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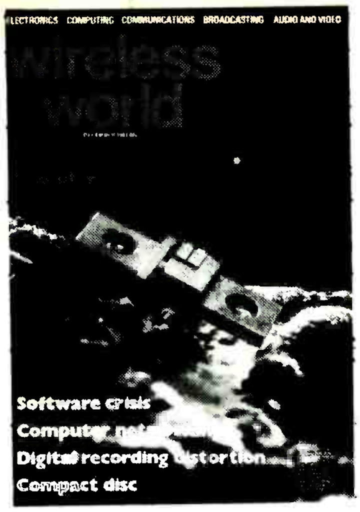

Photographed by Michel Mathieu, the front cover shows a Thomson-CSF laser diode for fibre communication systems.

NEXT MONTH

J. Tait discusses tracking digital filters for servosystems in which synchronous generation and filtering provide accurate feedback conditioning over wide frequency ranges.

Program development for the Nanocomp eprom is simplified by a method for developing software in the locations it is intended for, shows G. Bettridge in Eprom development aid.

Data acquisition on a Pet, by two authors involved with education, describes circuits and software for reading analogue and digital signals on a microcomputer widely-used in research and teaching.

Matching tuning diodes by A. Maciejewski gives a program for selecting variable-capacitance diodes for use in critical circuits such as the r.f. and oscillator u.h.f. receivers.

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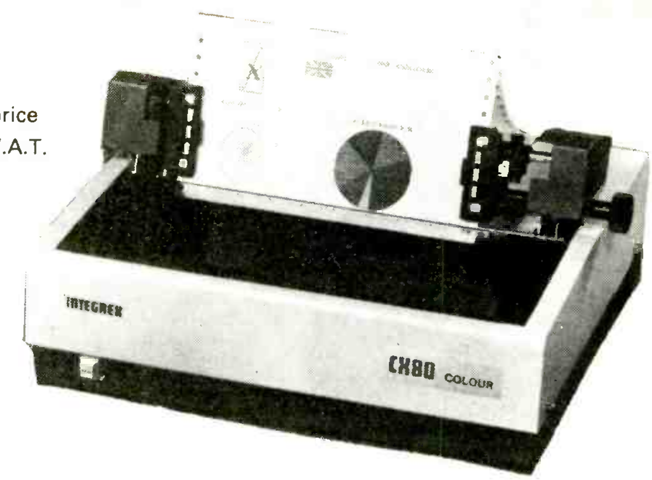

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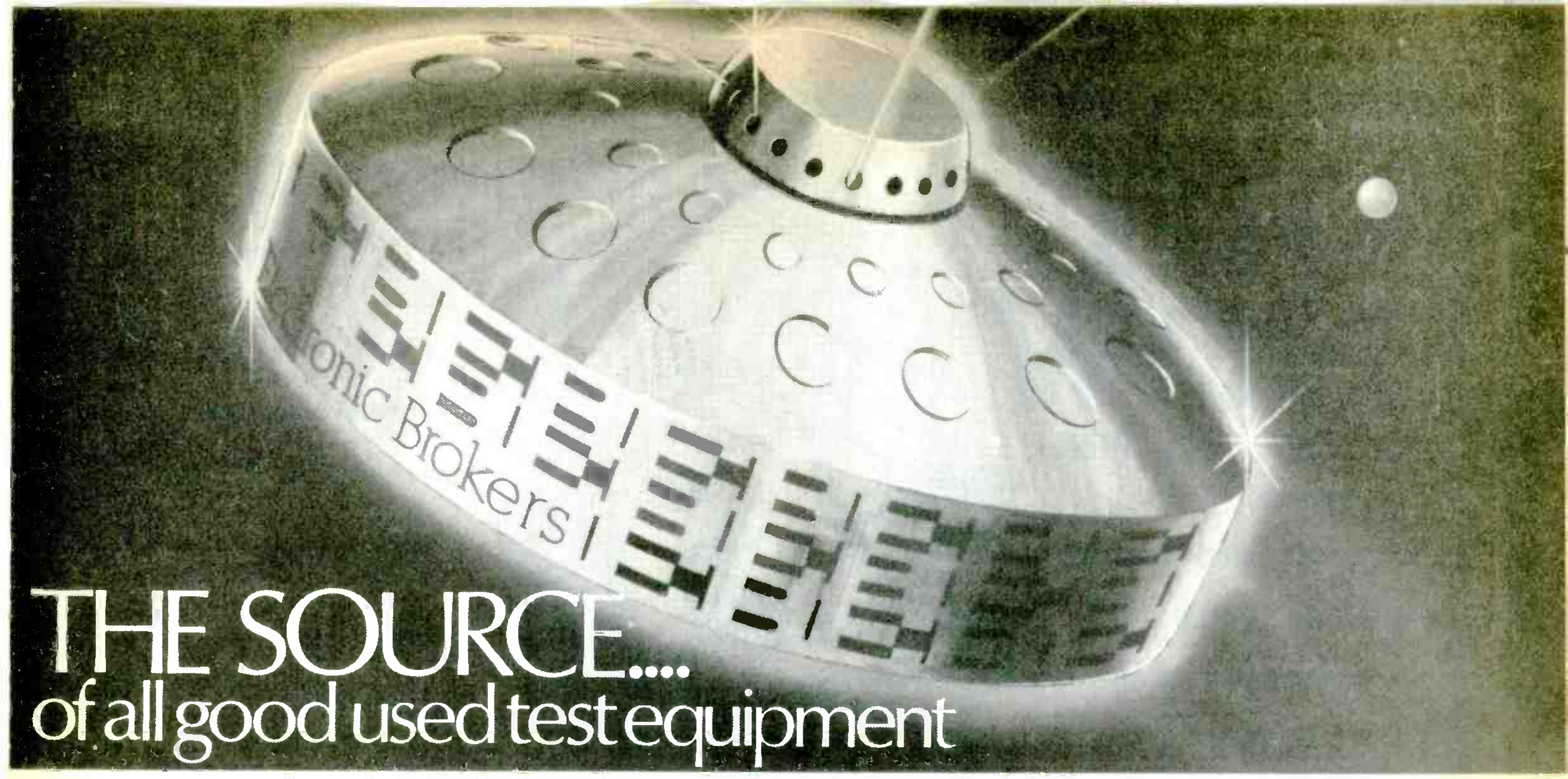

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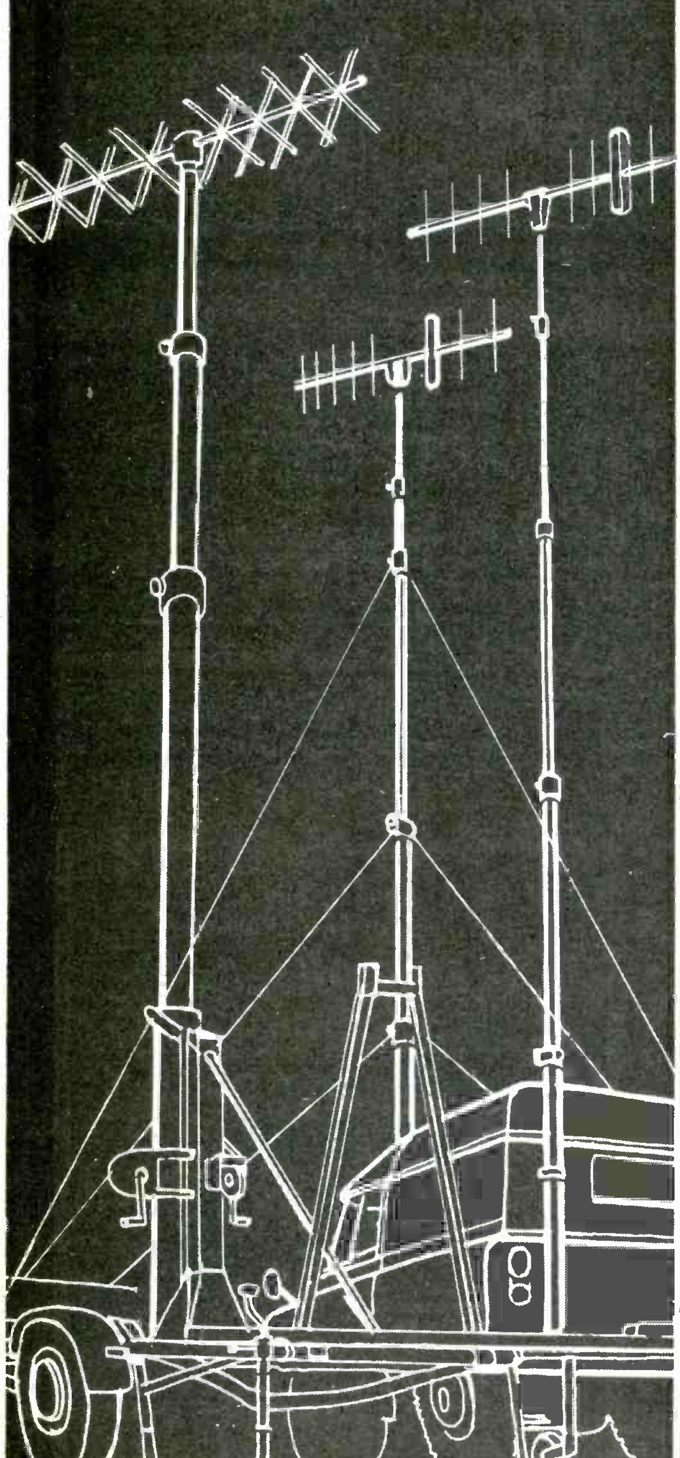

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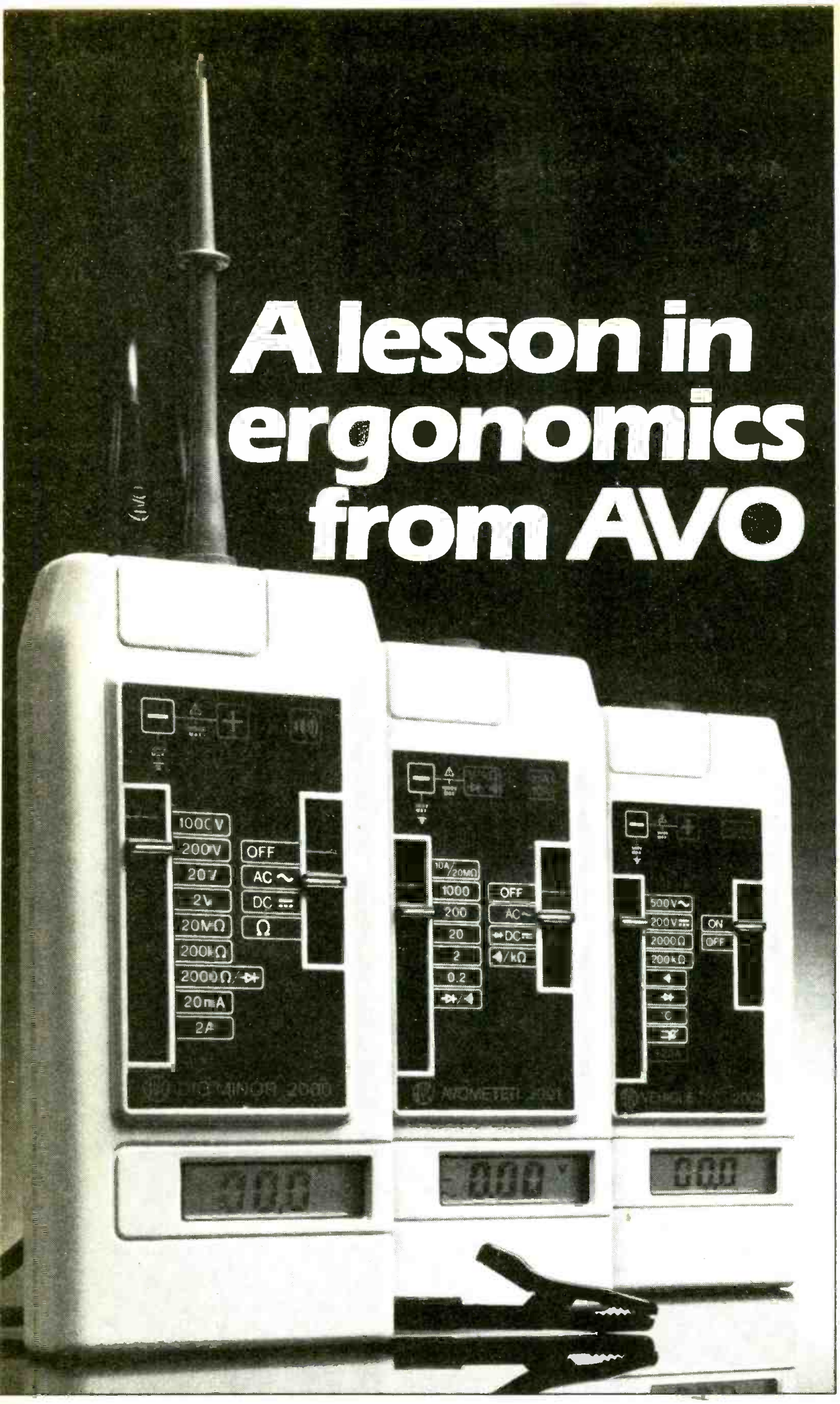

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SPDT c/over 60p
SPDT centre off 85p
SPDT biased both ways 105p
DPDT 6 tags 75p
DPDT centre off 88p
DPDT biased both ways 145p
DPDT 3 positions on/on/on 185p
3-pole 2 way 205p

SLIDE 250V:
DPDT 1A 14p
DPDT 1A c/off 15p
DPDT ½A 13p

PUSHBUTTON 6A
with 10mm Button
SPDT latching 99p
DPDT latching 145p
SPDT moment 99p
DPDT moment 145p

Mini Non Locking
Push to Make 15p
Push to Break 25p

DIL SWITCHES
(SPST) 4 way 70p, 6 way 85p; 8 way 90p; 10 way 145p.
(SPDT) 4 way 190p.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way, 2p/2 to 6 way; 3 pole/2 to 4 way, 4p/2 to 3 way 45p

ROTARY: Mains DP 250V 4 Amp on/off 56p

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

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

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

THUMBWHEEL Mini front mounting
Decade Switch Module 220p
B.C.D. Switch Module 275p
Mounting Cheeks (per pair) 75p

VEROBOARD 0.1in

	clad	plain
2½ × 3¼	80p	
2½ × 5	91p	–
3¾ × 3¾	91p	–
3¾ × 5	105p	87p
3¾ × 17	360p	232p
4¾ × 17	470p	–

Pkt of 100 pins 50p
Spot face cutter 135p
Pin insertion tool 178p

VQ Board 180
DIP Board 350
Vero Strip 374

PROTO DECs
Veroblock 405p
S-Dec 350p
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DALO ETCH RESIST PEN
Plus spare tip 90p

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

ULTRASONIC TRANSDUCER
40KHz 325 pr

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	Pins Angle	Female Header Plug
10 way	90p	99p	85p
16 way	130p	150p	110p
20 way	145p	166p	125p
26 way	175p	200p	150p
34 way	205p	238p	169p
40 way	220p	250p	190p
50 way	235p	270p	200p
60 way	–	–	230p

EURO CONNECTORS

	Female Socket Strt. Pins	Female Socket Angle Pins	Male Plug Strt. Pins	Male Plug Angle Pins
DIN41617 31way	170p	–	–	175p
DIN41612 2×32 A+B	285p	325p	220p	295p
DIN41612 2×32 A+C	300p	340p	240p	300p
DIN41612 3×32 A+B+C	360p	385p	260p	400p

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided	S.R.B.P. 9.5" × 8.5"
6" × 6"	90p	110p	95p
6" × 12"	150p	195p	

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	99p

EDGE CONNECTORS

	.1	.156
2 × 15 way	–	140p
2 × 18 way	180p	145p
2 × 22 way	199p	200p
2 × 23 way	190p	–
2 × 25 way	225p	220p
2 × 28 way	210p	–
2 × 30 way	245p	–
2 × 36 way	295p	–
2 × 40 way	315p	–
2 × 43 way	395p	–
2 × 75 way	550p	–

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	99p
16 pin	49p	105p
24 pin	89p	179p
40 pin	250p	255p

ZIF DIL SOCKETS
24 pin 575p
28 pin 820
40 pin 975p

RIBBON CABLE
price per foot

	Grey	Color
10 way	12p	22p
16 way	18p	32p
20 way	25p	40p
24 way	35p	50p
34 way	48p	60p
40 way	55p	75p
50 way	65p	90p
64 way	85p	110p

ETI PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	595p

IDC Header Socket Jumper Leads 24"

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

ANTEX SOLDERING IRON
C-15W 450p CX17W 475p
CCN-15W 495p CX25W 500p
Spare tips, assorted sizes 65p
Spare Elements 210p
Iron stand with sponge 165p

SIL Socket
0.1" pitch
20 way
65p

D CONNECTORS: Miniature

	9 way	15 way	25 way	37 way
Plugs				
Solder lugs	80p	110p	160p	250p
Angle pins	160p	210p	250p	355p
W/wrap pins	120p	130p	195p	295p
Sockets				
Solder lugs	110p	160p	210p	360p
Angled pins	185p	215p	290p	440p
W/wrap pins	150p	180p	240p	420p
Covers	95p	95p	95p	110p

IDC 25 way Plug 385p
Skt. 450p

25 way 'D' CONNECTOR
Jumper Lead Cable Assembly
18" long, Single end, Male 495p
18" long, Single end, Female 525p
36" long, Double Ended, M/M 1025p
36" long, Double Ended, F/F 1050p
36" long, Double Ended, M/F 995p

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0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
495p each

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32.768KHz	100
100KHz	235
200KHz	268
455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0NHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

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2in, 3½in, 2½in, 3in 80p
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pcb mounting Miniature Split Bobbin
3VA: 2×6V-0.25A; 2×9V-0.15A; 2×12V-0.12A; 2×15V-0.1A 200p
6VA: 2×6V-0.5A; 2×9V-0.3A; 2×12V-0.25A; 2×15V-0.2A 270p

Standard Split Bobbin type
6VA: 2×6V-0.5A; 2×9V-0.4A; 2×12V-0.3A; 2×15V-0.25A 220p
12VA: 2×4.5V-1.3A; 2×6V-1A; 2×9V-0.6A; 2×12V-0.5A; 2×15V-0.4A; 2×20V-0.3A 295p (35p p&p)
24VA: 2×6V-1.5A; 2×9V-1.2A; 2×12V-1A; 2×15V-0.8A; 2×20V-0.6A 330p (60p p&p)
50VA: 2×6V-4A; 2×9V-2.5A; 2×12V-2A; 2×15V-1.5A; 2×20V-1.2A; 2×30V-0.8A 465p (60p p&p)
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(75p p&p charge to be added over and above our normal postal charge).

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1A T0220 Plastic casing

	+ve		−ve	
5V	7805	40p	7905	45p
12V	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p

100mA T092 Plastic package

	+ve		−ve	
5V	78L05	30p	79L05	60p
6V	78L06	30p		–
8V	78L08	30p		–
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H 170p
LM304H 170p
LM305H 140p
LM309K 135p
LM317K 320p
LM317KP 99p
LM323K 450p
LM337 175p
LM723 Var. 38p
TAA550 50p
TDA1412 150p
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5x2¾x2½"	130p
6x4x2"	120p
6x4x3"	150p
7x5x3"	180p
8x6x3"	210p
10x4x3"	240p
10x7x3"	275p
12x5x3"	260p
24x8x3"	295p

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4008	32	4082	13	4549	375
4009	24	4085	50	4553	245
4010	24	4086	60	4554	190
4011	10	4089	125	4555	35
4012	16	4093	20	4556	35
4013	20	4094	70	4557	320
4014	48	4095	96	4558	120
4015	40	4096	70	4559	395
4016	20	4097	290	4560	180
4017	32	4098	75	4561	104
4018	45	4099	110	4562	495
4019	25	4160	95	4566	185
4020	42	4161	98	4568	250
4021	40	4162	98	4569	175
4022	40	4163	98	4572	30
4023	13	4174	98	4580	480
4024	32	4175	105	4581	250
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4030	15	4412	775	4599	290
4031	125	4415	480	45106	598
4032	80	4419	280	40085	90
4033	125	4422	770	40097	45
4034	140	4433	770	40098	193
4035	45	4435	850	40100	215
4036	275	4440	999	40101	130
4037	115	4450	350	40102	140
4038	110	4451	350	40103	175
4039	250	4490	350	40104	95
4040	40	4500	675	40105	110
4041	40	4501	28	40106	46
4042	40	4502	60	40107	60
4043	40	4503	40	40108	450
4044	40	4504	75	40109	100
4045	105	4505	185	40110	300
4046	46	4506	35	40114	240
4047	40	4507	35	40161	194
4048	40	4508	130	40163	65
4049	25	4510	46	40174	65
4050	25	4511	45	40175	75
4051	45	4512	50	40181	220
4052	60	4513	199	40182	90
4053	50	4514	115	40192	90
4054	86	4515	115	40193	98
4055	86	4516	56	40194	90
4056	86	4517	275	40195	72
4057	1915	4518	40	40244	195
4059	435	4519	30	40245	195
4060	45	4520	50	40257	195
4061	1195	4521	110	40373	240
4062	995	4522	125	40374	245
4063	85	4526	70		
4066	24	4527	85		
4067	245	4528	70		
4068	14	4529	150		
4069	16	4530	90		
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4071	13	4532	70		
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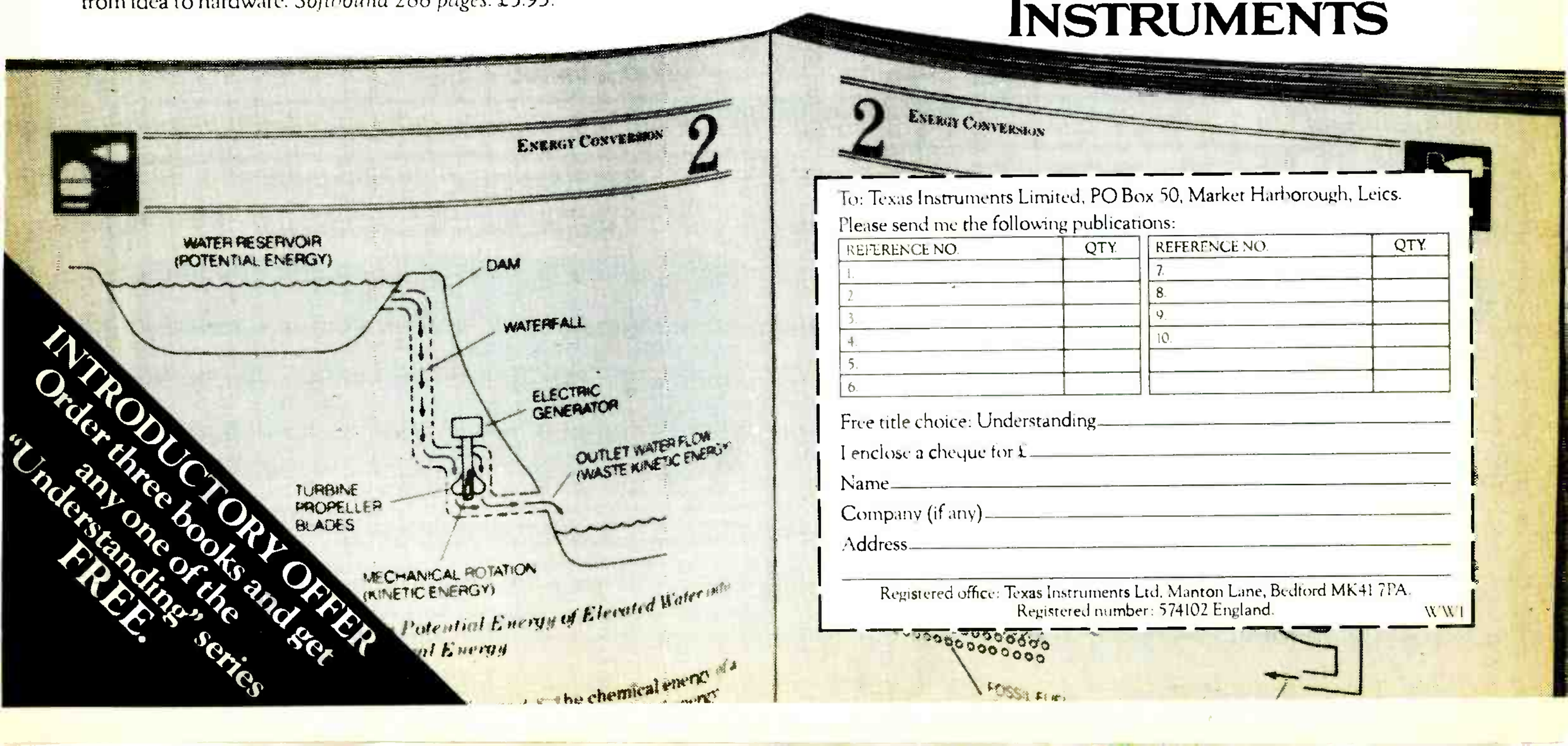

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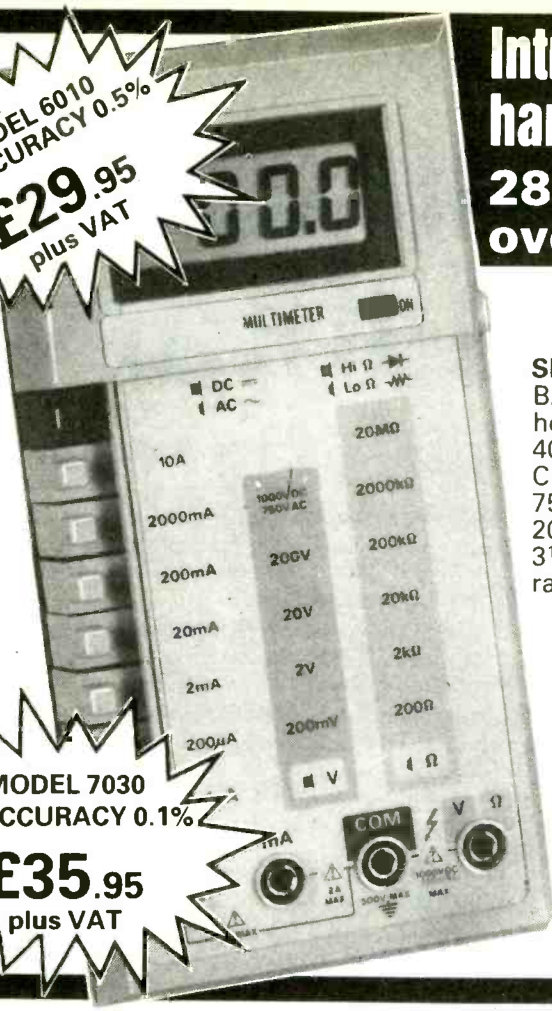

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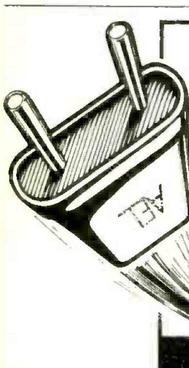

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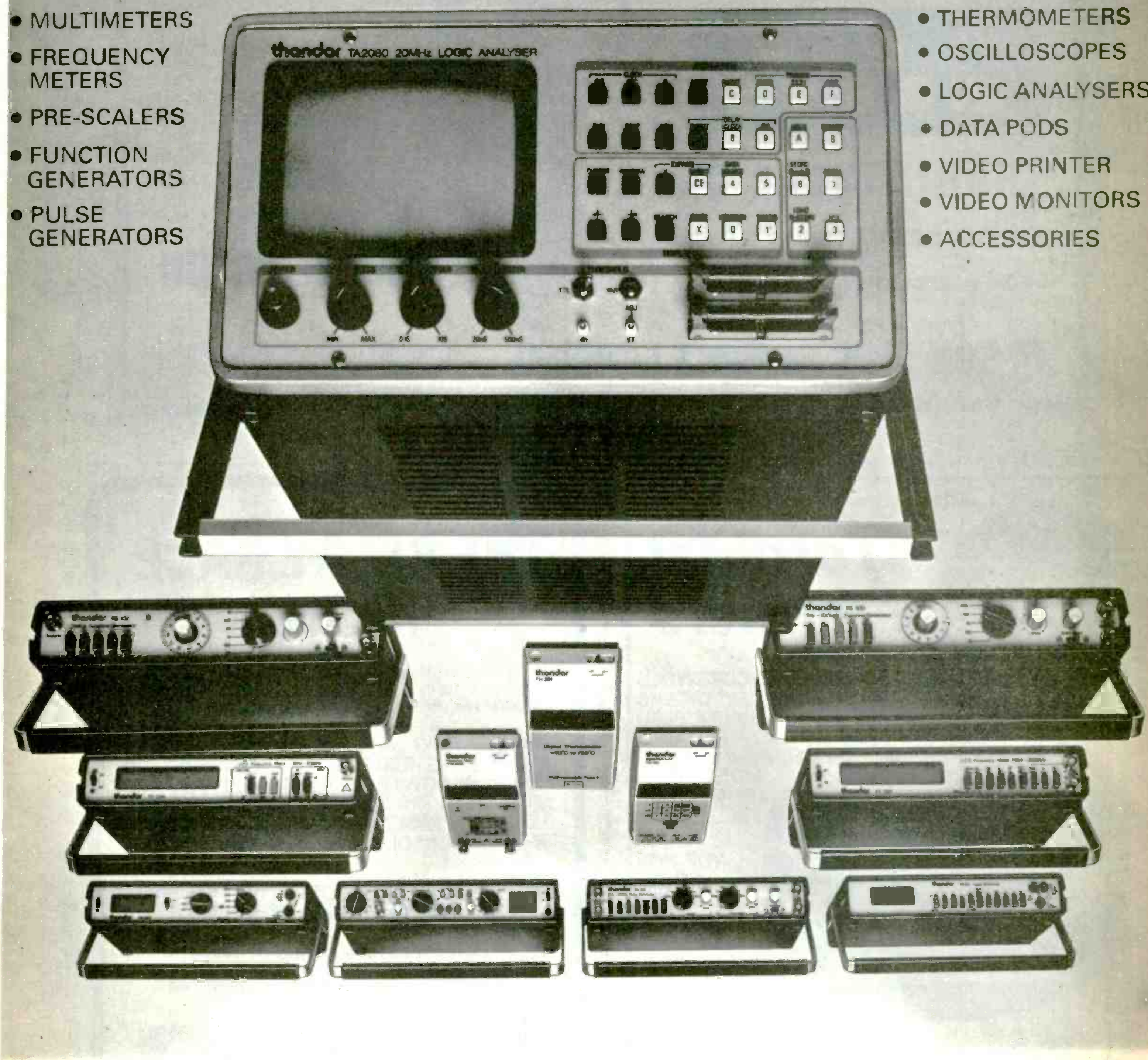

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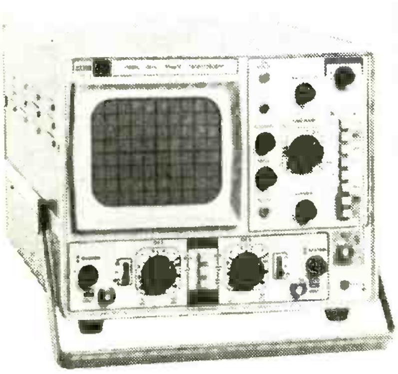

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Z80ASIO-0	11.99
Z80ASIO-1	11.99
Z80ASIO-2	11.99
MK3886	11.00
MK3886-4	14.47
6800 FAMILY	
6800	2.99
6802	3.49
6803C	12.10
6809	8.45
6810	1.12
6821	1.20
6840	3.95
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6880	1.07
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68488	9.11
6875	5.62
6843	13.99
68B00	6.30
68B09	19.11
68B21	2.29
68B10	2.00
68B40	4.70
68B50	2.86
6500 FAMILY	
6502	3.45
6520	2.99
6522	3.19
6532	5.95
6080 FAMILY	
8085A	4.40
8212	1.55
8216	0.60
8251A	3.19
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81LS97	0.90
81LS98	0.90
8T26A	1.20
8T28A	1.20
8T95	1.35
8T97A	1.35
8T98	1.45

Device	Price
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ZN426	3.00
ZN427	5.99
ZN428	4.75
ZN429	2.10
ZN432	13.00
ZN433	25.90
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UPD7002	4.35
ZN447	7.29
ZN448	5.46
ZN449	2.55
ZN440	56.63
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FD1791	21.75
FD1793	22.75
FD1795	27.75
FD1797	27.75
WD1691	10.87
WD2143	5.77
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DP8304	4.50
MC1488	0.55
MC1489	0.55
MC3446	2.95
MC3448A	4.25
MC3480	7.95
MC3487	2.95
MC14411	6.94
MC14412	7.99
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R03-2513U	6.99
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4702	7.45
7660	2.58
LF398N	5.56
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ZN423 1 26V	1.00
ZN588 2 45V	1.08
ZN Ref 025 2 49V	1.60
ZN Ref 040 4 10V	1.60
ZN Ref 062 6 17V	1.60
ZN Ref 100 1 96V	2.56

Device	Price
OVM CHIPS	
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ZN450 KIT	17.35
LINEARS	
LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.14
LM324N	0.30
LM348N	0.59
LM555N	0.16
LM556CN	0.45
LM741 (8 PIN)	0.14
LM474CN	0.64
LM748 (8 PIN)	0.34
LM725CN	3.20
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7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
LM309K	0.99
LM317K	3.20
LM323K	4.95
LM338K	POA
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6MHZ(UM1111)	3.70
8MHZ(UM1233)	4.40
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1 008MHZ	2.90
1 8432MHZ	2.20
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3 6864MHZ	2.95
4MHZ	1.45
6MHZ	1.45
8MHZ	1.70
9 6804MHZ	1.95
CMOS 4000 'B' SERIES	
4001	0.10
4002	0.12
4006	0.65
4007	0.15
4008	0.60
4009	0.34
4010	0.39
4011	0.11
4012	0.15
4013	0.24
4014	0.49
4015	0.49
4016	0.19
4017	0.37
4018	0.67
4019	0.41
4020	0.49
4021	0.69
4022	0.65
4023	0.15
4024	0.31
4025	0.16
4026	1.29
4027	0.23
4028	0.49
4031	1.69
4033	1.64
4034	1.90
4035	0.94
4040	0.49
4041	0.77
4042	0.44
4043	0.69
4044	0.64
4045	1.69
4046	0.64
4047	0.49
4048	0.54
4049	0.24
4050	0.24
4051	0.44
4052	0.59
4053	0.77
4054	0.64
4055	0.84
4060	0.59
4063	0.98
4066	0.29
4068	0.21
4069	0.15
4070	0.14
4071	0.14
4072	0.19
4073	0.14
4075	0.14
4076	0.45
4077	0.25
4078	0.25
4081	0.15
4082	0.20
4085	0.64
4086	0.51
4093	0.25
4502	0.89
4507	0.38
4508	1.29
4510	0.45
4511	0.44

Device	Price
4512	0.49
4514	1.14
4515	1.14
4516	0.54
4518	0.39
4519	0.28
4520	0.49
4521	1.09
4522	1.24
4526	0.69
4527	0.64
4528	0.69
4532	0.69
4541	0.99
4543	0.79
4553	2.44
4555	0.50
4556	0.50
4585	0.78
NB. Other devices available	
74LS SERIES	
00	0.10
01	0.11
02	0.11
03	0.11
04	0.11
05	0.11
08	0.11
09	0.11
10	0.11
11	0.13
12	0.11
13	0.15
14	0.29
15	0.12
20	0.12
21	0.12
22	0.13
26	0.12
27	0.12
28	0.12
30	0.12
32	0.12
33	0.14
37	0.12
38	0.12
40	0.12
42	0.27
47	0.34
48	0.45
49	0.60
51	0.14
54	0.14
55	0.15
73	0.18
74	0.18
75	0.19
76	0.17
78	0.24
83	0.34
85	0.47
86	0.15
90	0.28
91	0.80
92	0.31
93	0.25
95	0.40
109	0.27
112	0.20
113	0.20
114	0.22
122	0.35
123	0.35
125	0.24
126	0.25
132	0.39
136	0.23
138	0.27
139	0.29
145	0.70
148	0.69
151	0.39
153	0.28
155	0.34
156	0.34
157	0.25
158	0.29
160	0.35
162	0.35
163	0.34
164	0.39
165	0.54
166	0.63
173	0.64
174	0.40
175	0.44
181	0.90
190	0.36
191	0.44
192	0.44
193	0.44
194	0.34
195	0.34
196	0.45
197	0.45
221	0.54
240	0.55
241	0.65
242	0.64
243	0.64
244	0.59
245	0.69
247	0.40
248	0.40
249	0.68

Device	Price
251	0.29
253	0.30
257	0.34
258	0.35
259	0.57
261	1.95
266	0.19
273	0.59
279	0.59
283	0.39
290	0.57
293	0.40
365	0.29
366	0.29
367	0.29
368	0.39
373	0.59
374	0.64
377	0.69
378	0.45
379	0.65
386	0.34
390	0.49
393	0.41
629	1.21

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14	9	29	35
16	9	31	35
18	13	33	52
20	14	25	60
22	17	40	70
24	19	42	70
28	25	54	80
40	29	81	99

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50 PIN	2.70
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16 PIN	2.10
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34 PIN	3.80
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50 PIN	5.48
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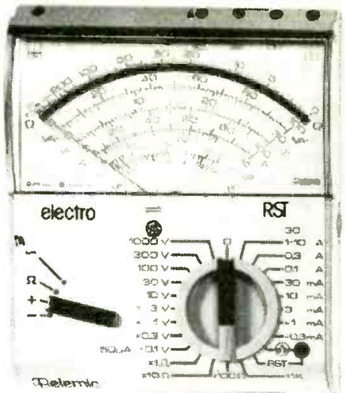

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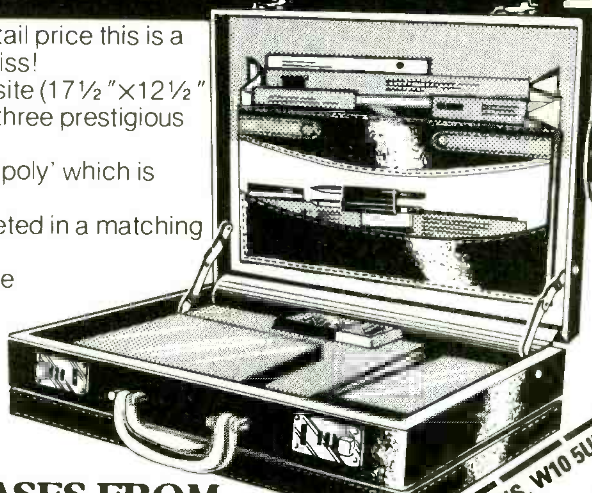

EXPANDER CASE **£17·95**
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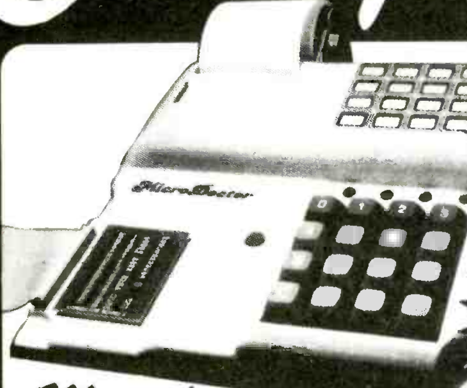

Reduced price

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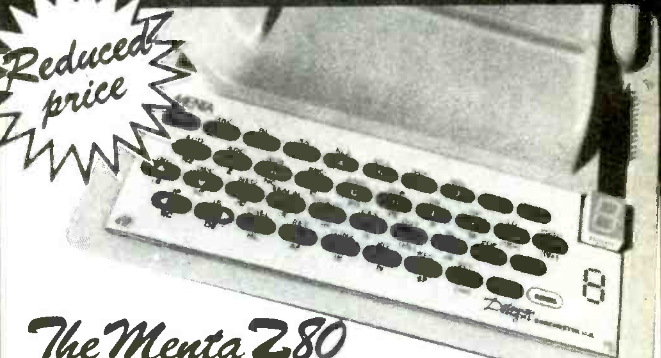
Microdoctor

is an alternative to AUTOMATIC TEST EQUIPMENT which can be very expensive. MICRODOCTOR is perfectly adequate for diagnosing faults in microprocessor boards or computers in the REPAIR SHOP or on the PRODUCTION LINE. Reports are PRINTED on the integral thermal printer. Tests supported are CHECKSUM, RAMTEST, WAIT, READ, WRITE, I/O READ, I/O WRITE, DUMP IN HEX, DUMP IN ASCII, TEST DATA LINES (for shorts between data, address and rails), SEARCH (for two specified bytes), MAP (print a memory map of ROM, RAM, I/O and EMPTY SPACE). Supports both multiplexed and non-multiplexed address/data. Standard software will also DISASSEMBLE in Z80 mnemonics – other disassemblers cost extra. Programs for board-testing can be written in MINUTES – and retained for MONTHS even if the power is switched off (CMOS RAM is backed-up with rechargeable battery). Capacity is 15 different programs of 12 tests each. Included are two PROBE CONFIGURATION CARDS (One Z80, other uncommitted), PROBE with 24 inch cable and 40-pin DIL plug – and POWER SUPPLY. Extras available are 6502 disassembler retrofit . . . £35, Clip-over PROBE (only needed if µP is soldered-in) . . . £35.

£295 +VAT



The Menta Z80 Development System

uses the MOST POWERFUL LANGUAGE OF ALL – direct ASSEMBLER MNEMONICS. MENTA has VISUAL AIDS to program development which the big systems lack: a TV display of PROGRAM, REGISTERS and STACK; single-step operation (watch the cursor move from instruction to instruction, see the register-contents change, observe stack operations, etc.) BUGS can be fixed immediately without reassembling. Full speed operation is supported too – with or without BREAKPOINTS. Designed originally for the Schools' Council to teach microprocessing, MENTA is a complex CONTROLLER in its own right, like any other Z80 system, with practical, commercial applications in ROBOTICS. Features include CASSETTE INTERFACE, ASSEMBLER/EDITOR, serial DISASSEMBLER (now included as standard), 24 bits of I/O – also TV FLYLEAD, POWER SUPPLY and COMPREHENSIVE MANUAL with SOURCE-CODE LISTING.

£99 +VAT

Goodies from Dataman

Olivetti Typewriter Interfaces

for ET121 and ET221 machines which permit the typewriter to be used as a DAISY WHEEL PRINTER for computers implementing the RS232, IEEE 488 (PET) or CENTRONICS PARALLEL busses: almost all computers in fact. Great for word processing and letter-writing! Same price, fitting free if requested (you pay carriage on typewriter if we fit). **£195.00**

Thandar Logic Analyser Enhancements

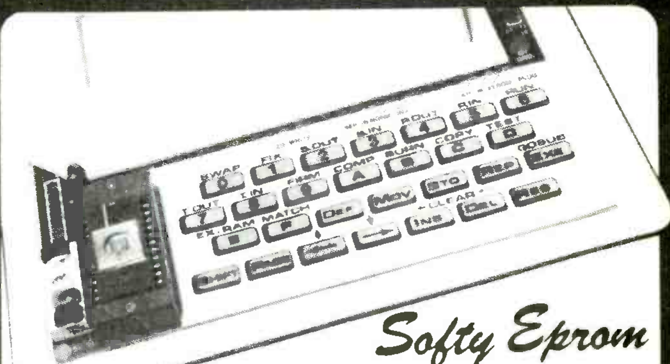
The THANDAR TA2080 LOGIC-ANALYSER was NOT designed by DATAMAN – but we like this instrument and use it for product development. When writing software we use SOFTY for ROM-EMULATION, following the program-flow on the TA2080 screen. We modified our TA2080 to make it more useful; adding an RS232 OUTPUT TO PRINTER – also Z80 and 6502 DISASSEMBLERS. Now we can follow program operation in MNEMONICS on-screen and print TIMING or STATE DIAGRAMS and DISASSEMBLED CODE. Cost of this RETROFIT kit (12K of program ROM, socket for RS232, interface board, instruction sheet) is, if fitted by us and purchased with a TA2080 **£195.00**

if purchased as a kit without TA2080 **£295.00**

Softy 1 with PSU

Yes, we still have a few old faithful 3 rail EPROM PROGRAMMERS around, as seen in Kensington Science Museum, if you are still using 2708's get yourself this fine old classic at a bargain price **£95.00**

Ultra-Violet Eprom Erasers from **£33.00**



Softy Eprom Programmer/Emulator

SOFTY has functions equal, at least, to equipment which sells for over £500. SOFTY EMULATES AND PROGRAMS 2716, 2516, 2732, 2532 EPROMS. (The type is selected by a personality switch. SOFTY will copy any of these EPROMS to any other). SOFTY has a HEX KEYPAD, a fast CASSETTE INTERFACE, a MEMORY MAP TV DISPLAY with powerful editing – such as INSERT, DELETE, SHIFT-BLOCK and many other facilities – too many to list here. RS232 SERIAL and CENTRONICS PARALLEL routines for INPUT and OUTPUT are standard. The price includes TV FLYLEAD, POWER SUPPLY and ROM EMULATOR CABLE WITH 24 PIN DIL PLUG. SOFTY is used as a DEVELOPMENT SYSTEM for new products or just as a STAND-ALONE EPROM PROGRAMMER.

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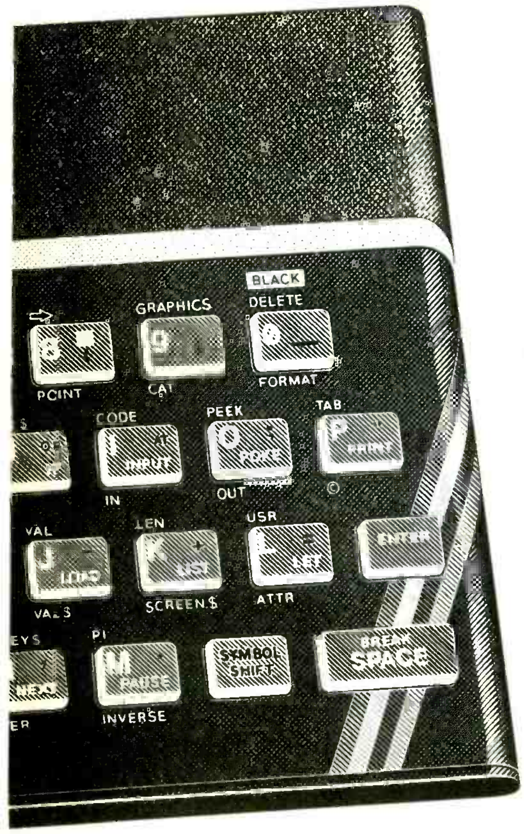


ZX Spectrum software on cassettes – available now

The first 21 software cassettes are now available directly from Sinclair. Produced by ICL and Psion, subjects include games, education, and business/household management. Galactic Invasion...Flight Simulation...Chess...History...Inventions...VU-CALC...VU-3D...47 programs in all. There's something for everyone, and they all make full use of the Spectrum's colour, sound and graphics capabilities. You'll receive a detailed catalogue with your Spectrum.

RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

sinclair

Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS.
Tel: Camberley (0276) 685311.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive – coming soon

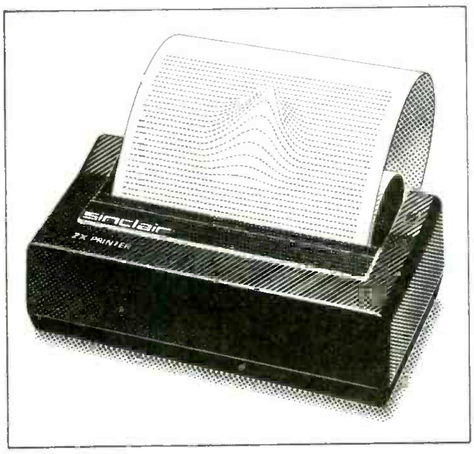
The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.



