OA47	0.06
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OA200	0.07
OA202	0.07
OC28	1.00
OC29	0.80
OC35	1.00
OC45	0.50
OC71	0.30
OC72	0.50
OC200	1.80
OCP71	1.00
ORP12	1.00
ORP60	1.00
ORP61	1.00
R2008B	0.80
R2010B	0.80
SAS560	1.10
SAS570	1.10
SN76003N	1.40
SN76013N	1.40
SN76023N	1.40
SN76033N	1.50
SN76110N	0.70
SN76115	0.70
SN76226	0.90
SN76227	0.80
T2800D	0.52
TAG06-60	0.42
TAG521-200	0.72
TAG4443	0.76
TAG4444	0.76
TAA550	0.16
TBA120S	0.45
TBA395	0.60
TBA396	0.60
TBA520	0.75

TBA530	0.75
TBA540	0.75
TBA560	0.70
TBA800	0.35
TBA810S	0.60
TBA820	0.75
TBA920	0.80
TBA950	0.80
TBA990	0.80
TCA800	0.80
TCA940	0.85
TDA1170	0.90
TDA1412	0.60
TDA2002	0.80
TDA2003	1.50
TDA2020	1.40
TDA2030	1.40
TDA2522	0.80
TDA2530	0.80
TDA2532	0.75
TDA2540	0.70
TDA2560	0.70
TDA2593	0.80
TDA2690	0.70
TIP29	0.15
TIP29A	0.22
TIP29C	0.25
TIP30	0.16
TIP31A	0.24
TIP32	0.24
TIP32A	0.24
TIP33	0.50
TIP34	0.50
TIP41A	0.22
TIP41C	0.25
TIP42A	0.22
TIP42C	0.25
TIP47	0.40
TIP48	0.40
TIP49	0.40
TIP110	0.47
TIP112	0.54
TIP115	0.45
TIP117	0.56
TIP120	0.43
TIP121	0.46
TIP122	0.47
TIP125	0.47
TIP126	0.56
TIP127	0.56
TIP2955	0.34
TIP3054	0.38
TIP3055	0.34
TIS61	0.15
TIS90	0.15
TIS91	0.18
2N 2904	0.20
2N 2905	0.20
2N 2906	0.18
2N 2907	0.18
2N 2926	0.08
2N 3019	0.28
2N 3063	0.18
2N 3054	0.35
2N 3055	0.32
2N 3055H	0.38
2N 3440	0.58
2N 3442	0.85

2N 3771	0.85
2N 3772	0.90
2N 3773	1.00
2N 4031	0.25
2N 4036	0.25
2N 4037	0.25
2N 4443	0.76
2N 4444	0.76
2N 5061	0.20
2N 5294	0.30
2N 5296	0.30
2N 6106	0.40
2N 6107	0.40
2N 6109	0.40
3N 128	0.55
3N 143	0.65
IN 914	0.02
IN 4001	0.04
IN 4002	0.04
IN 4003	0.04
IN 4004	0.04
IN 4005	0.04
IN 4006	0.04
IN 4007	0.06
IN 4148	0.02
IN 5400	0.09
IN 5401	0.10
IN 5402	0.10
IN 5403	0.11
IN 5404	0.11
IN 5405	0.12
IN 5406	0.13
IN 5407	0.13
IN 5408	0.13

VOLTAGE REGULATORS	
7803	0.35
7812	0.35
7815	0.35
7818	0.35
7824	0.35
7905	0.35
7912	0.40
7915	0.40
7918	0.40
7924	0.40
78L05	0.28
78L12	0.28
78L15	0.28
74L18	0.28
74L24	0.35
LM309K	1.00
LM317K	2.20
LM317T	1.80
LM323K	4.20
LM723	0.32
78HGKC	5.70
78H05KC	5.20
78GU1C	1.90
79GU1C	2.15
79HGKC	6.70

JAPANESE TRANSISTORS	
2SA73	0.30
2SA104	0.32
2SA198	0.22
2SA203	0.30
2SA473	0.37
2SB54	0.25
2SB77	0.32
2SB337	1.20
2SB405	0.22
2SC460	0.21
2SC495	0.60
2SC733	0.40
2SC1161	1.10
2SC1172Y	1.50
2SC1279	0.24
2SC1306	1.00
2SC1307	1.00
2SC1520	0.25
2SC1969	1.30
2SC2029	1.20
2SC2078	1.20
2SC2122A	2.00
2SC2952	0.27
2SD234	0.37
2SK135	4.00
MB3712	1.50
TA7205	1.50
UPC575	1.00

ICS SOCKETS	
8 pin	0.06
14 pin	0.08
16 pin	0.09
18 pin	0.12
20 pin	0.14
22 pin	0.16
24 pin	0.18
28 pin	0.20
40 pin	0.25

VALVES	
DY87	0.53
DY802	0.45
ECC82	0.40
ECC83	0.43
ECC83	0.40
ECC85	0.40
ECH81	0.49
ECH84	0.52
ECL80	0.57
ECL82	0.25
ECL84	0.57
ECL85	0.57
ECL86	0.49
EF80	0.31
EF85	0.34
EF89	0.43
EF183	0.45
EF184	0.53
EL34	1.90
EY86	0.31
EY87	0.31
PC97	1.00

PCC85	0.42
PCF80	0.58
PCF200	1.35
PCF801	1.10
PCF802	0.57
PCF806	1.15
PCH200	1.00
PCL81	0.54
PL519	4.50
PCL82	0.63
PCL84	0.50
PCL85	0.55
PCL86	0.55
PCL805	0.55
PFL200	0.85
PL36	0.80
PL504	0.95
PL508	1.90
PY81	0.70
PY88	0.48
PY500A	1.60

ZENERS
400MV
BZY88 Range
2V7 to 39V0 060
13W Zeners
BZX61 Range
2V7 to 39V0 120

MEMORIES	
2114	2.00
2716	3.00
2532	4.00
2732	4.00
2764	7.00
4116	0.75
6116	6.00
LM324	0.30
LM380	0.50
LM381	1.00
LM709 Dil	0.30
LM723	0.32
LM741 Dil	0.15
LM741 Met	0.45
LM3900	0.25
NE555	0.15
NE556	0.40
BYX55/350	0.30
BYX55/600	0.30
BYX55/600	0.30
BYX55/800	0.32
BYX70/500	0.29
BYX70/500	0.31
BYX70/800	0.36
BYX71/600	0.80

LED	
LED 3mm RED	0.05
LED 3mm YELLOW	0.10
LED 3mm GREEN	0.10
LED 5mm RED	0.05
LED 5mm YELLOW	0.10
LED 5mm GREEN	0.10

BRIDGE RECTIFIERS	
1A/50V	0.16
1A/100V	0.18
1A/200V	0.19
1A/400V	0.21
1A/600V	0.23
1A/800V	0.28
2A/100V	0.35
2A/200V	0.36
2A/400V	0.42
2A/600V	0.54
2A/800V	0.58
3A/200V	0.66
3A/400V	0.68
3A/600V	0.78
6A/200V	1.00
6A/400V	0.80
25A/100V	1.60

ELECTROLYTIC	
4700UF 16V CAN	0.20

TRIPLERS	
LP1195 (4000Ser)	2.25

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The Information Society—4

Overview of telecommunication techniques

If the telephone instrument itself generated digital output when spoken into, and the line, the exchange, and the remainder of the network could handle digital signals, then either the telephone or any other device generating a digital output could be used as the source — limited to some data rate according to the design of the systems. This, or something resembling it, is currently the objective of many major PTTs.

To convert the world's telephone/data system to an ISDN (integrated service digital network) is a mammoth task which has to be done without interrupting existing facilities. For example British Telecom is changing the UK system to an ISDN by overlaying[51, 52] and gradual substitution. Ultimately all subscribers will be able to use digital data or voice equipment from their home or business at up to 140 kbit/s (System X).

It turns out that the existing pair running from the telephone to the local exchange has a much higher bandwidth than the 2.5kHz that is used for telephone speech. Existing cables are quite capable of handling the higher speeds. Subscribers will be able to use equipment running at various bit rates up to the permitted maximum. the ISDN must be able to work at a range of speeds and pack the data into lines up to the limits of their capacity to minimise costs. This will entail modifications — hence the word 'overlay'. For example at exchanges, variable bit-rate switches will be required. Initially they will run in parallel with existing equipment. Eventually all subscribers will be provided with the new facilities and at that time the old equipment can be removed.

Packet switching

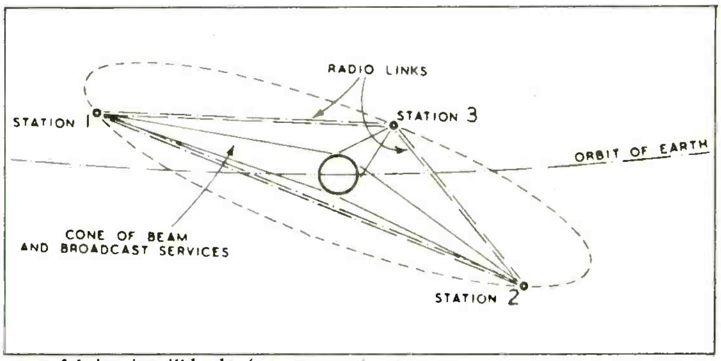
The essence of packet switching is the breaking up of messages into short packages, each containing the address of the destination, and then collecting up packets from numerous sources and sending them down a channel in a continuous stream as fast as the channel's bandwidth allows. At the remote end they are sorted out, all the packets being reformed into a complete message at each remote address. The benefit is maximized when there is sufficient traffic to fill expensive long distance channels — hence the widespread adoption of packet switching for public data networks.'

LANs and PABXs

Local area networks (lans) are intended primarily for the interconnection of office machines like word processors, printers, central files etc., within a single site[53]. Some networks, such as Ethernet and Cambridge Ring, use baseband transmission — that is digital data are transmitted as generated round a single-channel system with special measures to control collisions between inter-station messages. With broadband systems, mutual interference is avoided by using modulated carriers of different frequencies with bandpass filters for channel separation.

In more elaborate systems the bandwidth may be 'carved up' according to requirements — for example into a hundred dedicated channels for 1200 band terminals, an Ethernet channel, a television channel, channels for digitized voice etc. The major lan suppliers are listed in ref.53 together with much other information.

Methods for long distance transmission are different — packet switching for example — so, to interconnect lans at a distance from each other via national or international networks, protocol translation problems must be solved. One way of doing it will be by 'gateways' at interconnection points.



Part of A.C.Clarke's prophetic article.

When wideband cables and longer range lans become generally available, businesses, homes, and workers-at-home could be interconnected with online access to remote databases provided over the same cable[54]. In 1981 the Viacom San Francisco cable network and the Manhattan New York network were connected in an experiment conducted with SBS and Tymnet. The cable tv circuits were used as a local network for data distribution.

At present it is easier to connect local traffic to the outside world with a p.a.b.x. (private automatic branch exchange) which can also be used to connect any digital or analogue device to any other internally. These exchanges are well proven for reliability and ease of expansion, and could be connected to a lan in order to gateway at least the slower of the lan terminals to a public network[55].

Modems

A modem is a device used to enable data to be exchanged between digital devices interconnected by an analogue communication channel such as a telephone line. For example, two-level 0, 1 signals can be used to modulate two carriers of different frequencies within the voice band, with the remote modem demodulating, or vice versa.

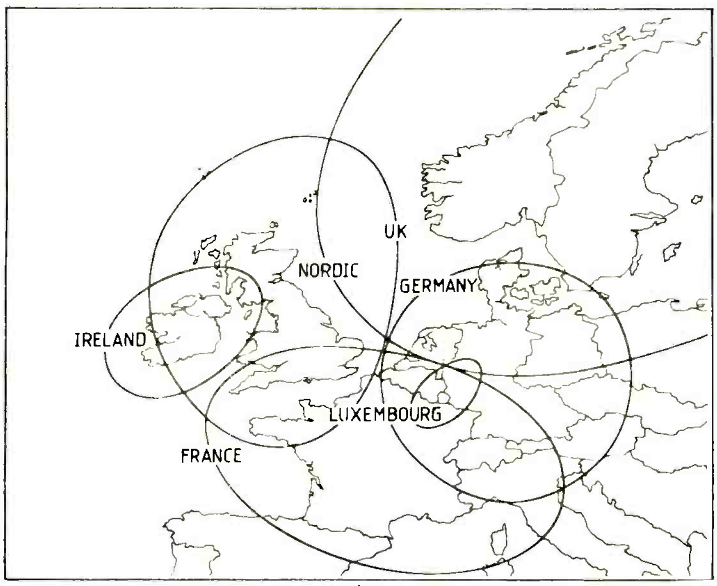


Fig.5.0 · **9m aerial DBS tv service areas.**

References
51. Hughes, C.J.
In Williams, M.B., (Ed). Pathways to the Information Society. Proc. 6th Int. Conf. on Computer Communication London, Sept. 7th 1982. Published by North-Holland 1982. Page 13.
The long term future of circuit and non-circuit switching in multi-service networks.
52. Hardy, J.H.M., Hoppitt. C.E. In Pathways (see ref.51) Page 43
53. Cheong, V.E., Hirschheim, R.A. John Wiley. 1983.
Local Area Networks: issues, products, and developments
54. Anon.
International Resource Development Inc. report 193, March 1982. Published by IRD, 30 High Street, Norwalk, Conn 06851, USA.
Local networks and home information systems: the cable connection.
55. Pitt, D.A.
In Williams, M.B. (Ed), (See Ref.51). Page 351.
Alternatives in the use of circuit switching for local-area data networks.
56. Anon.
EMMS 7(1), 7-9, January 3rd 1983. Published by EMMS, 30 High Street, Norwalk, CT 06851, USA.
The intelligent modem & PC communications.
57. Leaflet from D.C. Hayes Associates Inc., 5923 Peachtree Industrial Blvd., Norcross, GA 30092, USA. 1982. Micromodem 100.
58. Leaflet from Computer and Systems Engineering plc., (CASE) Caxton Way, Watford Business Park, Watford, Herts. WD1 8XH, England. 1983.
59. Kimura, Tatsuya, Yamamoto, Y. Optical and Quantum Electronics 15, 1-39, 1983
Review: progress of coherent optical fibre communication systems.
60. Hackett, William H. Saul, R.H., Shumate, P.W. Bell Laboratories Record, 5—9, March 1983. Optical links brighten office opportunities.
61. de Jonquieres, Guy. The Financial Times, Page 13, November 1st 1982. Mobile communications.
62. Smith, D.A.D. The Financial Times, February 11th 1983. Mobile telephone systems and future markets.
63. de Jonquieres, Guy. The Financial Times, February 22nd 1983. Mobile telephone systems and future markets.
64. Martin, James, Prentice-Hall Inc., 1978. Communications Satellite Systems.
65. Dusio, Emilio W., Murphy, Thomas P., Cashman, William F. Computer 16(4), 21-34, April 1983. Communications satellite software: a tutorial.
66. Courault, R., Smith, G.K. Microwave Journal 25(1), 83-90, January 1982. Technologies for the next European satellites.

A modem can be purchased in the US for $100, and an auto-dialling/auto answer modem for around $250[56]. Texas Instruments offer a modem chip for $30 to form the heart of simple plug-in modem-on-a-p.c.board. Devices like the Hayes Micromodem 100 have been available for some time[57], and comes on a board ready to plug into the S100 standard microcomputer socket within a machine, includes programmable auto-dialling and answering and may be directly connected to the telephone system.

The only auto-dialling modem known to me which is available from a UK manufacturer is supplied by Case[58] and costs £695. The simplest modem available costs around £200. The stranglehold exerted until recently by BT's modem monopoly has inhibited the growth of competitive manufacturers.

If transmission proceeds at one bit per baud and, as is normally the case, there are eight bits per character, the bit rate will be at least eight times the character rate. In fact it is usually about ten times for technical reasons so that 300 baud is 30 characters/s, and 1200 baud is 120ch/s. These are the speeds in most common use. At higher speeds special modulation techniques and several bits per baud are used in order to send information at a faster rate within the same bandwidth. 9600 baud modems are now available for use on the p.s.t.n., and these employ adaptive equalising — that is circuit elements in the modem are used to improve the effective characteristics of the line.

Optical communications

Fibre-optic communication is achieved by modulating a light source with electrical signals using a light-emitting diode (low power), or laser (higher power). the light is propagated along a fibre and detected at the other end by a photodiode which produces electrical voltages when light falls on it. With monomode fibres — the subject of intense development work — propagation is better explained in terms of waveguide mathematics. The core diameter is reduced to about 5μm and light with a wavelength of around 1.3 to 1.5μm is used. This dimensional/wavelength relationship permits the propagation of only one 'ray' or mode. Interference between rays is minimised, and dispersion in the material is also at a minimum at these wavelengths so that minimum attenuation occurs together with inherently high bandwidth[59].

British Telecom, Bell, and KDD research in Tokyo all claim very high bit rates over long distances without repeaters (amplifiers) using monomode optical fibres. Speeds of 200 or 300Mbit/s in 100km fibres are typical. These improvements have prompted the adoption of fibre optics for the next transatlantic cable — TAT-8 — operating at about 600Mbit/s. This is a classic example of the 'sailing ship' effect which occurred at the onset of steam propulsion when improved design enabled sail to hold out against steam for much longer than was expected. Cables are holding their own against those upstart satellites.

Over shorter distances fibre-optic cables may well be used for cable television networks, arranged 'star' fashion. They are physically much less cumbersome than coaxial cable, can be used without repeaters, are immune to interference, and will soon be cost-competitive. Thirty fibres, each carrying several tv channels, can be accommodated in an armoured polythene protected cable only 11mm in diameter.

For yet shorter distances — as in local area networks — fibreoptics are likely to be increasingly adopted and systems are now commercially available from Western Electric, Hewlett-Packard and others[60].

Cellular radio

People in cars may well be able to connect to the communications infrastructure. The range of Citizen's Band (CB) radio is only 5 to 15 miles depending on the effects of line-of-sight obstacles on the low power 27MHz radio waves. In the US, much more space is available — particularly in the newly allocated 900MHz band — but this is still not enough; wavebands available below about 1GHz are at a premium. In the UK the mobile business radio-telephone is not widely used — there are less than 4000 such telephones in the Greater London area, using BT's systems.

In a cellular radio system an area is divided into small cells, each with a low-power station, for handling telephone calls from mobiles — mainly cars — in its area. As the user moves out of range a central control system detects this, and the radio link is automatically transferred to the station handling users in the next cell. The beauty of the idea is that if the number of mobiles exceeds the number that each or any cell can handle, you simply decrease the size of the cell or cells, which is rather easily done.

Toward the end of 1982, the UK government decided to licence two competitive networks, one to be run by British Telecom/Securicor, the other to be decided[61]. In December 1982 the other was awarded to Racal/Hambros Bank/Millicom, who defeated a Ferranti-led consortium and Cable & Wireless/Telephone Rentals. Several technical alternatives were considered, particularly AMPS and MATS-E developed by Philips. In the event, TACS, a UK manufactured version of AMPS, will be used by both UK services. This version will conform to what is expected to become the European standard, provided up to 1000 channels separated by 25kHz in the 890-960MHz band.

The Racal award provoked a response from Philips[62] who suggested that an opportunity to create a European system had been lost, and Europe would end up once again as a good market for US exports. However, optimistic forecasts about job creation in the UK followed, in the expectation that there would be a demand for cellular radio in the hundreds of thousands[63]. We will be unable to see what happens until 1986 — the earliest date by which sets will be available in any volume.

Satellite communications

Satellite communications have come a long way since Clarke's 1945 prediction[7], mentioned earlier. A portion of Clarke's famous article is shown in Fig.4. The available bandwidth for satellite communications lies between about 700MHz and 30GHz. A digitized telephone circuit occupies about 32kHz, and a digital tv channel at least 36MHz, so this bandwidth, if occupied by isotropic transmitters, could accommodate about 900,000 telephone channels or 800 tv channels without mutual interference.

However satellite transmitters are not isotropic — that is they do not radiate in all directions. The energy is beamed, and one beam need not interfere with another. Consequently the available bandwidth is much greater since a number of transmitters can use beams on the same frequency without mutual interference. But satellites require to be spaced in orbital 'slots' and for geosynchronous satellites there are only so many slots available in positions for optimum coverage of the areas of greatest demand. Thus in spite of the huge bandwidths potentially available, the slot limitation offsets the beam advantage, and slot positions are at a premium. The allocation of slots is a matter for intense international haggling.

Typically, signals are beamed up from a narrow-beam ground station to a satellite transponder, changed into a different frequency, and beamed down using a beam designed to cover a specific area of the earth. A transponder may be designed to receive signals from more than one ground station, and may re-transmit a signal singly, or with others spaced out over a frequency band from one aerial, or may re-transmit one or several signals from several different aerials beamed to cover particular areas. The latest satellites embody on-board switching to arrange for various combinations of signals and aerials for particular areas of the earth.

A one-hop up-down signal to and from a transponder on a satellite at a height of 22,282 miles takes about half a second to make the round trip. The adverse effects of this delay have been much less than expected, and provided the design and application of a system using a satellite link takes proper account of it, it is unlikely to present much of a problem. For general information, see reference[64]; an overview of current general developments is provided in refs[65-68].

The Comsat Corporation was set up in 1963 to manage the Intelsat satellites for international telecommunications on behalf of participating countries. Their impact on the public has been the increasing coverage and falling costs of long distance telephone calls, and the relaying of tv programmes of high quality in real time. Later, commercial satellites started operating in the US with ground stations scattered round the country. For example the WESTAR satellite had 12 transponders each capable of handling 60Mbit/s. they were hired for a variety of purposes including remote publication of the Wall Street Journal, oil rig communications, Sports tv links, telegrams and telex. More recently, Satellite Business Systems became fully operational with the addition of its third satellite earlier this year. It offers digital intra-organisation communication services (CNS) using a network of ground station and leased lines[69].

Transponders, usually one per channel, have been in high demand for cable tv programme distribution, nearly a hundred now being used on seven different satellites. Their use on RCA's Satcom 1 were shown in Table 1. These transponders are used for distributing programmes to cable tv ground stations for further distribution through terrestrial cable networks. A new journal caters for the 'satellite freak' demand by providing a 'guide to satellites' with a schedule of all the programmes which can be intercepted if you have the right gear.

Direct broadcast satellites, expected to be functioning by 1986 in the US, are a more recent development for programme distribution direct to homes. The probable cost of the dish and receiving adaptor seems to be fairly clear. Technical details are discussed in ref.[70] with an estimated volume production cost of £200 in the UK. However, the expectations of the companies getting into the business are far from clear.

The European space industry was a joke for some years. Then it grew gradually, characterised by grudging co-operation delayed by national aspirations and national/commercial jockeying for leadership as the importance of the communications potential became evident. Currently the major actors are the European Space Agency which supports the Ariane rocket launcher and a later more powerful version, and also supplies hardware for use by EUTELSAT, a consortium of European telecommunication administrations.

The Orbital Test Satellite was launched in 1978 as a Telecomms testbed. It is being followed by the European Communication Satellite series of five satellites from 1983 onwards. Another larger multi-purpose satellite was started — the H-SAT, supported particularly by the Germans , but was stopped in 1978 apparently because the Germans wanted to jump to an operational phase more quickly. In addition to these ESA activities, France is launching a series of three TELECOM satellites for its own communication purposes, starting in 1984. Satellite television activities also rely on ESA services, but national and commercial forces seem to take over at the operational stage.

The work on H-SAT spawned three successors. L-SAT is a large multi-purpose satellite — the first to have spot beams with on-board switching — to be launched in 1986. Under the aegis of ESA, it is of particular UK interest, with British Aerospace as the prime contractor. It will be used for Italian tv and may be used for direct tv broadcasting. Two other satellites followed H-SAT — the Telediffusion de France (TDF), and the German TV-SAT, with transponders for at least three channels on each, possibly to be used for direct broadcasting. They will be operational in 1985.

Apart from these ESA-based activities various national activities are in progress. A UK consortium of British Aerospace/Marconi/GEC/Brit. Telecom with some US participation as well, called UNISAT, has contracted to make three satellites for BBC DBS ready in 1985/6. There is some doubt about the activities of Luxembourg RTL which at one time was contemplating private tv broadcasting over central Europe. This would upset the control of content maintained by the state monopolies.

In the 1977 World Administrative Radio Conference the UK was allocated a position at 31 degrees West for a satellite operating in the 12GHz band with provision for five tv channels radiated with a specified power, polarisation, and earth footprint. A report was published in May 1981 setting out options in the UK, ref.71. The service area for reception using a 0.9 metre aerial dish in a satellite to the WARC specification is shown in Fig.5. Following the UNISAT proposal a decision was needed about upgrading the picture quality to take advantage of the wider bandwidth available — the major restriction on the quality of terrestrial tv.

During 1982 discussions started about the virtues of the BBC's improved system, extended PAL, or a system claimed to be better in several respects, developed by the Independent Broadcasting Authority and called C-MAC, the C designating the type of sound and the MAC meaning multiple analogue component. At the end of 1982 the government accepted the recommendations of the Part committee and decided on C-MAC. Attempts were made in 1983 to convince other European countries, through the European Broadcasting Union (EBU), that C-MAC should be the European standard. Agreement could not be reached.

In August 1983 IBA asked for channels on Unisat for a service competing with the BBC. It was also reported that the BBC was wavering in view of increasing costs, and was worried about its large borrowing requirement with attendant risk. The final form of UK DBS has yet to be decided.

In the context of telecommunication infrastructures, satellites may simply play a technical role — that is they are a communications relay to be used when economic, technical, and political considerations are favourable. However they have the unique property of potentially providing $n(n - 1)/2$ two way circuits — the equivalent of a universal multi-port network over the surface of the earth. Experiments are in progress lasting until 1984 to interconnect lans via the OTS satellite and terrestrial networks[72]. The extra dimensions of satellite communications are technically available to produce a profound effect on networking. The pace will be determined yet again by the art of the politically possible.

References

67. Churan, G.G., Leavitt, W.E. Comsat Technical Review 11(2), 421-321, Fall 1981. Summary of the SBS satellite communications performance specifications.
68. Bodman, Richard S. Comsat J, 9, 5—18, 1982. SBS off & running.
69 Chase, Scott. Comsat J., 9, 12—18, 1982. CNS: communications, advanced, private, intergrated.
70. Phillips, G.J. Proc. IEE 129(7), 478-484, September 1982. Direct broadcasting from satellites.
71. Anon. HMSO 1981. Report of a home office study. £4.50. Direct broadcasting by satellite.
72. Kirstein P. T., Burren J., Daniels R. et al. In Pathways (see ref 51) pps.442-447. The Universe project.

Telemetry decoder for Oscar–10

by J.R.Miller

Aligning the decoder without test equipment

Several constructors have asked for a method of aligning the decoder without test instruments. It *is* possible to manage without an audio generator or oscilloscope, but you need a good ear and headphones. This method will not enable you to fault-find. It assumes that the decoder is electrically all right, and that only the phase-locked loops need setting-up correctly.

These instructions should help you align the decoder itself though the p.l.l. dynamic characteristics will not have been checked. For maximum performance it is necessary to optimise receiver and p.l.l. bandwidths. To do this you will still have to follow the procedure given in the article; however, very good results may be obtained this way.

The method makes use of the fact that there are crystal-controlled 2400 and 1200Hz reference signals available from the serialiser clock, IC_{19} pins 11 and 12. Make up a simple audio mixer using two resistors (try 2.2kΩ to start with) to the live terminal of the headphones, the common connection going to the 0V rail. One resistor connects to the reference tone, and the other is a test probe. With this probe connected to signals in the decoder two tones will be audible, and with care the frequency of the tested signal can be gauged by ear.

Main p.l.l.

The range offered by the main tuning pontentiometer VR_3 should be from about 1200Hz to 2400Hz. Tune to the low-frequency end. Connect the reference probe to IC_{19} pin 12 and the test probe to IC_4 pin 11. Adjust trimmer VR_2 until zero beat is heard. Make sure that you have matched 1200Hz to 1200Hz, and not harmonics — this is why you need a careful ear. Now move the reference probe to IC_{19} pin 11 (2400Hz). Retune VR_3 to maximum frequency and confirm that you hear about 2400Hz.

Clock p.l.l.

This loop should run at 400Hz exactly. Connect the reference probe to 1200Hz (IC_{19} pin 12), and the test probe to TP4. Adjust VR_4 until you hear zero beat between the reference and the third harmonic of the 400 Hz clock. The mixture is particularly sonorous. Now connect noise to the system audio input (J2 pin 1). Re-adjust VR_4 carefully for zero beat.

The 6V supply should be adjusted as described in the article. Apply noise to the input, connect an analogue voltmeter between IC_{12} pins 1 and 2, and adjust VR_1 for an average reading of zero volts.

Corrections

In the main circuit diagram in the October issue the numbering of pins 1 and 2 of link LKY should be transposed. The p.c.b. is correct.

On the first page in the paragraph headed Y Block, the date reference should read (0=January 1 1978). In the caption to Fig. 4 the second 'would' should be omitted. Finally, in parts 1 and 2, in Table A the bracket 'to S_1' should embrace J2 pins 3,4,5 and 6.

Digital multimeter suppliers

Numerous requests for addresses of multimeter suppliers prompt us to give this list which relates to our December table. In our table, the 'ALTA1' brand name belongs to L.H. Altaras, while the MIC brand is sold by House of Instruments (HI). In the Sanwa entry, columns 6 onward should be shifted one column to the right. In the range columns A means autoranging.

Armon Electronics Ltd, 109 Wembley Hill Road, Wembley, Middlesex HA9 8AG. Tel 01-902 4321

ALTA1 Components, (L.H. Altaras Ltd), Sillavan Way, Salford, Greater Manchester M3 6AE, Tel 061-832 4578

Anders Electronics Ltd, 48 Bayhem Place, London NW1 0EU. Tel 01-387 9092

Bach Simpson (UK) Ltd, Trenant Estate, Wadebridge, Cornwall PL27 6HD. Tel 020881 2031

Beckman Industrial Ltd, 11 Wagon Lane, Sheldon, Birmingham B26 3DU. Tel 021-742 7761

British Brown-Boveri Ltd, Normelec Division, Grovelands House, Longford Road, Exhall, Coventry CV7 9ND. Tel 0203 364021

Canadian Instruments & Electronics Ltd, Harris-Bass House, Station Road, Ilkeston, Derbyshire. Tel 0602 302331

Centemp Ltd, Unit 5 Kirby Works, 122 Heston Road, Heston, Middlesex TW5 0QU. Tel 01-572 6190

Cirkit Holdings plc, Park Lane, Broxbourne, Hertfordshire EN10 7NQ. Tel 0992 444111

Cropico Ltd, Hampton Road, Croyden CR9 2RU. Tel 01-684 4025

Danesbury Instruments, 22 Parkway, Welwyn Garden City, Hertfordshire AL8 6HG Tel 07073 38623

Delristor Ltd, PO Box 130, Uxbridge UB8 2YG. Tel 0895 52222

Dorman Smith Instrumentation, Salterbeck, Workington, Cumbria CA14 5DT. Tel 0946 830345

Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU Tel 01-902 8832

Electronic Brokers Ltd, 140 Camden Street, London, NW1 Tel 01-267 7070

Electroplan Ltd, PO Box 19, Orchard Road, Herts SG85HH. Tel 0763 41171

ETI, (Limestar Electronics Ltd), PO Box 81, Worthing, W. Sussex BN13 3PW.

Farnell Instruments Ltd, Sandbeck Way, Wetherby, W. Yorkshire LS22 4DH. Tel 0937 61961.

Fluke (GB) Ltd, Colonial Way, Watford, Hertfordshire WD2 4TT. Tel 0923 40511

Griffin & George, Ealing Road, Wembley HA0 1HJ. Tel 01-997 3344

Harris Electronics, 138 Grays Inn Road, London, WC1X 8AX. Tel 01-837 7937

Hewlett Packard Ltd, King Street Lane, Winnersh, Wokingham, Bucks. Tel 0734 784774

House of Instruments Ltd, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE. Tel 0799 24922

Iskra Ltd, Redlands, Coulsdon, Surrey, CR3 2HT. Tel 668 7141

JMI Ltd, 137 Sandgate Road, Folkestone, Kent CT20 2DE. Tel 0303 54002

Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks RG0 NL. Tel 0734 861287

Kelgray Marketing Ltd, Kelgray House, Sandy lane, Crawley Down, W. Sussex RH10 4HS. Tel 0342 715066

Lascar Electronics Ltd, Module House, Whiteparish, Salisbury, Wilts SP5 2SJ. Tel 07948 567

MIC — see House of Instruments

Pantec (Carlo Gavazzi UK Ltd), 162 Upper Richmond Road, London SW15 2SL. Tel 01-785 9022

Philips Measuring Instruments (Pye Unicam Ltd), York Street, Cambridge CB1 2PX Tel 0223 358866

Racal Dana Instruments Ltd, Duke Street, Windsor, Berkshire SL4 1SB. Tel 07535 69811

Robin Electronics Ltd, Wembley Commercial Centre, Unit 3.2, East Lane, North Wembley, HA9 7YA. Tel 01-908 5446

Rohde & Schwarz (UK) Ltd, Rohde & Schwarz House, Roebuck Road, Chessington, Surrey KT9 1LP 01-397 8771

Ross Electronics (Ross Marks Ltd), 49 Pancras Road, London NW1 2QB. Tel 01 278 6371

Servo & Electronics Ltd, 24 High Street, Lydd, Kent. Tel 0679 20252

Siemens (UK) Ltd, Windmill Lane, Sunbury on Thames. Tel 09327 85691

Sifam Ltd, Woodland Road, Torquay Road, Devon TQ2 7AY. Tel 0803 63822

Solartron Electronic Group Ltd, Farnborough, Hampshire GU14 7PW. Tel 0252 44433

STC Instrument Services, Edinburgh Way, Harlow, Essex CM20 2DF, Tel 0279 29522

Telonic Instruments, 2 Castle Hill Terrace, Maidenhead, Berks SL6 4JR Tel 0628 73933

Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambridgeshire PE17 4HJ. Tel 0480 64646

Thorn EMI Instruments Ltd, Archcliffe Road, Dover, Kent CT17 9EN. Tel 0304 202620

Thurlby-Reltech (Thurlby Electronics Ltd), New Road, St Ives, Huntingdon, Cambridgeshire PE17 4BG. Tel 0480 63570

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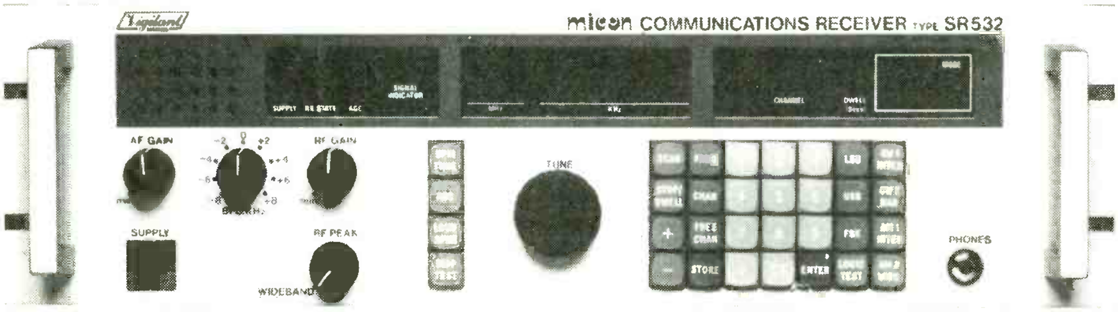

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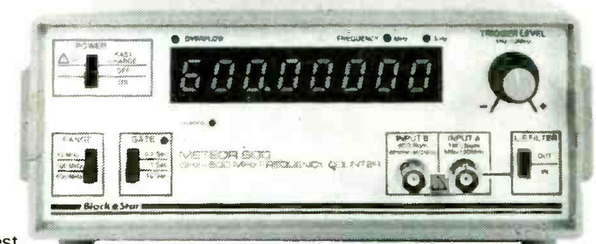

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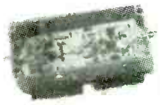

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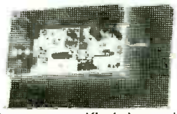

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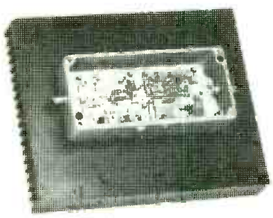

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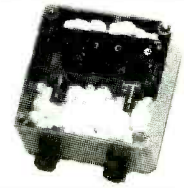

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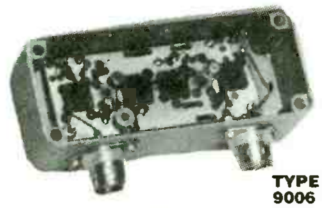

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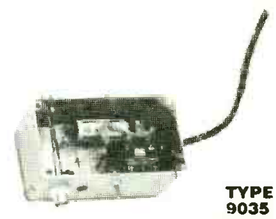

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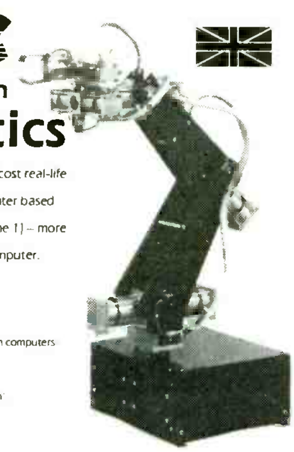

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Marconi 84

The recent 'Marconi 84' exhibition/symposium at the Penta Hotel, Heathrow made an effort to show that the Marconi group of companies retains a large foot in the civil telecommunications market, but the clear impression was of Defence in the driving seat. For example while a new Marconi civilian maritime satellite terminal "Oceanway" sells at "under £20,000", Marconi Defence Systems announced receipt of "the largest order ever placed with a European company for satellite terminals" — a £40-million order for 19 of the latest "Scot" terminals for frigates of the Royal Navy. These digital, all-weather systems are far more complex than those for Marisat. The cost-differential of some 100 times is an indication of the attractiveness of Defence contracts.

Marconi 84, however, provided a good example of the continued need for rapid improvisation with the story of the company's 15-day development of the "Blue Eric" Sea Harrier radar jammer at the time of the 1982 Falklands campaign. The full story is told in "Harrier and Sea Harrier at War" by Alfred Price.

In the technical presentations, Marconi engineers placed emphasis on future needs for v.l.s.i. design skills, system understanding, software engineering, ergonomics, improved reliability and better man-machine interface under adverse environmental conditions, spectrum enhancement by more use of millimetric and optical frequencies, intelligent knowledge based systems, Bragg-cell spectrum analysers, reduced vulnerability to e.m.p. and r.f.i. and the need for improved batteries. But the emphasis throughout seemed to be on "management of complexity" and the handling of more and more information, made possible by "enabling technology". I felt so out-of-step when I raised the question of "disabling technology" that I refrained from expressing my feeling that the military mind should be thinking far more on how to reduce dependence on continuous communications links from command posts which could be destroyed by a single accurately-directed missile. There is still a lot to be said, if only in a whisper, for "kiss".

Military paramount

The British radio communications industry has become increasingly locked into the Defence scene, despite occasional attempts to break out of what could prove a restrictive if profitable yoke. The hard-fought Whitehall battle to establish communications as a "force multiplier" rather than concentrate on weapons systems appears to have been won. A major role has been assigned to complex battlefield systems for C^3I (command, control, communications and intelligence) though some still warn of the dangers of abandoning "kiss" (keep it simple, stupid).

Satellite systems, for example, can provide superb 24-hour coverage, free of distance or major propagation problems. Yet nobody can be sure that in a major war they would not become a casualty to jamming and/or anti-satellite weaponry. So you still need h.f. and v.h.f. terrestrial systems.

Here again, v.h.f. is excellent for C^3I in Europe bu far less effective in steamy jungles, while h.f. propagation is unreliable in the Artic.

Frequency hopping and unconditionally secure digital encryption for telephony and data are available to all major powers and seem capable of rendering much of the equally elaborate SIGINT surveillance systems of limited value. Electronic counter measures produce counter-counter measures and so *ad infinitum*.

The problem for Defence planners is age-old: one can never assume that a future conflict will follow any of the foreseen patterns — if military history teaches us anything it is that history seldom repeats itself. It does teach us that reliability, flexibility and improvisation, with minimal central control, are more important that planning to move enormous number of digits in star networks.

Electromagnetic compatibility

More and more designers are recognizing the immense importance of minimising the vulnerability of their equipment to r.f.i., lightning or nuclear e.m.p. or just plain cross-talk. A process that should also involve consideration of how similarly to minimise the generation or radiation of unwanted r.f. The rushing about of high-speed digital pulses, the use of plastic rather than metal enclosures, the vulnerability of c.m.o.s. devices to r.f., all combine to make it necessary to take e.m.c. into account right from the initial stages of design rather than hoping that problems can be all cleaned up later with a few filters, a little conductive paint and adhesive copper tape — useful though these may be.

The high-technology of e.m.c. gets another airing at Zurich on March 5-7, 1985 at the 6th Symposium & Technical Exhibition on "Electromagnetic compatibility", though I notice that of some 120 papers listed in the provisional programme only six are from the U.K., none of them from British industry. There is still a wide gap between e.m.c. reserach and the shopfloor.

It is no secret that the prospects for switched-star cable-television networks have not been improved by the greater-than-expected difficulty of producing video switches free of cross-talk.

Swinton and Baird

The recent unveiling of a memorial inscription at 9 Albyn Place, Edinburgh, birthplace in 1863 of Alan Archibald Campbell Swinton, by Lord Thomson of Monifieth, IBA Chairman and Vice President of the Royal Television Society, was a welcome if belated tribute to the first man to propose an all-electronic system of television. Although he never succeeded in putting together a working model — and died without ever seeing high-definition television — he undoubtedly inspired the efforts of the Marconi-EMI research team. There is evidence that V.K. Zworykin, who developed the iconoscope picture tube in the USA, was aware of and used some of Campbell Swinton's ideas.

Campbell Swinton was one of the earliest and most persistent critics of Baird's 30-line mechanical system which he regarded as totally inadequate for reception by the general public and of the frenzied efforts of the Baird Company to suggest otherwise. His views were so strong on this that the editor of *The Times* removed from one of his letters his more outspoken comments for fear of a libel action. This is not to disparage the undoubted break-through made by Baird in 1926.

In the November 1984 "Feedback" Douglas Pitt, chairman of the Narrow Bandwidth TV Association, took strong exception to my suggestion (June 1984) that one reason why Baird's 30-line 12.5-frame system, as reluctantly transmitted by the BBC, was blatantly futile from the outset, was the lack of effective synchronization. This was not intended as a reflection on Baird's ingenuity or his established role as the first person to demonstrate however crudely and with whatever degree of subsequent press manipulation, images of a living person. Nor have I been any part of a conspiracy by *Wireless World*! Its columns have reflected both sides of the argument, if sometimes showing scepticism on some of the 'over-the-top' claims made on behalf of Baird's early work.

There can be little doubt that Baird tried a variety of systems to achieve some sort of synchronisation, ranging from the the effective, but hardly "television", technique of a common rotor shaft to the use of synchronous motors fed over a pair of wires. Synchronism using the 50Hz a.c. mains was of limited value in the 1920s, in advance of the National Grid. For some of early demonstrations, when at last these included a radio link, there seems little doubt that sync. was a matter of manual adjustment of the receiving motor with little or no hope of holding pictures steady over any length of time.

The 'cogged wheel' system, about which Doug Pit waxes so enthusiastic, was at best incapable of providing truly automatic synchronisation, but rather semi-automatic isosynchronism (requiring manual 'framing' by rotating the motor physically). With no distinctive pulses it was prone to produce double images. At its best the pictures floated up and down to some degree, as it was in effect a flywheel system based on the frame rate of 750 r.p.m. and not, as implied, strictly compared to later line-frequency flywheel systems.

To work effectively the black-edge signals needed amplification separately from the vision signals, yet the "Televisor" was sold, if only in small numbers, as suitable for use with a standard radio receiver. A more realistic design was the later Baird-Bush mirror-drum receiver, though this was not marketed until *after* the BBC had sought to cancel their agreement to provide the experimental 30-line service.