How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item Price £	Total £
	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
	Postage and packing: orders under £100	28	2.95	
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			Total £	

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2 YEAR GUARANTEE

Optional probes – see below.

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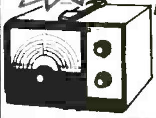
6 Band Trio RF Generator. Int/Ext MOD. Variable O/P to 100mV Am Int 400HZ MOD.

SPECIAL PRICE £59.95 inc. VAT (UK C/P £2) SAVE £10+



AG202A matching 20HZ to 200 KHZ Audio Generator £ 78.00 inc. VAT **(UK C/P £2)**

LOW COST DIGITAL MULTIMETERS

3½ DIGIT LCD HAND HELD DMM's: (SW = slide switch: PB = push-button: RS = rotary) (models * with carry case)

UK C/P 65p all models

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***KD30C** 26 Range 1A AC/DC 200 megohm (RS)	£37.50
***KD55C** 28 Range 10A AC/DC 200 megohm (RS)	£41.50
***601** 26 Range 2A AC/DC 20 megohm (PB)	£36.50
188m 16 Range 10A DC (NO AC) 2 megohm plus Hfe (TRANSISTOR) tester (RS)	£43.50
189m 30 Range 10A AC/DC 20 megohm plus Hfe Tester (RS)	£69.95
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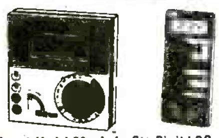
All models complete with leads and batteries

2010A LED 31 range. 10A AC/DC basic 0.1% (Sabtronics)	£81.50
TM353 LCD 27 range 2A AC/DC basic 0.15% (Sinclair)	£86.25
2015A LCD 31 range 10A AC/DC basic 0.1% (Sabtronics)	£89.50
TM351 LCD 29 range 10A AC/DC basic 0.1% (Sinclair)	£113.85
2001 LCD 28 range plus 5 range capacitance meter 10A AC/DC basic 0.1% (Pantec)	£108.00
TM451 4½ digit LCD every facility and function 0.02% basic (Thandar)	£171.00
1503A 4¾ digit LCD 30 ranges 10A AC/DC MHZ counter 4 KHZ osc. 0.05% basic (Thurlby)	£171.00
1503HA As above but 25A and 0.03% basic	£189.75

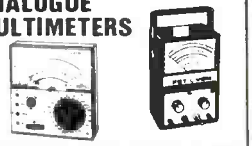


Hand Held Models 3½ Digit LCD **(UK C/P 65p)**

129 25 range 0.8% basic 10A AC/DC rotary switches (Keithley)	£79.35
130 as model 129 but 0.5% basic (Also see above)	£102.35

Bench Models 3½ digit LCD unless stated **(UK C/P 90p)**

ANALOGUE MULTIMETERS



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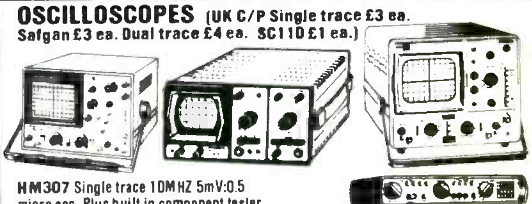
PAN3001 34 range 40K/V. 5A AC/DC 50 Meg. (PANTEC)	£59.80
Also 500KHZ - 500MHZ signal injector and 3 range cap. meter	
PAN3003 42 range 1 Meg/V. 5A AC/DC 1 µA FSD (PANTEC)	£66.70

(NOTE 3001 & 3003 Electronic Protection Mirror Scales)

OSCILLOSCOPES

(UK C/P Single trace £3 ea. Salgan £3 ea. Dual trace £4 ea. SC110 £1 ea.)



HM307 Single trace 10MHZ 5mV:0.5 micro sec. Plus built in component tester 6 x 7 cm display (HAMEG)	£158.70
Optional Case	£18.40
3030 Single trace 15MHZ 5mV:0.5 micro sec. Plus built in component tester 95mm tube. Trig. to 20MHZ (CROTECH)	£172.50
HM203/3 Dual 20MHZ: Trig. to 30MHZ 5mV: 0.5 micro secs. 8 x 10cm display (HAMEG)	£253.00
HM203/4. As above but 2mV + Algebraic add (HAMEG)	£276.00
CS1562A Dual 10MHZ 10mV. 1 µ sec. 140mm tube (TRIO)	£276.00
3131 Dual trace 15MHZ trig. to 35MHZ 5mV: 0.5 micro sec. 130mm tube plus component tester.	£276.00
3034 Battery-mains dual trace 15MHZ trig. to 20MHZ built in Nicads. 5mV 0.5 micro secs (CROTECH)	£414.00
(Eliminator charger optional	£36.00)
HM204 New model with component tester Dual 20MHZ delayed sweep: trig to 40MHZ. 5mV 0.1 micro sec 8 x 10cm display (HAMEG)	£419.75
(Optional case	£21.85)
SC110A New model 10MHZ battery portable. 10mV 0.1 µsec 2" trace. All facilities (THANDAR)	£171.00

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AC Adaptor	£5.69
Nicads	£8.63)

CS1577A Dual 35MHZ. 2mV 0.1 µsec. Single sweep facility. 140mm tube (TRIO) List price £540.00 Our price **£475.00**

CS183011 Dual 30MHZ. 2mV 0.2 µsec (fitted delay line) Delay sweep 140mm tube (TRIO) List £665.00 Our Price **£570.00**

HM705 Dual 70MHZ delayed sweep: Single sweep: Delay line: Trig to 70MHZ: 2mV:0.1 micro sec. 8 x 10cm display (HAMEG) **£667.00**

CS2070 70MHZ 4cm 8 trace List £965.00 **Our Price £918.85**

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PS1307S twin meter 8-15V 0/7A	£35.95

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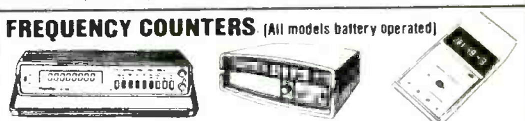

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PFM200A Pocket 8 digit LED 200MHZ 10mV (THANDAR)	£67.50
Max 50 50MHZ 6 digit LED Pocket (GSC)	£56.35
Max 550 6 digit LED Pocket (GSC)	£97.75
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8610A 8 digit LED 3 range 600MHZ. Bench (SABTRONICS)	£94.00
Max 100 5HZ-100MHZ 8 digit bench LED (GSC)	£97.75
8610B 9 digit LED 3 range 600MHZ Bench (SABTRONICS)	£113.85
8000B 9 digit LED 3 range 1000MHZ Bench (SABTRONICS)	£178.00
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TF200 8 digit LCD 2 range 200MHZ (THANDAR)	£166.75
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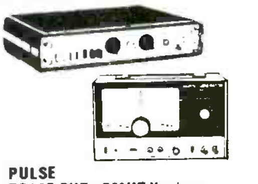

AUDIO 4 band Sine/SQ output

TE22D Max distortion 1% 20HZ/200KHZ	£59.95
LAG27 Max distortion 0.5-1% (LEADER) 10HZ-1MHZ	£86.25
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LAG125 As LAG120A but 0.02% dist. (LEADER)	£273.00
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5020A 1HZ - 200KHZ (SABTRONICS)	£90.00
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TG102 0.2HZ - 2MHZ (THANDAR)	£166.75

PULSE

TG105 5HZ - 5MHZ Various outputs (THANDAR)	£97.75
4001 Ultra-variable 0.5HZ - 5MHZ (GSC)	£113.85

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LDM170 20HZ-20KHZ distortion meter	£281.75
LFG1300 0.002HZ-2MHZ sweep function generator	£377.20
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LTC907 Signal injector/tracer and transistor checker	£173.65

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CS820 20 value Cap. box. 470 pf to 1 µF	£21.00

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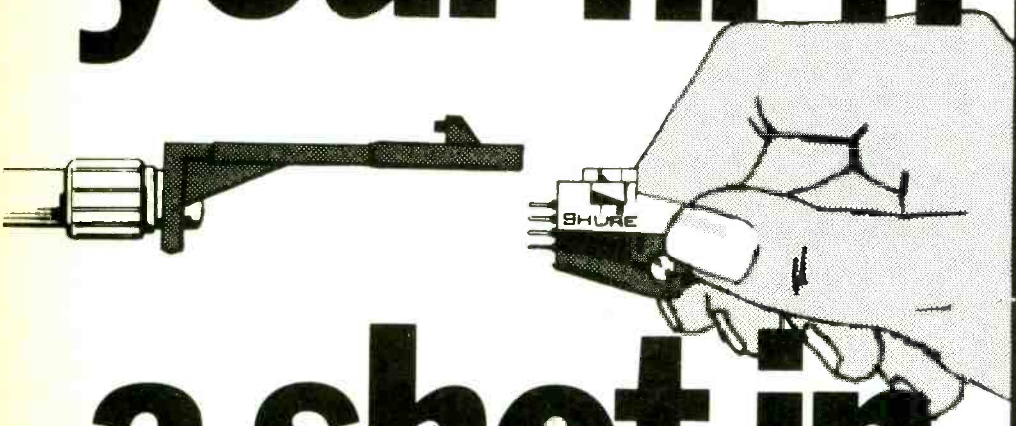

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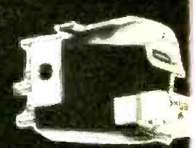

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Factories of the future

As IT82, the government focus for information technology, expires amid mixed feelings, Britain is faced with the question of what action to take, if any, over its place in the market for microcomputer-based information processing systems. Market share in this area is surely set to fall, particularly when the Japanese collaborative programmes in electronics and computing technology begin to take effect; one source suggests that UK trade deficit could be as high as a billion pounds by 1990. To reverse this, protect the jobs of the existing i.t. industry, and insure against restrictions in the supply of high-technology components on the right terms by overseas competition (compounded by reported secrecy in US v.l.s.i.c. work), J. Alvey and a committee of eleven urge speedy implementation of their Programme for Advanced Information Technology. The study, commissioned by the DoI, was catalysed by the competitive threat of Japan's "Fifth generation" computer programme.

Taking evidence from 115 organizations, the committee identify the "enabling technologies" that designers need to interface machines with humans, to organize and process information, and to build them in a way that is competitive in the market place. To create more powerful information processing systems with more effective human interfaces that at the same time are easier to build and use, requires a strong domestic capability in software engineering, advances in v.l.s.i. and human interface technology, and "intelligent knowledge-base systems" that use inference to apply knowledge.

The committee focuses on the supply of computer systems – hardware and software – to provide tools for producing i.t. systems using software engineering techniques that will put the UK into position as a world software leader by the end of the 1980s. Automatic software production, c.a.d. for v.l.s.i. data or knowledge bases of available hardware and software, and both local and wide area networks to collaborating teams, all go to form a so-called Information Systems Factory. To obtain sufficient expertise, collaboration between industry and research bodies is essential, requiring government support and direction (a directorate within the DoI is likely). But the chief task is recruitment.

Too many courses in tertiary education do not match industry's need for highly skilled engineers having a wide appreciation of computer science and knowledge of both hardware and software (a point Ivor Catt makes elsewhere in this issue). The supply of graduates with the relevant skills needs increasing by at least 1,200 and 90 teaching jobs, and both polytechnics and the TEC must step up training. At the postgraduate level, new courses and teaching jobs are required for studentships and fellowships (250-300 a year). As well as strengthening courses at the masters level, the committee recommends 50 studentships at the doctorate level to enable industry to sponsor students on four-year sandwich courses. And for people already on the job a case is made for on-site instruction via the proposed communication network, with the potential of development into a "distributed college" linking industry with the academic sector.

This skilled work force could be built up rapidly for the programme; but Britain does not have the people in anywhere near the numbers and skill levels required to translate it into products. The key to this is action in the educational sphere. It is no good just providing schools with microcomputers; that merely produces a generation of poor Basic programmers, says the committee – Universities are already having to give remedial education to entrants with A-level computer science. The languages taught must be chosen with the future in mind.

The programme recommends spending £70million for software engineering, £90million for v.l.s.i.c.s (excluding radiation-hardened v.h.p.i.cs for defence work), £58million on prototype demonstrators, £44million on human interface technology, £26million on knowledge-base systems, £25million on c.a.d., £19million on a communications network, and £20million on education and training. This totals £352million pounds over five years and on the basis of a 100% government funding for academic support, 90% industry funding where wide dissemination of results is required, and 50% otherwise, the government is being asked for roughly two thirds funding. (Industry will have to find much larger amounts as results are translated into marketable products.)

A start date of 1 April 1983 is recommended for the programme, but the costings reveal a more immediate sense of urgency – two million pounds is allocated to education and communications for spending this year. Will the government fund it? And how quickly will academia respond?

A Heretic's Guide to Modern Physics

A MORE REALISTIC DUALITY?

Instead of trying to ignore Planck's quantum hypothesis because it conflicts with electromagnetic theory, suppose we were to afford it more than lip-service – what then? New situations would arise that could be tested by experiment.

by W. A. Scott Murray,
B.Sc.,Ph.D.

I have suggested that an experiment in the interference of light which was first performed as long ago as 1909 might profitably be repeated with modern photon-counting light detectors. Its purpose would be to explore whether or not a simple alternative concept might be offered in place of the currently-accepted, but philosophically dubious, doctrine of the wave/particle duality of light. The experiment is neither expensive by modern standards nor particularly difficult, but it would require great care; it would require tests to ensure that the apparatus was dealing with single photons rather than with naturally-radiated bunches of photons forming coherent wave-trains. Of the various phenomena in light which could be chosen for test, interference in a space interferometer would seem to afford the greatest facility for detailed analysis and the least scope for dissentient arguments.

It would be very wrong to pre-judge the outcome of this experiment, and we should be careful to avoid doing so. We should also remember that there may be other conceptual alternatives to the duality doctrine to be considered besides this one. This one seems to be the simplest, but that doesn't mean that it is necessarily correct; we may have to try several before Dame Nature smiles on us. For these reasons I have said that I cannot yet offer an alternative doctrine, at any rate with confidence. We really must have recourse to experiment here. Nevertheless it is interesting and quite exciting to speculate as to how the subsequent developments might go if the concept were upheld that light radiation consists of photons travelling at velocity c, and light "waves" consist of periodic variations of photon density, as Einstein once auggested. Without commitment, we may explore some of the consequences which might follow if that concept were true.

The first point to be cleared up is the business of light travelling happily in a vacuum, where – by the Michelson-Morley experiment – there is no physical ether medium for light waves to undulate in. Waves of the newly-postulated type, which are *statistical manifestations of varying photon density*, do not require a medium for propagation. Sound waves in air, on the microphysical scale, consist of variations of the density of gas molecules above and below the mean air density, and it is this mean density which establishes the velocity-zero of the "medium" through which, we say, the waves travel. In the case of light there is no mean density; even within a solid crystal such as a diamond the photons are travelling by direct or devious routes through the space (that is, the vacuum) between the adjacent crystal ions. On this concept, then, a wave crest would correspond to a maximum of photon density, while at a wave trough there would be no photons.

The number of photons involved in a light-wave is staggering to comprehend. In a typical medium-wave radio broadcast transmission one half-cycle of radiation – a millionth of a second's worth – will contain about 10^{25} photons. It is not surprising that with such numbers of photons around their average density adds up to a very smooth and precisely-defined wave-shape indeed. That is why the wave theory provides such an accurate description of the behaviour of radio radiation and even of ordinary, visible light. On the other hand, as we move up through the spectrum past the ultra-violet and into the x-ray region, individual photons become heavier and contain more energy, so that in consequence there tend to be fewer of them. In the end there are no longer enough photons present for their average density to establish a reasonably accurate wavelike shape; in such cases x-rays and gamma-rays are found to behave like particles and to show no obvious wave characteristics, and we *say* that such situations "require quantum treatment". Now we can begin to see why.

This experimental observation is entirely consistent with the photon-waves proposal, but diametrically opposed to the continuity concepts of electromagnetic theory. The proposed mechanism is very different from that of sound waves. At sufficiently high altitudes the effective continuity of air as a wave-propagating medium breaks down and sound is no longer transmitted; individual air molecules are still present and travelling at tremendous speeds, but their motions are random. By contrast, the photons of natural light are generated and travel together thereafter in a systematic way, whose statistical effect is that of a partially-coherent wave system. In this manner the photon-waves concept is able to explain – not just to describe – the wavelike behaviour of light in those low-energy situations where the electromagnetic analogy works to a high degree of approximation, and it is able to explain equally well the particulate behaviour of light in situations where electromagnetic theory fails. There would seem to be a *prima facie* case for taking the concept further, and for performing some of the fundamental experiments that would be required in order to test it in the laboratory.

The celebrated wave-like properties of light which led to the general acceptance of the wave theory in the 19th century are principally those of refraction, diffraction, and interference. According to the photon-waves concept all these phenomena are manifestations of *group behaviour* – that is, of the behaviour of photons in quantities so large that the wave theory is valid as an approximation. Greater detail is not appropriate here, except perhaps to say that it seems a distinction can be made between pure diffraction, due to the deflection of photons in the near vicinity of material objects such as prisms, slits or gratings, and pure interference, due to "exclusion" forces acting between individual photons in space. Practical situations tend to involve combinations in varying amounts of the effects of pure diffraction and pure interference. Because their mechanisms would seem to differ, the possibility arises that suitable experiments might be able to separate the two effects and thereby quantify both.

Such experiments would be quite new. Although we now have photoelectric detectors that can record the arrivals of individual photons, the general acceptance of the duality doctrine has effectively inhibited a systematic re-exploration of this area. Suffice it to say that even if they have been performed, no such experiments have ever been reported in the published literature. Perhaps we should not be too surprised at this. The particular experiments that we have been considering would constitute steps towards determining the size and physical structure, if any, of a photon, and few suggestions would be more likely to excite ridicule in the scientific hierarchy than a proposal to investigate the physical properties of an entity so fundamental as a photon! Such a proposal would cut right across the accepted dogma of modern physics, which holds that because of the "completeness" of the quantum-mechanical theory we already know all that we shall ever be able to know about these fundamental matters . . .

Now: what *do* we know about photons? By the harsh discipline of experiment – before fundamental experiments became unfashionable – we have been taught that light is radiated in packages or quanta. From the photoelectric experiments in particular we realise that these quanta do not dissipate in flight but remain complete as units, as if they were particles. As particles, we call them photons. From the same experiments we deduce also that photons carry physical energy and physical momentum, the amount of this energy and momentum determining the colour of the photon. To our surprise we conclude (because both photons and "waves" travel at the same velocity and therefore must have constant relative phase) that an individual photon does not possess a frequency or a wave-length – which is *not* what we were taught at school! And we note as a point of great significance that the only means by which we can detect light (in the retina of ur eye, on a photographic plate or film, by photocell, or by photosynthesis in plants) is by some variant of the photoelectric effect. *Summa:* we *deduce* the wavelike properties of light, sometimes; whenever we *detect* light we seem to be detecting photons.

It is photons, not electromagnetic waves, which eject electrons from light-sensitive materials, and it is worthwhile to ask a few "improper" questions about the photoelectric process. (This, of course, is new and heretical work not approved of by the hierarchy.) If one considers the collision of a single photon with a single, isolated electron and takes the standard, accepted expressions for the energy and momentum of each, and then equates photon energy with electron kinetic energy, photon momentum with electron momentum after collision – that is, if one applies the Conservation Laws to the encounter as if it were an ordinary mechanical collision – then the sum does not work out. A single line of working within the competence of any sixth-form physics student leads to the result that, whatever the energy of the photon and whatever the mass of the electron (or other particle), the velocity of the electron after the collision must always be twice the speed of light.

Clearly that result is nonsense. We have two choices. On the one hand we can accept the verdict of conventional doctrine, that the question was an "improper" one that should never have been asked – that is, that photons and electrons are mystical, hazy entities, amorphous and structureless, and that one cannot envisage an encounter between them as if it were an ordinary mechanical collision. "Ask a silly question, receive a silly answer" is the kind of supercilious comment that one might expect. On the other hand we can hold fast to the conservation laws – for it is the *conservation laws,* and not mechanics, that conventional doctrine is seeking to by-pass here – and say that the result of our very simple calculation is correct: the situation cannot happen, and we are to interpret the result to mean that *an encounter in which an isolated electron absorbs the entire energy of any photon cannot take place*.

The reason why it can't take place is as simple as the calculation itself: a photon carries far more energy per unit translational momentum than any ordinary "material" particle can contain kinetically. A third object must be present to absorb the excess energy and allow the mechanical energy and momentum equations to balance. What would happen if no material particle besides the electron were present? Energy and momentum must still be conserved in the encounter, and the obvious way for this to happen is for a second photon to be radiated, from the point of impact, to carry away the excess energy.

By now probably someone is screaming that I am giving free rein to fantasy, or at least inventing in a thoroughly unscientific way. How can I dare to treat photons and electrons as if they were ordinary mechanical particles when "everybody knows" that both photons and electrons are *wave systems* that just don't behave like that? I'm sorry to be so tiresome about it, but they really are particles, you know, and according to experiment they do behave like that. I have been describing to you a commonplace phenomenon known as the Compton effect. A. H. Compton applied this same, purely mechanical reasoning to the encounters of gamma-ray photons with electrons in 1923 – after Planck, but before the Copenhagen school got going with their doctrines of matter-waves, statistics, and haziness – and his calculations were confirmed *exactly* by experiment. There is no indication whatever of wavelike properties of either photons or electrons in the Compton effect. Also, the conservation laws are obeyed.

Thus far the discussion has concentrated on checking the photon-waves concept against various aspects of the experimental evidence, and I assure you that it can be submitted to, and pass, many other such tests that I don't have space to go into here. I would like to go forward now to report on two new developments that follow from the concept. They suggest alternative interpretations of two details familiar from electromagnetic theory, and represent two differing degrees of conflict with that theory.

The Compton effect as Compton treated it involves the collisions of photons with *free* electrons, but at the temperatures we normally encounter very few electrons are truly free; almost all of them are "bound" in one way or another – usually by electrical forces – to individual atoms or within the general crystalline structure of a conducting or semi-conducting material. When a photon collides with an electron in the presence of a third, massive body (and the minimum such body is a proton, nearly 2000 times heavier than the electron), no secondary photon need be radiated to balance the books. The third body enables the excess energy to be absorbed and the Conservation equations to be satisfied, subject to two very interesting mechanical conditions: one is that almost all the photon's energy must be absorbed by the electron, which takes off at very high speed and leaves the heavy supporting structure almost standing still; the other condition is that the direction of the electron's motion must be *at right-angles* to the incident photon's track to within a few hundredths of an angular degree.

Those results constitute an entirely straightforward, new explanation of the photoelectric effect, calculable to any accuracy one pleases on the purely mechanical basis that both photons and electrons are particles whose interactions obey the conservation laws. It is truly and literally a *quantum-mechanical* calculation. Since no light waves or matter-waves are involved the conventional "quantum mechanics", so called, will have none of it. It does not

Continued on page 87

Summary

Although it would be wrong to prejudge the outcome of modern low-light-level experiments it is legitimate to speculate on the consequences of a positive result. The wave-like behaviour of "photon-waves" can be accounted for by making a small number of working assumptions which can themselves be tested by experiment (not discussed in detail). Their particle-like behaviour can be explained by purely mechanical arguments – by applying the conservation laws to collisions between photons and electrons treated as particles. The highly successful work of Compton in 1923 can be extended to provide new and simple explanations of the photoelectric effect and of the ionization of the atom (the latter again is not discussed in detail). These arguments raise conflicts with electromagnetic theory, as is to be expected; but the crucial conflict is raised by the statement of the new theory that an isolated electron – a "point charge" – does not radiate energy when accelerated, as electromagnetic theory has always asserted that it must. This particularly important issue could also be put to experimental test.

IMPROVING THE "VIEWING EXPERIENCE"

Digital signal processing finds ways of getting better quality television pictures without sacrificing system compatibility. In this report Tom Ivall looks at some of the papers presented at IBC82, the recent international broadcasting convention at Brighton.

by Tom Ivall

Channel 4 arrives like a cheeky young gate-crasher at Auntie Beeb's sixtieth birthday party, where everyone pretends not to notice, while outside a threatening-looking gang of satellites, cables and videos peer through the window, grinning in anticipation of the havoc they are going to make of such dignified occasions. The broadcasting engineers and manufacturers – highly sophisticated operators who know the difference between a video and a v.t.r. – look on at this little scene with restrained amusement, secure in the knowledge that they can supply whatever technology is necessary to keep the audio-visual fodder flowing smoothly into the great maw of a consumer-happy public.

Or so it seems, to judge from the stream of new ideas presented by engineers at the recent International Broadcasting Convention – held, appropriately enough, in that fairground of evanescent pleasures, Brighton. With the strong likelihood that artistic talent will be spread even thinner in the promised multi-channel future and that programme standards will, on the whole, decline, the broadcasters have fallen back on the safe thought that they can always stimulate the jaded palate of the viewer by prosthetic means. What the public now needs, in the words of one IBC contribution, is "the enhanced viewing experience". This does not mean 'the smellies' or 'the feelies' – yet – but simply improving the quality of the pictures and the sound.

The big question is, how can this be done compatibly, without having to replace hundreds of millions of tv sets all over the world working on the established NTSC, PAL and SECAM transmission standards?

A big step was taken, it appears, when digital coding standards for television studio equipment were agreed and formalized by the CCIR earlier this year. Briefly, this means keeping the video information in the component, as against composite, form of a luminance signal (Y) and two colour-difference signals (U and V) and sampling these at rates of 13.5MHz for Y and 6.75MHz for U and V. The samples are digitally encoded at eight bits per sample and all of this results in a serial bit stream of 216Mbits/s (see page 41, May issue).

This standardization agreement is not merely a matter of making things better for the broadcasters by improving the performance and simplifying the operation of their equipment. It opens a window to a whole new vista in television engineering. According to C. P. Sandbank, head of the BBC's research department, it brings about a new approach to television systems practice by allowing "the processing and storage of tv programmes in a way not constrained by the limitations of the broadcast standard" and is a timely trend when many new forms of tv distribution are emerging as alternatives to conventional terrestrial broadcasting.

The constraining "broadcast standard" is, of course, NTSC, PAL or SECAM, according to area. In the view of F.H. Steele and K. R. Barratt of Sony Broadcast, a serious constraint is due to the composite nature of the video signals. Although effective and robust for transmission purposes "it is now generally accepted that NTSC, PAL and SECAM composite signals not only add their own impairments – particularly cross colour and cross luminance – but also greatly inhibit much of the desirable picture processing". And, in a reference to video developments outside of broadcasting, "it is entirely possible that the broadcaster, remaining dependent on composite signals, may well find himself alone in this respect by the end of this decade".

In short, picture quality for the viewer can almost certainly be improved by digital signal 'pre-processing' at the transmitter, using compatible techniques that do not interfere with existing transmission standards. Other IBC speakers made it clear that digital signal 'post-processing' could also be added compatibly to the tv receiver, to improve the picture by overcoming cross colour, cross luminance, large-area and inter-line flicker, line crawl and the obtrusive visibility of the raster.

One of the major IBC contributions in this area was from the Philips laboratories in both the UK and the Netherlands. A group of six researchers described a range of experiments and equipment intended for examining many possible improvements, from cleaning up the present European 625-line transmissions to high-definition transmissions on 1249 lines with a wideband transmission medium. (See also November's News, page 76.)

To clean up the existing transmissions the Philips people are addressing themselves to two main problems: first, the picture impairment due to luminance and chrominance band sharing (cross colour, cross luminance, loss of detail due to filters); and secondly, impairment due to large-area flicker, inter-line flicker and line aliasing.

The approach to luminance/chrominance separation in the receiver is based on

comb filters employing one or more field delays. These give good results on stationary pictures but do not eliminate cross colour resulting from motion effects, where possibly some kind of movement-adaptive process could be used, with the decoder reverting to a notch filter at certain levels of motion. An optimum solution, according to the researchers, appears to be a line-delay comb filter in the encoder at the transmitter and a field-delay comb filter at the receiver. For best results the encoder filter would only be inserted when movement occurs.

Their technique for removing large-area and inter-line flicker is based on the use of picture stores. An experimental receiver includes two fields of storage. Luminance and chrominance signals are fed into the store at the normal 50Hz rate and fed out to the display at a 100Hz rate. Results so far show that "excellent reduction of large-area flicker is obtained without serious impairment of motion portrayal". Removing inter-line flicker is not so easy, as the use of the store results in jerking effects on moving scenes, but here movement-adaptive switching between sequences may prove to be effective.

Work on removing line aliasing and the Kell factor effect is not so advanced but the researchers think it is worth pursuing. Results so far suggest that signals could be originated on a 1249-line standard and "filtered as part of the down-coding process such that the compatible signal has reduced aliasing components".

This idea of standards conversion within the existing transmissions is the next step up in the Philips programme for picture quality improvement. Obtaining the desired "enhanced viewing experience", however, depends on having at the receiver a large-area display (about $1m^2$) on which the human eye would be able to resolve about one million elements – an improvement in resolution capability of about three times. Present experiments are based on originating a 1249-line, 50 field/s, 2:1 interlaced picture with a 25MHz video bandwidth. And of course the large-screen display would have a similar definition.

The big question, however, is whether these signals could be compressed into the bandwidth of the existing television channels. To give full information about every element the transmission would have to exceed the Nyquist rate for the normal 8MHz channel. However this would not be necessary as coding systems could be devised to take advantage of the redundancy in the picture, either spatial or temporal.

Such possibilities for reducing bandwidth requirements for colour television signals are being investigated by the IBA, and their G. J. Tonge presented some aspects of this work at the convention. The present approach is based on the principle that the spatio-bandwidth properties of a typical television system are not well matched to those of the human eye. For example, the spatial resolution available for a moving image is the same as it is for a stationary image – but the eye doesn't need this. Also, if the sampling in each field is orthogonal then the resolution attainable on diagonal frequencies is greater than it is on horizontal and vertical frequencies, but the properties of the eye favour the opposite.

The technique used to exploit these characteristics is based on "three-dimensional" digital filters – meaning filters which not only limit bandwidth horizontally in the picture, as do ordinary analogue filters, but vertically and temporally as well. So the useful bandwidth can be represented diagrammatically as a volume. The shape of this volume is therefore chosen to match the properties of the eye. For example, on the criteria mentioned above, the spatial resolution is arranged to reduce with increasing temporal frequency and the diagonal resolution to be slightly worse than the horizontal or vertical resolution.

The three-dimensional digital filters constructed so far incorporate two field delays, four line delays and 35 coefficient taps. The system requires pre- and post-filtering and first experiments have been made from component Y, U, V signals sampled at 13.5, 6.75 and 6.75MHz respectively. Mr Tonge reported that "the results obtained indicate that commencing with 18MHz luminance sampling an extended definition signal should result from this sampling".

However, if such attempts at bandwidth compression based on redundancy and the properties of the eye do not prove successful in practice, the Philips workers have another plan up their sleeves. They suggest that two normal television channels should be used to provide the higher information rate needed for a single "high fidelity" tv programme. This could be done in such a way that one of the two channels would carry a completely compatible signal for all standard tv receivers.

The information to be transmitted could be separated into the two television channels in terms of space, time or video spectrum. So far the work has concentrated mainly on spectral separation. In this respect it coincides with similar work by the BBC's research department on improvements to the PAL system to give higher quality pictures for future direct broadcasting by satellites. The essence of "extended PAL", as the BBC call it, is that in the encoder the spectrum of the luminance signal is split and the high frequency part of this is shifted up in frequency so that it no longer shares the chrominance band.

Details were given at Brighton by P. A. Ratliff and A. Oliphant. In the encoder the chrominance modulation is the same as in a conventional encoder. The luminance signal, however, is split into two frequency bands, Y_1 below about 3.5MHz and Y_2 above 3.5MHz, by a complementary band-splitting filter. The Y_1 signal is added directly to the modulated chrominance signal. The Y_2 signal is frequency-shifted by multiplying it by the colour subcarrier frequency and high-pass filtered to remove unwanted components near zero frequency. The shifted signal is then added to the low-frequency and chrominance components to give the complete extended PAL signal, which occupies a bandwidth of about 10MHz.

This frequency-shifting process can also be thought of as suppressed-carrier single-sideband modulation of the Y_2 signal onto the the colour subcarrier. Other frequencies could be used for frequency shifting, but the colour subcarrier is particularly convenient because it is available with accurately known phase in both the encoder and the decoder. It is also a frequency chosen for minimum visibility, so that any residual subcarrier in the modulated signal causes little impairment. Furthermore the use of only one subcarrier frequency precludes the possibility of intermodulation occurring between two subcarriers, which could produce visible low-frequency beat patterns on the decoded picture.

In the receiver's decoder the chrominance is demodulated in the conventional way. The composite signal is low-pass filtered to give the low-frequency luminance Y_1 and high-pass filtered to give the shifted high-frequency luminance Y_2. This signal is shifted back to baseband by multiplying by the subcarrier frequency and low-pass filtered to remove unwanted components near $3f_{sc}$. The two components Y_1 and Y_2 are then added together to reconstitute the complete luminance signal.

The 'extended PAL' signal is compatible with conventional PAL and can be received on existing colour tv receivers; its main advantage is the reduction of cross colour. However, the Philips two-channel experiments in spectral separation differ from the BBC's scheme in that the higher frequency part of the luminance band is not restricted to about 2MHz and is not transmitted in the same channel.

In one system reported on by Philips the separation point was at 3.8MHz. This enabled a low-band quasi-compatible PAL signal with colour-out-of-band to be formed. The high-band signal was then transposed by mixing with a $2f_{sc}$ reference to occupy the 0 to 5MHz region of the second channel. At the receiver the low-band signal is decoded in the normal way to produce Y,U,V components with substantially reduced cross colour. The signal from the second channel is mixed with $2f_{sc}$ to reproduce the high-band luminance component. Finally the two Y components are combined to form a single wideband luminance signal.

In this type of approach the quasi-compatible signal gives "a significant reduction of cross colour". But it is also causes a noticeable loss of resolution and this is permanent as far as standard receivers are concerned. This could be overcome in the two-channel approach by changing the configuration so that the low-band signal has a completely normal PAL specification. In this case the luminance information would be transmitted through both channels. It would therefore be possible to use the second chrominance-free component to achieve separation of luminance and chrominance, with consequent reduction of cross colour in a high-fidelity receiver.

These experiments suggest, according to the Philips workers, that "two-channel systems are possible in which one channel carries a signal that is compatible with the PAL (or other standard) specification". This compatible signal could not only be handled by any existing receiver but could also be processed to give an enhanced quality image by the methods outlined above.

Professor B. Wendland of the University of Dortmund, Germany, discussed the possibility of improving picture quality by getting rid of some of the deficiencies of conventional television scanning. For example, interlacing produces heavy aliasing in moving parts of the picture, bad vertical resolution, inter-line flicker and line crawl. One way of avoiding these problems would be to use sequential scanning. At the same time the main advantage given by interlacing, namely reduction of large-area flicker, could be retained by the use of digital picture stores.

In this proposal the picture is sequentially scanned with 1250 lines and the resulting video signal is two-dimensionally band-limited by a digital filter. It is then converted to a 625-line interlaced picture by a scan converter using a digital store. This signal is transmitted and is compatible with existing 625-line television receivers. In any tv receivers designed for the new system, however, the 625-line signal is re-converted by a scan converter and interpolating two-dimensional filter into a sequential 1250-line picture. By means of the digital store in the receiver the picture is displayed at twice the normal rate so that large-area flicker is prevented.

The first practical result, according to Professor Wendland, is a "fairly high improvement" of picture quality with no line crawl or 25Hz flicker. Scanning is free from aliasing and picture detail reproduction is good, especially for details with horizontal contours of high contrast. In addition Professor Wendland described a system of "offset sampling" (in which the sample positions are offset in adjacent lines) which, with pre- and post-filtering, "gives an impressive improvement of resolution for fine vertical structures".

With so much digital signal processing in the air for television broadcasting, one thing that seems almost inevitable is the microprocessor-based television set. But what could it do any better than an ordinary tv set? Well, apart from any developments at the transmitting end, it would seem from an IBC paper by H. M. Jacobsen, of the Technical University of Braunschweig, Germany, that improvements might be made to the received picture quality by adaptive digital signal processing under programmed control. His idea is to introduce variable equalization in the composite video signal channel and adjust this automatically according to reception conditions causing picture impairment (noise, reflections, propagation anomalies etc.).

The received composite video signal is digitized and passed into a digital signal processor under the control of a microprocessor. Luminance and chrominance components are first separated and then passed through equalizers which, when ordered by switching signals, can sharpen up rates of change in this video information. For example, Mr Jacobsen suggests that "it seems reasonable to sharpen the chrominance edges if the rise-time exceeds 500ns". The microprocessor program causes the signal-to-noise ratio to be measured during blanking intervals and also obtains information on the properties of the signal source. From this data the qualization process is controlled adaptively.

The International Broadcasting Convention held at the Metropole Hotel, Brighton, 18-21 September ended with a record attendance totalling more than 7000 from 80 countries, with nearly half from overseas. Cable and satellite organizations as well as programme makers and broadcasters were in evidence reflecting interest in the new areas of broad and narrowcasting. There was particular interest in the opening session on broadcasting technology for the future, and in the papers dealing with the latest developments in satellite broadcasting, higher definition television proposed for use with satellite broadcasting, and the use of fibre optics for programme distribution. The full text of the papers in the technical programme are published in the Convention Publication which costs £28 from the IBC Secretariat, c/o IEE, Savoy Place, London WC1. The tenth IBC will be held at the Metropole Conference and Exhibition Centre, Brighton, 22-25 September 1984.

If television is a strong contributory factor in child illiteracy, as recent studies suggest, it is faintly ironic that the broadcasters are bending all the might of their technology to refine the appearance of text presented on the tv screen. "You may not be able to read it but at least we'll make it look nice for you" would seem to be the policy. Of course, the graphic designers employed by broadcasters have an influence here. Apparently those in the BBC don't care for the jagged kind of text produced by electronic character generators and prefer to stick to conventional television typography based on artwork. Not to be outdone, the engineers of the BBC's research department have come up with an answer to the problem of electronic coarseness, and the results were demonstrated at Brighton.

Apparently, master data on type founts is available from many type foundries in high-resolution digital form. This master information has been filtered and subsampled, using BBC software, to produce fount data for characters of reduced resolution in sizes appropriate for television – for example 20 to 50 picture lines for a capital 'M'. The filtered characters are represented by a range of grey-levels which reproduce edges as smooth transitions between the background and the character, rather than the abrupt changes usual with electronic character generators. As a direct result the typographic integrity of a particular fount is maintained even at small character sizes. Fine serifs are accurately reproduced and inclined strokes and curves are free from jagged edges. All practical character sizes can be derived directly from the master data.

The next step, perhaps, is to try and make these beautiful shapes actually mean something to the illiterate. Can technology do anything for semiology?

To return to the original topic of digital standards for studio equipment, one of the latest examples of such digital equipment was shown in the exhibition and described in a paper: a 'line array' telecine machine just introduced by Marconi Communications Systems. In this machine the camera tubes or flying-spot scanners of earlier technology are replaced by three (red, green, blue) c.c.d. image sensors in the form of linear arrays. These devices provide a very simple method of scanning film because the vertical scan is produced entirely by continuous motion of the film. Horizontal scanning in each line array of 1024 photosensitive elements is obtained by digitally controlled stepping of a shift register.

During a television line a charge accumulates in each charge element proportional to the light falling on it. In the subsequent horizontal blanking interval the charge from each element is transferred to a corresponding location in a shift register by momentary operation of a gate. The contents of the shift register are then clocked out serially during the active line period, in the form of analogue sample pulses at 19MHz clock frequency. After clamping, the signal from each sensor is applied to a 5.5MHz low-pass filter to produce a continuous video signal and eliminate the 19MHz components. Then each signal, R, G & B, passes to an a-d converter in readiness for digital processing.

Here the R,G,B signals are first converted to parallel digital signals of 11 bits per sample – 11 bits providing the necessary amplitude resolution for gamma correction. Subsequently the coding is the standard eight bits per sample mentioned earlier. Gamma correction and masking are performed by logarithmic conversion, multiplication/matrixing and exponential conversion. After this process the R,G,B signals are matrixed to give a luminance, Y, and two colour difference signals, B−Y and R−Y, each of eight bits per sample.

The scanning process of the machine produces complete frames sequentially scanned. These are converted to pairs of interlaced fields in four field stores – two fields for Y and two shared by B−Y and R−Y multiplexed. Digital vertical and horizontal aperture correction is applied to the Y signal, followed by d-a conversion of all three signals. Finally, R,G,B signals are formed by de-matrixing to feed out to a standard PAL, NTSC or SECAM encoder. According to R. Matchell of Marconi, this digital telecine provides "the highest picture quality combined with predictable drift-free performance which is maintained from day to day without the need for routine line-up". WW

NEWS

Focus on standards

A local area network standardization project team recommends that there should be "massive" Government support for a three-year project to develop UK capabilities in lans. Local area networks usually serve large organisations with possibly many distributed computers and workstations, interlinked so that they may share a database and communicate with each other.

The three main approaches to lans are the extended bus, typified by the Ethernet, the ring system as used in the Cambridge Ring, and the star system used in conjunction with digital private telephone exchanges. The lan report, submitted to the Focus committee of the DoI, suggests that the Department should sponsor pilot installations involving interconnection between current examples of data and text-oriented lans with wide-area networks, with similar internetworking being tried between pabx systems and both Ethernet and Cambridge ring networks.

There are not yet any formally recognised standards for "integrated service" local networks. The report suggests that in this area "the UK could be established as a world leader in the manufacturing, marketing and use of integrated service networks," and that the DoI should invite suppliers to bid for parts of a combined technical and marketing activity towards that aim.

The DoI is recommended to further activities on lan standards. It is considered vital that standards be developed in accordance with the requirements of the open-system interconnection model of the International Standards Organisation (one of the functions of the Focus standards committee has been to fund delegates to attend ISO meetings and those of the IEEE 802 committee, both of whom are investigating standards for lans).

The lan project team were reporting to the Focus Committee set up by the Department of Industry in April 1981 to identify areas in information technology standards and related work which are of "strategic" importance to the UK. The Committee identified 14 significant areas for attention but there are three paramount topics on which the others depend: open-system interconnection (OSI), local area networks (lans) and videotex.

Perhaps the most crucial area for standardizing is the open system communication, the concept that any data processing system should be able to communicate readily with any other. The committee suggests that standards for such systems must be international and need to be adopted by all parts of the computer and telecommunications industries. To ensure that this can happen, the standards need to be developed in a non-partisan form and be in the public domain. The only way that these requirements can be realistically fulfilled is through such international bodies as the ISO.

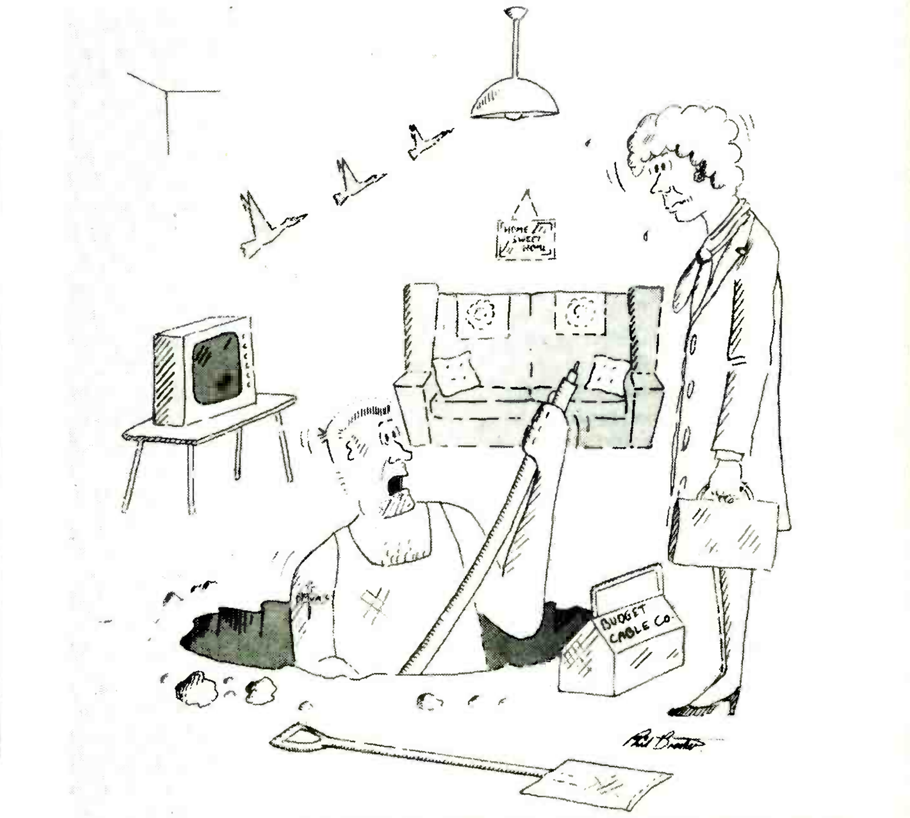
Applications for open-system interconnection cover data communications standarization and processing support services, which would ensure that the various services required could be supported by networks. Typical uses for o.s.i. systems include text processing, electronic mail and such open-access systems as electronic fund transfer and accommodation or airline reservations.

The advantages of agreed standards for o.s.i. are legion. Economic efficiency for the user is one. A user will be able to purchase whatever computer system that is appropriate to suit his needs, confident that it will be able to communicate with other systems within or outside the user's organisation. Suppliers of equipment will be able to specialise without running the risk that their equipment might become outmoded by another communications system. This could give a boost to the computer and telecommunications industries.

In teletext, the problem is not so much which standard to adopt but which standard other countries will adopt. The US offer a giant market for a prestel-like system. However, the telephone company AT&T have announced that they have adopted a system similar to Telidon. Grandly titled the "North American Standard", Prestel marketing countered it by promoting the "World System" on the pretext that Prestel has now been selected for a dozen countries around the world.

If the US market is 'open' then Prestel has a very good chance of successful sales as the hardware is a lot less expensive than that for Telidon.

The Committee has initiated an information technology standards unit which has already commissioned a survey of user needs in o.s.i. to help identify the priorities for specific tasks in supporting and developing the use of IT standards in industry and research establishments. Four broad subject areas have been chosen, each with its own manager: communications and switching standards; application-support standards such as presentation, file transfer, terminal handling and standards not specific to any application; application-dependent standards such as office automation, electronic fund transfer and other standards specific to a task; and lan standards. The unit will operate for the next three or four years.



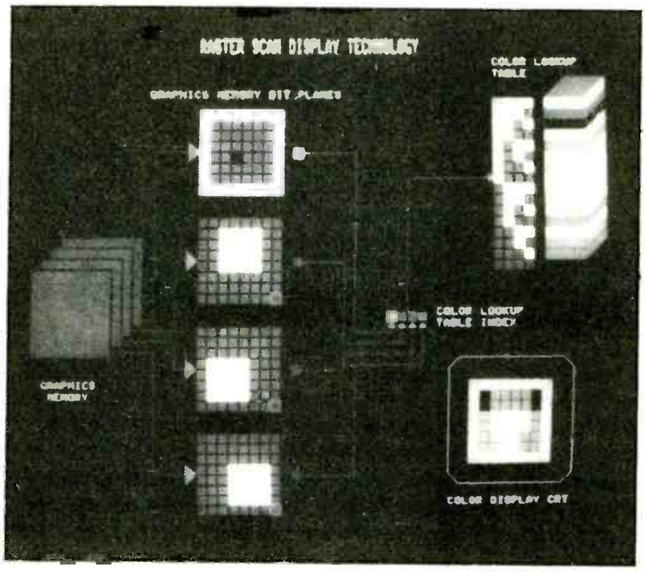
Fill it in? We'd only 'ave to dig it up again when the fancy glass stuff comes in.

Words into pictures

Computer graphics is one of the fastest growing segments of the microcomputer software market according to the recently appointed director of Digital Research's renewed European assault Paul Bailey. In response, the company plans to make its graphics-based software as successful as its word-based CP/M operating system, despite informed and aggressive competition in the same field.

If the plan succeeds, presumably the equivalent of the current 3000 CP/M-compatible programs will be available in graphics form and all conforming to one standard. It is not claimed that these products will comply with ISO and ANSI standards, but they "will incorporate emergent graphics standards" laid down by these two organizations.

Contracts with Honeywell and ICL for their CP/M system have no doubt helped to incite the company's European offensive but at the conference announcing the plans, the emphasis on computer graphics was hard to miss. Reading between the lines, computers of the future intended for productive purposes will not give prompts in words, but will present the operator with easily assimilated images which will speed up reaction time and theoretically increase productivity.



One of the more informative displays seen at the recent Computer Graphics exhibition showed how a raster-scan colour graphics system works. The Ramtek 6211 terminal used for this diagram can show 16 colours from a palette of 64 but a technique used by Bradford University showed simply how additional tones of these colours could be produced by omitting colour elements to enhance the display.

Brokers break new ground

The second-user test gear company Electronic Brokers, claimed by its managing director Peter Fraiman to be the largest of its kind in Europe, has taken another step in its diversification into new product marketing by acquiring the sole franchise for a range of Philips test equipment. Equipment to the value of around £200,000 will be stocked by EB at the Kings Cross Road warehouse and showroom.

EB is now 15 years old, having started in the classic 'one man and a dog' manner to buy, recondition and re-sell test gear. During the last 10 years, the emphasis has shifted to professional instruments and, in the last five, to the computer field. The company is now at the point where it inhabits its own offices, showroom, workshop and warehouse in Central London, and supports its own standards room under the wing of Mike Jones, technical director.

The original suggestion that EB should handle Philips equipment came from Philips themselves – a compliment to the company's performance and management. EB intend to concentrate the new products side of their range on Philips. "A distributor" said Peter Fraiman, "should understand a maker's equipment intimately, and to achieve that you need to specialize".

Stereo tv experiments

The BBC has at last admitted they have been running tests for stereo sound on BBC2 tv channel from the Crystal Palace transmitter. The method they have selected transmits a second discrete sound channel in addition to the main channel, similar to that used in Germany. The main channel consists of a sum of the left and right signals and the second channel the right-hand channel information only. A control sub-carrier included in the main channel identifies the type of transmission – stereo, mono or two seperate channels which could be used for two different languages. The additional f.m. sound carrier was set at various frequencies around 300kHz from the main carrier.

Earlier tests using the system caused a certain amount of interference which included buzz on both sound channels, interference from the second sound channel on the main channel and patterning on the picture. To minimize these effects and provide a signal compatible with ordinary receivers they needed to reduce the main sound carrier to 10 to 13dB below the vision carrier level; the second sound carrier was reduced even further to between 16 and 22dB below the vision carrier. The trouble with this was that viewers in fringe reception areas could not receive a sufficiently strong second sound signal. Another drawback to such a low level for the second sound carrier is that the design of a suitable receiver becomes more difficult.

The principal rival to the two-channel sound approach is the f.m./f.m. system developed by NHK, with an f.m. main carrier, f.m. subcarrier and a.m. control subcarrier. For stereo the f.m. subcarrier is used for the difference or 'S' component. Under some conditions there can be a severe degradation of the signal/noise ratio though there is very little impairment to the vision channel.

The selection of one system over another seems to have political rather than technical overtones. As the PAL patents run out there could be an inrush of cheap Far-East tv sets and one way to overcome it was to incorporate some new system into the PAL set; the Germans have a number of patents on the two carrier sound system. If the f.m./f.m. system were to be adopted, there would be no restrictions on Japanese manufacturers.

The BBC point out that they are still at a very experimental stage and there is no commitment to introduce stereo sound for the BBCs terrestrial tv service or to adopt any particular system, but the results of the current investigation should assist the BBC in its future planning.

Electronics for peace

The inaugural meeting of the Electronics for Peace network is on Saturday November 20th at Langley Hall, Church Road, Bracknell, Berks, starting at 10.30 in the morning. Details are available from Anne Yarwood, a founder member of Electronics for Peace, who is investigating the impact of the link between electronics and arms on the Berkshire community, telephone: 0990 (Ascot) 21167. The one-day meeting will have wide-ranging discussions dealing with possible 'conversion' of military electronics to peaceful and productive purposes.

● Concerned about the massive and increasing involvement of the electronics industry with military projects, Steve Holmes and Tim Williams, both electronics engineers who themselves once worked on defence equipment, started Electronics for Peace, along with Anne Yarwood.

Private BT – Good, says Jenkin. Bad, says Stanley

In answer to criticism about the denationalization of British Telecom, Patrick Jenkin said that unprofitable services such as telephones and call boxes in rural areas would be continued. In a paper distributed to MPs to explain the Government's proposals, Industry Secretary Jenkin confirmed that the sale of 51% of the shares in BT would be an election issue and no final decision would be taken until after a general election. "BT's licence will ensure that everyone who has access to telephone services at present will continue to have access in the future" say the paper.

On the profits from the service Mr Jenkins sidesteps the issue of whether the money would be reinvested in the Corporation by saying that giving BT freer access to private capital means that customers would not have to bear such a large proportion of cost of new investment. Other issues such as the maintainance of the 999 emergency service and provision of new services to the most remote areas are "being considered at the moment".

Strongest criticism of the scheme has come from the Post Office Engineering Union. Bryan Stanley, it general secretary, has said that the privatization of BT is "divisive and against the interests of the community as a whole". Despite Mr Jenkin's assurances, Mr Stanley still believes that rural areas are threatened with a 'telecom blight' which could have serious implications in development areas, reflecting back on the business community by reducing their market penetration and affecting decisions on business location.

Mr Stanley claims that according to information leaked from a government 'think tank' meeting, it is the Government's intention to cut the workforce of BT by 20% or nearly 50,000 workers, and that this is one of the main purposes of getting BT into the private sector. He said that "far from being 'freed' by privatization, BT is set to be shackled so that its competitors can have a free rein to plunder its most profitable services. It is ludicrous for an expanding industry to have to reduce its workforce when customers are demanding more and better services".

According to the leaked papers, BT would only be allowed to expand if it:

- had the finance to do it (Government controlled)
- achieved a target rate of return (Government controlled)
- had the employees to do it (after the 20% cut)
- meet other criteria (determined by the Government and enforced by an office of Telecommunications).

If the corporation were to act on a purely commercial basis it would no longer be obliged to buy British, warns Mr Stanley, and there could be further losses to the British information technology industry. "It is by no means certain that the attempt to private BT will succeed. If the attempt failed or went badly, BT would be left in an even worse position in the future in a permanent state of uncertainty. But whatever happens ultimately, the Government is ensuring that BT and national telecommunications policy, will be in a state of flux for many crucial years to come".

One-line telecine

Though charge transfer devices, long set for use in domestic tv cameras, have not found a place in broadcast quality cameras, they can now be used as line sensors in telecine equipment. A full two-dimensional array requires half-a-million elements, but a single-line sensor needs only about 1,000 picture elements, with the motion of the film past the sensor providing the vertical scan.

Such a scheme has been held up in the past by the lack of a suitable line-array sensor. Another difficulty has been that lines are scanned sequentially but need to be displayed interlaced, so a standards converter with a large memory is needed. But the rapidly falling cost of electronic storage and the availability of control microprocessors has made a charge transfer line-array telecine at last viable according to Rank Cintel, who are making machines under licence from the BBC.

An advantage of such a system is that film can be run at various speeds without loss of picture quality (except at the extreme of viewing the film at 400 frames a second). A fourth optical channel, in addition to RGB signals, that is sensitive to infra-red light, can be used to detect dirt particles on the film. Such noise can then be eliminated from the transmitted image.

● The BBC/Rank Cintel telecine uses analogue signals with digital control, but another system using totally digital video system is described in our IBC report, page 34.

News in brief

Blumlein biography. The 40th anniversary of the death of Alan Blumlein has reawakened interest in the pioneer inventor who was much involved in the early history of television and in stereo sound recordings through his work at EMI. F. P. Thomson has been writing a biography now for nine years and there has been some criticism of the delay in getting it finished. In answer, Mr Thomson has told us that he has found some very interesting material about Blumlein's father and maternal grandfather who had much influence on him. His research into the family has taken F. P. Thomson into such fields as mediaeval tapestry when he found the coat of arms of the Blumlein family of Strasbourg in a 500-year-old tapestry. All this has taken time, he says, and the illness of both Mr Thomson and his wife has also caused delays. The biography is now expected to be published in mid-1984.

A "support information retrieval system" is being developed by Systems Designers Ltd, for use in London's air traffic control centre. The system will be capable of providing several hundred pages of text and graphics information in 16 foreground and background colours for up to 300 terminals. The information includes meteorological conditions, runway allocation, communication frequencies, aircraft holding patterns and much more. The network is doubled so that two pages are available to each operator and still provide a single channel in the event of a failure. The system will be run from a continuously operating Tandem minicomputer which will also have access to other computer databases including that of the Met Office. Fibre optic cables will transmit the data to each display position, chosen for their immunity from electrical interference, and freedom from radiation. The complete system will take two years to install.

Sessions on design principles, customer needs and case studies are part of the first **UK seminar on semi-custom i.c.** applications at the Ashridge Management Centre on 19 & 20 November. According to the organizers, Academic Media Inc, main emphasis of the seminar is on practical aspects of semicustom i.cs and aims are to give consultants the background required to assess the impact of technological developments, advances in design techniques and new application areas. The organizers can be contacted on 01-947 4069.

IBA have designed microprocessor-based test equipment to measure the phase noise and the purity of signal from a uhf tv transmitter. Maintenance automatic test equipment or MATE incorporates a specially developed frequency synthesiser and precision u.h.f. demodulators to provide accurate measurements of broadcast transmitters. Compact, portable MATE is to be marketed by Continental Microwave.

The APT140 numerical control coumputer system for machine tools, developed by British Aerospace, is to get commercial exploitation by Compeda. Capable of controlling five-axis machining, it combines the advantages of interactive graphics with the best features of the a.p.t. computer language.

DISTORTION IN DIGITAL RECORDINGS

Physical measurements for subjective assessments of reproduced sound obtained by a new method enable distortion in p.c.m. processors to be compared with that of analogue tape recorders.

by Yoshimutsu Hirata

This article presents measurements of non-linearities in analogue and digital recordings with comments on the sound qualities of both recordings.

Some pulse-code modulation recorders now in use are inexpensive compared with professional analogue tape recorders and even commercially available for the hi-fi market. In a similar way to the debates about valve and transistor amplifiers, the sound qualities of analogue and digital recordings are currently the talk of recording engineers. What data are there for quantifying such qualities?

A new method is used for measuring non-linear distortion in analogue and digital recordings. The method uses composite rectangular pulses as the test signal that permits transfer-function shapes to be predicted directly from non-linear distortion figures given by the measurement[1]. Before going on to the description of such distortions in digital and analogue recordings, the non-linear distortion (n.l.d.) figures and the predicted transfer function shapes in transistor and valve amplifiers are presented so that readers may appreciate the measurement method.

Fig. 1 shows typical examples of the distortion figures of top-class transistor amplifiers. Amplifier A shows an s-type non-linearity, subjectively judged as "soft or glossy". Amplifier B shows a bow-like non-linearity, subjectively judged as "live or strong". Amplifier C shows a relatively small non-linearity and is subjectively judged as "clear or definite".

For comparison Fig. 2 shows the distortion figures of valve amplifiers. One can see s-type non-linearities in these amplifiers. The amount of distortion in these valve amplifiers is large compared with that in the top-class transistor amplifiers used for Fig. 1. Soft distortion, as represented by the s-type non-linearity, makes music sound "rich", "round" or "fat", which though likely to appeal to some people is unlikely to appeal to the hi-fi purist. One can also observe crossover distortion in amplifiers E and F, usually only found in push-pull type amplifiers – a remarkable result for such small input signal levels.

Dr Hirata is now an independent researcher working in Tokyo.

In listening to music the input of an amplifier can be either the output of a pickup cartridge which traces the waveform in the groove of a disc surface or that of a replay head which picks up the flux waveform recorded on magnetic tape. Usually, a signal being recorded in a disc or tape has passed through a master tape recorder, often considered to be the weak link in the current sound record/reproduce system[2]. Distortions in analogue recording depend on both tape speed and coating.

Distortion figures of three types of analogue tape recorders are given in Fig. 3, the Ampex A80, an open-reel type for professional use, the Sony TC-5550-2 open-reel

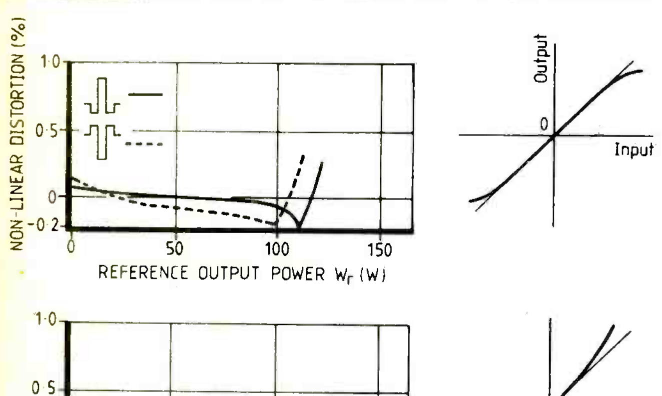


Fig. 1. Non-linear distortion figures of transistor pre-main amplifiers together with transfer function shapes. $W_r = V_1^2/16$ where V_1 is defined by the peak voltage of the output signal. Top(A) is for the Revox B750 MKII, middle(B) for the Yamaha CA-S1 and bottom(C) for the Trio KA-9900.

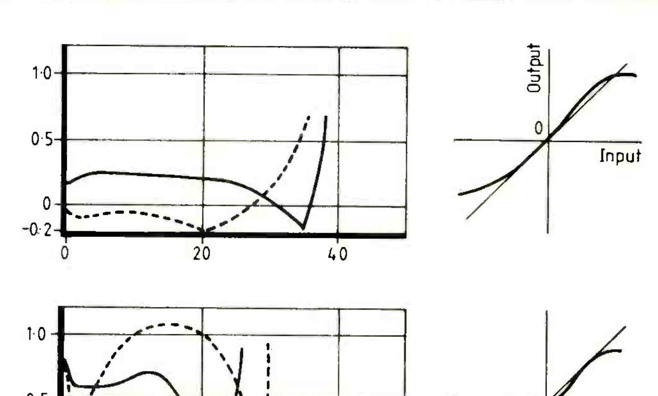
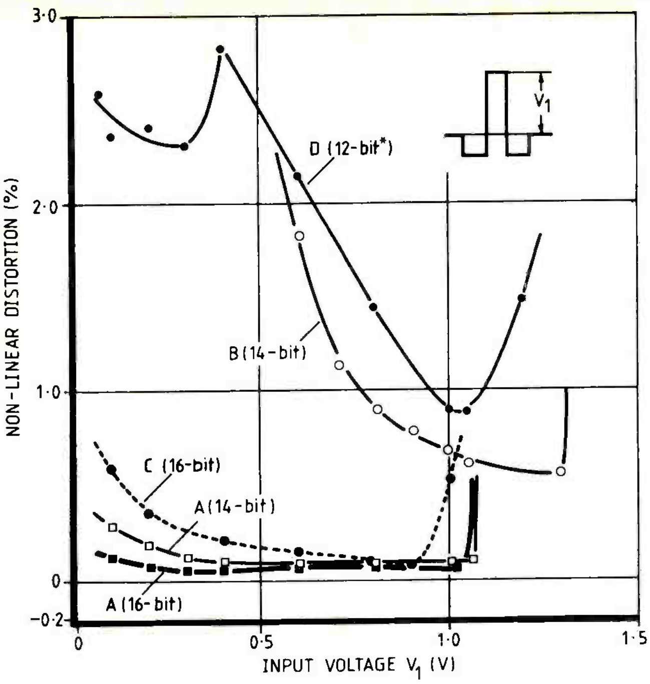
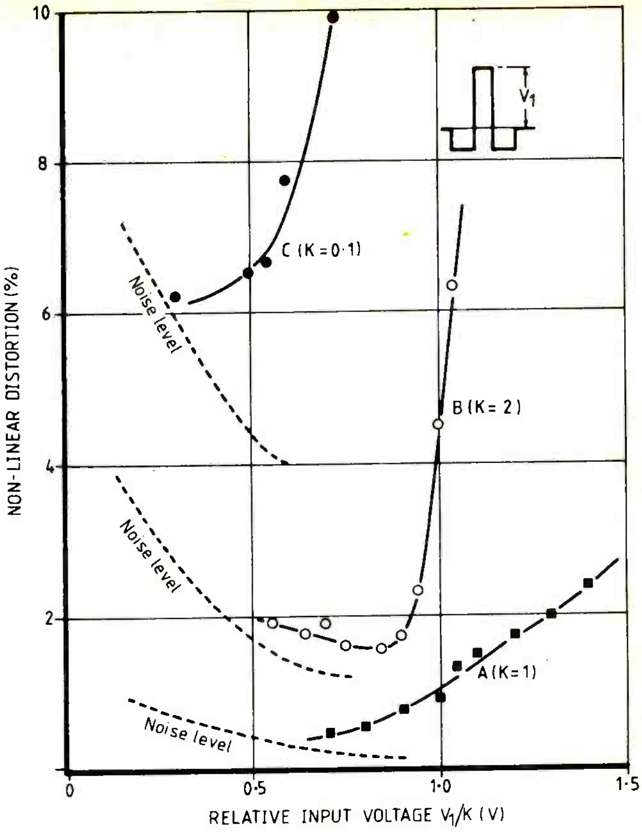


Fig. 2. Non-linear distortion figures of valve amplifiers together with transfer function shapes. Top(D) is for the Marantz 8BK (EL34 push-pull), middle(E) for the Hall Independence MKIII (KT88 push-pull, triode mode) and bottom(F) for the Conrad Johnson (6550 push-pull).





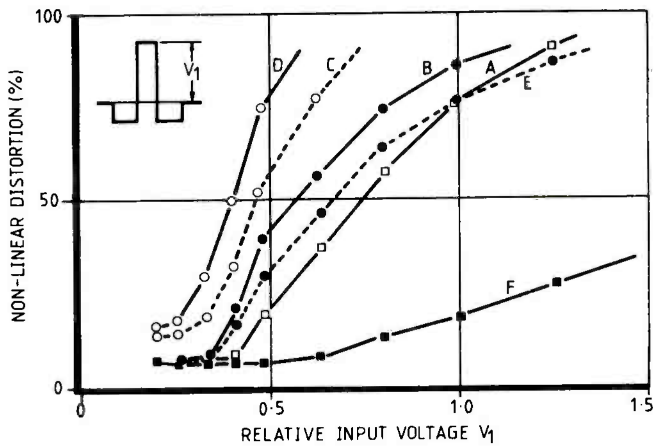


Fig. 3. Non-linear distortion figures of analogue tape recorders (top left). A is for the Ampex A80 (open-reel, ferric tape, 38cm/s), B for the Sony TC-5550-2 (open-reel, double coating tape, 19cm/s) and C for TC-K555 (cassette, metal tape, 4.5cm/s).

Fig. 4. Non-linear distortion figures depending on tape coatings (left). A and B are for normal bias position tapes (Fe_2O_3), C and D for FeCr tapes, E for a CrO_2 tape and F for a metal tape.

Fig. 5. Non-linear distortion figures for PCM processors (above). A is for PCMF1 (14 and 16bit), B for PCM100 (14bit), C for DN035R (16bit) and D for XD60 (12bit, floating point, 14bit output).

type, intended for battery operation, and the TC-K555 cassette type, using metal tape. As the desirable level of input voltage for these analogue tape recorders is not uniform, the abcissa of the distortion figure is given by different scale, *viz.* input voltages V_1 are given by the number indicated on the abcissa multiplied by the values of K shown. A common feature in the form of the non-linearities in these analogue tape recorders is the s-type non-linearity, which is typical of soft distortion.

The distortion in analogue tape recorders is principally generated by the magnetic saturation of tape coatings such as gamma-phase iron oxide (Fe_2O_3), gamma-phase ferric oxide with small amounts of cobalt and other metals, chromium dioxide (CrO_2), metal, and so on. There are variations between nominally similar tape coatings, but details are kept secret by tape manufacturers.

Distortion figures relating to tape coatings are shown in Fig. 4. In the measurement a cassette tape recorder Technics M77 was used with the bias point for tape coatings being tuned. As seen, the metal tape is superior to others. The sound of a metal tape is subjectively judged as "clear or cold" in contrast to that of metal oxide tapes. It should be mentioned that the distortion depends also on the instrument being used, provided that a tape speed and coating are the same. Thus, the rank of distortion figures for metal oxide tapes may change when a tape recorder is changed.

In the process of digital recording, an analogue signal is converted into digital form by using an analogue-to-digital converter prior to recording. In the replay process, the recorded data are converted into analogue form using a digital-to-analogue converter. When recorded data are not missed, due to drop-out in the recording medium for example or when the error correction system is complete, the input of a d-to-a converter is the same as the output from an a-to-d converter. Thus distortions in a digital recording are reckoned to be from the p.c.m. processor which consits of input and output low-pass filters, a sample-and-hold circuit, and converters.

Fig. 5 shows the distortion figures of four p.c.m. processors, the PCMF1 (made in 1981, 14bit and 16bit linear), PCM100 (1979, 14bit linear), DN035R (1979, 16bit linear) and XD60 (1982, 12bit floating point, 14bit output). The amount of distortion in A (16bit mode) is very small, which competes with the top-class transistor amplifier in linearity. Generally speaking, distortion due to the conversion error or quantization error increases with decreasing input signal level, which is similar to the crossover distortion in push-pull amplifiers. Such distortions are easily detected and disliked.

At present, sound qualities of digital recordings are widely spread: some are superior and some are inferior to that of analogue tape recording using professional equipment. The reduction of distortion in analogue tape recording depends on the development of tape coating material and one of the answers is metal tape. In digital recording, distortion could be reduced by the efforts of i.c. designers. WW

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2. Moir, J., 'Just detectable' distortion levels, *Wireless World*, February 1981, p.32.

LOGIC MAPS – FROM LULL TO KARNAUGH

The progress of methods of showing logical truths, from a 13th century monk, by way of Lewis Carroll, to the Marquand/Karnaugh map used by logic designers today.

by N. Darwood

We begin in the Thirteenth Century. The Spanish monk Ramon Lull wanted to demonstrate religious truths, and began a chain of events by enclosing attributes of God in circles. He then showed the combinations: God is merciful and wise, kind and wise, all-knowing and merciful etc., as lines on a diagram, as in Fig. 1. It was an original idea for finding combinations of things, and the diagram had the added attraction that it "perplexed disbelievers".

About 1600, realising the importance of Lullian diagrams, Liebnitz dreamed of an algebra by which disputes would be resolved by calculation. Lullian diagrams were used as part of natural science for 500 years, until Euler.

Euler

In 1760 Euler overlapped appropriate circles, which by now were also used to enclose classes of non-pious things. For instance, if all four-legged animals were herded into circle A of Fig. 2 and all things that fly were in circle B, then the Euler circles, because they did not overlap, demonstrated that there are no four-legged flying things. Figure 2 also demonstrates the conjunction – all Bs are C and, some Cs are B.

Lewis Carroll[1] wrote "Apparently it never occurred to him (Euler) that something that hasn't the attribute cannot be shown on this diagram".

Venn

In 1850, Venn[2] solved this problem and with the same stroke united all the circles into one. The gist of the method is to overlap all the circles and shade the empty areas. Figure 3 (a) corresponds to Fig. 2.

Figure 3 (b) shows that the Venn diagram of two circles, i.e. for two classes A and B, has four areas·

$\overline{A}B$ (Not A and B)
$A\overline{B}$ (A and Not B)
$\overline{A}\overline{B}$ (Not A and Not B)
AB (A and B)

Lewis Carroll wrote of the Venn diagram "After shading some areas, the class $\overline{A}\overline{B}$, outside his diagram, is allowed the rest of infinite space to wander around in. However, when the class is empty, Mr Venn evades shading this area by a footnote – ('I have not troubled'). My solution is to enclose the diagram in a square box, the enclosure then represents the Universe."

The Venn diagram usually uses overlapping circles. It is easy to draw three overlapping circles to show eight areas. But to show 16 areas by overlapping four circles A, B, C and D is a puzzle the reader may care to try. Venn resorted to ellipsis. Even so, for five classes A to E, a sixth ellipse was needed, which had to be drawn inside all the others. It represented the outside of one of the classes. Lewis Carroll wrote "For six classes A to F, Mr Venn suggests "the best plan would be to draw two such five (A to E) diagrams, one for F and one for Not-F". This, however, would give one area which two classes would, somehow, have to share. Above six Mr Venn does not go".

Carroll

He then explains how the diagram of Fig. 4 may be constructed for eight classes. Figure 4 (a) is for four; for eight Fig. 4 (b) is drawn in each compartment.

Marquand and Boole

In 1881 the torch was passed to Alan Marquand[3] who published the Logical Map shown in Fig. 5 (a), which is the one used today. It is now called the Karnaugh Map[4], but then empty squares were shaded, whereas in Fig. 5 (b) and (c) non-empty squares are shaded.

In 1884 Boole published his Algebra which fulfilled Liebnitz's dream. Boole was a professor of Probability Theory and in probability the values range from 1 (for true), through all the fractional values less than 1, to 0 (for false). For example, the probability of drawing an ace from a pack of cards is 1/13. On drawing two cards the probability of drawing an ace and a 4 is

$$\frac{1}{13}\cdot\frac{1}{13}=\frac{1}{169}$$

The mystery (the explanation is nowhere in the literature, and electronic engineers often wonder) why Boole used + for or, evaporates when we consider the probability of drawing either an ace or a 4, which is 1/13+1/13.

He began his algebra by allowing only the two extreme truth values, true or false, i.e. 1 or 0 for statements. The variables A, B, C etc., now stand for Boolean statements. A Boolean statement is a statement which can only be true or false. Nowadays,

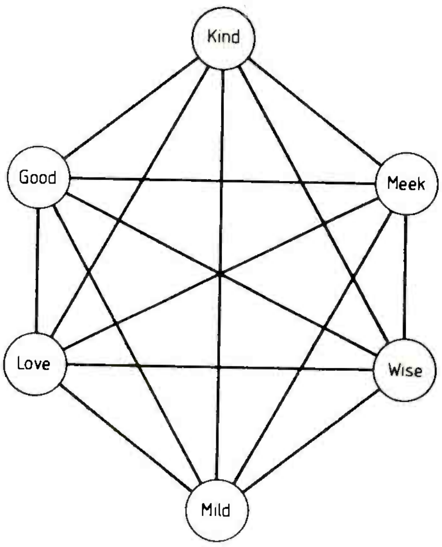


Fig. 1. Diagram due to Ramon Lull, who evidently enjoyed a comprehensive understanding of God.

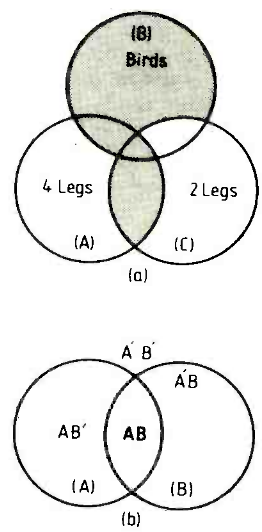


***Fig. 3.** Three overlapping Venn circles, with empty areas shadded, are equivalent to Fig. 2. At (b) two-class Venn diagram shows four areas, including universe outside.*

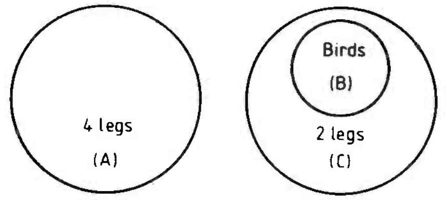


***Fig. 2.** Euler circles.*

we employ the Laws of Thought[5] to manipulate compound Boolean statements. Some laws, because they are based on language, are obvious – consider the compound And statement: it is raining (A) and it is not raining ($\bar{A}$). This is written algebraically $A\bar{A}$. Obviously, the truth value of this And statement is always false, i.e., zero. Hence the law, $A\bar{A}=0$. This law has a name; in fact, all the laws have names. For instance, the Idempotent Law states that the following two statements are equivalent:
"It is raining and it is raining"
"It is raining"
Hence $A.A=A$.

Some laws only appear obvious because they are based on mathematics: e.g. $0+A=A$, similarly $0.A=0$, also $1.A=A$. Another instance is $A(B+C)=AB+AC$. Now having learnt the rules, to simplify $\bar{A}(A+B)$ we proceed as follows

$$\bar{A}(A+B)=\bar{A}A+\bar{A}B$$
$$=0+\bar{A}B$$
$$=\bar{A}B$$

We all feel at home with $A+\bar{A}=1$; for instance, it is true that it is raining (A) or it is not raining ($\bar{A}$). But no one at first, and few ever, feel at home with the final law

$$A+BC=(A+B)(A+C)$$

However, by substituting $\bar{A}$ for C, it gives

$$A+B\bar{A}=(A+B)(A+\bar{A})=(A+B)\cdot 1$$
$$=(A+B)$$

Now although $A+B\bar{A}=A+B$, we cannot subtract A from both sides, because having done so would result in $B\bar{A}=B$; e.g., It is Tuesday and not raining = It is Tuesday, which is only true if it never rained on Tuesdays.

Finally, out of the four basic arithmetic functions, +, −, × and divide, this leaves fractions to consider. We may define

$$A/B \text{ as } A+\bar{B}$$
then $A/A=A+\bar{A}=1$
also $A/1=A+\bar{1}=A+0=A$.

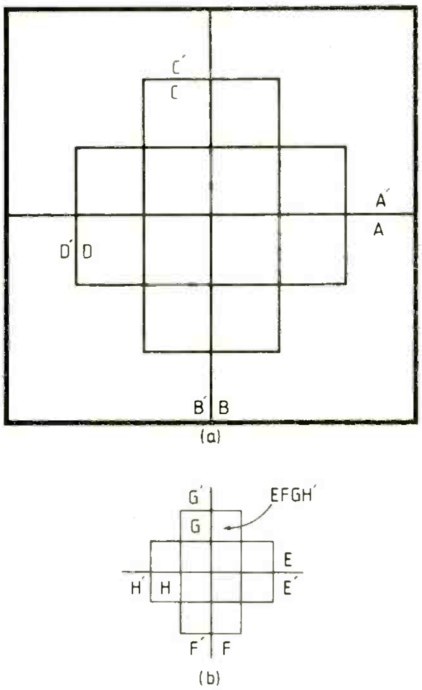


Fig. 4. Lewis Carroll's Logical Map for four classes at (a); for eight, (b) is drawn in each square.

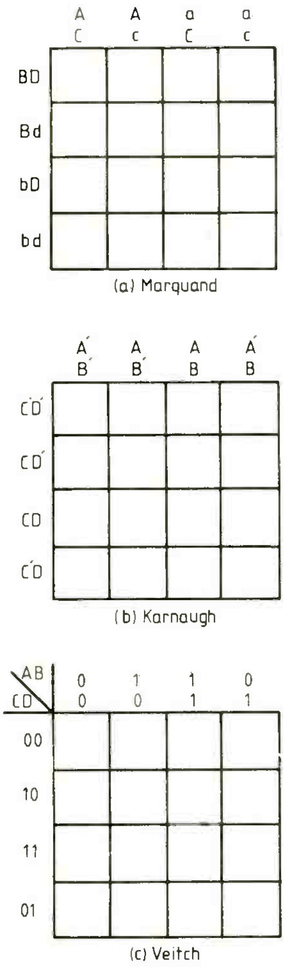


Fig. 5. Three modern logic maps.

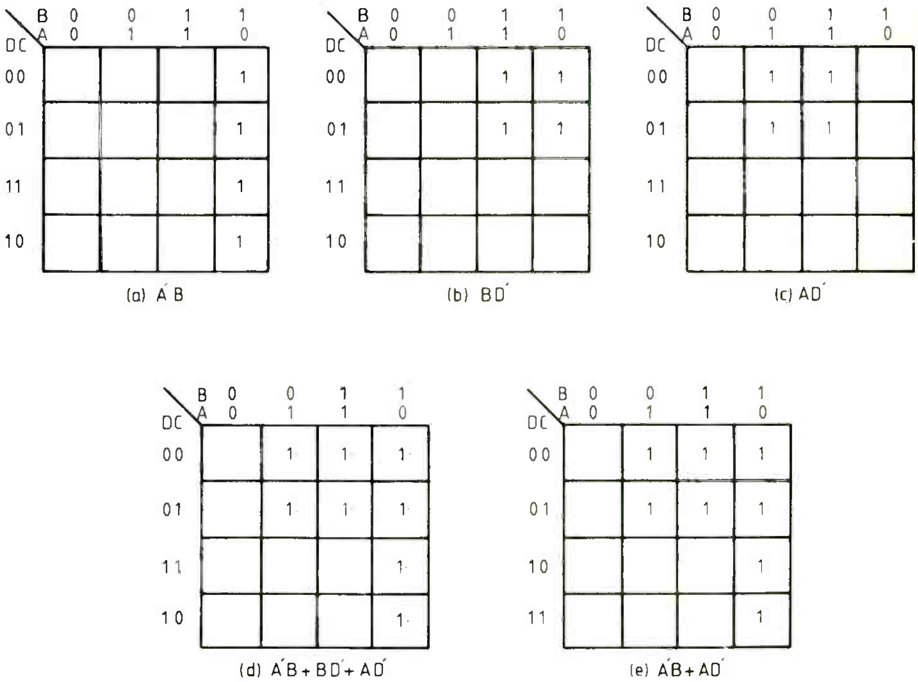


Fig. 6. Simplification of $\bar{A}B+B\bar{D}+A\bar{D}$ into $\bar{A}B+A\bar{D}$ by means of Karnaugh map. This diagram used for up to four variables.

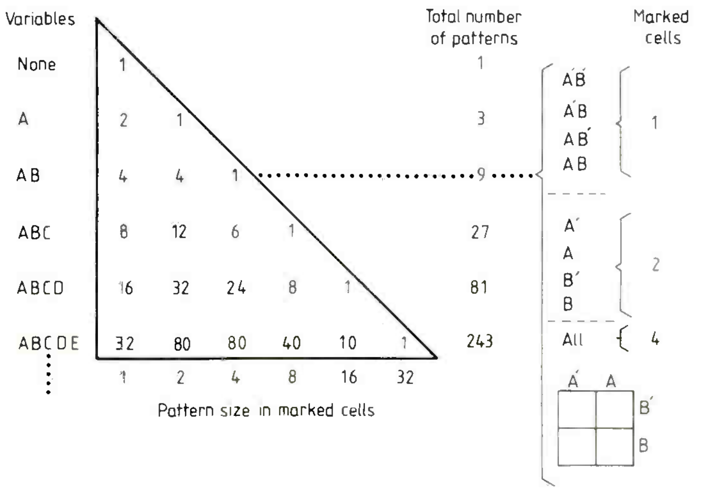


Fig. 7. New diagram showing number of patterns in Karnaugh map for n variables and number of marked (true) cells.

DC \ AB	00	10	11	01
00	0000	0001	0011	0010
01	0100	0101	0111	0110
11	1100	1110	1111	1110
10	1000	1001	1011	1010

(a)

	DCBA	Cell no
D′C′B′A′	0000	0
D′C′B′A	0001	1
D′C′BA′	0010	2
D′C′BA	0011	3
D′CB′A′	0100	4
D′CB′A	0101	5
		⋮

(b)

0	1	3	2
4	5	7	6
12	13	15	14
8	9	11	10

(c)

***Fig. 8.** Completed Veitch map. Map at (c) is decimal version of (a).*

This seems promising, especially when we derive

$$1/A=1$$

Perhaps, by analogy with A.A=A we could tolerate the cancellation law, which is

$$\frac{AB}{B}=\frac{A}{B}$$

but, unfortunately, to expand the simple expression

$$A\left(\frac{B}{C}\right)$$

we multiply the numerator and divide the denominator, by A. This means that the fraction becomes more complex.

In summary, values are restricted to 0 and 1, addition and multiplication is valid, subtraction is meaningless and fractions are no help at all.

Using the Karnaugh map

To show the use of the map, consider simplifying

$$\bar{A}B+B\bar{D}+A\bar{D}$$

Here, there are three terms to plot, i.e., $\bar{A}B$, $B\bar{D}$ and $A\bar{D}$; see Fig. 6 (a), (b) and (c). Superimposing these three patterns, Fig. 6 (d), gives the plot of the original expression from which it can be seen that the plot is equivalent to

$$\bar{A}B+A\bar{D}$$

See Fig. 6 (e).

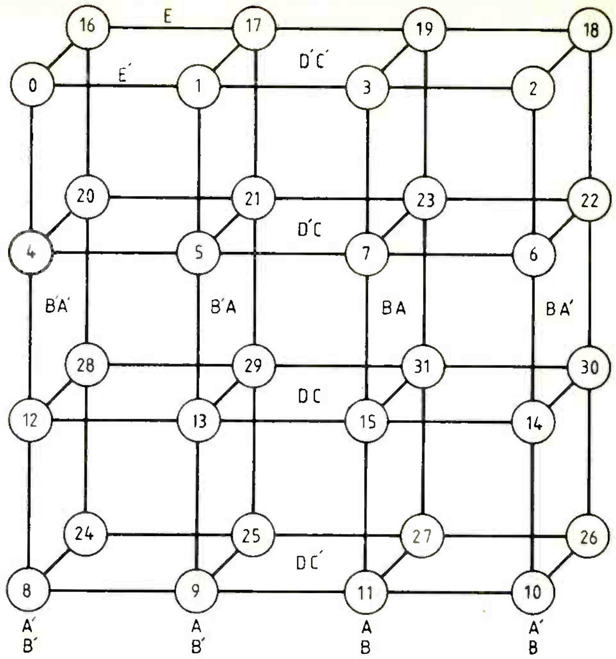


***Fig. 9.** Back to Lull. A five-variable Veitch map.*

Hence, $\bar{A}B+\bar{B}D+A\bar{D}=\bar{A}B+A\bar{D}$. The reader may care to show by plotting the expressions, that $AD+BC+B\bar{D}+D\bar{C}$ simplifies to $AD+B+D\bar{C}$.

Five variables. Now a pattern consists only of 1, 2, 4, 8, 16 . . . squares; hence, if the map contains say five marked squares then it consists of a combination of two or more patterns. How many patterns are there for n variables? The triangle in Fig. 7, published for the first time, tabulates the results. The analogy with Pascal's Triangle is that an element is formed from the sum of twice the element above plus the element to the left of it. A row of Pascal's Triangle sums to 2^n, which is the number of squares on a map, whereas a row in Fig. 7 sums to 3^n which is the number of patterns on that map.

On a Karnaugh map, the position of the variables around the map is chosen so that as we move along an axis only one variable at a time changes (corresponding edges are joined together). By using this arrangement, which is binary Gray code, all rectilinear abutted cells on a four-variable map form a pattern. One would assume all patterns are of this form: however, for a five-variable map two four-variable maps are drawn along-side each other in the manner of Venn. And the idea falls down.

To further the story, we need to complete the Veitch Map of Fig. 5 (b) by first entering the minterm of each cell as shown in Fig. 8 (a) and (b). Then convert binary to decimal as shown in Fig. 8 (c). This diagram differs from the Cartesian co-ordinate plane since, in the Cartesian plane, two numbers X and Y are required to specify a point on the plane, whereas one number on the Veitch map is unique to one point; conversely every integer corresponds to a unique position.

Now ever since Euler, logical maps have consisted of areas of different shapes and sizes, depending upon whose map it is. But, having arrived at the notion of the Veitch Map we can now construct a diagram which allows logical truths to be more readily demonstrated, as in Fig. 9.

The diagram is, of course, Lullian.

References

1. Lewis Carroll, Symbolic Logic. Republished by Dover Press Inc. N.Y. 1958
2. Venn, *Philosophical Magazine*. July 1880
3. Marquand A., On A Logical Diagram For N Terms. *Philosophical Magazine*. November 1881
4. Karnaugh M., A Map Method For Synthesis of Combinational Logic. *Trans IEEE*. November 1953
5. Boole, The Laws of Thought. Dover Publications. 1884

WW

N. Darwood . . .
Although not a writer by trade, N. Darwood has had over 40 articles published in the technical press. This has enhanced his career which began as a radio technician in the Forces. He then progressed from a computer maintenance engineer through development to become a computer-hardware designer. In 1973 he formed a Computer-design Consultancy company and has since done work for many large companies, including Plessey, Decca, Marconi and EMI.

His published works range from the practical (multiple error detection with a single parity bit – The abacus method of converting a logic-diagram from AND/OR to NAND – decimal Gray-code – digital sinewave generation), to the interesting (decision tables theory – Boolean fractions – history of the Karnaugh map). He has 'modernized' Lewis Carroll's Game of Logic into a board-game, which makes the game ideal teaching-aid for today's digital logic, and besides being fascinating as a pastime it is useful for the practicing electronic engineer.

BOOKS

Underground radio communication

Leaky Feeders and Subsurface Radio Communications, by P. Delogne. 283 pp, hardback, Peter Peregrinus (for IEE), £28. 0-906048-77-X.

Underground radio propagation has been a vexing subject of investigation since the early 1920s, but it was not until 1956 that the breakthrough of this communications barrier came with the demonstration in the USA of what is now known as the "leaky feeder" principle for artificially propagating vhf signals through tunnels. Even then, it was another ten years before further progress was made, with the commencement of separate scientific studies in Belgium and the UK. In a short while powerful American effort, which had been concentrating on direct "through the earth" propagation at low frequencies for possible mine rescue applications, was alerted to the new developments and was making important theoretical contributions.

By 1978 in UK mines alone there were over 100 underground radio systems installed using leaky feeder principles, and still no text-book referred to the subject or even gave more than a passing reference to the problems of underground radio communication in general. Then one of the two leading theoreticians in the work (Prof J. R. Wait, then of Boulder, Colorado) suggested to the other (Prof P. Delogne, of Belgium) that he should remedy this unsatisfactory situation. It is a blessing that Delogne agreed to undertake the task, for this very commendable book is the outcome.

The prospective reader with a practical or "systems-oriented" interest should not be daunted by the academic background of the author. Abstruse mathematical treatments there certainly are, drawing on the publications of himself and Wait (and their respective co-workers) and necessarily so in such a serious work. But these are confined to a single (the longest) chapter which the reader is invited to skip if he does not feel up to it. Even so, the theoretical derivations are interspersed with important conclusions and discussions which should be noted by any serious reader; these sections are helpfully indicated by asterisks.

The book commences with an introductory chapter which effectively summarizes its whole scope. "Through-the-earth" as opposed to tunnel propagation is not to be treated, nor are surface applications of leaky feeders – two points that might be in doubt from the title. A brief historical survey concludes this chapter.

There follows the main theoretical chapter – almost half the text of the book – dealing primarily with propagation in tunnels either bare or containing simple axial conductors. The coupling of dipoles, both electric and magnetic, into these fields is also considered here.

This leads on naturally to a chapter on mode-conversion, the essence of leaky-feeder and associated techniques. The concluding two chapters are more practical, dealing separately with applications in the HF and VHF / UHF bands. It becomes clear here that the author is not only a theoretician. The systems he describes in most detail are naturally those that he himself has engineered, using his patented techniques of discrete mode converters or of "leaky sections" instead of continuous leaky feeders. Further useful material on mobile aerials is included here, and advice on the positioning of leaky feeders. On the investigative side, the final chapter cites an obscure but remarkable student thesis describing work carried out in the Paris Metro in which 15 different types of leaky feeder were studied over a range of frequencies.

Although the author does not claim to introduce a great deal of unpublished material, even the (rare) knowledgeable reader familiar with all the literature will find a new enlightenment in his commentaries; he has reconciled differing theoretical approaches and finally resolved any confusion in terminology that remained.

The very full bibliography lists 180 references up to 1980, including 27 from the Belgian school and an astounding 51 out of Boulder. It possibly includes every paper of significance published up to 1979.

If there is a weakness it is in the treatment of repeater systems. This aspect receives only ten pages, even though repeater symbols feature prominently in the dust-cover design; but the author may rightly feel that this is a subject for a separate work. His explanation that such techniques are disfavoured in continental Europe for their dependence on the continuity of mains power ignores the fact that every UK coal-mine system has an endurance of three days against such failure on the insistence of the Inspectorate of Mines and Quarries. On the important question of cumulative repeater noise, he is mistaken in suggesting that fewer repeaters of higher gain are preferable; the opposite is generally the case, because of the over-riding effect of span loss. On the associated question of cumulative intermodulation effects he contents himself with (rightly) disagreeing with one paper cited, whereas a fuller analysis of the problem by himself would have been most valuable.

An unfortunate optical illusion in Fig 3,11 may at a cursory glance confuse the fact that the curves actually cross, and so rob the author of the valid point he is making about the advantage of the leaky-sections technique.

This book is essential reading for the systems engineers of all manufacturers and undertakings concerned with practical leaky feeder communication. Equally, every academic involved in research in this or related fields will need to have it to hand for constant reference. And the subject will, one hopes, now find its rightful place in student curricula. Paul Delogne has fulfilled his task admirably.

D. J. R. Martin

Computing is Easy by David Parker and Martin Hann, 113 pages. Butterworth Group, £3.95 paper cover.

Beginner's Guide to Microprocessors by E. A. Parr, 218 pages. Newnes £3.95 paper cover.

Control in Hazardous Environments by R. E. Young, 111 pages. Peter Peregrinus £12.00 paper cover.

James Clerk Maxwell A Biography by Ivan Tolstoy, 184 pages. Canongate Publishing £9.95 hard cover.

How to Identify Unmarked ICs by K. H. Recoor. Babani £0.65 paper cover.

Feedback Design of Systems with Significant Uncertainty by M. J. Ashworth, 246 pages. Wiley, £15.50 hard cover.

Electronic Servicing – 1 by Rhys Lewis 278 pages. Macmillan Press £5.95.

Reliability and Maintainability in Perspective by David J. Smith, 243 pages. Macmillan £15.00 hard, £8.95 paper cover.

Microwave Field-effect Transistors – theory, design and applications by Raymond S. Pengelly, 470 pages. Wiley £15.50 hardcover.

Electronic Checkbook – 2 by Knight, 112 pages. Butterworth Group, £2.95 hardcover.

Electronic Checkbook – 3 by Knight, 105 pages. Butterworth Group, £3.50 hard cover.

International Video Yearbook 1982/83 by Angus Robertson, 731 pages. Blandford Press, £25 hard cover.

Electronic Equipment Reliability – 2nd Edition by J. C. Cluley, 177 pages. Macmillan, £6.50 paper cover.

Energy in Electromagnetism by H. G. Booker, 360 pages. Peter Peregrinus, £25 hard cover.

Electronic Music Circuits by Barry Klein, 302 pages. Prentice Hall, £12.70 paper cover.

Digital Logic Circuits by Robert G. Middleton, 308 pages. Prentice/Hall, £12.70 paper cover.