There is plenty of evidence to show that this was futile from the start, at least as a television service for the public. It was, admittedly, of interest to hobbyists and experimenters. Nor should one disparage *mechanical* television as such. But had large numbers of 30-line Televisors been sold it would have been virtually impossible for the BBC to have launched an *effective* high-definition service in 1936.

One can admire Baird's innovative work, particularly his wartime work on high-definition colour and his development of the Telechrome display tube, without condoning the way in which in the late 1920s the Baird company bamboozled politicians, the press, the Patent Office, investors and the public into believing that he alone held the key to television.

Investors heavily subscribed to the Baird companies. The concept of Baird (after 1928) as a lone pioneer fighting big and powerful organizations is just one of many myths.

By strange coincidence the current Newsletter of the N.B.T.A. of which Doug Pitt is editor contains an article "Baird or Jenkins" which disputes that Baird was the first to demonstrate "true television", favouring the claims of C.F. Jenkins!

Amateur Radio

Using up v.h.f.

The introduction by Marconi Communications Systems of a new family (7500 series) of Band 3 v.h.f. transmitters, all-solid-state up to 2kW rating and thereafter incorporating Philips cavity-tetrodes, brought home once again the lonely path of the UK in finally forcing all broadcasters out of v.h.f. by January 6, 1985, instead of retaining at least some frequencies for a re-engineered 625-line service as originally intended.

One or two encrypted subscription channels on v.h.f. would have avoided the financial questions that still hang over the UK 12GHz direct broadcasting from satellite project. Mobile radio will gain much-needed spectrum space but even those who lobbied on its behalf never expected to inherit all of Band 1 and 3, and indeed will probably never be given so much extra spectrum. Was it all part of the great Information Technology euphoria that has dominated official thinking in the 1980s? D.T.I. justify early allotment of Band 3 to mobile radio on the prediction of almost 2-million mobile users by the end of the century. But what happened to the "millions" who wanted c.b.?

The feasibility of using envelope demodulation of s.s.b. for mobile and other communications is argued by M.A.M.A. Zeid of Bell Northern Research and Canada and G.B. Lockhart of Leeds University in *Electronics Letters* (October 28, 1984). They believe that the problems of coherent detection, with its need for precise tuning, could be overcome by partial correction of the distortion produced by envelope demodulation based on a development of proposals made by H. Voelcker in 1966, but requiring only a narrow-band rather than a wideband Hilbert transformer. For mobile systems with pilot carrier this could permit 5kHz channelling.

Lost memory

Attention has been drawn recently to the problems that may arise with some current amateur transceivers having factory-programmed r.a.m. devices to control basic functions, rather than just for users to store frequently-used channels, etc. Such equipment usually have a soldered-in lithium battery to form a non-volatile memory. If for any reason the battery or its connections fail, or it reaches the end of its useful life, the entire equipment, or the board involved, has to be returned to the makers for re-programming and replacement of the battery.

This sounds fine in theory, and is common practice with some modern professional equipment. But for some amateurs it is sounding a warning of future problems. What guarantee can there be that the manufacturer or distributor will still be around or serving the amateur radio market in say 7 years or so, the normal operational life of a lithium battery in such an application? Or that they will be prepared to service a model that may have been bought secondhand or from someone other than the manufacturer's authorised dealers? Or that the same size and type of battery will still be available, in view of the still developing lithium battery technology?

Radio amateurs expect considerably more than seven years operational life from a top-of-the-line transceiver; some have clocked up more than 40 years use of vintage h.f. valve communications receivers. It may be advisable to think a long way ahead when "investing" in models which, no matter how well they perform, could prove to have a form a built-in obsolescence.

Sir Martin Ryle, G3CY

With the death of the former Astronomer Royal, Professor Sir Martin Ryle, G3CY, British amateur radio has lost one of its most distinguished licence holders. Martin Ryle was licensed in 1937 while still at university and was active on h.f. bands, using Morse, in the period before the outbreak of war. I have a QSL card from him for a 1939 7MHz contact to prove it! Although, in the post-war period he does not appear to have been particularly active as a radio amateur, he retained his licence and callsign and his interest. With a gift for improvisation, his early radioastronomy work at Cambridge in the 1940s depended largely on British and German radar equipment that he managed to scrounge. His wartime work on airborne radar at T.R.E. disillusioned him of any wish to continue working in the military field. In the 1971 Mullard publication "Search and Research" edited by John P. Wilson, GW3BGP, he wrote: "By the end of the war we were all very tired... I was very tense and if I barely knew what I wanted to do, I certainly knew what I didn't want to do. I did not wish to remain in the Civil Service and I wanted nothing more to do with military equipment. I was not one of those who would be content to go on designing bigger and better radars in preparation for the next war." In recent years he was an outspoken critic of the use of nuclear energy for either military or civil purposes. His fundamental contributions to the science of radioastronomy, of which he was one of the great pioneers, included the use of aperture synthesis interferometers and the classic mapping of the sky for radio sources in the Cambridge surveys. As a lecturer he had the ability to infect his listeners with a little of his own enthusiam for radio-astronomy, delivering to the R.S.G.B. one of the first public lectures on the subject when in 1948 he spoke on the subject of "Signals from the Sun".

In brief

The DTI has issued the additional 60 permits for restricted operation inthe 50MHz band although there is still no information on when and whether this band will be open to other stations, including Class B, after the final 405-line v.h.f. stations close down by January 6, 1985... Class A licences with the GO prefix began to be issued during November 1984. PAT HAWKER.

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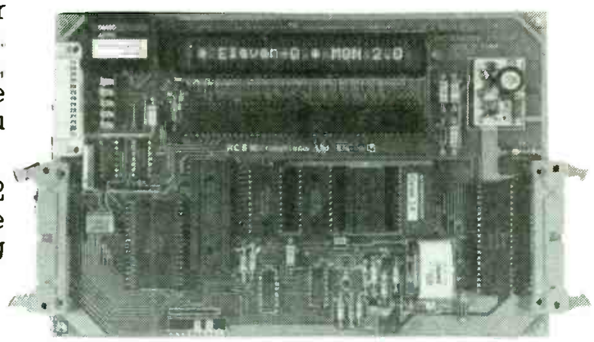

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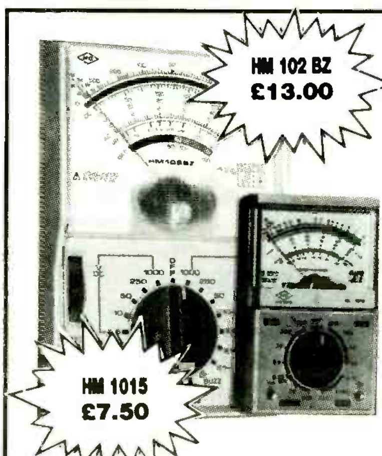

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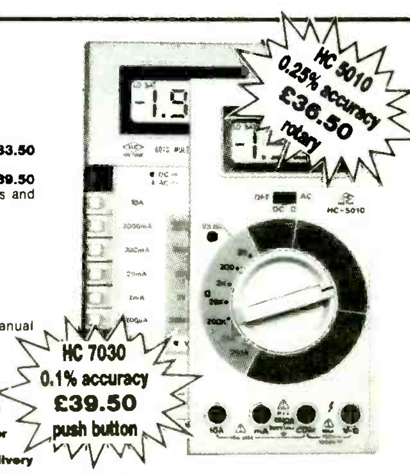

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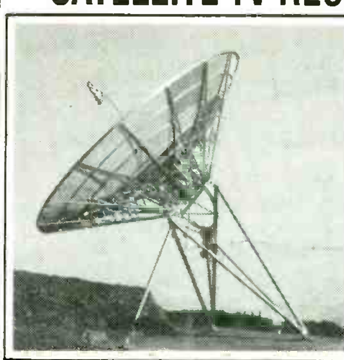

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Symmetry in audio amplifier circuitry.

by J.L. Linsley Hood.

A description is given of two fully symmetrical circuit blocks, for use in audio amplification applications, where it is thought by some designers in this field that this type of circuit 'architecture' may convey audible benefits.

As an electronic circuit designer, I have been involved on the fringes of the 'hi-fi' field for a number of years, mainly because of a personal interest in the potential for improvement in the reproduction of music in my own home environment. but also because it seems that an inevitable outcome of publishing any original circuitry for this purpose is a degree of entanglement in external commercial activity — if only in answering queries from those whose business is in this field.

This latter involvement generates perplexities which an electronics engineer developing designs to a normal engineering specification would hope to be spared. In particular, the question of 'sound quality' differences betweeen different design approaches, which lead to an apparently identical performance specification, is inevitably raised.

There are three possible responses to this query. The first of these is simply to deny that there are any differences, since all electrical measurements indicate an identity in characteristics. The second is to try to develop new test methods, or increase the sensitivity of existing tests to try to uncover small differences between otherwise identical units. The third approach, and the least elegant, is to try to discover whether, between apparently identically specified units, there is any consistent user preference for the one or the other.

My own conclusions, which have gradually formed over a number of years, is that the human ear — and that of domestic pets, too!* is astonishingly adept at observing small differences in sound quality, even in the presence of substantial amounts of distortion and other unwanted artefacts.

The question which cannot easily be answered, in the absence of instrumental confirmation, is which direction is 'better'.

*I once shared my home with a Siamese cat, which had an apparent liking for Bach organ music. It demonstrated a keen awareness of changes which I had made to the electronic circuitry, and wouldn't settle down if it disapproved.

The difference may be observed, but it then becomes a matter of opinion or taste whether it is preferable or 'more natural', or even more dramatic in its quality.

These, then, are the difficulties in relying on one's own or on other listeners' ears for quality assessments in audio circuitry. However, it is possible to form opinions on the nature of circuit structures which lead to favourable audience responses, and of these the most readily defined is that of symmetry in the circuit architecture.

Of course, one must accept that true symmetry, as between n-p-n. and p-n-p devices, or between those of n-channel or p-channel construction, is not really practicable, simply because of mobility of electrons and holes is so dissimilar. Nevertheless, at low frequencies, some measure of mirror-image symmetry is feasible, and this seems sometimes to be preferred by listeners when two otherwise similar circuit structures are compared.

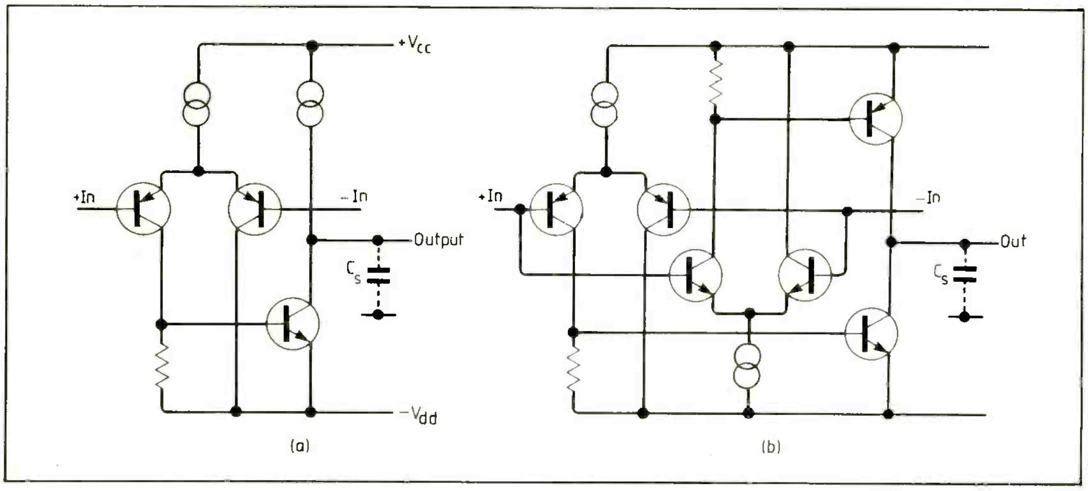


Fig. 1. **Assymetrical (a) and symmetrical (b) driver systems.**

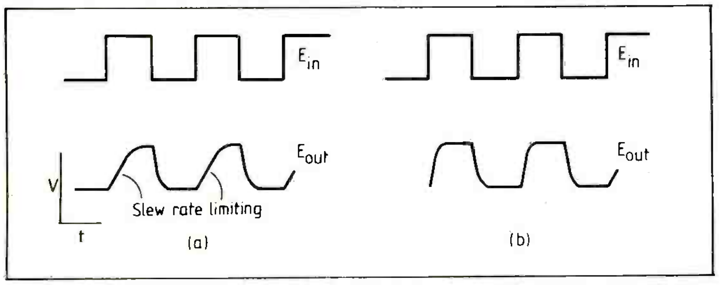


Fig. 2. **Response of assymetrical (a) and symmetrical (b) systems with stray load capacitance when driven by a fast square wave.**

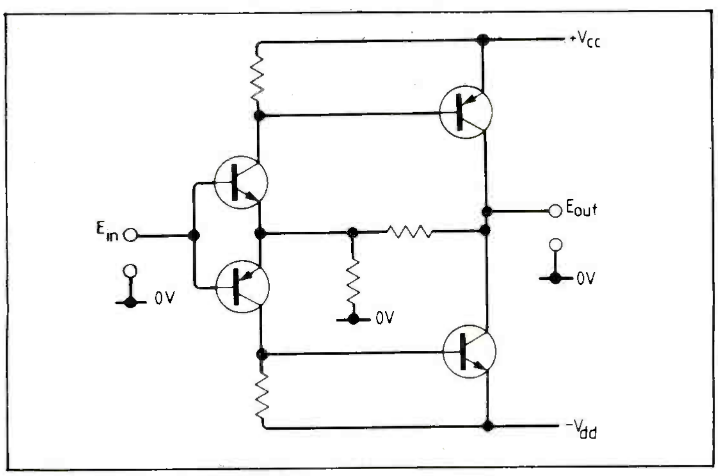
In contemplating this observation, it is tempting to rationalize this preference as a consequence of the sensitivity of the ear to any slew-rate limiting effects, since it can be argued that in a truly symmetrical structure the inevitable stray load capacitances will be driven in both polarity directions. and will, in consequence, have better slewing characteristics than a single-ended driver system.

I surmise that it is for these reasons that there has been a growing interest among audio designers in fully symmetrical audio circuit configurations, in spite of the relative inconvenience of this type of circuit structure in comparison with the more conventional amplifier device acting into a high-impedance or constant-current load. I have illustrated this comparison, in simple form. in Fig. 1(a) and (b), with the normal step-function response of such circuits as shown in Fig. 2(a) and (b).

A problem with the circuit of Fig. 1(b) is that of maintaining a constant mean current through the amplifying device, a problem which does not arise when the load, as in (a), is itself a constant-current source, and some external feedback network is employed to stabilize the d.c. working point, whereas some other circuitry must be used for this purpose with the layout of (b).

To explore the sound characteristics of such symmetrical circuit layouts, without the added problems associated with changes in the structure of the audio output stages, I have experimented with two small-signal gain blocks of symmetrical form, of which the first is employed as a very-low-noise head amplifier, for use with low-output, moving-coil, gramophone pick-up cartridges; the second is used as a high-gain linear amplifier stage — which could be looked at as a fully symmetrical, discrete-component substitute for an operational amplifier.

Fig. 3. **Simplified circuit layout of a moving-coil head amplifier.**



Moving-coil p.u. head amplifier.

The basic circuit layout of this is as shown in Fig. 3. in which a complementary pair of bipolar junction transistors is driven by a signal applied to both bases simultaneously, and in which overall negative feedback is applied jointly to the emitter circuits.

The requirements to employ complementary input devices rules out the otherwise very attractive possibility of using one of the monolithic multiple parallel transistor arrays such as the NS LM394, which feature very low input noise resistance values, but are, at present, only available as n-p-n devices. Similarly, the need for very low input-circuit impedances, in the interests of low thermal noise, argues against the use of junction or mos field-effect transistors.

I have, therefore, as the input devices in the circuit of Fig.3. used small power junction transistors, of 3-4A maximum collector current levels which give an adequate gain and noise performance. Some measure of selection needs to be employed to avoid occasional poor devices in this application, but having investigated this requirement, using mainly Motorola transistors, the proportion of unsatisfactory transistors was small, among over a hundred transistors of different types tried in this position. The complete circuit is shown in Fig. 4, in a form which allows it to be powered from a pair of 1.5V dry cells, though, of course, an alternative power source would work as well if it has an adequately low noise and ripple content.

Since the input devices are effectively in parallel, so far as their base-emitter noise resistances are concerned, the effective input noise is reduced by 2 in comparison with either transistor on its own. Also, since the bases are indeed directly connected, it is necessary to generate the required forward bias by an appropriate potential developed at their emitters, because of current flow through R_3 and R_4.

The second amplifier stage is conventional, as a pair of symmetrically driven small-signal transistors, each of which sees the other as its collector load.

D.c. negative feedback to the emitters of the two input devices Tr_1 and Tr_2, through R_7 and R_9, stabilizes the output potential at a level within the differential V_{b-e} offsets of these transistors, and the collector currents through Tr_4 and Tr_6 are controlled by the actions of Tr_3 and Tr_5 in their base circuits, which diminish the drive to the output transistor bases if the emitter currents, through R_{12} and R_{13} force Tr_3 and Tr_5 further into conduction. The trimmer pot. R_{17} can then be used as a 'fine' control of the d.c. output level of the amplifier, to set it to ±1-2mV, if needed, by modifying the control characteristics of Tr_3.

The gain of this unit is determined by a.c. negative feedback through R_7 and R_9, which are effectively in parallel, developed across R_8 and R_{14}. Two switched gain levels, of 20× and 40× are available, controlled by $S_{2(a)}$.

It is found, in practice, to be helpful to reduce, somewhat, the h.f. bandwidth of this type of unit, and this is done in the case of the circuit described by an output h.f. roll-off network, R_{11} and C_{11}, which has a pole frequency of 480kHz, and by h.f. negative feedback through C_5 which has a pole at 220kHz.

It is also good practice to bypass all polar decoupling capacitors in the signal-handling positions by smaller value non-polar units, to reduce the equivalent series resistance of the combination over as wide a bandwidth as possible, within reason.

The spare contact of the d.p.d.t. battery on/off switch is used as a battery voltage indicator by using a switch biased to a 'centre-off' position, with a led in series with resistor and diode across the positive and negative supply lines.

Each half of the amplifier circuit (two are needed for a stereo signal) draws 2.2mA. For reasons of convenience in the board layout, the d.c. offset trim pots. (R_{17} and its equivalent) are positioned on opposite supply lines on the RH and LH channels, since this is immaterial in their actual mode of operation.

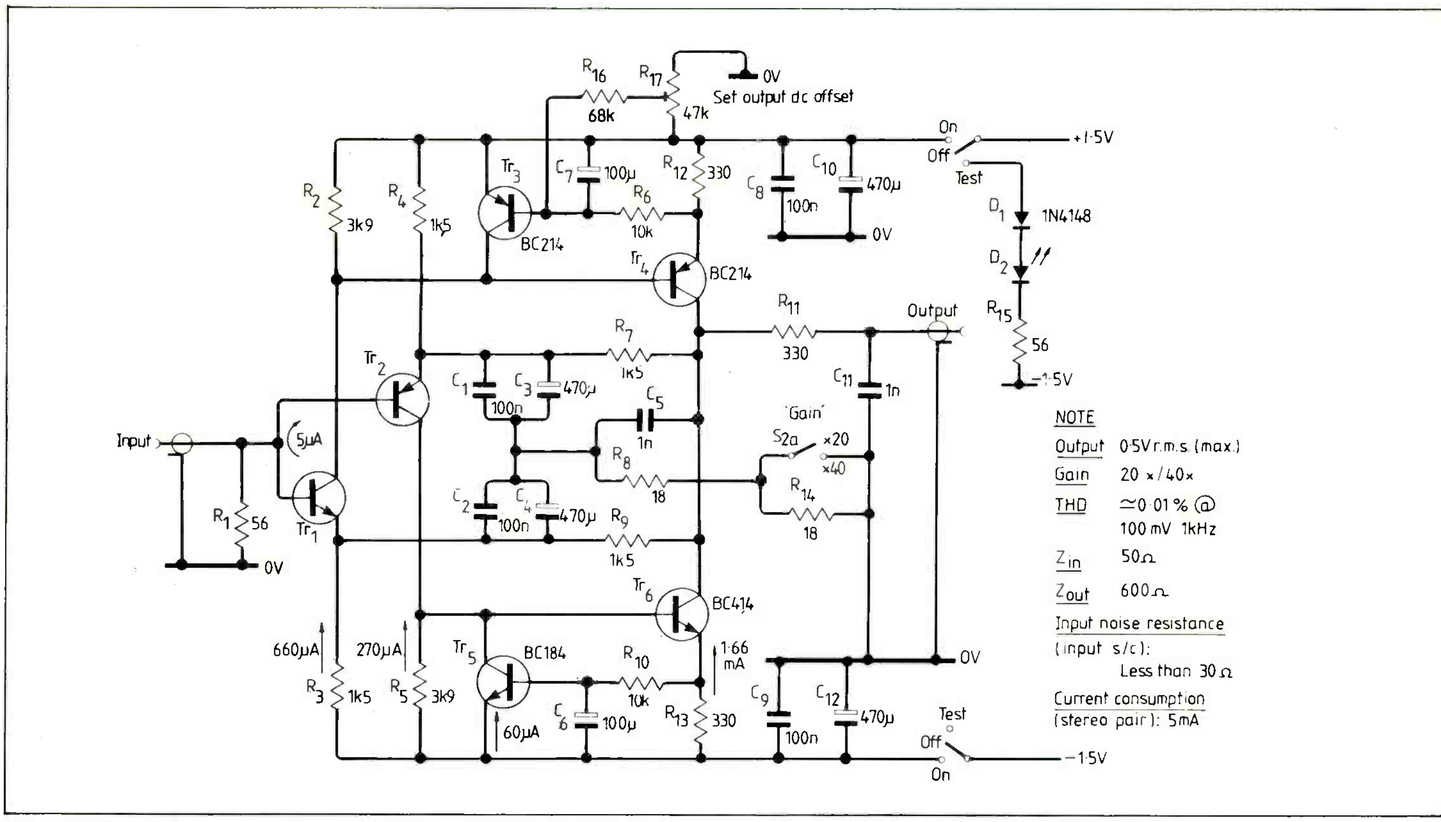


Fig. 4. **Symmetrical, direct-coupled, moving-coil head amplifier.**

The performance of this head amplifier, in sound terms, is very good, and preferable, in my opinion, to an assymmetrical design which I had used prior to this. The maximum output level, at the onset of clipping, is approximately 0.5V r.m.s. and the t.h.d. at 100mV output, is less than 0.01% at 1kHz. The input and output impedances are 50 and 600 ohms, respectively, though the input impedance can be increased to several hundred ohms, if necessary, by increasing the value of R_1.

The equivalent input noise resistance, on several prototypes, now in the hands of frields, was less than 30 ohms, measured at 25°C, with the input short-circuited, and with a 100 kHz meter bandwidth, in the ×40 gain position. Although the current consumption may seem relatively high for battery use, the intermittent nature of its employment allows a battery life of a year or more from a pair of HP7 type alkaline cells.

General purpose symmetrical gain block

The stimulus behind the development of this circuit was the realisation, about eighteen months ago, following a most impressive demonstration of digitally encoded music set up by a friend of mine, recorded via a Sony PCM.F1 encoder/decoder and a Sony Betamax video recorder, of the substantial improvements in sound quality now available.

My friend, who has an active interest in sound recording and disc manufacture, had staged this demonstration for me at a time when he was trying to decide whether such a digital recording system would be an acceptable, or perhaps preferable, alternative to his existing 15in/s twin-track analogue recorder system.

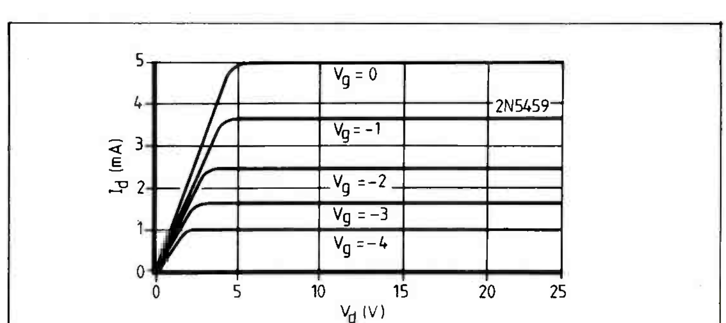
The conclusion that we both came to was that there was a very slight difference between these two systems, which we felt we could identify if we listened carefully to the one or the other for a prolonged period. However, when the test was run so that the two competitive methods, which had been employed to record the same performance with identical microphone types, in closely similar positions, were performing in synchronism at the same signal level so that a 'click-less' switch over could be made from one to the other, and back again, we could neither of us identify which was which, so that our guesses became effectively quite random and, indeed, we sometimes supposed that a change over had occurred when none had happened, and vice-versa.

The effect of this — to me — magnificent demonstration of the present state of the sound recording art, was to make me consider the ways in which these signals were handled in the subsequent audio circuitry, to see whether there were practicable improvements which could be incorporated in the electronics, the argument being that it was necessary for the circuit designer to ensure that the performance of his designs was sufficiently good, in relation to the quality of the incoming programme signal, that it would not cause a significant degradation of this.

While I could be satisfied that this criterion would be met, in relation to existing material from radio, tape or disc, I was no longer so sure that future improvements in the quality of the incoming signal might not call for equal improvements in subsequent circuitry.

The regions in which such performance improvments might be sought, apart from the symmetrical drive systems discussed

Fig. 5. **Typical drain-current/drain-voltage characteristics of junction fet.**



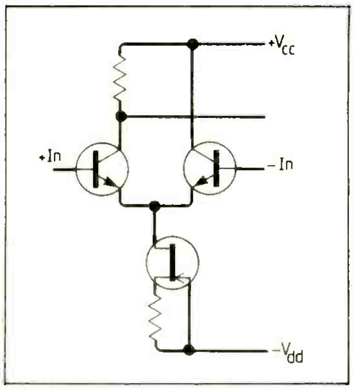


Fig. 6. **Use of junction fet as 'tail' load in long-tailed pair.**

above, which could reasonably be expect to offer an improved slewing characteristic in comparison with the more conventional assymmetrical layouts of existing op-amp circuitry lie in improved rejection of supply-line signal breakthrough, improved open-loop linearity, and improved common-mode rejection, in respect of a signal applied equally to the inverting and non-inverting signal inputs.

Consideration of these aspects led to the thought that junction fets, with their very flat V_d/I_d characteristics, shown typically in Fig.5. would offer both improved supply-line signal rejection, when used, for example, as a 'tail' of a long-tailed pair, as in Fig.6, but would also make very good amplifying devices, for the same reason, with good rejection of drain-potential signal breakthrough, and good common-mode rejection.

A further thought was that, since a junction fet will normally require a gate potential which is negatively offset in relation to that of its source, it would be possible to combine a pair of fet long-tailed pairs so that each acted as the 'tail' of the other, as shown in Fig.7. An attractive feature of this arrangement is that the 'tail' in such circuit provides an entry route for unwanted signal components into the input of the amplifier. If this can be removed, this would lessen such unwanted breakthrough.

The practical embodiment of this design is shown in Fig. 8. In this a pair of junction transistor 'current mirrors' (Tr_5, Tr_6, Tr_7 and Tr_8) in the drain circuits of the fets combine the output currents, and generate a drive signal for the output transistor pairs.

These are connected in 'cascode' form, in the interests of high output impedance (desirable to minimize supply-line signal breakthrough) and good linearity.

The output resistor chain, (R_{10}, R_{12} and R_{13}) provides the necessary forward bias for the cascade 'followers', and the resistors R_8 and R_9 cause the output current to be routed through the sensor half of the 'current mirror' to provide a measure of d.c. negative feedback to stabilize the current flow through Tr_9 and Tr_{12}.

Several units of this design have been made, and the performance, which has proved consistent from one unit to the other, is typically as shown, when operated from a +/− 24V supply.

Gain 30,000 at 330Hz, open-loop.
Bandwidth. d.c.—100kHz (−3dB), at gain ×50.
Harmonic distortion, Open loop. Below background noise level.
Harmonic distortion, Gain ×50 Less than 0.002% at 10V r.m.s. output, at 1kHz and 20kHz.
Output voltage swing. 15.5V r.m.s.
D.c. offset. +50mV without adjustment. Trimmable to ±3mV.
Square-wave overshoot. Nil.
Current consumption. 8mA.
Minimum supply-line voltage ±12V.

For optimum performance from any such units, it is recommended that the d.c. supply lines should be decoupled to the 0V line at points close to the supply input terminals on the board, using good quality non-polar dielectric capacitors, of 0.1-0.47uF, and that the supply lines themselves should be derived from low a.c. impedance, low-noise sources.

A number of these modules has been built, and experimentally substituted for existing op-amps in audio circuits — a quite straightforward exchange when ±15V lines are available — and I am very pleased with the resultant sound quality. I don't want to make specific claims, since I realise the psychological difficulties in this type of evaluation, unless a statistically adequate number of listeners is available, and the tests are conducted in a manner which avoids the possibility of prejudice in the resultant assessments.

On the general subject of the desirability of symmetrical circuitry for audio use. I feel that if it can be employed without incurring other significant penalties, such as a worsening of quiescent current stability, or a degradation of reactive load step function response it is a generally desirable move.

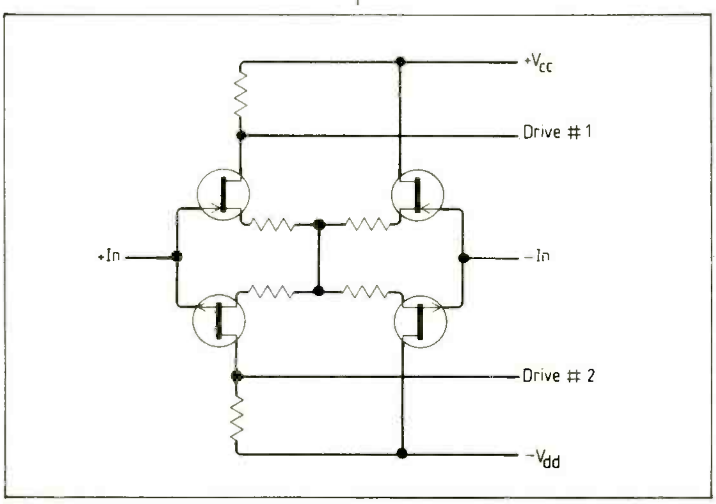


Fig. 7. **Symmetrical fet input stage.**

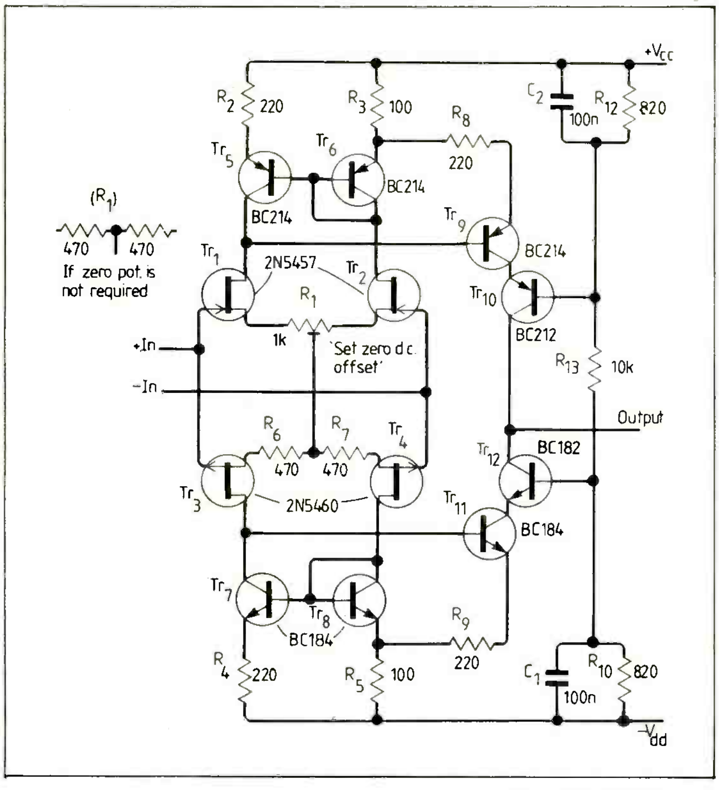


Fig. 8. **Symmetrical, low-distortion gain block.**

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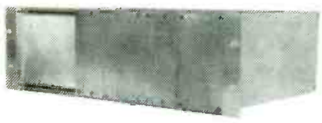
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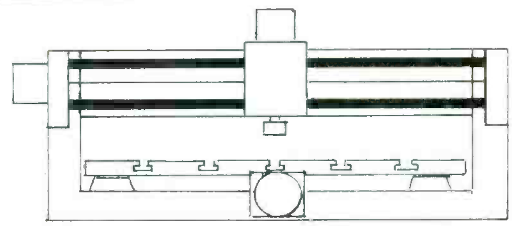

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CIRCLE 33 FOR FURTHER DETAILS.

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MULTI-FORTH 83 FOR THE BBC MICRO

CIRCLE 21 FOR FURTHER DETAILS.

Variable-speed video playback

by J.R.Watkinson, M.Sc.

Vertical lock at high speeds

At a speed of +3×, the VTR plays back every third field by performing a 2 track jump every drum revolution. The head ramps up the drum as the track is followed, causing a steady rate of timing advance, and jumps down, giving a step delay of 7 lines. Figure 10 shows the offtape timing relative to drum timing. The field begins 3½ lines late, but because of the high head to tape speed, finishes 3½ lines early. As the field proceeds, the write address gets closer to the read address.

The amount of timing variation that a t.b.c. can correct is known as the window size, expressed in lines, and this will always be smaller than the memory size. Some r.a.m.-based t.b.cs arrange the memory to store pairs of lines, such that read and write addresses must be kept apart by two, causing the window to be four lines less than the memory capacity. Second-order velocity compensation requires at least two lines delay between writing and reading, so that two velocity errors are available, and where this is used, the window will be two lines less than the memory size. Figure 11 shows a typical window timing diagram which illustrates the need to advance the drum by one half of the window to achieve a symmetrical correction range.

Vertical locking is necessary to ensure that the first line of an offtape field becomes the first line of a reference field despite the arbitrary relative timing caused by varispeed operation. This is necessary to avoid vertical picture movement.

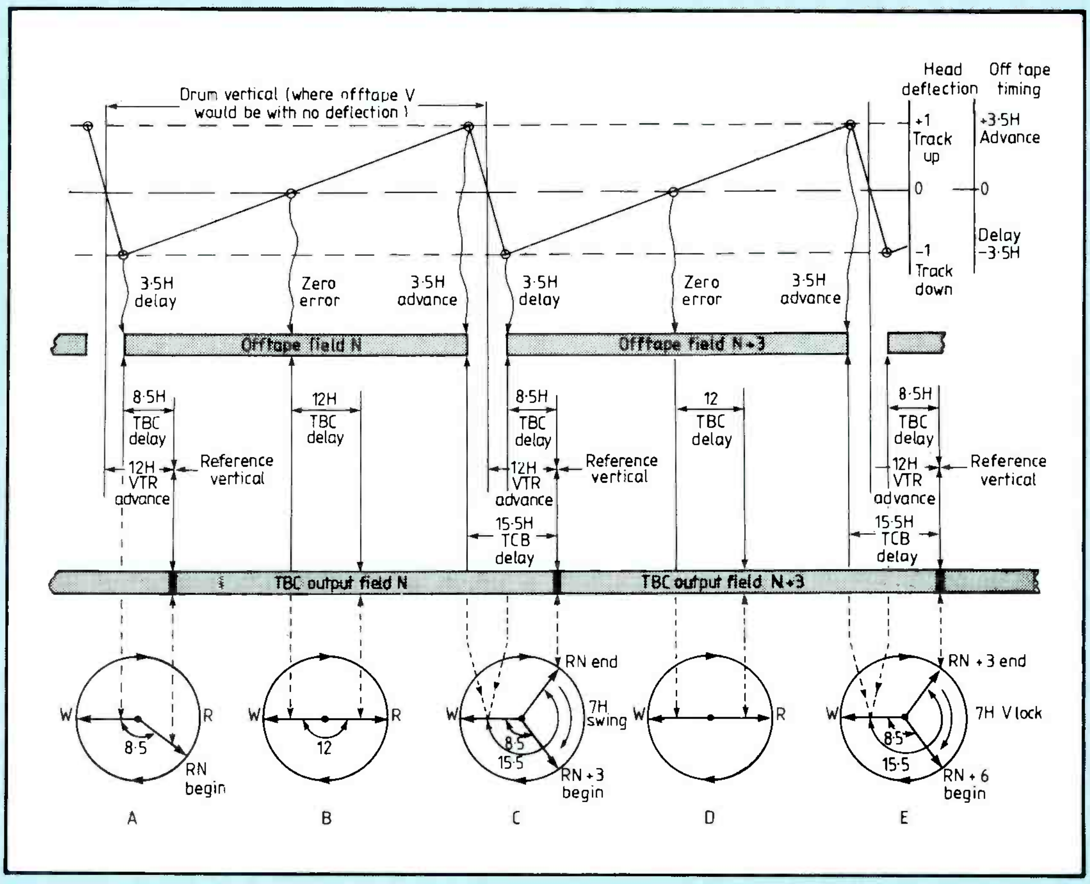
Consider the relationship of read and write addresses in the memory. At normal speed, they will both increment at the same speed and will remain opposed in the memory. At non-normal speeds, this is no longer true.

At higher speeds, the field is compressed, and the write address changes faster than the read address. The write address commences a field delayed, and finishes it advanced relative to the drum phase. Since drum phase is the same as window centre, the read and write relationship of Fi. 12(a) follows. In reverse, the field is extended, and the write address changes slower than the read address. The write address commences the field advanced relative to window centre, and finishes it delayed as in Fig. 12(b).

The write address of the first line in a field is remembered by the vertical lock circuit, whenever it occurs, and the memory read will begin at that address when the field is subsequently read out. A temporary V-lock address latch is necessary, as in Figure 12(c). The write address at offtape vertical time is latched in, and at reference vertical time, the V-lock address is jammed into the read address counter. Since the C-format does not necessarily store all of the vertical interval, the beginning of an offtape field is harder to establish in the presence of jumps, and it has been explained how the VTR derives a verticle signal in varispeed.

The action of vertical lock on read addresses is to make them jump by the same amount (in lines) as the timing shifts owing to head jumps. Figure 12(d) shows that at high speed, the write address starts the field late and ends early, close to the read address. V-lock causes the read address to jump forward to find the first add-

Fig. 10. Composite timing diagram for v.t.r. and t.b.c. running at +3X speed. t.b.c. has 24 line memory, requiring 12-line v.t.r. advance.
Line 1 shows both head deflection and the effect on office-tape timing, since these are directly related (see Fig. 9). At 3X, the v.t.r. head performs a two-track jump every drum revolution, playing every third field (see Part 1, Fig. 8). Line 2 shows the time compression of the offtape fields owing to the raised head/tape speed.
Line 3 shows the t.b.c. output which has restored the fields to reference timing.
Line 4 shows the relative address relationships in the t.b.c. at different times A,B,C,D and E. It does not show absoulte addresses.
Example A, At the the beginning of a field, head is deflected 1 track down, and offtape timing is 3½H behind drum timing (lines 1 and 2). Since reference is 12 lines behind drum timing, the t.b.c. requires a delay of 12−3½=8½ lines, and line 4 shows the memory read address 8½ lines behind the write address.
Example B, Midfield, with no head deflection or timing error the t.b.c. delay of 12 lines matches the drum advance.
Example C, End of field N, head deflected 1 track up, offtape timing is 3½H ahead of drum timing (lines 1 and 2) t.b.c. requies a delay of 12+3½=15½ lines. During the field, the raised head/tape speed has caused the write address to swing from an 8½ line advance to a 15½ line advance. At the end of the field, the write address stops advancing, and the head jumps to find field N+3. However, Read address keeps advancing as t.b.c. completes the output field. When 7 lines have been output, Read address will be at RN+3, coincident with the start of offtape field N+3, thus the new field is commenced with the same address relationship as example A. The Write address begins to advance again, and the first write address of the new field is stored in the V-lock memory.
8½ lines later, the read address will have advanced to where the first line was stored, coincident with reference vertical, and coincidence is ensured because the read address will be jammed to the write address in the V-lock memory.
Example D is as for B, and E is as for C.
Note that this example has assumed optimum timing. In real life, there would be an uncertainty of 3½H in the offtape timing, owing to the random tape/drum phase with an unlocked capstan. Note also that the format dropout has been neglected for simplicity.



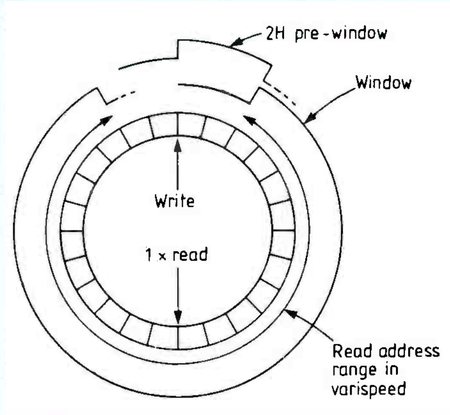


Fig. 11. The window of t.b.c. represents the range of timing errors which can be corrected. Since variable speed operation causes both advances and delays in the off-tape signal, the v.t.r. drum is advanced relative to reference by one half of the window, to change all necessary corrections into delays.

ress of the next field, which in relative terms, makes the write address late again so that it can advance during the field.

In reverse the opposite happens. The write address starts the field early and ends late, and the effect of V-lock is to make the read address jump back to find the first line in the next field, which also permits the write address to lag again during the field.

When the VTR is not playing or recording, it will default to E-E (Electronics-to Electronics) mode where video is modulated and demodulated in the usual way, but the heads and tape are bypassed. In this case no advance will be possible, since the VTR input has reference timing. The t.b.c. resorts to a 4 line delay, which is the smallest delay which will not disturb the 4 line sequence, and a 4line vertical shift, 8 lines with interlace, has to be accepted on the monitor. Similarly, in confidence playback, the VTR record head is locked to reference, and the confidence replay head, which is 120° away around the drum will give an output which has a one-third-field timing shift. Since this is in excess of 100 lines, the t.b.c. cannot correct the timing error. Instead, the t.b.c. generates composite video which is one third of a field out from reference, to which a monitor can synchronize to view the confidence picture. These compromises in F-F and confidence are of no real consequence since neither signal is needed for broadcast.

The window size of the t.b.c. is determined by the speed range to be covered at broadcast quality, aand by an added amount to cater for inertial error on tapes. Where these come from portable recorders, the timing errors due to inertial error may be of the same order as those due to variable speed play.

There is, however, a requirement to view pictures at speeds beyond the designed broadcast quality range, since this facilitates editing. In this case, timing errors can exceed the correction window of the t.b.c. The effect at high forward speed is that the write address catches up with the read address before the end of the field. Since simultaneous write and read is impossible, this condition, known as a write overload, must be avoided. An equivalent condition occurs in reverse when the slowly advancing write address is caught up by the read address, causing a read overload.

The condition is handled with varying degrees of sophistication. The simplest approach is to blank the video until the addresses have moved apart again, a procedure which results in momentary black bars appearing in the picture.

A more complex approach is to cross couple the read and write generators such that each knows if it will create an address the same as the other by incrementing. In this case the increment cannot be performed. Clearly an interruption of the address sequencing of this kind could destroy the 4 line sequence in the memory. The solution is to subtract three from the line address instead of adding one, which will point to a line having the same position in the four line sequence. In some t.b.cs a subtraction of one line can be made, which causes a chroma inversion. Chroma inverted lines will then be Y/C seperated, and the chroma can then be inverted for the addition to the luminance.

The effect of write overloads is to cause memory locations to be overwritte, causing a vertical contraction of the scene within the raster. The effect of read overloads is to repeat certain lines, causing a vertical expansion of the scene.

The final part will cover dropout compensation and colour in t.b.cs.