Microprocessor Systems Design by Edwin E. Klingman, 349 pages. Prentice/Hall, £22 hard cover.

Microcomputer Design and Construction by Alan Clements, 520 pages. Prentice/Hall, £18.95 hard cover.

How to Get Your Electronic Projects Working by R. A. Penfold, 81 pages, Babani, £1.95 paper cover.

Designing Microprocessor-based Instrumentation by Joseph J. Carr, 323 pages. Prentice/Hall, £17.55 hard cover.

30 Solderless Breadboard Projects – 1 by R. A. Penfold, 149 pages. Babani, £2.25 paper cover.

Fiber Optics by Waldo T. Boyd, 221 pages. Prentice/Hall.

Amateur Television Handbook – 2 by Trevor Brown, 97 pages. BATC Publications, £2.40 paper cover.

Supervisory Remote Control Systems by R. E. Young, 195 pages. Peter Peregrinus, £12.75 hard cover.

Understanding Digital Logic Circuits by Robert G. Middleton, 392 pages. Prentice/Hall, £12.50 paper cover.

Electronic Components and Systems by W. H. Dennis, 258 pages. Butterworth Group, £12.50 hard cover.

Phase Noise in Signal Sources by W. P. Robins, 321 pages. Peter Peregrinus, £28 hard cover.

Integrated Circuits by William C. Till and James T. Luxon, 462 pages. Prentice/Hall, £24.70 hard cover.

Alphanumeric Displays by G. F. Weston and R. Bittleston, 194 pages. Granada, £16.50 hard cover.

Handbook of Semiconductor and Bubble Memories by Walter A. Triebel and Alfred E. Chu, 401 pages. Prentice/Hall, £18.70 hard cover.

Radio Handbook by William I. Orr, 1200 pages. Prentice/Hall, £24.45 hard cover.

Radio and Television Servicing 1981/1982 models by R. N. Wainwright, 738 pages. Macdonald, £19.50 hard cover.

Tools of the Mind by V. Stibic, 297 pages. North Holland Publishing, $35 hard cover.

Computer Programming in Cobol by Melinda Fisher, 202 pages. Hodder & Stoughton, £2.95 paper cover.

Understanding Digital Electronics by R. H. Warring, 156 pages. Lutterworth Press, £6.95 hard cover.

Public Address Handbook – 2nd Edition by Vivian Capel, 238 pages. Keith Dickson Publishing, £7.95 hard cover.

Wind/Solar Energy by Edward M. Noll, 264 pages. Prentice/Hall, £9.05 paper cover.

UK CB Handbook by Alan C. Ainslie, 150 pages. Newnes, £3.95 paper cover.

Microshop Series vol 8 (index) by Trevor Toms, 207 pages. Phipps Associates, £9.95 paper cover.

Radio Control for Modellers by R. H. Warring, 132 pages. Lutterworth Press, £6.95 hard cover.

Aerial Projects by R. A. Penfold, 84 pages. Babani, £1.95 paper cover.

Servicing Radio, Hi-Fi and TV Equipment by Gordon J. King, 205 pages. Newnes, £5.95 paper cover.

Apple Personal Computer for Beginners by Seamus Dunn and Valerie Morgan, 257 pages. Prentice/Hall, £6.95 paper cover.

Microprocessor Data Book by S. A. Money, 264 pages. Granada, £16 hard cover.

Practical Handbook for Valve Radio Repair by Chas E. Miller, 221 pages. Newnes, £13 hard cover.

Interfacing to Microprocessors and Microcomputers by Owen Bishop, 147 pages. Butterworth Group, £4.95 paper cover.

Microcomputer Experimentation with Mos Technology Kim – 1 by Lance A. Leventhall, 467 pages. Prentice/Hall, £14.35 paper cover.

Microprocessor Circuits vol. 1 by Edward M. Noll, 109 pages. Prentice/Hall, £7.45 paper cover.

Microshop Overview vol. 1 by John Phipps, 140 pages. Phipps Associates £9.95 paper cover.

Software Development 2nd Edition, 1127 pages. Texas Instruments, £12.90 paper cover.

Influence of Microelectronics on Measurements Instruments and Transducer Design (conference proceeding), 296 pages. IERE, £37.50 paper cover.

Fibre Optics (Conference proceedings), 200 pages. IERE, £27 paper cover.

Video and Data Recording (Conference proceedings), 405 pages. IERE paper cover.

Electromagnetic Compatibility (Conference proceedings), 322 pages. IERE., £35 paper cover.

Digital Circuits – Ready Reference by John Markus, 162 pages. McGraw-Hill, $12.50 paper

Communications Circuits – Ready Reference by John Markus. McGraw-Hill, $12.50 paper cover.

Special Circuits – Ready Reference by John Markus, 234 pages. McGraw-Hill, $12.50 paper cover.

Popular Circuits – Ready Reference by John Markus, 216 pages. McGraw-Hill, $12.50 paper cover.

Electronics Projects – Ready Reference by John Markus, 181 pages. McGraw-Hill, $12.50 paper cover.

Electronics TEC Level II by D. C. Green, 150 pages. Pitman, £4.95 paper cover.

Transmission Systems TEC Level II by D. C. Green, 148 pages. Pitman, £4.95 paper cover.

Electronics TEC Level III by D. C. Green, 207 pages. Pitman, £5.50 paper cover.

Essential Electronics – an A-to-Z Guide by George Loveday, 257 pages. Pitman, £5.95 paper cover.

Information Technology & People, vol. 1, 299 pages. Citech (Uxbridge), £20 hard cover.

EVENTS

November 23-25
2nd International Conference on Semi-custom ICs. West Centre, London SW6. Details from Prodex (Seminars) Ltd, 79 High Street, Tunbridge Wells.

November 25
Fibre Optics Forum. ERA Technology are investigating the potential market for short range fibre optic systems, particularly sensors for automation and process control. Details from Robert Stafford 0372 374151.

November 25
Chemicals in the Electronics Industry: IMRA/IEE Symposium at the Cafe Royal, Regent Street, London. Details from IMRA, 11 Bird Street, Litchfield, Staffs WS13 6PW.

November 25
Hi-Fi TV – Bigger, Better Pictures: Royal Television Society Lecture at IBA, 70 Brompton Road, London SW3, 7pm.

November 26-28
Pie in the Sky? A Royal Television Society symposium examines impact of satellite and cable distribution. At BBC Broadcasting House, Manchester.

November 26-December 5
International Exhibition of Inventions, also Special Techniques. New Exhibition and Conference Centre, Geneva. Secretariat: International Exhibition of Inventions, 8 rue du 31-Decembre, CH-1207 Geneva.

November 29
British Aerospace Industry. Lecture at the Institute of Mechanical Engineers, 1 Birdcage Walk, London SW1. Details: Fellowship of Engineering, 2 Little Smith Street, London SW1.

November 29-30
Robotics and Artificial Intelligence; information from State-of-the-Art Ltd, Victoria House (M9), Southampton Row, London WC1B 4EF. Also in Paris, Nov 25/26.

November 29-30
Fibre-optics and Lasers; conference sponsored by Technology Transfer Society and the Technical Marketing Society of America. Russel Hotel, Bedford Square, London WC1. Details from State-of-the-Art Ltd.

December 2
Prestel: Lecture by J B Millar of BT. Room 612, Ashby Building, Stranmillis Road, Belfast. Details from IEEIE, 2 Savoy Hill, London WC2R 0BS

December 7
Photon Connection: IEE Faraday Lecture, presented by STC as part of their centenary celebrations. Great Hall, Unversity of Exeter. Three presentations at 10.30am, 2 and 7.30pm.

December 8-9
IT 82 Conference review, Barbican Conference Centre. Online Conferences Ltd, Argyle House, Northwood Hills, Middlesex HA6 1TS.

December 9
Technical Picture Quality: Royal Television Society discussion. 7pm at IBA, 70 Brompton Road, London SW3.

December 9
Word Processors in the Microchip Office: IEEIE Lecture, Norfolk College of Art and Technology, Tennyson Avenue, King's Lynn, 7.30pm.

December 13-15
Automatic Testing and Test Instrumentation: International conference and exhibition. The conference is devoted to CADMAT systems. Metropolitan Convention Centre, Brighton. Network Exhibitions Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX.

December 14
Electronics in Motor Vehicles: IEEIE Lecture at IEE, Savoy Place, London WC2, 6pm.

14 December
50 Years in Communication: IEEIE lecture by E G W Miller of BBC Scotland. At SSEB, 75 Waterloo Street, Glasgow, 7pm.

December 14
The Photon Connection (see December 7) two presentations at The Dome, Brighton, 2.30 and 7pm.

December 15-17
Remote Sensing and the Atmosphere: Annual conference of Remote Sensing Society at the University of Liverpool. Details from Dr A Henderson-Sellers, Geography Department, University of Liverpool, PO Box 147, Liverpool L69 3BX.

THE NEW BUREAUCRACY

Three anti-technology forces in society – the bureaucracy, management and the pure scientists – are coming together under the banner of software in their rearguard battle against the rising power of technology and the technocracy.

by Ivor Catt

What is the nature of the relationship between the manager and the technocrat? Do they, hand in hand, mutually trusting, mutually supporting, venture bravely into a prosperous future? Does the manager never doubt his technocrat's loyalty? Does the technocrat never doubt his manager's loyalty?

My twenty years' experience in ten companies in Britain and the USA indicates that there is deep hostility and fear between manager and technocrat. Currently the manager holds the upper hand and fights a nervous rearguard action against the rising technocrat.

In the early days, a factory was owned by the man who managed it, controlled it and understood all the details of its operation. But later, in the industrial revolution, business and industry became larger and more complex, and the owners began to lose detailed knowledge of their operation. The introduction of the joint stock limited liability company allowed ownership to be fully divorced from the understanding. A professional managerial class developed which knew all the details and was therefore able to make the crucial decisions.

Power passed from the owners to the management, because as J. K. Galbraith says in *The New Industrial State,* power is where the most complex decision making is. Whereas nominally the owner, the stockholders, still had control, in reality because of their ignorance they could only "ratify" the decisions made by the management. In his book *The Practice of Management* Peter Drucker describes how Henry Ford behaved like an industrial Canute when he tried to keep power out of the hands of his professional management, virtually bankrupting his company in the process. Today, as Henry Ford showed, stockholders can only obstruct the actions of company management, nothing more.

The latest shift is in high technology industry, where most complex problems and decisions are technological, so that power should now move from management to the technocracy. We can see bitter battles during the transfer of power, re-enacting what had happened in the Ford company during the previous transfer of control from owner to manager. For example, during my first year in one computer company, employees within the design department who had more than four years of design experience were driven out of the company. Also, it was common to categorise those engineers above a certain level of qualification and experience as temporary (contract engineers), the idea being that a manager can have someone working for him at more than his own salary provided he is described as temporary.

The generally near-bankrupt conditions of most high technology industries can be attributed to the Canute-like rearguard action by management against a new rising power elite called the technocracy. This bankruptcy is both financial and technological. High technology industry not only loses money at an unprecedented rate; it also fails to innovate to any significant degree. We must look through the barrage of propaganda to the reality in order to see this.

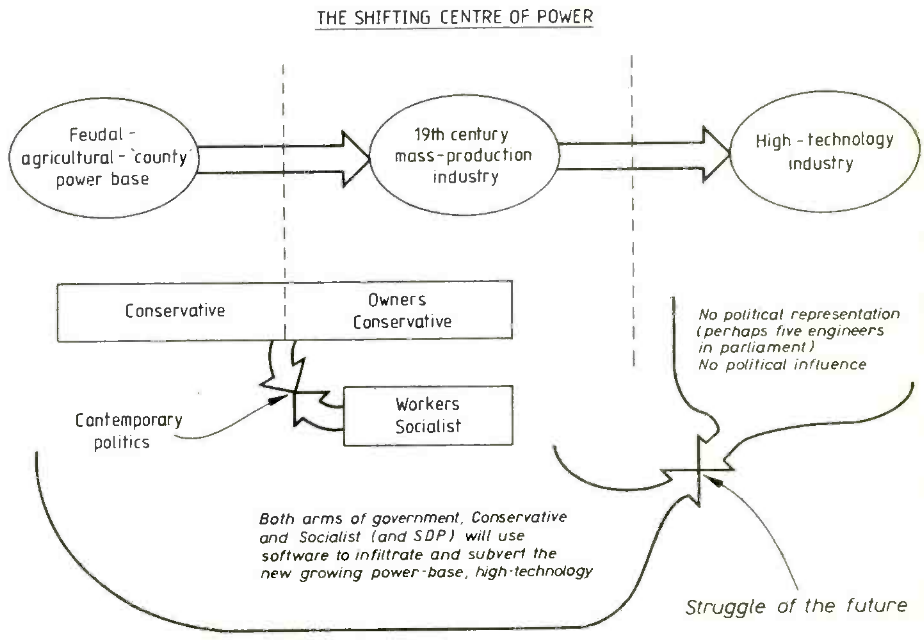
The Henry Ford syndrome affected only some companies during the previous transfer of power. The reason why the present transfer from management to technocracy is so much more acrimonious is because management, already badly paid in Britain, look forward to a greatly circumscribed role in the future, short on money and prestige; very much the role of the doorman at the swank hotel.

According to Galbraith, after a transfer of power to the new group who make the most complex decisions, the old, declining group can only act obstructively. For example, Henry Ford obstructed the work of his rising managerial class. Today, similarly, the declining managerial class obstructs the work of the new, rising technocracy.

In the past, management would wax enthusiastic about simplistic pseudo-technical questions – for instance the alleged brilliance of the technically ignorant Weinstock, head of GEC, Britain's biggest high technology company, when he demanded of his chief engineer that he reduce the number of valves in the television they manufactured from three to two. As background to the story, it did not need to be said that the chief engineer, being technical, would not know, first that two valves cost less than three, and secondly that a cheaper television would sell better.

Onto the scene of this rearguard battle comes software, a simplistic new pseudo-technology with no technical content, administered by programmers who are as ignorant as management when it comes to engineering. There are virtually no so-called 'computer science' degree courses in this country containing any physics or engineering. The arrival of software is a heaven-sent aid to management in its battle to limit the work of technocracy, particularly because software, the modern clerk's job, is in fact low level management work.

It is in the interest of both management and of programmers to play down and limit technology, and they do this by developing the myth that software *is* technical, possibly *the* new technology, putting around such false phrases as "software engineering" and "information technology", although software has no engineering content and the information industry has no technical content, and employs almost exclusively programmers with no knowledge of engineering or even of school physics.



This article is an expansion of the New Bureaucracy theme of the February 1981 leader, developed for "The Software Crisis", last October's conference organised by the Netherlands software association, ASI. New material has been added for this article.

It is a simple matter for the new management-programmer axis to ensure that no new product will be allowed which does not contain at its centre a general purpose (von Neumann) computer, so ensuring that every product or activity in the future will mimic the data processing systems of the past on which both today's managers and programmers cut their teeth. As the cost of such a machine falls, the technically ignorant programmer, egged on by the technically, ignorant manager, infiltrates deeper and deeper into the design of the engineer and freezes it into one particular structure – a structure which is expensive in software overhead, is unreliable, and also runs slowly. Since the machine runs slowly, having at its core a slow microprocessor, more and more engineering activity has to be off-line rather than real-time and the divorce from physical reality, always the objective of the bureaucrats, gathers pace. As in the past the bureaucrat would function in a false, simplistic model of reality, so the new, slow, off-line machine functions in a false, simplistic model of reality. Pressure is then put on reality to conform, and this pressure is exerted by programmers without knowledge of reality, that is, without knowledge of either physics or engineering.

Software is the weapon which the bureaucracy uses to infiltrate into the heart of technology in order to control it and stop it from developing.

In Britain, after many years of inaction, the government recently pumped large amounts of money, into what it called the microelectronics revolution. Virtually all of this money has now been subverted into teaching a whole generation how to program, always in the language called Basic, the language most far divorced even from the reality of the old von Neumann computer. But none of the government intended subsidy of the microelectronics revolution found its way into hardware or engineering.

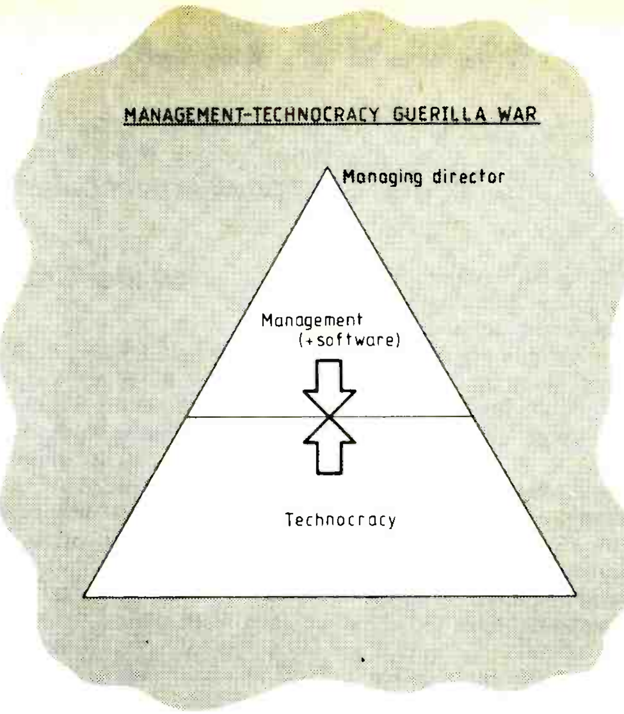
By "von Neumann computer" I mean a machine where one instruction is obeyed at a time and the use of content-addressable memories, also called associative memories, is not allowed. In a content-addressable memory you can call up words of a certain type, rather than having to call for a word by its physical location, as in ram.

Most software techniques turn out to be devices to make up for the defficiency of content-addressable memory. In the 1940s, unlike today, it was technically very difficult to build a content addressable memory, so the von Neumann team did not include one in their machine. Today we refuse to use them because the ancients did not use them.

★ ★ ★

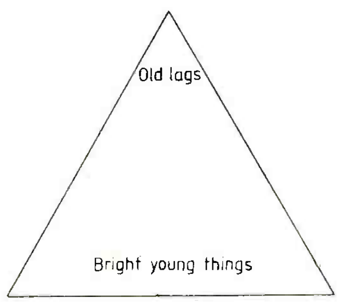
So far, we have seen that the bureaucracy and also management in industry join forces with software in order to subvert and control technology and stop it from advancing.

Up to the present time another quite distinct battle has been fought between the pure scientist and the technocrat. You will all be familiar with this battle, between sacred scientific search after truth on the one hand and profane technological search after profit on the other. In the range from sacred to profane, pure mathematics stands at the most sacred end of the spectrum, then comes applied math, then physics, then engineering. Now the mathematicians, being divorced from the profit motive, found it difficult to make a living. However, a decade or two ago, some of these technology-free individuals



Pyramidal battlegrounds

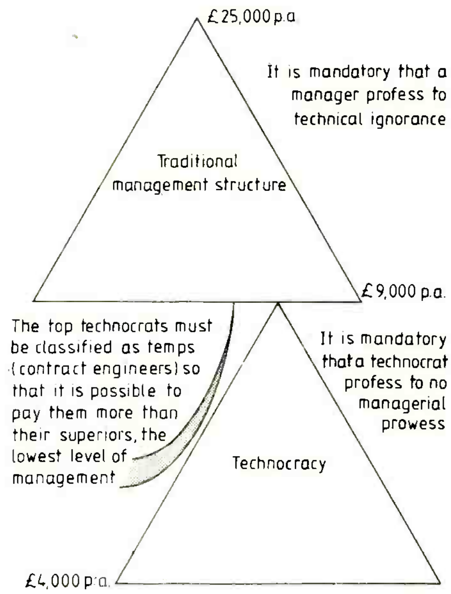
Properly, the technocracy should form a pyramid with the older, more experienced technocrats at the apex and the new, bright young graduates at the bottom.



The True Technical Hierarchy

Overall control and direction will properly come from technically well-qualified engineers with ten to twenty years of design experience. The mature engineer will not only control the way in which major modules in the system are interconnected, but will also direct the detailed design within each module. (A module may be a computer memory, or a correlator, etc.) Management properly becomes merely a service in high technology industry, much as the shareholders do not figure very much in the operation of companies today. Management, like security or health care in a company, is important but not pre-eminent. This is the background against which the present confused reality in high technology industry can be viewed.

Because management maintains the myth that it is still in control, a structure develops as shown.



I once worked in a reasonably small project ($5 million spent in two years, some 40 years employed in it) which because of the above farcical structure had six levels of authority in the administrative tree. One company in Los Angeles at the time, with less than 200 employees, had 12 levels in its heirarchy. This kind of situation results from a defunct management structure trying to sit on top of the real high-technology hierarchy.

In large projects in Britain today, the attempt to make the above structure look more reasonable takes the following course.

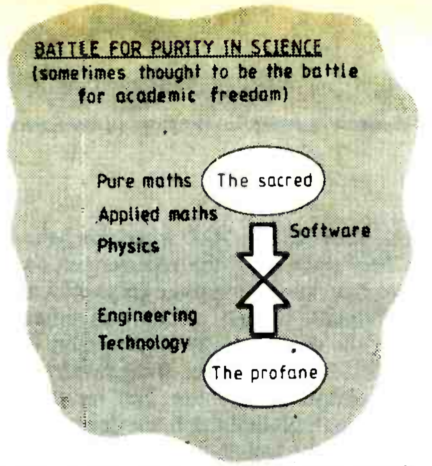
- The work of the technocracy is (incorrectly) broken up into
  – The interconnection of major modules.

stooped to programming in order to earn a crust. They discovered that a lack of knowledge of physics and engineering was no handicap, that programming had no technical content, so, reassured, they called themselves computer scientists (although programming is not a science) and talked about such things as "cybernetics", the "information revolution", and so forth. Without realising it, they were exploiting the fact that the limited technologies of the 1940s and 1950s had led to a very awkward machines, the von Neumann computer, which required the services of large numbers of clerks (programmers) to get useful work out of it.

The fact that many out-of-work mathematicians took up programming meant that software ended up on the side of pure science in its century-old battle against profane applied science.

Programmers managed to get inside the colleges both in Britain and the USA, something digital electronics has still today failed to do, and set up departments in what they called computer science, which must be a false name because in such departments no science or computer hardware is taught, only programming. Further, entrants to such university departments are not required to have any qualification in physics or engineering.

In Britain, the bureaucracy is populated at its upper levels by the old pre-industrial



ruling class, and by tradition they despise management in industry. However, the class origins of the bureaucracy are widening, and both the bureaucracy and management in industry see software as a useful weapon to fend off the growth of technology.

Software unites three previously separate groups, the bureaucracy, industrial management, and the pure scientists, all of whom are opposed to technology.

If we want to prevent such a powerful anti-technology axis from developing, we must ensure that at least the upper levels in the programming industry have some knowledge of technology so that they will come to think in terms of using it rather than merely fearing it as a threat. In the British context, this would be achieved by legislating against any college giving a degree in computer science if the course contained no scientific or technological material, as is the case in virtually all computer science degrees today. There is no possibility that the present industry, containing as it does personnel 98% of whom have no knowledge of technology, will be able to exploit the gigantic potential of digital electronics into the future.

The nature of information

In 1964 Marshall McLuhan discussed the massive increase in the flow of electronic information, and developed the idea that in the future this information would be an important commodity to be bought, sold and processed. For him, information was any signal of any kind. However today, the so-called information industry restricts information to verbal information, a sequence of words and numbers. This restriction in the type of information we are willing to handle cuts us off from the massive potential service that digital electronics offers.

To illustrate the point, I shall ask a question. Suppose that a flying aircraft sends out radar pulses which bounce off other aircraft, or the ground, and return. Are the returning pulses information? If they are, it follows that an information technologist or computer scientist must be qualified in technology, or else the industry will not be able to relate to its potential. If however the returning pulses are not information, then we need to set up a new industry, an "electronic signals" industry, which will have far greater prospects in the future that the small, bureaucratically structured information industry.

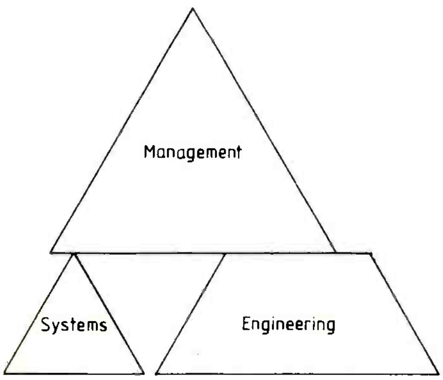
In general, electronic signals will cause machinery to act, and only rarely will these signals be verbalized and put into a form which can be fed into a line printer and processed by a von Neumann-type computer program. Our present insistence that signals should all be of the von Neumann computer-input and computer-output form is hampering our develoment and turning our industry into a mere adjunct of the bureaucracy. WW

This is then called systems engineering, or just "systems".

– Design within one module. This is called engineering, or "design".

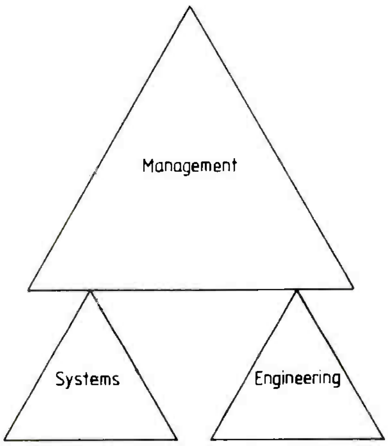
There is a grain of truth, but little more, in the idea that the interconnection of large modules is a more sophisticated engineering task than the microscopic design within one module.

● The technocracy is then truncated, and the upper Systems portion taken down and laid alongside the Engineering portion



● Presumably because it is thought that the interconnection or large engineering modules involves only paths through which information flows, nothing more (it being believed that we live in the information age); the Systems triangle above is populated with young programmers with no engineering competence, while the engineering competence is relegated to the Engineering trapezium on the right.

● Management, because it identifies with software and indeed contains many programmers within itself, then attempts to control (curb) the technocracy, Engineering, at second hand, via Systems. Communication through the dangerous, abrasive interface between Engineering and Management is reduced to a minimum.



Following a divide-and-rule policy, management presides over a field of battle, where each individual in Systems has been allocated a sparring partner in Engineering. One pair will do battle over the autopilot, another pair over the computer, etc. At the top, the head of Systems fights a major battle for control with the head of Engineering. Since obviously little product of value results from all this, the head of one unit has to be fired as scapegoat periodically, say once per year. Again paradoxically, this is usually the head of Systems, the senior programmer, since the head of Engineering controls the real machine rather than merely sheafs of hopeful paper specifications. However, in some projects the pattern is one of alternately firing the head of system and the head of engineering, who dutifully fight to the death as required.

None of this pervasive madness within our major high technology projects is ever discussed or admitted. The cost in human misery is incalculable, while the direct cost to Britain in waste in major weapon and other projects runs in billions of pound per year rather than hundreds of millions.

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Tetrode klystron

It has been said that it was *after* the advent of steam that the greatest progress was made in the design of sailing ships. Be that as it may, it is interesting to note that at the 1982 International Broadcasting Convention at least two of the most interesting new developments were in the form of thermionic devices. Thomson-CSF described their new TH539 tetrode for m.f. broadcasting that is capable of delivering no less than one megawatt of carrier power. And if you still think in terms of receiving-type valves it may be a shock to lean that the TH539 has a heater taking 30V at 900A and an anode current of 90A at 13kW!

But a more fundamentally radical development is the new single-cavity u.h.f. "klystrode" developed by Varian. This, as the name implies, is half klystron and half tetrode and offers the possibility of developing a high-power, Class B, linear amplifier for vision or sound transmissions, as a means of improving overall conversion efficiency. Early power klystrons in vision service were only about 25 per cent efficient at peak sync. output. Since collector current remains unchanged regardless of the input waveform the true conversion efficiency, in terms of kilowatts consumed from the supply mains related to output, was only a few percent. Since then considerably higher efficiencies have been achieved both in the basic klystron design and by the use of pulsers to reduce collector current at other than sync. periods (EEV devices tested on the BBC Crystal Palace transmitters have achieved 70 per cent, measured on the basis of peak sync. output) but the klystrode appears to be the first klystron-type device to offer the possibility of Class B operation. But already, for m.f., all-solid-state sound radio transmitters are now available up to 10kW output.

All digital?

While in the communications field the main emphasis – as noted at Racalex 82 – is on the extension of digital techniques into the analogue domain, it was evident at IBC82 that the vogue phrase now is not "all digital" but "component coded". The separation of luminance and chrominance signals is the key feature of the new generation of integrated camera/recorders using ½-inch M-format (VHS) tape or the ½-inch Beta-format or the Bosch prototype unit with ¼-inch CVS cassettes. At IBC82 most of these equipments were working on the 625-line standard.

Component-coding is also the key to the IBA's MAC (multiplexed analogue component) system that resulted at IBC in many BBC-IBA clashes at a not particularly enlightening level. Philips showed what can be done with 625-line PAL when you have three field stores in every receiver but so far even this fails to overcome cross-effects on movement, though certainly in other respects the digital processing overcomes flicker and interline flicker and provides a really excellent still picture. But for true wide-screen, high-definition television one had to go to the closed-circuit demonstration of the Sony system working on the proposed NHK standard of 1125 lines, 60Hz, 5:3 aspect ratio. Magnificent, near cinema-film quality, but little hope of finding spectrum space for its 30MHz or so of component-coded video, at least in Europe. I came away from Brighton feeling that priority should be given in Europe to raising the field rate on all transmissions to at least 60Hz – it is only when you see 50 and 60Hz systems working side by side that you realise that, as brightness of colour pictures increases, large area and interline flicker are becoming more and more obtrusive.

Excess radio officers

The original *Wireless World*, then under the title *The Marconigraph*, was directed primarily towards the many young radio officers who have been carried on all large sea-going merchant ships since before World War I. It is remarkable how many of the pioneers of radio communications began their careers as brass-pounders.

Today, radio and electronic officers are facing something approaching a crisis. Not only are owners seeking to change the present regulations relating to the compulsory carrying of ROs on coastal ships of more than 1600 tons, but also there has been a dramatic decline in the number of ships, what with the recession and the rise of the super-tanker and the container vessels. Many newly-trained ROs are finding it near impossible to obtain berths and are often taking jobs not requiring Morse operating skills. Yet Morse remains supreme for low-power and emergency communications. I was reminded of this talking to Lady Virginia Fiennes, base operator of the three-year Transglobe expedition at Racalex 82. Both in the Arctic and Antarctic, the notoriously poor radio propagation, with polar cap absorption, multipath and other effects, meant that most of her contacts with her husband Sir Ralph Fiennes and co-explorer Charles Burton were made using hand Morse sent slowly to counter the worst polar conditions. Yet her long-distance contacts with Cove Radio and Portishead Radio, using relatively high-power and good aerials, were on s.s.b. In an emergency or when portable it is still often more useful to have a Morse key than either a microphone or a qwerty keyboard.

Spectrum share-out

Odd things indeed are happening in the field of r.f. spectrum management these days. The interim report of the Merriman committee has not only recommended giving to "land mobile" all and more than they could possibly have sought – denying to British viewers the entire Bands 1 and 3 – but it is being claimed that cellular radio, tried and tested in Japan and the USA, is some entirely new form of technology that will be the responsibility of the Department of Industry rather than the Home Office.

While it can be argued that the present broadcasters have less need than the communications industry of v.h.f. (internationally recognized as economically and technically the most suitable band of frequencies for terrestrial television broadcasting) past experience underlines the inadvisability of one country departing so radically from the ITU frequency table – even though footnotes inserted at WARC 1979 enable this to be done. Police and ambulance communications were prematurely put into the radio broadcasting band. East Europe has sound broadcasting around 70 MHz. Australia originally used Band 2 for television and that delayed v.h.f./f.m. radio and led to other problems.

Transmitter manufacturers will find it more difficult to sell v.h.f. transmitters overseas where these bands will most certainly continue to be the prime television bands. The British public will have no chance of any future development of new standards or systems for terrestrial broadcasting with the four u.h.f. networks already allocated. Educational channels, local community channels, higher definition channels cannot be fully met by satellite or cable. In the past the introduction of new systems has depended upon the availability of alternative bands of frequencies. It will be said that broadcasters have an axe to grind but the fact remains that the public's benefit from the use of a natural resource will be far less in the UK than in almost any other country in the world. Most people would agree that in the past the balance has been weighed too heavily in favour of the broadcasters – but if the Merriman report is accepted it is the land mobile service that will have more than it needs.

Pulses on m.f.

A number of interesting papers on communications and broadcasting topics were presented by guest speakers at a recent two-day antenna symposium run by C&S Aerials. For example J. H. Bote (Birmingham University) described work on automatic, microprocessor-controlled aerial matching units based on simple L networks, suitable for use with any whip aerial over the range 1.6 to 30 MHz. Unlike a comparable system described last year by Dr M. J. Underhill (MEL) in connection with his "quiet tuning" system and using a two-stage pre-matching technique, this is a single unit device, having larger values of L and C (up to 250μH and 9500pF).

Another presentation, by Professor E. D. R. Shearman, was on sea-state detection using radio echoes from sea waves and ships from an installation in Wales, using the active-loop receiving aerial array developed by C&S Aerials. The system has proved able to detect echoes from sea-waves and ships at much greater range than conventional microwave radars. He believes the system may come to be used quite widely for ship tracking.

AMATEUR RADIO

Early in the morning of September 21, big-dish signals from the American Stanford installation finally broke through into the UoSAT command receivers and control of the satellite was re-established. For five months UoSAT would not respond to commands due to the simultaneous activition of both beacon transmitters desensitizing the receivers. All systems appear to have survived and it is hoped to re-activate the full experimental programme of scientific studies, including the use of the c.c.d. television camera.

Propagation study

September proved a month of exceptional propagation conditions on v.h.f. and u.h.f. but with some correspondingly disturbed h.f. conditions. Although the high peak of solar activity of cycle 21 lasted unusually long, at least 2½ years, critical frequencies this autumn are averaging about 1.5MHz lower than in 1981, representing an average lowering of maximum usable frequencies for ionospheric reflection of roughly 5 MHz. The extremely good tropospheric propagation conditions during the second half of September has resulted in CCIR study group 5 seeking information through the RSGB propagation studies committee of contacts of more than 1000km on 144MHz, 500km on 432MHz and 250km on 1296/2304MHz. There were massive auroral events on September 6 and 26 and, on the 22nd, critical frequencies remained below about 4MHz.

Microwave record

An Italian amateur, Nicola Sanna, IOSNY on a visit to the Valencia area of Spain is believed to be the first amateur to break the 100km barrier on the 10GHz band while making three super-refraction contacts over the largely-sea path to the Rome area last July. First contact was with IOYL1 over a distance of 1101km followed by a contact with IWOBFZ (1117km). Then a second contact with IWOBFZ was made from a high location to the west of Valencia over a 1166km path.

A group of microwave enthusiasts from Oxford University took their equipment to Alderney, Channel Islands and succeeding in making mainland contacts on 1.3, 3.4, 5.7 and 10GHz. Attempts to span the sea path on 24GHz were not successful.

Rain-scatter contacts have now been made by Clive Elliott, G4MBS on 5.7GHz but appear much rarer than on 10GHz.

The new h.f. bands

Restricted use of the new 18 and 24MHz became possible on October 1 and a few British stations have been heard. The 10MHz band which was opened last January is proving an excellent band for short, medium and long-distance contacts though one finds, in the evenings, that only a few windows remain usable by amateurs among the many high-power "fixed-service" and Russian coast radio stations. Such stations are not due formally to quit the band for several years yet built seems unfortunate that 10,100 to 10,150kHz seems even more heavily occupied than the neighbouring frequencies, a situation which has encouraged New Zealand amateurs to seek an extension to 10,200kHz with the object of making the band width wide enough to accommodate s.s.b. as well as c.w./r.t.t.y.

Using a home-built 25-watt transmitter in a band in which "dx pile-ups" are rare, I have found it easy going with a simple long-wire aerial to work Canada, Guadaloupe, Australia, Antartica and Japan though one notices that skip distances change rapidly and signals may suddenly fade out or build-up rather quicker than usually experienced on 14 MHz.

50MHz?

Amateurs, if not broadcasters, have reason to be grateful to the Merriman Committee which has firmly recommended that an allocation somewhere between 50 and 50MHz should be made available when Band 1 television ceases. The committee also recommends that closure of the 405-line televison services should be brought forward to 1984 rather than 1986. This augments the earlier announcement that some British amateurs are being granted permission to use 50MHz outside of broadcasting hours.

This will be extemely good news to those enthusiasts who have made so many long-distance cross-band contacts with North and South America during the peak of sunspot cycle 21. It will ensure that British amateurs will be watching for unexpected ionospheric-reflected openings and/or transequatorial propagation (t.e.p.) at all phases of the sunspot cycle.

Nevertheless the new band, if the recommendations are accepted, will have the drawback that it cannot, in Region 1, be an international allocation and is unlikely to be available in many other European countries. This could mean that, as for 70-MHz, the Home Office may be unwilling to make the band available to Class B licensees.

Russian licences

Several of those who argue that h.f. bands should be open to British amateurs without a Morse test, regardless of international regulations to the contrary, have been suggesting that code tests have been abolished in Japan. This is not the case, only restricted low-power h.f. licences are code-free and these are justified under international regulations as being unlikely to cause interference outside of the Japanese islands. Indeed, many Japanese amateurs are fine c.w. operators.

There is, curiously enough, a viewpoint that the traditional approach to the hobby is now to be found mainly in the USSR, where the vast majority of amateurs still use home-built equipment, including many multi-band transceivers. Russia has several classes of licence, including a "novice" licence (EZ-type prefix) for c.w./s.s.b./a.m. operation with 5 watts input on 1850-1950kHz available at the age of 14. There is a v.h.f. licence (prefix begins with an R) for all bands above 30MHz but also allowing use of 28 and 1.8MHz. Although no code test is required, many of these stations use c.w. on 28MHz for world-wide contacts. The regular h.f. licences include no less than three categories with technical and Morse examinations taken at the nearest regional radio club. Russian amateurs are among the most skilled c.w. operators of any national group. The USSR has about 30,000 amateur stations, including club stations, and roughly some 100,000 short-wave listeners, many of whom regularly operate from the club stations. Many eagerly seek technical information from other countries and I have been surprised on a number of occasions to learn in the course of contacts that at least some Russian amateurs regularly read *Wireless World* and other British amateur and professional journals.

PAT HAWKER, G3VA

PICOTUTOR ASSEMBLY-LANGUAGE TRAINER

Machine-code programs run hundreds of times faster than their Basic equivalents and take up significantly less memory space, but they are difficult to write. Assembly language simplifies machine-code programming by allowing hexadecimal-form microprocessor instructions to be written as mnemonics. This simple and economical trainer – designed to illustrate assembly-language programming – can be used for simple control applications.

by R. F. Coates

Most home computers are programmed in what is known as a high-level language, usually Basic, which is fairly consistent between different types of computer and relatively easy to learn as it uses English-like words. But high-level languages are not the native languages of microprocessors and they require a program called an interpreter or compiler to convert English-style language into binary words that can be used by the processor concerned.

There are many applications, particularly in the field of process control and microprocessor-based consumer products, where high-level languages are not used. In these applications, where control rather than computing is the main concern, programming in high-level language can be much more difficult than programming in machine code; but the difficulty of programming using binary numbers remains.

To make machine-code programming easier, a low-level assembly language is used. This enables the programmer to work with English-related instructions, or mnemonics, which can be converted directly into the equivalent machine-code instruction. Conversion is preferably carried out using an assembler program, but it is possible to assemble by hand using a conversion table when working on a shoe-string.

Programs written using assembly language are much more efficient, use significantly less memory space and run faster than equivalent programs written in any high-level language. This can be very important in real-time applications, where even a millisecond can be a long time. Assembly language programming is best learnt by writing programs on a microcomputer and watching them operate. These programs will initially be from existing examples, but later you can generate your own.

The unit described is designed for use with a series of tutorial articles intended to teach assembly language from the ground up and containing many such examples. Each microprocessor has its own specific assembly language and hence for practical reasons the planned articles will be based on the Motorola 6805 used in the Picotutor, but will also refer to the Intel 8080, Zilog Z80 and other eight-bit microprocessors in the Motorola range. Examples written in a general form should allow them to be run on any microcomputer system provided that it has facilities for machine-code programming and is based on one of the microprocessors mentioned.

The Picotutor is designed with price and ease of construction in mind. Only three i.cs are used on the main single-sided circuit board, and one of these is a voltage regulator. Construction should present no problems, even for readers with no previous experience. A second and equally simple circuit board demonstrates how a microprocessor can generate and read analogue signals.

One of the microprocessors of the latest generation was chosen for the Picotutor

Elements of a micro

Microprocessor operation is sequential, i.e. instructions are taken from memory and executed one by one, and some means of timing the sequence of operations is required. The clock used for this is usually controlled by a quartz crystal because of the accuracy required; frequencies vary between about 500kHz and 10MHz, depending on the type of processor used.

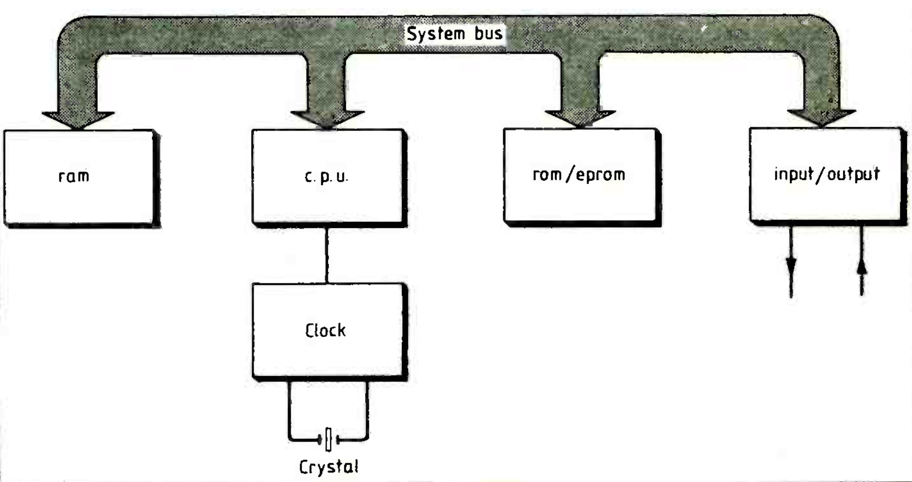
Temporary data storage is provided by random-access memory. Data in this type of memory may be modified by the c.p.u. and is lost when the power is removed.

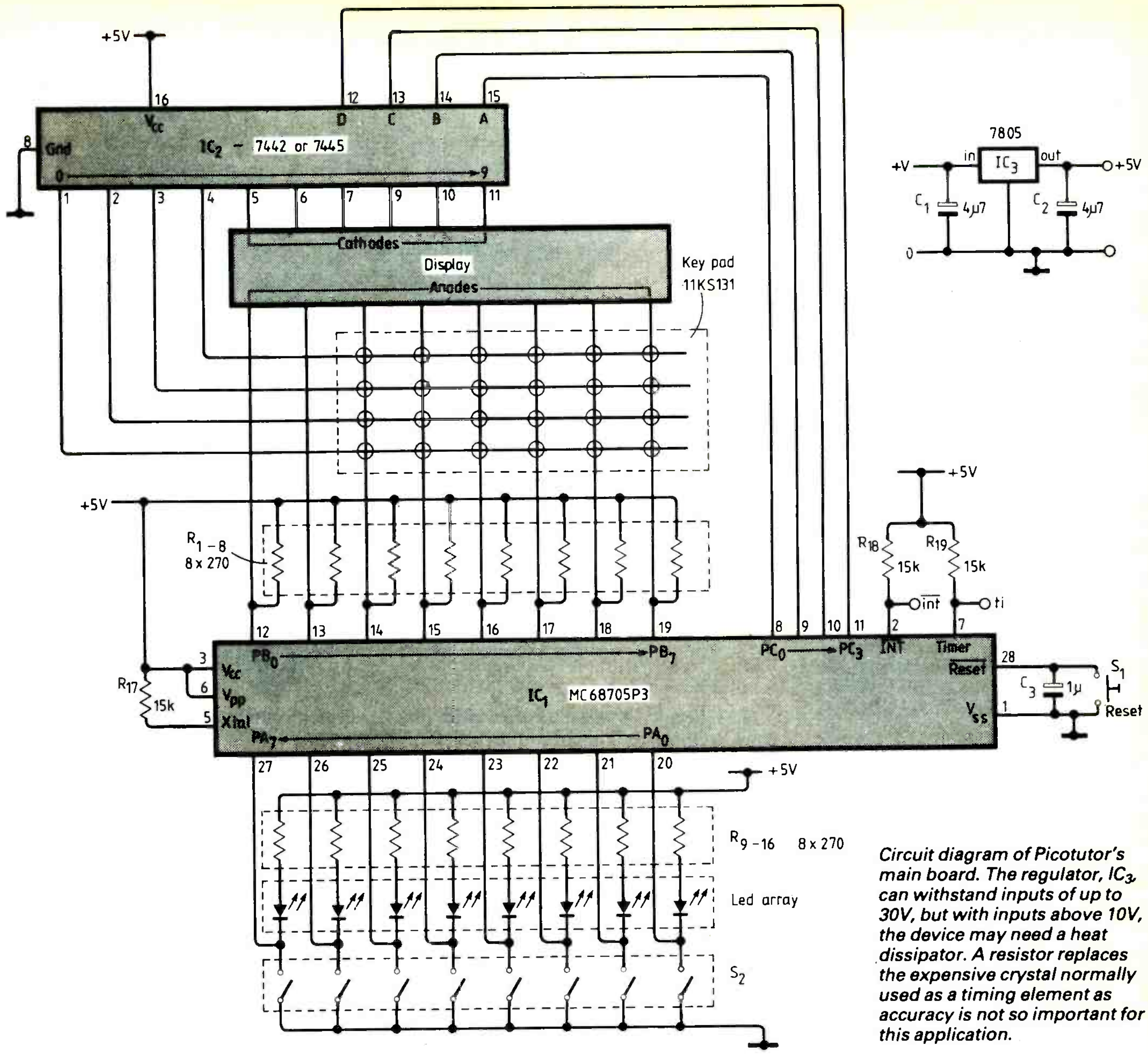
The sequence of instructions that form the program are stored in a read-only memory. Some roms are programmed irreversibly, others may be erased using ultra-violet light and reprogrammed. Both types retain data when the power is removed and every computer requires a memory of this type even if it only contains a program to tell the processor how to load the main program into ram from a storage medium.

Finally, one has to be able to read and modify data within the microcomputer, hence the input/output or i/o section. This may be a keyboard input and tv-screen output in the case of a home computer, or simply logic-compatible lines for reading switches and driving relays, etc.

All of these elements have to be connected together so that data can be transferred between them and that is the purpose of the collection of interconnections called the system bus.

For a microprocessor trainer such as Picotutor all five of these elements are required; c.p.u., clock and i/o are essential in any system; ram is required not only for holding temporary data but also for storing programs that the operator will wish to write and run; and eprom is required to hold a monitor program. This tells the microprocessor how to read the keypad, drive the display, store programs entered and run them when requested.





Circuit diagram of Picotutor's main board. The regulator, IC_3, can withstand inputs of up to 30V, but with inputs above 10V, the device may need a heat dissipator. A resistor replaces the expensive crystal normally used as a timing element as accuracy is not so important for this application.

because the number of components required would be as low as possible, hence the resulting unit would be easy to construct and physically small. Microprocessors of this type containing rom are much cheaper than those containing eprom but the rom has to be programmed during the manufacture of the device so tooling charges levied by the manufacturer make it unviable in quantities of less than about 1000. The Picotutor uses an eprom-based processor. This means that once the unit has fulfilled its original purpose, it may be modified for other applications.

The device finally chosen, a Motorola MC68705P3, is a member of the 6805 family of microprocessors with a pruned 6800 c.p.u. Extra instructions are included to improve its performance in control applications and it has 1.8Kbyte of eprom, 112 bytes of ram and 20 pins that can be individually programmed as inputs or outputs.

Circuit description

Referring to the circuit diagram, IC_1 is the 68705 microcomputer. As a special programmer is required for this device, it is assumed that the processor contains the monitor program (see components list) and that the 21V programming-voltage input is tied to the positive rail regulated at 5V by IC_3.

A crystal is normally used to control the clock but with this microprocessor a resistor may be used in its place. Many applications do not require the accuracy of a crystal so the reduction in cost outweighs the 10% loss in timing accuracy in this case. The resistor concerned is R_1 and a value of 15kΩ gives a clock frequency of about 800kHz.

The reset pin is used to start processing from a known point at switch-on and to regain control if a programme has an error and crashes or runs out of control. An internal resistor from reset to V_{cc} and the capacitor C_3 cause the reset pin to be held low momentarily at switch-on to cause the reset function to take place. When reset approaches V_{cc}, as C_3 is charged up, the c.p.u. starts to run the monitor program. When operating, pressing S_1 will have the same effect.

Interrupt (int) and timer pins are used for interrupting the current program to run a program of higher priority, and to time or count external events. These are not used in the basic unit but are tied to +5V through $R_{2,3}$ and brought out to external pins.

This leaves the 20 input/output lines. Eight of them are not used by the monitor and go straight to two spare i.c. sockets. These can be used to connect the lines to external circuitry such as the analogue interface described later, or an led array and dil switch can be plugged into them to demonstrate input/output techniques. A 10-element led array is used here, as these are commonly available, but only 8 elements are used.

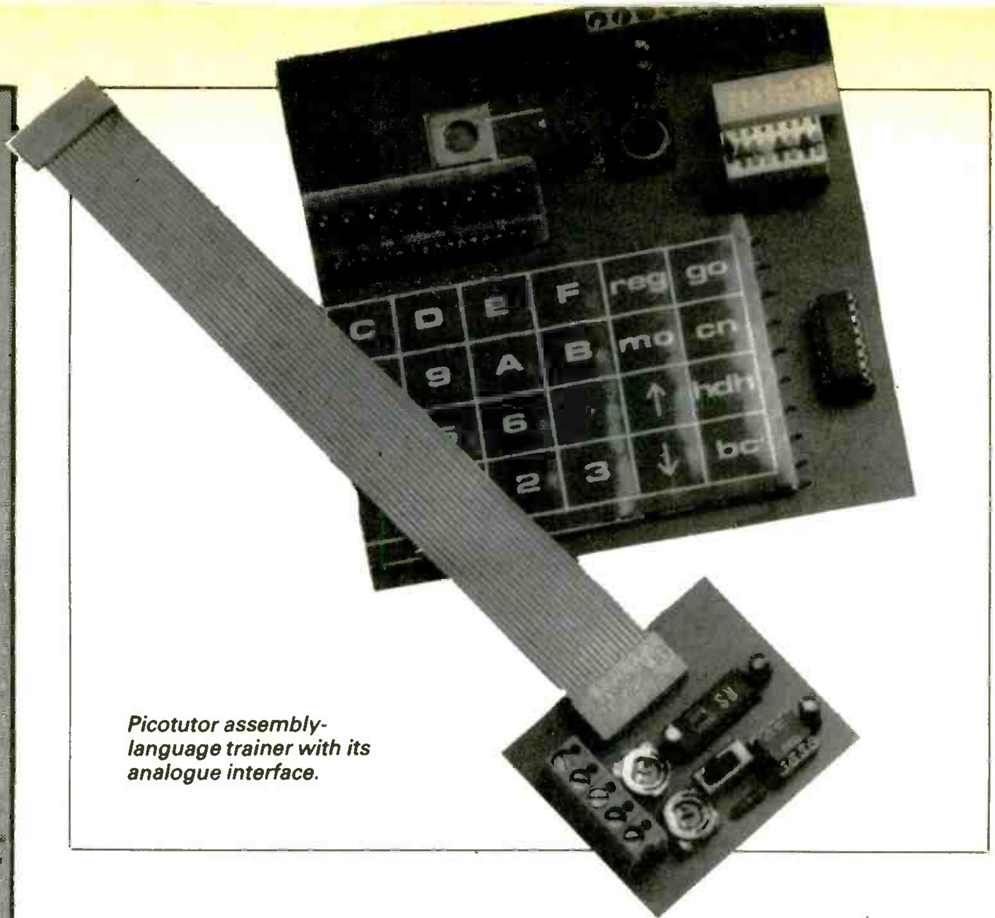
The other 12 lines are used to interface to the keypad and display. Twelve though is not enough so IC_2 is added to increase the number of lines available. Pins PC_{0-3} are programmed by the monitor to be outputs and drive the four inputs of IC_2. This is a t.t.l. 4-to-10 line decoder with ten outputs normally at a logical 1. However, one of the outputs will be at a logical 0.

Components, main board

IC_1	MC68705P3 (28-pin socket)
IC_2	7442 or 7445 (16-pin socket)
IC_3	7805
R_{1-16}	270, 2×sil resistor networks or 16×1/8W
R_{17-19}	15k, 1/8W
$C_{1,2}$	4.7μ electrolytic, 35V
C_3	1μ electrolytic, 10V
S_1	single-pole momentary push switch
S_2	s.p.s.t. 8-way dil switch (16-pin socket)
keypad	Texas 11KS131 with legend
led array	10-bar dil array
p.c.b. with feet	see note
terminal block	vertical p.c.b. mounting, 0.2in spacings

Kits including p.c.b.s and programmed processors are available from Magenta Electronics Ltd, 135 Hunter Street, Burton on Trent, telephone 0283 65435.

Software listings can be obtained by sending an s.a.e. to Wireless World Picotutor, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.



Picotutor assembly-language trainer with its analogue interface.

Which one, is determined by the four-bit binary number on IC_2's inputs. If this number is 0000 then output 0 will be low, for 0001, output 1 will be low, and so on up to output 9. So the four input lines are expanded to 10 output lines.

Consider first how the processor reads the keypad. When the monitor program wishes to read the keypad, the 8 lines PB_0 to PB_7 are programmed by it to be inputs. The resistor network pulls all of the inputs to a logical 1 (+5V).

The keypad is manufactured with its keys arranged as a matrix of six columns and four rows, giving 24 keys, and when a key is pressed a short occurs at the column/row intersection for that key. Any one of the rows can be taken low by the appropriate code from PC_{0-3} and if a key on that row is pressed, the output from IC_2 overrides the pull-up resistor and takes the PB input low.

If the processor now reads the PB lines it will find one of these low, indicating that a key is pressed. By knowing which row is activated and which column is being pulled low, it can determine which key is being pressed.

By activating each row in turn, the complete keypad can be scanned.

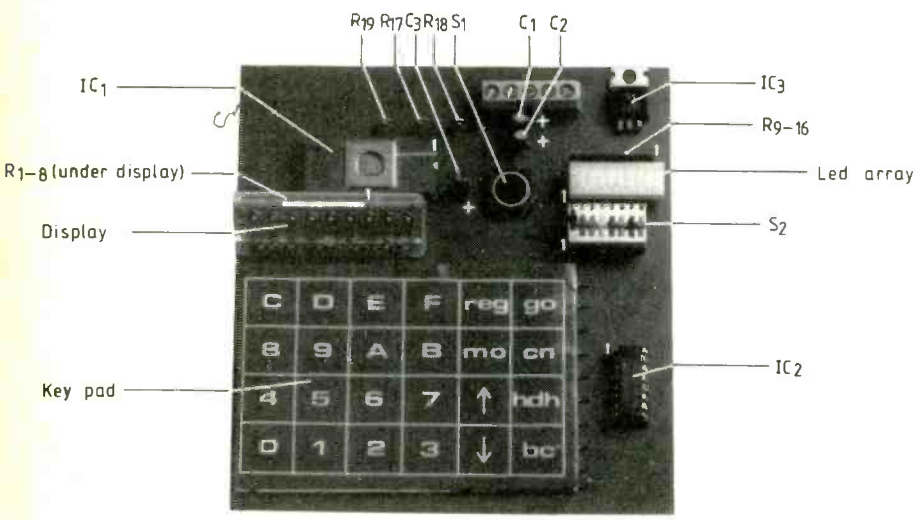
To drive the display, the other six outputs of IC_2 are used and PB_{0-7} are programmed by the monitor as outputs. The display contains eight or nine digits, depending on the type used, of seven segments and a decimal point. Only six of the digits are used in this design and the common cathodes of each digit are connected to the six outputs of IC_2. The segment anodes of the digits are multiplexed together on the display and the eight connections (seven segments and decimal point) are taken to PB_{0-7}.

To light up a digit, the appropriate cathode is taken to 0V depending on outputs PC_{0-3}. If PB_{0-7} are all logical 1 outputs, the anodes will be connected to +5V through the current limiting resistors of R_{1-8} and all the segments of that digit light. The PB outputs can only source a very small current when at a 1 and so have no effect.

If any of the PB_{0-7} outputs are programmed to a 0, they are capable of sinking sufficient current through the resistor to pull the anodes nearly to 0 volts, so there will be no current through that segment and it will not light. Therefore a digit can be made to light the appropriate segments to form an alphanumeric character. This can be done for each digit in turn according to the code from PC_{0-3}. Clearly only one digit at a time can be displayed and the keypad cannot be read when the display is lit.

If each digit is lit in turn, the keypad read, and the process repeated at high speed, the whole operation appears continuous to the operator, except for a slight flicker apparent from the display.

Circuit IC_3 provides a regulated +5V supply from an external power source which should be greater than +7V d.c. and capable of supplying 200mA. The regulator is capable of taking +30V on its input but if the input voltage is higher than 10V, IC_3 will probably require a heat sink.



As the microprocessor i.c. used in the Picotutor has its own ram, rom and i/o section, the only other components required are a keyboard, a voltage regulator, a four-to-ten-line decoder, display/drivers and a few passive components.

To be continued

ENGINEERING AND SOCIETY

Technological choices facing the UK in the regeneration of society, and the part engineers have to play, was discussed in the first part of this article. This final part is concerned with the legacy of humanism and the possibilities of social reform to attain a 'sustainable future'.

by R. W. Howes
M.Sc., M.Ed., M.I.E.E.

Peter Hartley has discussed in fairly general terms the issues of engineering education and social responsibility[13]. He has found that humanism, which involves the 'conquest of nature' is the dominant ideology of modern times; it exists in both capitalist and socialist societies, and its agent is engineering. In engineering, unlike the other learned professions, the practitioner bases his professional judgements not on ethical but on technical criteria. The engineer thus fails to take full responsibility for the consequences of his professional activities. To correct this, it is not sufficient to broaden the engineering curriculum by adding extra courses, it must be radically changed. This change would involve the use of systems analysis to deal with the social effects of engineering; the aim being to design a permanently sustainable social system.

Dr Hartley uses the term humanism to represent the philosophy behind the conquest of nature. I prefer the term 'scientism', a word coined by C. S. Lewis to denote the uncritical acceptance of scientific aims and methods as good in themselves. He attacked scientism in his science fiction trilogy Out of the Silent Planet (1938), Perelandra (1943) and That Hideous Strength (1945), and his philosophical position underlying the trilogy is given in The Abolition of Man (1943). Here he says "Man's power over Nature turns out to be a power exerted by some men over other men with Nature as its instrument". This is quoted by Hartley and is central to Hartley's whole argument.

Humanism as a 'religion' of our time has been analysed by Ehrenfield, one of Hartley's references. It involves a supreme faith in human reason to solve human problems by both rearranging the world of nature and the affairs of men. The use of the word humanism causes confusion since it is not necessarily connected with being humane nor with the study of the humanities. Its historical origin lies in the belief that the natural world has been arranged by God for the benefit of man. In the Renaissance, humanists were those who studied Greek and Roman classics, God became dethroned and man exalted. Organised religion in the West with its talk of our "dominion over all the earth, and over every creeping thing that creepeth upon the earth" (Genesis 1:26), finally brought forth godless humanism.

The Jewish and Christian view that nature is there for the sole benefit of man is discussed in a 'classic' ecological paper by Lynn White[14]. "Our present science and technology are so tinctured with orthodox Christian arrogance toward nature that no solution for our ecologic crisis can be expected from them alone. Since the roots of our trouble are so largely religious, the remedy must also be essentially religious, whether we call it that or not. We should ponder the greatest radical in Christian history since Christ: Saint Francis of Assisi, who was so clearly heretical that the Franciscan Order tried to suppress accounts of their founder's beliefs. He believed in the virtue of humility – not merely for the individual but for man as a species. His view of nature and of man rested on a unique sort of pan-psychism of all things animate and inanimate, designed for the glorification of their transcendant Creator, who in the ultimate gesture of cosmic humility, assumed flesh, lay helpless in a manger and hung dying on a scaffold".

The exploitation and abuse of 'Brother Ox' and other animals has always existed but it has taken the 20th century to produce species extinction on a massive scale by destruction of habitat and by hunting, to use millions of animals in laboratory experiments, and to replace the traditional husbandry of the mixed farm by the mass production techniques of factory farming. We all want cheap food, but on what terms? Tristan Beresford, a farmer and a writer on farming affairs, has commented on factory farming "A sweated pig, an abused fowl, a shorn sheep sent over a mountain pass, suffer as all animals suffer – as wild animals suffer, even to death, with none to relieve the pain. But their sufferings are not cumulative. They do not suffer for one another. But man exploiting animals, and other men by their acquiescence keeping exploitation going, degrade themselves. This degradation is cumulative and indelible. By condoning exploitation we do ourselves an injury. We harden our hearts. We assert the primacy of greed for gain, of ends rather than means. We arrogate to ourselves mastery over life – nothing higher than we. We have the technology and we are the masters"[15].

This example shows that humanism is not necessarily humane but that it is also an article of faith for most people in industrial societies. Its main tenets are that all problems are soluble, either by technology or by social or political means ('social engineering'), some resources are infinite and those that are not have substitutes, and that, whatever happens, human civilisation will survive. To flavour these tenets at their optimistic best the book The Doomsday Syndrome by John Maddox is recommended, or the 'no limits to growth' science journalism of Adrian Berry.

If the humanist tenets are correct, why is Utopia so long in arriving? The usual, but humanistically inadmissible, answer to this is that the delay is due to faults in human nature, which become aggravated in the large scale technologies and centralized control of industrial society. As Professor John Gofman, formerly with the US Atomic Energy Commission, pointed out in 1970 "The environmental crisis is not really a diversion from what might be regarded as the truly important issues of our time – poverty, war, racism, Man's general inhumanity to Man. Rather, it is a manifestation of the ultimate retribution that faces a society which, at best, can be charitably said to be free of a system of human values and, at worst, possessed of a grossly inverted set of values centering around human greed and human power over other humans. There is an unbridled Madison Avenue hucksterism bent upon the creation of products and the diversion of energies into activities, both of which are totally unrelated to worthwhile human needs and goals".

Scientism and its effects

Both scientism and humanism are terms for a belief shared by most people, whether pro- or anti-technology, in industrial societies. Scientists are not necessarily believers in scientism and being on the 'inside' of science may be in a better position to reject it. A major analysis of scientism has been presented by Professor John Ziman[16]. As a leading figure in the SISCON/STS movement, he is concerned with STS (Science, Technology and Society) education, or rather the lack of it. "In the absence of any deliberate discussion about science, science education is naively 'for' science, without qualification or limitation as to its reliability, scope or relevance. More by what it leaves out than by what it actually says, science (as taught) is deeply imbued with scientism. It reinforces without question or comment, the widespread sentiment that science should be the only authority for belief and the only criterion for action". Ziman argues that this has led science to take on the trappings of a religion, complete with its high priests – the technocrats – who provide the only reliable advice. But the scientist, as scientist, is ill equipped by his science to make responsible decisions on political and social matters. "Every form of social action is constrained by imperfect knowledge of the situation, the short time available for cogitation, and the multitudinous possibilities of wickedness and folly".

Since all engineers get basic education in science, and are taught engineering as an applied science according to the Finniston

Report, they are likely to be imbued with scientism. They also have to contend with a popular view in which science is seen as creative and humane, like pure mathematics, whereas science-based technology is often seen as debased and destructive (in terms of TV programmes 'Tomorrow's World' versus 'Horizon' perhaps). However, as an engineer's experience on the job increases, he starts to appreciate how little science can tell him about complex systems and their interactions, how varied are the technical options in any given problem, and how intractable are the ethical dilemmas associated with intervening in the real world. Far from being a technocrat, he probably feels 'on tap, rather than on top'. Technologists are needed by society, of course, as were scribes or blacksmiths in earlier ages. In positions of high responsibility in industry or government there are few technologists compared with people trained in law, accounting and business. Real power lies not with the technologists but with the rich, the bold and the clever – and their friends – just as it always has.

Science is taught as if it had a high intrinsic worth but is otherwise morally neutral and value free, but this is no longer how it and its products are seen. For young people especially, physics is the bomb, chemistry is pollution and biology is germ warfare. Others still see pure science as neutral but liable to be abused when it is applied. Yet others see technology as still neutral but liable to produce bad unforseen side-effects. Many feel that progress cannot be stopped and that whatever technically can be done, will be done. This is illustrated by the remark by J. Robert Oppenheimer on the atomic bomb 'It was technically sweet, so we had to go ahead and do it'.

The Manhattan Project should remind us that science and technology cost a great deal of money and that you get what you pay for. For example, what do we pay for in the UK? In the UK R and D budget for 1982 more than half the money goes to defence, and of the remainder more than 20% goes to the AEA for civil nuclear power. Most industrial nations would show a similar breakdown, with the bulk going to defence, space and nuclear R and D, and what is left going mainly to economically motivated research. Health, welfare and environmental protection do not tend to get much R and D funding. It is not surprising that with these financial inputs we get appropriate outputs – outputs characterized, as Professor Steven Rose points out, "by the continued escalation and technological innovation of the arms race, the technological gigantism of such projects as the space race and Concorde, and by the lop-sided economic and social development which characterizes almost every country in the world". Since society, or rather certain groups in society, can decide on the outputs, this means that science loses its moral neutrality and technology loses its inevitability. Science and technology are planned and if we do not like the results, it is time we got in on the planning act. Isn't this what a democratic society is supposed to be all about?

In 1961, in his farewell speech to the nation, President Eisenhower warned about the influence of the military-industrial-complex (MIC). Its activities in the electronics field have been the subject of lively debate in the editorial and correspondence columns of *Wireless World* during the last four years. A recent book[17] by Lord Zuckerman, formerly Chief Scientific Advisor to the British Government, places much of the blame for the uncontrolled exploitation of new scientific knowledge on the technologists, who did not simply act as the servants of politicians and military chiefs but themselves initiated new developments and created new demands. As current examples of the weapons technologists pre-empting political decisions he gives Chevaline, the Polaris missile updated to defeat a Soviet ABM system which did not exist, and Trident, the Polaris replacement. He concludes: "A new future with its anxieties was shaped by technologists, not because they were concerned with any visionary picture of how the world should evolve, but because they were merely doing what they saw to be their job".

The activity of the MIC in developed countries tends to distort developing countries whose leaders are often military dictators who are firmly plugged into an overdeveloped world of electronic surveillance systems, computer printouts and helicopter gunships. Arms sales to the Third World and to all the oil rich states of the Middle East provide a vital source of revenue and employment to Western and Eastern governments, suggesting that modern industrial societies need, or at least choose, the Cold War and the arms race as ways of absorbing their surplus production.

The civilian equivalent of the MIC is found in large-scale capital-intensive complexes, usually subsidized by the taxpayer, such as nuclear power and road transport. John Tyme[18] argues that the scale of these technocracies is now such that there are no effective checks or balances on them within the UK system of government. This characteristic of our age he calls the technological imperative. Its component parts are the technology itself, the firms who invest in and build and use the hardware, the technologists who provide the expertise and whose careers are dependent on the industry, a 'lobby' based on the industry to influence MPs and others in government, an 'interest section' within the relevant government department which co-operates with the lobby so that decisions are made in its favour, and finally those journalists who attempt to persuade their readers with repeated slogans in favour of the lobby such as 'Road haulage is efficient, being door-to-door, while rail haulage is inefficient' or 'Electricity generated from nuclear power is cheaper than that generated from any other source'. In spite of reports by House of Commons and House of Lords Working Parties and Select Committees on the mode of operation of these complexes, the professional lobbyists can still get to work, prating about freedom and sheltering their profligacy behind the excuse of consumer demand, to flatten all protest.

These features of modern industrial society manifest the scientism, in its naive form of materialism, that has been evident since the Industrial Revolution. Lord Clark[19] in his chapter entitled Heroic materialism quotes Wordsworth's poem on the arrival of the night shift:

Within this temple, where is offered up
To Gain, the master idol of the realm,
Perpetual sacrifice.

Clark comments: "Lots of squalor, and, in the luxury, something parasitical. One sees why heroic materialism is still linked with an uneasy conscience. It has been from the start". A recent critic echoes this when he says: "In the nominally Christian West the political establishments, which for centuries have openly worshipped money and profit and ignored the fundamental teachings of Jesus, do in fact sense in Marxism a moral challenge to their shallow and corrupted values and it makes them very uncomfortable".

However, as I pointed out in a letter to *Physics Bulletin* (December 1979), the state capitalism of the East shows a face even less acceptable than the individual capitalism of the West. Both these forms of capitalism are wasteful and exploit natural resources beyond the limits of sustainability, and are committed to giant industrial systems beyond the limits of human scale. The Soviet experiment in socialism went off the rails long ago and in the rush to become a major industrial power after 1917 the USSR embarked on a large-scale experiment in 'social engineering' which involved death and misery for millions of its subjects. Perhaps there is no genuine conflict based on ideology ('freedom' versus 'socialism') between the two superpowers who represent the two forms of capitalism. Each needs the other as an excuse for holding together its sphere of influence and for justifying the activities of its MIC.

The problem of reform

It is easy to criticize, but very difficult to reform industrial society. A change towards a sustainable society with reduced input of energy and resources and reduced output of goods will involve a reduction in the material 'standard of living', although it could increase the 'quality of life'.

In considering changes in technology it is important to separate out those sectors of society which are likely to benefit and those which are likely to suffer 'disbenefit'. To give one example only, the majority of the UK population does not have the discretionary use of a car, as even now less than 60% of households are car owning. A curtailment of private transport in order to improve public transport would reduce the standard of living of the car owners. This is unlikely to be accepted voluntarily because the decisions in society are made by car owners who are quite prepared to inflict the disbenefits of their use of cars on others. Even those without cars will say they want cars because they wish to enjoy the advantages of mobility

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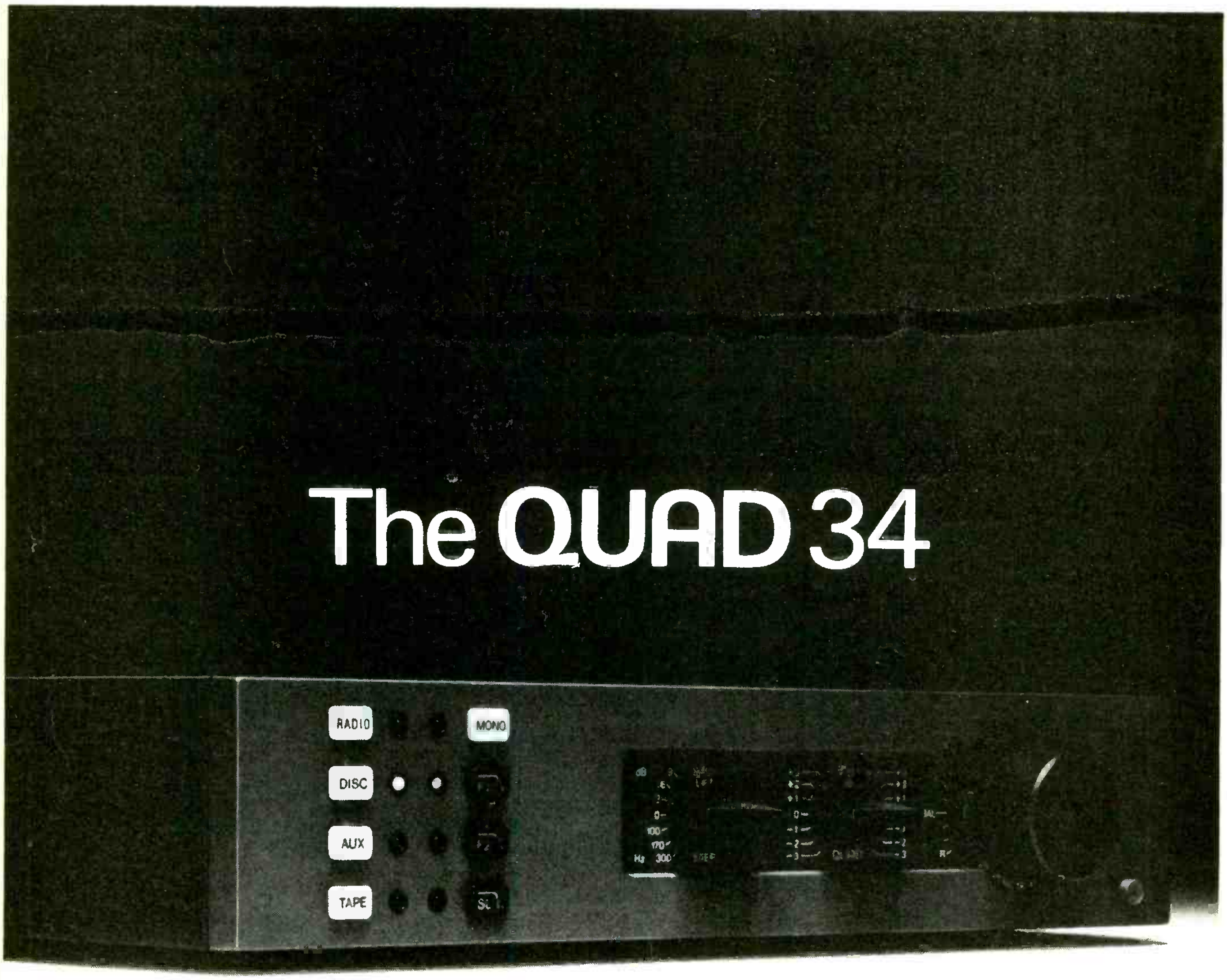

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and convenience. Disbenefits, including the fact that UK road casualties are equivalent to those produced by a continuing, medium-sized war, are not seen as relevant. This collective degradation, which results from a large number of individuals trying to maximize their own advantage, is an example of what Garrett Hardin calls "the tragedy of the commons", the phrase originating from the overgrazing of common land. Hardin argues that such problems, which also include the arms race, cannot have a technical solution and can only have a social one, such as 'mutual coercion mutually agreed upon'. This last tends to work in small village-sized communities but not in large urban ones.

If change towards a sustainable society is unlikely to come about by democratic means, it might be enforced by circumstances. It could even be imposed by an anti-technology totalitarianism – some sort of neo-feudalism arising from the devastation of nuclear war. Stemming from scientism, there is the widespread assumption that the future is under our control. We believe that we can reshape the environment, cure the ills of the human body including cancer, manipulate human behaviour and even the human brain, bypass evolution, and, when spaceship earth will serve us no more, move out into new habitats in space. But in fact our power to control the future is very limited. Circumstances may well arise which will force us in directions we do not regard as acceptable. Even if nuclear war is avoided, resource scarcity and structural unemployment could lead to a polarization of society, both within the UK and also between developed and developing countries which will lead to conflict. Rather than wait for a catastrophic change later, it is advisable to start a planned reduction in inputs now.

The scope of systems analysis

Hartley sees systems analysis as necessary to the design of a permanently sustainable social system. Certainly there is a need to think creatively about the system as a whole, but the engineering discipline of systems analysis tends to be used to optimize a partial system model. The systems analyst decides on the system boundaries and sees himself set apart from the problem which he investigates as a neutral observer, using standard techniques such as PERT (Program Evaluation and Review Technique) and CBA (Cost Benefit Analysis).

The Club of Rome report 'Limits to Growth' used a systems approach for their 'world dynamics model', but as their critics pointed out the model was too highly aggregated (e.g. no one can starve unless everyone starves) to be a valid prediction. However, the model was intended to produce changes in policy to avoid its more unpleasant scenarios, and many of its critics all too obviously had a vested interest in ensuring that no such policy changes were made. The system boundary in this model was presumably intended to include the policy makers.

Failures in man-made systems have shown that it would be arrogant to think we can manage and plan systems whose total structure is not understood, many of whose interactions are completely unknown, and of which we form a part. If we look for sustainable systems, living organisms and eco-systems provide examples. These do not operate by a linear chain of cause and effect but by cyclical patterns of feedback loops. Homeostasis and harmonious interaction rather than continued growth characterize their behaviour. The continual economic growth of our industrial systems would correspond to cancer.

The instabilities in industrial society are increased by those who are able to use technology to promote their own short-term interests at the expense of the long-term interests of the society as a whole, as the 'tragedy of the commons' shows. The problem is how to control large-scale technologies, and how to build into the process systemic checks and balances. This will not be easy. In the infancy of a technology, e.g. the internal combustion engine, it is difficult to predict its social impact; and in its maturity it is difficult to change, as society and other technologies have adapted to it.

Some suggestions have been made earlier which may be relevant. These include a much more open decision-making process, more citizen participation in planning, a reduction in scale of new projects and, of course, a new sense of social responsibility by the technologist. David Collingridge[20] has developed a theory of decision making in which a decision about technology made under conditions of ignorance should still be reversible even when the technology is fully developed. His case studies include aspects of the arms race and also the lead-in-petrol issue. The problem of the continued monitoring of advanced technologies has been considered by the Council for Science and Society. Experts available are seldom, if ever, impartial, and should be considered instead as committed advocates. At Walter Patterson, spokesman on nuclear matters for Friends of the Earth, has said, "I am sometimes accused of being emotional in opposing nuclear power, but you should just see the emotional commitment of the nuclear lobby".

Systems analysis clearly does not go far enough if genuine participation in technological decision-making is required. The system analyst is still an external expert and the analysis itself is a logical process which is not entitled to make value judgements, even though science is often used to disguise or legitimize biased decisions (often in favour of some 'technological imperative'). Such a decision is not acceptable to those people on the receiving end, simply because they played no direct part in reaching it. Decisions involving value judgements are thus political, not technical, and should be recognized as such.

Current measures in engineering education

From the late 1960s onwards, various university courses were started in the USA

In our next issue

Eprom development aid describes a method for developing Nanocomp eprom software in the locations for which it is intended, removing the problem of software juggling. Deviser of the method, G. Bettridge, includes a small copy program in his description.

In a description of a servosystem, J. J. Tait demonstrates another advantage of digital filtering over analogue methods. Synchronous generation and filtering provide accurate feedback conditioning over wide frequency ranges.

Basic program simplifies calculations and presents data in tabular form in A. Maciejewski's article on **matching tuning diodes.**

Data acquisition on a Pet is discussed by two authors involved with microcomputers in education – Harvey and Hills. Circuits and software are for multiplexed reading to ten or 12-bit analogue signals and 8-bit digital information, using control lines easily synthesized by other microcomputers.

Also in this issue . . Boris Allen looks at the logic of logic related to computer languages, Tim Forresters' third article gives regulator and f.m. i.f. modules of his two-metre transceiver, and John Watkinson discusses data integrity – the final subject in his illustrated description of disc drives.

Dec 15

dealing with STS issues. A good example is the work done by the College of Engineering at the University of Utah[21]. This book includes in its extracts 'The tragedy of the commons' by Garrett Hardin.

The interdisciplinary courses of the Open University are justly famous and the following are particularly relevant: The technology foundation course T 101 which, from its first tv programme 'Facts are not enough', stresses the importance of values in technological choices (its predecessor T 100 pioneered the study of 'not just the how, but the why and should of technology'); T 263 (originally T 262) on design and technology; T 361 on the control of technology. Many other OU courses are relevant, including several systems courses.

The Science in a Social Context (SISCON) project was set up in 1973/4 among several universities and polytechnics. It has produced a large number of course units and is coordinated by the Department of Liberal Studies in Science at Manchester University. Some teaching material has also been produced by the General Education in Engineering (GEE) project (Bath University). SISCON's extension into Colleges of Further Education, schools and elsewhere is planned via its progeny the STS Association (STSA) which was inaugurated in 1979. The STSA Support Centre is at Newcastle-upon-Tyne Polytechnic. These projects have found that there is still resistance to STS studies from some single-subject specialists. The latter tend to fall into two groups, the old fogies who oppose from conservatism and the young thrusters who oppose because of their total confidence in their discipline and complete dismissal of anything outside it, i.e. from scientism.

The Engineering Responsibility Forum was set up in 1978 by some IEE members. It has now become the Engineering and Society Group of the Management and Design Division of the IEE. Its scope is convervation of resources, responsibility to the community, the image and role of the engineer, the impact on the environment including aesthetics etc., the implications of change, and national engineering manpower requirements.

Several UK engineering courses are concerned with the design and practice of appropriate technonology, often in a Third World context, e.g. Department of Engineering, Warwick University; Department of Engineering, Reading University; Department of Mechanical Engineering, Queen Mary College (University of London); School of Engineering Science, Edinburgh University. Several others are doing research work on renewable energy sources, e.g. University College Cardiff, Brighton Polytechnic.

Mention should also be made of the following organizations, even though some of them are not directly connected with engineering: The Conservation Society, Friends of the Earth, The Council for Science and Society, Social Audit, Intermediate Technology Development Group, Industrial Common Ownership Movement, Parliamentary Liaison Group for Alternative Energy Strategies, Science in Society Project (Association for Science Education), Society, Religion and Technology Project (Church of Scotland), Society for Social Responsibility in Science.

Conclusions

This article has discussed some of the issues raised by the statement by C. S. Lewis 'Man's power over Nature turns out to be a power exerted by some men over other men with Nature as its instrument', and has considered the implications this has for the professional activities of engineers. Several quotations have been given which show that 'many thoughtful people in positions of responsibility' realise that in the long-term industrial societies are not sustainable on this planet and that worldwide industrialization will lead to a further degradation and possible destruction of the biosphere. What was once the province of 'subversive' eco-freaks is almost becoming the new conventional wisdom. A recent OECD (Organisation for Economic Cooperation and Development) report entitled 'Economic and Ecological Interdependence' warns of impending ecological disasters resulting directly from economic exploitation, and asks "If short term advantage destroys the resource base what could be more uneconomic? In the UK, there have been reports such as the 1981 Monopolies Commission report which was highly critical of the CEGB forecasts which were being used to justify the massive nuclear power programme. However, although politicians may give lip-service to the slogan Small is beautiful, the proposal that industrial societies should drastically reduce their energy and resource inputs is dismissed as Utopian. The problem of confronting the powerful vested interests that benefit from the present system and that oppose any fundamental institutional change has yet to be faced.

This raises the question of the values underlying industrialization, in particular the fact that we get the science and technology we pay for, and so can choose our possible futures. Because of this, science cannot be considered as morally neutral and purely objective, and technology is not an unstoppable juggernaut. In the large-scale technologies and the centralized bureaucracy of a modern industrial state, participation by the citizen in decision making is minimal. Using a 'whole-system' approach, we need to explore the untidy and unpredictable middle ground between old large scale industries and AT village size communities, where participation tends to be effective. In the medium-term some of the former might end up by being almost fully automated (e.g. mining, steel production), small-scale technology-based industries may continue to thrive, but the structural unemployment among the unskilled and the young will remain a problem. Two aspects of RAT philosophy may help here. The need exists for labour-intensive activities, such as repair, recycling, reclamation of land, restoration of buildings for food production. Secondly, we should think of new concepts of work, far removed from the philosophy of the Manpower Services Commission, possibly in the form of initiatives such as those recommended by the Council for Science and Society. We need to heal the disastrous divorce between brain, hand and heart which seems to characterize the 20th century. This may involve an entirely new relationship between man and the rest of nature, which will be an essentially religious one.

Looking at the short-term future, we must realise that most people are not willingly going to see their standard of living fall. A major drive towards a softer-technology future carries within it the possibility of an eco-Fascism (soft technology with hard politics). We should recognize that most people, even if they had the option, prefer life in high-rise flats and office buildings to the rigours of hill farming, and like spending their money on cars and electric tin openers. We should remember that past ages when people lived more in tune with nature were also characterized by callous brutality, unrelievable pain and the ever-present threat of untimely death. Today such horrors tend to be localized, for those of us in the UK, to repressive regimes far away.

The engineer should realise that if he refuses to concern himself with the social implications of his work because this is being 'political', such a refusal is still a political stance because it constitutes a defence of the *status quo*. The implicit politics of energy consumption is shown by Ivan Illich's remark "If you tell me how fast you travel, I'll tell you who you are".

To alleviate the problems of industrial societies and those of the Third World, and to move gradually towards more sustainable futures, we are going to need more, but different, technology rather than less. As Robert Pirsig has told us, "The flight from and hatred of technology is self-defeating. The Buddha, the Godhead, resides quite as comfortably in the circuits of a digital computer or the gears of a cycle transmission as he does at the top of a mountain or in the petals of a flower. To think otherwise is to demean the Buddha – which is to demean oneself". WW

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TWO-METRE TRANSCEIVER

These transmit converter and power-amplifier/regulator modules are part of a multi-mode two-metre transceiver. The microprocessor-controlled design comprises ten modules, the first of which was described in the November issue.

by T. Forrester, G8GIW

The transmit converter, module 2, is similar to the receive converter in that it uses the same type of helical filter and an MD108 mixer. It would have been possible to use the same mixer and helical filter for transmitting and receiver but despite the extra cost I decided to keep them separate to avoid the risk of instability caused by transmitter r.f. being fed back through the receive path and into the transmitter amplifier.

The 9MHz transmitter i.f. signal from module 7 yet to be described is amplified from −30dBm to −5dBm by a class A amplifier based on a 2N3866. Should the synthesizer lose its lock, this amplifier can be turned off, so disabling the transmitter. The amplified 9MHz signal is then passed through a −6dB pad to the MD108 transmit mixer.

An amplifier similar to the one used in the receiver feeds the mixer, through a −6dB pad, with +7dBm of local oscillator drive at 135MHz. The mixer output provides approximately −25dB of local-oscillator rejection so the local-oscillator level at the mixer output is approximately −20dBm while the wanted signal is −18dBm (see transmitter block diagram).

Local oscillator and difference signals (126MHz) are removed by a helical filter which also limits the transmitter bandwidth to the two-metre band and makes it impossible to accidentally tune the transmitter to the difference frequency due to the relatively low bandwidth of the filter.

In between the mixer and helical filter is a class A amplifier, Tr_{201}, which provides +14dB gain to compensate for the filter loss and present a reasonable level of −10dBm to the next stage.

Transistors 202 and 203 are both 12dB class A amplifiers whose collector currents are set to 40mA each by the 1kΩ potentiometers, R_{213} and R_{217}, in the base circuits. Tr_{203} has a broad band-pass pair before passing the signal on to Tr_{204} and Tr_{205}, whose quiescent collector currents are 7mA adjusted by R_{227} and R_{231}; the output power of Tr_{205} is around 1½ to 2 watts.

Power for the transmit converter is a 10V regulated supply from the power change-over circuits, module 3. Bias for Tr_{205} and Tr_{204} is further regulated at 5V before being fed to the bias diodes, D_{200}, $_{201}$, which are mounted in thermal contact with their respective transistors.

This unit is the most difficult to align due to the number of trimmers etc. It could be replaced by a ready made module, but at the time of writing their cost is prohibitive and they tend to be class-C types which are unsuitable for s.s.b.

The ideal instrument for aligning this unit is a spectrum analyser but this type of equipment is not likely to be available to the average constructor; the simplest alternative is to use a diode probe and gradually move down the amplifier chain, tuning for a peak. A second alternative is to a use receiver with an adjustable attenuator, etc.

Although these are not particularly scientific techniques, they should be sufficient, providing that care is taken not to introduce instability during tuning by the presence of the probe. If trouble with instability is experienced when using a diode probe an absorbtion wavemeter may be loosely coupled to the stage being tuned.

The prototype was initially aligned using a spectrum analyser and found to be stable, regardless of trimmer adjustments etc., so little trouble should be experienced.

Transistors 200 and 204 have clip-on heat sinks fitted, while Tr_{205} is attached to a copper heat-sink. Components associated with Tr_{204}, Tr_{205} are assembled in a point to point manner to keep lead lengths as short as possible.

Circuit-board mounting methods and filtering techniques used for module 1 apply here also.

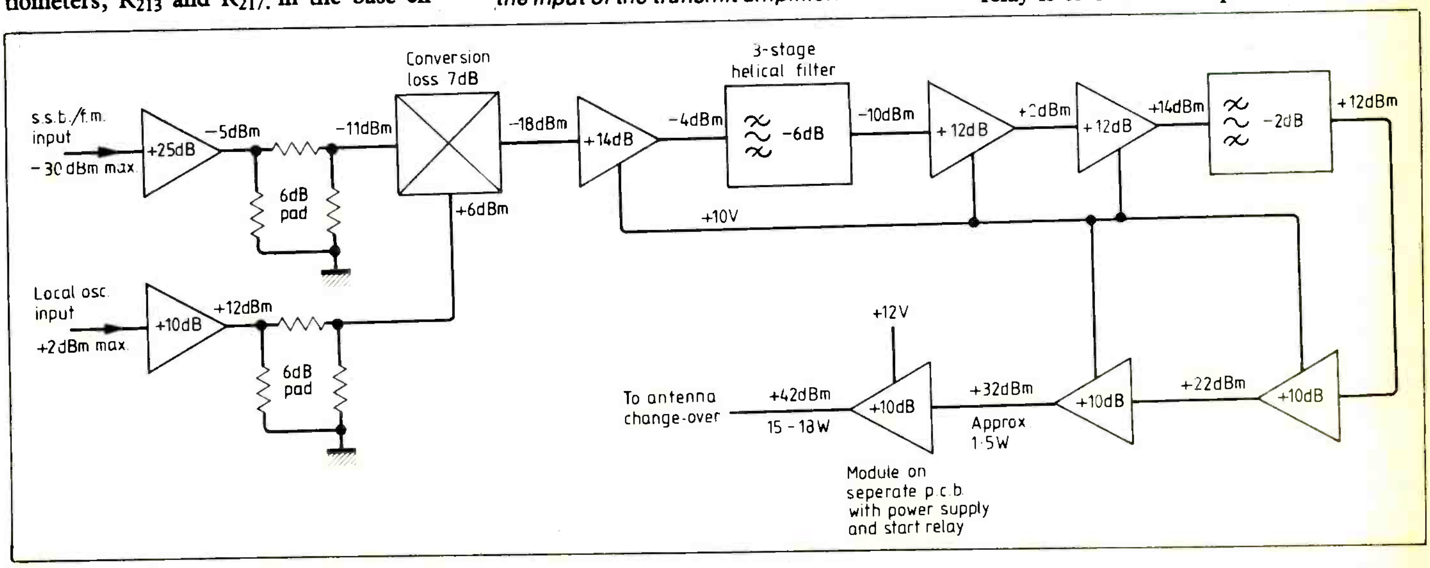
Power section – module 3

This module contains the transmitter final stage, the start relay (a relay which feeds the power to the entire transceiver), and some of the power change-over circuits. Transistor switches are used to change the power feeds over from the exciters to the receive sections, while a 12V feed to the transmitter power amplifier is permanent because a transistor switch here would lead to inefficiency.

Two regulated 10V power lines are provided from this unit, one switched, Tr_{302} etc., and one unswitched, Tr_{305} etc. The unswitched 10V line is used to power the synthesizer, tone burst and a.f. pre-amplifier, while the switched 10V line is used to power the transmit converter, final stage power-amplifier bias and antenna change-over relay. The 12V rail direct form the start relay, RL_{300}, is switched by a single transistor, Tr_{304}, to the receive converter.

Transistor 300 associated with the start relay is to overcome a problem associated

Fig. 1. Transmit-converter block diagram. The helical filter and Schottky-diode mixer used in the receive converter are duplicated here as switching them between circuits may cause instability due to r.f. feedback through the receive path to the input of the transmit amplifier.



Components

Resistors

200	1.8k
201	3.3k
202	27
203, 207, 221, 310	22
204, 206, 224, 225	
308	150
205, 226	36
208	4.7k
209	820
210, 223, 307, 309	100
211	560
212, 216	1k
213, 217, 231	1k sub-min preset
214, 215, 218, 219	10
220	6.8k
222	2.7k
227	50 sub-min preset
228, 229	180
230, 303, 306, 312	470
300	12k
301	33k
302, 304	330
305	2.2k
311	4.7
312	470k

Capacitors

200, 201, 203, 209, 227, 305	10n disc
202, 204, 206, 210, 213, 215, 218, 219, 222, 223, 224, 304, 310	1n disc
205, 208, 211, 216, 228, 231, 236, 237	1n chip
207	18p disc
212	15p disc
214, 217, 220, 303	33p disc
221, 233, 234, 302,	27p disc
225	10p trimmer
226, 239	15p trimmer
229, 230	2.2μ tantalum
232, 235, 238	30p trimmer
300	13p trimmer
301, 307	40p trimmer
306	100n disc
308	22p trimmer
309	1p disc

Inductors

T_{200}	6 turns primary, 2 turns secondary, 30 s.w.g. on T68-2 toroid*
T_{201}	as previous but on T37-12 former
L_{200}	3½ turns, 20 s.w.g. tinned copper 6mm mean dia.
L_{201}	4½ turns, 20 s.w.g. tinned copper 6mm mean dia.
L_{202}	5¾ turns, 20 s.w.g. tinned copper 6mm mean dia.
L_{203}	3 turns, 20 s.w.g. tinned copper 7.5mm mean dia.
L_{204}	5 turns, 20 s.w.g. tinned copper 7.5mm mean dia.
L_{205}	1 turn, 20 s.w.g. tinned copper 7.5mm mean dia.
L_{206}	4 turns, 20 s.w.g. enameled copper 7.5mm mean dia.
L_{207}	4 turns, 20 s.w.g. enameled copper 7.5mm mean dia.
L_{208}	6μ fixed
L_{300}	4 turns, 20 s.w.g. tinned copper ¼in inside dia., ½in long
L_{301}	2.2μ sub-min r.f. choke
L_{302}	as 300 but ¼in long
L_{303}	2 turns, 18 s.w.g. tinned copper 5/16in i.d., ½in long
HE_{200}	3-stage helical filter, part number 17-10063*

Semiconductor devices

$Tr_{200, 202}$	2N3866
$Tr_{201, 206}$	2N918
$Tr_{203, 204}$	2N3553
Tr_{205}	BLY83
$Tr_{300, 301, 303, 304, 306, 307}$	BC108
$Tr_{302, 305}$	BD132
Tr_{308}	2N6083
$D_{200, 201, 300, 305}$	1N4001
$D_{301, 304}$	BZY88, 10V
$D_{302, 303, 306, 307}$	1N914
IC_{200}	7805
IC_{300}	78L08
MX_{200}	MD108*

Components marked with an asterisk are available from Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG. According to this distributor, their SBL 1 mixer is equivalent to the MD108. Resistors are ¼W, 5% tolerance, except 304 and 309 which are ½W. The relay of module 3 is available from RS Components.