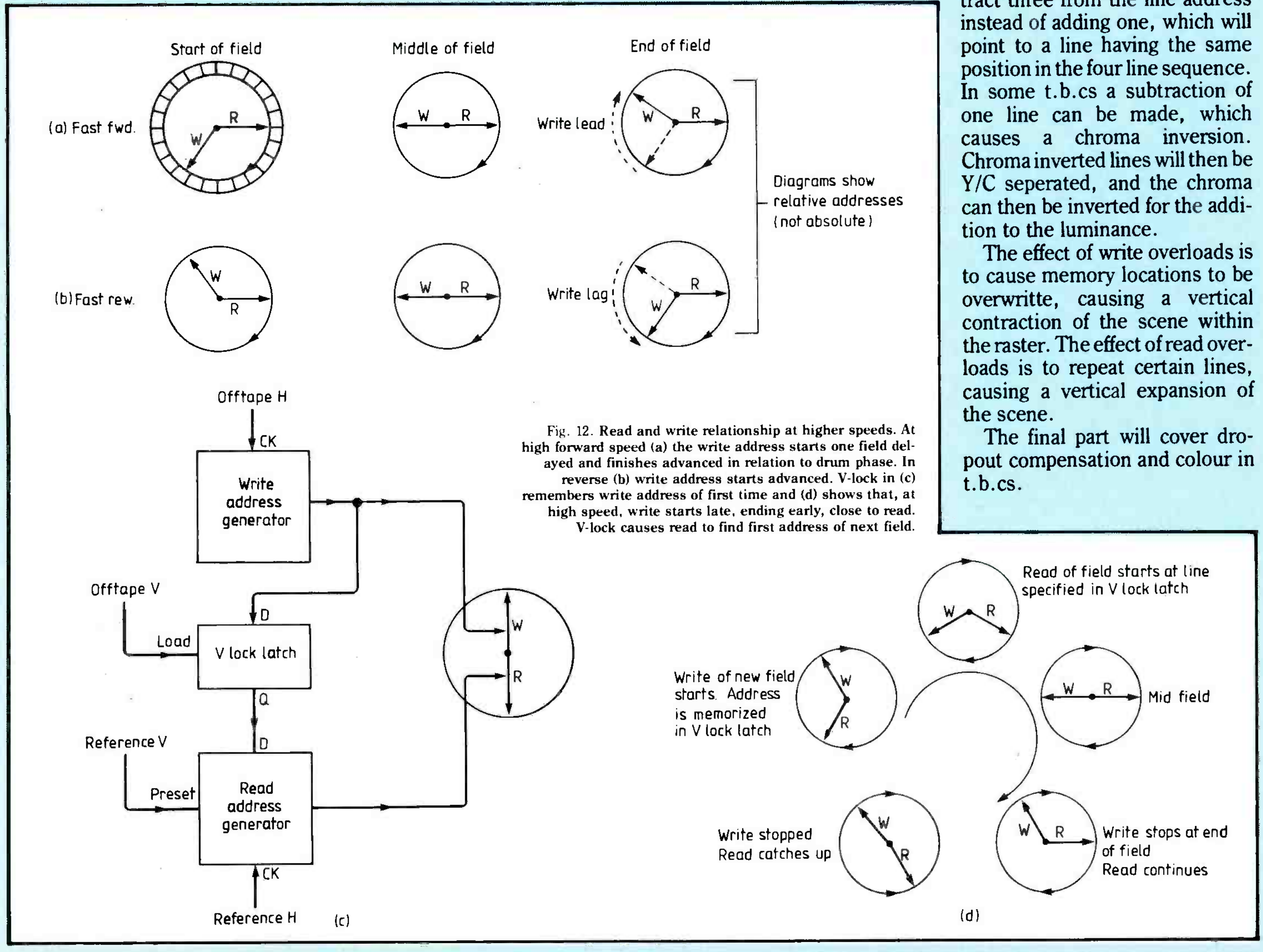
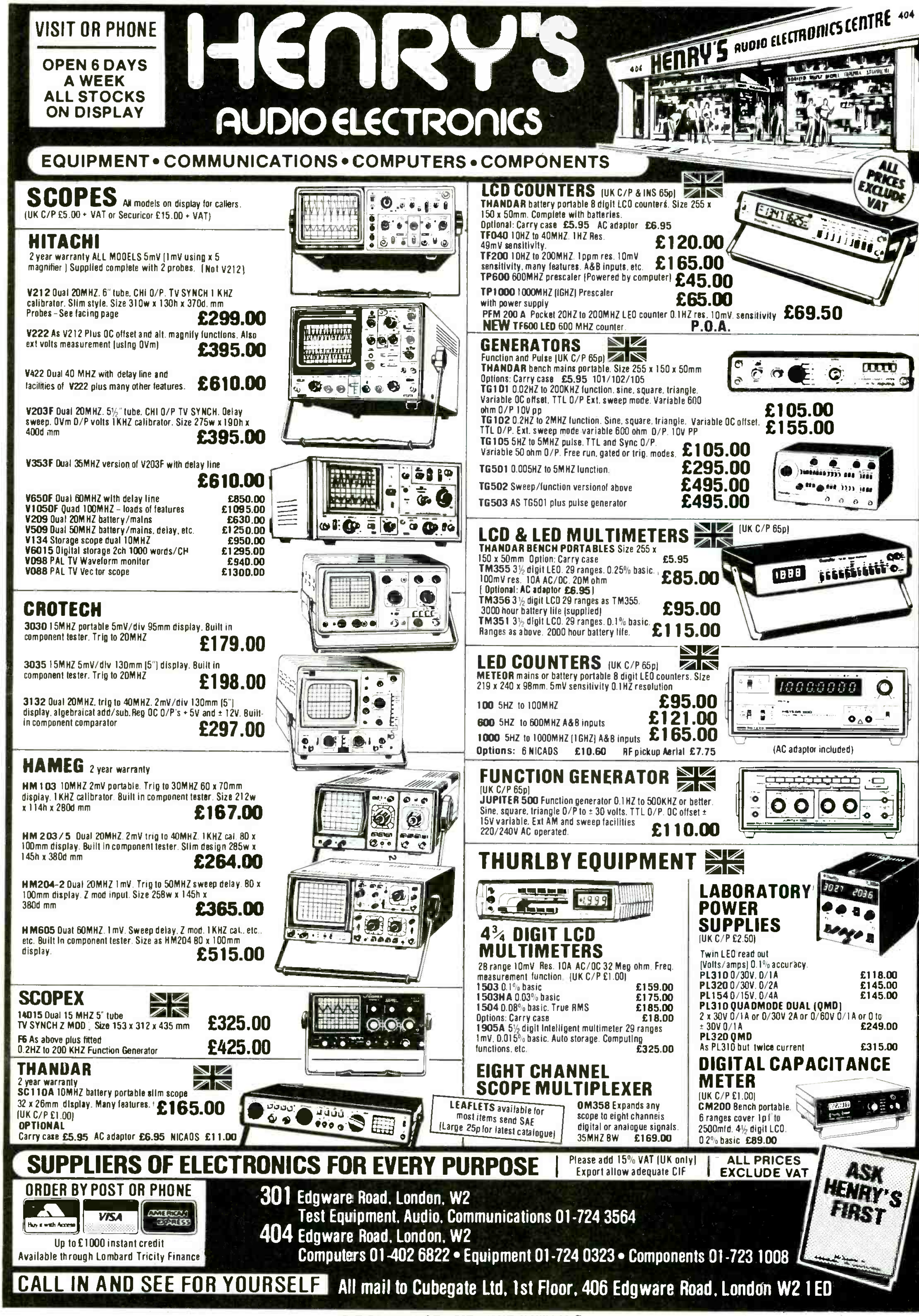


Fig. 12. Read and write relationship at higher speeds. At high forward speed (a) the write address starts one field delayed and finishes advanced in relation to drum phase. In reverse (b) write address starts advanced. V-lock in (c) remembers write address of first time and (d) shows that, at high speed, write starts late, ending early, close to read. V-lock causes read to find first address of next field.



CIRCLE 17 FOR FURTHER DETAILS.

Floppy discs

by David March

Floppy discs provide a cheap and convenient replaceable storage medium for use with microcomputers. David March explains how discs and disc operating systems work.

A floppy disc is a thin flexible disc coated with magnetic material inside a square sleeve. Inside, the sleeve is coated to provide a smooth, low friction surface. In operation the sleeve remains stationary whilst the disc spins within it.

The sleeve has various apertures and notches to allow access to the magnetic coating, to allow a drive cone to engage and for mechanical/photo-electrical sensors.

The write protection notch allows the user to ensure that valuable information is not inadvertently overwritten. The disc drive will sense when a protected disc is present and will only allow reading of data from the disc. Unfortunately, two standards exist for the different floppy disc sizes: on 5¼in. floppy discs the notch is covered to protect the contents, whilst on 8in floppy discs the reverse is the case.

For detecting the rotational position of the disc two different methods are available. Both use a single index hole in the magnetic disc to determine the start of each revolution. This is sensed photo-electrically. Subdivision of each revolution is provided for either by a further set of index holes (in hard sectored discs) or by magnetically recording a special identity pattern at the required intervals around the disc (soft sectored discs). The two systems are not compatible.

The remainder of this article deals solely with 5¼in soft-sectored floppy discs.

Originally only one side of the magnetic disc was used for recording information (the reverse of the side shown in Fig.1) but modern drives may have two read/write heads and use both sides of the disc. The disc is rotated at 300 rev/min, clockwise as viewed in Fig. 1.

On double sided discs, each face is usually treated separately. The sides are numbers 0 and 1, side 1 being the side with the label; however, some manufacturers prefer to number the sides 1 and 2.

The read/write head is moved radially in discrete steps, dividing the magnetic disc into a set of concentric data storage areas. Each area, known as a track, is one bit wide. For reference purposes these are numbered: the outermost track on side 1 is track zero, the next, track 1 and so on. Side 2 again starts with the outermost track — depending on the implementation this may be known as track zero or continue numbering after the whole of side 1.

The number of tracks on a side is determined by the mechanical precision of the disc drive. The tracks are spaced either 48 or 96 to the inch. The total movement of the head is restricted to rather less than one inch, giving 40 or 80 usable tracks.

The rate at which data is read or written is determined by the floppy disc controller (f.d.c.). It is necessary for the f.d.c. to remain in synchronism with the data being transferred. Originally this was achieved by interposing a clock pulse between each data pulse but with modern techniques the clocking information may be recovered from the data pulses. This allows a higher packing density for data. The transfer rate at the lower density (single density) is 125000 bits per second whilst at the higher density (double density) it is twice this.

Each track, which can hold about 3100 or 6200 bytes of data depending on the density, is divided into sectors. This provides a more manageable unit of storage, one sector being the minimum amount of user information which can be transferred. Typical sector sizes are 256 or 512 bytes of user information.

The sectors are numbered and each one begins with a series of synchronizing bytes followed by a set of seven bytes known as the address field. These contain information used by the f.d.c. to determine the sector number and data type and to confirm the track number. Further synchronizing bytes precede the user data in each sector and then two bytes of checking information complete the sector. Taken together these housekeeping bytes add an overhed of at least 40 bytes per sector. In addition, there are synchronizing and padding bytes at the beginning and end of each track.

Thus there is a trade-off between sector size and usable storage capacity. For example, with double density ten 512-byte sectors give 5120 usable bytes, whilst eighteen 256-byte sectors give only 4608 usable bytes. Yet both occupy the full track.

Formatting

The user establishes the sector structure by formatting the disc. This process uses special commands to the f.d.c. to create the appropriate synchronizing, add-

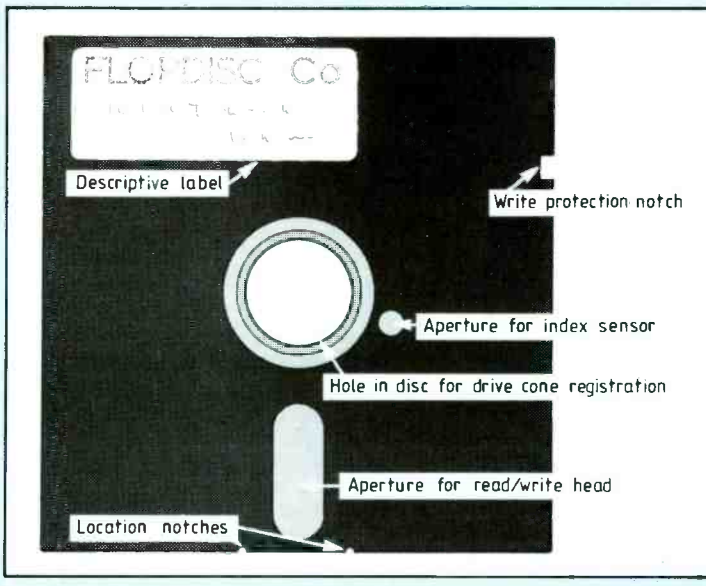


Fig. 1. **Features of a 5¼in. soft-sectored floppy disc.**

David March, C.Eng., M.I.E.E., was born 1941. He began dabbling in electronics at an early age when a Z80 was the size and shape of a light bulb and produced rather lumpy d.c.! He practised as an electrical power engineer until he was introduced to programming in 1968 on an ICL mainframe computer using Cobol and Fortran. He moved via assembly language programming on a mini computer to system design, and latterly system procurement, for real-time supervisory systems. he still dabbles in electronics: His interests centre on a Z80-based microcomputer and electronic organ. He is married with two daughters.

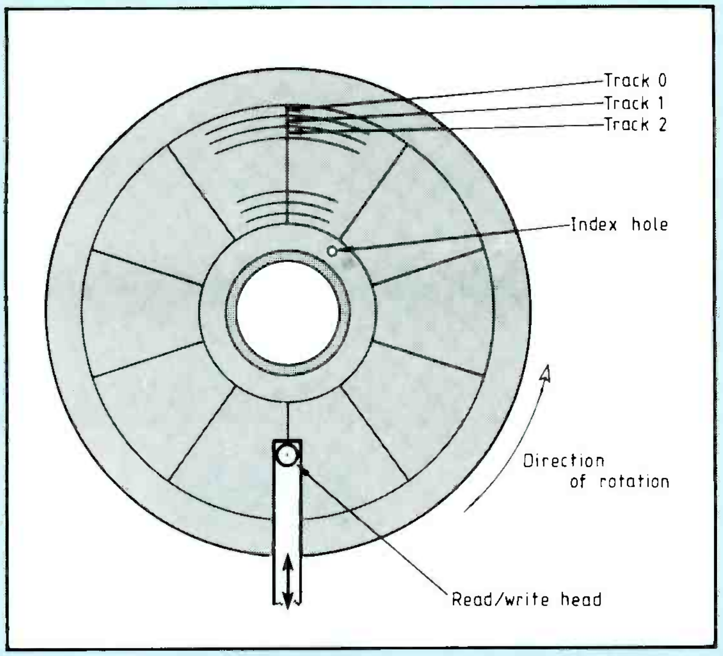
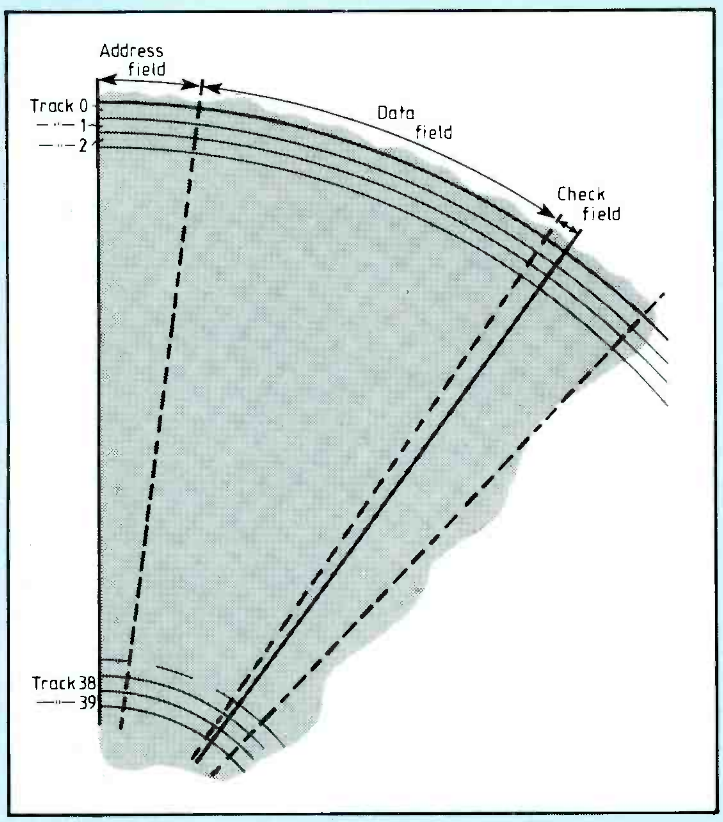


Fig. 2. **On a soft-sectored disc the index hole marks the start of the first sector in each track.**

Fig. 3. **In each sector, the data field is preceded by bytes which specify the sector and track numbers and the size of the sector. At the end of the field comes a cyclic redundancy check to protect against error.**



ress, data and checking bytes on each track.

A track begins when the index hole is detected and comprises a set of sectors which pass sequentially beneath the read/write head (Figs 2 and 3). During formatting each track is laid out on the disc in turn starting with the outermost (track zero) and proceeding inwards.

Disc drives

The drive unit includes the drive mechanism itself and some electronic logic to send and receive signals from the f.d.c. An independent power supply may be incorporated or the low voltage requirements may be derived from the attached microcomputer.

The main feature of the drive mechanism is a robust frame, typically made of cast aluminium, to which are attached the main drive shaft and its motor. The drive shaft is supported so that when the floppy disc is placed within its slot, the disc rests against one end of the shaft.

When the door or latch is closed a free-running cone passes through the major hole in the centre of the disc and locates in a recess in the end of the drive shaft. This centralises and grips the disc ensuring that it is held in precisely the same position each time it is mounted.

The shaft may be driven directly by a flat (pancake) motor, for example in a low profile disc drive, or via a belt from a motor mounted clear of the disc. According to characteristics of the drive the disc may be rotated continuously or only when sending or receiving information.

Behind the drive shaft and mounted in some form of slide is the read/write head assembly. This consists of a single head and a corresponding pressure pad or, for double-sided operation, a pair of heads one either side of the disc. When the drive is quiescent these do not touch the disc. When the drive is active for reading or writing a solenoid presses the head and pad (or both heads) into contact with the magnetic surface of the disc to allow the transfer of information.

A further motor, invariably a stepper motor, connected by some form of linkage to the head assembly, allows the head to be positioned precisely above any track. The linkage may be a helical screw, a cam track or a flexible steel band. Good design in this area and a robust frame are essential to allow the head to be positioned repeatably on tracks with a spacing of about 0.3mm (in an 80 track drive). When the door or latch is opened the head assembly is moved well clear to allow the floppy disc to be withdrawn or replaced.

Also mounted on the frame are the sensors for the index hole and for the write protection notch. On some drives these may additionally serve to detect when a floppy disc is being inserted. This permits the drive shaft to be rotated as the floppy disc is gripped by the cone and improves the precision with which the disc is located.

The electronic logic receives signals from the f.d.c. to activate the motors and solenoid and return status information to the f.d.c. The logic carries out various timing and interlocking functions to rotate the disc at a constant speed, to isolate the writing circuits when write protection is activated and to amplify and shape the reading and writing data pulses.

A photo-electric sensor enables the computer to synchronize reading and writing with the physical position of the magnetic disc. In most drives, the read/write head is pressed into contact with the disc only when read or write commands are issued from the computer. A sensor detects the presence of the write protection notch. When a write protected disc is present, the electronics associated with writing are inhibited within the drive itself and the write protected status is passed to the computer.

Disc interface

Most disc drives pass data pulses to and from the f.d.c. through a standard electrical and physical interface. Known as the Shugart interface after the disc drive manufacturer, this consists of a 34-way edge connector for a printed circuit board carrying t.t.l. compatible signals.

The **drive select** signals allow several disc drives to be connected in daisy chain fashion to a single f.d.c. which will then activate only one drive at a time, causing the read/write head to be loaded in the selected drive.

Motor on causes the discs to be spun in all drives irrespective of which drive is selected. This minimises the time taken to switch from drive to drive.

Other commands are inhibited except when the drive is selected.

R/W head direction presets the head movement inwards or outwards.

R/W head step causes the head to move one track in the preset direction.

Write data and clock receives the pulse steam from the f.d.c. for writing to the disc.

Write gate activates the writing amplifier to allow the pulse stream through to the read/write head.

Side select chooses side 0 or 1 in a drive equipped for double sided use.

Index pulse is triggered by the index hole at the start of the track.

Track zero is active when the read/write head is positioned at the outermost track.

Write protection is active when a protected disc is placed in the drive.

Read data and clock sends the amplified and shaped pulses to the f.d.c.

The BBC microcomputer interface supports only Drive Select 0 and 1 (pin 14 left unconnected) and uses the spare pins 2 and 4 as an alternative Side Select and Index Pulse respectively. The TRS-80 Model 1 allocates Side Select (pin 32) as an additional Drive Select to allow a fourth drive to be connected. These inconsistencies are generally benign.

Floppy disc controller

Most of the logic to control the disc interface is provided by a single l.s.i. chip. This handles timing and synchronization, parallel-to-serial conversion and vice versa, track and sector positioning and error detection and reporting.

Other discrete logic provides drive and side selection, address decoding and primary clocking information. All this logic is closely coupled to the microcomputer through the control, data and address buses for receiving commands and returning status signals and user data.

The f.d.c. operates under the control of the attached microcomputer. The commands (and parametric data) are placed in registers internal to the f.d.c. wich initiates the commands by signalling to the disc drive and advising the microcomputer when data is required or available. When the command is complete it provides a status report.

Typically the command and parametric data registers are allocated adjacent addresses in the microcomputer input/output memory space or i/o ports. The f.d.c. will provide additional internal registers for its own use. It may also be connected into the interrupt hierarchy and d.m.a. interface if these are provided.

On initialization of the disc system the microcomputer loads any basic parameters which the FDC requires for normal operation, for example disc drive selection and head stepping intervals, and then issues a command to reset the head to track zero. The f.d.c. sets the Head Direction signal to outwards and pulses Head Step until it recognises from the Track Zero signal that the head is at track zero. The f.d.c. then clears the track register, sets the Disc Controller Ready status indication and triggers the interrupt signal. The microcomputer is now free to issue further commands to the f.d.c.

Other commands operate in a similar way, the microcomputer loading the track and sector numbers as parameters into the f.d.c. registers before issuing the appropriate code to the command register.

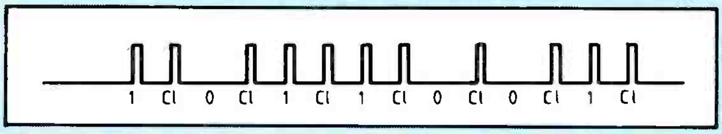
During normal read/write operations, the microcomputer specifies which track and sector are to be used for the transfer. The f.d.c. determines whether head movement is required and in which direction by comparing the value in the track register with the requested track number. It then issues the appropriate number of step pulses.

Normally the f.d.c. will ready the address fields to confirm that the correct track has been found and will update the track register. Either or both of these supplementary actions can be suppressed to allow processing of discs which have inconsistent physical and logical track numbering schemes. For example, an 80-track drive can handle a 40-track disc if the head is always moved in two track increments from track zero. The physical track number will always be twice the logical track number.

Data synchronization

The pulse stream to and from the disc contains both data and synchronizing information. At the most primitive level, information is needed to enable individual data bits to be recognised. It is at this level that the differences between single and double density arise.

In single density working, a regular clock pulse stream is interleaved with data pulses whose presence or absence indicates a data bit value of 1 or 0. For example, a data pattern of 1011001 looks like this:



The time interval between clock pulses is 8µs and the data pulses occur midway between adjacent

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Basic disc controller commands provide the following functions:

- reset all logic and terminate any active command
- reset head to track zero
- activate drive motor and time out if no commands for an appropriate time — typically about five seconds
- select drive and side
- move head to specified track
- read user data from specified sector
- write user data to specified sector
- verify user data in specified sector
- format track
- terminate current command.

Basic disc controller status signals include the following:

- disc ready to receive next command.
- controller ready to receive next command.
- disc write protected.
- requested track/sector not found.
- ready to send/receive next data byte or direct memory access ready/acknowledge.
- head at track zero.
- various failure conditions.

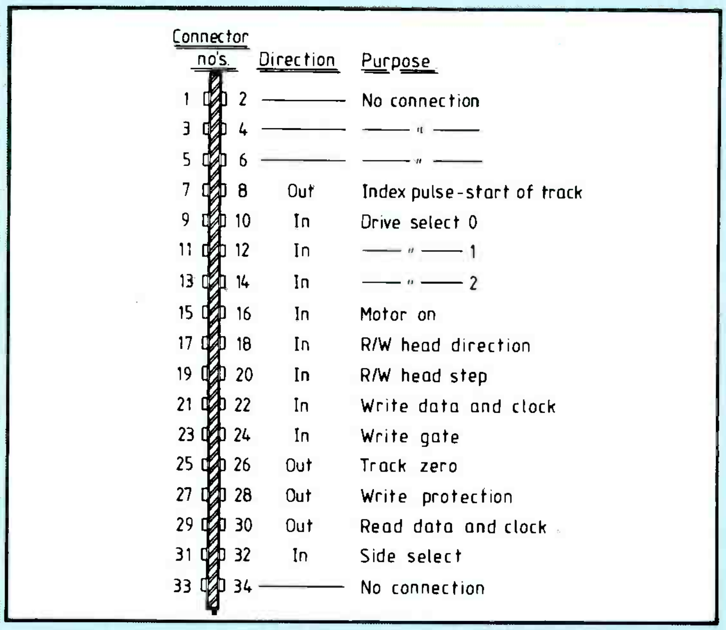


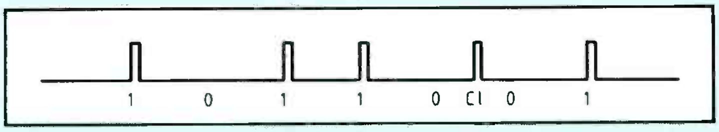
Fig. 4. **Edge connector details of a 5$\frac{1}{4}$in. disc drive. Direction *in* denotes a signal towards the disc drive, *out* a signal from the disc drive. Even-numbered pins 16 to 24 inclusive require 150Ω pull-up resistors at the end of the cable remote from the f.d.c. Odd-numbered pins are all signal ground.**

In the second part of his article, David March will describe some practical disc operating systems.

clock pulses. This has the effect of producing a frequency modulated (f.m.) signal which switches between 125kHz and 250kHz.

Data bits are zero when the frequency is low and one when the frequency is high. Each pulse is recorded on the disc as a pair of magnetic flux changes. The minimum distance between pairs of flux changes occurs on the innermost track between data pulses representing a bit value of 1 and the adjacent clock pulses and is less than 0.005mm. This is the limiting factor for reliable magnetic storage.

In double density working, the clock pulses are suppressed except between successive data bit values of 0. The same data pattern as in the single density example above reveals the significant reduction in pairs of magnetic flux changes for the same data pattern. The worst case occurs when adjacent data bit values are 1. A comparison with the single density case gives a time interval of 8μs for 101, 4μs between two 1s and 6μs at the beginning and end of 1001.



The result is a modified frequency modulated (m.f.m.) signal switching among 125kHz, 250kHz and 167kHz. Thus the data storage density is doubled with no increase the proximity of magnetic flux changes, but at the expense of additional complexity in generating and recovering the data stream.

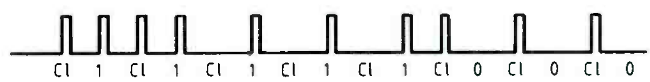
Field synchronization

At a higher level the f.d.c. must be able to recognise the address and data fields. This it achieves by placing a unique bit pattern at the front of each field. The de facto standard for the original 8in. floppy disc was the IBM 3740, which established the address and data field structure. In a slightly modified form this has been retained for 51/4in. floppy discs. Since all 256 possible values of an eight-bit byte must be available for use within the data field, the unique bit pattern is created by suppressing further clock pulses.

To ensure that the f.d.c. is in a stable condition, the bit pattern commences with a minimu of 400μs of data value zero, i.e. uninterrupted clock pulses. In single density, a single byte in the range $F8_{16}$ to FE_{16} with three missing clock pulses follows. In double density, three bytes of A1 or C2 with one further clock pulse missing are followed by a single byte in the range F8 to FE. F8 to FB precede the data field, FC indicates the index hole and FE precedes the address field (FD is unallocated).

Track structure

The purpose of the track structure is to allow the data within individual sectors to be read into the microcomputer and to enable new data to be written from the microcomputer without interfering eith data in other sectors. The f.d.c. recognises the field synchronization information and presents or requests data. When the specified sector has been found. Small gaps are left between the various fields to allow time for this response.



Field synchronization: F8 (above) and A1 (below), both with missing plot pulses (see text).

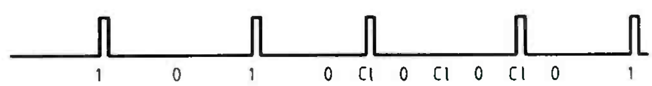
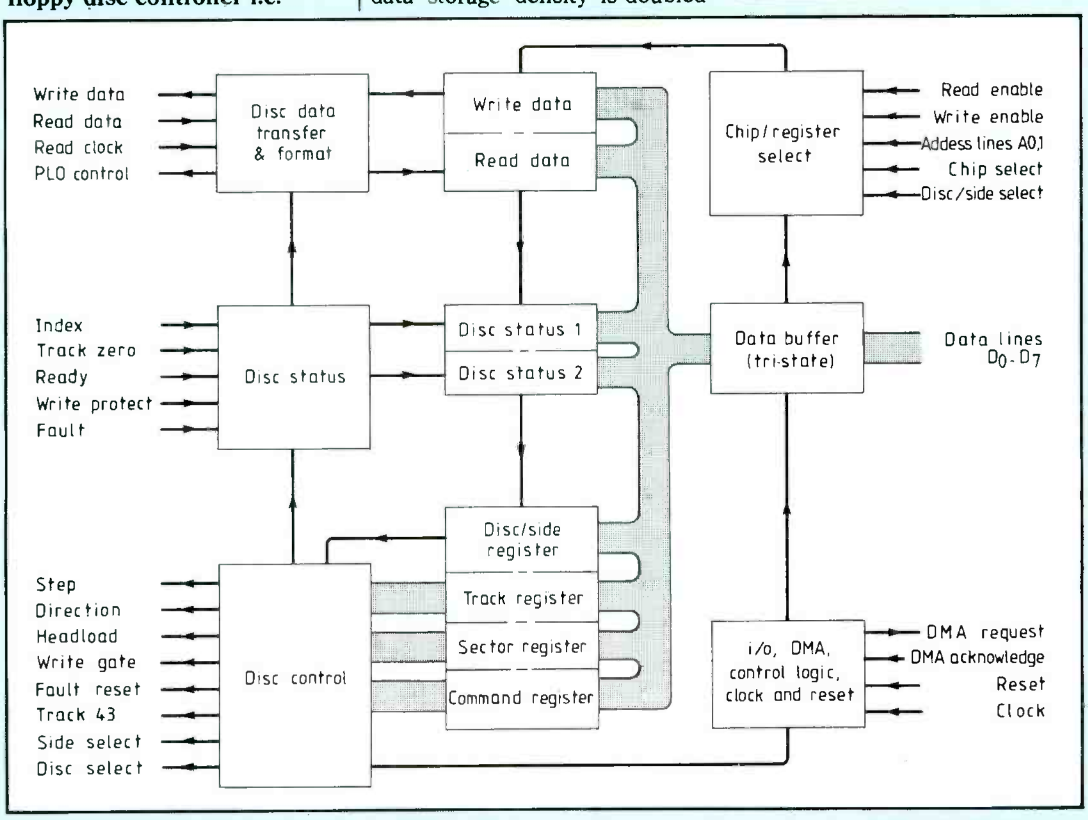


Fig. 5. **Block diagram of a floppy disc controller i.c.**



The start of each track is determined by the index hole but may also be indicated magnetically by a field synchronization pattern with a coding of FC. This magnetic encoding appears to be redundant. Each track begins with padding bytes to leave a gap.

Each sector begins with a synchronization pattern with a coding of FE followed by four bytes which specify the track number, side, sector number and coded sector size. These four bytes are processed to generate a 16-bit cyclic redundancy check which is held in the next two bytes. Furter padding bytes are succeeded by a field synchronisation pattern with a coding of F8, F9, FA or FB and the by the data bytes themselves. The data bytes are also processed to generate a cyclic redundancy check which is held in the succeeding two bytes.

Each sector is completed by a small gap of padding bytes and finally the track is filled up with padding bytes until the index hole recurs.

More on the XY plotter

Concludes the up-dating article on this versatile design by P.N.C. Hill

If both options yield the same deviation then both stepper motors could be stepped simultaneously to give a true 45 degree step. However, the extra time involved in checking for this condition is probably not justified, as performance seems to be more or less unaffected (although this may differ from one plotter to another).

The above method only caters for lines in the first quadrant (lines from bottom left towards top right). The movement in the X direction can either be left or right whilst the Y direction can either be up or down. This is calculated before the start of the actual drawing and made note of so that when say MOVE IN X DIRECTION is executed the motor is moved either left or right as noted. From then on X1 and Y1 are only important in magnitude and not sign. This generalizes the algorithm for any line.

The last important point to consider is a step repetition rate. This is best done by experiment. A delay routine is added to ensure that neither motor receives pulses too quickly to respond. If a gently sloping line is to be drawn (gradient less than one) then a delay need only be inserted each time the X motor is stepped. No delay need be inserted after a Y step as no two consecutive Y steps are ever issued without interposing X steps which serve as the delay. The situation is conversly true for lines with gradients greater than one.

Improved performance can also be achieved by accelerating the motors at the start of a line and decelerating them to standstill at the end. Overall plotting speed may be improved by this technique as the main limitation appears to be the overshoot obtained when the pen suddenly changes direction. This would naturally be reduced with the more gradual changes.

Complete vector generator. A complete line drawing procedure written in Pascal is shown in Listing 1, which is fairly self-explanatory, even to those not familar forms all the above mentioned tasks and need only be given the coordinates of the endpoint of the line to be drawn.

In addition, the routine is able to draw dashed lines. The underlined section controls this function. Setting the variables DASH SIZE and GAP SIZE controls the mark-space ratio of the resulting line.

The delay procedure will naturally depend on the speed of the computer on which the program is run.

Drawing circles. Once the line drawing routine has been perfected everything follows onwards from it. Drawing circles can be done in a number of ways.

A circle can be drawn parametrically by making the X component proportional to a sinusoid and the Y component proportional to a cosinusoid. Changing the relative phases of the functions results in an elipse. This is just a simple form of Lissajous figure.

As the circle is one of the basic shapes required for drawing diagrams, an integer-based routine which yields an optimun step approximation of a true circle is obviously desirable. This can be done in four parts; one for each quadrant. In each quadrant there are only two possible directions in which the pen can be moved, as Fig. 9 indicates. The technique is similar to that used in the DRAW procedure. Each of the two solutions are tried and the distances of the pen from the origin of the circle are then calculated for each by a simple application of Pythagoras. The solution which leads to the smallest deviation from the required radius is chosen for the actual movement of the pen. The resulting circle drawing procedure should use the DRAW procedure for actually moving the pen even though only one step at a time is moved. This enables dashed circles to be drawn in the same way as for straight lines so maintaining compatibility. Figure 10 shows how this technique performs.

Although the above technique will give the best results possible, it is not so easy to adapt it for drawing arcs, which form another of the important building blocks required for drawing larger diagrams. This can be done more easily with the parametric technique.

Use as a stencil and drafting aid. The technique for drawing alphanumerics was mentioned in the previous article. Each character is defined on a 16×16 grid in much the same as with a matrix printer except more points are used. The sequence of coordinates is then processed by the program which simply moves the pen from one point to the next. The actual active area of this grid that is used for normal characters is shown in Fig. 11. Rows 0,1,2 are reserved for descenders and graphics, underline etc. Columns 11-15 are also not usually used to provide for extra-long symbols to join with the following characters.

Listing 2 gives the data for the full ASCII character set in both upper- and lower-case. FEH is used as a pen drop code, EFH is used as a pen lift code and FFH is used to terminate the data for each character. The data table is accessed by scanning from the

Fig. 9. **Demonstrates the smoothness with which circles can be drawn.**

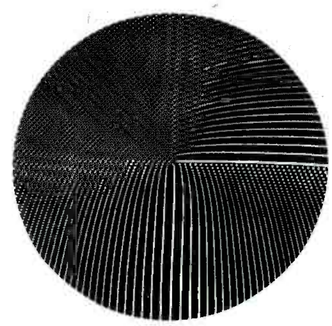
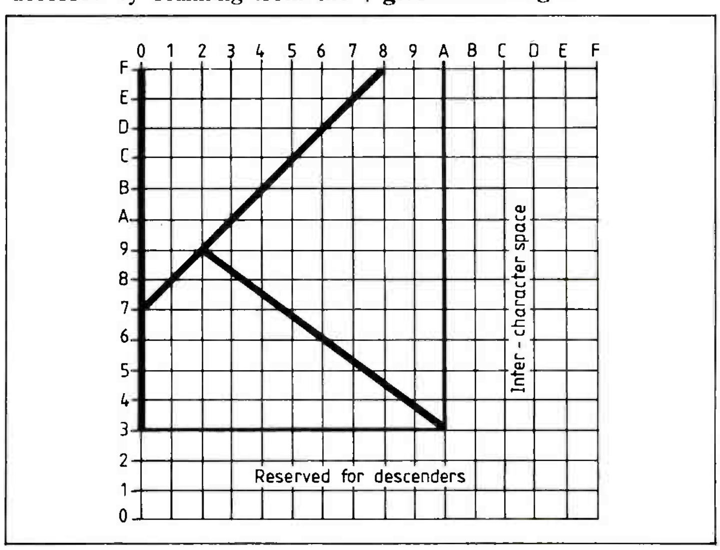


Fig. 10. **Grid system used to define alpha-numerics and simple graphics. The data representing the letter K is given in listing 2.**



FOOTNOTE

*Listings referred to in this article can be obtained by sending a stamped, addressed envelope to this office. Please mark your letter 'XY PLOTTER'.

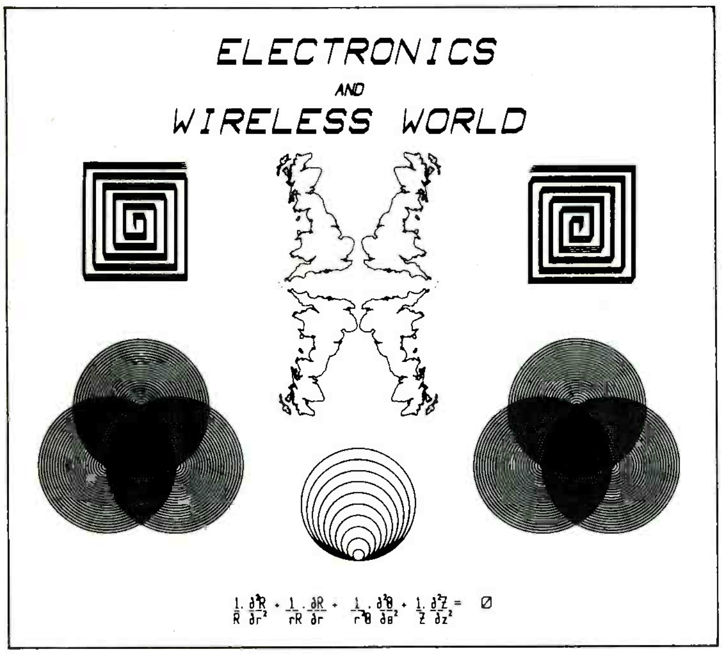


Fig 11. **With suitable software the plotter is a useful aid in preparing artwork.**

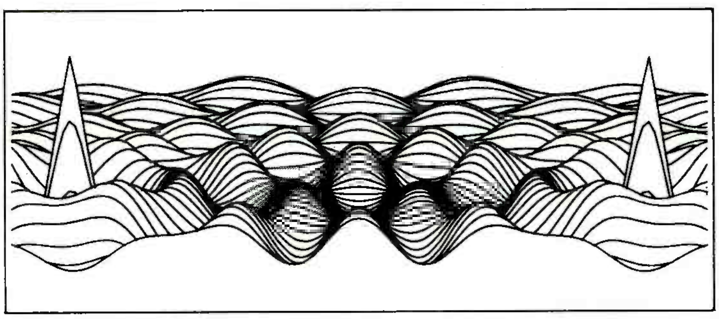


Fig. 12. **A clear indication of the effectiveness of the hidden line removal algorithm described.**

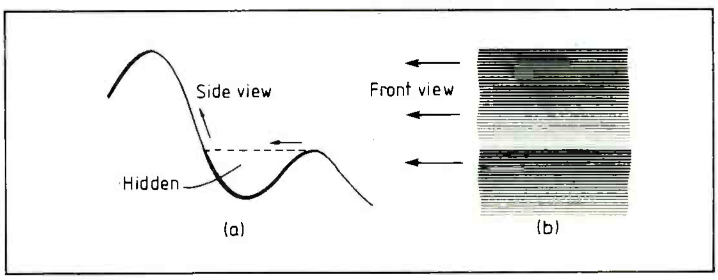


Fig. 13. **Hidden line removal. The area marked as hidden in (a) is lower than the peak to the right.**

beginning for FFH. When this code is found, the following byte contains the character code. When the correct character code is found, the following bytes as far as the next FFH form that character's data.

The data as given produces a standard 'Elite' character set. Other types faces can be produced by manipulating the coordinates. They can be scaled (enlarged or reduced), the aspect ratio can be altered, they can be 'tipped' forwards for italics or leant backwards as shown in the text at the end of Listing 2. Characters can be over-written to thicken the lines and produce print with apparent depth. All this can be supported in the control program by using control characters embedded in the text which is to be drawn. If control characters (ASCII 1-26) are used for this purpose then these can be embedded in text prepared using a word-processor such as Wordstar. Figure 12 shows the various options available in the interactive control program mentioned. Sub-scripts, super-scripts, overprints, underlines, half-spaces etc. may all be inserted as control characters.The cylindrical coordinate version of Laplace's equation was written out using this program and is shown in Fig. 13. This took only a few minutes to enter at the keyboard but the results would take much longer to achieve by using stencils.

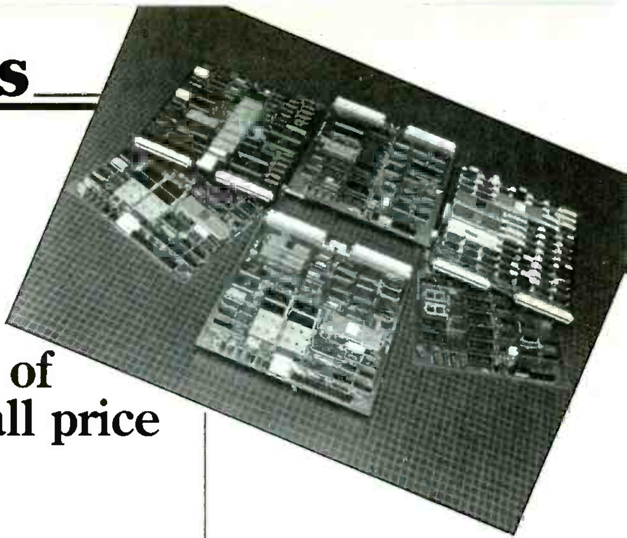
Picture with depth. The X/Y plotter is naturally limited to expressing diagrams and pictures in two dimensions. There are a large number of instances, in engineering particularly, that benefit from analysis in three dimensions. The plotter can be made to express such three-dimensional drawings on the two-dimensional sheet of paper. A technique which can be used in general applicatiions is simply a trick to fool the eye. The diagrams in Fig 14 and 16 illustrate this. It shows the interaction of two circular wavefronts on a membrane. The result is naturally an interference pattern. The program required to draw such figures is suprisingly simple and short.

The three dimensional effect is a result of hidden-line removal, which is particularly evident in Fig. 16. This is simply the removal of any lines that would be hidden from direct view if the object was truly three-dimensional. Figure 15 shows this. Viewing from the right side, all points to the left of and lower than the right hand peak are hidden. If the shape is drawn in front projection (Fig. 15(b)) the drawing is done from the 'near' side backwards. When the pen drops below the highest line drawn on the paper so far at that current X coordinate then it is lifted from the paper. It is only put back in contact with the paper when the pen moves above the level of the highest line drawn so far. We must therefore keep a continually updated record of the highest point (greatest Y coordinate) reached on the paper at all corresponding values of X. This horizon is stored in an array equal in length to the number of steps acros the page (left to right). The draw procedure is modified such that if the Y coordinate of the current pen position is less than that held in the corresponding element of the array, then the pen is lifted. If the converse is true, then the pen is dropped onto the paper and the element of the array updated with the current Y coordinate of the pen position.

As mentioned, a modified draw command performs all this. The actual program which generates the ripple patterns is shown in listing 3: the version shown only produces a single peak rather than the double peak as shown in Figs. 14 and 16. The program is easily understood if it is imagined that the height of the surface above the floor is given by the trig. function whose argument is the horizontal distance from a fixed point on the floor. The height is calculated at regular intervals and then projected as if viewed from an angle to the horizontal. Altering the various parameters at the start of the program allows an almost limitless selection of patterns to be drawn.

Other uses. The plotter is also useful for drawing graphs and histograms: Fig. 17 is an example. Labelling was added using the separate interactive program described. The graph shows a frequency response simulation of the digital filter whose impulse response is shown top right. Phase and pulse responses and output sequences resulting from any specified input can also be calculated and shown graphically. Graphs are accurately drawn so relative measurements can be taken from them, although absolute measurements can be obtained in tabulated form from the program.

Computer boards



This starting point for potential buyers of computer boards includes products in all price ranges for everyone from enthusiast to equipment manufacturer.

One thing that all buyers of computer boards have in common is the need for i/o other than just a v.d.u. and keyboard. Ideally, a board conforms to a bus system for which there are add-on boards from more than one manufacturer. These buses include STD, IEEE696 (S100), Multibus, 80-bus, Q-bus, Versabus and more recently, VME, STE, G64, Futurebus, etc. (and IEEE488 for readers thinking of interfacing measuring instruments). Ideally, the board also complies with standard 19in rack equipment but not all popular bus specifications allow that, especially the older ones.

A drawback of compatibility with 19in rack equipment and standard buses though is that it tends to make the end product expensive. Boards with edge connectors are often used to save costs, but to conform with 19in-rack Eurocard backplanes, DIN 41612 connectors must be used. Complete computer boards reduce the need for connectors and hence reduce cost, but often at the expense of flexiblity. With boards designed for rack mounting, one invariably has ready access to the microprocessor bus; this is not necessarily so with complete computer boards.

As the first decision you will have to make is whether or not you want a rack-mounting board, these descriptions have been divided into two sections — computer boards, and Eurocards for rack mounting. A Eurocard sized p.c.b. measures 100 by 160mm, a double Eurocard measures 233 by 160mm. Note that there is equipment for mounting boards conforming to other standards in 19in racks (inc. Multibus and S100).

Board descriptions

Designed primarily for program development and o.e.m. applications, **CA901/2** boards from Costgold Research Ltd support CP/M86 (concurrent version due this month) and MP/M86 and use vectored interrupts. The optional CP/M86 operating system with utilities is £199. Prices include hardware manual with circuit details and a user guide for program development/debugging using the inbuilt monitor program. A real-time clock is standard on the 902. Three variations on these boards are available as are v.d.u., floppy and hard disc, colour graphics, i/o and IEEE488 interfaces. Software is also supplied by the company.
E&WW 301

For use as a general-purpose computer or development system, **Maggot 09** requires a keyboard, disc drives, video monitor, supply and either Flex or OS9 operating system. Manufacturer Deephaven says that the product is intended for professional and o.e.m. applications, but may be of interest to the 'serious home user'. A bare board with roms, programmable logic array for address decoding and data is £70 (ex. v.a.t.).

One of four d.m.a. channels is used for disc interfacing, for 8 51/4 or 31/2in drives (mixed type and density if need be); the three remaining channels are spare. Serial data rates are selectable and the versatile interface adapater used for parallel i/o with handshaking has two interrupting timer counters. A battery-backed r.t.c. is included. Peripheral boards are planned for hard discs, eprom programming, printer, analogue input and colour graphics. E&WW 302

Over **30 single board computers** and processor units are supplied by Fulcrum. There are some 200 products in the short-form catalogue including memory, video controller and i/o boards, hard/floppy disc drive controllers, development systems and software. The company specialises in IEEE696 bus (S100) systems for professional use and sells a technical manual describing these products — over 150 of them — for £15.

Prices of processing units range from £320 for a 6MHz Z80 board with vectored interrupts and capable of addressing up to 1Mbyte, to £3300 for a complete 80186/8MHz single-board computer with 128Kbyte ram, d.m.a., disc interface and serial/parallel ports. The 80186 computer board is CP/M86, TurboDOS and MSDOS compatible. Three boards use the 68000, one uses the 16032 and one a 6809; all others have either a Z80 or 8086-like processor. Computer board manufacturers represented are CCS, Compupro, Macrotech, Dual Systems, LDP, ADC, IAC, SD Systems, Teletek, Ackerman and Sierra Data Sciences.
E&WW 303

The **Eleven-Q** microcomputer from RCS Microsystems runs Forth using a 6500-family processor and can be developed by attaching a keyboard and 5V supply, or on a higher level using Rockwell development systems. With its 20-character display, a keyboard and full source listing of the monitor program the board costs £299; Eleven-Q Forth with manual is £48. The 4Kbyte of cmos ram is battery backed and the board accepts Rockwell peripherals and other i/o cards. Three 11-bit timers are available to the user.

Development boards for the Rockwell **single-chip Forth** system are also available. The Essex Forth Microboard at £125 and a Eurocard single-board computer, the **SBM-CO2**, using the cmos R65C02 (to be anounced, around £250), are new products from the company. E&WW 304

Interfacing and monitor software on Deltek's **IQ200** computer accommodate floppy and hard-disc drives. The board uses a SASI interface for hard discs and d.m.a. to speed up data handling. CP/M bios is included in the price, but not the system disc,

These double Eurocard boards (above) all look different and use different microprocessors, but they all have a similar specification. (Sirius Microtech).

Late details

Products not listed in the tables but included in the text section are Fulcrum, Sirius Microtech, L.J. Electronics, Siemens Flight Electronics, Quant Systems, Pelco, GNC Electronics and Thomson CSF. Macro Marketing for National Semiconductor, NEC, RCA, Texas Instruments and Zilog, (E&WW 305) and MEDL Distribution for Intel, Microtek, Di-An Microsystems, Zitel and Advanced Micro Support (E&WW 306) produce comprehensive and straightforward product guides. S100-bus boards from High-Technology Electronics are distributed by Verospeed. (E&WW 307) Microprocessor manufacturers invariably produce evaluation boards for their products.

and the company is currently working on software modifications to use recent Kodak 2.6Mbyte, 51/4in drives with the same data rate as 8in drives. Ports are included for v.d.u. (with graphics), keyboard and a serial printer. A Centronics interface is available. E&WW 308

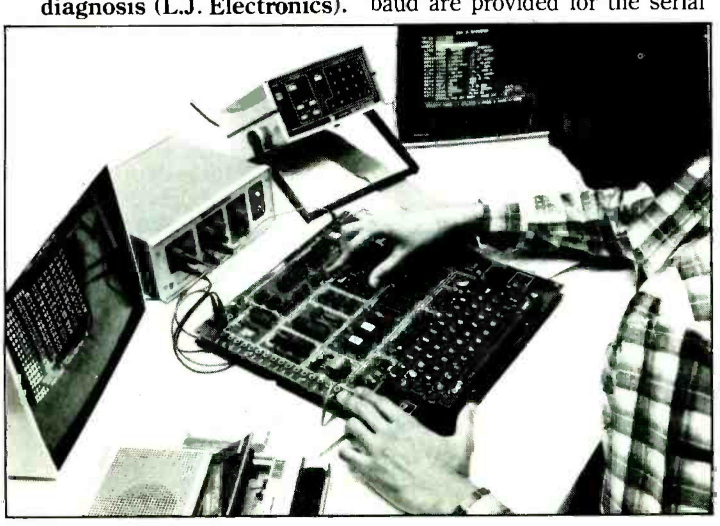
Two solely educational computer boards, **Marc** with a Z80 and **Tina** with a 6502, are produced by by L.J.Electronics. Both boards have a keyboard, selectable faults (for diagnosis teaching) and are compatible with other educational products from the same company.

Marc includes assembly/disassembly software, a monitor and routines for a light-pen and debugging. On-board facilities include system monitoring points and direct connection for the company's SA2 logic analyser. Memory limits are up to 16Kbyte of battery-backed ram and 40Kbyte eprom. Tina, intended for advanced applications control programming, has colour graphics, 'user-friendly' software and an on-board eprom programmer. Interfaces include RS232, IEEE488 and Centronics. E&WW 309

Dedicated output for a 640 by 576-row colour-graphics board is provided on the **Delvex 801806** computer, one of three boards from Country Computers. It also has input for an auxiliary keyboard, mouse or digitizer and supports 31/2, 51/4 or 8in floppy disc drives, and hard drives through an SCSI port. Memory may be expanded to 32Kbyte of rom and 1Mbyte of ram, on the board, using 256Kbyte devices. Interrupts are handled by an Intel 8259 controller, there's one spare d.m.a. channel, and an r.t.c. provides additional timing support. Buffered address, data and control lines are accessible.

Two other boards from the company use 4MHz Z80's — in fact the **PCB04** uses five of them, each with its own bank of 64Kbyte ram, counter/timer i.c and serial i/o device. Sections of the board communicate with each other through a 'letterbox'. Applications suggested are concurrent sequential processing, data acquisition and processing high-speed, asynchronous, serial data for sending to a mainframe computer through the board's synchronous serial interface. The last board, also with a 'letterbox' and compatible with the PCB04, is said to be of interest to developers of file servers, networks, etc, due to facilities like three serial ports, one of them high-speed RS422, d.m.a. and a QIC-02 streaming-tape interface. This board, Masterboard 5, has a hard-disc interface that can be adjusted to suit either SASI or Western Digital controllers, a floppy-disc interface and a real-time clock/calender. E&WW 310

An educational board on which faults are programmable helps students learn fault diagnosis (L.J. Electronics).



As a bare board with monitor rom, fuse-logic chip set and documentation only the 68008-based Micronix **ESB-1** computer board costs £199. Fully built, the board runs Microware's OS9/68000 operating system (extra) using 51/4, 31/2, 31/4 or 3in drives. For compatibility with much existing software, single-user CP/M 68K is also supported. The 16Kbyte monitor includes debug facilities, i/o control, single-line assembler and disc read/write routines. Software selectable data rates from 50 baud to 32 kilobaud are provided for the serial ports. Address, data and control lines are brought to a connector for use with peripherals and the company's 128Kbyte ram expansion board (£199). Micronix supplies operating-system/language software. E&WW 311

Boards conforming to the STD-bus standard and IBM PC compatible add-ons are supplied by Altek. The **Pulsar 6000** microcomputer is a small Australian import that includes a 64Kbyte ram, 2Kbyte monitor prom, floppy-disc controller, r.t.c. and software-selectable serial data rates from 50 to 19200 bit/s. Its CP/M bios, supporting 'type ahead' and time of day, switches automatically between single/double density (512byte sectors). The CP/M operating system has six utility programs; other operating systems are planned. Utility program/bios source listings and circuit diagrams are included in the manuals. Input/output is through STD-bus connectors.

STD cards from Pan-Asia are also supplied by Altek. These include a 4MHz Z80-based processor with counter/timer device (the **B-CPU2**), a 192Kbyte ram expansion board, floppy disc controller, eprom programmer, analogue i/o, relay output, isolated i/o and a printer card. Among the **IBM PC add-ons** from Multitech are colour graphics, memory expansion, display adaptor, hard-disc controller and serial communications boards. A multifunction peripheral board comprising memory expansion, communications port, printer output, r.t.c., disc emulator and spooler is also available. E&WW 312

Possibly the cheapest 10MHz 68000 board with memory and i/o is the **Andelos** Systems' **68000**, which sells mainly to universities and technical colleges. Its monitor, in two 2764 eproms, has 16 basic commands and allows input in binary, octal, decimal or hexadecimal form. There is 12Kbyte of eprom spare, but if more is needed, the 2764s can be replaced by larger devices. Similarly, the static rams can be replaced by larger ones to give 16Kbyte. Eight data rates from 110 to 9600 baud are slectable on the programmable serial interface, which includes modem control lines and an interrupt facility. Two decoded select signals and all address, data and control lines are brought to i/o connectors. Monitor listings, circuit diagrams and an eprom programmer that plugs directly into the main board are available as are cross assemblers. E&WW 313

Simultaneous text and high-resolution graphics on separate c.r.ts is possible on the **Microkey 4500.** Three processor options are 6502 with Forth 79 (Poly Forth optional), 6809 with Flex, and the Werstern Design Centre 16-bit 6502, the W65SC816, which is capable of addressing 512Kbyte of memory in two banks; 128Kbyte in two banks is used with the eight-bit processors. Eprom, in the form of two 2764s or 128s (27256s using the 16-bit processor), can be switched out of the address space. Floppy-disc interfacing for 31/2 or 51/4in discs is standard and 16-colour 640×200 pixel colour graphics is optional. Modem signals are incorporated in the 16 data rate serial interface. Bus signals, including a d.m.a. channel for the 6809 version are brought to a 50-way connector. E&WW 314

Since our mention of Rade in the January 1984 computer board survey, the company has brought out a version of its 150 board without video and disc interface sections, but with serial and parallel interfaces added. This board, the **Rade 50,** has space for up to 16Kbyte eprom, independent data rate selection for each serial channel and memory bank switching in 16Kbyte increments. Applications include a Z80 add-on (with CP/M using optional floppy-disc board/operating system) for any computer or RS232-compatible device, and turning a dumb terminal into an intelligent one.

The company's **150** board includes floppy-disc, d.m.a. and video controllers. It also has a keyboard port, eight expansion connectors and a light-pen input. Optional boards are available for parallel, serial, analogue, IEEE488, printer i/o and memory expansion, hard disc, high-resolution colour graphics, r.t.c. and tracker-ball connection. E&WW 315

With an IEEE488 interface, four parallel channels, two eight-bit switch inputs and RS232 ports, the **IBS 750** is intended for industrial and scientific applications where i/o facilities and ease of use are important. A keyboard port with 80 character by 24-line v.d.u. output provide

Computer boards

Type	Application	Proc.	MHz	RAM/ROM(K)	OS/Language	Bus	I/O	Size mm	Price
Andelos	Dev., ed., o.e.m.	68000	10	4/16	Mon.	—	RS232, 24 par., exp. bus	—	295
Archer	Dev., o.e.m.	Z80	4	(64)	(Mon., Basic)	—	2×RS232, 32 par., 8 control, exp. bus	208×204	185
B-CPU2	Dev., o.e.m.	Z80	4	(2/8)	—	STD	—	—	—
CA901	Dev., o.e.m.	8088	8	128/8	Mon. (CP/M86)	80-bus	Exp. bus	203×203	375
CA902	Dev., o.e.m.	8088	8	256/8	Mon. (CP/M86)	80-bus	Exp. bus, RS232	203×203	525
Delvex186	Dev., o.e.m.	80186	8	128/(4-32)	Mon.	(Multibus)	4×RS232	310×325	—
DSTD101	Dev., o.e.m.	Z80	2.5 (4)	(5×28-pin)	(Mon.)	STD-bus	2×8-bits, 10-pin c.t.c. channel	165×115	$297
DSTD102	Dev., o.e.m.	Z80	2.5 (4)	(3×28-pin)	(Mon.)	STD-bus	2×RS232	165×115	—
DSTD187	Dev., o.e.m.	8088	5 (8)	(1×28-pin)	(Mon.)	STD-bus	2×RS232	165×115	$822
DSTD168	Dev., o.e.m.	68008	8 (10)	(2×28-pin)	(Mon.)	STD-bus	2×RS232	165×115	$619
Eleven-Q	Dev., o.e.m.	R6511Q	—	4/(8)	Mon./(Forth)	—	RS232, 44 par. lines	228×153	225
ESB1	Dev., o.e.m., ed.	68008	8	128/16	Mon.	—	2×RS232, 2×8-bit ports	203×146	499
GM813	Dev., o.e.m.	Z80	4	64/2	Mon., (CP/M)	80-bus	2×RS232, 2×i/o ports	—	—
IBS750	Dev., o.e.m.	2×Z80	4	64/(32)	Mon., (CP/M)	IEEE488	2×RS232, 4×i/o ports 16 inputs, exp. bus	—	—
IQ200	Dev., o.e.m.	Z80	4	64/8	Mon./(CP/M)	—	60-way exp. bus, 2×ser.	384×277	360
Maggot	Dev., o.e.m., am.	6809	2	64/2(32)	Mon. (OS9, Flex)	—	Exp. bus, d.m.a., RS232×2, 16 par. lines	305×234	420
Master05	OEM	Z80	4	192/4	—	—	2×RS232, RS422, d.m.a.	—	—
Microkey	Dev., o.e.m., ed.	6502	1.85	128/32	-/Forth 79	—	RS232, 10 par., exp. bus	342×145	—
Microkey	Dev., o.e.m., ed.	6809	1.85	128/32	Flex/-	—	RS232, 10 par., exp. bus	342×145	—
PCB04	OEM	5×Z80	4	64/(4) each	—	—	1×RS422, 5×ser., 1sync. ser., d.m.a.	—	—
Pulsar	Dev., o.e.m.	Z80	4	64/2	Mon., CP/M	STD	2×RS232	204×115	—
Rade 50	Dev., o.e.m.	Z80	4	64/4	Mon.	—	2×RS232, 2 exp. ports	—	185
Rade 150	Dev., o.e.m.	Z80	4	64/(16)	—	—	DMA, 2 exp. ports	—	350
SGSZ8003	Dev., o.e.m.	Z8003	4 (10)	(4/16)	Mon.	Multibus	2×RS232, 12 par.	305×171	—

user i/o. The monitor prom contains 22 commands for writing and debugging low-level programs. Software options are proms containing languages such as XTAL Basic with IEEE drivers and an editor/assembler, or disc-based languages running under CP/M 2.2. The board has a battery-backed r.t.c. and can be obtained in a number of partially-built forms. E&WW 316

Specialising in 80-bus Z80 systems running CP/M, and quite happy not to move away from them, Gemini Microcomputers has recently produced a 16-bit co-processor board for running CP/M86, Concurrent CP/M and MSDOS on existing systems. The company's main Z80 computer board, the **GM813**, uses paged memory and extended addressing for up to 2Mbyte ram. A further Z80 board with more limited capabilities is available for use as a controller. The 8MHz 8088 co-processor with battery-backed r.t.c. has a socket for an 8087 arithmetic board.

A Z80 processor (6MHz) is also used on the **GM832** 256×256 pixel video card that can display 25 lines of 80-column text (includes foreign character sets). Colour graphics is possible using a separate board, the **GM837,** or the Pluto high-resolution system. Other products include serial/parallel i/o, networking and hard and floppy disc drive interfaces. Ram expansion boards, and ram boards that look like very fast disc drives to CP/M are also produced. Gemini supplies a range of software. E&WW 317

Components used in Sherwood Data Systems' **Archer** board with optional built-in power supply are a 4MHz Z80 processor, a four-channel counter/timer, two parallel-interface devices giving 32 i/o lines with handshaking, and an asynchronous receiver/transmitter for two-port serial communications at up to 9600 baud. Four sockets that can be moved about in the memory map accept 24 or 28-pin rams with battery back-up, 2716-27128 eproms, or a mixture of both.

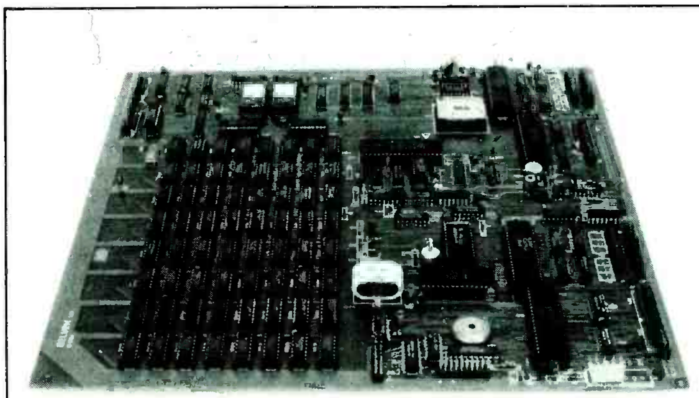
A 'watchdog' circuit resets the system if the software loses control; other circuits protect data from transient interference and shut down and restart the system tidily if power is interrupted. Processor bus lines and other signals including power supply (if appropriate) are brought to a 50-way connector for expansion. SDS Basic (£45) designed for use with this board includes special commands for input/output control. The SDS debugging monitor with 18 commands is £35 E&WW318

Some 20 boards conforming to the STD-bus standard are manufactured by DY-4 systems and distributed through Dage. Three of these are Z80 processor units, **DSTD101/2/3**, the first of which is a 'stand-alone' board with five sockets for 1 to 8K eproms or rams, and a four-channel counter/timer with on-board connectors. The 102, also with four counter/timers, has three sockets for rams or 1 to 16K eproms and a programmable serial interface with modem controls. Connectors for two eight-bit parallel ports are provided on the DSTD 103 with five memory sockets. This board, called an intelligent slave processor, can access all external ram and i/o on the STD bus. E&WW

Remaining processor boards are the 8088-based **DSTD187** and **188**.The 187 board differs from the 188 board in having an 80130 real-time executive processor and in being able to support MSDOS. The DSTD168 has three counter/timer channels. All three 16-bit processor boards have dual RS232 channels with programmable data rates, and transparent dynamic ram i.c. refresh. Some 15 peripheral STD boards are manufactured, four for memory expansion, five mainly for RS232 and serial or modem communications, and the remainder for disc interfacing, v.d.u. control, d.m.a., parallel i/o etc. E&WW 319

A Multibus system consisting of a **Z8003 processor** board and 128K to 2Mbyte ram board is produced by SGS chiefly for evaluation purposes. With separate 'SAM' bus for connecting other SGS modules, the processor unit has sockets for up to 16Kbyte rom and 4Kbyte of static ram and

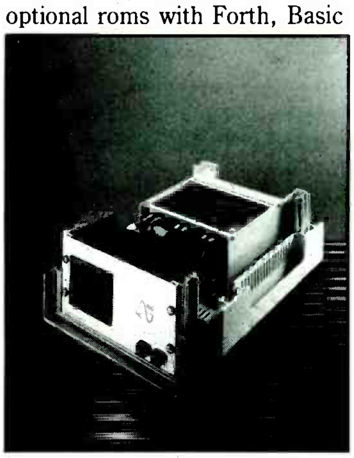
Example of a single board computer. This one even has an auxiliary input for a mouse or digitizer and a special port for connecting a high-resolution colour-graphics card.



uses an 8003 16-bit virtual-memory processor, 8015 paged memory-management unit, 8016 d.m.a. controller, 8030 communications controller and 8036 counter/timer and i/o device. Development systems, monitor source listings and technical information is available. Prices of SGS 16-bit c.p.u. boards start at around £929. E&WW 320

Education computer boards with display facilities, keyboard and input/output ports are distributed by Flight Electronics. Of the four main boards, two have Z80 microprocessors, one has an 8088 (16-bit) and one a 6502. Educational i/o boards and books support the range.

With printer/cassette interfaces and monitor with line assembler/disassembler, the 8088-based **MPF1/88** takes optional roms with Forth, Basic or a two-pass assembler. It has 2Kbyte of ram, expandable up to 24Kbyte, and 16Kbyte of rom expandable up to 48Kbyte. Expansion is through a 62-way edge connector.



These Eurocards in an enclosure with disc drives use all high-speed cmos i.cs and have a bus specially designed for use with these devices (Ctronix).

The 6502-based **MPF1/65** with colour graphics has 64Kbyte of dram and 16Kbyte of rom based monitor routines for software writing/debugging, screen editing, disassembly and printer driving. Expansion is through a 50-way connector.

Two Z80 based boards are the **MPF1B/P,** the B version with a 2Kbyte machine-code monitor, cassette interface, 2Kbyte ram and 6-digit/7-segment display and the P version with 4Kbyte battery-backed ram, a 2Kbyte monitor rom and a 20-character/14-segment display. Rom/ram expansion is possible on both these boards and Basic/Forth roms are available for the P version. Sixteen i/o pins and four counter/timer channels are provided on the B version. Expansion on the P version is through a c.p.u.-bus connector.
E&WW 321

Possibly the smallest CP/M computer board with serial, parallel, printer and floppy-disc i/o is the **Omega** distributed by Quant systems. With 64Kbyte ram and 2732 system eprom, the board measurers 196.85 by 146 by 19mm and costs around £580 with disc drive and CP/M operating system with utility programs. One of the two serial ports runs from 75 to 384kbaud. An SCSI hard-disc/tape-controller with software support and i/o expansion lines is available for £99.
E&WW 322

A low-cost 4MHz Z80 Eurocard-sized board with 4Kbyte eprom and battery-backed ram space, the **Cub**, is supplied by GNC Electronics. It includes a 2Kbyte monitor eprom, 2Kbyte ram, assembly-language listings and circuit diagrams for £104. The Cub, which can also be supplied as a bare board for £20, has 64 i/o lines. Other boards are available with up to 64Kbyte ram, 8Kbyte eprom, RS232, etc.
E&WW 323

Boards supplementing the Rockwell range from **Dynatem,** and the **Rockwell range** itself, are available through Pelco Electronics. The Dynatem range includes cmos, memory, p.s.u. and Aim-65 look-alike cards. Recently, this company has started distributing a Scandinavian single-board computer from Micronor, the **SBC6511Q,** which can be developed using optional monitor software with terminal communication routines or Forth. This small development board has two serial ports, one of which can be split into two. E&WW 324

Eurocards for rack mounting

The EuroCube range of 6502/6089 rack-mounting and single-board computers for industrial/laboratory applications are manufactured by Control Universal. **EuroCube65** and 09 boards can be developed at low cost through a serial link using a terminal or BBC computer.

The **EuroBeeb** board supports BBC Basic/VDU calls and is supplied with Control Basic, Control Net for multiprocessor use and a battery r.t.c. Applications can be written using Forth, Pascal, BCPL or assembler. EuroCube09, also with r.t.c., supports the Flex disc-operating system and can be developed using TSC Basic, Forth, Pascal, BCPL, C or assembly language. There are some 30 products in the range and development systems are available for both 6809 and 6502 processors. E&WW 325

Three main cards from CMS are a 6809 **second processor** for the BBC microcomputer with 64Kbyte ram, a **6809**-based **single-board** computer also with 64Kbyte ram, and a **universal controller** using either the 6809 or 6502 and fitted with an r.t.c. All three are said to be Acorn-bus compatible and have battery-backed cmos ram either as standard or optional. The 6809 card has its own machine operating system and allows Flex operating-system discs to run on the BBC computer through an interface board (extra). The second processor also allows Flex use. Other products in the range include 12-bit a-to-d cards, IEEE488 and high-resolution graphics controllers, input/output modules and development aids. CMS supplies software.

Late news is that the CMS 6502 universal controller can now be supplied with operating system for BBC Basic, 8Kbyte of cmos rom, an r.t.c. and v.i.a. for £199. It communicates with a BBC computer through the 'tube' using an optional adaptor (£59) which allows many languages to be used for development.
E&WW 326

Some 20 products in the Modular 96 range from Measurement Systems include the **9600 processor**, ram (up to 1Mbyte using bank switching), rom, floppy-disc, communications, analogue/digital i/o, colour graphics, eprom programming and frequency-counter boards. Networking and multi-tasking are possible and program development is done on the system, itself using languages running on the OS9 disc-operating system such as Basic, Pascal, C, Cobol and assembler. Two analogue cards are for eight-channel 12-bit in and output. A hard disc option is available. The company supplies software.
E&WW 327

Recently introduced eight and 16-bit single-board computers from Sirius Microtech are for industrial and educational applications. Processors used are **Z80, 8085, 6502, 68000** and **8086** and the units are all **double Eurocard.** They look different physically but all have the same features — buffered c.p.u., buses 32Kbyte rom, 32Kbyte ram, d.m.a. and eight or 16 led output and switch input lines. Each also has two uncommitted parallel and serial i/o devices (inc. RS232 drivers) and a counter/timer; what these devices are depends on the processor family. Typical prices are £580 for 8-bit boards and £790 for 16-bit ones.

Polestar, a CP/M-based development system for these boards, allows dynamic program modification in real-time control applications. E&WW 328

With a power supply and terminal, the **Essex Tiny Basic** Eurocard becomes a small low-cost computer cum development system. Software is written using the National Semiconductor 8073 Tiny Basic interpreter on the board. While under development, a program is stored in either ram or battery-backed rom; when complete, it is programmed into up to 8Kbyte of eprom using the board's own programmer. Apart from peripheral boards for mains switching, speech, analogue/digital i/o, etc., there are options available for writing software in assembly language and for compiling Basic programs. The assembler and compiler on a separate board with two additional eprom sockets are currently on special offer at £98. Under development are an 80 by 100mm Forth card designed using the same philosophy as for the Tiny Basic board but with the Rockwell R65F12 processor, and a 16-bit computer board with Basic interpreter. E&WW 329

Consuming typically 16mA when working, 9mA when idle, the **TDS900** from Triangle Digital Services is a Fig-Forth computer board with all cmos i.cs that can be developed from a simple terminal. It uses a 6303 processor and Forth is in an 8Kbyte rom. A free socket holds a further 8Kbyte rom. Using optional software on tape, the board can be programmed by a BBC microcomputer through a serial link. Forth 'screens ' may then be saved on the BBC computer disc system.

Essex Tiny Basic

. . . the system for all reasons

You need Control? Data Acquisition? Monitoring or Datalogging? AND you need *fast* development? If these are your reasons, you need the **Essex System!**

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Processor Card – Basic interpreter, up to 8K RAM /32K ROM, RS232C, 48 1/0 lines, Eprom Programmer. **12 Bit Analogue Card** – 16 channels A-D plus 2 channels D-A. **Opto-Isolator Card** – 12 inputs, 12 outputs at 3A/50V. **Buffer Timer Card** – 24 inputs, 16 outputs, 4 timers. **Memory Card** –24K battery backed RAM, 24K ROM, Rea. Time Clock. **'Alex'** – Assembler, disassembler, text editor & monitor in a ROM. **'Tiny Turbo'** – compiles programmes to run at twenty times normal speed. **VDUs, Memory Modules, Cases, Backplanes.**

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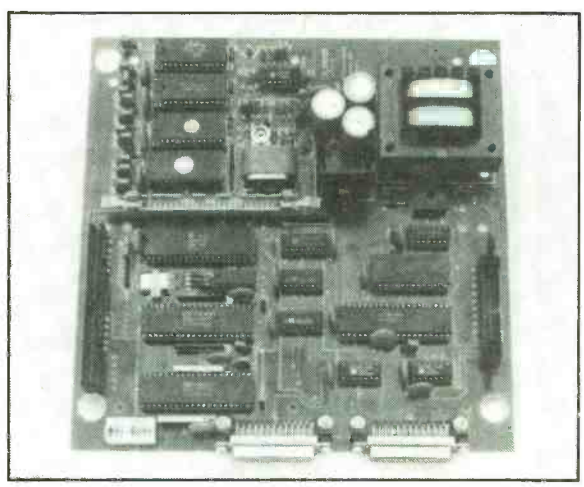
CIRCLE 74 FOR FURTHER DETAILS.

The Archer-Single Board Computer

The **SDS ARCHER** — The Z80 based single board computer chosen by professionals and OEM users.



FEATURES

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* 4 Parallel ports with handshaking
* Bus expansion connector
* CMOS battery back-up
* Counter-timer chip
* 2 serial ports
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OPTIONS

* **SDS BASIC** with autostart and "user program in ROM" facility
* **SDS DEBUG MONITOR:** a powerful 8k byte development aid
* On board 120/240 volt mains power supply
* Attractive two tone instrument case

Sherwood Data Systems Ltd

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CIRCLE 56 FOR FURTHER DETAILS.

Eurocard boards for rack mounting

Type	Application	Proc.	MHz	RAM/ROM (K)	Operating system	Language	User i/o	Price
ARC40	Dev., o.e.m.	8671	—	4(16)/4(32)	Mon.	Basic	RS232, 40 par., Arcbus*	169
ARC8000	Dev., o.e.m.	Z8001	4(10)	8/16	Mon.	—	2×RS232, 34 par., VME, Arcbus*	874
CLZ80S	Dev., o.e.m.	Z80	4	64/(16)	—	—	2×RS232, 34 par., Gammabus*	—
CMS 09sp	Dev., s.p.	6809	—	64/4	Mon. (Flex via BBC comp.)	—	—	249
CMS09sb	Dev., o.e.m.	6809	—	64/4 (32)	Mon. (Flex via BBC comp.)	—	20 par.	229
CMS09un	Dev., o.e.m.	6809	—	(32/128)	—	—	20 par.	119
CMS 02un	Dev., o.e.m.	6502	—	(32/128)	—	—	20 par.	119
CPU01	Dev., o.e.m.	68000	8	128/(64)	Mon.	—	3×RS232, 23 par, VME	1075
DVME102	Dev., o.e.m.	68000	8(12)	256/(32)	(Mon., Unix)	—	2×RS232, VME	$2803
DVME105	Dev., o.e.m.	68000	8(12)	(14×28)	(Mon.)	—	2×RS232, VME	$1668
Essex TB	Dev., o.e.m. ed, am.	8073	—	2/(16)	(Mon.)	Basic (Ass.)	Ser., 48 par.	198
Eurobeeb	Dev., o.e.m.	6502	—	(64)	Mon.	(via BBC comp.)	Ser., 16 par.	269
Euro05	Dev., o.e.m.	6502	—	(64)	Mon.	(via BBC comp.)	Ser., 16 par.	175
Euro09	Dev., o.e.m.	6809	—	(64)	Mon. (Flex)	—	Ser., 16 par.	175
HC120	Dev., o.e.m.	68008	8	(256)	(Mon.)	(Forth)	2×ser., 20 par.	490
MP09	Dev., o.e.m.	6809	1(2)	(32)	(Mon.)	—	RS232/422	153.15
MP19	Dev., o.e.m.	6809	1(2)	(64)	(Mon.)	—	2×RS232/422	261.05
SCPUA	Dev., o.e.m.	Z80	4	64/(32)	CP/M+	—	2×RS232, 5 par., STE	580
SCPUB	Dev., o.e.m.	Z80	4	4/(32)	(Mon.)	(Basic)	2×RS232, 6 par., STE	157
SYN68K8	Dev., o.e.m.	68008	.8	(128)	(Mon.)	—	RS232, 8 par.	356.07
TDS900	Dev., o.e.m.	6303	—	12/8	Mon.	Forth	Ser., 11 par.	162
9600	OEM	6809	2	-/(14)	(OS9)	—	4 ch d.m.a.	295

*** Peculiar to manufacturer**
Brackets indicate non-standard features

Board links reconfigure some 10Kbytes of the 12Kbyte area normally holding cmos ram for 2716 eproms. Memory limits are 160Kbyte ram, 640Kbyte prom, using expansion. Peripheral boards include 20Kbyte ram expansion, cassette, RS232, eprom programming, IEEE488 talker/listener, parallel i/o and analogue input interfaces. Variations on the basic board include ones with higher speed, non-volatile ram and cheaper nmos i.cs. E&WW 330

By starting afresh using only high-speed cmos i.cs, a **68008 processor** and a bus designed specially for this combination — HC-bus — Ctronix claims to have drastically reduced power consumption, simplified back-plane requirements and reduced the number of decoding components required over processor independent buses like VME and STE. In defence of this adventurous approach, Director Godfrey Suckling says "One could argue that independent buses will be suitable for a new generation of super processors, but who knows whether current buses will be fast enough to support the new breeds, when they arrive."

HC-bus products include floppy-disc controller, eight-colour video, isolated parallel i/o, analogue i/o, power supply and eprom programmer cards. With the HC-bug monitor and multitasking HC Forth, the c.p.u. board with battery-backed r.t.c. costs £650 (the monitor includes a 'full-line' assembler/disassembler). The bus allows addressing of up to 1Mbyte. E&WW 331

Three main processor cards from Syntel, two 6809 based and one 68008, are G64-bus compatible. On-board prom/ram up to 128K may be mixed on the 68008 processor, the **68K8,** whose RS232 interface is synchronous or asynchronous. Four programmable timer/counters are included and options allow cheaper, slower memory devices to be used.

MP09/MP19 boards have 6809 processors, bipolar memory-mapping proms (to allow memory allocation to match existing software/hardware) and a G64 bus but are otherwise quite different. The MP09 has 32Kbyte prom/ram sockets, a 6840 triple counter/timer i.c. and serial port for either RS422 or 232. The MP19, allowing up to 64Kbyte of memory devices, is built on a four-layer p.c.b. and has two serial ports, eight counter/timers and eight 50V, 500mA i/o lines. Numerous peripheral boards, including IEEE488 controllers, and over 40 software products are available as are versions of these boards with different clock speeds and with or without monitor/ram. E&WW 332

A range of VME, STD and STE-bus products (see also Arcom for STE) are stocked by Dage. The VME-based **CPU01** from MicroSys, whose ram is expandable up to 256Kbytes, includes four timer/counters and an r.t.c. There is also a **CPU02,** at £886, with three timers, optional r.t.c. and fixed on-board memory of 128Kbyte. This board caters for up to 32Kbyte of static ram. Other VME products from MicroSys include memory expansion boards, a floppy-disc controller, a universal i/o board and an assembler/disassembler.

Both VME and a wide range of STD-bus boards (see Computer boards) are manufactured by DY-4 systems. The company's main VME 68000 processor board (for 8, 10 or 12.5MHz devices), the **DVME102,** holds an optional 68451 memory-management unit. It has three counter/timer channels, parity-checked dram and independent data rate selection on its synchronous/asynchronous RS232C serial channels. Monitor eproms, technical manuals and a Unix development system can be ordered separately. The **DVME105** is more a single-board computer than a processor card, with fourteen sockets for eprom, ram and eprom, but no dram bank. Its serial interface/timer-counter specifications are similar to those of the 102. Other boards in the range are for memory expansion, floppy-disc control (Z80-based), i/o and colour graphics. Recent additions include a 68000-based Winchester disc controller and a streaming-tape adapter.

Other Dage VME products are the Performance Technologies **PT-VME100** with 68010 processor, 68451 memory-management device and 4Kbyte high-speed cache memory ($4211) and, from Lynx Business Machines, ram, i/o and **20Mbit/s disc/tape controller** boards. Performance Technologies also manufacture a VME expansion interface.

STE-compatible cards from GMT include 6809 and 68008 processing units, ram/rom expanders and disc interface. Other boards cater for serial, parallel, isolated parallel, analogue i/o and parallel i/o with display and keypad input. E&WW 333

The only **Z8001-based VME** board is manufactured by Arcom (distributors, Dage, Gothic-Crellon). It uses an 8030 high-speed communications controller, an 8036 parallel i/o and counter/timer i.c. and programmable-logic address decoding. Monitor software in two 4Kbyte eproms can be replaced by 16Kbyte devices for more rom. Similarly, the eight 2Kbyte cmos static rams can be replaced by 8Kbyte ones. Arcom's Arcbus-compatible boards can also be used to provide i/o at low cost and a cheaper version of this board without VME is available (£650).

Products conforming to the STE-bus standard — currently in its final stages of approval by the IEEE as IEEE P1000 — are also manufactured by this company. They include a 64Kbyte CP/M microcomputer, the **SCPUA,** with floppy-disc controller, high-speed serial interface and keyboard port. A low-cost STE processor board, the **SCPUB,** has no on-board dram (up to 1Mbyte addressing through STE) or floppy-disc interface but includes four counter/timers and can be used with an optional Basic interpreter or monitor software. Six

Continued on 73

Choosing a computer board

Ten tips for first-time buyers of single-board computers. Chris Nabavi argues that complete computer boards offer advantages over rack systems with industry standard buses, especially for users requiring an economical small system for use with non-standard interfaces.

The microcomputer board market has changed drastically over the past few years. Whereas five years ago one could select from a wide variety of different products, the choice now is much more limited. This is particularly due to standards which have emerged recently, and partly due to the fact that many of the original manufacturers have moved up into the personal computer field. As any intending purchaser will know, this has left quite a large gap.

Microcomputer boards now available fall into four main categories,

- Hobby computers
- Personal computer enhancements
- Rack-based systems
- Single-board computers

Hobby computers

The object of most technical hobbies is to have fun constructing a model aeroplane, boat, wireless, etc. Once the object is ready, it is time to move to the next project. The same is true in the computer field; the computer enthusiast revels in the problems of getting a machine to work with devices for which no proper interface exists. Hours will be spent trying to get a computer board to work with the largest and most up-to-date ram devices, but the final product is rarely used in earnest.

Professional users however want a product to do a specific job with the minimum amount — if any — of constructional work. For instance, they do not want to have to add special cables to convert the serial interface connector on the board to a standard form. For this reason it is important to discover the intended market for a particular board before buying it.

Personal-computer enhancements

These boards probably represent the fastest growing area at the moment. They include a wide range of plug-compatible peripheral and memory cards for popular microcomputers as well as a selection of second-processor options. While of great importance in wider terms, these boards are of no interest to the original-equipment manufacturer who wants to implement a particular system, unless the rest of the personal computer involved can be made use of.

Rack-based systems

Recent standards such as the IEEE S100 bus and various European introductions have had most impact on rack-based systems. It is now possible to buy almost every conceivable type of interface, processor or memory board for the more popular standard buses. These standards allow powerful computer systems to be assembled for a variety of complicated applications but often, for simpler applications, the expense of card frames and bus-interface circuits cannot be justified.

Single-board computers

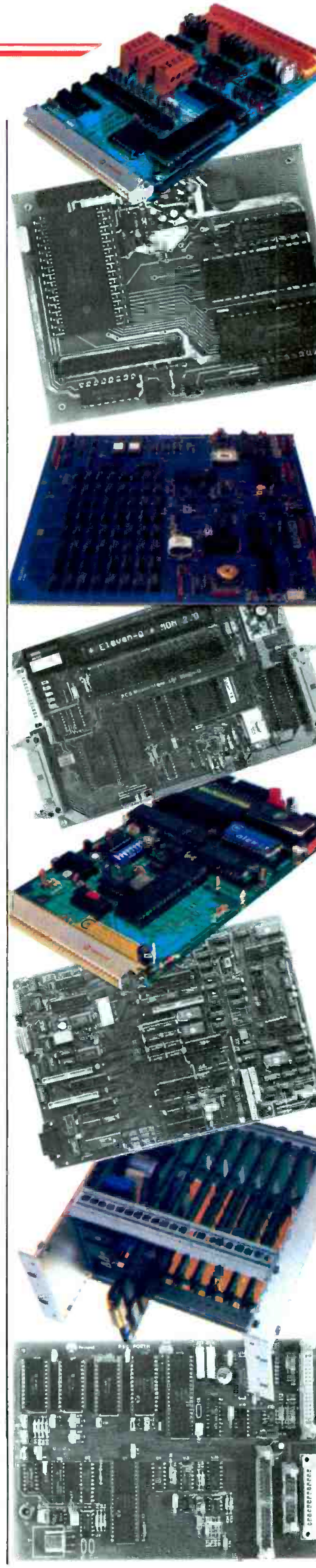
There exists a large number of straightforward control, monitoring and instrumentation applications for which a single-board computer is ideally suited. In many such applications, the two most important considerations are cost and ease of use. These factors often rule out both the rack-based approach and hobby boards. Many single-board computer users are not computer engineers; they may even be process-control or mechanical engineers, which makes ease of use even more important.

These ten guide lines are for potential single-board computer users. They are not in any particular order and how you weight them will depend on your application.