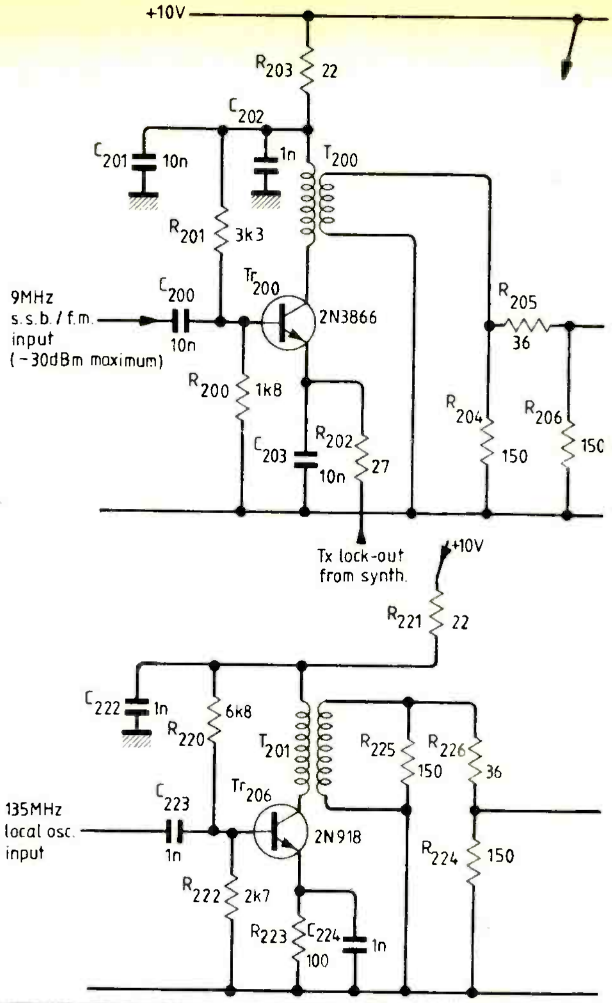


***Fig. 2.** Circuit of the transmit converter with 1.8W output. Where a spectrum analyser is not available this module may be aligned using a diode probe or receiver with adjustable attenuator by sequentially tuning each stage to obtain a peak reading. Cores of transformers 101, 102 and 103 (module 1) are any small v.h.f. toroid such as the one used for transformer 200 of this diagram (see parts list). Inductor tappings from the cold end are at 1¼ turns for L_{200} and 1½ turns for $L_{201,202}$.*

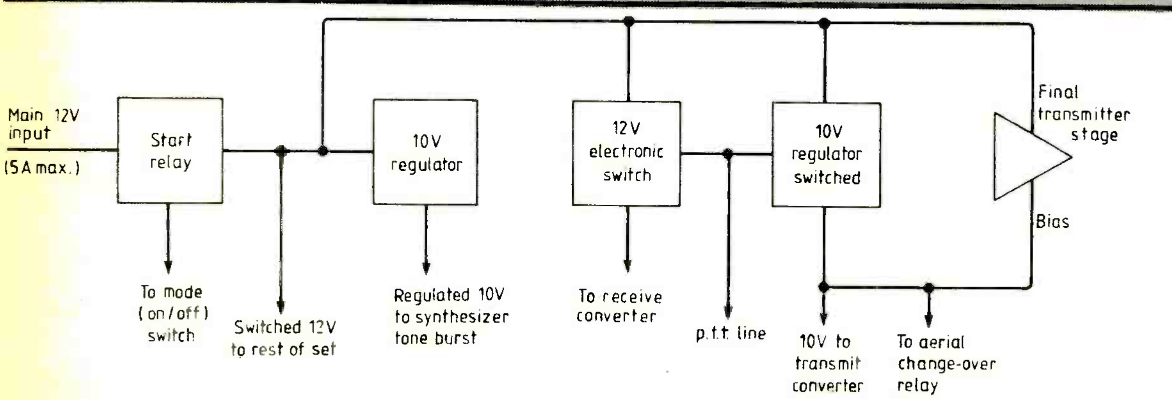
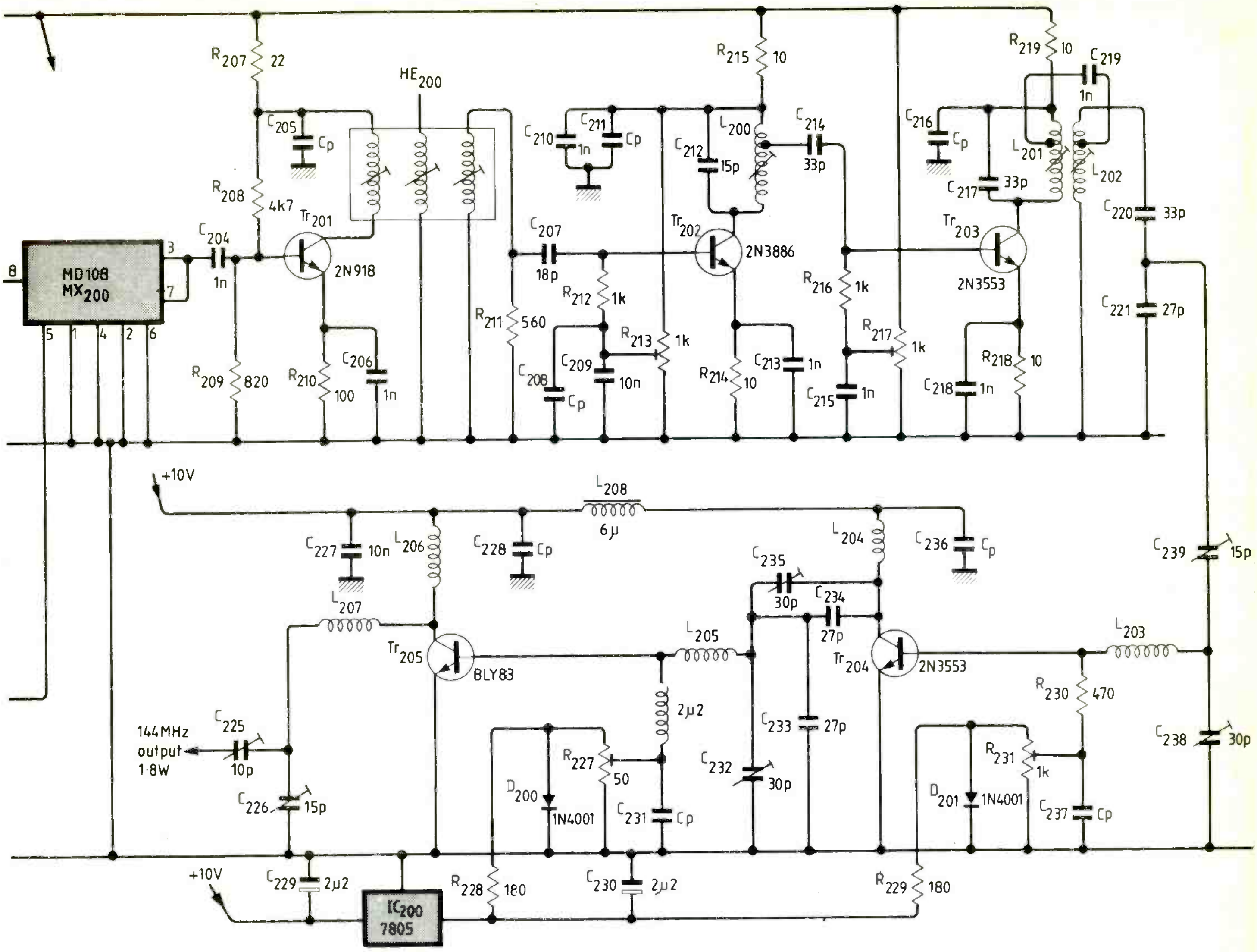


***Fig. 3.** Block diagram of power-supply distribution and transmitter power amplifier. This module contains the start relay and uses transistor power switches to change over feeds from the exciters to the receive sections.*



with using a wafer switch with a break-before-make action and diode D_{300} provides reverse-polarity protection. When the transceiver is turned off the base of the relay transistor is shorted to earth, so turning the transceiver off, but when the mode switch is in any position other than off, Tr_{300} is turned on and the relay operates, leaving the switch earth pole free to inhibit the 1750Hz tone burst in other modes, when the tone burst is not required.

The main relay-switched 12V supply also feeds separate regulators on the display and microprocessor boards.

The power-amplifier stage is a conventional 2N6083 transistor, Tr_{308}, with forward bias to give 10mA collector current which is set by adjusting the 22Ω resistor, R_{310}, in the bias chain. Output power is indicated on an S-meter driven by the circuit around diodes 306, 307.

On the prototype, a three-position switch marked scan, high and low was included to adjust the output of the power amplifier. This switch operated a miniature relay controlling a 10dB pad between the driver and power amplifier stages.

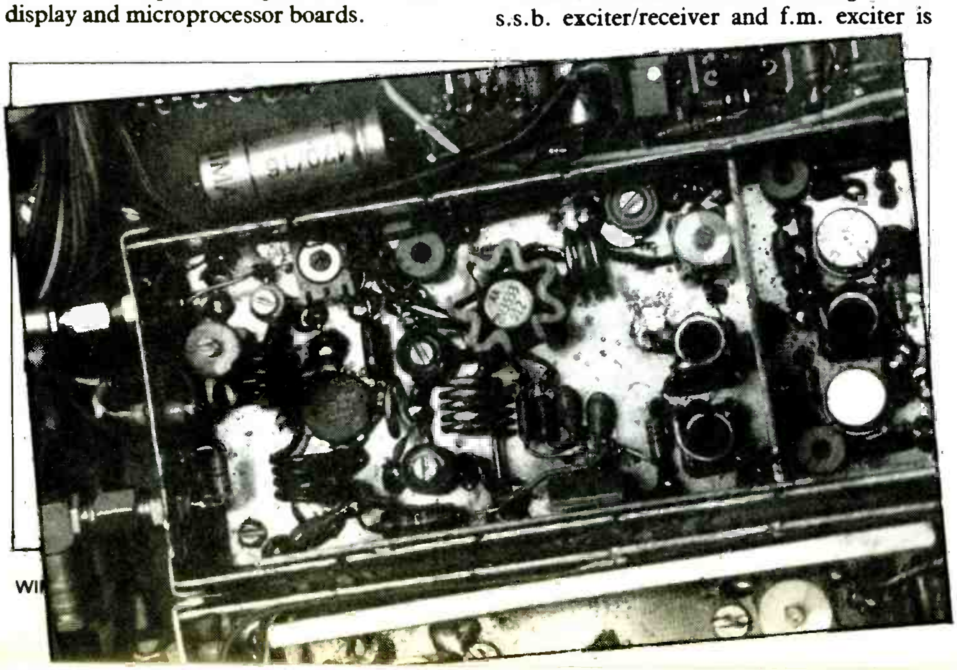
Power distribution and switching for the s.s.b. exciter/receiver and f.m. exciter is handled by separate regulator units and switches on the voltage-controlled oscillator board, module 6. This section is permanently powered by an unswitched 12V supply from the f.m. i.f. board of module 4.

Capacitors 300, 301, 307 and 308 are used to tune the power amplifier. This amplifier is best tuned using a two-tone signal in the s.s.b. mode but good results can be obtained by tuning for maximum power on f.m.

Transistor 308 is mounted on a heatsink attached to the p.c.b. Diode 305 makes contact with the heatsink – made from ⅛in sheet or extruded aluminium in an 85mm-long L shape – to stabilize the operating point. A small cut-out, the length of the heatsink, is made on one side of the p.c.b. to allow clearance for the vertical side of the sink.

When the power regulators have been constructed, it is a good idea to check their regulation and output-voltage capabilities. A load resulting in about 250mA current should be connected to each output in turn and the voltage monitored. Changes in voltage between load and no-load should be less than 5mV.

Transistors 302 and 305 should be mounted on the side of their metal shielding box with mica washers and insulating bushes, otherwise they will overheat.



To be continued

LETTERS

DEATH OF ELECTRIC CURRENT

In August 1982, page 60, I discussed a serious anomaly in classical electromagnetism which, if unresolved, must force us to reject the conventional view of the subject as invalid. I asked eight leading experts to comment. Three did, but one of these asked that his comments remain unpublished. The second reply, by Professor Abdus Salem, was as follows:

"Dear Dr Catt, I am sorry I cannot write to the Journal as you suggest, since you seem to be having a private discussion in which it would be fruitless to enter for an outsider. With kindest regards, Yours sincerely, Abdus Salam."

I am very grateful to Professor J. Brown, CBE for the third reply, Letters, October.

Brown does not seem to grasp the problem, which is that 1/30 nanosecond after the state shown in the diagram, electric charge must have reached a distance 1 cm further to the right, ahead of the wavefront's position shown in the diagram. To get there, the charge must travel at the speed of light in a vacuum so as to be in place to sustain the newly appearing electric flux. It is not good enough for ten times as much charge to travel at a tenth of the speed; the correct charge would have to travel at the full speed.

The letter from Dr J. Brown, CBE, was published in *Wireless World*, October 1982, along with a letter from F. N. H. Robinson, who makes the same elementary error, which is that if I have promised to deliver one dozen eggs to Oxford, one hour from now, Oxford being 100 miles away, there is no point in despatching ten dozen eggs in a vehicle which travels at only 10 mile/h. I must find a way to transport eggs at 100 mile/h.

Today, 80% of electronics is digital, and the primitive in digital electronics is a logic step travelling from one gate to the next. The reigning theory *must* cope reasonably with this, Theory C (*Wireless World*, Dec. 1980) does so perfectly, and no other theory does.

* * *

In answer to R. T. Lamb's letter, WW Oct 1982, I never attributed the existence of the electron to Maxwell. The four axioms that I stated in my August 1982 letter do not mention the electron. Later on in my letter I adopt conventional parlance, which embraces the electron. However, the content of what I said remains equally disastrous for the conventional view if for "n electrons" you read "n coulombs of charge".

"Classical electromagnetism" is not Maxwell taken out of deep freeze. Rather, it is the Maxwell view embellished by later luminaries.

Lamb goes on to write, "Electrostatic theory requires that electric flux lines terminate on charges, but this is not always so for the electromagnetic wave." By this statement, he sets himself apart from the whole tradition in electromagnetic theory. Can he supply any reference or expert to support this extraordinary statement, that a line of electric flux does not have to terminate on electric charge?

Ivor Catt
St Albans
Herts

Although Ivor Catt has again been rather dropped on (Letters, October), he should regard that as a small price to pay for the privilege of being instrumental in exposing the shortcomings of our current physical theories.

Almost everyone's picture of the behaviour of a radio dipole is of electrons rushing from one end of it to the other, and back again, once in every r.f. cycle; it is easy to see that in order to travel anything like two half-wavelengths in one r.f. cycle the average velocity of the electrons would have to be something like c, the velocity of light. But if one does the sums the result turns out to be not like that at all. A *heavy* electric current – one that makes a copper wire too hot to touch – corresponds to an electron flow of only about one millimetre per second, irrespective of the gauge of the wire.

So it would seem that the rapidly-moving "lines of force" of Heinrich Hertz's radiation field cannot be connected to the real electric charges that are carried by real, slow-moving electrons. They must terminate instead on imaginary charges which oscillate at the speed of light, or at least at velocity v where, as Dr Brown says, "v is the velocity with which the wave moves", which is as near to c as makes no matter. Nobody at my school told me that the "charges" of electromagnetic theory, which give rise to the electromagnetic radiation field, were *imaginary* charges . . .

The feature that I find amazing is that your correspondents do not seem at all disturbed by the difference – only a factor of 10^{12} or so! – which they agree exists between the values of the charge velocity according to the two theories. It isn't a matter of mixing models or of likes and dislikes; one at least of the theories must be wrong. So why not be honest and admit it?

Scott Murray
Cloughton
Yorks

I have followed Mr Catt's correspondence about his new theory of current flow with great interest, even if without a full understanding. As indeed I have the sentiments of those who think it possible that Einstein was not quite right in some of his conceptions. And moreover have often wondered myself.

It is extraordinary how mankind has made so much of his progress starting from ideas that later were contended to be quite wrong. For instance, how the 'flat earthists' of long, long, ago, went on their voyages of discovery and all came out right in the end. But, all based on notions that experience subsequently showed were not quite right. So with this in mind I am working hard to get into such mental state as will allow me to follow Mr Catt's new thinking.

Brought up as I was in the days of the gold-leaf electroscope, I can imagine how a source of potential can be applied to a conducting surface and spread out over it. As one can drop oil onto water and watch it spread out. I expect the new theory explains this, but that I have failed to grasp it.

Where I have failed miserably, in Mr Catt's terms, is to be able to visualize (because for such as myself, visualization is the only tool) how charges originate and subsequently dispose themselves, where both the surfaces concerned are non conductors. In other words. I go back as far as rubbing the ebonite rod with the cat's fur.

What is it that comes from where, and, what is sitting on what?

How I wish simplicity still ruled.

Ouida Dogg
Hurstpierpoint
West Sussex

THEORIES AND MIRACLES

Wellard (August 1982, p.57) appears to claim that the phenomenon of Cerenkov radiation contradicts special relativity. His fallacy lies in confusing the speed of light in a medium (exceeded when emission occurs) with that in vaccum, which is greater and which cannot be exceeded according to relativity.

T. B. Tang
Cambridge

ELECTROMAGNETIC ANALOGY

Dr Murray's very interesting article in the Heretic's Guide series, implies that scientific opinion was opposed to a null-result from the Michelson-Morley experiment of 1880.

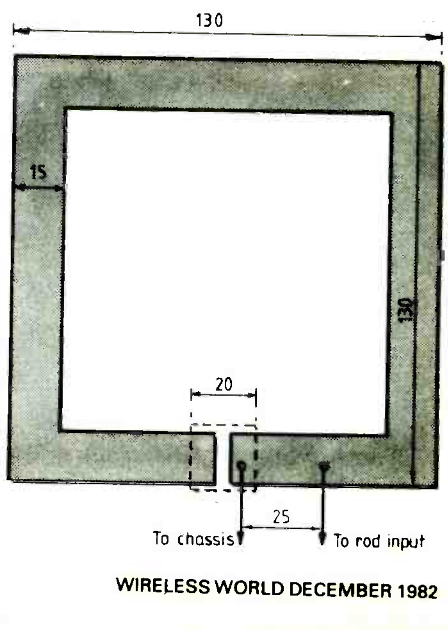
It should be remarked that while the fringe shift reported then could be dismissed as experimental error, Miller's more refined measurements in 1933, confirming the shift, had to be assigned to an 'unknown disturbance' in order to invalidate them.

A null result appears to have been not merely acceptable but mandatory.

H. Wright
Northampton

FOIL LOOP ANTENNA

I was interested to read in your September issue of the use of a small loop antenna at 3.5MHz as I have been using a smaller single-turn unbalanced loop to replace the rod antenna on a Band II portable f.m. receiver. This has resulted in a marked reduction both in distortion from standing waves and body capacity effects. In this area, which is near the Wrotham transmitter, cross-modulation splashing is common on Radio 3 but can be removed by a second, loosely-coupled loop tuned as an absorption wave-trap.



The loop can be made in any convenient way and have sufficient bandwith to make variable tuning unnecessary. Mine, cut from cooking foil, was stuck to the polythene lid from a food carton. The tuning capacitor is a short strip of foil on the reverse side below the gap in the loop. Output can be taken from two taps on the loop. The whole assembly is mounted on the back of the receiver.

H. S. Ffennell
Gravesend
Kent

WHY REPEATERS?

I would like to report an interesting phenomenon observed recently on the 2 metre band:

For some time now the local two-metre repeater and its nearest neighbour have been off the air for a variety of reasons, technical and otherwise. Bad news, one would think, for the average 144MHz f.m. operator, but tuning through the top half of the band reveals quite the opposite to be true. What were once lifeless simplex channels are now buzzing with activity, operating standards have improved dramatically, the need for increased simplex range has prompted many amateurs to improve both their antenna systems and equipment performance and the misbehaviour often heard on repeaters has disappeared from the band. While never doubting the technical splendour of our repeater network I cannot help asking myself: what do repeaters really contribute to amateur radio?

Paul Russell, G4BWQ
University of Sussex
Brighton

THE ETHER

It is a pity that even radical scientists such as Drs Aspden and Murray (October 1982 issue) hold to the conventional but quite erroneous view that the Michelson-Morley result means that Maxwell's ether cannot exist as a universal frame of reference. There is in fact no requirement for Dr Aspden's ingenious special terrestrial rest-frame, and it is likely that the existence of some kind of "ether" has an important bearing on the duality problems raised by Dr Murray.

Einstein was the first to state that if the (Poincaré) principle of relativity was to be universal, then *all* kinds of physical interaction had to have the same upper limiting propagation velocity as that of light, and so would obey the Lorentz transformations. Few would now argue with that conclusion, though it was a very bold one at that time. Illogically, he then threw out the causal baby with the ethereal bath-water by claiming that the concept of a unique, universal frame of reference was "not required": this was like announcing that where Ohm's law rules supreme, physical conduction mechanisms are not necessary! It is implicit in this denial of causality that relativistic effects are only artefacts of observation, which leads to the paradoxical consequences described by Dingle, Essen and others.

Einstein later saw his mistake: "More careful consideration teaches us that special relativity does not compel us to deny the ether . . . " (1), but 1920 was already too late: the ether had gone the way of caloric and phlogiston and was fit only for ridicule. The mere mention of the name now produces hysteria in an audience of physicists. Nevertheless, the (almost ignored) publications of Ives, Builder and Prokhovnik (2, 3, 4) show in detail how the principle of relativity and all its consequences follow necessarily and solely from the concept of a single, universal frame of reference with its attendant upper limiting velocity for energy propagation.

It is open to speculation whether the mechanism of the "ether" is a Machian one involving the aggregate of matter in the Universe, or a Newtonian one involving some structured property of an underlying "absolute" space as favoured by Aspden, or some quantized-general relativistic fusion of the two, or indeed something else. What is quite certain, however, is that there is no conflict whatsoever between the principle of relativity and the concept of a unique substratum as reference frame for all energy transfer: the latter is a necessary and sufficent physical, causal basis for the former.

W T Morris
Teddington
Middlesex

(1) Einstein, A; Relativity and the Ether – Lecture at Leyden, May 5, 1920 – English trans. by G B Jeffery & W Perrett; Sidelights on Relativity (Methuen, 1922)

(2) Turner, D & Hazelett, R; The Einstein Myth and the Ives Papers (Devin-Adair, 1979) – A complete collection of Ives's papers and other material.

(3) Builder, G; Ether and relativity, *Australian Journal of Physics*, vol. 11, pp. 458-480, 1958.

(4) Prokhovnik, S J; The Logic of Special Relativity (Cambridge University Press, 1967: 2nd Edn. by New South Wales University Press, 1978)

Einstein's theory precludes belief in the ether by making the observer, rather than the ether itself, the frame relative to which all physical laws are to be formulated. W T Morris challenges this and says that ether and relativity are compatible. He refers to Builder's 1958 paper 'Ether and Relativity', for example, a paper which suggests a causal physical process by which clocks are retarded in dependence upon their speed relative to an absolute frame of reference. The conclusion is that the ether and relativity are mutually permissible.

Yet, if this is so, Nature provides the ether as the fundamental physical reality and man provides relativity as the philosophical veil which clouds what is there and makes it difficult to discover the causal basis of other phenomena by reference to the ether.

W. T. Morris says 'there is no requirement for Dr Aspden's ingenious special terrestrial reference frame', though he concedes that an ether may have an important bearing upon the wave-particle duality problem raised by Dr Murray. Yet, my theory is based on the fact that this special lattice-structured ether frame plays an essential role in determining the photon mechanism. Nature surely does not offer us alternatives. The doctrine of the wave-particle duality needs to be reinterpreted. This is possible if we accept electromagnetic wave theory without assuming energy to be transferred by the wave process. The ether is a sea of energy, a resource which can be topped up or tapped anywhere as statistical photon events involving the lattice are triggered under the constraint of a balance of momentum. Non-radiation of energy by electromagnetic waves, a direct contradiction to the Larmor process, is the very characteristic which permits us to have a quantum theory.

Indeed, it was the assumed non-radiation of energy by the electron, when accelerated, that allowed Einstein in his earliest writings to correlate $E=Mc^2$ and the relativistic increase of mass with speed. We cannot have duality, as W T Morris suggests. There is no room for compromise in Nature. If technology is to progress and if this depends upon the choice between ether and relativity, then we must march firmly under the 'ether' flag.

H Aspden
Southampton

CLASS S

I would like to make a few comments on A. M. Sandman's article "Class S, a novel approach to amplifier distortion" (*Wireless World*, September, 1982).

It seems strange to refer to the amplifier as Class S, as this classification is usually reserved for r.f. switching amplifiers similar to the better-known Class D amplifiers, except that the switched voltage waveform is applied to a low-pass filter which allows only the d.c. and very low frequency components to appear at the load. As far as I am aware Class S was invented by Bedford in 1932 (US Patent 1874159).

Certainly, lower distortion can be achieved for a given voltage swing by employing high impedance loads, hence the long established use of "bootstrapping" and constant-current sources to give high a.c. loads in voltage amplifiers. These techniques are not, however, the substance of Mr Sandman's article. The voltage amplifier based around A_1 is essentially irrelevant and the power amplification is achieved by the differential trans-admittance amplifier A_2. This circuit is a variant of the well-known Howland current source.

These circuits are fairly simple examples of the use of multi-loop feedback, and often find application in active impedance matching which eliminates the noise contribution which would result from the use of passive terminations. In this case, an ideal balanced "bridge" does tend to give rise to an infinite input impedance. However, as might be expected the use of positive and negative feedback loops poses a problem of amplifier stability when the frequency dependent open-loop gain and common-mode input impedances are taken into account. Unless very high-quality amplifiers are employed, such methods are usually only successful at very low frequencies.

Re-drawing Mr Sandman's circuit as Fig 1, where the distortion D is introduced as a disturbance input *after* the op-amp, we obtain the following relationship (assuming that the op-amp is ideal, with the open-loop gain A being very large)

$$V_L=\frac{R_L(R_1+R_2)}{R}.V_s+\frac{R_1R_L}{AR}.D$$

where $R=R_1R_2+R_1R_L+R_2R_L$

Hence the voltage transfer function only approaches unity as R_L approaches infinity. Using the values given in Fig 4 of the original article, $V_L=0.82\ V_s+3\times10^{-8}.D$, which does appear to give an improvement in distortion of ≈ 280 times over a single-loop negative feedback amplifier (i.e. using a reduction factor of $1/1+A\beta$).

However, when the amplifier is taken as being less than ideal, that is finite common and differential imput impedances, and a finite cmrr are taken into account, this improvement is greatly reduced. The wide discrepancy between these very low distortion figures, and those achieved in practice are due to two factors. Firstly, the inherent time delays in feedback systems (hence the advantage of feed-forward systems), and secondly the application of analysis based on linear models, whereas cross-over distortion is a non-linear effect. To a simple approximation, in the Class B cross-over region the open-loop gain of the system falls to zero, and no amount of feedback is going to stabilize the system. Also during the cross-over region, the collapse of feedback around A_2 causes the input impedance of the trans-impedance amplifier to drop from infinity to a low value. This will have a detrimental effect on the voltage amplifier A_1, resulting in voltage spikes which would be absent if A_1 was driving a passive load. When these effects are taken into account Mr Sandman's circuit offers little advantage over conventional single-loop amplifiers.

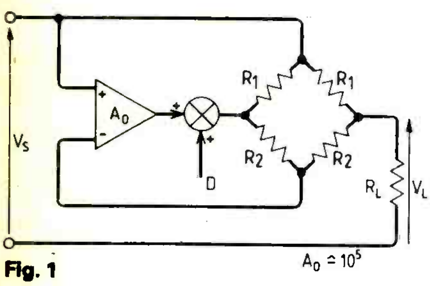


Fig. 1

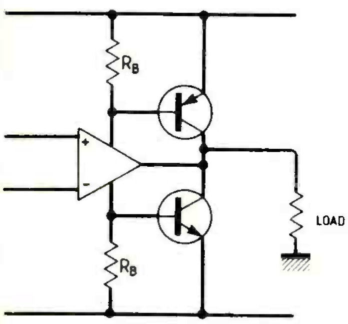


Fig. 2

Owing to the finite slew rate (another example of a non-linear process) of the op-amp the use of a simple Class B emitter followers at the amplifier output gives rise to noticeable cross-over distortion even with feedback. It can be reduced considerably by inserting a resistance (50-100Ω) between the bases and emitters of the transistors. Even so, with 741 op-amps, a large-signal bandwidth of only about 1 kHz is attainable. A better approach is to use complementary common-emitter output stages, as in Fig 2. In this way, for small output currents, the output transistors are turned off, and the op-amp provides all of the output current. At higher output currents, the external transistors conduct, and the contribution of the op-amp is limited to approximately $0.7/R_B$. The quiescent current of the op-amp biases the external transistors, and hence greatly reduces the range of crossover.

A study of multi-loop amplifiers and their possible effects on reducing amplifier non-linearities would no doubt prove useful, since it is an area which seems relatively uncharted, and I hope that further work will attempt to present solid theoretical and experimental evidence of their advantages.

N. M. Allinson,
University of Keele,
Staffordshire.

CABLE vs RADIO FOR TELEVISION

In your editorial in the October *Wireless World* you cited the release of radio channels as one advantage of cable TV. But the closing down of the present broadcast TV service would have to wait (I hope) until substantially *all* of the country had been provided with the cable system. I live in a village within 10 miles of a substantial city but in which there is no gas supply – how long would it be before cable TV comes here?

Another point which is usually overlooked (or suppressed) is that the development of modems for data transmission has made it possible for the ordinary telephone line to handle the other services such as electronic funds transfer (shopping at home), communication with a computer (working at home) and remote meter reading. The mention of such services as a reason for installing broad-band cable is therefore spurious.

D. A. Bell
Beverley
North Humberside

COST-EFFECTIVE ELECTRONIC IGNITION

Since 1965 I have used a Lucas TAC unit (circuit similar to that of D. J. Cope, 'Letters' Dec. 1980). It gave good service for 130,000 miles in a Rover 2000 and then, with another distributor, a further 25,000 miles in an Austin Maxi. During its time in the Rover the same points in the original distributor were used with occasional minor (1 or 2 'thou') adjustments for heel wear; spark plugs were changed – only after persuasion by service manuals – three or four times in the 130,000 miles; suppressor leads were not changed. The same performance pattern was being followed with the now two years old Maxi until it recently failed to start! The fault was traced to an open circuit resistor in the first transistor collector (and high-voltage transistor base) circuit due, it appears on examination, to corrosion. Replacing the resistor restored the sparks. However, confidence then impaired, I arranged, as Mr Cooper suggests, for quick change reversion to conventional ignition.

Certainly the electronics schemes are kind to contacts, but if correct timing is to be maintained, heel wear still needs occasional checking; surface finish on the cam lobes must be an important factor in the rate of heel wear. Incidentally, the conventional system's contacts dealing with several amperes results in 'pitting and piling' as tungsten is transferred, thus defeating d.i.y. checking with feeler gauges, but if timing and dwell are adjusted correctly the need for contact set replacement may not be as frequent as garages would like us to believe.

As correspondents have suggested, the ordinary car user is unlikely to notice any performance advantages for complex ignition equipment because the conventional system can provide adequate energy for even moderately maintained engines although sophisticated ones, or even transistor-assisted contacts, may cope better with difficult conditions. My recent experience, when time and chemistry combined to leave me sparkless, made me wonder whether even this modest addition of components to assist the contacts is warranted – three resistors and two transistors to fail in the unkind environment of a car's engine compartment. Is the possible failure of extra components too high a price to pay for less frequent timing and dwell checks? Nevertheless, after 17 years of reliable service I shall keep the TAC unit installed to save anxiety over that molten tungsten at the contact breaker.

Alan A. Tomkins
Stourbridge
West Midlands

The various articles and many letters on electronic ignition which have appeared in *Wireless World* over the years prompts me to seek an opinion from readers on their use in modern engines fitted with emission control systems. I refer in particular to the Land Rover in which up to three independent and separate systems may be met, depending on the market for which it was produced. In general, the devices used recycle the gases from the crankcase, petrol tank and exhaust system back through to inlet manifold to reduce atmospheric pollution. Part of the system design means that the tick-over speed is higher than usual and a special distributor is fitted with a wider variation in ignition timing, giving a 6° retard at tickover and normal centrifugal advance at higher engine speeds. One of the special features of the distributor appears to be a 57° dwell angle with a small variation tolerated.

In the past, on older models, a capacitive discharge unit built from a Sparkrite kit has been used without any problems, but reliable starting in hot wet or dry weather overseas and the usual cold climate of the UK. The unit was capable of being switched from electronic to Kettering and appeared to cause the engine to run much more smoothly using the former with less burning of the contact breaker, but I would not like to express an opinion on any petrol consumption improvement.

However, I have no wish to argue the pros and cons in this context, but as these emission control devices are probably incorporated in many modern cars to meet local or overseas regulations, I would be interested to know if there is any problem using electronic ignition particularly in respect of the unusual retarded ignition, the close tolerance dwell angle and if it would degrade or perhaps improve the polution caused by an internal combustion engine.

N. L. Smith
Stoke-on-Trent
Staffordshire

LEAKY FEEDER RADIO SYSTEMS

Dr Martin in his interesting article on Leaky Feeder Communication, *WW* June 1982, refers to work carried out in South African mines around 1978. In 1960 the SA Chamber of Mines asked the undersigned to design and produce prototype transceivers for use with the Protea rucksack-type rescue appliance. I proposed a s.s.b. system, operating at about 70kHz, and predicted that conductors, in particular railway lines, would greatly extend the range. S.s.b. was chosen because it is most efficient with regard to battery power, and 'amplitude' radio noise is much lower underground. In the event of an emergency, machines generating such noise could be shut down. Frame aerials are cumbersome, as Dr Martin states, but were no problem since the slave sets had the frame wound round the rucksack and the SA Chamber of Mines came up with the bright idea of putting the frame wires in a large inflatable rubber tube that wedged itself in the tunnel walls at the master station. This allowed rail and pedestrian traffic to pass through the loop. The relative number of turns of wire in the slave and master frame aerials was adjusted to present approximately the same impedance so that the slave and master transceivers were identical, an important point under emergency conditions.

The transceivers used some cunning circuitry and s.s.b. filters and were very simple, the low radio frequency used greatly assisting the filter design. Subsequently models were produced using ferrite rod aerials and the s.s.b. 'phasing' method and gave a similar performance. The transceivers provided a p.e.p. of about 6W and a s/n ratio of 10dB with an input signal of about 0.6μV.

The SA mines are more extensive than those in most countries and tests were carried out in both gold and coal mines. Mainly due to the presence of conductors, particularly railway lines, clear speech was obtained over distances up to a few miles and no nulls were noted when rotating the slave frame aerials. This led us to suggest that in tunnels where there are no railway lines suitable conductors should be provided to assist in propogating the signals. Also direct injection of the signals into the railway lines at the master station could well be advantageous.

Subsidences and rockfalls in mines do not usually break railway lines or, if they do, the broken ends of the lines are usually near together and the transmission loss is not greatly increased. However leaky feeder cables are relatively fragile and easily broken and considerably attenuation is introduced at a break. This is a serious disadvantage since a rockfall causing an emergency could disrupt the communication system required for such an emergency.

F. G. Clifford
Wynberg
South Africa

The article by Dr Martin in the June 1982 issue of *Wireless World* was most interesting to myself and my employer. We have been involved in the application of radio in an underground environment for the last three years. During this time we have installed radio equipment in 50 coal and metalliferous mines in Australia and New Zealand. One installation in particular, covers a length of 10 miles from the portal to the coal face. The results that have been achieved lead us to believe that in time, radio will become the preferred method of underground communications.

The type of leaky feeder used by this company is 300 ohm ribbon in a sheath. No particular attention is paid to the placement of the line. Water on the leaky feeder is the worst problem, having the effect of reducing the system range. Up until the present time we have not used a coaxial feeder; however, it is being considered for future installations.

Our equipment operates on 27 MHz a.m. for voice mode and 40 MHz f.m. for control mode, typical powers used ranging from 0.5W to 5W. Using this equipment the distance over which a hand-held unit base station can communicate reliably is 2000 yards. Hand-held to hand-held units use the feeder in the parasitic mode over a distance of 800 yards.

Experience has taught us that no two sites perform the same and that there is much more "art" than "science" involved in the application of radio in an underground environment. Although many phenomena appear to defy explanation, the usefulness of the system has been proved. This company is engaging in research to improve operation of underground radio; we are investigating the use of repeaters instead of multiple base stations and are examining different modes of modulation.

D. Hughes
Illawarra Communications
Wollongong
NSW

POOR DEAL FOR AMATEUR RADIO

I object, as many pre-1947 A-licence holders will, to Mr Reay's Sept. 1982 view that I have my Nov. 1938 amateur radio transmitting licence under false pretences. Mine was granted under the regulations then in operation, which included the compulsory passing of the Morse code test. Luckily I have been able to respond to the annual invitation to renew ever since. I should add that my experimental receiving licence was first granted in Dec. 1920 in my father's name, on account of my youth (now 77). Pre-WW2 we had of necessity to build and learn to use our own equipment if only because commercial equipment was almost unobtainable and certainly out of most people's price range.

The majority of professional radio engineers, however exalted, regard amateur radio as their hobby to be shared with others "suffering from the same disease from which there is no cure" (my definition of amateur radio) and they will bend over backwards to help the "pure amateur". Unfortunately, during the years, I have come across – and suffered from – at least three profesional radio engineers whose boast was that they had individually come into amateur radio just to show us twerps "how it should be done properly."

If the Editor decides to use this letter may I take the opportunity to ask who in the UK started the use of the American 1938 amateurs' habit of asking "What is your handle, Old Man?" Since 1947 and certainly of recent years, no v.h.f. band QSO – even the first – seems considered complete without the question being asked "What is your handle OM for the log?" This information seems more important than, to me, the information in the original CQ call of the QTH of the caller and the direction in which the beam is pointed, or the direction from which replies to that call are expected or hoped for. Some do give the "square" from which the CQ call is originating, but not the beam direction; if they did an awful lot of time and frustration would be saved and avoided. 73s & CU all on animated colour s.s.t.v.

R. F. G. Thurlow G3WW
Wimblington
March
Cambs.

SOLENOID FIELDS

I feel that I must pass comment on the article "Electric Fields in a Solenoid Coil" from the August issue. Whilst I agree with the result, I must dispute the arguments used.

The use of 'voltage' is incorrect in this case. Voltage is the scalar potential of the electric field vector **E**, and its existence is conditional on the curl of **E** ($\nabla \times \mathbf{E}$) being zero, which is only true for time invariant fields:

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \qquad (1)$$

B is magnetic flux density vector, which is only zero for a time-invariant field.

The result given in the article can be arrived at by:

- Noting radial electric field =0. This can be seen by considering the integral of **E** over a closed, cylindrical surface which shares its **axis** with the solenoid. Neglecting end effects, **axial** field will be constant along length of solenoid so that applying Gauss s theorem (which is a corollary of Maxwell 2: $\nabla \times \mathbf{H} = \mathbf{J} + \dot{\mathbf{D}}$) with net charge equal to zero, we conclude that radial electric field is zero.

- Circumferential field obtained by applying Maxwell 1 (integral form $\oint \mathbf{E.dl} = \int \mathbf{B.ds}$) to circular loop contained within surface of solenoid:

$$E_{\phi a} 2\pi a = j\omega\phi \qquad (2)$$

with a as coil radius, d the separation between turns, using nomenclature of the article.

- Noting that the conductor forming the coil (assumed perfect, infinitely thin, close wound) constrains the electric field to be normal to the windings (no electric field can exist at surface of a perfect conductor), and from above the electric field is tangential to the solenoid surface, hence

$$E_{za}/E_{\phi a} = \cot\psi \qquad (3)$$
$$\cot\psi = 2\pi a/d$$

which is equation 1 from article.

From equations 2 and 3 we can determine the axial electric field at surface of coil:

$$E_{za} = (\cot\psi) j\omega\phi/2\pi a$$
$$E_{za} = j\omega\phi/2a \qquad (4)$$

It is easy to develop equations for electric field at a radius less than that of the coil.

The authors state that it is difficult to define a unique terminal voltage for the coil if it is loosely wound. This is an understatement – it is impossible to define the terminal volts for any coil carrying a.c., since voltage, by definition, does not exist. What happens, is that the 'voltage' perceived using a voltage measuring device becomes more sensitive to the measurement technique if we use a loosely wound coil.

I do not suggest that the field vectors **E, D, J, B** and **H** really exist (see the excellent article "The Electromagnetic Analogy" from the same issue), but if we are going to use this model, we must abide by the rules.

P. Bramley
United Peripherals Ltd
Winsford
Cheshire

NON-BINARY LOGIC CIRCUITS

Non-binary integrated circuits that increase processing capability of bipolar l.s.i. circuits could have considerable impact in situations where the number of pin connections is limited. By using both multiple quantized current and voltage levels information capacity can be increased by up to 18 times.

by C. W. Ross

Increasing demands on the capability of logic circuits to provide multi-function operation using the minimum number of connections has produced some interesting alternative concepts. Practical non-binary integrated circuits increase the information processing capability of bipolar l.s.i. devices perhaps four to ten times. Other areas of application, especially process control and systems requiring some positive indication of mode, are described showing the extreme flexibility of the non-binary concept.

Non-binary techniques using multiple quantized current levels *or* voltage levels can be considered "first-kind" non-binary systems. The subject of this article is a combination of both – perhaps it may be considered "second-kind" non-binary. But before looking at non-binary techniques, compare a typical tri-state device and its function with non-binary, because the tri-state circuit can be modified to work in a simple non-binary mode.

In a tri-state device, two of the states are the normal logical 0 and 1 conditions and the third is a high-impedance or off condition, allowing the output to be controlled by some other source, by parallel or bus operation. Alternatively, the output could be taken to a mid-point bias level via some suitable current source so that the third state is designated, and the chip will pull up or down from that mid-point. Here we are, back to a 'three-designated levels' system, converting as it were from binary to non-binary using a bias network. Figure 1 shows a simplified switching arrangement for a tri-state device and a typical integrated circuit. Non-binary techniques are particularly useful and economic where multichannel process or mode controls are required, the object being the use of a single conductor for each channel plus a single common connection, with excellent noise immunity and positive mode indication. In general, it is usually convenient to use a non-binary converter to return the commands to multifunction binary logic within the confines of the active machine or processor.

The basic concept of a second-kind non-binary system is shown in Fig. 2: the same method is used for both the digital data application (a) and the process control application shown in (b). The basic commands are voltage levels on line x–x and the required feedback of information (status or data) exists as current changes within that line.

Circuit V_1 establishes voltage levels for the line and I_1 detects current flow in that line, for the transmitting end. At the receiving end, circuit V_2 detects and translates these voltage levels back into binary format. A programmable current sink circuit I_2 produces the current level changes in the line to form a feedback signal (positive status indication or data).

One of the interesting features about non-binary techniques is that the active elements are basically simple and easy to implement in integrated form. There are obviously limitations to the number of increments of current and voltage that can be used. As an introductory exercise consider two current levels and three voltage states as a basis for discussion.

Digital data application

From a purely digital point of view there are a great many options for the non-binary concept using a single wire per channel and a common earth.

Figure 3 shows a simple configuration using two converters, a comparator and two-state current sinking. Obviously there could be multi-state current sinking and multiple comparators, but let's keep it simple here to properly demonstrate the features of the non-binary concept.

The two-bit digital-to-analogue converter and the a-to-d converter can be implemented very simply using a minimum of readily available integrated circuits. Looking from left to right in Fig. 3, the two-bit converter plus the offset buffer generate four distinct voltage levels for the control line V_c. The offset buffer conveniently applies some low potential to the line for zero input bits to allow the current sink to operate properly for all states. The comparator detects current changes in the line by using a reference input derived from a constant current network.

On the receiving end of the line, the discrete voltage steps are level shifted and fed to a simple a-d converter which feeds a two-to-four decoder and four gates. The data inputs are enabled by the binary output of the a-d converter, one of the data lines being selected according to the

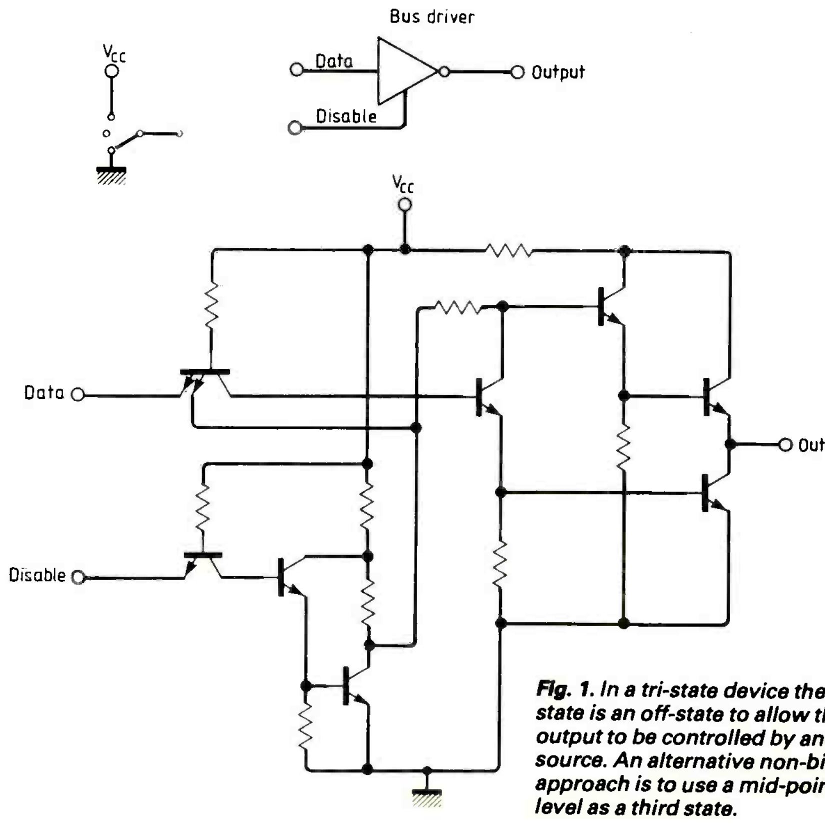


***Fig. 1.** In a tri-state device the third state is an off-state to allow the output to be controlled by another source. An alternative non-binary approach is to use a mid-point bias level as a third state.*

Clive Ross, MIERE, works with Normalair-Garrett Ltd, Yeovil.