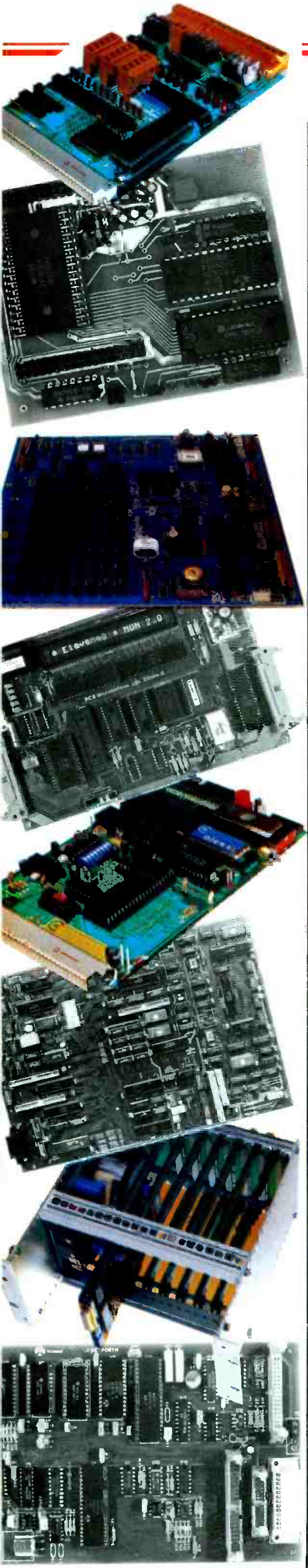
How complete is the board?

Find out what needs to be added to the board to make it usable. Typical items that may need to be added are a power supply, memory i.cs, connectors and sometimes even input/output i.cs. It is, for example, quite common for reasons of cost or board space to terminate RS232 serial ports using non-standard connectors (insulation-displacement types for example). Adding a ribbon cable with appropriate connectors at each end can increase overall cost considerably.

Chris Nabavi is Director of Sherwood Data Systems.



Here (and over) are products from manufacturers and distributors mentioned throughout our computer board feature (starting on p. 49).



Is extra i/o easy to add?

Facilities offered on a board always represent a compromise. Some users will bemoan the lack of an extra input/output port while others would prefer a simpler and cheaper board. While the flexibility of a rack system cannot be achieved with a single-board computer, it should at least be possible to add one or two 'daughter' boards, particularly when one considers that many users require non-standard interfaces. The main board should have some means of supporting such boards both physically and electrically.

Are the main i.cs all from the same family?

Designers of general-purpose single-board computers are often tempted for reasons of cost to mix different chip families. For example, the microprocessor may be from one family and the uart (universal asynchronous receiver/transmitter) from a totally unconnected family. This can destroy the coherent nature of the design and ruin such things as interrupt structures. It also usually increases component count, leading to reduced reliability. It is better to have a few large-scale integration i.cs than many more small-scale ones.

What happens when the power fails?

A well designed board will have protection circuits which prevent information in memory from being corrupted by switching transients or by the microprocessor itself as its supply rail collapses (assuming battery backup). A power-fail interrupt circuit may also be available. This causes an interrupt signal when the mains supply fails which can be used to close the system down in a controlled manner before the supply capacitors run out of charge. The system can then be programmed to shut down dangerous machinery or to save the microprocessor status to enable it to continue when the power returns.

Is maintenance easy?

It is important that any system should be easy to maintain in the field, preferably without too much reliance on any other single organization. This means that as far as possible, all components should be available from a second source and that no special devices should be used unless their continued availability can be guaranteed. While programmable logic arrays and the like are an excellent way of implementing a design, their use in this type of single-board computer should be treated with caution since it can place unwary users at the mercy of the original board manufacturer.

How versatile is the board?

Versatility is a two-edged sword. Too much versatility can make a system very difficult to work with, as users of some of the larger rack-based systems will already know. It can however be useful to be able to configure the board for various popular memory i.cs and to activate various other clearly defined options. This is normally done by jumper links or wire-wrapping options. Straightforward designs which are easy to understand and set up are often the best option.

How rugged is the design?

This is probably the most difficult question of all to answer without buying the board concerned. For the design to be rugged, and hence reliable, several criteria must be met. Firstly the components must be conservatively rated, which is not too difficult to achieve nowadays. The board must have a clean layout with sensible tracking, particularly for the ground lines. Pull-up resistors should be used on any mos signals that leave the board and adequate decoupling capacitors should be used. This last point is particularly important when one considers where such boards are likely to be installed. Timing must not be critical — something which is easier to achieve if the designer sticks to one device family.

What about software?

Applications software is usually the responsibility of the purchaser. As a starting point, boards based on popular and proven microprocessor families are much more likely to result in a successful end product. Choose a board which uses a microprocessor whose quirks are well understood by the average programmer and for which suitable software development tools are available.

Emulators simplify the program development considerably and the owner of a good development system with an emulator and associated software will generally not need any support from the board supplier. This approach is however expensive in terms of capital investment.

Users without such facilities are much more dependent on the board supplier. They can use software support from the board manufacturer in the form of say a debug monitor, preferably used in conjunction with a personal computer. Alternatively, a high-level language such as Basic, if available, may be used to write applications software. In either case, it is important to check how much support software is available and what it does, since without it the board is not much use.

How is the board installed?

Practicalities of installing an off-the-shelf board into one's own system are often overlooked. Boards vary enormously in their physical size, power requirements, connector positions, etc. Generally speaking, boards designed for rack mounting are more difficult to install in a non rack-based system than boards specifically designed for more independent mounting.

Boards are now available with built-in mains power supplies. These are ideal where no other electronic circuits are required. Even if other circuits are required, the supply on the main board may be capable of powering them. Positions of connectors and switches can make a great deal of difference to the convenience with which a board can be installed. Finally, look at overall heat dissipation since this can ruin an otherwise attractive design.

How useful is the documentation?

Since the board is a subassembly intended to be used as part of a larger system, how it works and what it does must be crystal clear. This means that documentation must be complete and accurate. A full circuit diagram is of course mandatory as is a description of how the circuit works. When the board offers various options to be selected by say jumper links, the function of each should be fully described.

It is useful to describe the operation of such links on two levels; firstly at a simple recipe level, for example 'for an 8K ram install jumper link seven...' and secondly on a more technical level such as 'jumper link 7 selects the signal on the ram pin 23...'. This approach can be adopted in other areas too. It allows the more enterprising user to apply the board in ways not forseen by the designer.

FRIENDLY SETS

"The UK plans" (those of the BBC?) mentioned in Communications Commentary, EWW, Nov, 1984 for segmentation of the band by function are superficially elegant — but they are grossly wasteful of the spectrum as perceived at the listening end. Surely Britain is the only developed country with as much as 2.2MHz (11 channels) interval between three different main channels and nothing (officially) in between them even in metropolitan areas?.

Is it necessary to remind the BBC that when they started broadcasting three programmes on this plan, the transistor — let alone the i.c. — was unheard of in v.h.f. receivers? The typical f.m. receiver of that time had a broad-band fixed-tuned r.f. stage followed by one i.f. stage (two in sets described as "fringe area models") and one final stage to a ratio detector, the i.f. transformers being broadly tuned with a view to low distortion and common-channel rejection and often working in the anode circuit of the same valves as the m.f./l.f. i.f. transformers. Adjacent and even alternate channel selectivity was... negligible..., image rejection poor. The r.f. performance of even cheap portables of today is several orders of magnitude superior and it is simply not arguable that frequency allocation for the '80s and '90s should resemble that of the '50s.

It is arguable that a wider perceived choice of programmes (a "full dial" — even if most listeners may in fact stay most of the time with one of two favourite stations) could help bring about the desirable resurgence of interest in listening to sound radio and the long-overdue (in UK) swing to f.m. listening, and in this respect the following story in your pages, "F.m. for the young", reporting American trends, is suggestive.

It is unlikely that many of the young Americans have as few choices, or as much f.m. repetition of programmes perceived as more easily tunable on m.f./a.m., as British ones. On a recent visit to Toronto I counted 38 different programmes clearly receivable on the f.m. dial of a very ordinary portable.

I believe that the BBC could easily, at the very least, provide a separate v.h.f. network for R1, making four national services, simply by reducing the spacing of the existing three. Then the pirates have shown that relatively low-power transmitters can operate between the frequencies of the national network. This is a desirable arrangement if real variety of listening is to be promoted: it is by being "found" when a listener tunes manually from one main station to another that the smaller, less publicised ones will get heard.

Ian Leslie
London

PREFERRED VALUES

I would like to add to recent discussions on preferred values series for electronic components. In the early period after World War II, when the existing series was proposed, manufacturing techniques were generally of limited prescision. Thus the over-riding consideration was to provide a series of numbers for labelling bins into which products could be stored. Applications were mostly for analogue circuits where relatively large tolerances were permissible. Precision components, needed for instruments, were made by special low-run techniques and binary circuit applications were non-existent. Modern technology has modified considerably the scenario.

A more desirable set of numbers can be constructed by taking advantage of the close approximations between suitably chosen, regularly spaced powers of 2 and 10, derived from the fact that $2^{10/3} = 10.079 \approx 10$. Thus regular integral powers of $2^{1/6}$ approximately match integral powers $2^{1/20}$. We can thus set up a series which includes integral powers of 2 and at the same time can be adjusted to merge into a scale including integral powers of 10.

The table shows a proposed series of such numbers. Simple integral values 1 to 10 are represented, apart from 3,6,7.

Powers of 10		Powers of 2		Number series	
10^{0}	1	2^{0}	1	0	1
$10^{.05}$	1.122	$2^{1/6}$	1.122	1	1.12
$10^{.1}$	1.259	$2^{2/6}$	1.260	2	1.25
$10^{.15}$	1.413	$2^{3/6}$	1.414	3	1.4
$10^{.2}$	1.585	$2^{4/6}$	1.587	4	1.6
$10^{.25}$	1.778	$2^{5/6}$	1.782	5	1.8
$10^{.3}$	1.995	2^{1}	2	6	2
$10^{.35}$	2.239	$2^{7/6}$	2.245	7	2.25
$10^{.4}$	2.512	$2^{8/6}$	2.520	8	2.5
$10^{.45}$	2.818	$2.^{9/6}$	2.828	9	2.8
$10^{.5}$	3.162	$2^{10/6}$	3.175	10	3.2
$10^{.55}$	3.548	$2^{11/6}$	3.564	11	3.6
$10^{.6}$	3.981	2^{2}	4	12	4
$10^{.65}$	4.668	$2^{13/6}$	4.49	13	4.5
10^{7}	5.012	$2^{14/6}$	5.04	14	5
$10^{.75}$	5.623	$2^{15/6}$	5.657	15	5.6
$10^{.8}$	6.31	$2^{16/6}$	6.35	16	6.4
$10^{.85}$	7.08	$2^{17/6}$	7.127	17	7.2
$10^{.9}$	7.943	2^{3}	8	18	8
$10^{.95}$	8.913	$2^{19/6}$	8.98	19	9
10^{1}	10	$2^{20/6}$	10.079	20	10

These can each be implemented by combinations of pairs of numbers selected from the series. Ranges of 9 successive doublings are available. The numbers 1,2,4,5 and 10 are useful for scale multipliers and the 9.1 and 8.2 combinations would be useful for potentiometric applications.

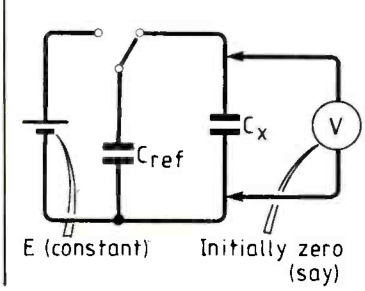
H.W. Holdaway
Coogee
N.S.W.
Australia

DISPLACEMENT CURRENT

Maxwell's displacement current provides a physical mechanism for the thermodynamic concept of entropy.

When a capacitor is connected across (strongly coupled with) an e.m.f. the microscopic electronic configuration of the circuit changes as charges are re-distributed around the circuit, The 'information' that any changes in (relative) position of the microscopic elements has occurred propagates out at a finite speed to ('communicates with') distant space (entropy losses), which constitutes the loosely coupled environment (Mach's principle). In other words, the circuit scatters energy to space when it is closely coupled to the e.m.f.

Consider the problem of bucket charge transfer from a virtually infinite source to a finite reservoir



On each cycle of the changeover switch C_{ref} charges to a constant voltage E then shares its charge with the (unknown, say) capacitance C_x, On each switching contact there is energy loss (or 'taxation') from the circuit. It is elementary to calculate the voltage on C_x after n switchings and obtain the assymptotic solution (sent to *WW* Editor in 1982, I believe, and dramatically forgotten as of no significance to the theoretical real world).

How does Mr Catt's theory, based on its fundamental causal concept of 'energy' (whatever that really is), and, no doubt, on the principle of its conservation within any electrical system, account for entropy losses?

P.J. Ratcliffe
Stevenage
Herts

ROOTS OF RELATIVITY

Strangely enough, it is often the exponents of the theory of Special Relativity, in their enthusiasm to expound and defend the theory, who do it more harm by their inadequate presentations than is ever done by the theory's opponents. An example is N.B. Taylor's letter in October 1984. In discussing Dr Murray's Roots of Relativity (May 1984) N.B. Taylor begins by stating that "AM′ is not equal to BM′" and then not only misses the point of the discussion but also misses Dr Murray's glaring error. To obtain a paradoxical conclusion by applying a deductive process to a set of premises, then either the premises are inconsistent or the deductive logic is faulty and possibly both. The error in Dr Murray's analysis is a purely logical error which has nothing to do with relativity or, for that matter, with much of the discussion preceding the error. During his discussion, Dr Murray concludes that the passage times for the light travelling from A to M′ and B to M′ are the same. Whether or not this is a valid deduction is incidental to the logical flaw that then appears: Hence the light from both sources must reach M′ at the same time,...". Quite simply, for this conclusion to be valid given the equality of passage times, an implicit assumption has been made that the two beams of light started their journeys at the same time. Naturally, Dr Murray is discussing time as measured by M′ with a view to showing that M′ will conclude that the lightning flashes are simultaneous. Given the implicit assumption few would experience an problem demonstrating such simultaneity!

The absurdity of the conclusion is obvious: the flashes were chosen to meet each other at M and during flight the observer M′ simply moves on towards B from M. This, of course, is true no matter how the light propagates, so that the absurdity is not caused by any premise concerning the velocity of light and one is left with little choice but to look for a logical error.

Another flaw, which introduces the same assumption, is easy to find in Roots of Relativity. This time there is the misuse of the word instant in: "But at the 'instant' when the flashes occur..." when analysing what M′ observes. Since there are two flashes they can only occur at an instant if, in some sense, they occur simultaneously and as far as M′ is concerned this would be an assumption. The gradual disappearance of qualifiers such as "relative to" or "as observed by", in articles of this type is a strong pointer to the intent to introduce such misuse!

When Dr Murray concludes that the distances AM′ and BM′ are equal, he is intending to establish that the passage times for the light to travel to M′ are the same, as observed by M′ in a co-ordinate measuring system travelling with M′ and the train. This is done by using the assumption made in the theory of relativity that an observer such as M′ will measure and observe the velocity of light to be a constant which is independent of the direction of the light or the state of motion of its source. Thus if A′ is the point on the train that coincides with A as A is struck by lightning then the distance A′M′ as measured by M′ is the passage time measured by clocks at A′ and M′ multiplied by the velocity of light. Similarly, B′ is the point on the train which coincides with B when it is struck and the passage times are equal if the distances A′M′ and B′M′ are equal. Clearly A′M′ and B′M′ are the distances between fixed points A′, M′, B′ in the system moving with the train and AM, BM are distances between fixed points A, M, B on the railway embankment, the choice of M ensuring that distances AM and BM are equal. But A′M′ is the distance, measured in the system moving with the train, of the interval AM: M′ was chosen to coincide with M, just as A′ coincides with A, at the same time, at least as far as the observer M on the embankment is concerned. An identical statement can be made concerning B′M′ as a measurement of the interval BM. Now the theory of special relativity requires space to be homogeneous so that where such measurements are has no effect on the result and we must conclude that A′M′ equals B′M′.

By not defining the spatial origin of the co-ordinate system he uses on the train, N.B. Taylor continues the longstanding tradition of contributors to these pages by avoiding explicitness and engaging in undefined and therefore meaningless symbolism. From his statement, "their signals reach him simultaneously at t′=0", where "him" refers to M′, one might conclude that the definition of M′ has been completely misunderstood. As has been shown there is no question of the light from the flashes ever reaching M′ simultaneously. The real point is that the introduction of the Lorentz transformation is wholly inappropriate at this point: Dr Murray's presentation is basically that of Einstein in his book "Relativity The Special and the General Theory" and is discussing the foundations of the theory and the need to revise the concept of simultaneity. Of course the Lorentz transformation, if used carefully, will give a consistent picture! It was designed to!

A.J. Clayton.
Stoneygate
Leicester

TV CAMERAS

May I comment on Mr Stocks' letter in the October issue.

He is quite correct in summarising the BBC's equipment buying policy as aimed at acquiring what is most suitable for the job:'suitable' of course covers many factors including technical and ergonomic performance, cost, manufacturers support, and others. We are very conscious of where our money comes from — the licence payers — and our policy is directed to giving them the best value for their money.

As a national organisation we have of course the desire to buy British where possible. We fulfil this, not by settling for second best where foreign equipment is superior, but by encouraging and assisting British manufacturers in any way we can, so that what is British is in fact the best.

No doubt Mr Stocks will understand that I cannot detail the comparisons which led to our choice of Fernseh for the news studio cameras, but I can assure him that the principle outlined above was very much in mind.

D.P. Leggatt
Head of Engineering
Information Department
BBC

ENERGY TRANSFER

My article in *Wireless World*, September 1984, entitled Fundamentals of Electromagnetic Energy Transfer led to a large number of comments being published in the November issue.

D.J.O'Reilly complained about my confusing impedance and resistance, "...leaving (my) transmission line analysis without value."

I have for long thought that use of the term 'characteristic impedance' for a transmission line is misleading — it certainly is for a lossless line, because the word "impedance" implies a combination of resistance and reactance, (see for instance "Advanced Physics" by S.M. Geddes, pub. Macmillan 1981, page 189,) whereas a lossless transmission line contains no reactance. It is for this reason that for many years I have wanted to use the term 'characteristic resistance'. (Also note in *Wireless World* Oct, 1984, page 50, the criticism of the repeated LC model for a transmission line. The idea that a transmission line contains alternate L and C is false and destructive.)

When O'Reilly writes, "It is rubbish to say that modern physics ignores the impedance of free space, antenna theory and practice is based on it," he ignores the distinction made earlier in the article between 'modern physics' and digital electronics. Under such classification, antenna theory would certainly not fall within modern physics. Ask modern physics pundits, for instance Professor Paul Davies of Newcastle University or Nobel Prizewinner A.Salam of Imperial College whether they have studied antenna theory. O'Reilly is surely not disputing my point, that modern science is seriously fragmented.
No comment on Messrs. Potter and Morton. Whatever lecturer or text book taught P.L. Taylor that "...the wavefront is bowed outwards, convex...", i.e. that a TEM wave is not TEM? Certainly not Heaviside, see refs. 2 and 3 in my September article.

I agree with Alan Robinson that if a conductor were filled with a row of rigid electrons touching each other, simulating a rigid rod, then an effect could travel at infinite speed even if the electrons (= rigid rod) travelled slowly. This has nothing to do with the theory of the TEM wave, at least as discussed heretofore. Is Robinson inventing the 25mm — 26mm scenario, or will he give us its pedigree?

Referring to Robinson's final point. At the diameter of the wires entering the capacitor, the characteristic impedance of the pair of parallel plates is already very small, and is resistive not inductive. Any reflections resulting from the mechanism he mentions, of a semi-circular flowing out from the entry point to the two plates, can only serve to reduce an already low resistance. This effect does not correlate with the traditional values of series inductance alleged to be contained within capacitors, (and which are actually a function of something outside the capacitor - its legs;) which are orders of magnitude larger. Robinson has introduced a high quality red herring.

Ivor Catt
St Albans
Hertfordshire

ELECTRIC CHARGE FROM A RADIO WAVE

Your November correspondent M.G.T Hewlett makes several points that should be answered. I believe he is quite wrong in saying that a field built from time-varying but spatially-static vectors is not a rotating one in the true sense, but this point is not pertinent to the main argument, so I shall let it pass.

Mr Hewlett should read again the original article (Aug, 1983). There, Professor Jennison told us of his theory, and demonstrated in the laboratory what was happening. That machine, which was illustrated in colour on the *Wireless World* cover, was a 32-stage cyclic oscillator, or a 32-ph generator. I have no objection to the machine as such, and it may have a valuable role in demonstrating rotating fields. My objection is simply that it does not model the theory advanced, so nothing of that theory can be deduced from it.

Consider Professor Jennison's postulates. Basic to his development is that in principle we can have dielectric with a propagation velocity so low that we can achieve it in mechanical drives. Let us suppose that we have such a material and that it is transparent to light, which it will similarly slow. Suppose now that we make a vehicle windshield from such a material and drive it towards a source of light. The light will approach the front surface of the window with the velocity of light in air, but in the material will be retarded. If Professor Jennison's theory is right, an observer stationary on the road would see at a certain vehicle speed, the light arrested within the glass. In other words the glass would be opaque to him if the vehicle approached the source at the propagation velocity.
On the other hand, the driver would get a different picture, for he would note the reduction in velocity in the glass, but nevertheless the light would emerge from the rear surface and resume its normal velocity. It would indeed be a curious and complex law of physics that could explain the opacity to one observer and the transparancy to another. There is a law of physics to the effect that the velocity of light is the same for all observers, and I believe that the conclusion of Michelson and Morley's celebrated experiment of 100 years ago, is that the velocity of the propagation medium, if there be such a medium, does not affect the observed velocity of light.

If Professor Jennison is right, what are we to make of the condition where we drive the machine faster than the speed required to arrest the light pattern? Are we to conclude from that that it would be possible to reverse the direction of propagation of electromagnetic energy by mechanical means, without reversing either the E or H vector? What new and exciting vistas in physics that would open.

Chris Parton
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Scotland

In considering what Ivor Catt has to say, one has, I think, on the one hand to be aware of the situation that existed between the Church and Galileo. Although his findings were of the utmost significance to the world in the end, he was a heretic for propounding them. But on the other hand one is tempted to think that it is just possible that Mr Catt is learning as he goes; that I shall not condemn. After all, this was the great genius of Michael Faraday, noticing happenings he was not in the process of seeking, and then following them up. But one has to be so careful of mistaking what one is learning as one goes, for discovery.

I have been poking pulses out of sources to distant destinations since 1924, whether on wires, down tubes, or just plain flying off into space. And thought processes that have occurred on the way are related to the most incredible mental gymnastics. As early as 1919, when I constructed my first radio set having a valve, a huge affair with massive oak ends for the loose coupler (about 2ft long) at a time of relatively low-frequency operation, I wondered what would happen if wavelengths ever became shorter than the dimension of the tuning condenser. Would the charge get to the outer edge of the plate, before reversal took place and it was on its way out again. I now know that in fact it would have been an unterminated line of non-classic shape. This was to help me in later life, when it came to the contriving of broad-band aerial systems.

Then again, in my mind I would slow down the velocity of a dot on its way over the single-wire telegraph poles, in imagination keeping up with in on my bicycle, waiting for the other dot which had just left the other end. What, I thought, is to be the nature of the collision if the dots are of like polarity? Or the merger if they are unlike? Now that I am very old, using this slowed down technique, I now have a very fair non-mathematical mental image of what goes on.

But the arrival of Ivor Catt on the scene has set me off again. Take the case of a baterry of steady e.m.f. connected to an unterminated line. Wait for the reflections to be absorbed in line resistance, and of course we then have a charged condenser, but no magnetic field in evidence. Now, attempt to change the state of that charge by any means you care to employ, and what have you while charge value is being changed? Why, a magnetic field as long as the state of change exists. It was not there before, so where has it come from. Having charged and stabilised the line, then close it with it characteristic impedance. How does the sending end discern what has happened. One thing that immediately manifests itself is magnetism. Where has it been lurking? Like the heat in unburned fuel. While I have no difficulty in visualising the changes in (dare I use the word)

current value when one does this sort of thing, I have not yet got the answer to the appearance and vanishing trick that magnetism can perform. My answer when provided has to be non-mathematical, so visualisation can be communicated. So if Ivor Catt is on the track of this, even by accident, good luck to him.
Ouida Dogg
Hurstpierpoint
West Sussex

May I add to the constructive comments of P.Hesketh (Jan 1984) and M.Hewlett (Nov, 1984) on Professor Jennison's Occam's razor article (Aug, 1983).

In experiments of this type, the wave is guided by the wire, e.g. a coil wound with Litz wire. The length of the wave probably equals the total length of the wires of the inductors connected in series, which may be several hundred metres in Jennison's experiment. The apparatus appears to be acting as one closed winding of a toroidal transformer, a closed coiled coil.

Jennison's ingenious experiment visually confirms and emphasises a fundamental fact established by experiment and ignored by modern theorists: that by whatever means the action-at-a-distance force of attraction and repulsion we call 'electricity' is generated, equal quantities of positive and negative electricity are always produced. In all experiments the sum of positive and negative electricity produced is zero. Current electricity always flows in closed circuits. Both requirements are necessary to satisfy the equation of continuity.

Jennison's red and greed leds are connected to sensitive on-off switches designed to detect the presence of either positive or negative electricity, but not their intensity or phase. C.Parton's (Oct, 1983) suggestion that the apparatus is a 32-phase generator was illustrated by a diagram showing only three of his phases detected by three different coloured leds to detect 32 different kinds of electricity.

Art. 763 of Maxwell's Treatise deals with his experiment performed to determine the resistance of a coil measured in e.m.units. "A circular coil is made to revolve with uniform velocity about a vertical axis. A small magnet is suspended by a silk fibre at the centre of the coil. An electric current is induced in the coil by the earth's magnetism, and also by the suspended magnet. The current is periodic, flowing in opposite directions through the wire of the coil during dirfferent parts of each revolution..."

Maxwell's magnetically induced wave-like current is not flowing in the laboratory's frame of reference. The closed coil is flowing through the induced closed current. The strength and direction of the earth's magnetic field is stationary in the laboratory's frame of reference, and so too is the intensity of the electricity induced at any two diametrically opposite elements of the coil, forming a crest of trough at the two stationary points on the earth's frame where two oppositie elements of the coil cut the earth's magnetic field at right angles, and forming nodes where the motions of two opposite elements of the coil are tagential to the direction of the magnetic field. A wave of equal quanta of positive and negative·electricity stationary in the laboratory's frame of reference is the only possible distribution of electricity along the wire of Maxwell's revolving coil.

The magnetic induction of a second quantity of stationary positive and negative electricity in Jennison's torus could be detected by rotating the torus with the power to the amplifiers disconnected. A line joining the crest and trough of the standing or stationary wave may always point in the direction of the earth's magnetic poles, with or without the amplifiers operating, a gyro-compass.

The only equation used by Jennison's is derived from Maxwell's laws and equations of the electromagnetic field. Jennison agrees with Maxwell's assumption that his laws and equations depend on the existence of only two kinds of electricity, positive and negative. According to A. Freeborn (Nov, 1983) Jennison and Maxwell are mistaken. Freeborn assumes the positive and negative electricity existing as alternative half cycles of a wave of electricity dependent on the existance of the conducting matter of Jennison's apparatus.

Hertz agreed with Jennison and Maxwell. In the introduction to his Electric Waves (p.19) he said that the most important "philosophical result" of his experiments was "the fact that the electric forces can disentangle themselves from material bodies and can continue to exist as conditions and changes in the state of space." According to Hertz the only two kinds of electricity, plus and minus, are two equal and opposite charged conditions of the state of only one kind of space. The sum of the equal and opposite charged states of space is always a mathematical zero or unchanged state of space, absolute and at rest, satisfies the equation of continuity.

One of the culprits responsible for the present multiplicity of electricities is not too hard to find. In Jennison's experiment the wave's observed velocity relative to the uniformly moving torus is Newtonian. The velocity of a wave of electricity guided by a wire is indentical to the velocity of a wave of the same kind of electricity in non-conducting free space. Perhaps blue and orange leds would indicate the presence of Einstein's frequency modulated electricity guaranteed to prolong active life.

I have followed the example set by Ivor Catt and assumed that Poynting's Theorem,, being a theorem of the exact science of applied mathematics, is beyond philosophical criticism.
M.G. Wellard
Kenley
Surrey

DC SUPPLIES

Having read Dr K.L. Smith's article on d.c. supplies from a.c. sources (Oct. 1984, p.63 on..), it would appear that some very important omissions have been made.

There seems to be an implicit assumption that there is a direct linear relationship between d.c. load current and secondary winding current and the losses which arise therefrom. Surely, if d.c. supplies are being considered, then these supplies would embody output filtering (unless the end object is, say, a very crude battery charger). That being the case, then the effects of the output filter must be considered in the design calculations for the transformer. This is particularly so in relation to the magnitude of the conduction angle of the rectifiers and the resulting size of the peak current flowing in the rectifiers/secondary winding. It is the size of this peak current (very much larger than the mean current) which dictates the cross-sectional area of the wire to be employed for the winding and the consequent losses.

It is my experience that, unless this consideration is 'built' into the design and then worked backwards towards the primary winding requirements, then a poor design is inevitable.
A.M. Wheeler
Essex

One or two comments on Dr K.L. Smith's interesting article may throw some further light on a much-neglected subject.

Transformer design is an art because the science has to be tempered with all sorts of practical limits, such as the finite gradations of lamination sizes and wire gauges. Also, transformer designers quickly realise that a 'little black book', containing details of successful designs, can dramatically cut design times. At the very least, a list of 240V primaries for all the common lamination sizes is an obvious asset.

It is surprising to read that the use of electrostatic screens has declined, because the screen can be an integral part of the safety provisions in a transformer for Class I (protection by earthing) equipment. Perhaps the reported decline applies only in some sectors of the market, where Class II (protection by double insulation) is the norm.

The clear and helpful explanation of the advantages of grain-oriented silicon-iron (not steel; there is no carbon) might be extended to point out that bolt-holes in the corners of the laminations are not helpful in avoiding core saturation, and that if through-bolts are used, they must be insulated from the core at one end to avoid circulating currents, which cause excess heating and magnetising current.

'No-waste' laminations are also called "scrapless'. Unfortunately the geometry of scrapless laminations is incompatible with the loss characteristics of copper and silicon-iron, which is the reason why one does not design for maximum efficiency, with equal fixed (iron) and variable (copper) losses at full-load. Such a design would be much larger than necessary, because for the 'scrapless' geometry, with iron and copper, the ratio of winding area to core area is so small. In order to overcome this some 'semi-scrapless' laminations are available, (which produce 4 I's for each pair of E's at stamping) with twice the winding area.

There is a rather important correction to make concerning clearance and creepage. The relevant British Standard is BS414, not BS800 (which is concerned with r.f.i.); alsorelevant is BS3535. The subject is somewhat convoluted, but construction rules are given in the Standards, and moulded bobbins allowing compliance with the requirements are commercially available. This is an area where a thorough knowledge is essential, and risks are not to be taken.

Finally, some comments on the practical design, since that may be most relevant in reducing the mystery surrounding trasformers.

(1) The standard mains voltage is 240V. Because of the rapid rise in iron loss as saturation approaches, the assumption of 230V would not normally be justified.

(2) A current density of 3.1 A/mm^2 is 2000 A/in^2. this is a little conservative: 3.6A/mm^2 is usually tolerable for transformers up to 100VA, which is helpful with scrapless laminations due to the small winding area.

(3) However, using 3.64/mm^2, it would not be satisfactory to use the same sort of approximation as Dr Smith uses to justify 30s.w.g. Professional designers usually have access, if necessary, to 'half-gauges' and, naturally, metric gauges are extensively used now. Actually, 275mA in 30s.w.g. is 3.53 A/mm^2, which is quite satisfactory.

I hope these annotations will increase the value of Dr Smith's article.

J.M. Woodgate
Rayleigh
Essex

ISOLATED VIDEO DRIVER

Following Mr McLau's design published in the July issue and Mr Bacon's comment in the October issue, it seems appropriate to clarify the situation, and hope that this clarification will help future designers.

For household electronic equipment, the relevant safety standard is BS415(1). Compliance with this standard is not mandatory, even for high-volume manufactured products, but failure of a design to comply with the standard is evidence that it is probably not safe, either due to risk of fire or of electric shock. Equipment offered for sale is required to comply with the Electrical Equipment (Safety) Regulations (2), and compliance with BS415 is prima facie evidence of a degree of safety acceptable under the Regulations.

Different requirements are given in BS415 for Class I equipment, in which protection against electric shock hazard is (partly) obtained by earthing accessible metal parts (and other parts connected to them), and for Class II equipment, in which protection is obtained by insulation of high reliability (so-called 'double insulation').

While BS415 is a long and complex document, the following abbreviated guide indicates the main requirements, and if these are met the equipment should be reasonably safe, even if it is in an experimental 'one-off'.

The requirements for mains switches also give rise to confusion, particularly since the rules have changed in the past. The basic requirement is for a double-pole mains switch but there are several important exceptions. Fuses, clocks, r.f.i. chokes and capacitors can be on the supply side of the switch. Equipment supplied through a mains transformer with separate windings (i.e. not an auto-transformer) may have a single-pole mains switch. A switch which appears to turn the equipment on and off (but is not a mains switch) is allowed if the equipment consumes less than 10W when the switch is off, and an indicator shows that mains power is still applied under these conditions. No switch is required if the equipment consumes less than 10W when fully operational. Mains switches are readily available, although there appears to be no generally-available *light-touch* approved mains switch. Hint to manufacturers!

Constructional requirements are fairly in accordance with common sense. Housings must be of adequate mechanical strength, and the equipment must not overheat so as to risk harm to the user. Live parts must not be accessible without the use of a tool: there are several different tests for accessibility which must be passed. Mains leads must be either captive or connected by means of an approved connector. 'Captive' means adequate resistance to *pulling out, pushing in* or *twisting*.

Naturally, this is only an overview of the contents of the Standard, but it contains most of the major points likely to arise in experimental designs.

Applying these considerations to Mr McLay's design, we see that:

(1) The common rail of the video amplifier circuit must be earthed to mains earth (as implied in the text).

(2) If, as is likely, the circuit is built inside the tv cabinet, it must be enclosed in an insulating box, in case a stray wire from the tv circuit should fall on the isolated circuit.

(3) The transformer screen must be earthed directly, not through the rectifier.

It should be noted that, contrary to Mr Bacon's comment, the main risk with this type of equipment is electric shock, rather than fire.

J.M. Woodgate
Rayleigh
Essex

REQUIREMENTS FOR:	CLASS I	CLASS II
Mains lead	3-core insulated and sheathed	2-core insulated and sheathed
Soldered joints (and the equivalent) at mains voltage inside the equipment.	may be exposed	*must be covered by 0.4mm insulation.
Internal mains wiring.	single-insulated	**double-insulated
Air-gap between mains and other circuits (clearance and creepage).	3mm	6mm
Dielectric test voltage for insulation between mains and other circuits.	*1500V r.m.s. 50Hz (sinusoidal)	*3000V50Hz (sinusoidal)
Construction of mains transformers.	Metal screen between primary and all other windings. Screen to be earthed.	Positive insulation barrier (min. 0.4mm thick) between primary and all other windings.

*Practical solutions to the requirements: for more details see the Standard.

** Either special wire or ordinary insulated wire in sleeving.

References
1 BS415. 1979. Safety requirements for mains-operated electronic and related apparatus for household and similar general use. British Standards Institution London 1979.
2. Electrical Equipment (Safety) Regulations 1975
Electrical Equipment (Safety) (Amendment) Regulations 1976. HMSO London.

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CIRCLE 77 FOR FURTHER DETAILS.

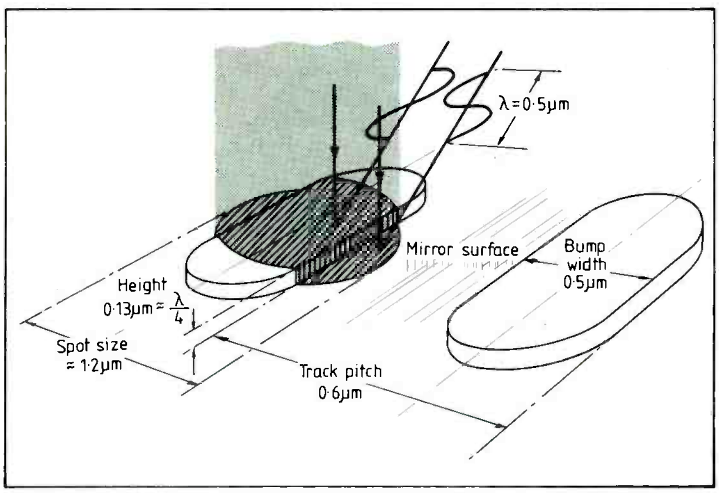
The Compact Disc system

CD has delivered the goods and been accepted as a Very Good Thing — history will have to forgive those who claimed otherwise, says John Watkinson in another penetrating and highly illustrated series.

Sufficient time has elapsed since the launch of the compact disc for the world to listen and evaluate. The promises which heralded CD — no pops and crackles, unmeasurable wow etc. — are demonstrably true. The compact disc has delivered the goods and has been accepted as a Very Good Thing, and history will have to forgive those who claimed otherwise.

CD results from a marriage of many disciplines, and yet in each is so close to the current limits of human knowledge that it is little short of a miracle to find it a mass-produced world standard and not a laboratory curiosity. CD is a synergy of laser optics, servomechanisms, error correction techniques and both analogue and digital electronics that was only realised by the joint efforts of Philips and Sony.

A history of the compact disc should include not only the technological problems, but also the human problems of coordinating such an enormous research effort and gaining acceptance for the



In readout of a Compact Disc the presence of a layer raised by a quarter wavelength causes destructive interference in the reflected light. Fig.2.

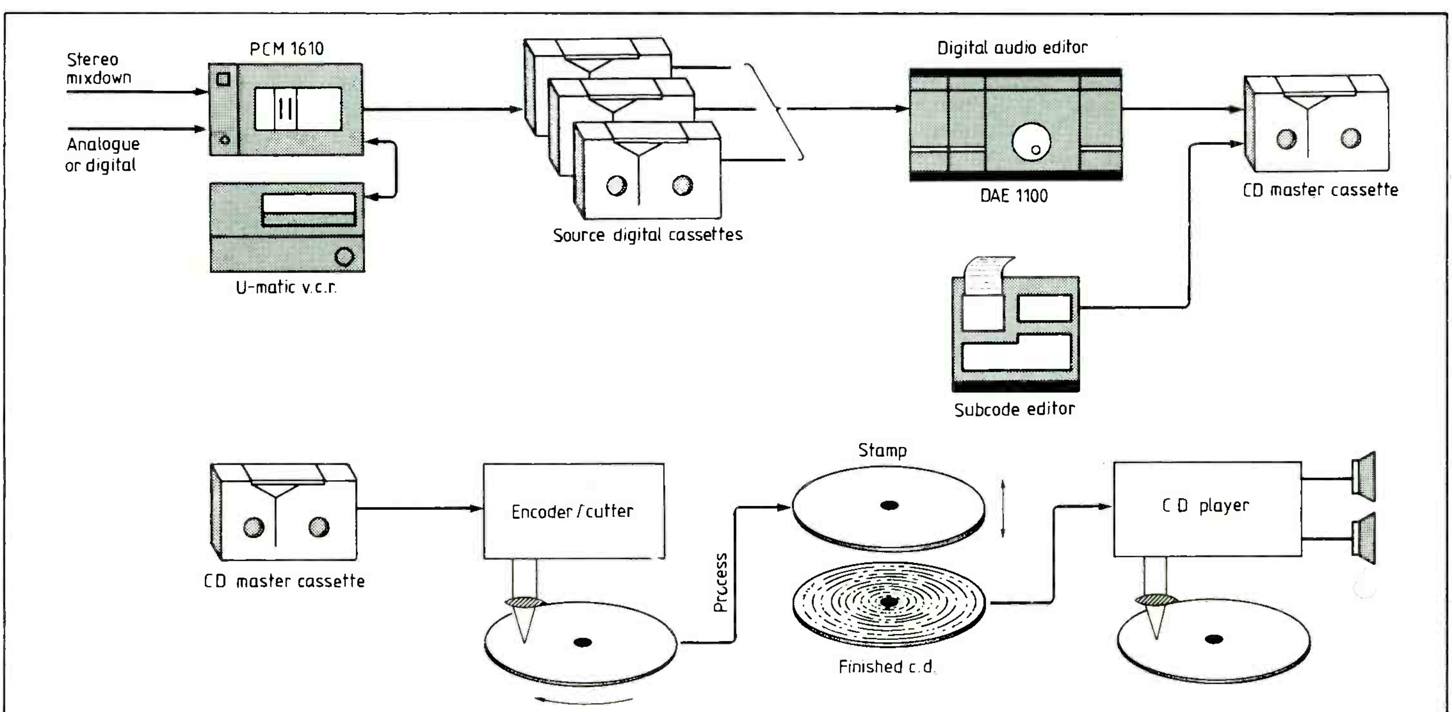


Fig 1. **Main steps in Compact Disc mastering and cutting process. This first article covers the 'cutting' and stamping process, while following parts reveal the detailed operation of the player optics and electronics (lower part of diagram). Later installments describe p.c.m. encoding from stereo mixdown, digital audio editing, and subcoding onto the master cassette (upper part of diagram).**

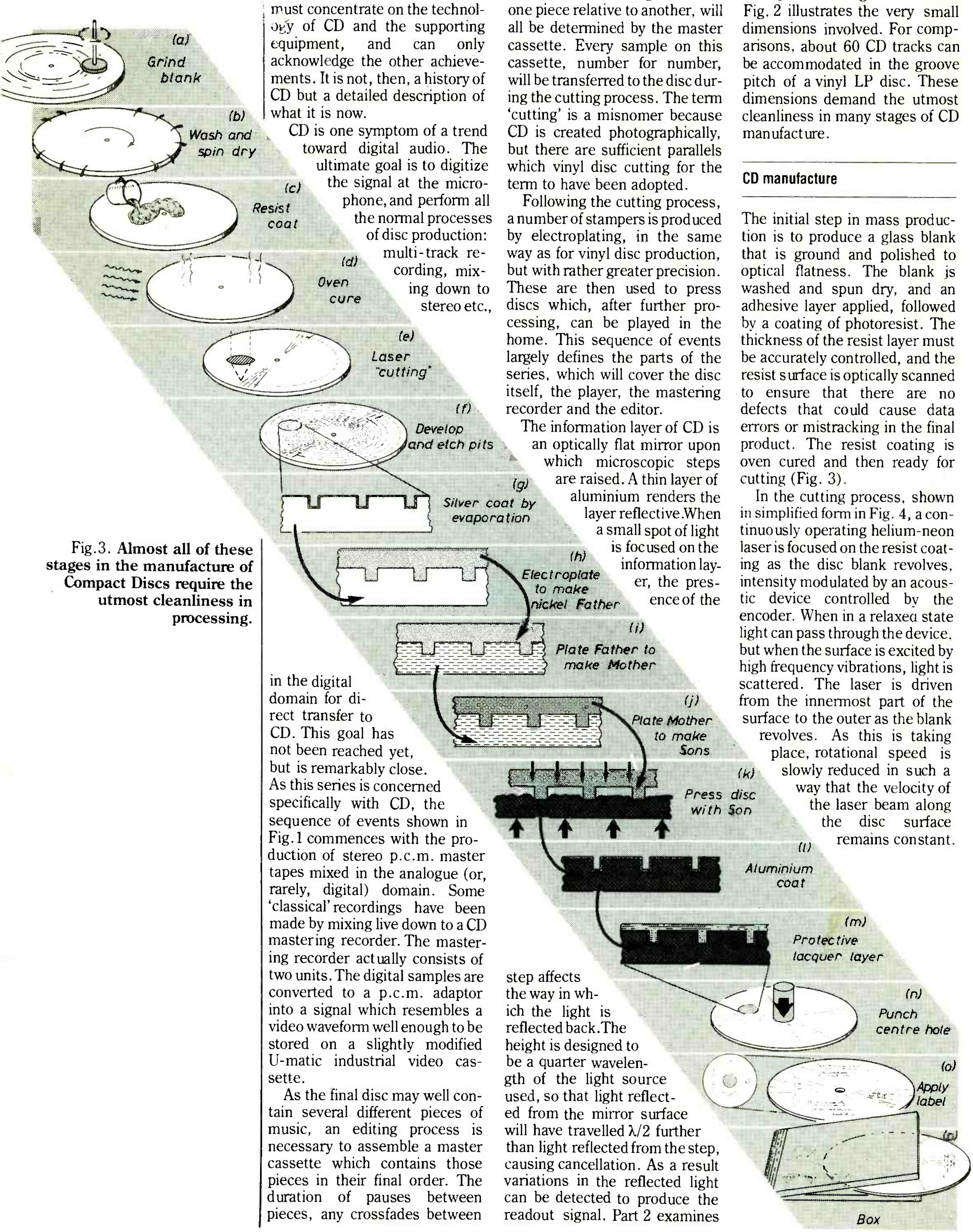


Fig.3. **Almost all of these stages in the manufacture of Compact Discs require the utmost cleanliness in processing.**

results. This series of articles must concentrate on the technology of CD and the supporting equipment, and can only acknowledge the other achievements. It is not, then, a history of CD but a detailed description of what it is now.

CD is one symptom of a trend toward digital audio. The ultimate goal is to digitize the signal at the microphone, and perform all the normal processes of disc production: multi-track recording, mixing down to stereo etc., in the digital domain for direct transfer to CD. This goal has not been reached yet, but is remarkably close. As this series is concerned specifically with CD, the sequence of events shown in Fig.1 commences with the production of stereo p.c.m. master tapes mixed in the analogue (or, rarely, digital) domain. Some 'classical' recordings have been made by mixing live down to a CD mastering recorder. The mastering recorder actually consists of two units. The digital samples are converted to a p.c.m. adaptor into a signal which resembles a video waveform well enough to be stored on a slightly modified U-matic industrial video cassette.

As the final disc may well contain several different pieces of music, an editing process is necessary to assemble a master cassette which contains those pieces in their final order. The duration of pauses between pieces, any crossfades between pieces, and the setting of levels of one piece relative to another, will all be determined by the master cassette. Every sample on this cassette, number for number, will be transferred to the disc during the cutting process. The term 'cutting' is a misnomer because CD is created photographically, but there are sufficient parallels which vinyl disc cutting for the term to have been adopted.

Following the cutting process, a number of stampers is produced by electroplating, in the same way as for vinyl disc production, but with rather greater precision. These are then used to press discs which, after further processing, can be played in the home. This sequence of events largely defines the parts of the series, which will cover the disc itself, the player, the mastering recorder and the editor.

The information layer of CD is an optically flat mirror upon which microscopic steps are raised. A thin layer of aluminium renders the layer reflective. When a small spot of light is focused on the information layer, the presence of the step affects the way in which the light is reflected back. The height is designed to be a quarter wavelength of the light source used, so that light reflected from the mirror surface will have travelled λ/2 further than light reflected from the step, causing cancellation. As a result variations in the reflected light can be detected to produce the readout signal. Part 2 examines this process in greater detail. Fig. 2 illustrates the very small dimensions involved. For comparisons, about 60 CD tracks can be accommodated in the groove pitch of a vinyl LP disc. These dimensions demand the utmost cleanliness in many stages of CD manufacture.

CD manufacture

The initial step in mass production is to produce a glass blank that is ground and polished to optical flatness. The blank is washed and spun dry, and an adhesive layer applied, followed by a coating of photoresist. The thickness of the resist layer must be accurately controlled, and the resist surface is optically scanned to ensure that there are no defects that could cause data errors or mistracking in the final product. The resist coating is oven cured and then ready for cutting (Fig. 3).

In the cutting process, shown in simplified form in Fig. 4, a continuously operating helium-neon laser is focused on the resist coating as the disc blank revolves, intensity modulated by an acoustic device controlled by the encoder. When in a relaxed state light can pass through the device, but when the surface is excited by high frequency vibrations, light is scattered. The laser is driven from the innermost part of the surface to the outer as the blank revolves. As this is taking place, rotational speed is slowly reduced in such a way that the velocity of the laser beam along the disc surface remains constant.

The resist is then developed, a process which hardens the unexposed areas. Etching removes the exposed areas to create pits in the surface of the resist. The surface is then given a coating of silver by evaporation to render it electrically conductive. In a smiliar way to the vinyl record process, a Father is made by electroplating with nickel, itself plated to produce a Mother. From the Mother, a number of Sons can be made which will be the dies used to stamp discs. Stamping transfers the pit structure to the transparent plastics disc material.

Because every step in this process produces a mirror image, the fact that there are an even number of processes—Father-Mother-Son-Disc—means that the disc will be identical to the blank. A thin layer of aluminium is applied to the information layer followed by a protective coating of lacquer. The disc is centred by optically optimizing track runout, the hole punched, and the label printed or fixed to the lacquer surface. The disc will be read from the opposite side to the information layer, so the pits appear as bumps. The quality of the pressing can be checked optically, as any defect which would corrupt data will be visible.

Disc dimensions

Within an overall diameter of 120mm the programme area occupies a 33mm-wide band between the diameters of 50 and 116mm; lead-in and lead-out areas increase the width of this band to 35.5mm, the track pitch constant at 1.6μm, there will be $35.5 \times 10^3/1\cdot6 = 22{,}188$ tracks crossing a radius of the disc. As the track is a continuous spiral, the track length will be the above figure multiplied by the average circumference. So track length is

$$2\pi \times \frac{58.5 + 23}{2} \times 22188\text{mm} \approx 5.7\text{km}.$$

These figures give a good impression of the precision involved in CD manufacture.

Part 2 takes a detailed look at the physics of CD reading.

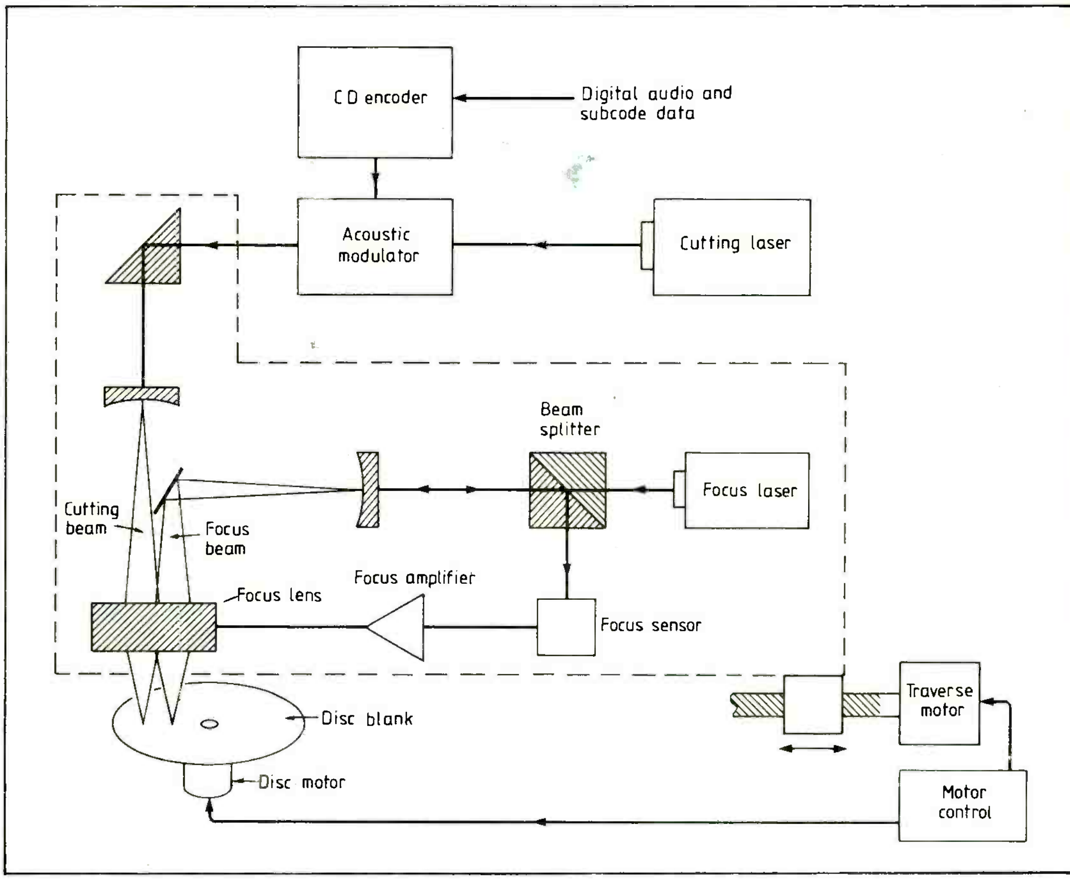


Fig.4. **Focus subsystem controls the spot size of the main cutting laser on the photosensitive blank. Rotational and travers motors need to be coordinated for constant pitch and velocity.**

Advantages of the Compact Disc

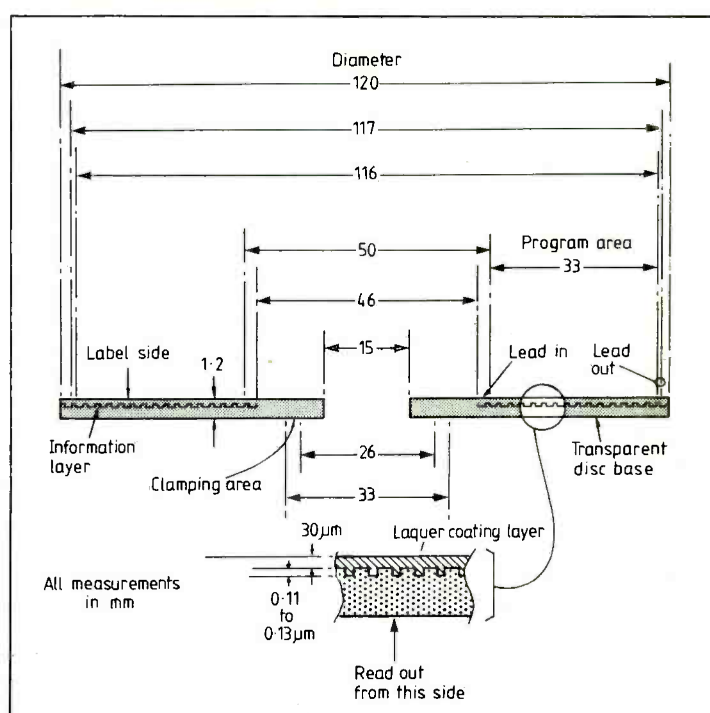
Optical readout is a non-contact process, so there is no wear mechanism. The optical system focuses on the information layer below the disc surface in such a way that debris and surface scratches are generally out of focus and their effect reduced. The combination of this and a powerful error correction strategy produces a medium which is highly resistant to handling.

A disc format permits the use of pressing for mass production, and rapid access to a desired location. Access is further facilitated by codes buried in the data stream that permit the beginnings of items to be precisely located, allowing remote timer control, and making possible the construction of a CD juke box.

The digital sampling system means that the CD process, from cutting through pressing and reading, produces no audio degradation because it simply conveys a series of numbers that are the same as those on the master recording which fed the cutter. The only part of a CD player which can cause subjective differences in sound quality is the digital-to-analogue conversion process.

The use of 16-bit quantizing permits a wide dyanmic range, not to be confused with the signal-to-noise ratio. Left and right channels are carried by separate number streams, thus crosstalk due to the disc is zero. Samples are temporarily stored in ram in the player and clocked out by a crystal oscillator giving zero wow and flutter, since disc speed variations only affect the ram writing speed. The small size of the disc permits future development of dashboard and portable players.

Fig.5. **Dimensional specification of the Compact Disc shown means the spiral track between diameters of 46 and 117mm is 5·7km long!**



by A.J. Ewins

Micro-controlled cassette recorder

Concludes the series with a description of the machine-code control software.

M/C subroutines to control deck

I have only briefly described the operation of the programs for automatically SAVEing and LOADing computer programs, because my detailed m/c program could be written for the BBC computer since it, too, has a vectored input routine. In addition to SAVE and LOAD commands, the BBC computer uses a CHAIN command, so that routines would have to be written to handle AUSAVE, AULOAD and AUCHAIN. It is my intention to write a suitable program for the BBC computer as soon as time allows but as the BBC computer is also a 6502-based machine I describe some of the m/c subroutines for handling the cassette deck.

The first m/c subroutine, :RUTR, is one designed to put the cassette deck into its various modes of operation. I use Port B of a 6522 v.i.a. chip for controlling the deck's functions. The base address of my 6522 is $F110. Table 1 shows the logic signals required on the outputs of the various bits of the 6522 to put the cassette deck into its various modes of operation. The A-register must be loaded with the desired logic function followed by the command JSR :RUTR.

The second routine, :CHRU is one that determines whether, or not, the tape-recorder is running. It is particularly useful when rewinding the tape to the beginning, and is able to detect when the motion ceases so that the rewind function may be stopped and the next function started. The input on bit PB_6 is derived from the output of the tape-recorder's motion sensor and is continually changing whilst the deck is in motion. Once motion ceases PB_6 does not change. The program simply checks that the bit, PB_6, has changed since it was last read. It is exited after a short delay, determined by the various loops, once PB_6 is constant. Effectively the program remains within this routine whilst the tape is in motion and exits once motion ceases.

The third subroutine, :REST, uses the previous two to rewind the tape to its beginning and then resets the electronic up/down counter to zero. The up/down counter is addressed via Port A of the 6522 v.i.a. chip.

The fourth and fifth subroutines, :GOED and :GOEP, are very similar and both use the very much longer sixth subroutine, :EDEP, to wind the tape to the required location. I have used a number of temporary stores, from $02EE to$02FF (which are part of an unused area of ram below the Basic program memory, in the UK101), to hold various values. In the case of the :GOED subroutine, $02F8 and $02F9 hold the high and low bytes of the electronic counter value for the beginning of the directory on tape. The values are stored in b.c.d. format. For the :GOEP subroutine, memory locations, $02F6 and $02F7 hold the high and low bytes of the electronic counter value for the position of the start of the program again in b.c.d. format. (The 'find program name' subroutine loads these stores with the appropriate values of the program's position on tape by looking-up the directory.) The remaining memory locations, $02F0 to $20F5, are working stores for use by the :GOED, :GOEP and :EDEP subroutines. Both the :GOED and :GOEP subroutines merely transfer the appropriate values of the directory's or program's position on the tape to the two working stores, $02F4 and $02F5 and then jump to the main subroutine :EDEP.

The first part of :EDEP simply separates the upper and lower nibbles of stores $02F4 and $02F5 and places them in the lower nibble positions of stores $02F0 to $02F3. The second part of the subroutine compares the low nibbles of $02F0 to $02F3 with the four digits of the current value of the electronic counter, from the most-significant-digit (m.s.d.) to the least significant digit (l.s.d.). The X register is used to index the base store, $02F0, and also as a means of 'fetching' the appropriate digit of the electronic counter via the :FECV subroutine. As soon as an inequality is found between the value held in $02F0, X and its associated counter digit, the direction of tape motion can be determined. Having set the tape in motion in the appropriate direction, the comparison is continued with the current value of the X register. However, in this case, the comparison of $02F0, X with its associated counter digit continues until the counter digit reaches the value in $02F0, X. The comparison then continues with the next value of X, and so on, up to X equals 3. Once the l.s.d. is equal to the value in $02F3 ($02F0,X), the required tape position has been found and the tape-recorder is stopped and the subroutine exited.

The seventh subroutine, :FECV, is used by :EDEP and the next subroutine, :UDEP, to load the A-register with the value of the appropriate counter digit. The current value of X is transfered to the A-register and rolled left four times into the upper nibble position. It is then ORed with %10000000 (remember, bit 7 must be '1' to prevent the electronic counter from being reset) and stored at $F111, which is the Port A i/o address. (Bits PA_0 to PA_3 are inputs and PA_4 to PA_7 outputs.) Loading the A-register

Function	PA_7	PA_6	PA_5	PA_4	PA_3	PA_2	PA_1	PA_0	Hex
Stop	0	0	1	0	1	1	1	1	$2F
Record	0	0	0	1	0	0	1	0	$12
Play	0	0	1	1	0	0	1	0	$32
Rewind	0	0	1	1	0	0	1	1	$33
Forward	0	0	1	1	0	1	1	0	$36
Search forward	0	0	1	1	0	1	0	0	$34
Search rewind	0	0	1	1	0	0	0	1	$31

with the value at $F111 reads the four lower bits which is the value of the selected digit.

The eighth subroutine, :UDEP, updates the record of the position of the end of the recorded programs on the tape: it determines the position of the 'next free space' on the tape. The loop of the subroutine effectively does the reverse of :LP1 in the :EDEP subroutine. The four digits of the electronic counter are read and stored as two bytes in stores $02F6 (high byte) and $02F7 (low byte). The reading of the counter at the end of SAVEing a program marks its end. In order that the next program to be SAVEed starts in a position some distance further along the tape, a value of 40 (decimal), or 28 (hexadecimal), is added to the tape counters record. Because the values stored in $02F6 and $02F7 are in b.c.d. format, the 'decimal mode' must be set (SED) before 40 is added to the low-byte ($02F7) of the counter record. Having added any 'carry' to the high-byte ($02F6) the decimal mode is cleared by the instruction, CLD.

The final subroutine is :SICO (set initial conditions). I describe it so that some idea of what is required in initialising the overall program may be obtained. The first statement, :DIAD #$76, labels and stores the high-byte of the memory location ($76) from which the directory will be stored in ram. Although my m/c program for running the cassette deck automatically has been developed and tested, I have not yet decided where to store it in eprom. For the present it is stored in 2K of non-volatile ram at $7800 to $77FF. Consequently, I have chosen to reserve the space $7600 to $77FF (512 bytes) for the storage of the directory. The start of the directory, $7600, is referred to by several parts of the program. Therefore, to enable me to change my location easily without having to modify several lines of program, I refer to the high-byte address, $76, via the label :DIAD. (the low-byte is always assumed to be $00.)

I use bit 4 of $02FA (part of the temporary storage area) as a flag to indicate whether or not the directory has been loaded into ram. It is thus set to indicate non-loading at the start of the program. Next, the low and high bytes of the start address of the 'new input routine', :INPR, are stored in the input routine's vector locations, $0218 and $0219. The values of the tape counter (low and high bytes) for the start of the directory location (on tape) and the beginning of the program storage space are shown in $02F9, $02F8, $02F7 and $02F6, respectively. The start location of the directory is also stored in $02F5 and $02F4 upon initializing.

Stores $02EE and $02EF are used to hold the address of the 'next free memory location' for storing the directory in ram. Initially, $02EE, holds the value of $00. As each new program is SAVEd the directory storage space is used up, ten bytes at a time. The address stored in $02EE and $02EF is thus incremented by 10 (or $0A) each time a program is SAVEed.

As a means of determining when a cassette is removed and a new one inserted into the deck, I have coupled the output from the 'cassette-in-position, micro-switch (see Figs. 1&2 of the first part of the article) to the CB1 input of the 6522 v.i.a. chip. Loading $F11C (F110+C. which is the peripheral control register of the 6522) with $10 sets bit 4 of the p.c.r. to '1', with the result that the interrupt-flag register bit 4 is set on a low-to-high transition of CB1. As part of the routine 'check directory loaded', bit 4 of the interrupt-flag register is thus read. If it is set it is assumed that the cassette has been changed and the directory on tape will be (re)loaded into the directory ram store location.

The final lines of the :SICO routine simply zero all the store locations of the ram area where the directory is to be stored.

Concluding comments

In writing this article, I have attempted to give an indication of the sort of m/c program necessary to provide automatic control of the SAVE and LOAD functions of a microcomputer. I recognise that few readers may own a UK101 microcomputer and for that reason I have not given full details of my own m/c program. I am prepared to consider providing details of my m/c program to interested UK101 users if they will first write of their interest to me, via *Wireless World*, enclosing a stamped-addressed envelope

Continued from 59

parallel i/o expansion, dynamic ram/SASI controlling, eprom programming, analogue i/o and a video output.

There are three processors (single Eurocard) that are normally used with the Arcbus mentioned above, **Arc 40,41** and **42**, each with Z8 Basic/debug in processor rom. They are based on the Zilog Z8671 single-chip microcomputer with uart, two counter/timers 144 bytes of ram, 124Kbyte addressing range and six maskable vectored interrupts. The Arc 40 is described as a development computer with eprom programmer and buffered i/o lines, the 41 as a board with r.t.c. for control, measurement and data logging, and the 42 is a 'minimum-chip' computer with prototyping area. Arcbus compatible boards are available for i/o control (also isolated), IEEE488 interfacing, analogue conversion, video output, eprom programming and cassette output. Assembly/cross assembly software is available. E&WW 334

A set of double-Eurocards from SGS form the **CLZ80S** microcomputer system, intended as an o.e.m. product rather than an evaluation system. The computer board has 64Kbyte ram (256K addressing), 16Kbyte eprom space, two programmable synchronous/asynchronous serial channels with modem control lines and provision for d.m.a. The board's three parallel ports each have two handshaking lines and there is a 16-bit programmable counter/timer. Memory, i/o, video, eprom-programming and analogue boards are available with the same bus. The system's floppy-disc board interfaces with the WD1000 hard-disc controller. E&WW 335

Two board systems are manufactured by Siemens, helpfully named **AMS** and **SMP**. The AMS system uses double Eurocard boards and can have more than one bus — Multibus II (standard pending) with a 32-bit multiplexed data word, and AMS-M bus (same electrical spec. as Multibus) with 16-bit non-multiplexed data word, and a user's own bus (or Siemens SMP bus with 8-bit data word, non-multiplexed for SMP-bus cards). SMP products, intended for measurement and control applications but also suitable for general data processing, are single Eurocard and conform to the SMP or SMP-M (SMP expanded) bus.

There are four AMS c.p.u. boards, the M6 and M61 with 8086 processors, the M5 with an 8085 and the M16 with an 80186. They all have a timer/counter, interrupt controller and serial i/o in common; only the M16 has no parallel i/o. A coprocessor and intput/output controller are optional on the M6 and M61. There is also a ram board with 128, 256 or 512Kbyte options.

The choice of SMP boards is wide. There are 15 c.p.u. boards with processors ranging from the 8080 to the 8088 with maths coprocessor and d.m.a. In addition, there are 23 memory options, 29 i/o boards and 19 peripheral boards, not to mention power supply units. Monitor programs are available with and without floppy-disc functions and there is a wide range of other software/development aids.

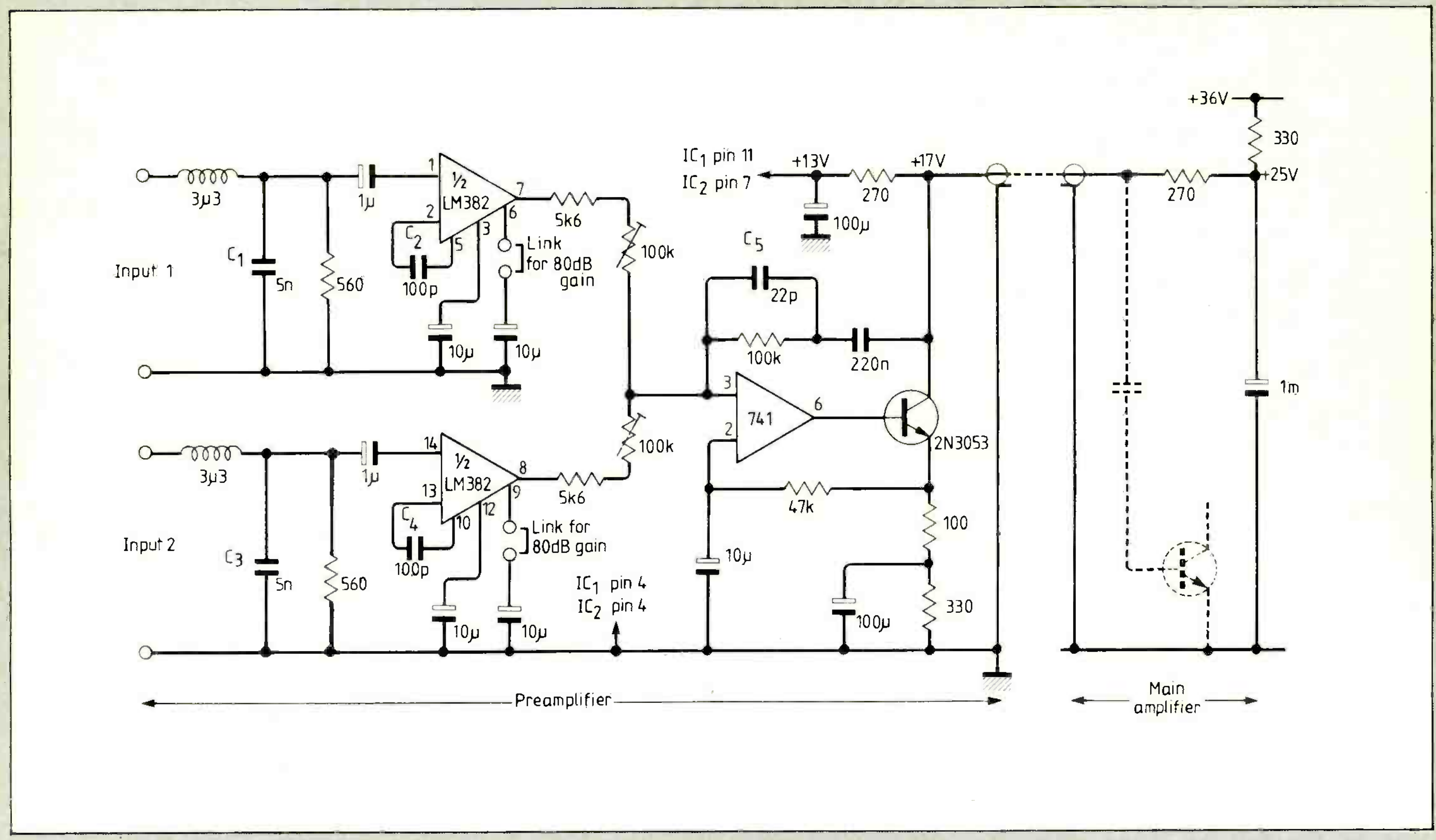
Siemens says of the AMS system, 'its trend-setting multimaster capability and multibus structure enables an adaption to the performance required in the most different applications'.

E&WW 336

Buses conforming to G64 and VME are used by Thomson CSF for their two main computer-board ranges. In the G64 range, there are **eight c.p.u. cards** with 6800, 6802 or 6809 processors. Variations are in memory capacity (all have a small area for ram and rom) and serial/parallel i/o capabilities. Separate static ram/eprom cards, parallel/serial/analogue i/o interfaces, IEEE488 and v.d.u. controllers are also in the range. Other controllers include a floppy disc interface and an arithmetic coprocessor.

The company's latest VME board, the **EFD-COMBO** running CP/M 68K, holds 256Kbyte ram with parity checking, 128Kbyte eprom, and has a SASI hard-disc interface. A choice of debugging software is available for the **EFD-CPU1 68000** processor board with space for 256Kbyte rom or 64Kbyte ram (16Mbyte addressing). Three timer/counters are used. Other boards are for memory expansion, serial and parallel i/o, v.d.u. and disc control. A range of software is available.

E&WW 337



Line-powered preamplifier

Designed to allow a second microphone to be used in a p.a. system, this preamplifier has advantages over existing designs. It requires no additional wiring between microphone and amplifier; existing screened cable is used. Further, the preamplifier can be mounted close to the microphone, reducing hum problems, and no local power-supply is required. Based on an LM382 dual low-noise preamplifier and 741 mixer/driver, the prototype operates satisfactorily with over 20m of screened cable between it and the main amplifier.

Each channel provides 55 or 80dB gain, depending on which i.c. pin is grounded for a.c., and mixer gain is adjustable between 0 and 25dB. Output of the LM382 (self-biased to 6V) sets quiescent current through the 2N3053 transistor. Frequency response is set by the inductors and C_{1-5}, giving −3dB points of 20Hz and 20kHz with a roll off of about −80dB/decade above 20kHz. Output is about 1.5V r.m.s. Power supply for the preamplifier, at around 30mA, is obtained by RC smoothing of the main-amplifier supply line. Note that the smoothing capacitor is connected to the common rail at the amplifier input.

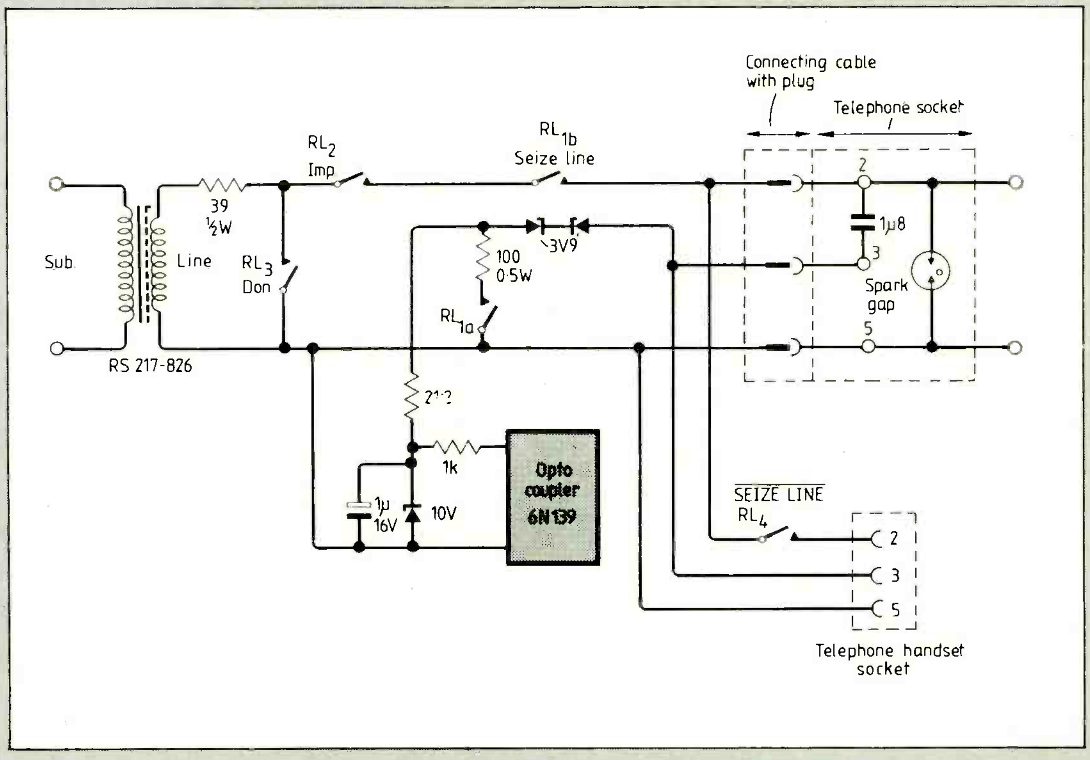
A.J. Chadwick
Hull
North Humberside

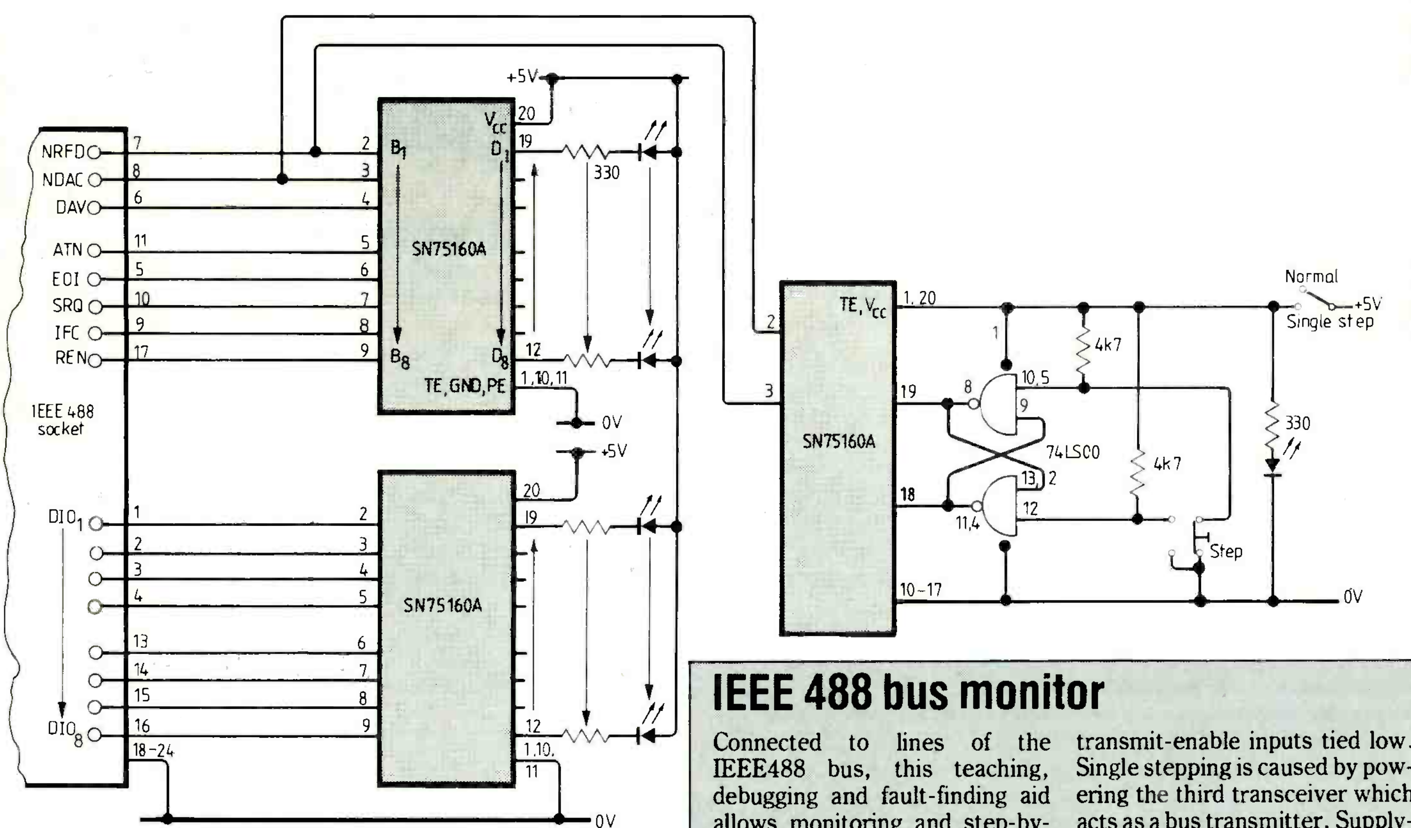
Simplified modem line interface

Telephone sockets fitted with a bell-feed capacitor allow the line interface of Richard Lambley's multi-standard modem to be simplified. Acting also as a spark-quenching device, the bell capacitor replaces two components in the modem line interface.

Further reduction in components is possible if the telephone line-isolating transformer can take around 120mA d.c. without saturating (e.g. an RS217-826). This allows the gyrator circuit to be left out. Relays $RL_{2,3}$ are unchanged since they perform such functions as dial-off-normal (DON) and impulsing (IMP). Relays $RL_{1a,b}$ operate together to seize the line. An inverted logic signal drives RL_4 which connects the external telephone line.

T. Segaran
York





IEEE 488 bus monitor

Connected to lines of the IEEE488 bus, this teaching, debugging and fault-finding aid allows monitoring and step-by-step examination of bus messages. It uses three 75160 non-inverting bus transceivers, two acting as bus receivers with their transmit-enable inputs tied low. Single stepping is caused by powering the third transceiver which acts as a bus transmitter. Supply-current requirement is about 400mA.

A.H. Howe
Bexleyheath, Kent

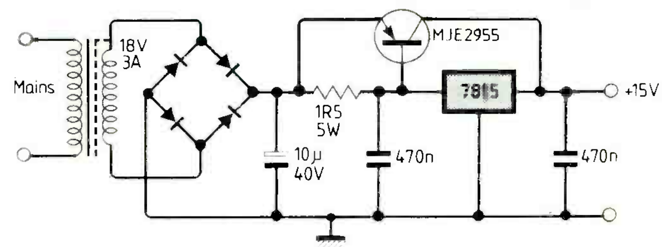
Class-A power amplifier

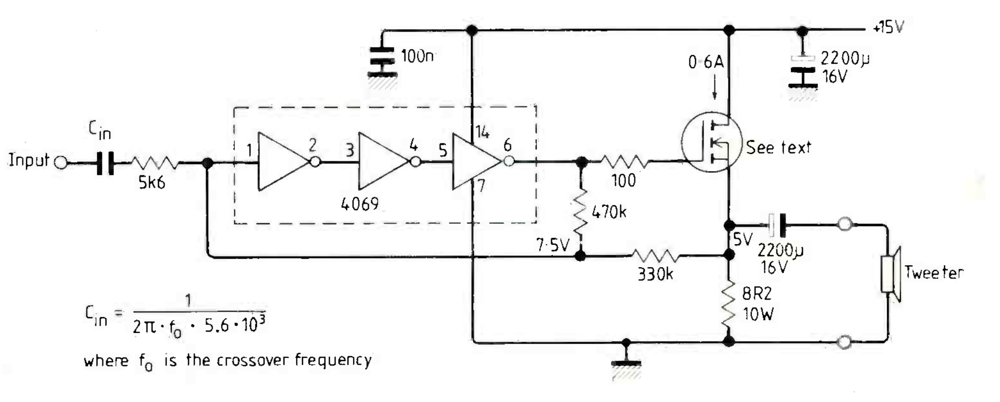
Being low powered, the main application for this class-A circuit is as a tweeter amplifier in high-fidelity systems using active crossover networks; it delivers around 1.5W into 8Ω. Using the circuit as a full-range amplifier driving a Rogers LS3/5A loudspeaker, I find the sound quality very good, though the acoustic level is limited.

Three cmos inverters in series drive a power mosfet. Due to symmetry of the inverter output devices, negative feedback causes output self biasing at about half the supply rail. With a 15V supply this is 7.5V, at which point the inverter transfer characteristic is most linear. I have used an RCA 9195 n-channel power mosfet with good results similar devices such as the Hitachi 2SK133 should work equally well.

Assembly is critical. To avoid oscillation, the fet gate resistor should be mounted directly on the gate terminal and the leads at both ends of the resistor should be kept as short as possible. The 100nF decoupling capacitor should be mounted as close as possible to pins seven and 14 of the 4069 and the loudspeaker decoupling capacitor as near to the drain terminal as possible. The 4069 contains six inverters so the other three can be used for a second channel; the supply shown feeds two channels easily.

Per Hojlev
Copenhagen





$$C_{in} = \frac{1}{2\pi \cdot f_0 \cdot 5.6 \cdot 10^3}$$

where f_0 is the crossover frequency

by Henk Bender

Eprom duplicating aid

Connected to the WW emulator, this simple circuit can read and copy 2716 eproms

Fig 1. **A printed circuit plan for the eprom duplicator is available from the *Wireless World* editorial office in return for a stamped adressed envelope or an international reply coupon.**

Only three cmos integrated circuits and a few other components are required to build this useful extension to the emulator*.

The emulator was originally intended to work the other way round: that is, an external system was to read the emulator's ram. But it can also be used to *load* the ram.

The circuit uses a 4049 hex inverting buffer i.c. in three different ways. Sections 1, 2 and 3 form a square-wave oscillator with a frequency of about 1700Hz. Section 4 acts as an inverter to control the data outputs of the eprom. Sections 5 and 6 buffer the chip select and write-enable inputs of the emulator.

With S_1 in the Hold position, IC_1 and IC_2 are reset and the CE input of IC_1 is held high, so the oscillator has no effect on the counter. The transistor switches on the led.

Binary counter IC_2 resets the eprom to address 000 and inverter 4 makes sure that the data outputs are in the high impedance state.

When S_1 is set to Run, the reset pins and CE go to logic 0. Then IC_1 starts counting to control the write cycle (Fig.2). The led is switched off.

Write cycle

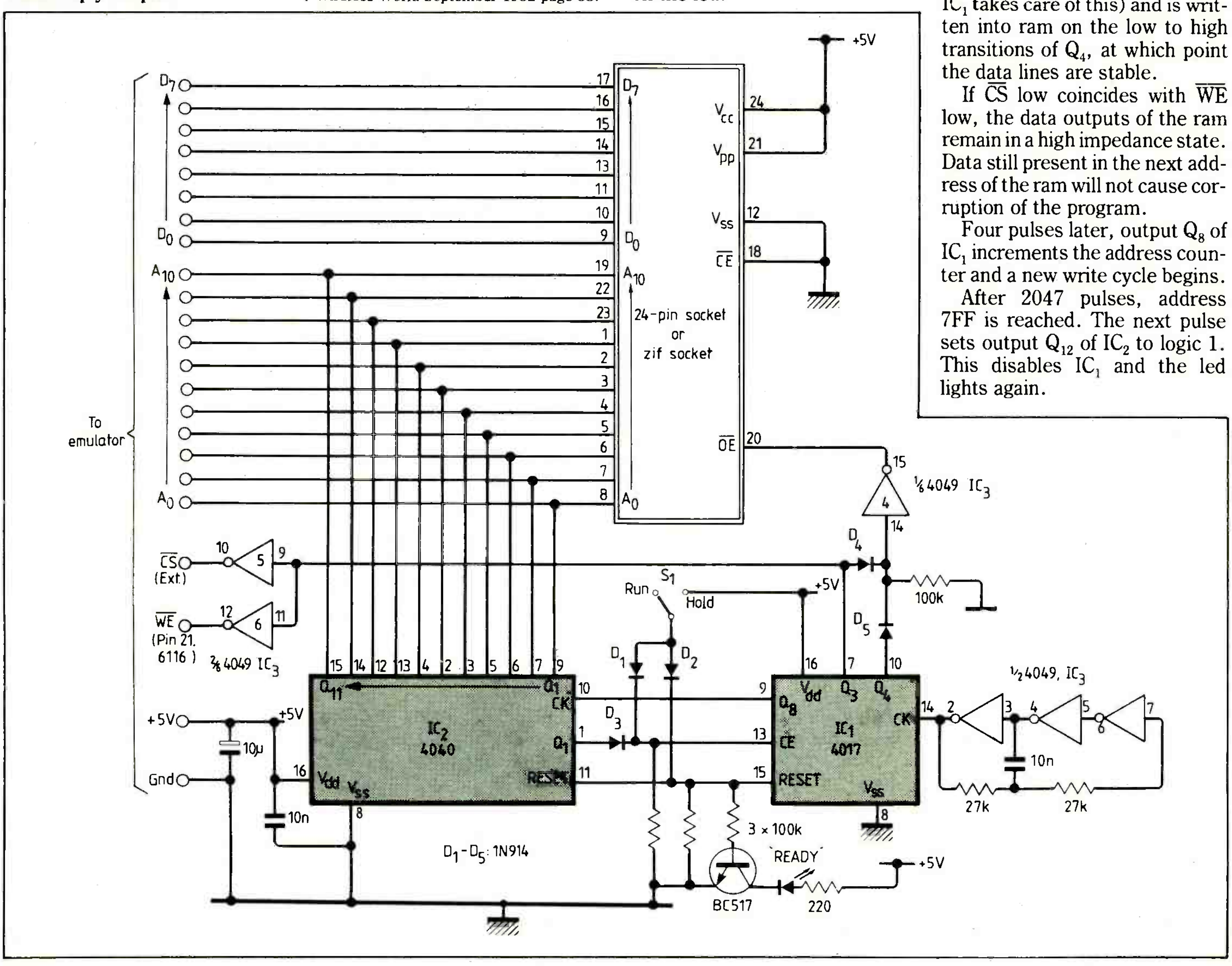
Data appears on the data lines as $\overline{CS}$ and $\overline{WE}$ go low (output Q_3 of IC_1 takes care of this) and is written into ram on the low to high transitions of Q_4, at which point the data lines are stable.

If $\overline{CS}$ low coincides with $\overline{WE}$ low, the data outputs of the ram remain in a high impedance state. Data still present in the next address of the ram will not cause corruption of the program.

Four pulses later, output Q_8 of IC_1 increments the address counter and a new write cycle begins.

After 2047 pulses, address 7FF is reached. The next pulse sets output Q_{12} of IC_2 to logic 1. This disables IC_1 and the led lights again.