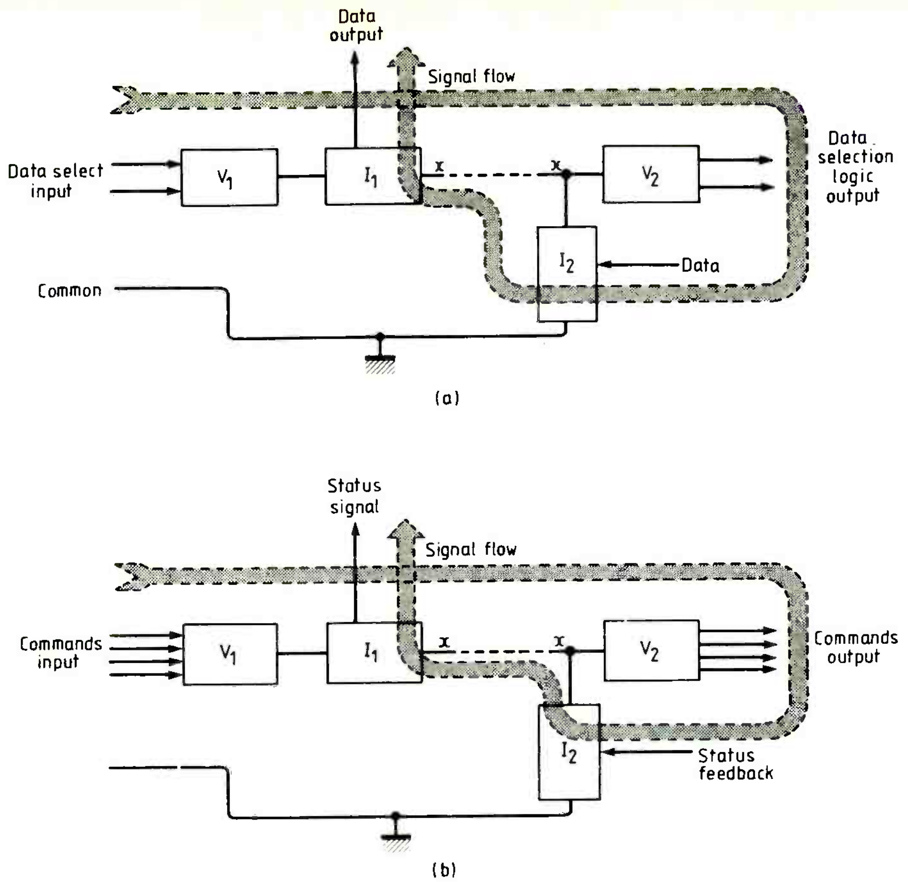


Fig. 2. Basic commands in a multistate data application (a) or process-control (b), are voltage levels on the line selected by V_1 and detected by V_2, while status or data feedback is provided by I_2, detected by I_1.

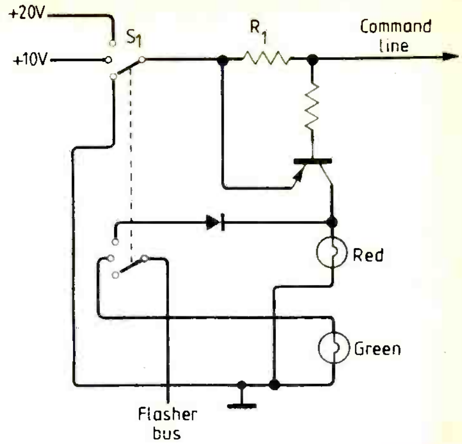


Fig. 4. Three voltage states and two current states are used in this tape recorder control system. This voltage sending end senses the current states.

voltage state of the line V_c. The constant-current sink switches at data rate and the selected data appears at the left hand end of the line at the output of the comparator. In this case, four sets of data can be interrogated in sequence and read out remotely, at the end at which the selection is programmed using a single line plus common.

Process control application

Consider a typical case for non-binary control logic. A magnetic tape recorder system has three operational modes and up to 24 channels. The bias current in the head circuit during the record mode needs to be detected at some convenient threshold and the information fed back as a positive indication at the remote control box. The three operational modes are

– playback (normal)
– record
– playback from record head (sync.)

while the self-test mode is

– h.f. bias current in head circuit to exceed a pre-determined threshold, and control lamp at sending end as a positive record indication.

In a 24-channel system, 24 conductors and one common are required, one conductor per channel for the four modes and a common conductor serving all channels. For high noise immunity, 10 volt command increments may be used.

0 volts≡normal playback
+10 volts≡playback from record head
+20 volts≡record.

For the positive indication in record mode there are in addition to the voltage states, two current states:
0 to 0.5 mA≡record bias current zero or below required value
and 5.0 mA≡record bias current normal or above.

Therefore, in this case, five conditions are satisfied using a single control line. Obviously more options are available if two current states are available for two voltages, say.

Look now at some circuits to perform these functions, first the sending end. A three-state voltage and two-state current system is shown in Fig. 4. At the sending end, a switch selects the voltage level appropriate to the function required, and a current sensor with two states determines the acknowledgement signal.

In this example, when the highest potential of the command group is selected the acknowledgement signal at the receive end changes the terminating impedance of the line and the current sensor at the sending end detects this condition and produces a visual indication. A 1 Hz supply alternating between 0 and +20V is used for the lamp, producing a flashing warning indication.

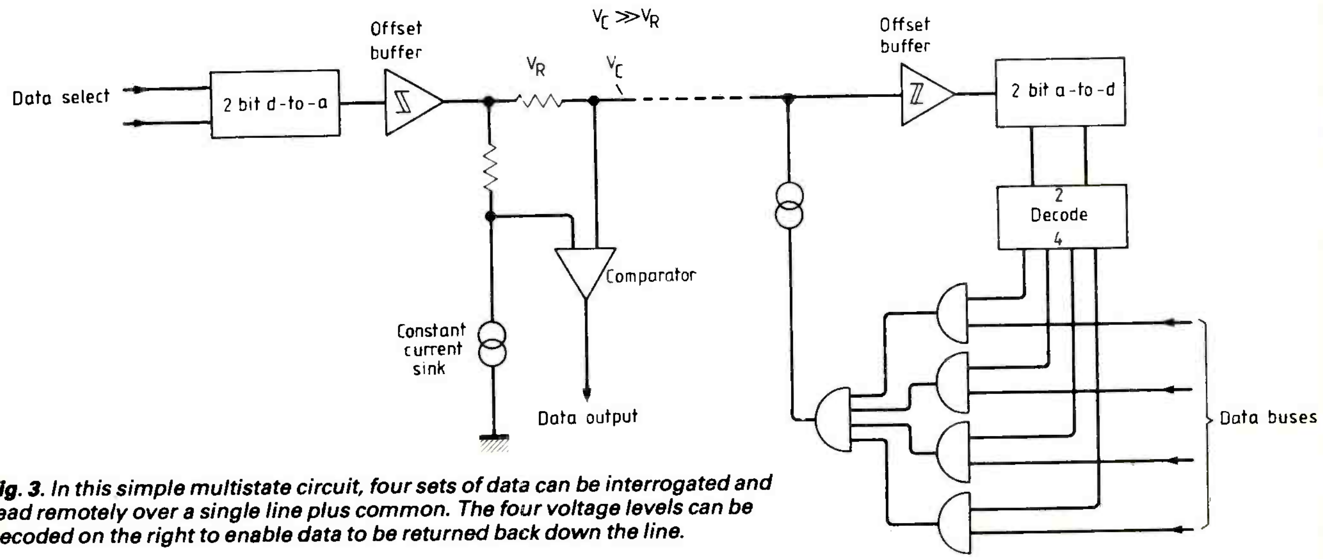
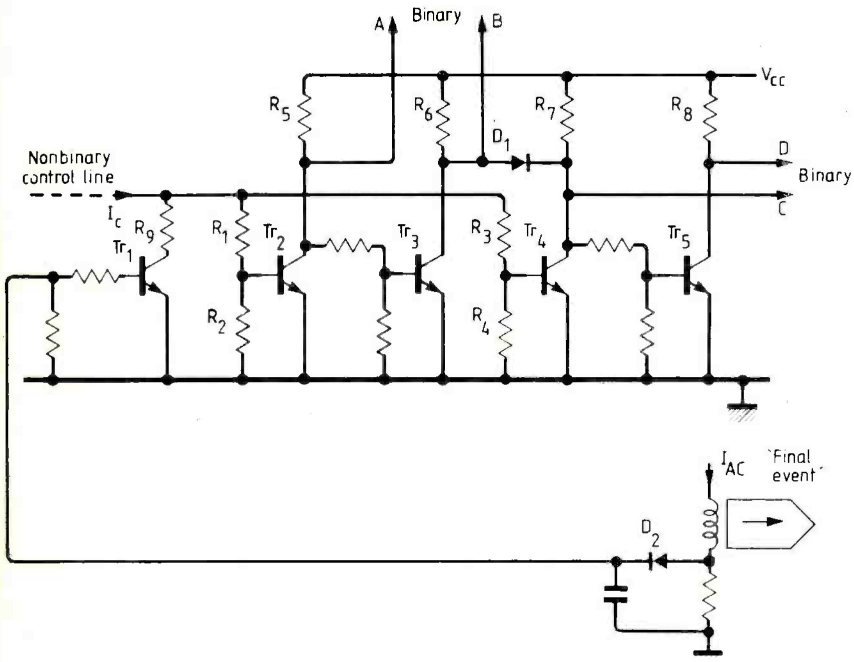


Fig. 3. In this simple multistate circuit, four sets of data can be interrogated and read remotely over a single line plus common. The four voltage levels can be decoded on the right to enable data to be returned back down the line.

When the record position is selected (20V) the flasher bus is connected via the diode to the indicator lamp. When the command line current rises due to a logic decision at the receiving end terminating the command line with a low resistance, the transistor pulls up and saturates, applying a steady voltage to the lamp. The diode allows independent operation of the flasher supply during this condition.

At the receiving end, a circuit is required that will translate the voltage levels back into binary form. Again there are many ways of implementing the conversion. A set of fairly simple comparators is required and a means of applying a binary current sink, controlled by some final event to acknowledge that the chain of command is complete. Figure 5 shows a typical circuit for the receiving end.

The ratios of R_1, R_2 and R_3, R_4 are chosen so that Tr_2 and Tr_4 saturate at control line potentials of 10 and 20V respectively. (These transistors actually start to switch at lower potentials but proper saturation is attained at the control potentials used.) The diode has the important function of avoiding ambiguity of output B when Tr_4 and Tr_5 function. The transistors are a dual in-line array for convenience, their function is a crude form of twin comparator. When the record command is received (+20V) the bias current in the record head circuit rapidly rises to operational value and Tr_1 is turned on using the half-wave rectifier network detecting record head current. Transistor Tr_1 turn-on provides the current sinking action on the control line.



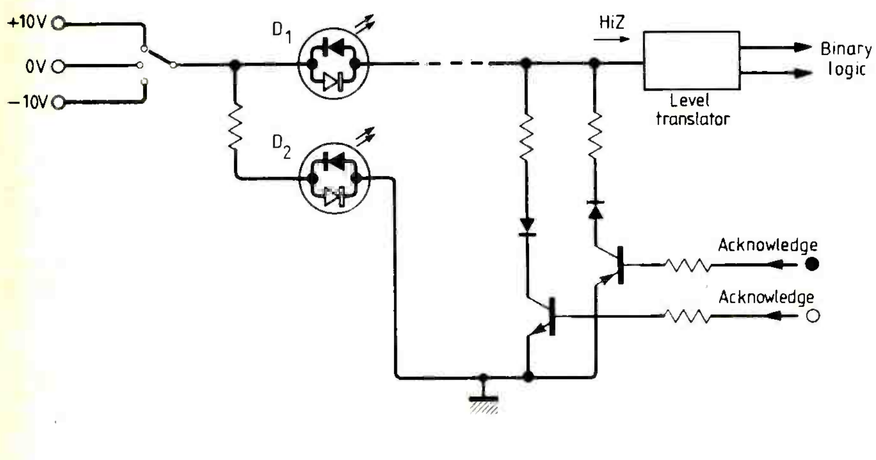
Function	$V_{control}$	I_c	A	B	C	D
Play, normal	0	0	1	0	1	0
Play (rec head)	10	0	0	1	1	0
Record ?	20	0	0	0	0	1
Record OK	20	1	0	0	0	1

Fig. 5. *This receiving end uses simple comparators to translate the voltage levels back to binary form and a final current acknowledges command completion.*

An interesting variation on these circuits is shown in Fig. 6, where the sending end circuit is extremely simple. In this version there are three potential states and three current conditions, giving additional capability for positive indication. The l.e.d. is a dual bi-colour type, red/green, one of the most useful configurations available.

Where pure logic functions are required the concept is similar, but the actual circuits at each end will be designed to fit the particular application. Non-binary systems need not be unidirectional in terms of current and voltage, but the application will often dictate the configuration.

At the present time when conventional binary logic devices are in such wide use, along with a sprinkling of tri-state, non-binary devices could have considerable impact in those areas where there are obvious limitations to the number of pins used in medium and large-scale integrated circuits. A practical second-order non-binary system could have over 18 times the information capacity of its binary counterpart – something that will bring a smile to the system engineer's face but dismay to the trouble-shooters! WW



Command	Voltage state	Current state	Visual indication D_1	Visual indication D_2
Standby	0 ± 0·5V	0 ± 100μA	–	–
Forward propulsion on velocity low	+10 ± 2V	0 to +500μA	–	G
Forward propulsion on velocity normal	+10 ± 2V	+15mA ± 20%	G	G
Reverse propulsion on velocity low	−10 ± 2V	0 to −500μA	–	R
Reverse propulsion on velocity normal	−10 ± 2V	−15mA ± 20%	R	R

Fig. 6. *Very simple system with two-colour leds has three voltage levels and three current combinations.*

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MORSE DECODING BY MICROCOMPUTER

Using a 567 tone decoder and a seven-bit clock to time incoming signals, Morse code is interfaced to a ZX81 via a Z80A p.i.o. chip. Machine code routines use this data to provide up to nine lines of decoded text.

by J. P. Sargent

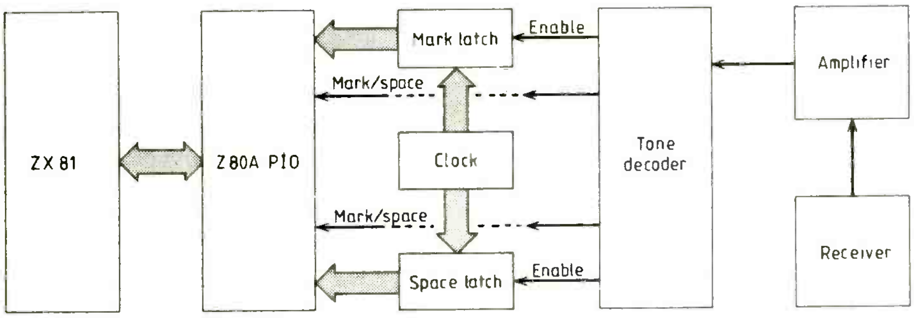
The ZX81 uses the Z80A microprocessor for both the servicing of the television display and for computing. The display is handled on an interrupt driven basis, which means the processor is unavailable for computing for a large proportion of the time. Since the decoding procedure requires reasonably accurate timing of the Morse signals, the use of a software timer would introduce an unacceptable level of timing errors because of the necessity to regularly service the display. A hardware clock was therefore implemented, which required an interface between it and the ZX81. Of the several purpose-built chips available, a Zilog Z80A p.i.o. chip was chosen because the necessary compatible signals are available directly from the edge connections on the ZX81 p.c.b. Software to accomplish the decoding is based on the flow diagram by Kyriazis*.

Although Sinclair are unwilling to disclose details about the duration and frequency with which the display is serviced, this must be dictated by the British tv standards. Thus an interrupt must be issued with a frequency of 50 Hz, and the time required to service this interrupt must be less than 20 ms. This places a maximum rate of 50 tone/no-tone transitions on the incoming Morse signals, decoding then taking place during the periods normally reserved for computing. As the processor may be in the interrupting routine when a transition occurs, the clock timing when either a mark or space has finished must be stored until the processor is free to read the data. This is achieved by latching the clock reading.

The circuit consists of three main sections.

Tone decoding. Output from the recording socket of the receiver feeds into a miniature a.f. transformer which has an earthed screen between the primary and secondary. The ZX81/Z80A p.i.o. combination produced a great deal of r.f. interference, about which more will be said later. Signals are amplified using a 748 op-amp with manual gain control and fed to the 567 tone decoding chip. With the components selected, the chip has a bandwidth of approximately 14% of the centre frequency of the tones; for 1000 Hz the acceptance bandwidth is approximately 140 Hz. For reliable decoding the receiver should have comparable stability.

Timing. A clock implemented using a RS components programmable timer operated to provide a seven-bit binary output. Each of the bits are then sent to both a mark latch and a space latch, to provide a temporary store for the binary output from the clock, and are enabled by the mark signal and the space signal respectively. The speed at which signals are decoded depends on the clock period. Although an automatic software speed control was incorporated by Kyriazis, decoding was less prone to error if a manually-selected speed control was used by varying the period of the clock.



Interfacing. A Zilog Z80A p.i.o. chip takes the seven bits of data from each of the latches, plus one bit to indicate whether a mark or space is present, to the p.i.o. ports A and B respectively. The chip requires two lines to address it as an input-/output port and one line for the chip enable. The i/o request line, clock, RD and M1 are already present on the ZX81 p.c.b. edge connections.

The ZX81 does not fully decode the i/o port addresses internally and address lines A^7, A^6 and A^5 may be used directly for the addressing of the p.i.o. chip. In this configuration, A^5 is used for the chip enable (CE), A^6 is used for port B/A select (B/A) and A^7 is used for command/data select (C/D). Thus for example, sending 0FFH to port 9FH selects the command register of the p.i.o. chip, port A, mode 3 operation, and at the same time the remaining bits A^4-A^0 stay high which should deselect any of the ZX81 internal ports. The Z80A p.i.o. chip is used in its mode 3 configuration with all the port data bits as inputs. Refer to the appropriate Zilog technical manual for further details about the chip. It is then a simple matter of addressing ports 1FH or 5FH to read in data from the mark or space latch respectively.

Software

So that the computer has the necessary speed and compactness to fit into 1K of memory the program was written in machine code. It is based on that given by Kyriazis with important modifications to accommodate

- the display routines of the ZX81
- the hardware configuration of the ZX81/Z80A p.i.o. combination
- the hardware timing routine
- and the deletion of the automatic speed control.

The program starts displaying on line nine and gradually fills the screen upwards, scrolling each time a new line appears.

Character printing is accessed by executing a RST 10H instruction with the A register of the processor containing the character to be printed. The SCROLL and PRINT AT routines are accessed by calling addresses 0C0EH and 08F5H respectively, details in "Understanding your ZX81 rom," by I. Logan (Melbourne House, 1981).

The flow diagram of Kyriazis is modified by replacing all references to the Test Input routine by a call to two important subroutines which read in the data from their respective latches. Each of which waits until the end of a mark or space is detected before returning with the timing of the mark or space to the main body of the program. As the latches are activated by the mark/space rising edges, data are only held for a period which depends on the length of the following space for the mark data, and the length of the following mark for the space data. Therefore the program must read this data in before new data arrives; this is the main factor limiting the rate at which Morse can be decoded.

It is not known how long the RST10H, SCROLL or PRINT AT instructions take.

*Morse decoding' by N. Kyriazis. *Wireless World*, February 1981, page 44-6.

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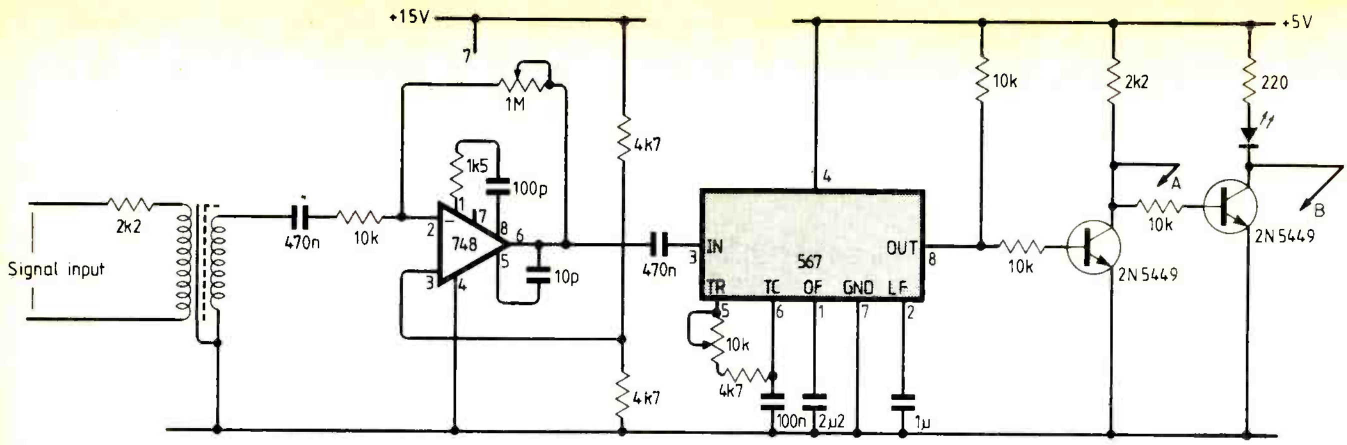
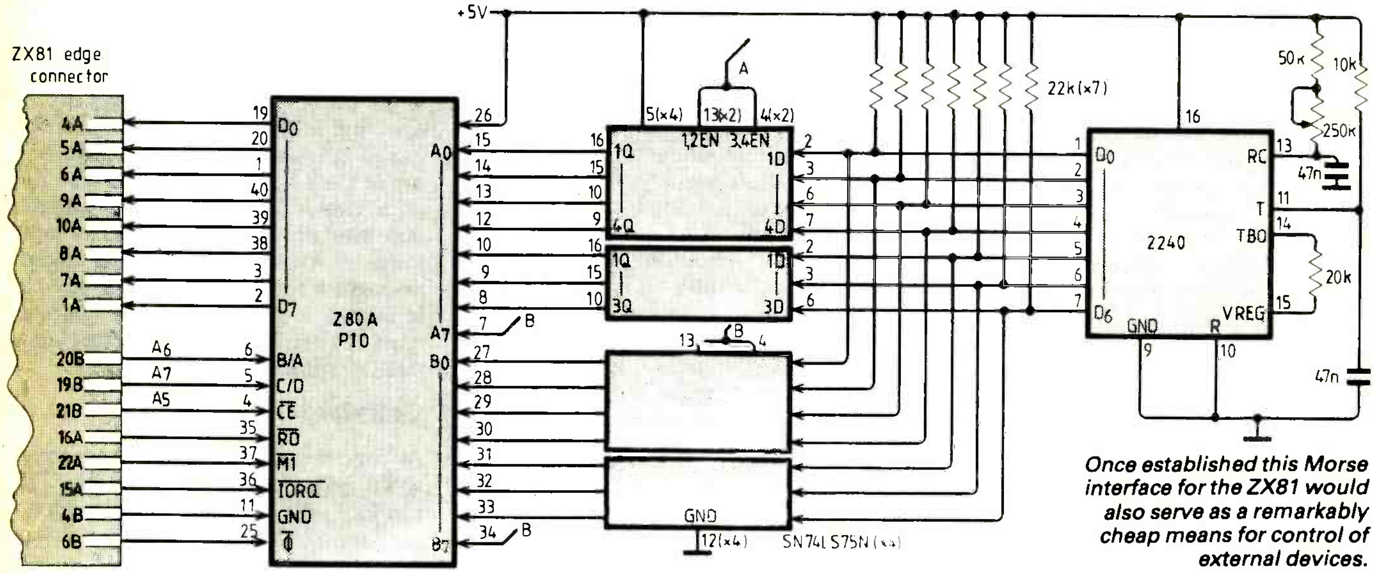




Once established this Morse interface for the ZX81 would also serve as a remarkably cheap means for control of external devices.

With the Z80A running at 4MHz the longest non-interrupted section of the program excluding these routines will execute in less than 1 ms.

The program may be entered into the ZX81 using the following:

```
1 REM 000... 367 ZEROS...00000
2 LET L=USR 16514
3 FOR I = 16514 TO 16879
4 INPUT X
5 POKE I,X
6 NEXT I
```

and executing a GOTO 3 instruction. After entering, program lines 3-6 may be deleted and the program saved in SLOW mode. The machine code occupies 366 bytes, leaving room for about nine lines of text for the display of the Morse code. The table contains a list of the bytes in decimal which should be poked into memory beginning at address 16514.

062	255	211	159	211	159	211	223	211	223	205	021	065	001	001	015
033	000	000	024	045	205	061	065	132	103	203	063	203	063	203	063
184	056	002	024	232	205	089	065	133	111	120	203	063	189	056	007
124	133	103	046	000	024	222	124	203	063	184	203	017	038	000	151
024	003	205	089	065	133	111	203	063	203	063	184	048	017	205	061
065	103	120	203	063	188	056	035	125	140	111	038	000	024	227	121
254	001	040	006	205	010	065	205	010	065	046	000	038	000	205	061
065	103	120	203	063	188	048	244	151	024	157	120	203	063	128	189
220	010	065	046	000	151	024	144	121	028	254	001	032	021	123	254
025	056	016	197	229	205	014	012	006	008	014	000	205	245	008	030
000	024	019	197	229	213	121	001	050	000	033	136	065	237	177	001
049	000	009	126	215	209	225	193	014	001	201	229	213	033	236	065
219	031	087	230	127	095	150	048	002	198	128	254	121	048	042	203
122	040	237	115	209	225	201	229	213	033	236	065	219	095	087	230
127	095	150	048	002	198	128	254	121	048	006	203	122	032	237	024
226	219	095	203	127	032	250	024	006	219	031	203	127	040	250	230
127	095	062	121	024	205	001	006	023	021	011	003	029	009	031	007
024	010	027	004	005	008	025	018	013	015	002	014	030	012	022	020
019	048	056	060	062	063	047	039	035	033	032	046	106	045	076	053
186	122	115	071	085	082	055	000	000	038	039	040	041	042	043	044
045	046	047	048	049	050	051	052	053	054	055	056	057	058	059	060
061	062	063	029	030	031	032	033	034	035	036	037	028	020	027	024
026	008	022	019	015	014	025	017	011	023	000	148	160	166		

Construction

The ZX81/Z80A p.i.o. combination produced a great deal of r.f. interference and careful precautions had to be incorporated to reduce interference to the incoming signals. The most important steps were the use of a shielded audio transformer in the input stage and having the entire assembly housed in an earthed metal box. In addition it was necessary to ensure that the ZX81 was provided with a good earth to the box.

Connection of the Z80A p.i.o. to the ZX81 was achieved by means of a 50-way ribbon cable terminated with a 50-way Speedbloc edge connector. These were subsequently cut down to 46 ways to fit the edge connections on the ZX81.

Operation

Hardware timing of the Morse signals is the only practicable method by which the ZX81 could simultaneously decode the Morse and maintain a continuous display. Although this makes decoding more vulnerable to interference than when using software timing where digital filtering techniques can be used, it was found that the 567 was very efficient at locking onto even weak signals. Effective suppression of locally generated r.f. interference and the narrow bandwidth of the 567 combined to give accurate decoding under most conditions. WW

HOW WILL THE COMPACT DISC AFFECT AUDIO DESIGN?

The nature of disc-playing equipment has always affected the design of related equipment. As the Compact Disc has different characteristics to the analogue disc, the design of the rest of the audio chain may be affected.

by R. I. Harcourt B.Sc., M.I.E.E.

Whereas low frequencies in analogue discs are limited to those for which groove space is available, and to those which are not filtered out for lack of it, the situation with the Compact Disc is that far more bass range is generally possible. Most of the low frequency content of analogue pickups is noise and so a rumble filter is employed, particularly where reflex loudspeakers are used. A Compact Disc (CD) will achieve more wanted signal and less noise in the range below 50 Hz, and one would not wish to lose signal because of a rumble filter. However if a bass reflex loudspeaker is employed without rumble filter, the bass driver coil could be driven out of the linear region of the magnetic gap, as large amplitude low frequency signals can now reach it. This is already true for at least one "digital" AD, where the cannon shots recorded during a rendition of the Tchaikovsky 1812 overture with a low fundamental of 6 Hz cause bass reflex loudspeakers to "bottom", producing a most unrealistic sound, even at moderate pressure levels. Thus far from being a large power handling device at low frequencies, the reflex system becomes an embarrassment. Therefore the closed box loudspeaker will, in my opinion, become more favoured as a result, and the rumble filter will die out.

Larger loudspeaker systems capable of reasonable sound pressure levels at low frequencies are presently the exception rather than the rule, possibly because of the filtering out of low frequencies recorded onto the AD by recording engineers and thus a general lack of good low frequency signals. The greater signal and lower noise of CD will cause more of these larger loudspeakers to be designed and sold, and a change in design of those presently available. Apart from bass reflex becoming anathema, steep cut-off rates or 'high-order alignments' will also be less favoured, because bass transient response suffers. I believe that the closed-box equalized active woofer (e.g. refs 1) will become more favoured, and that the sub-woofer market will increase.

The effective dynamic range of CD depends on the number of bits used to encode signal levels; 16 bits is presently favoured as a maximum, for while 20, 22 and 24 bits have also be mentioned, the limitations of present technology restrict the choice to 16 or below. Sixteen bits in the binary system represent numbers 0-65,535. The least signal is that signal represented by alternating 0s and 1s, and the greatest that represented by alternating 0s with 65,535. Thus the ratio of greatest-to-least signal is 65,535:1, or a range of 96 dB. The likely, more common, 14bit system has a dynamic range of 12dB less, or 84dB. The dynamic range of the power amplifier and loudspeaker system should therefore be increased for maximum fidelity. In the power amplifier, the signal-to-noise ratio is often less than even 84dB, let alone 96; but it should be a simple matter to improve on the figure. Whether such a range is in fact achieved will depend on the audible range in the listening environment, and on listener preferences.

There is presently some debate as to the lower limit of sound pressure level which is audible as a signal in the presence of ambient noise, and whereas the ambient noise level in a living room may be 40dB s.p.l. or more, recent work has suggested that the "cocktail party" effect enables the ear to hear as low as 4 dB s.p.l. in such an environment (ref. 2). This establishes the minimum desired maximum s.p.l. from a CD system as 84+4=88dB. Such a figure is achieved at present. The same criterion applied to a 16bit system would require s.p.ls of 96+4=100dB, and larger present-day systems can achieve this figure, using reasonably efficient loudspeakers. If the criterion is in fact that the minimum s.p.l. is the ambient figure, then even a 14bit system requires 40+84=124dB spl as a maximum, which is not often presently attained. The truth will depend on market reaction, and will lie somewhere between these extremes; there will be those who would consider that a large dynamic range was undesirable and "too loud" in a living room. Thus there will be some demand for a general uprating of amplifier power – possibly the instantaneous/continuous power ratio will increase – of loudspeaker efficiency, and of drive unit power handling.

Lack of noise in a conventional sense distinguishes CD from AD; there is no surface noise nor is there any rumble. However errors can occur in the digital chain, due to extraneous factors such as impulsive interference or surface damage to the record. It is possible for these to cause brief, high-amplitude transients, or even extended high-amplitude noise, and these could be severely damaging to the loudspeaker tweeters. Better CD electronics will include error correction and interleaving to eliminate the effects of surface damage to the signal, but this may not be universally true. Only experience will tell, but it may be that loudspaker and amplifier designers will have to take steps to prevent damage caused by uprating components, and to prevent discomfort by shutting down the signal. Of course this should best be done within the digital electronics of the CD player, but poorly designed players may exhibit the problem.

There is an additional noise problem, namely that the operation of a CD player in the vicinity of a broadcast receiver will most probably cause interference to reception. That digital electronics can interfere with reception is well known by those readers who have operated a home computer while trying to listen to a portable radio in the same room. However the simple cure for this is to turn off the CD player when listening to the radio. More serious may be interference picked up by a tape recorder while recording from CD. I expect the record industry will be delighted if this happens.

With a larger dynamic range, adequate shielding of the input-stage electronics from interference will take on a new importance, especially with the broadband modulated pulse spectrum of digital interference. The present difficulty of many home computer manufacturers in shielding digital electronics from causing excessive spurious radiation is a guide here, and the solution will lie in part with the amplifier design, not just with CD player shielding. To the phenomena "fridge plop", "hf burble" and broadcast TV breakthrough will now be added "CD whistle" if designers are not careful. The problem will be the rectification by input stage base-emitter junctions of electromagnetically induced noise, and while the solutions should be well known, they are not always present in current designs. WW

References

1. Loudspeaker system design, S. Linkwitz, *WW* May/June 1978.
Synthesis of loudspeaker mechanical parameters by electrical means, a new method for controlling low-frequency loudspeaker behaviour; K. E. Stahl, *JAES* Sept 1981.
2. Dynamic Range Requirement for Subjective Noise-Free Reproduction of Music; L. D. Fielder; 69th AES Convention, preprint 1772, May 1981.

COMPUTER NETWORKS

It will soon be feasible for every home to contain a computer system interlinked via local area networks to ground stations and then to satellites. In principle, such an arrangement could provide a social communication medium far more powerful than any of its speech counterparts.

by Philip Barker

The range of computer systems that can be constructed increases substantially as soon as the designer starts to replicate any of its basic components, memory, processor or i/o subsystem. It is quite common to find computers containing two, three or even more central processors linked together in ways that enable particular types of computational task to be undertaken. A twin processor system might use one for conventional processing and a second to act as a controller for a memory management system. Similarly, a computer designed for vector processing might contain 50 to 100 interlinked c.p.us. Such an arrangement would enable many computations to be performed simultaneously, vastly improving the speed at which computer data processing can be achieved.

Producing interlinked computing facilities often requires connecting together many different types of hardware unit. The methods used will obviously depend on the geographical proximity of the elements to be connected, the way in which their activity is to be coordinated, and the architecture of the systems involved. Nowadays, proximity doesn't really present any significant problems because by means of satellite communication networks it is feasible to link together computers distributed anywhere on the earth's surface. At the other extreme, through the use of integration technology, the production of single circuits containing many central processors is a realistic possibility. Between these two ends of the spectrum a variety of other types of interconnection is possible.

The detailed nature of the connection made between individual processing elements within multiple processor configurations depends critically on separation. This enables four basic categories of system to be distinguished.

Geographically distributed – as in a conventional distributed computer network with elements separated by significant distances – perhaps thousands of miles.

Locally distributed – linked by means of short-haul communication systems called local area networks, residing in the same building or site.

Proximally distributed – located within the same laboratory or room, or within a single machine. Office automation systems, robots and multi-dimensional process control applications are common examples.

Closely connected – on the same printed circuit board or within the same integrated circuit.

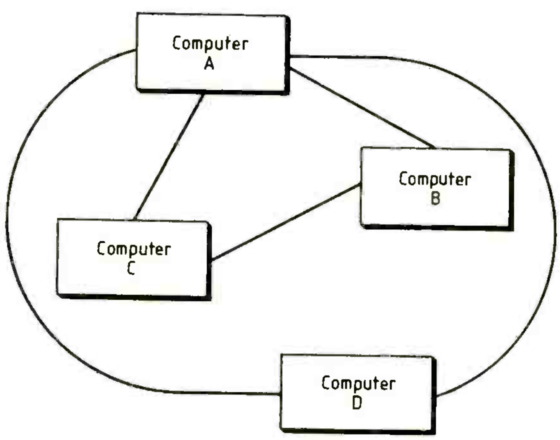
As well as micros, minis and mainframes, computer systems technology embraces super-computers[1] based on the highly parallel interconnection of many processing elements to produce multiple c.p.u. configurations and array processors. The latest trend in this domain is the use of "ultra-computers[2]" consisting of thousands of interlinked elements. The motivation for connecting computing elements together, of course, lies in the exceptionally high speeds of computation through parallelism, greater reliability through redundancy, and more flexibility as a result of dynamic sub-task allocation. Computers linked together in this multiprocessing way are usually located within close proximity, often within the same room.

A distributed processing system is an interconnection of many geographically dispersed digital sub-systems, see diagram on page 75, each has certain processing capabilities and communicates with other sub-systems through the exchange of messages of various sorts – a more rigorous list of criteria has been given elsewhere[3]. Within such a system each host node may have its own local operating system and applications software, which may be unique to that node. The various hosts will communicate with each other using common message-transmission protocols.

Two commonly used techniques for transmission of information around a network – message switching and packet switching – are described in more detail later.

An important feature of the network is that the route information takes from an originating node to destination node is not guaranteed; it will be influenced by the state of the network at any time. To the user the system will present a common command language through the network operating system. This will usually provide a set of high-level commands that enable the user to control the services and facilities that the network offers – for example Create, Send, Fetch, Find to control the manipulation of files of stored data, Database XYZ to establish connection with a particular remote data base system, and so on.

There are many factors that must be evaluated in order to choose the most suitable topology – the arrangement of links and nodes within a network. One factor likely to influence this choice is the type of participation required by each of the nodes. Thus it is possible for a node to act exclusively as a consumer of resources, exclusively as a provider of resources, or as both a consumer and a provider of resources, or as both a consumer and a provider of network resources. Depending on the likely resource utilisation and the way in which nodes need to communicate with each other, about half-a-dozen different types of network topology are commonly used, diagrams at the top of page 75.



The term computer networking describes digital systems interconnection over substantial distances. The geographical distribution of computers or nodes in the network – its topology – will usually not influence its operation or the functions it is designed to perform. Thus, computer A might be located in London, B in Paris, C in New York and D in Oslo. Sometimes there will be more than one direct link between given nodes as in the case of A and D to provide greater overall system reliability. In distributed computing the computational tasks to be performed are serviced by the resources of the network as a whole rather than those associated with any particular node. Laboratory data collected by an acquisition system attached to computer D could be transmitted to computer A for processing; and the results sent to computers B and C for storage. Retrieval requests for inspection of particular items of data could arise from users of any of the four computers. Distributed processing of this type offers high availability, greater reliability, improved work throughput and response time, distributed processing storage and retrieval, load levelling and resource sharing, greater security, and system modularity.

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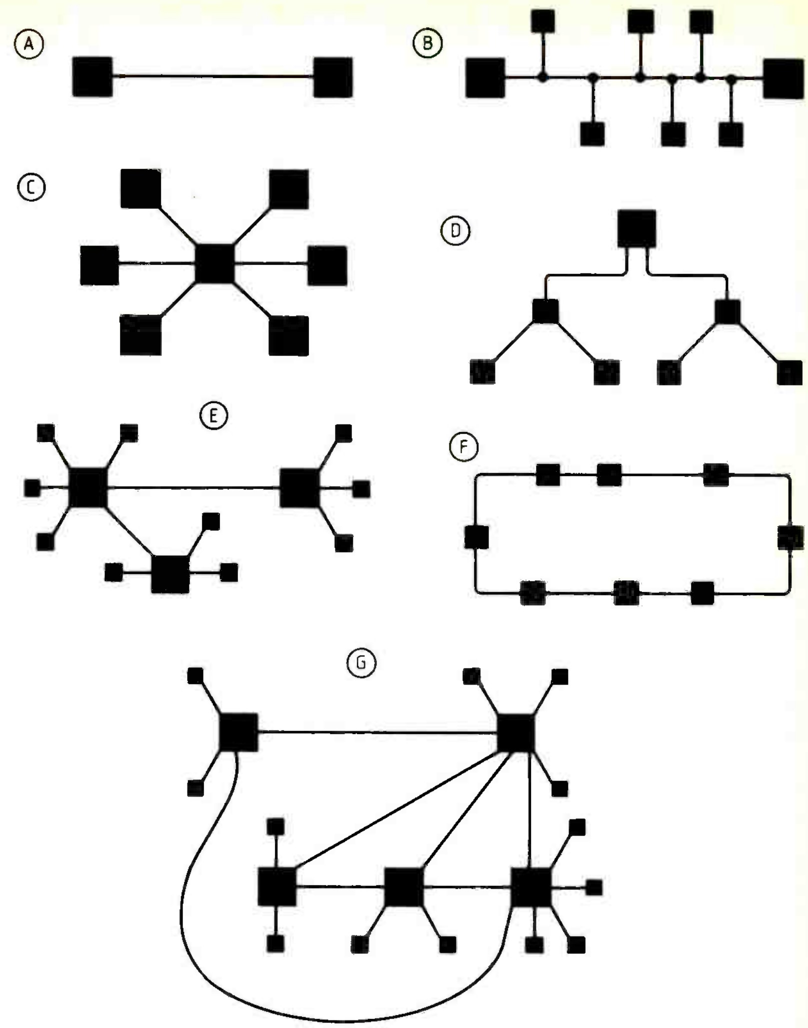
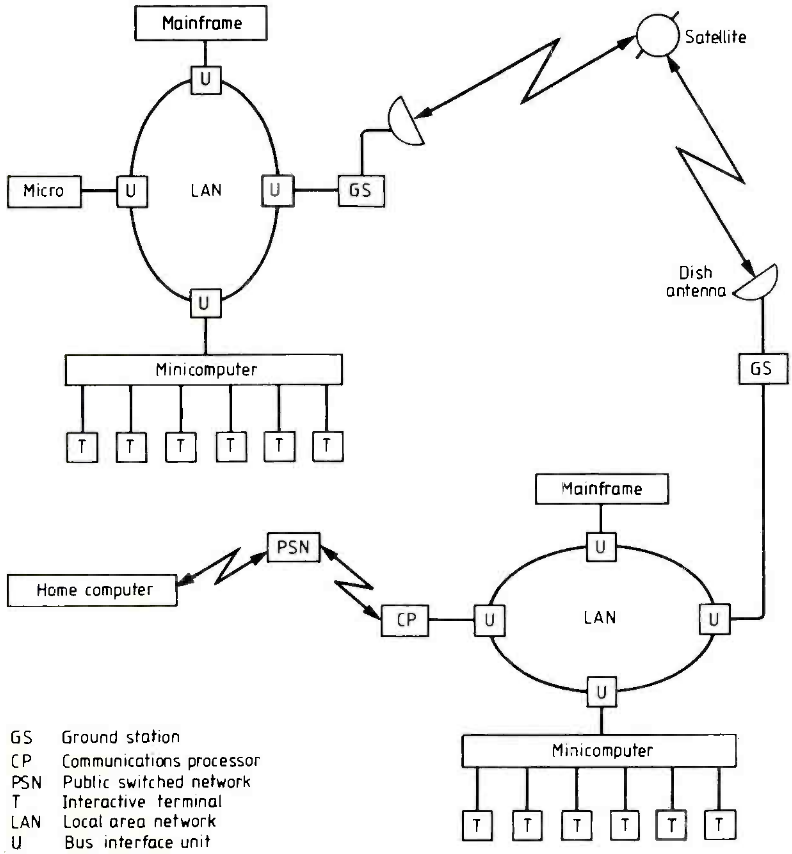
In the point-to-point arrangement of A the link may be either a private wire or a shared line, as in the public switched telephone network. The multi-point system requires that several nodes share the same link, one designated as the controller and the others as tributory stations, B. The controller manages network traffic by polling, i.e. inviting other stations to send messages in turn, usually over non-switched leased lines. In a centralized star system all users communicate with a central point with supervisory control over the system, C. Peripheral nodes can only communicate with each other via the central controller which provides a central message switching service for other nodes. In supervising real-time process monitoring applications a hierarchy of computers controls various processes, synchronizes them and reports their status D . Both microcomputers and minicomputers can occupy the lower levels of the tree structure with perhaps a mainframe or large minicomputer at the top. A loop or ring arrangement is economical when several remote stations and host processors are located near to each other – e.g. within the same building or plant, E. When stations are dispersed over long distances and line costs too expensive a multi-star network is often used in which there are several supervisory or exchange points, each having a local cluster of attached nodes, F. Properly designed, distributed networks can increase reliability as a failure at one node does not affect the rest of the configuration. Where continuous communication is important, a fully distributed network in which every point is connected to several neighbouring ones may be preferred, G. Detailed traffic analysis determines where links are required.





The network structures shown represent the most common types of discrete network architecture. Using these as building blocks, two, three or more networks having topologies similar to that shown in diagram G may be interconnected to form a highly distributed arrangement of nodes. Logically, such an arrangement would appear as two separate networks linked at particular points, but because the individual networks require to retain various attributes of autonomy, and because they differ considerably from each other in their characteristics, special modes of interconnection are required. Nodes used to interlink networks of different types in this way are called gateway nodes, whose design has been described by a number of people[4]. In particular, Ball[5] describes one such gateway that connects the University of Rochester to the Arpa network in the USA.

Computer networks are classified by any of a wide range of possible attributes: by topology (star, tree, loop) control discipline used (centralized or distributed), type of information carried and the mechanisms for transmitting it (message or packet switching), data links employed (cable, twisted pair, optical fibre, radio etc), and the nature of the computers. Of the many different kinds of network that currently exist, those that depend on conventional telecommunication links are probably the most popular – some examples of this category are discussed next.

Message and packet switching networks

Of the three basic methods of routing communications traffic from a source to a destination within a computer network – circuit switching, message switching and packet switching – circuit switching is similar to the public switched telephone network, where the switching centre establishes a direct connection between nodes in the network. Once established these may then carry on one-way or two-way communication. There is then minimal delay between the transmission of a message and its arrival at its destination. When communication is complete, the switching centres disconnect the circuit and restore the system in readiness for other connections. Circuit switching often requires long connect times and ties up transmission capacity for long periods because of a fundamental property of circuit switching – once a path is determined through the network nodes, all traffic between a source and destination pair then follows the same path.

An alternative mode of transmission which does not require a fixed route between source/destination could have many advantages. Two possibilities exist – depending on the volume of data to be transmitted: message switching and packet switching. In message switching, each item of data is sent into the network as a discrete unit and then routed to its destination. A message makes its way through the network to the destination whose address is specified in the header. Each station in the network uses an appropriate routing algorithm to decide which node the message has to go to next to reach its destination. As some stations may be busy, a message may often have to be stored at intermediate nodes before it is passed on. For this reason, an arrangement such as this is often called a store and forward system.

Packet switching is similar to message switching and is used when large volumes of information are to be transmitted. At the source station a large message is subdivided into a series of fixed-length segments called packets of size 1,000 to 8,000 bits. Each packet has a unique number associated with it which enables the reconstruction of the complex message at the destination, and whose format is not unlike that of a message, as shown in the format diagram.

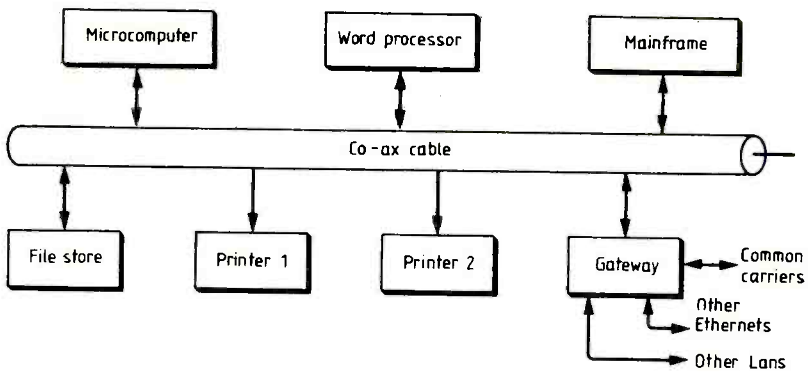
Each packet is treated individually and forwarded along the route with shortest transmission delay. Packets are checked for errors at each node along the way by an error-checking field contained in the packet. When errors are detected packet re-transmission is requested. Because long messages are broken up and sent over different routes, it is possible for them to arrive at their destination more quickly. Furthermore, because intermediate nodes in a packet-switched network only have access to segments of the whole, they are unable to assemble the complete message. Thus if data encryption is not being used, transmission by this technique ensures greater privacy of data.