* Eprom emulator, by Peter Nicholls, *Wireless World* September 1982 page 83.



Using the duplicator

1. Set the emulator switch to Ext.
2. Set the duplicator to Hold.
3. Insert a programmed eprom in the socket.
4. Connect the duplicator to the emulator: the led will light.
5. Switch the duplicator to Run: the led will go out.
6. The led will light again after 12 seconds.
7. Set the duplicator to Hold.
8. Disconnect the duplicator from the emulator.
9. Switch the emulator to Load.
10. Press Reset to return the starting address to 000.

The data can be edited, printed, stored on tape or loaded into a new eprom.

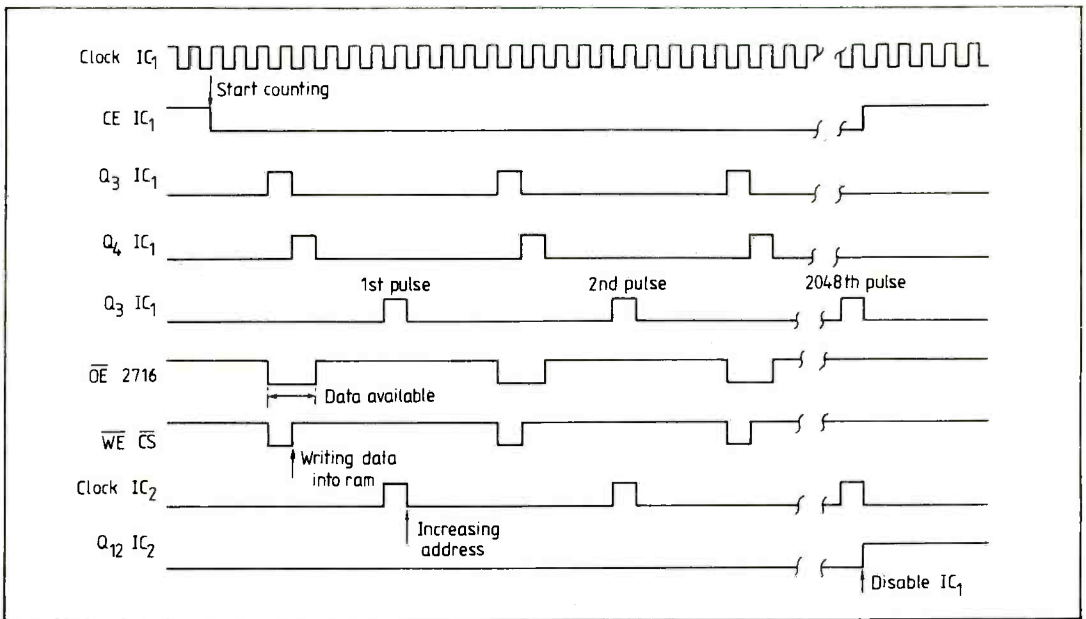


Fig. 2. **Timing diagram: a single write cycle takes about 6ms, the entire programming operation about 12s.**

Testing

The duplicator may be connected to the emulator via a 31-pin DIN 41617 connector or through a ribbon cable. The only modification needed in the emulator is a wire link from pin 21 ($\overline{WE}$) of the 6116 ram to the external connector.

In testing the duplicator, there is no need for an eprom in the socket. Set S_1 to the Hold position, and the led should light. Now set S_1 to Run. The led should go out and light again after about 12 seconds.

Data exchange between microcomputers

by G.A.M. Labib

Combination of interrupt-controlled and programmed I/O enables higher data rate.

This article describes an efficient method for data exchange between microprocessors via I/O ports. It combines the interrupt-controlled and programmed I/O techniques, to achieve a higher data transfer rate than that achieved in the case of applying either one of these techniques separately, or using DMA.

In the combined technique, and prior to data transfer, the sender checks whether interrupts are enabled in the receiver or not. If not, the sender branches to a Fail routine before returning to the main program once again. Otherwise, the sender will interrupt the receiver by executing the OUT PROC1 instruction, causing $\overline{Out1}$ line to go to the low state, resetting latch1 whose output is connected to the priority interrupt encoder of the receiver. Thus, an interrupt request is generated, and when this request is processed, the INTE line of the receiver goes to the 'low' state and remains at this state until an EI instruction is executed. The sender checks the state of the INTE line by executing IN PROC1 instruction, causing $\overline{In1}$ line to go to the 'low' state. At the negative edge transition of $\overline{In1}$ line, latch 4 stores the status of the INTE line, and this status is transfered to the accumulator of the sender during the 'low' state of $\overline{In1}$ line.

Transmission of data takes place when the sender executes the instruction OUT PROC2, causing line $\overline{Out2}$ to go 'low', triggering buffer 2,3 to save the contents of the ACC of the sender. The receiver reads the stored data in buffer 2,3 by executing IN PROC2 instruction, causing line $\overline{In2}$ to go 'low' enabling the output of these buffers to be connected to the data bus of the receiver, and to be stored in its ACC.

At the end of data transfer operation, the sender will issue another interrupt request to the receiver by executing OUT PROC3 instruction. This interrupt will cause the receiver to branch from the data transfer subroutine to either a data processing routine or the main program, according to the user application.

Data transfer rates achieved by the application of the programmed I/O, the interrupt-controlled I/O, and the direct memory access methods are 7.6, 14.8, 34.5kByte/s respectively. With the application of this combined technique, a data transfer rate of 42.6 kBytes/s is achieved. Thus, the ratio of the data transfer rates of the 4 mentioned techniques will come to 1 : 2 : 4.5 : 5.6 respectively.

The above calculations are made on the assumption that each machine state has a duration of 500 ns, and that the microprocessor under consideration is the Intel 8080A.

REFERENCES

Bellm, H. and A. Sauer "Methods of data exchange between microcomputers", Euromicro 1977.

```
SEND    PUSH  PSW       /Save the ACC and the status
                        register contents in stack.
        PUSH  H         /save the contents of H&L
                        registers in stack.
        PUSH  D         /save the contents of D&E
                        registers in stack.
        IN    PROC1     /check the INTE line status of the
                        receiver.
        RAR
        JNC   FAIL      /if INTE is not set, then branch to
                        FAIL.
        LXI   H,BUFADR  /if INTE is set, then load register
                        pair H-L with data buffer starting
                        address.
        MVI   D,BUFSIZ  /and load register pair D-E with
                        buffer size.
        OUT   PROC1     /interrupt the receiver to execute
                        the data transfer subroutine.
SENSE   IN    PROC1     /check if the receiver has
                        processed the interrupt request,
                        and reset INTE line.
        RAR
        JC    SENSE     /if INTE is still set, then check it
                        again,
MOVE    MOV   A, M      otherwise, move the byte
                        appointed-to by H-L pair, from
                        memory to the ACC,
        OUT   PROC2     /transfer byte to the receiver,
        DCR   D         /check if it is the last byte to be
                        transferred.
        JZ    END       /if yes, terminate the transfer
                        operation.
        INX   H         /if not, increment buffer pointer,
        JMP   MOVE      /and start the transfer of the
                        following byte.
END     OUT   PROC3     /interrupt the receiver to terminate
                        the transfer subroutine.
        POP   D         /retrieve D-E original contents.
        POP   H         /retrieve H-L original contents.
        POP   PSW       /retrieve the ACC and status
                        register original contents.
        RET             /return to Main Program.

RECV    PUSH  PSW
        PUSH  H         /
        LXI   H,BUFADR  /
        EI
        --              /optional delay (see n
        --              /
READ    IN    PROC2     /store transferred byte ı
        MOV   M, A      /store byte in data buffeı
        INX   H         /increment buffer pointer.
        JMP   DELAY     /perform a compensating ،
                        be in-step with the sender.
DELAY   INR   A         /
        JMP   READ      /prepare for another data byı
                        storage.

TERM    POP   H         /restore original H-L contents,
                        and set stack
        POP   H         /pointer to point at ACC and
                        status register.
                        /original contents locations.
        POP   PSW       /restore ACC and status register
                        original contents.
        RET             /return to Main Program.
```

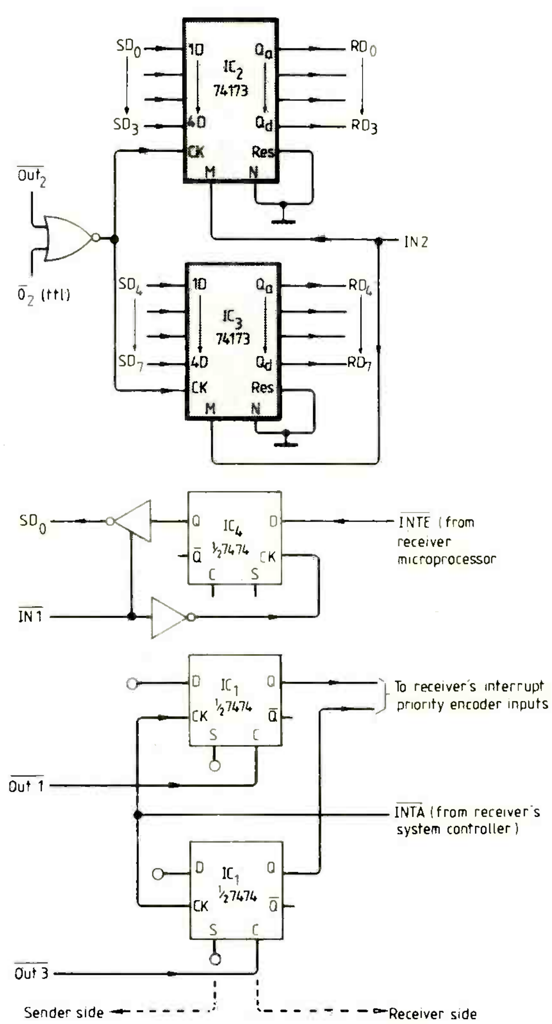
Note: OUT PROC3 instruction execution by the sender will cause the receiver to branch to TERM subroutine in which the user-defined destination may be specified for the u.p.

Note$_2$: This optional delay program segment may be inserted if any expansion in the sender subroutine is made following OUT PROC1 instruction, in order to maintain processors synchronisation.

Figure 1. contains data transfer subroutines for both the sender and the receiver.
Figure 2. contains four cases of the transfer subroutine, demonstrating the mechanism of synchronisation of the sender and the receiver, starting with the best case, and ending with the worst case.
Figure 3. demonstrates the hardware circuitry of both the sender and the receiver interfaces.

sender side		receiver side$_1$		receiver side$_2$	
1					
2					
3					
4					
5					
6	24	RST	11	SUI	7
7	7	1	22	RST	11
8	10	2	10	1	22
	---	3	4	2	10
	41	4	0	3	4
		5	10	4	0
			---	5	10
			57		---
					64
9	5	6	7	6	7
10	10	7	5	7	75
11	15	8	25	8	25
7	7	5	10	5	10
8	10		---		---
	---		47		47
	47				

sender side		receiver side$_3$		receiver side$_4$	
1					
2					
3					
4					
5					
6	24	LXID	10	XTHL	18
6	24	RST	11	RST	11
7	7	1	22	1	22
8	10	2	10	2	10
	---	3	4	3	4
	65	4	0	4	0
		5	10	5	10
			---		---
			67		75
9	5	6	7	6	7
10	10	7	5	7	5
11	15	8	25	8	25
7	7	5	10	5	10
8	10		---		---
	---		47		47
	47				



Countdown to cellular radio

by
N.S. Cawthorne, MIEE

Among the topics discussed at the Comex 84 conference in Northampton were plans for Britain's public cellular radiotelephone service, which opens this month.

Derek Wordley, marketing director of Cellnet and Ken McGeorge of Racal-Vodac both used "Countdown to Cellular Radio" as the titles of their lectures to the Comex 84 conference.

In accordance with their licences, both systems operators, Cellnet and Racal, have to be operational by 1st March 1985 with the first phase of the 900MHz cellular radio network. The cellular radio public mobile telephone service will start in the London area and spread rapidly along the main trunk routes and major cities of Great Britain.

Both Cellnet and Racal-Vodafone issued detailed network projections in October. By mid-1986 Racal expects to have reached as far north as Aberdeen and to have completed coverage of all the main motorway arteries and cities in the U.K. Cellnet's published plans extend to the end of 1985, by which time they hope to cover most major cities including the motorway links.

The high level of network planning and installation activity by both systems operators will continue long after the opening of the first phase of the network in the London area in early 1985.

The work of Oftel, the Government's newly created telecommunications watchdog body, was outlined by John Compton, formerly of the Department of Trade and Industry, but now manager of Oftel's general licensing policy and apparatus approvals branch.

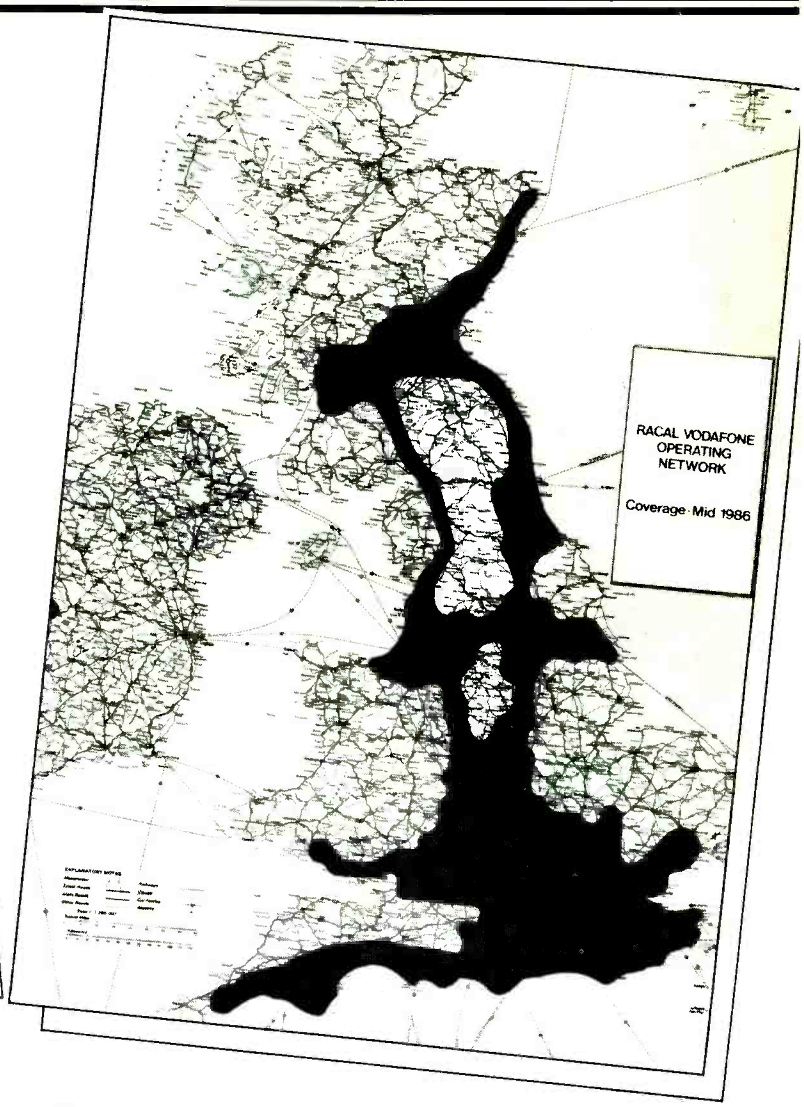
Oftel's key functions included keeping under review all activities connected with telecommunications worldwide, collecting information on all telecommunications activities in the U.K., as well as giving advice, information and assistance to the Secretary of State for Trade and Industry and other Government departments.

However, Oftel's main role, he said, was the monitoring and enforcing of compliance with the conditions of licences granted under the 1984 Telecommunications Act. Oftel's staff of about 50, would later increase to 80 but Oftel would also use outside consultants for specialised studies. Oftel was entirely funded by licence fees.

To the surprise of some delegates, Compton announced that Oftel had commissioned a study into the Bands I and III issue. This would be in addition to the Government's own Green Paper activities which were later described by a D.T.I. representative. Oftel's own study of Bands I and III is to be completed before the end of the year.

Asked whether Oftel sees itself in the role of telecommunications Ombudsman, Compton replied that Oftel was not specifically tasked with looking for cases of maladministration as was the case with the Ombudsman's office, but that it would expect to be in contact with the Office of Fair Trading on telecommunications matters.

Cellular radio for the City of London: Cellnet's first base station is lifted into position above Farringdon Street.



By the end of 1985 Cellnet, the British Telecom-Securicor consortium, plans to provide a cellular radio service covering the largest cities and their connecting motorways. Above right: coverage plans of the rival Racal-Vodafone network.

Further reading

Comex '84 conference papers (Northampton 16-17 October 1984): Federation of Communications Services.

Bands I and III Consultative Document, Her Majesty's Stationery Office, Cmnd 9241.

Mobile radio system and techniques (IEE conference report) by N.S. Cawthorne, Wireless World December 1984 page 69.

Developments in cellular radio, by Richard Lambley, Wireless World June 1984 page 31.

Band III

Ian Jones, head of the licensing branch of the D.T.I. informed delegates that about 60 replies had been received to the Bands I and III Green Paper published last May. This asked for opinions concerning future uses of the 405-line t.v. transmission frequencies after the close-down of t.v. transmitters in early 1985.

At WARC 79, it had been agreed that the U.K. could use Bands I and III and land mobile services after the t.v. transmissions had been phased out, even though all of the U.K.'s neighbours would be continuing to use Band III for broadcasting. This would inevitably present interference problems, particarly near to t.v. carrier frequencies.

Jones amused delegates by telling them that the 'crumby bits' of Band III, that is, frequencies near the vision carrier frequencies of overseas TV transmitters, could have been sold three times over even though they would not be of any use for conventional mobile radio. Many imaginative applications for these 'bad frequencies' had been proposed.

'Service providers', he said, potentially offered the most efficient use of Band III. Initially the service provider might have five or ten channels.

Where a number of channels were available, trunking systems could be introduced. By means of trunking the mobile user would have access to a group of channels and would be allocated one vacant channel from the group when he made a call.

Trunking achieves additional gain in the grade of service as the number of channels increases, as a consequence of the decreasing probability that all channels will be in use at the same time. Once the number of channels available exceeds three, the gain from trunking becomes significant.

The mobile radio service provider would offer a package of communications services to the user, including perhaps data transmission as well as conventional voice communications.

Criticisms of the concept of service providers for mobile radio (as opposed to individual businesses having their own networks) centred on the range of services provided. The private mobile radio user might require more services than were being offered by the service provider. Unless there was the facility to move from one service provider to another, mobile radio users might prefer to have their own networks.

A second criticism of the service provider principle came from operators who required national coverage. The A.A. and R.A.C. both required national coverage as did the nationalised power industries. A national network in Band III could not be catered for by smaller service providers.

An alternative proposals was that Band III should use a shared national infrastructure, installed and run by a single operator, but over which other could operate and provide services. In the London area this would require about 300 channels.

This national network could be installed by a national network operator in a similar way to present cellular radio activity at 890-960MHz. The service provider would then have access to the national network at a much lower cost than if he were to install his own network. The advantages of this national system would be in a more efficient use of the spectrum. But with 300 channels, it would mean using about one third of the new channels that became available in Band III.

If the same competitive telecommunications policy were followed as was now the case in cellular radio with BT and Mercury, then there would presumably be need for two competing national networks in Band III rather than one.

The national network idea waas criticized by delegates from outlying parts of the country, which because of their relatively low population and their distance from the main arteries might be left out.

Jones of the D.T.I. was quick to reassure delegates that if the national infrastructure solution were adopted for Band III, then there would not be any question of areas being left out because the national network did not yet or would never reach their area. Separate allocations would be available.

As if to emphasise the continued uncertainty over the exact way in which the new frequencies at Band III would be used for the land mobile service, the thorny old question of s.s.b. (and even i.s.b.) was raised and debated. Single-sideband represents a direct trade-off between spectral efficiency and equipment costs. But what price spectral efficiency?

The current rate of growth in mobile radio of about 8% or 10% per year may be an inadequate indicator of the true demand, because frequency availability and co-channel interference might both make the potential mobile radio user shy away. The release of the new frequencies may show the true demand for mobile services to be much greater than these figures indicate and that the spectral saving gained by the introduction of s.s.b. will be needed if the latent demand is to be adequately catered for.

Dr Fudge of B.T. Radiophone summed up the spectral efficiency argument thus: "Spectrum has to be paid for; and if it's through the equipment, then so be it."

In conclusion, Jones told the delegates that not all decisions concerning Band III would be made immediately. Delegates could expect to hear of some initial decision before the end of the year, but others would follow later. The D.T.I. was still listening to industry, users and all other interested parties.

Pagers: poor man's cellular

Strong assertions by pager manufacturers that pagers would overtake cellular radio were to be heard during the conference. Pager manufacturers believe that the enormous residential market for reliable but cheap radio communication can only be realized with pagers.

Compared with North America, Japan, and Hong Kong, Europe as a whole lags well behind in pager market penetration. The U.K. however, with 0.3% pager penetration is a long way ahead of the European average of 0.1%.

Estimates of the relative equipment costs between cellular radio and pagers show that tone-only pagers work out at about one-fifteenth of the cost of cellular radio. As the underlying costs of paging are much cheaper, service costs could be expected to be of the same order as those of cellular radio.

The cellular radio network would offer direct two-way voice communication from the mobile through the public telephone network, at a price that would be beyond the reach of domestic users for a long time to come. Pagers however would be affordable by domestic users. Pager manufacturers and systems operators saw their services as complementary to cellular radio and they expected to benefit from the enormous growth in the communications market of which both paging and cellular radio were part.

Licensing

On the subject of licensing under the new Telecommunications Act, John Taylor, principal of the telecommunications division of the D.T.I., described the D.T.I's licensing policy.

On cellular radio, Taylor admitted that there had been very considerable problems with the type of approval programmes and that an 'interim interim' approvals procedure would be available so that equipment manufacturers could have their mobile equipment ready by the time the networks start up in early 1985.

Band III problems

Jonathan Clarke, chairman of the Federation of Communicaton Services, listed what he saw as the major problem areas concerning the future use of Bands I and III for land mobile service operators. These included the question of connections to the public telephone network, the special cases (those users who are already operating, but have been unable to grow in their operations because of lack of spectrum), geographical coverage (whether it should be national or local) and the size of the system. A common signalling standard would allow transfer from one service provider to another, but there were those who would rather see a 'preferred' (but not obligatory) signalling system.

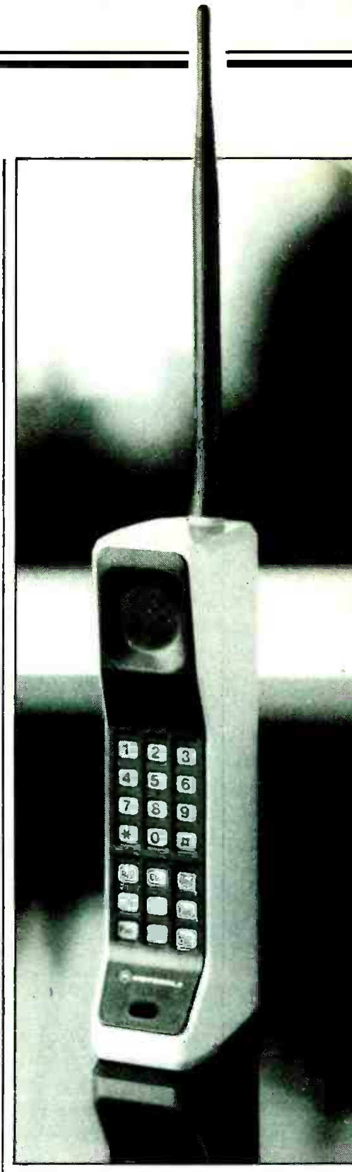
Frenzied activity

Land mobile services in the U.K. have never experienced so much concentrated activity at one time: the liberalization of telecommunications, the installation of the two major cellular radio networks and the bringing of all Band III and possibily parts of Band 1 into the land mobile radio service.

Comex 84 was just one small drop in the sea of discussions and meetings. The decisions taken mow will have a direct influence on the quality of the land mobile radio services available in the UK until well into the next century.

These decisions must reflect not only the needs of the telecommunications user and the telecommunications provider, but must also conform with the principles of good spectrum management. It would be unfortunate if decisions taken now were to jeopardize the efficient use of these newly available radio frequencies in years to come.

The Comex 84 conference and exhibition (supported by 42 exhibitors and attended by 800 visitors) came at a time of unprecidented mobile radio activity and discussion in the UK as well as on the eve of the installation and commissioning of the first few cells in the UK's new 900MHz cellular radio network.



This hand-held radio-telephone for the Cellnet services is available through Cellular One Ltd. Monthly rental charges start at about £130, or you can buy one outright for £2995.

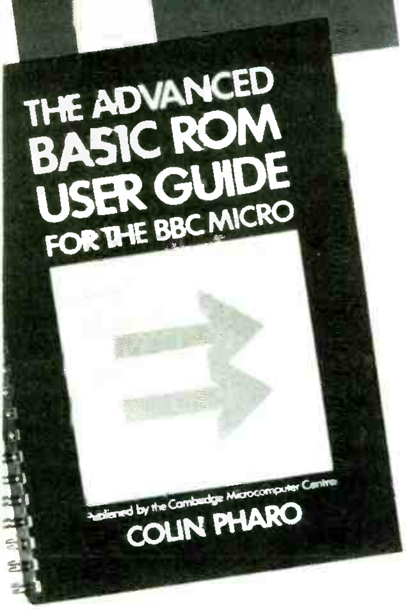
REFERENCES

1. Federation of Communication Services, COMEX '84 conference papers.
2. HMSO Cmnd 9241, "Bands I and III" Consulatative Document.

Number of channels	Voice channel traffic (Erlang)	Number of mobiles
1	0.12	22
5	3.22	580
10	7.93	1430
15	12.79	2300
20	17.70	3185

(Source: Bands I and III Green Paper)

Multi-channel trunking: As the number of channels increases in a trunked mobile radio system, so the number of mobiles that can be accommodated on the network increases significantly for a given grade of service. The grade of service for these figures is 5%, and represents the probability of finding congestion within the 'busy hour'. A 20 channel trunked network can accommodate in excess of 3,000 mobiles which is an enormous gain over the straight multiple of the numbers of channels and the number of mobiles for an equivalent grade of service on a single channel system.



The Advanced Basic Rom User Guide for the BBC Micro by Colin Pharo. Ring bound, 182 pages, Cambridge Microcomputer Centre (153-154 East Road, Cambridge CB1 1DD), £7.95 retail.

Practical machine code programs often rely on mathematical routines, and for speed and compactness it is usually hard to improve on those provided in the BBC Basic rom. This book explains how the programmer can make use of these routines in his own programs. It identifies 69 major subroutines within the Basic 1 and Basic 2 roms, giving call addresses, set-up conditions and typical timings. For many of the routines example programs are given. Also included is a detailed memory map of the Basic workspace.

Basic Rom User Guide for the BBC Microcomputer and Acorn Electron by Mark Plumbley. Soft covers, 359 pages. Adder Publishing, Cambridge, £9.95.

This very comprehensive guide not only covers routines accessible to the user (string handling routines as well as mathematical ones) but gives also a detailed description of how BBC Basic works. Topics covered include memory use, tokenising, the Basic stack, program control mechanisms, errors and methods of recovering from them.

The second part concentrates on ways of expanding Basic by trapping the errors it generates and adding extra code. The author includes listings of a variety of interesting utilities: among these are a selective renumbering routine, a 'bad program' rescuer and a routine which allows dynamic overlaying of procedures or functions from disc, for use with a Basic program which would otherwise be too big for the memory available.

A Hardware Guide for the BBC Microcomputer by A.D. Derrick, D.S. Harding, S.D. Middleton and M.P. Smith. Wise Owl Publications, Hull Innovation Centre, Guildhall Road, Queen's Gardens, Kingston-upon-Hull. Soft covers, 116 A4 pages and an appendix, £11.95+95p carriage.

Surprisingly, for a hardware guide, this one does not include a full circuit diagram of the computer: for that you have to turn to the Advanced User Guide (Cambridge Microcomputer Centre), which, although concerned mainly with software, covers some of the same ground.

But besides their description of the circuit and instructions for carrying out various upgrades, the authors provide numerous hardware hints and suggest some useful modifications: how to improve the accuracy of the a-to-d converter, for example, and how to expand the vocabulary of the speech processor.

A special feature of the guide is a 140-page appendix comprising data sheets of the all the computer's principal i.cs, including the 8271 floppy disc controller — information which for many owners might otherwise be hard to obtain.

The BBC Microcomputer Disk Companion by Tony Latham. Soft covers, 186 pages, Prentice Hall International, £7,95.

After surveying magnetic storage systems in general, the author moves on to a description of the Acorn disc filing system. There is an excellent section on file handling (a subject none too well explained elsewhere), with examples in Basic and assembly language.

Less useful, perhaps, are some of the program listings in the book. Most users will have received formatting and verifying programs on a utilities disc when they bought their disc drives and will not need any more. And the word-processor, described as the first such program written for the BBC Micro, must be of little more than historical interest now.

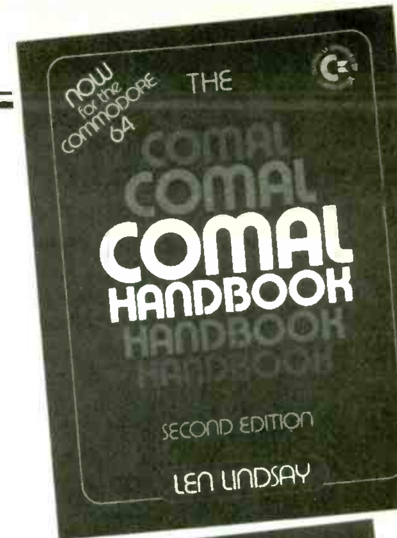
The book touches on double-density storage right at the end, but does not mention any of the double-density d.f.s. packages now available for the BBC Micro.

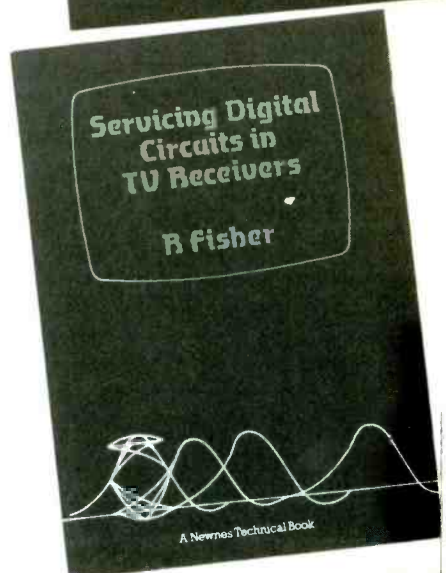
The Comal Handbook (second edition, Commodore 64 version), by Len Lindsay. Soft covers 467 pages, Prentice Hall International, £18.40.

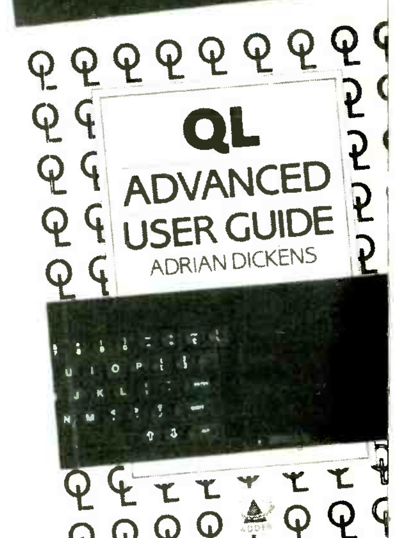
For those who are tired of Basic but nervous of Pascal, to paraphrase the anonymous Danish student quoted in the foreword. The Comal keywords, from Abs to Zone, are described individually, each with a sample program illustrating its function. There are 19 appendices covering Comal structures, different versions of the language, error handling, disc usage and troubleshooting.

Servicing digital circuits in television receivers by R. Fisher. Soft covers, 270 pages. Newnes Technical Books, £13.95.

The author begins with the basic principles of logic circuits and then examines practical methods of processing, storing, transmitting and display data. In the second part of the book he discusses in detail and with full circuit diagrams how teletext and viewdata work, using as his examples commercially-available decoders by Mullard and Texas Instruments. The final chapters explain the operation of digital tuning systems and an infra-red remote control system. The book should interest many people besides televison service technicians.







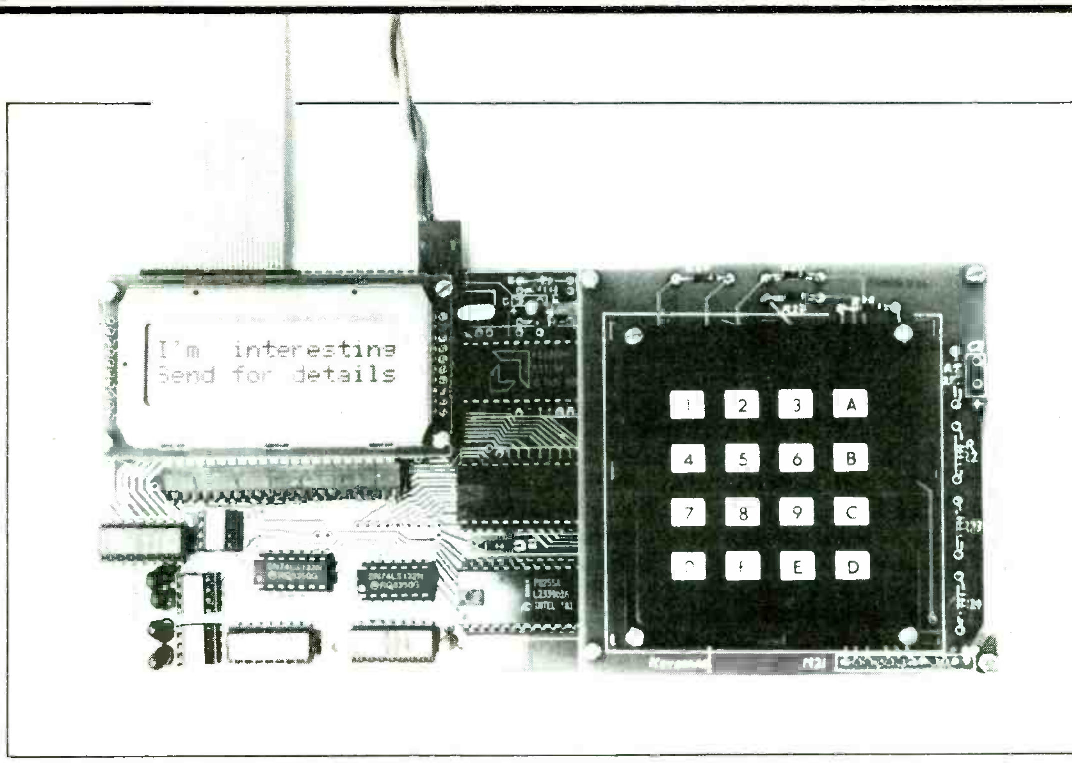
QL Advanced User Guide by Adrian Dickens. Soft covers, 352 pages. Adder Publishing, Cambridge, £12.95..

A detailed guide to what goes on inside (and if yours is one of the ones with a dongle, outside). Topics covered include 68008 machine code for the newcomer, QDOS, Super-Basic, i/o, Microdrives and more. The appendices contain much useful reference material for the advanced programmer.

EPROM PROGRAMMER (AND ERASER)

A low cost eprom programmer is available for the BBC micro. It can be used for 2764 and 27128 devices and is provided with rom software to operate it. Called the Uviprom, the unit is available initially in two versions: Uviprom 1 is the basic version with a normal 28-pin i.c. socket and cost £20.95; Uviprom 2 is provided with a z.i.f. socket for five pounds more. Both are uncased p.c.bs though an Uviprom 3 with case and z.i.f. socket should become available soon and will cost £29.95. The programmer plugs into the user port of the computer and takes its power direct from the computer. The circuit includes a switch mode power supply to generate the 21V programming supply. The rom with the Uviprom software is available for £8 and can be used to test an eprom to check that it is black; read an eprom to disc; blow the program into the eprom; view the contents of rom after it has been read onto disc and compare the contents of an eprom with the source.

The programmer is complemented by an ultra-violet eprom eraser which is also available in various versions: the Uvipac TS times 15 minutes from the switch-on and then sounds a warning (£28.95); Uvipac T has a timer but no sound (£26.45) and the Uvipac without timer or sounder is only £21.45. The eproms may be checked to make sure that they are fully erased by testing in the Uviprom. Prices quoted are applicable to the UK and include v.a.t. and postage. Ground Control, Alfreda Avenue, Hullbridge, Hockleyy, Essex SS5 6LT.
EWW 220



8085 CONTROL SYSTEM

A complete micro-computer system for control applications requiring up to 26 inputs or outputs is mounted on a small p.c.b. Software utilities are available for operating the 32-character display and 16-key pad. The module may also be supplied without a keyboard so that the designer can use any other pushbutton array. Assembly language programming, software design and eprom programming services are also available. The 83000 system is based around the 8085 processor and prices vary according to the options selected but work out at about £200. Automation and Control Technology, Cofton Road, Marsh Barton, Exeter EX2 8QW. EWW 226

VOICE DIGITIZERS

Two very similar products have been produced for the two great rivals in educational computing-the Mynah by Reasearch Machines for the Link 480Z, and Voxbox by Multiplex Computer services for the BBC micro. Both are capable of recording speech in digital form and then replaying it. Such techniques are very greedy in their use of memory and the Mynah, for example can keep 7.5 seconds of speech in the computers Basic ram at one time when used at the highest sampling rate. However both systems can record the speech onto floppy disc or for 'instant' access on to silicon disc, when whole paragraphs may be replayed in quick succession. Voxbox manages to save some space by using delta pulse code modulation, where the size of tthe sample is not recorded, only the difference between the size of each successive sample.Both systems can alter the sampling rate to give better quality or squeeze more speech into the available space. At the lower rates the speech become less distinct but is always of better quality than that produced by speech synthesizers.

The RML Mynah also includes a Texas music chip and uses the same sound and envelope commands as BBC Basic, it costs £99. The Voxbox can optionaly have a voice recognition program where words or phrases can be stored on file and accessed from within a user's program. It is claimed that the system can retrieve a word or phrase within a second and the system can be used for voice control of the computer. The Digitiser alone costs £85, the Voice Recognition system alone, £75 but both can be combined in a unit for £97. All prices inclusive and both manufacturers includefull operational software. Research Machine Ltd, Mill Street, Oxford OX2 OBW. Multiplex Computer Services, 250 Eastern Road, Brighton, Sussex BN2 5TA.
EWW 222

LCR METER

This hand-held batter-powered meter is able to measure inductance, capacitance and resistance and is thought to be ideal for use by the field service engineer and quality assurance engineers who wish to check quickly the value of a component. The Avo R183 is easy to use and does not require the careful balancing associated with bridge measurement. There are six inductance ranges from 2mH to 200H, seven capacitance ranges from 200pF to 200uF and seven resistance ranges from 200Ω to 20MΩ. All readings are shown to a $3\frac{1}{2}$-digit l.c.d. Measurement are made at a frequency of 1kHz or 100Hz depending on the range selected on the slide switch. The meter is fuse protected against accidental over-voltage. Test leads, prods and clips are included. Thorn EMI Instruments Ltd, Archcliffe Road, Dover CT17 9EN. EWW 223

MAGNETIC TAPE CONTROLLER

A buffered interface for magnetic tape transports is provided by the Kenda B8000. It may be used with any tape drive that conforms to the Pertec micro formatting standard. Input and output are through the 8-bit parallel Centronics port or through at RS232 or 20mA current loop serial port with a programmable data rate of up to 19200baud. Optional interfaces include GPIB · The interface has been designed to be fitted directly inside Thorn EMI Datatech tape streamers but may also be supplied as a self-contained boxed unit.

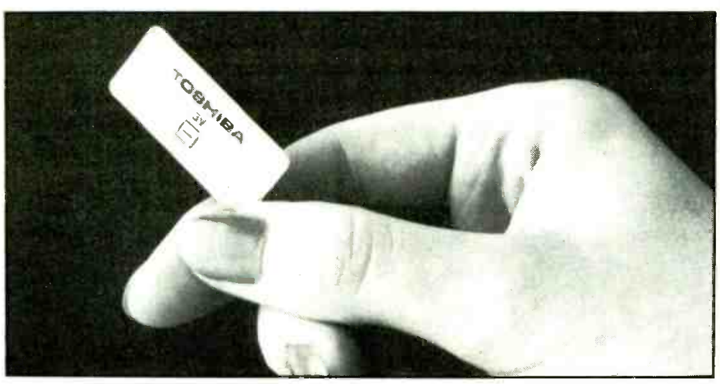
The buffer memory is from 2K up to 32Kbytes and may be used in three different modes: in single buffer mode data is transferred in blocks into the buffer and then out again. In Multi-buffer mode, the data buffer is divided into a selectable number of individual buffers which are used in a ring sequence. This means that data may be transferred into and out of the tape streamer at the same time, offering high-speed operation. The third mode is called transparent; although the data is theoretically being transferred directly between the computer and tape, the buffer still is used to even out any variation in the data transfer rate. In this mode there is no limit to the block size as long as the data rates are matched. The interface can be controlled internally through a built-in prom of up to 32K, or a mixture of rom and ram to allow it to be programmed and controlled externally. Internal programming includes a number of fixed commands which makes it very easy to control.

the boxed version of the B8000 enables connection between the tape drive and computer to be made with maximum ease since mains-driven power supplies are integral with the unit. A 25 way D-type socket at the rear and a pair of edge connectors on flying ribbon cables are all that need to be plugged up for the RS232 model. IEEE and parallel interface models are just as easy. Software interfacing consists of writing a small driver to send the relevent control code sequence in order to set read or write mode, specify tape block length etc.

For the case of a completely dumb piece of equipment or for those who do not wish to write a driver, a set of manual front panel controls forms a useful optional extra. These enable the user to manually control mode and block size, thus converting properly blocked industry standard tape to or from a simple continuous data steam. Kenda Electronic Systems Ltd, Nutsey Lane, Totton, Southampton SO4 3NB.EWW216

THIN LITHIUM BATTERY

By combining several technologies, Toshiba have developed a flat lithium battery that is only 0.5mm thick. It may be used to power the forthcoming 'smart' credit cards, very thin calculators and electronic watches, and even more compact cameras or radios. The battery sandwiches a non-aqueous electrolyte between a sheet of Manganese dioxide, the positive electrode, and another of Lithium, the negative. Each electrode is covered by a metal plate which also acts as the contact and the plates are sealed at the edges with a specially developed thermal melt adhesive. The battery is manufactured by a process similar to printing. The nominal voltage is 3V and the discharge capacity is 17mAh. Toshiba UK Ltd, Primley Road, Frimley, Camberley, Surrey GU16 5JJ.
EWW 214



NETWORK IN A PLUG

Computer terminals and a range of peripheral devices can be plugged into a ring network by the simple addition of a small box to the RS232 port. The Infaplug, whose largest dimension is 115mm, contains all the electronics necessary to transfer data to or from the device to which it is connected. Up to 255 devices may be connected to the ring which may itself have a virtually unlimited number of outlet sockets. The plug transmits and receives around the ring at 9600baud but may be matched to the data rate of the device to which it is attached.

Application for such a ring l.a.n. are many but include time-sharing with a host computer, point-of-sale terminals (i.e. cash registers), laboratory instrumentation, automatic testing, measurement and control.

The Infaplug is opto-isolated from the ring to prevent earth loops and is self-powered from a low-voltage supply on the ring. Each plug can 'hunt' for a connection to any one of the group of other plugs; important when many terminals require access to a central processor.

Infaplug is complemented by Infalink, a software protocol system to enable desk-top computers to link into the network. Full handshaking and error checking is incorporated into the file transfer software. The user purchases a single software licence for each type of computer on the ring. The price is £150 for each computer type irrespective of the number of computers in use. This reflects the cost of the Infaplug hardware which is under £200 per connection. Infa Communications Ltd, Castle Moat Chambers, Bath Place, Taunton, Somerset TA1 4EP.
EWW 224.

B. BAMBER ELECTRONICS

Lot No	Description	Qty.	Price Each As Seen	Price Each Tested
151	Rank Xerox 1385 Photocopier Camera with Spares & Service Manuals. (This is the original Xerox machine	1	£500	—
152	Tektronix Plug-Ins, Type G	19	£15	£20
153	Tektronix Plug-Ins, Type L	15	£15	£20
154	Ditto, Type D	2	£15	£20
155	Ditto, Type E	2	£15	£20
156	Ditto, Type D	5	£20	£60
157	Ditto, Type K	8	£10	£20
158	Ditto, Type Z	1	£10	£20
159	Ditto, Type W	1	£10	—
160	Ditto, Type 82	1	£15	£30
161	Ditto, Type 80	5	£15	£20
162	Tektronix Plug-in Extensions	5	£10	—
163	Tektronix Plug-In, Type N	1	£20	£40
164	Ditto, Type ISI	1	£30	£60
165	Ditto, Type IA2	1	—	£40
166	Ditto, Type IA1	1	—	£40
167	Tektronix Low Level Preamplifier, Type FM122	1	£20	£30
168	Tektronix Oscilloscope, Type 585A Less Plug In	1	£70	£200
169	Tektronix Oscilloscope Camera, Type C12	3	£30	£90
170	Tektronix Hard Copy Unit, Type 4601	1	£100	—
171	Tektronix Storage Display Unit, Type 611	1	£140	—
172	Tektronix Oscilloscopes, Type 551 Less Plug Ins	7	£30	£60
173	Tektronix Time Mark Generator, Type 180A	3	£20	£60
174	Tektronix Time Mark Generator, Type RM181	1	£20	£60
175	1 Tektronix Oscilloscope, Type 647 Less Plug Ins	1	—	£150
176	Ditto, Type 555 Less Plug Ins	3	£60	£180
177	Ditto, Type 531A With Type H Plug In	1	—	£120
178	Ditto, Type 547 with Type 1A2 Plug In	1	—	£180
179	Ditto, Type 581A Less Plug In	1	£40	—
180	Ditto, Type 515A Complete	3	—	£100
181	Tektronix Programmable Calculators, Type 31	16	£40	—
182	Tektronix Oscilloscope, Type RM45 Less Plug Ins	35	£20	—
183	Ditto, Type 545B	2	£50	—
184	Ditto, Type 545A Less Plug Ins	5	£40	—
185	Ditto, Type 545 Less Plug Ins	3	£30	—
186	Marconi Signal Generators, Type TF995A/5	23	£120	£240
187	Ditto, Type TF995B/5	8	£200	£400
188	Marconi TX & RX Output Test Set, Type TF1065A	21	£40	£80
189	Marconi V.H.F. Signal Generators, Type TF1064B/5	33	£50	£120
190	Cossor Mains Radio, Type 358	2	£5	—
191	Pilot Mains Radio	1	£5	—
233	Light Source	3	£5	—
234	Large Mains Isolation Transformer	6	£10	—
235	Ex. Equipment Instrument Fans	240	£0.50	—
236	Capacitors, 150mfd 16V	11,500	£0.05	—
237	Sony Empty Video Tape Reels	33	£0.50	—
238	Eddystone UHF Receiver, Type 770S	1	£70	—
239	Soldermaster Desoldering Pump	10	£5	—
240	Avo Meters, Model 7	20	£15	£40
241	Rectifiers, M201	400	£0.50	—
242	Pyrometers	20	£1	—
243	Berco Rheostats	4	£2	—
244	A.C. Chargers, 110V AC Input	1 ctn.	£10	—
245	Attache Cases with Intregral Peg Boards	3	£5	—
246	Baldwin Radiological Densitometers	2	£5	—
247	Reyrolle Metalclad 15 amp Connectors	4 ctn.	£10	—
248	Wild Barfield Incinerator	1	£20	—
249	Schomandl Frequency Meter, Type FD1	8	£25	—
250	C.R.T's Brimar Type D13/47GH	4	£5	—

Lot No	Description	Qty.	Price Each As Seen	Price Each Tested
251	Marconi R.C. Oscillater, Type TF1101	1	£40	£120
252	Pye UHF Signal Generator, Type TFSG5U	1	—	£100
252	Pye UHF Signal Generator, Type TFSG5U	1	—	£100
253	Marconi FM/AM Modulation Meter, Type TF2300	1	—	£185
254	Marconi Delay Generator, Type TF1415	1	—	£85
255	Marconi R.F. Power Meter, Type 0120A	1	—	£65
256	Marconi Valve Voltmeter, Type TF1041C	1	£20	£60
257	Pye SSB Transmitter Type SSB130	1	£150	—
258	Hewlett Packard Sweep Oscillator, Type 692D	1	£200	—
259	Airmec Oscillator, Type 858	1	£40	—
260	MESL Sweep Signal Generator, 1-2GHz	1	£180	—
261	Comark Time Scale Generator, Type 1401	1	£30	—
262	Marconi A.F. Power Meter, Type TF893A	2	£20	£60
263	Pye VHF Signal Generator	3	£10	£30
264	Airmec Millivoltmeter, Type 301	3	£20	£60
265	Ditto, Type 301A	3	£30	£90
266	Hewlett Packard RX Meter, Type 250B	1	—	£150
267	Hewlett Packard SHF Signal Generator, Model 620A	2	—	£300
268	Telequipment Oscilloscope, Type D43	3	£20	—
269	Ditto, Type S32A	4	£25	—
270	Advance Signal Generator, Type C2	4	£20	—
271	Solartron Pulse Generator, Type G01101	2	£25	—
272	Hewlett Packard Valve Voltmeter, Type 400D	2	£25	—
273	Marconi A.F. Power Meter, Type TF2500	1	—	£75
274	Marconi 25MHzP Pulse Generator, Type TF2025	1	—	£85
275	Wandel & Golterman Filter Accessory for LDE-2	1	£20	—
276	Marconi 100watt 7db Attenuator, Type TM5280	1	£40	—
277	Bradley Synthesized Digital Signal Generator, Type 235	1	£90	—
278	Hewlett Packard Signal Generator, Model 606A	1	£60	—
279	Pye I.F. Signal Generator	3	£10	£20
280	Avo Signal Generator	1	—	£30
281	Wayne Kerr Component Bridge, Type CT375	2	£20	£40
282	Marconi Oscilloscope Less Plug In, Type TF2200A/1	1	£50	—
283	Marconi Oscilloscope Less Probe, Type TF1331A	1	£50	—
284	Hewlett Packard Wave Analyser, Type 302A	1	£40	—
285	Dawe True RMS Valve Voltmeter, Type 612A	3	£20	£40
286	Jerrold Field Strength Meter, Type 704B	1	£40	—
287	Marconi Signal Generator, Type TF867	2	£30	—
288	Airmec Sweep Signal Generator, Type 352	1	£30	—
289	Pye Westminster, Low Band 24 volt, Type W30	14	£25	—
290	Marconi White Noise Test Set, Type 0A2090B	1	£200	—
291	Bruel & Kjoer Microphone Amplifier, Type 2604	1	£50	—
292	Pye pH Meter, Type PW9418	1	£40	—
293	Marconi Sine Squared Pulse & Bar Generator, Type TF2905/6M	1	£90	—
294	Marconi F.M. Signal Generator, Type TF1066A/1	1	£70	£140
295	E.H. Pulse Generator, Type 139LB	1	£40	—

Lot No	Description	Qty.	Price Each As Seen	Price Each Tested
296	AIM Pulse Generator	1	£40	—
297	Marconi Universal Bridge, Type TF868A	2	—	£75
298	3pH Variacs, 6 amp	3	£60	—
299	General Radio Unit Oscillator, Type 1209B	3	£40	—
300	Sanders Oscillator, Type CLC 2-4GHz	1	£90	—
301	Solartron Recorder Drive Unit, type H295	1	£20	—
302	Rohde & Schwarz Power Test Adaptor, Type BN4 13116	1	£50	—
303	R. & S. Power Signal Generator, 0.1MHz, Type BN41001	1	—	£125
304	R. & S. Selektomat Type USWV BN15221	1	£50	—
305	Ferranti Video Terminal Type WDM2000	1	£40	—
306	Coutant Power Unit 24V+7V+4V	1	£25	—
307	Trendata Data Test Set, No.5	1	£120	—
308	Rohde & Schwarz Standard Signal Generator, Type BN4 1409	1	£120	—
309	Hewlett Packard SHF Signal Generator, Model 618B	1	£120	£220
310	Dawe Phase Meter, Type 632A	2	£20	£50
311	Pye Deuterium Lamp Power Supply	5	—	£40
312	Solartron Digital Voltmeter, Type LM1420.2	2	£20	—
313	Airmec Wattmeter, Type 319A	4	£20	£40
314	Airmec Oscillators, Type 304A	2	£30	£60
315	Marconi Valve Voltmeter, Type TF1041B	3	£20	£35
316	Marconi Valve Voltmeter, Type TF1300	3	£15	£30
317	Audio Power Meter, Type TF893, Marconi	6	£10	£20
318	Hewlett Packard Microwave Power Meter, Model 430.C	1	£10	—
319	General Radio Unit IF Amp., Type 1216A	1	£10	—
320	General Radio Modular Pulse Generator, Type 1395A	1	£20	—
321	KSM Pulse Generator, Type T18/D	2	£20	—
322	Dawe Transistor Phase Meter, Type 630A	2	£20	—
323	Electric International VHF Preamplifier, Model AP501R	1	£20	—
324	Tekelec Digital Voltmeter, Typel TE3BB	1	£15	—
325	Honeywell Power Line Test Set, Type PLY-1	1	£10	—
326	Hewlett Packard D.C. Power Unit, Model 6268B	1	—	£300
327	Wavetek Programmable VCG, Model 155	1	£20	—
328	Marconi Programmble FM/AM Modulation Meter, Type TF2301A	1	£50	—
329	Pye Scalamp Voltmeter, 40KV	3	£20	£60
330	Pye Scalamp Galvanometer	9	£5	£15
331	Rohde & Schwarz Polyskop II, Type BN4245/50	4	£100	£200
332	Rohde & Schwarz VHF Test Receiver	1	£30	—
333	Ditto Enograph Type BN18531	1	£30	—
334	Pye mV Meter, Type 539	7	£20	—
335	Lampkin F.M. Modulation Meter, Type 205A	6	£10	—
336	Hewlett Packard Differential Voltmeter, Type 3420/B	3	£40	—
337	Marconi 20MHz Sweep Generator, Type TF1099	1	£50	—
338	Racal Frequency Meter, Type 9059	1	£70	—
356	Roband Oscilloscope, Type R050A	5	£10	—
357	Marconi VHF Signal Generator, Type TF1060	6	£60	£120
358	Marconi A.M. Signal Generator, Type TF801	6	£40	£80
359	Radiometer FM/AM Signal Generator, Type MS27g	8	£60	£180
360	Electrohome 9in. Video Monitors	8	£25	£50
361	Airmec Modulation Meter, Type 210A	12	£40	£120

RADIOTELEPHONE EQUIPMENT

Pye Base Station Type F30 AM High Band & Low Band	£220
Pye Base Station F401 AM High Band	£250
Pye Reporter Type MF6 AM High Band	£90
Pye Europa Type MF5 FM High Band	£70
Pye Europa Type MF5 U UHF	£70
Pye Olympic Type M201 AM High Band	£65
Pye Olympic Type M212 UHF	£65
Pye Motofone Type MF5 AM High Band & Low Band	£45
Pye M293 AM High Band	£120
Pye M296 FM UHF	£160
Pye Pocketphone PF1 Battery Charger 12 Way	£10
Pye Base Station Type F9U UHF	£90
Pye Base Station Type F412 UHF	£200
Pye Pocketfones Type PF2 FM High Band	£80
Pye Base Station Type F460 Tx. UHF	£50

PLEASE NOTE all sets are sold less crystals unless otherwise stated. Carriage on RT equipment — Mobiles £2.00 each. Base stations £15.00 each. Red Star available at cost

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Pye Modulation Meter 68 – 510Mhz Type MM1 with manual	£60
Marconi Universal Bridge Type TF868 B	£110
Servomex AC Voltage Stabiliser Type AC2 240v ac 9amp	£45
Servomec AC Voltage Stabiliser Type AC7 240v ac 40amp	£95
60 amp Alternator & Generator Noise Filter	£1.00 each.
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Pye Cambridge/Vanguard 18 Way Control Leads	£4.00
BNC Plugs 75 ohm	50p each
Circulators 590 – 720 Mhz "N" sockets	£25
Transistors Type 2N3055 Brand New	4 for £1
Transformers 30 volt @ 1 amp	£1.00
Transformers 36 volt @ 1.5 amp	£1.00
"Variacs" 2 amp. 8 amp. 15 amp. 20 amp. 25 amp	Phone for details.
Loudspeakers Richard Allan Type CP12. 12in. 15ohm	£6.00
10.7 Mhz SSB Xtal Filters (2.4 Khz Bandwidth) Low imp. type. Carrier and unwanter sideband rejection min -40db (needs 10.69835 & 10.70165 xtals for USB/LSB not supplied) Size approx 2in.×1in.×1in.	£10.00 each.
Low Pass Filters (low imp. type). 2 to 9 Mhz, small metal encapsulation	75p each.
IC Test Clips Gold plated pins, 28 pin DIL and 40 pin DIL	£2.00 each.
1in. Vidicon Scan Coils Transistor type but no details, complete with vidicon base	£6.50
Scews. Pack of nut, bolts, washers, tags, self taps etc. Mixed BA & Metric. Sold by Weight	£2.00 per Kilo.
Mains Isolation Transformers 500 VA 240 v input, 240 v CT output housed in metal box but less lid	£15.00
Avo Valve Characteristic Meter Type VCM 163 with data	£250.
Tektronix Oscilloscope Type 453 Dual-Trace 50 Mhz	£595

All Prices Quoted Exclude VAT, Packing & Carriage will be Charged at Cost, Please Check Availability Before Ordering, Minimum Order **£3** Value of Goods, Minimum P&P **£1**, Prices Shown are Subject to Change Without Notice.

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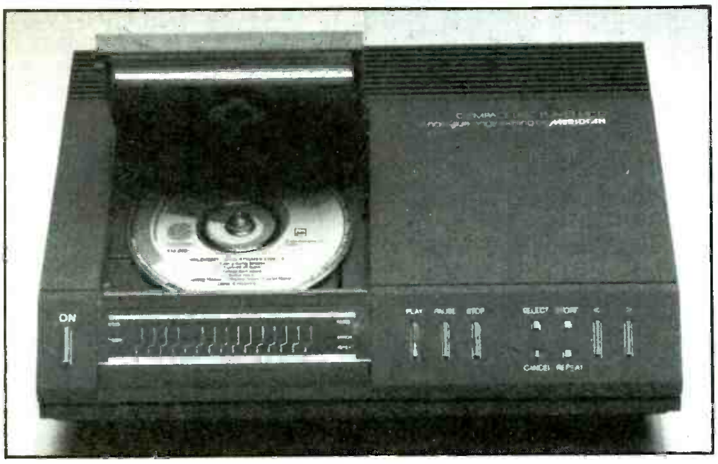
CIRCLE 54 FOR FURTHER DETAILS.

BRITISH CD PLAYER

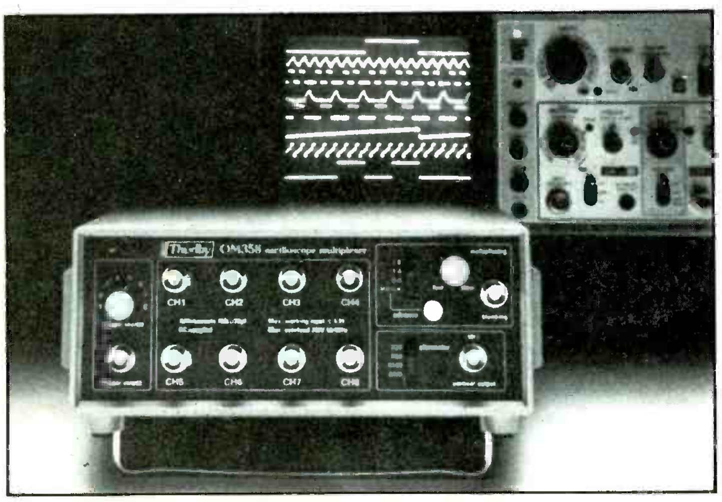
Although based around a Philips Model 101, which Meridian consider to be the best of the latest compact disc players, they have used their own expertise to produce a player which they consider to be a major improvement. With their experience in the application of psychoacoustics to audio design and the development of high-performance amplifiers, Mr. Boothroyd and Mr Stuart have extensively modified and rebuilt the player. It is produced in the grey finish that matches the Meridian range of modular amplifiers and the electronics have been modified to improve the servomechanisms, the error detection and concealment, power supplies, analogue filtering and amplifiers. The result, they claim, is stunning and the sound quality 'equals and in some cases betters the very best analogue signal sources.' The MCD (Meridian Compact Disc) costs £398 retail. Boothroyd Stuart Ltd, 13 Clifton Road, Huntingdon, Cambs PE18 7BR.
EWW 218



OSCILLOSCOPE-MULTIPLEXER

The release of a new multiplexer enables any oscilloscope to displayy eight channels. OM358 has a bandwidth of 35MHz and a calibration accuracy of 3%. Input impedance is 1MΩ and 20 pF and the attentuator has four positions ×100, ×50, ×20 and ground. The trigger signal can be selected from any of eight input channels and a variable multiplex rate control ensures the multiplexed capture of single-shot events on many channels.

Typical applications include the testing of microprocessor-based products, data transmission systems, a-to-d converters, phase-locked loops and frequency dividers. Level1 Electronics Ltd, Moxon Street, Barnet, Herts EN5 5SD.
EWW 219



ACORN COLLECTION

Just in time for Christmas, Acorn have hatched a whole clutch of new products for the BBC and Electron microcomputers.

Pascal

Perhaps pride of place should be given to the new implementation of ISO-Pascal which has passed all the tests and has received the British Standard validation certificate, and is claimed to be the first and only micro-based Pascal system which meets the International Standards Organisation standard.

Pascal was designed by Professor Niklaus Wirth to be both efficient and "suitable for learning programing as a systematic discipline based on certain fundamental concepts." It turns out, however, that the language had attributes far beyond these original goals and found use in the writing of systems and application software. The standard is a response to the increasing commercial interest in Pascal to ensure its portability between differing systems.

Pascal has the advantage of being suitable for large-scale programming. A programme is compiled to a compact intermediate code which is then interpreted to give a high-speep performance. This means that highly complex programs may be run; examples we know of are calculus, solving linear equations, FFT analysis and the like. One difficulty is that Pascal is not easy to get started on and Acornsoft have thoughtfully provided a reprint of the book *Pascal from Basic* by P.J. Brown as well as an operators manual which includes the full British Standard, BS6192:1982, as a reference, along with a full explanation of the minor deviations of the rom version from that standard. The language has been augmented by the inclusion of BBC/Electron-specific graphics and sound commands and operating system calls.

Pascal is implemented on two roms; the interpreter and the complier and is further added to by a disc which has extensions and examples and includes complete enhanced versions of the interpreter and compiler for use with the second-processor 6502 augmented BBC Micro. The version for the Acorn Electron is on a rom cartridge which plugs into the Plus 1 add-on peripheral. Both versions cost £69 inclusive and may be purchased mail-order from Vector Marketing Ltd, London Road, Wellingborough, Northants NN8 2RL.
EWW 205

Logo

A full implemenation of the Logo language is also provided on two roms for the BBC at the same price and from the same source as Pascal. This also has an educational purpose, to introduce computing to the very young. Seeing Logo and Pascal side-by-side one can detect similarities between them and the structuring implied in a Logo program seems to be a very good introduction to the higher levels of Pascal, more so than Basic. For example, it is necessary to declare all variables at the start of a program or procedure. Logo has a (false) reputation for being wholly concerned with turtle graphics; directing a cursor around the screen or controlling a robot turle to trundle around the floor. It turns out, at least from this implementation, to be a complete programming language which is at home with maths (including trigonometric functions, natural logarithms, square roots etc.) and with words, especially when organized into lists. Of course it is also very good at graphics and it is possible to 'hatch' a number of turtles and have them doodling all over the screen, producing very intricate patterns as well as painlessly teaching geometry to the pupil. A lot of attention has been paid to making the language easy to understand and use. The error messages do not give a terse 'Error XX' message but simple phrases like 'Logo doesn't know how to XX.' Similarly all the command words have been carefully chosen to be nearest to what the child would naturally use. As with Pascal, Logo has been extended to include some BBC-specific commands, such as changing screen mode to give additional colours and providing sound facilities. Logo comes with a cassette (duplicated on a disc) with demonstration programs, extensions and useful subroutines. Also provided are a reference card and three books; an introduction to Logo, a full users manual and a guide to the contents of the cassette/disc.
EWW 206

Music synthesiser

Acorn has also announced a music synthesiser for the BBC Micro, the Music 500, which plugs in to the 1MHz bus port. It does not use the internal square-wave sound generator at all but instead has its own 16 sound generating channels organised as eight voices which can be spread over seven stereophonic positions. There are very comprehensive waveform and envelope generating facilities produced by use of Ample, a music orientated control language. Sound output may be taken through a stereo hi-fi and/or recording system and there is provision for an add-on keyboard for 'live' music. Music 500 is available for £199 inclusive. We hope to give more details when we have actually tested a Music 500.
EWW 207

Electron discs

A self contained disc interface and 3.5 in. single-sided disc unit incorporates an Acorn advanced disc filing system, ADFS, to provide 300Kbytes of storage. The unit, called Plus 3, plugs neatly into the side of the Plus 1 add-on interface so that the whole forms a neat unit without trailing cables. £229.
EWW 208

Winchester discs

The Acorn Winchester disc system has been launched with a choice of 10MBytes (£1449) or 30Mbytes (£2299). The units are designed to be robust and are capable of automatically memory remapping, hardware error detection and automatic sector interleaving, with a data transfer rate of 1Mbit/s, average access time is 85ms. They are fully compatible with al BBC second processors and with the Econet networking system for which a new Level 3 file server has been designed especially for use with the Acorn Winchesters.
EWW 209

Networking

A new start-up kit for the Econet comprises a new precision clock, two unpowered terminators and three double socket boxes. With this system, the network can operate at 200Kbit/s even at the maximum distance of 500m. The new socket boxes do not need any soldering, making the system easy to install. The unpowered terminators reduces the number of power sources required to only one. Available now, the starter pack costs £99, but this is in addition to the installation of the Econet interface inside each computer. Coming soon is an Econet bridge which will link networks and also extend the networks maximum length. By sectioning the network, bridges optimise data transfer between nets and even if one network fails, the system can remain operational.
EWW 210

32-bit add-on processor

Originally announced as 'coming' when the BBC Micro was originally launched, the 32016 second processor for the BBC will now be available 'early in 1985.' It converts the BBC micro into a 32-bit computer system operating at high speed and providing 256Kbytes of ram. Included in the price of £899 are the PANOS operating system, designed for low-cost configuration and no less than five languages. BBC Basic, C, Fortran 77, Cambridge Lisp and Pascal. From this list it is obvious that the chief purpose of the device is for software development in a professional, scientific, engineering or educational environment. Further details of all these products are available from Acorn Computers Ltd, Fulbourne Road, Cherry Hinton, Cambridge CB1 4JN or from the distributors Vector Marketing as mentioned under Pascal.
EWW 211

FUNCTION GENERATOR KIT

An intergrated-circuit function generator can produce sine, triangular and square waveforms and can provide other functions such as sweep generation, a.m./f.m. generation, voltage-to-frequency conversion and phase-locked loops. The frequency range is 1Hz to 100kHz with 0.5% t.h.d.The Exar i.c. is available in a kit (XR-2206KA) with a socket, a p.c.b. and instruction manual all for £12.15 inclusive. Rastra Electronics Ltd, 275 King Street, Hammersmith, London W6 9NP.
EWW215

HIGH—POWER OP-AMP

Originally designed for automatic test equipment signal amplification the Teledyne Philbrick TP1460 is a high-speed op amp with ±30V output at ±150mA. The maximum operating frequency is 10MHz with a 300V/µs slew rate and a 1GHz gain bandwidth product. With a differential input, the amplifier is suitable for high-speed applications such as video amplifiers, yoke drivers, ATE pin drivers and inductive or capacitative load driving. The v.mos output stage means that secondary breakdown is almost impossible. The device is house in an 8-pin TO3 package. MCP Electronics Ltd, 38 Rosemount Road, Alperton, Wembley, Middlesex HA0 4PE.
EWW 213

BLUE LEDs NOW IN PRODUCTION

It is two years since we reported the development of blue-light leds but now Siemens are manufacturing them in large quantities. The leds use silicon carbide (SiC) as the source material and although it has not been able to produce them at prices similar to leds in other colours, the price, still to be announced, will be much lower than that for comparable blue leds made from other materials. Siemens say that the purity and repeatability of the colour (480nm) of the SiC led biophysical and medical applications and also as a calibration source for tv cameras and photographic equipment. It could also be used for the blue luminous dots in a flat tv screen. The blue led is less suitable as an indicator when compared with red, yellow or green counterparts. Apart from the higher cost, the angle of radiation and the intensity are lower than in conventional leds. They need a forward voltage of 4V at 20mA. Siemens Ltd, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS.
EWW 217

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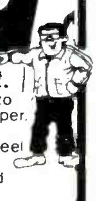
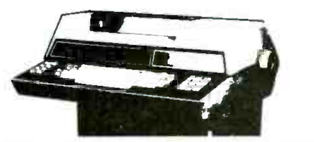


GE MODEL 30



A large purchase of these stand alone terminal units offers an EXTREMELY LOW PRICE for a professional printer for direct connection to your micro. The printer has a standard RS232 serial interface with switchable rates of 110, 200 and 300 baud. Upper and lower case characters are printed by a matrix head with character widths up to 132 columns. Unit accepts standard fan fold sprocket fed paper from 4" to 9.5". Many other features such as numeric keypad, electronic keyboard, auto motor on/off and FREE floor stand. Supplied in good S/H working condition – complete with manual ***ONLY £95.00*** ***CARRIAGE & INS. £10.00***

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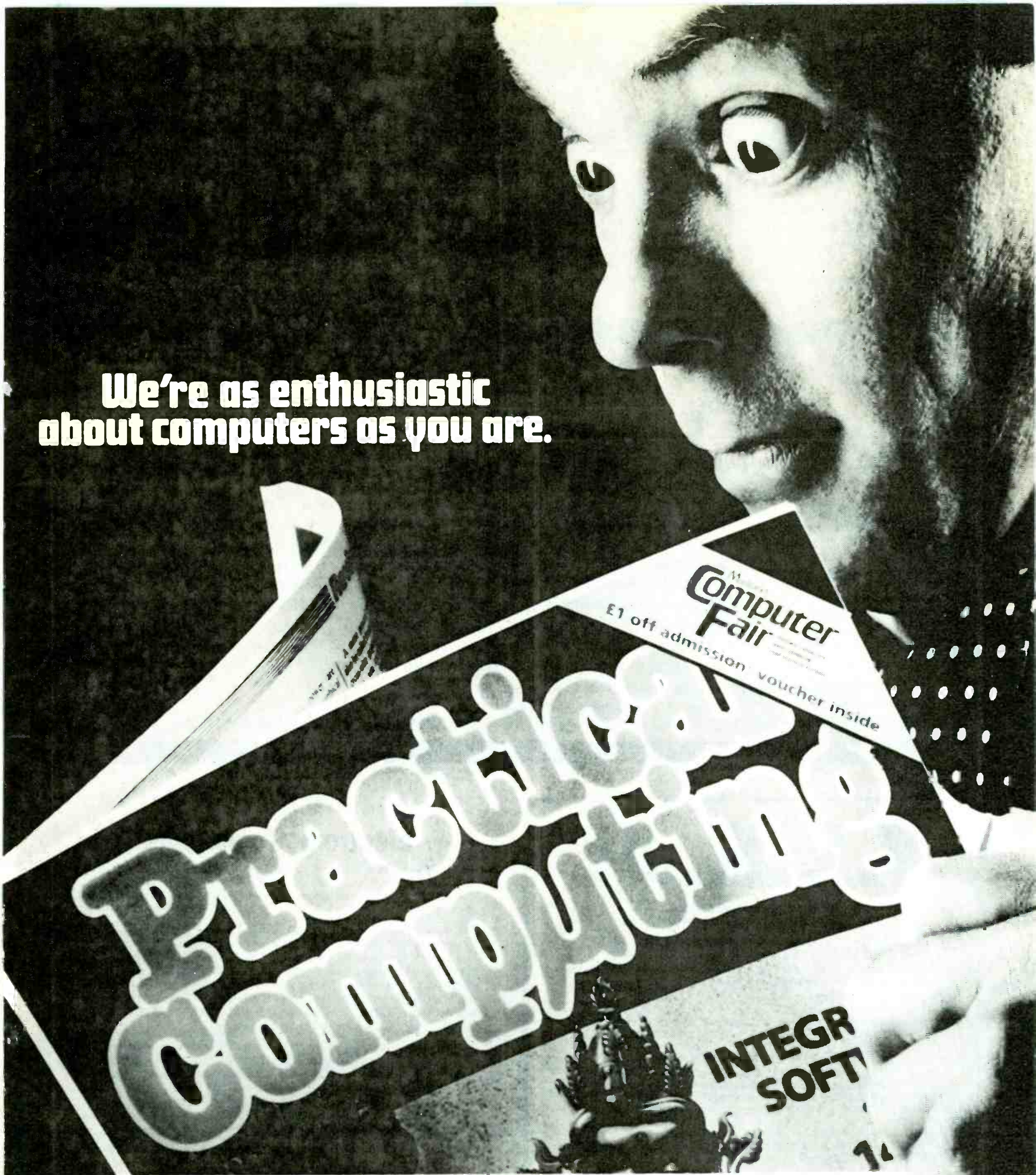

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(1926)

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(ST1/2) [Re-advertised9

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The closing date for completed application forms is the **2nd January 1985**
These post are suitable for Job-share.
ILEA is an Equal Opportunities Employer.

(2769)

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Qualifications: ONC/HNC or equivalent technical training combined with a sound practical electronics background in digital and/or analogue circuitry. The understanding of microprocessor systems with the ability to maintain low level software is an advantage. Academically well qualified younger applicants, but with limited practical experience will be considered and relevant necessary training will be given.

Salary: Dependant on qualifications and experience in the scale £6742 — £7930 p.a. (Professional and Technology Officer Grade IV).

The vacancy is at Professional and Technology Officer Grade IV for period appointment of 3 years.

Applicants should be physically fit and must be male as Antarctic field work requires successful candidates to share tented accommodation.

For further details and an application form please write to:
The Establishment Officer, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET.

Please quote Ref: BAS 14

Closing date: 11 January

NATURAL ENVIRONMENT RESEARCH COUNCIL

(2811)

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Mersey Television is looking for a Technical Co-ordinator to manage the technical operation for its twice-weekly drama serial "Brookside".

The successful candidate will be an experienced broadcast engineer with a comprehensive knowledge of vision, camera, sound, electrical and post-production departments. He/she will be responsible for co-ordinating all aspects of these departments. This is an exciting opportunity within a expanding company situated in a pleasant location on Merseyside.

We are an equal opportunities employer. Salary will depend on overall experience. Please send details c.v. to:

Personnel Administrator, Brookside Productions Ltd., 43 Brookside, West Derby, Liverpool L12 0BA. (2801)

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Madge Sidaway
Personnel Officer
Laser-Scan Laboratories Ltd.
Cambridge Science Park
Milton Road
Cambridge. CB4 4BH.
Tel: (0223) 315414

Laser-Scan Laboratories Limited

(2800)

RESEARCH IN SATELLITE COMMUNICATIONS/DIGITAL SIGNAL PROCESSING

Following successful satellite trials in the UK and the USA of the prototype Digital Pseudo Analogue (DPA) Modulation System for DBS, and the placement of a research contract by General Electric (USA), the Department of Communication Engineering is seeking a Research Assistant or Fellow with a background in digital electronics and an interest in digital signal processing.

Candidates must have a good first degree preferably in Electronics or Physics, and/or a post graduate qualification. Initially appointed for a 2 year period, the successful candidate, if not already qualified, will be expected to register for a higher degree.

Some travel to the USA/Canada during the project is anticipated.

Starting salary, dependent upon qualifications and experience, will be within the salary range circa £7000 to £10,000.

Application form together with further details are available from the Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA. Telephone (0752) 264639.

Closing date for applications 11.1.85.

(2802)

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(291)

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A suitable engineering qualification together with some experience in broadcast or the professional audio industry is essential.

ANALOGUE DESIGN ENGINEER

We are looking for an experienced engineer to join our development team. The successful candidate will be involved in all aspects of design from concept to production. He/She will most likely have a relevant degree and must be capable of producing innovative but practical designs with minimum supervision. Experience of the professional audio industry would be an advantage.

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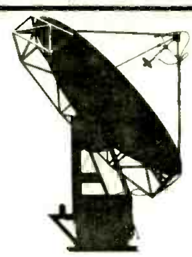
(2807)



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(2803)

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For further information contact: Sarah Kennedy, Dolby Laboratories Inc. 346 Clapham Road, London SW9 9AP. 01-720 1111

(2758)

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Further details are available from Martin Welch **(01) 794 0500 ext 3209** Job description and application form available from the Personnel Department Royal Free Hospital, Pond Street, Hampstead, London NW3 2QG

Please quote reference no: 1499

(2781)

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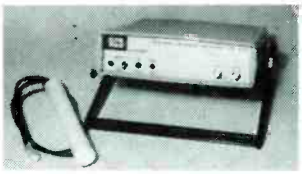

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6883B	8.20
6922	3.90
6939	19.50
6973	3.70
6975	66.00
7014	44.50
7015	50.00
7017	66.50
7018	18.50
7022	66.80
7023	103.50
7025	2.50
7027	4.60
7034	42.50
7056	2.50
7136	175.00
7189A	2.40
7199	4.20

7203 (NAT)	39.50
7203 (EIM)	49.00
7233	6.75
7234	72.50
7247	3.20
7262A	26.00
7289	39.00
7308	7.50
7322	604.00
7360	9.00
7486AL	80.00
7527	73.30
7527A	140.00
7534	23.50
7543	2.00
7551	5.50
7558	8.00
7581A	18.25
7586	11.50
7587	38.10
7591A	5.00
7723NE	28.65
7735A	26.00
7815AL GE	48.00
7815R AL	48.00
7868	4.20
7903	115.00
7905	13.50
7984	13.50
8008	18.80
8020	35.00
8032	8.20
8056	15.00
8068	13.00
8072	69.20
8117	165.00
8121	90.00
8122	90.00
8163	82.00
8164	332.00
8233	44.00
8278	39.00
8298A	7.50
8321 (EIM)	70.00
8321 (AMP)	68.00
8416	15.70
8417	5.55
8422	20.00
8438	80.00
8541	33.00
8552	8.20
8553	280.00
8608	27.50
8643	66.70
8754	17.35
8794	2330.00
8844	23.00
8874	165.00
8906AL	55.00
8908	10.50
8950	9.50
9001	6.00
9677M	31.00
9844A	420.00
9950	40.00
16411	118.00

R. F. POWER TRANSISTORS – Many other types available on request

2N3375	11.30
2N3553	2.00
2N3632	10.00
2N3733	13.20
2N3866	1.20
2N3926	11.26
2N3927	11.82
2N4416	0.75
2N4427	1.20
2N5090	13.90
2N5109	2.25
2N5160	4.80
2N5190	1.50
2N5589	6.00
2N5590	8.50
2N5591	8.90
2N5643	13.00
2N5913	2.50
2N5945	10.90
2N5946	15.63
2N6080	6.00
2N6081	8.75
2N6082	9.00
2N6083	12.00
2N6084	13.20
2N6094	8.00
2N6095	8.50
2N6255	3.45
2SC382	0.65
2SC458	0.22
2SC458B	0.36
2SC458C	0.22
2SC460	0.25
2SC460B	0.25
2SC461B	0.25
2SC535	0.38
2SC535A	0.38
2SC535B	0.38
2SC535C	0.35
2SC540	24.95
2SC608	0.75

2SC644	0.25
2SC684	0.28
2SC703	36.00
2SC710	0.45
2SC710D	0.28
2SC715D	0.40
2SC715E	0.40
2SC717P	0.38
2SC730	4.10
2SC731	3.95
2SC732	0.25
2SC741	2.50
2SC821	6.60
2SC28B	0.30
2SC29B	0.25
2SC890	8.50
2SC891	18.00
2SC900	0.18
2SC900F	0.19
2SC908	4.50
2SC911A	18.00
2SC945	0.21
2SC945R	0.21
2SC952	0.60
2SC982	0.30
2SC994	2.50
2SC998	3.90
2SC1001	9.90
2SC1011	15.00
2SC1070	1.15
2SC1096L	0.90
2SC1096M	0.90
2SC1117	£1.50
2SC1120	12.50
2SC1121	24.00
2SC1122	18.00
2SC1162B	0.90
2SC1165	6.95
2SC1169	4.85
2SC1176	14.00
2SC1177	17.25

2SC1178	18.00
2SC1209D	0.64
2SC1213A	0.40
2SC1213C	0.40
2SC1239	2.50
2SC1241	15.00
2SC1251	10.00
2SC1260	1.11
2SC1303	5.00
2SC1306	1.00
2SC1307	1.50
2SC1311	0.40
2SC1311E	0.32
2SC1314	25.00
2SC1318	0.40
2SC1368B	1.00
2SC1383B	0.50
2SC1424	1.35
2SC1509	6.00
2SC1546	0.45
2SC1568	0.45
2SC1589	5.00
2SC1622	0.33
2SC1623	0.30
2SC1688	16.68
2SC1674	0.25
2SC1675	0.20
2SC1678	1.25
2SC1729	18.00
2SC1730	0.25
2SC1740Q	0.20
2SC1765	7.75
2SC1815Y	0.28
2SC1906	0.33
2SC1907	0.30
2SC1945	3.50
2SC1946	18.75
2SC1946A	16.50
2SC1947	9.88
2SC1955	7.20
2SC1966	11.00

2SC1967	15.00
2SC1968	17.50
2SC1968A	22.00
2SC1969	3.20
2SC1970	1.50
2SC1971	4.00
2SC1972	11.00
2SC1978	7.50
2SC2001	0.45
2SC2026	0.75
2SC2053	0.80
2SC2097	36.00
2SC2099	15.00
2SC2100	24.00
2SC2103	18.00
2SC2105	15.00
2SC2116	1.60
2SC2118	9.00
2SC2221	5.50
2SC2233	0.90
2SC2237	16.00
2SC2281	13.00
2SC2283	9.00
2SC2287	11.00
2SC2289	12.50
2SC2290	27.50
2SC2347	0.30
2SC2369	2.00
2SC2370A	18.00
2SC2379	15.00
2SC2395	15.00
2SC2407	1.00
2SC2420	18.00
2SC2494	16.00
2SC2509	6.00
2SC2531	1.30
2SC2538	1.10
2SC2539	15.00
2SC2540	24.95
2SC2545E	0.29
BER90	1.50

BER91	2.00
BER96	2.00
BFY90	1.50
BLW29	10.00
BLW60C	15.00
BLW60CF	15.00
BLW64C3	65.00
BLW78	61.80
BLW80	10.25
BLW81	14.90
BLW90	13.00
BLW98	110.00
BLX39	13.75
BLX65	2.45
BLX67C	9.50
BLX67CF	9.50
BLX68C3	10.00
BLX68CF	10.50
BLX69A	20.00
BLX94A	36.00
BLX98	132.00
BLY87C	7.50
BLY88C	11.00
BLY88CF	11.00
BLY89C	13.00
BLY90	45.00
BLY91CF	11.00
BLY94	45.00
MRF208	12.00
MRF212	12.00
MRF221	12.05
MRF229	3.50
MRF231	12.36
MRF232	13.50
MRF233	14.30
MRF234	16.00
MRF237	3.10
MRF238	12.60
MRF239	20.00
MRF240	18.80
MRF243	35.00

MRF245	30.00
MRF247	30.10
MRF260	5.50
MRF264	11.00
MRF309	42.00
MRF316	55.00
MRF317	73.00
MRF321	35.00
MRF323	35.00
MRF326	63.00
MRF327	70.00
MRF329	58.06
MRF412	18.51
MRF421	36.85
MRF422	42.00
MRF426	23.00
MRF427A	21.00
MRF428	57.00
MRF428A	75.00
MRF433	16.21
MRF449A	10.50
MRF450	11.90
MRF453	14.00
MRF453A	14.00
MRF454	21.00
MRF454A	24.00
MRF455	16.00
MRF455A	21.00
MRF458	19.95
MRF466	24.50
MRF472	4.40
MRF476	2.20
MRF475	4.20
MRF477	12.50
MRF492	27.50
MRF497	18.50
MRF515	2.60
MRF517	3.50
MRF620	18.00
MRF644	25.70
MRF646	26.20

MRF648	30.85
MRF750	6.50
MRF846	46.00
MRF901	2.75
MRF904	2.95
MRF911	2.50
MRF5175	22.50
MRF5176	30.00
MRF5177	43.00
MRF8004	2.00
PT3134A	1.50
PT3134B	2.75
PT3134C	12.00
PT3134D	12.50
PT3134E	30.00
PT3161A	1.75
PT3161B	1.75
PT3161C	8.50
PT3161D	14.00
PT3161F	30.00
PT3503	6.95
PT4261A	16.00
PT4261B	24.00
PT4261C	60.00
PT4316C	12.00
PT4316D	18.00
PT4316E	25.00
PT4316F	30.00
PT5661C	14.00
PT8751	24.00
PT8820	15.00
PY8831	2.75
PT8837	10.00
PT8838	15.00
PT8854B	18.00
PT8861A	15.00
PT8864A	30.00
PT8874	18.00
PT9795	12.50
PT9797	14.00
PT9841	16.00

PT9847	16.00
SD1005	8.20
SD1006	2.10
SD1012-3	10.00
SD1012-4	10.50
SD1013	10.00
SD1014-6	10.50
SD1015	17.50
SD1018-6	13.00
SD1019	23.10
SD1019-5	23.10
SD1020	1.50
SD1074	16.10
SD1076	18.50
SD1077	1.60
SD1078	26.50
SD1080	1.55
SD1080-6	7.50
SD1080-7	7.50
SD1088	26.00
SD1089	28.50
SD1098	40.10
SD1115-2	7.50
SD1115-7	2.10
SD1127	2.50
SD1131	3.25
SD1133	9.50
SD1133-1	10.00
SD1134-1	2.50
SD1134-2	10.00
SD1134-8	10.00
SD1134-STUD	7.10
SD1135	10.25
SD1135-3	12.00
SD1136	11.70
SD1143	9.45
SD1143-1	10.00
SD1144-1	2.50
SD1158	7.95
SD1201	7.35

SD1202	7.50
SD1212-4	6.00
SD1212-7	4.00
SD1214	8.70
SD1216	11.00
SD1219	18.00
SD1219-4	18.00
SD1220-1	9.50
SD1222-5	11.00
SD1222-STUD	11.00
SD1224-2	13.00
SD1229-F1	10.95
SD1229-STUD	10.95
SD1244-6	12.75
SD1256	6.95
SD1262	15.00
SD1270	3.75
SD1272	10.95
SD1272-2	10.95
SD1278	13.75
SD1278-1	13.75
SD1285	12.75
SD1300	1.25
SD1303	2.50
SD1316	2.10
SD1317	8.00
SD1405	21.00
SD1407	27.50
SD1407MP	55.00
SD1410	19.65
SD1410-1	21.00
SD1410-3	21.00
SD1412	36.00
SD1412-3	24.00
SD1413	18.00
SD1414	36.00
SD1416	33.00
SD1418	30.00
SD1421	36.00
SD1428	24.00
SD1429	15.98

TERMS: C.O.W. **POSTAGE/PACKING**: Add £1 to order under £50 value. **VAT**: All prices are excluding VAT, please add 15% to order and postage. **GUARANTEE**: All goods are of current production and sold with manufacturer's warranty. **ENQUIRIES**: Are welcomed for other types/brands of valves. Please send SAE

CIRCLE 42 FOR FURTHER DETAILS.