Videotex networks

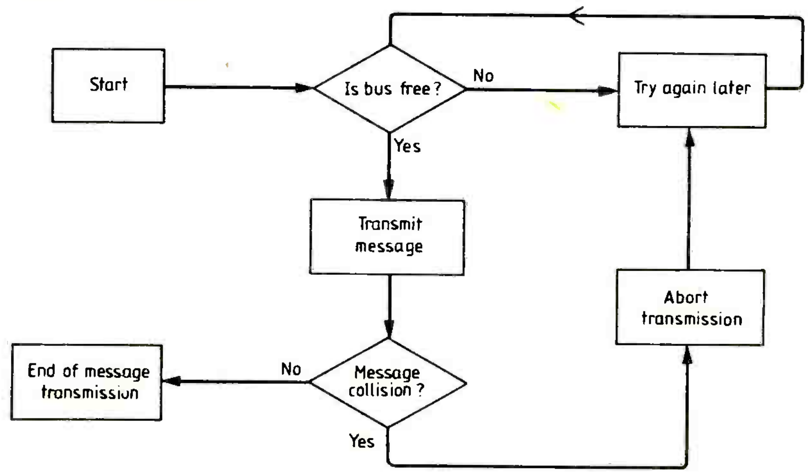
Originally introduced to provide low-cost public data and information retrieval networks based on either broadcast television signals or switched telephone links,

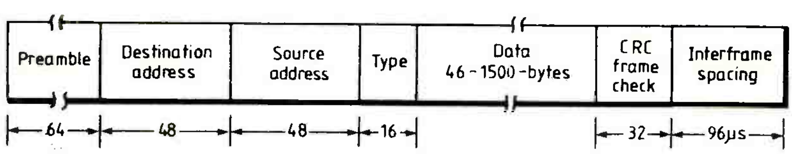
ETHERNET-TYPE CARRIER-SENSE MULTIPLE ACCESS

Bus organisation



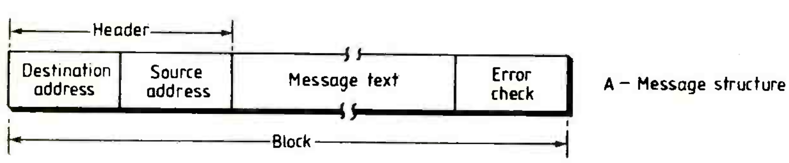
Collision detect algorithm



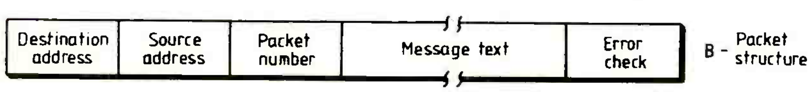


Numbers denote field widths in bits

MESSAGE & PACKET STRUCTURE



A – Message structure



B – Packet structure

videotex systems are intended primarily for use as public information utilities, and are thus designed around a single tree-structured data base[6]. Modified television sets implement a variety of menu selection techniques to facilitate information retrieval operations.

The information providers' terminal is responsible for entering data into the data base and ensuring its correctness. The arrangement of components is essentially a star network with the computer at the centre and the terminals and videotex data base attached as peripheral nodes. This type of equipment is used for the provision of in-house information systems – for a laboratory, operations room or sales office. In addition to their prime use as retrieval tools, the two-way communication capability of many of these systems enables the implementation of a wide variety of electronic mail and electronic publishing facilities. On a larger scale such systems provide global or national information utilities.

Local area networks

Normally, the distances involved in local area networks fall in the range of 0.1 to 10 kilometres.[7] Unlike the two kinds of networks described previously, local area systems do not use any of the global common-carrier communications resources – except by way of special gateway nodes. Furthermore, most lan transmission techniques attach little, if any, priority to data privacy. Instead, messages and data are publically broadcast over the data link at high speed. The intended recipient's address accompanies this data. In principle, only the addressed receiver should then listen-in to the transmission, but there is no easy way of enforcing this selectivity. If a high level of privacy/security between partners is required, then appropiate cryptographic techniques must be employed to achieve this. As in the case of conventional networks, gateway nodes can be constructed to permit the interconnection of several local nets. These may be either of the same type or of a different kind. Gateways also provide the means whereby local area systems can be attached to global common-carrier data links.

Local area networks employ one or other of three basic types of topology:
- shared bus architecture
- ring structure, or
- star configuration.

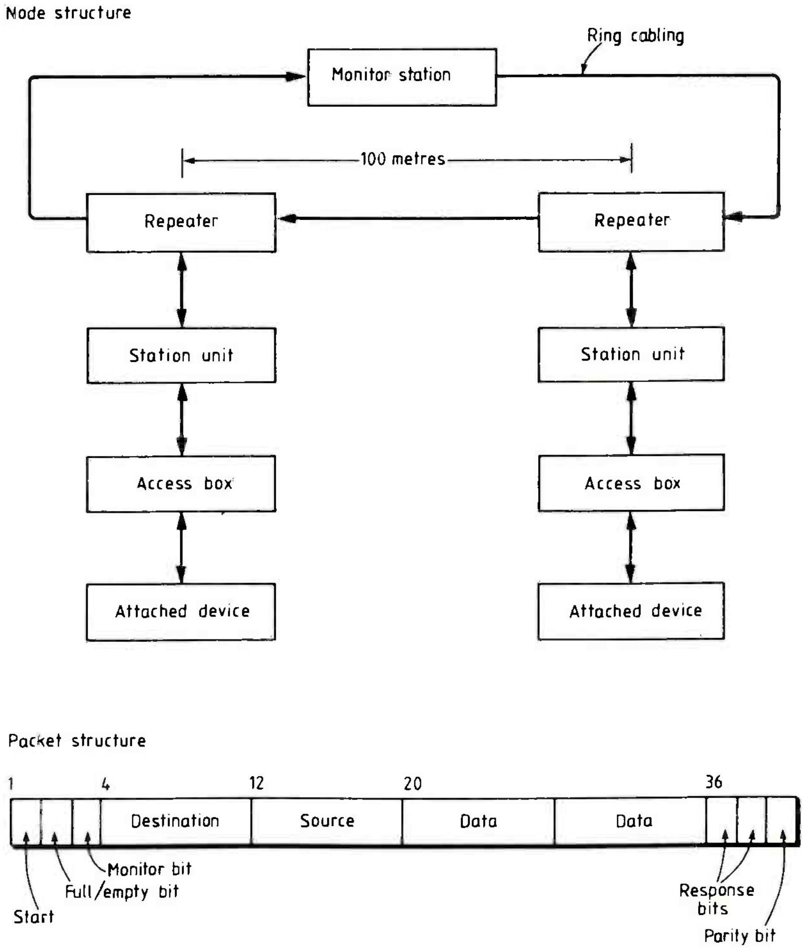
The first two are undoubtedly the most common. A number of schemes employ the bus or multidrop topology of case B – Z-net, Wangnet, Perinet, Cluster/One and Econet are typical examples but probably the most well-known network of this type is Ethernet[8] produced by Xerox, Intel and DEC.

Ethernet implementations use a single shielded coaxial cable to transmit data at rates up to 10Mbit/s using baseband signalling. Because all devices communicate through this single cable, the problem of access priority arises. Simultaneous transmission by two or more devices is prevented by means of an access control protocol called carrier-sense multiple access with collision detection. Before transmitting, each device inspects the status of the data link; if it is clear then transmission takes place, otherwise the device tries again later. Should two devices attempt to transmit simultaneously, their messages will obviously collide. If a collision takes place then a flag is set at each of the network nodes to indicate this state of affairs. After delaying for a randomly determined duration, each of the transmitting devices involved in the collision then attempts to re-transmit its message. The structure of the information packets transmitted along the cable carried in the packet is variable and can be much larger – usually from 46-1500 bytes[9].

The other popular approach to local area networking is the ring structure, for example Transring, Polynet, Xinet, and Toltec, all with a topology similar to that illustrated in case F. One of the most well-known pioneering implementations of this type of network was developed at Cambridge University[10]. Each node in the Cambridge ring contains three basic items: a repeater, a station unit and an access box. Data flows unidirectionally between the network nodes as a train of packets, each of total size 38 bits, as depicted in the ring diagram. Each one contains a framing bit (which is always set to one), two address fields, 16 data bits and various indicator fields. Bit 2, for example, is used to reflect whether a packet is full or empty.

The simplest implementations of this network system are based on standard twisted-pair cables (two pairs) to connect adjacent network nodes. Cables of this type permit data rates up to 10 Mbit/s to be achieved fairly easily; signal repeaters located at each node are separated by intervals of approximately 100 metres. These are an integral part of the station units through which devices access the ring. The function of a repeater is to extract phase-encoded signals from the ring and demodulate them into clock and data signals that are then passed to the station logic. The repeater also accepts signals from the station hardware, combines them with incoming data and then modulates the result onto its output lines. The station unit is responsible for handling data packet framing logic, receive/transmit logic, parity

CAMBRIDGE RING



Bit 2

0	Packet empty
1	Packet full

Response bits

11	Destination absent
01	Packet accepted
10	Destination deaf
00	Destination busy

checking and delay logic. In addition, it also provides facilities for configuring the ring, for example station address assignment. One station, the monitor station, has special significance; it continuously checks the status of the network and responds in an appropriate way to error conditions and systems failures. Its other functions include specifying the number of data packets circulating in the ring and keeping statistics on network performance and loading. The repeater/station units are the same for each node in the system. Different devices are accommodated by means of the access box, of which the host side is tailor made for each type of device. Three types of interface are supported: polled, interrupt driven and d.m.a. (direct memory access).

The access control mechanism used by the Cambridge ring is based on the empty slot principle. When a transmitter wishes to send data to a destination it has to wait for an empty data packet or slot. The transmitter station must thus scan bit 2 of incoming packets to locate an empty one. When it finds an empty packet, the data to be transmitted is transferred into bit positions 20 to 35. Source and destination addresses are then added, the response bits each set to one and the packet then marked as full (bit 2 is set). The packet then flows around the ring to its destination mode where it may be flagged (bits 36 and 37) as accepted, ignored, busy or rejected, as in the diagram. It then travels on around the ring back to the source station from which it was originally sent. The transmitter can then mark the packet as empty. If the destination was busy, the sending station can attempt to retransmit its data after a suitable time delay.

Both the Cambridge ring and the Ethernet system represent two similar but different approaches to local area networking, their essential differences lying in the topology and access control methods employed; ultimately, these determine the applications for which they can be used. They are similar in that they are both digital baseband systems, but this is also one of their major limitations. As demand for office automation, security and image processing systems increases there is growing interest in local area networks capable of carrying video signals. These cannot be handled by baseband systems and so require the use of broadband technology.

The difference between baseband and broadband technologies is the way in which data is carried between the network nodes. Broadband systems encode data on one of several existing carrier signals dispersed across the bandwidth of the coaxial cable, about 400MHz. In contrast, data carried in baseband networks uses its own carrier and the cabling used usually has a lower bandwidth, about 50MHz. Thus a broadband lan can carry many data signals, perhaps hundreds simultaneously, while baseband networks support only one. Furthermore, broadband operation can support both analogue and digital information transfer in parallel bands. Thus, video, voice and conventional digital data can be transmitted over the same circuit should an application require this.

An example of a broadband local area network is Wangnet, using 350MHz coaxial cable. Two cables are used: one for transmitting and a second for receiving. Like Ethernet, Wangnet employs a bus topology and carrier sensing with random re-try to resolve signal collisions. Several parallel channels (or bands) are available. In the Wang band – for linking together Wang equipment – speeds of up to 12Mbit/s can be used. Within the interconnect band, primarily intended for connecting other manufacturers' devices to Wang processors, transmission speeds ranging from 300bit/s up to 64kbit/s are available. In addition to these there is a third band which is allocated 42MHz of the available bandwidth for video channels.

Despite the growing interest in broadband local area networks, it is unlikely that in the short term they will become as popular as baseband systems – even though they offer significantly greater potential. However, many producers of lan systems are able to cater for both requirements; Ungermann-Bass, for example, offer Net/One in compatible baseband and broadband forms.

Physical data links

When a distributed computer network is constructed the locations of the nodes have to be specified and connected together before data transmission takes place. These physical data links may be constructed from a variety of communication media. Three obvious approaches to data link construction are based on metallic conductors, optical fibres or wireless transmission. Simple twisted pair cables as used for digital PABX telephones, can sustain a bandwidth of about 1MHz. Coaxial cables used in baseband local area networks (for example 50 ohm RG58C/U cable) can achieve bandwidths up to about 50MHz, while those used for broadband systems (such as 75 ohm RG59/U cable) are capable of extending this limit to about 400MHz. Although metallic cables have been the most widely used medium for the construction of physical data links, the optical fibre is now becoming popular.

Although there are many advantages to optical fibre cables, for computer data networks, there are some disadvantages. One of these is their limited scope within networks having the case B multidrop topology. Such networks require the availability of inexpensive T-taps and optical mixers to facilitate low energy-loss fibre interconnection. Unfortunately, currently available devices rarely permit the connectivity of a multidrop network to exceed a value of about ten devices. Because of this, fibres have most often been used for high speed point-to-point applications. Optical fibres are also being employed in local area networks, but their greatest use is in star and ring systems.

Of the wireless types of links that have been used for computer data transmission, microwave examples are probably the most well known, though extensive use has been made of infrared techniques.[12] One of the most rapidly developing types of data link for computer communications is on the use of satellites.[13] An interesting experiment[14] currently underway in the UK, project Universe, is designed to combine ground-based Cambridge rings located at six different sites with satellite links. Its aim is to produce a high bandwidth data channel for computer interconnection. Each of the sites is to be equipped with a ground station containing a 3m dish aerial, a 14GHz radio transmitter and 11GHz receiver to provide a two-way link to a satellite operated by the European Space Agency positioned in the geostationary orbit, 36,000km over Gabon. The local area networks at each site connect together the computing devices and link them to their associated ground station. This arrangement enables every computer at a particular site to communicate with any other computer at that site via the lan; computers at different sites can also communicate with each other via the satellite links.

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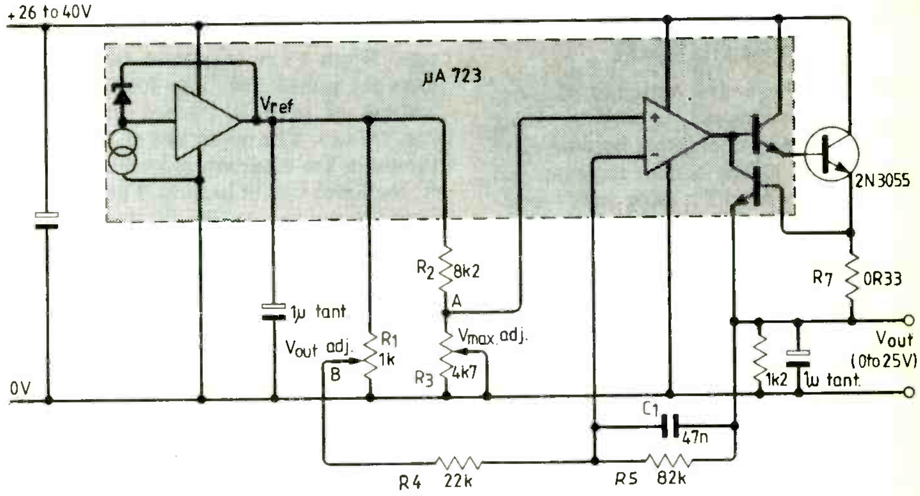
CIRCUIT IDEAS

723-based regulator goes down to 0V

Low-voltage power supplies for experimentation and design are often required to give outputs lower than 2V. For such applications the 723 regulator in its standard configuration is disqualified despite its versatility and accuracy. The configuration shown provides outputs down to around 0V and offers improved linearity.

The second amplifier, normally connected as a voltage follower, is used as an inverter. Output and reference voltages fed to the inverting input through R_4, R_5 are compared with the reference voltage at the junction of R_2 and R_3. Consequently, the output voltage increases as the voltage at B decreases and reaches its greatest value when the voltage at B is zero.

Alternatively, the output voltage is zero when the voltage at B reaches a predetermined value. Taking the ratio of the actual and total values of R_1 as K and the maximum output voltage as V_{max}, networks R_2, R_3 and R_4, R_5 may be calculated. Where



$V_{ref} = 7.15V$ and $K = 0.95$ as the first 5% of the potentiometer track is usually inaccurate and therefore discounted, $C = V_{max}/V_{ref}$ and

$$R_3 = R_2/(1+1/C+1/K)$$

and $R_5 = R_4\,C/K$.

Component values shown provide 1.8A up to 25V. Maximum output current may be altered by changing the value of R_7 where $I_{max} = 0.6/R_7$. Capacitor C_1 improves the frequency response.

P. Pazov
London

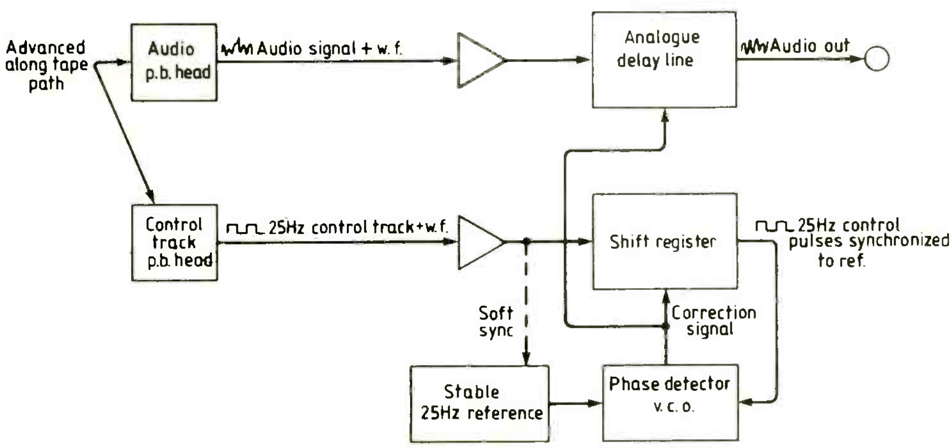
Wow and flutter reduction in video players

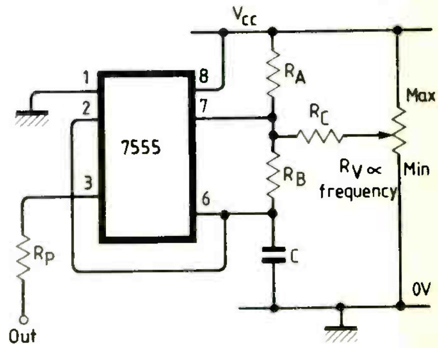
Wow and flutter performance of v.t.r. audio channel is usually poor because of the mechanical nature of the replay system. Synchronization of the video head to the video track on tape is achieved with the aid of a 25Hz control signal recorded on a separate track. The basis of this idea is to synchronize this signal to a stable reference and apply correction to the audio signal from the tape.

Block diagram shows the audio and control-replay heads advanced along the tape path by the same amount of time as the delay lines 1 and 2 to retain lip synchronization. The control signal from tape is passed through delay-line 2 to one input of a phase detector. The other input is fed from a stable 25Hz reference. Output of the phase detector is fed to a v.c.o. to drive the delay lines. A phased-locked loop is thus formed from the output of delay line 2, the reference, and the delay-line drive. As the audio signal is passed through a similar delay line this will also be synchronized to the reference.

Soft synchronization, shown as a broken line, may be needed for long-term correction of the reference speed to that of the speed tape. No circuitry exists, but delay line 1 would be an analogue charge transfer type and, as the control signal is a square wave, delay line 2 would be a shift register. The v.c.o. and phase detector would be a p.l.l. i.c.

W. K. Todd
Colchester





Accurate 555 control

Theoretically, this circuit works over a 10^6:1 frequency range using normal CR values and gives linear frequency control over a range of 2:1. Temperature changes within the device operating range have little effect on the output.

The secret lies in setting the fixed-resistor ratios, for which $R_C = nR_A$, $R_B \ll R_A$ and $R_V \ll R_C$. Resistor R_P is low enough to drive two t.t.l. loads, while

$$f_{max} = \frac{1.46}{CR_A\left(\frac{n}{n+1}\right)}$$

with frequency in Hz, resistance in MΩ and capacitance in μF.

J. A. Fryer
Bristol

Hall-effect keyboard with serial output

Mechanical keyboard switches do not stand up to prolonged use without giving some problems. As contacts become dirty and oxidized, switch bounce increases but this can be avoided by using sealed gold-plated switches or reed switches or, for little more expense, Hall-effect keys with integral i.cs. Each key has four connections, ground, power and two open-collector outputs. When keys are operated the outputs pull low either intermittently or for the duration of the key depression depending on whether pulse or level Hall-effect i.cs are used.

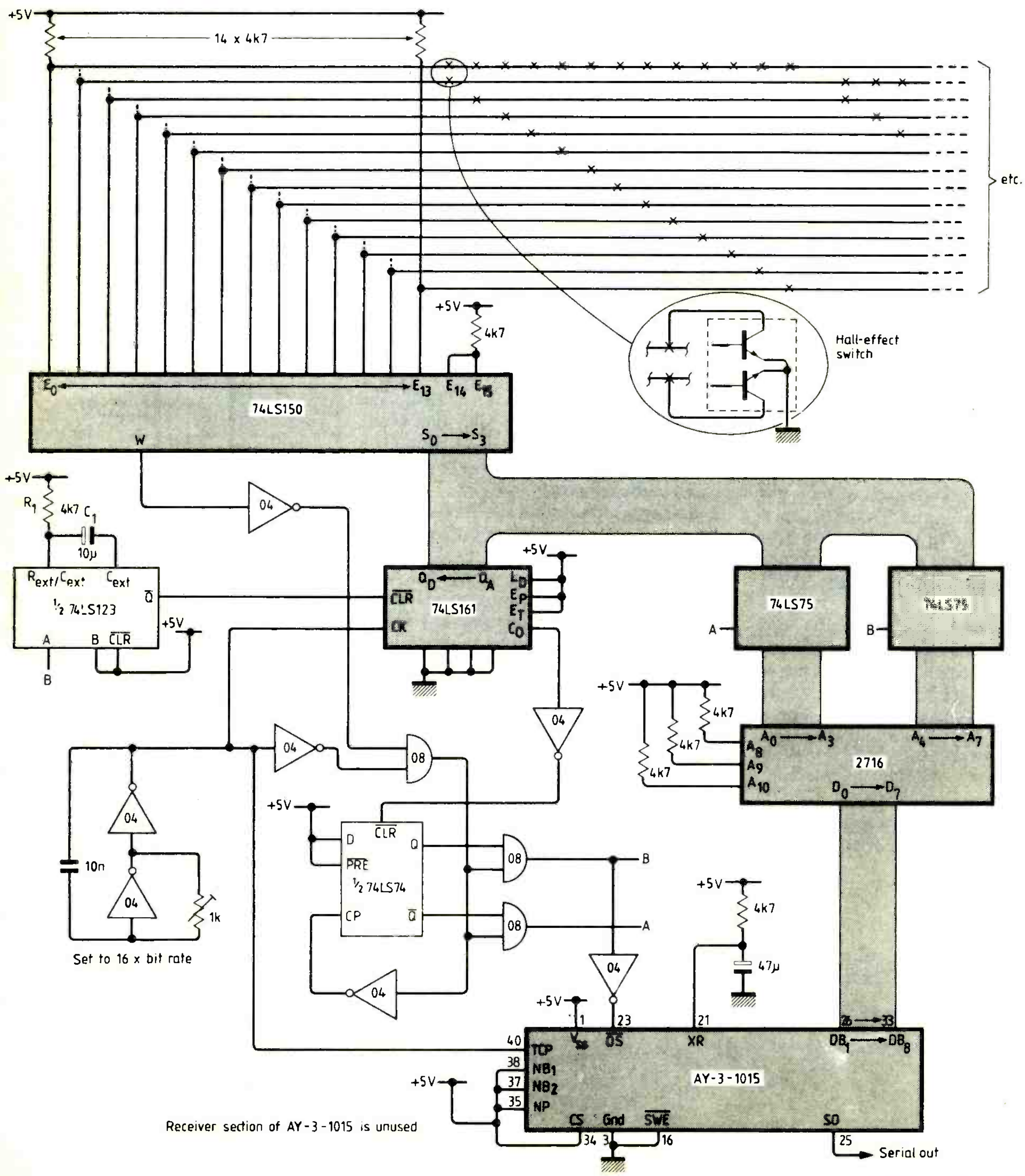
The circuit scans 14 lines all of which are normally held high by pull-up resistors. When a key is pressed two of these lines are pulled low. The four-bit binary address of each is latched in the two 74LS75 i.cs. The upper line of the pair, as shown in the diagram, is latched in latch A, the lower one in latch B. The rom code depends on the coding of the keyboard switches and for this reason is not given.

Three extra address lines on the rom can be connected to level rather than pulse keys and used as modifier inputs with a suitable rom program, eg; shift, control or function.

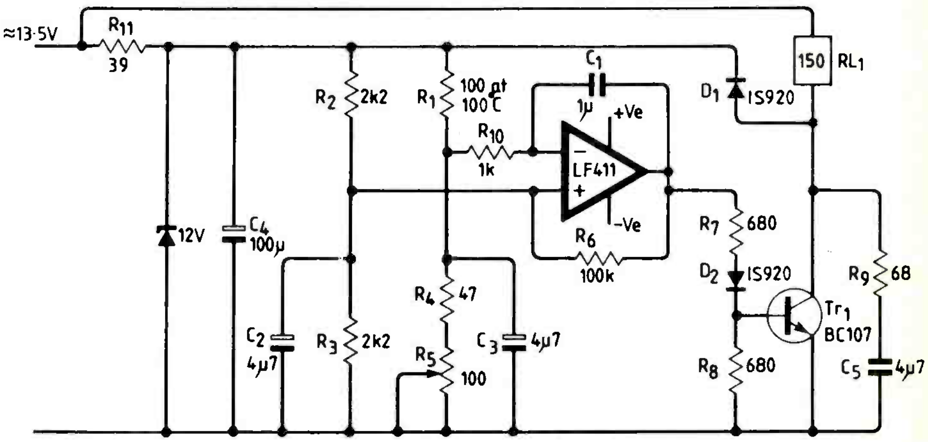
A serial interface is included. Extra expense is justified by the reduced number of connecting wires and increased flexibility. The RC oscillator is set to 16 times the required data rate; the minimum rate is governed by the hall-effect i.c. pulse-width as the encoder circuit is driven by the same clock. The maximum bit period of the serial interface must be less than the pulse width to ensure correct key detection. As the pulse width is usually 1ms or more, any rate over 1200 baud can probably be used.

Time delay introduced by R_1 and C_1 must be longer than the Hall-effect i.c. pulse width to ensure that each key depression gives only one encoded output.

P. N. C. Hill
Chichester



Automotive thermostat control



This otherwise familiar circuit uses a coil of copper wire as a temperature-sensing element to electronically control an electrical cooling fan and thus improve engine efficiency.

In my case, water constantly circulates through the hot-water supply to the car heater so this was the best place to fit the sensor, which is made from 92 metres of 32 s.w.g. enameled copper wire securely wound round the 25mm copper water pipe in three layers. On the prototype, the coil was 66mm long and gave a resistance of about 68 ohms at 25°C. Power for the circuit may be taken from the generator/battery supply as the sensing circuit is a bridge.

Under cold conditions the bridge is unbalanced and the voltage drop across R_1 is less than that across R_2 so the i.c. input is positive and the output thus off.

As water temperature increases, the resistance of R_1 increases at the rate of 0.4%/°C. When the voltage across R_1 is greater than that across R_2, the i.c. output changes state, energizes the relay, and turns the fan on. Resistor R_5 sets the temperature at which the fan turns on and R_6 reduces hystresis.

Negative feedback through C_1 and decoupling capacitors C_2 and C_3 help to reduce the effects of interference. Resistor R_1 and the zener diode provide transient protection.

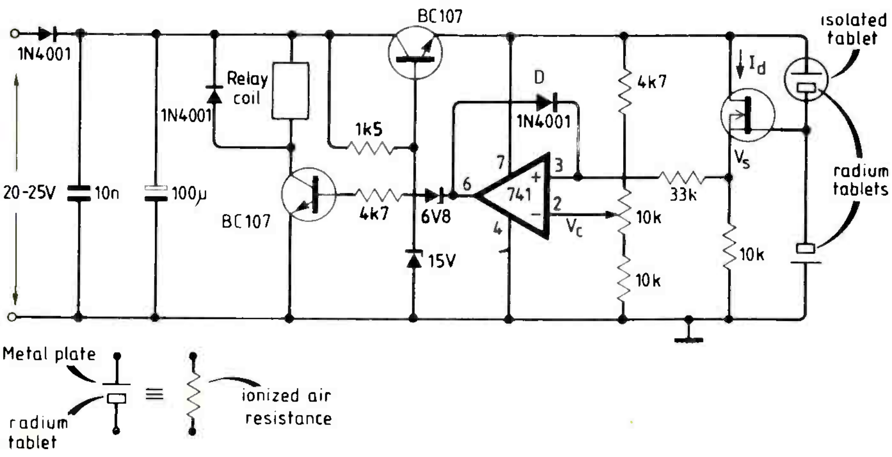
D. A. Fownes
Wolverhampton

Smoke detector

Resistance changes due to smoke in ionized air are detected by a mosfet in this sensitive circuit. Two radium-226 tablets are used to ionize air gaps; one gap is a detector and the other a reference. Ionized air has a lower resistance than non-ionized air so an n-channel mosfet may be used to detect resistance changes.

When smoke enters the detector gap, the air resistance increase raises the mosfet gate, and hence source, voltage until the comparator turns on and is held on by the clamping diode D. In this case a relay is used to drive an alarm and a potentiometer is used to set the switching level.

M. R. Mirabedini
Tehran
Iran

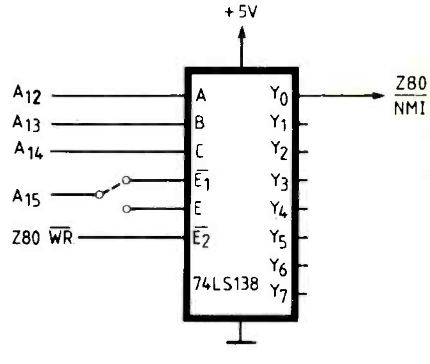


Memory-write protection for the Z80

Many of the new generation of 16-bit microprocessors incorporate some form of memory protection for systems software. This crucial software is often placed in ram to make the system more versatile. In the event of a program failing to operate correctly due to a software bug the processor will be interrupted if it tries to overwrite the system memory area. With older processors such as the Z80, no such protection exists. A total system crash will probably occur, unless of course this useful circuit has been incorporated.

If the Z80 tries to write into a protected block of memory, a non-maskable interrupt will be generated, causing the Z80 to jump to the interrupt service routine at 0066 (hex). The routine can then return control to the system monitor to allow one to investigate the cause of the error. 0066 should be in the protected area of ram, or in eprom, otherwise the service routine could be corrupted.

A. C. Dickens
Cambridge



4k Block protected	Connect Z80 NMI to	Connect E to	Connect $\overline{E_1}$
0000 – 0FFF	Y0	+5V	A15
1000 – 1FFF	Y1	+5V	A15
2000 – 2FFF	Y2	+5V	A15
3000 – 3FFF	Y3	+5V	A15
4000 – 4FFF	Y4	+5V	A15
5000 – 5FFF	Y5	+5V	A15
6000 – 6FFF	Y6	+5V	A15
7000 – 7FFF	Y7	+5V	A15
8000 – 8FFF	Y0	A15	0V
9000 – 9FFF	Y1	A15	0V
A000 – AFFF	Y2	A15	0V
B000 – BFFF	Y3	A15	0V
C000 – CFFF	Y4	A15	0V
D000 – DFFF	Y5	A15	0V
E000 – EFFF	Y6	A15	0V
F000 – FFFF	Y7	A15	0V

DISC-DRIVE CONTROLLERS

Data buffering and enhancements are main topics of the second of two articles in which John Watkinson describes disc-drive controllers and how their two main elements – data-handling and drive coordination sections – are controlled by sequencing logic.

by J. R. Watkinson, M.Sc.

Error-checking circuits insert check words at the end of data words written onto the disc. Following this a 'postamble' of zeros is written to protect the data block on the disc from transients caused by the write current turning off.

The data-circuit clock is derived from incoming data during reading but when writing the data clock may be crystal controlled, in which case the disc's rotational speed will be critical. This problem is reduced in a servo-surface disc drive where the data clock may be phase-locked to the servo track.

Data buffering. Words read from a disc appear at regular intervals and must be transferred to the memory as they are read since the disc cannot stop. Similarly, during writing, the drive needs to be supplied with data words exactly when it demands, or the disc format will be incorrect. Should either of these processes fail, a 'data-late' error will occur.

In a realistic computer system, the demands on memory come from many sources. The c.p.u. requires instructions, and there may be many different d.m.a. devices, such as tape drives and communications units, between which the system must arbitrate. In these circumstances it is impossible to guarantee immediate access to the memory by the disc subsystem so error-free operation is ensured by using a data-buffering silo made up of first-in-first-out arrays. Figure 10(a) shows the silo configuration during a disc read and Fig. 10(b) that during a disc write. Multiplexers are used to reconfigure the silo.

The system takes advantage of the time required by the drive to read preambles and headers. Figure 11(a) shows the silo contents during a read, which starts with the silo empty and Fig. 11(b) shows the silo contents during a write, which must start with the silo full. The sequencer fetches data from the memory before allowing the drive to start writing.

As the silo contains a variable amount of data, it is necessary to have two word-count registers, one which counts d.m.a. transfers with the memory and one which counts words transferred to or from the drive. This is of no consequence to the programmer, as both registers are loaded simultaneously by hardware and only the memory word count can be read by the system. When the memory word count overflows no further memory access is necessary, and when the drive word count overflows the drive function is about to terminate. Referring to Fig. 11, these two events take place at different relative times, dependent on the function.

With modern high-density disc drives, the data rate can be so high that even with a silo the host c.p.u. cannot cope. In this case, sectors on the disc can be interleaved so that every other block is used in a contiguously addressed transfer, and two revolutions are necessary to transfer one track. Figure 12 shows an interleaved track and the associated silo action. Disc interleaving should not be confused with memory interleaving, which is designed to make memory faster; if a disc drive is to be run with non-interleaved sectors, the memory may have to be interleaved.

A typical four-bit f.i.f.o. is shown in Fig. 13. In every cell, together with data, is a validity bit which when set indicates that the cell contains data. Each cell also has logic which monitors the state of its own valid bit and the one of the cell above. Data is presented to the input and clocked, to load the first cell and set the first valid bit. Logic associated with the second cell senses that its own valid bit is clear, but that the one in the cell above is set. Under these conditions only, the second cell latches the data from the first, sets its own valid bit and clears that of the first cell. The third cell now senses the same conditions and so on until the data has arrived at the last cell. The valid bit of the last cell acts as a data-ready signal and the valid bit of the first cell acts as an input-ready signal (data valid = input not ready).

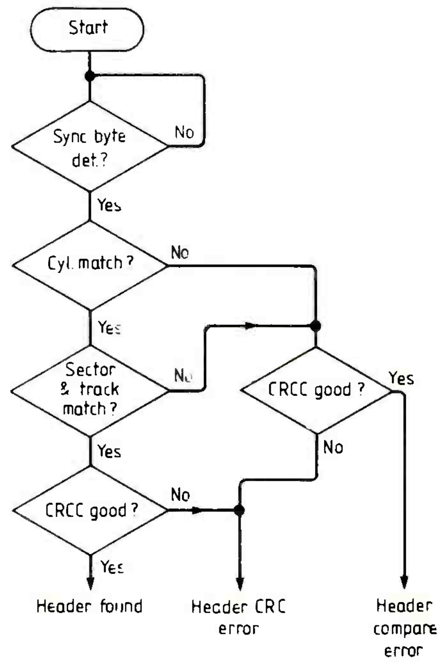


Fig. 9. Position confirmation is carried out according to above flow-chart. The decoder of Fig. 8 determines when the output of the serializer, Fig. 7, contains the appropriate words from the header which are then compared with the contents of the disc address registers in the subsystem. Only if correct header is found and read will data transfer take place.

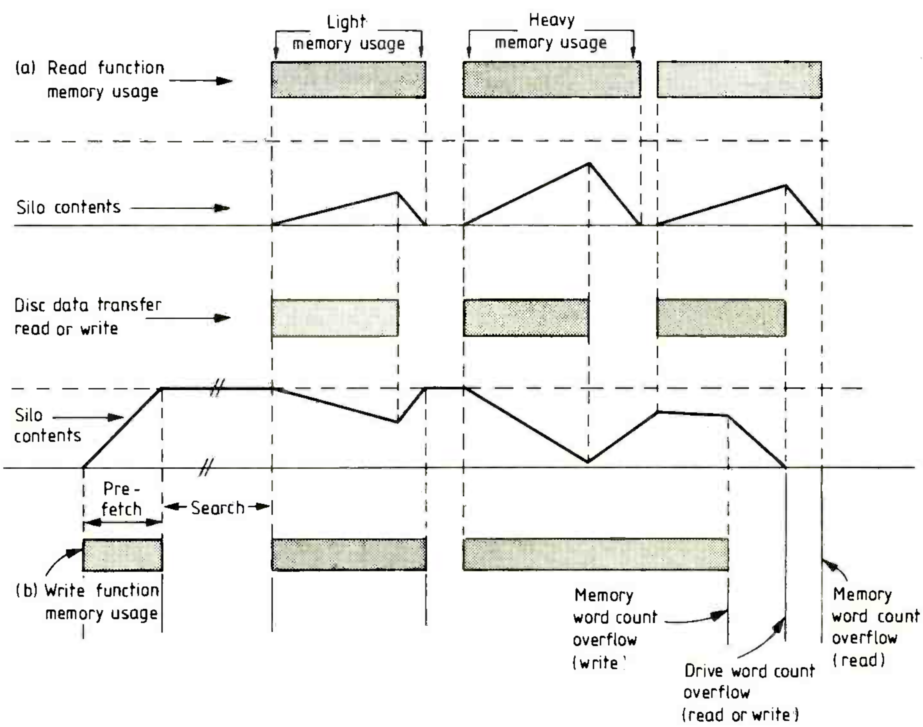


Fig. 11. During reading, the d.m.a. logic keeps the silo as empty as possible whereas during writing the silo is initially filled and kept as full as possible until the memory word-count overflows.

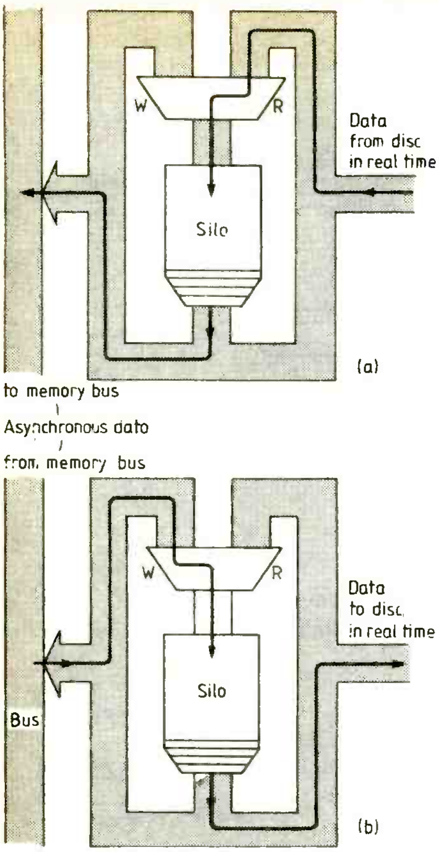


Fig. 10. To guarantee that the drive can transfer data in real time at regular intervals (determined by disc speed and density) the silo provides buffering to the asynchronous operation of the direct memory access process. At (a) the silo is configured for reading from a disc and at (b) for writing on a disc.

If a second word is clocked into the input, it will ripple down as far as the penultimate cell, because the last cell already has valid data. As soon as the first word is clocked out, the second will move down to the output. The time taken for data to ripple through the silo is appreciable, and depends on the number of cells which is typically 64 or 128. This time is not important if the rate at which data can be loaded or read is higher than the data rate of the drive.

Silo chips are connected in parallel to make a data buffer of the appropriate word length. As no two silo chips will ripple down at the same speed, it is necessary to AND together all of the input and output-ready signals. Figure 14 shows an 18-bit silo with two parity bits constructed from four-bit f.i.f.o. devices.

Figure 15 is a block diagram of a typical disc controller which can be split into two areas – one consisting of d.m.a. logic and the other drive-control circuits designed around the structure and format of the disc drive. Where a manufacturer offers a range of disc drives and c.p.us., the cost of developing for each drive-type a controller for each type of c.p.u. would be prohibitive. The solution is to separate the controller circuits into drive-dependent and host-dependent circuitry with a standard interface between them. The dividing line is shown dotted in Fig. 15.

Each family of c.p.u. has a d.m.a. and silo unit close to the memory bus, and each type of drive has a local set of control logic. As shown in Fig. 16, there is a standard mass storage bus linking the components. Some of the subsystem control registers will now be in the drives, and a section of the mass storage bus is required to select and communicate with them, in addition to that required for data transfer. With such a system it becomes relatively easy to add an arbitration unit between two or more standard buses and a drive, resulting in a dual- or multi-port drive. Arbitration is such that while a drive is performing a function for one port, the other is locked out. When the port using the drive has finished, a port-release function is issued, which allows the drive to enter a neutral state where it will then lock to the port issuing the next function. An overriding hardware switch will release the port automatically a few seconds after the last function in order to prevent the drive locking indefinitely to a failed system. Most multi-port drives have an operator control which allows the arbitration to be overridden so that the drive permanently locks to the selected port. This would be used for example where two non-related computers share a dual-port drive solely as backup for their own drives in case of a failure.

Enhancements. A basic disc controller can be enhanced in a number of ways where performance is more important than the extra complication and cost.

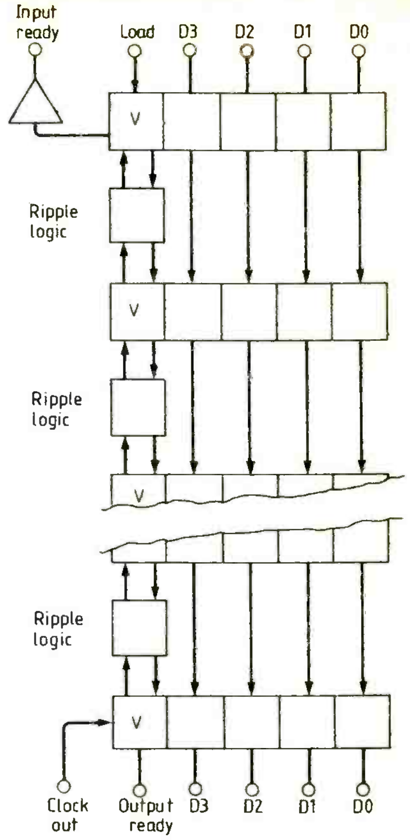
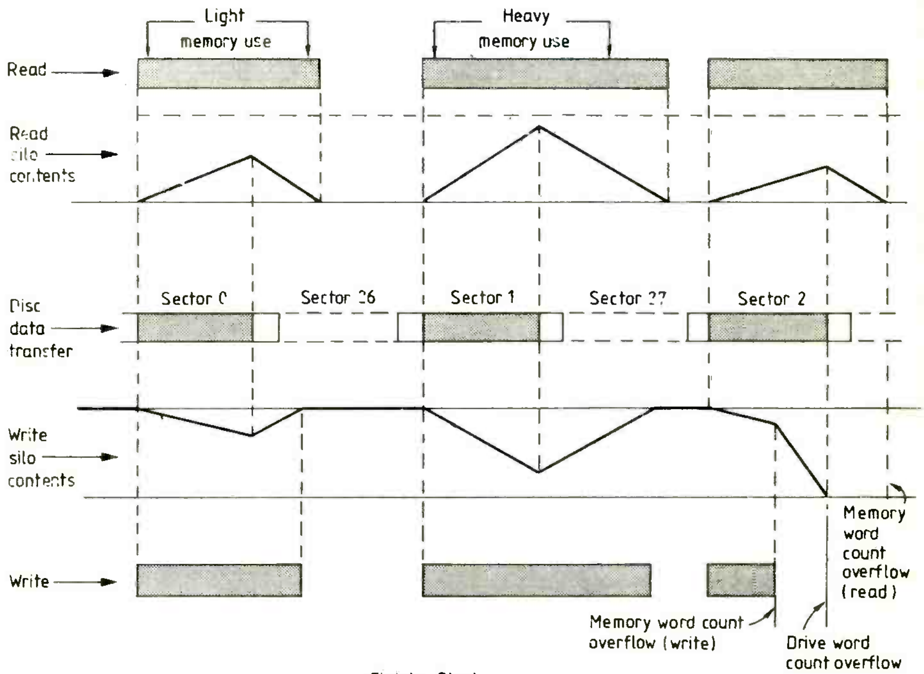


Fig. 13. The action of a four-bit first-in-first-out device with relevant input/output signals. Each cell carries four data bits and one data-valid bit.



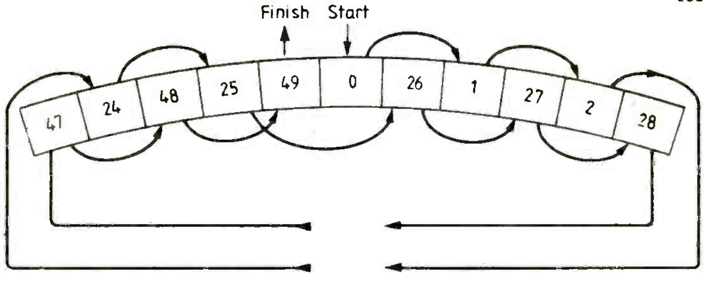


Fig. 12. Layout of an interleaved data track which artificially slows down high-density disc drives by requiring two revolutions for each data track to be written or read. The silo is used to spread the time available to the main processor to transfer data for each block.

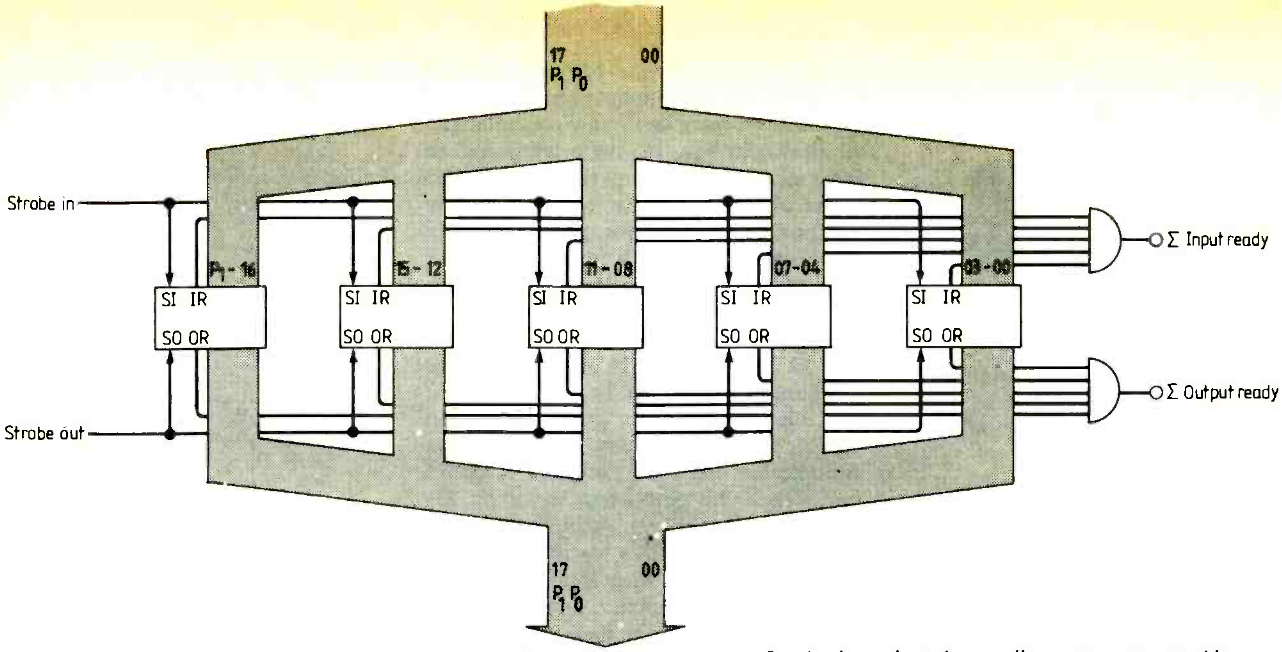
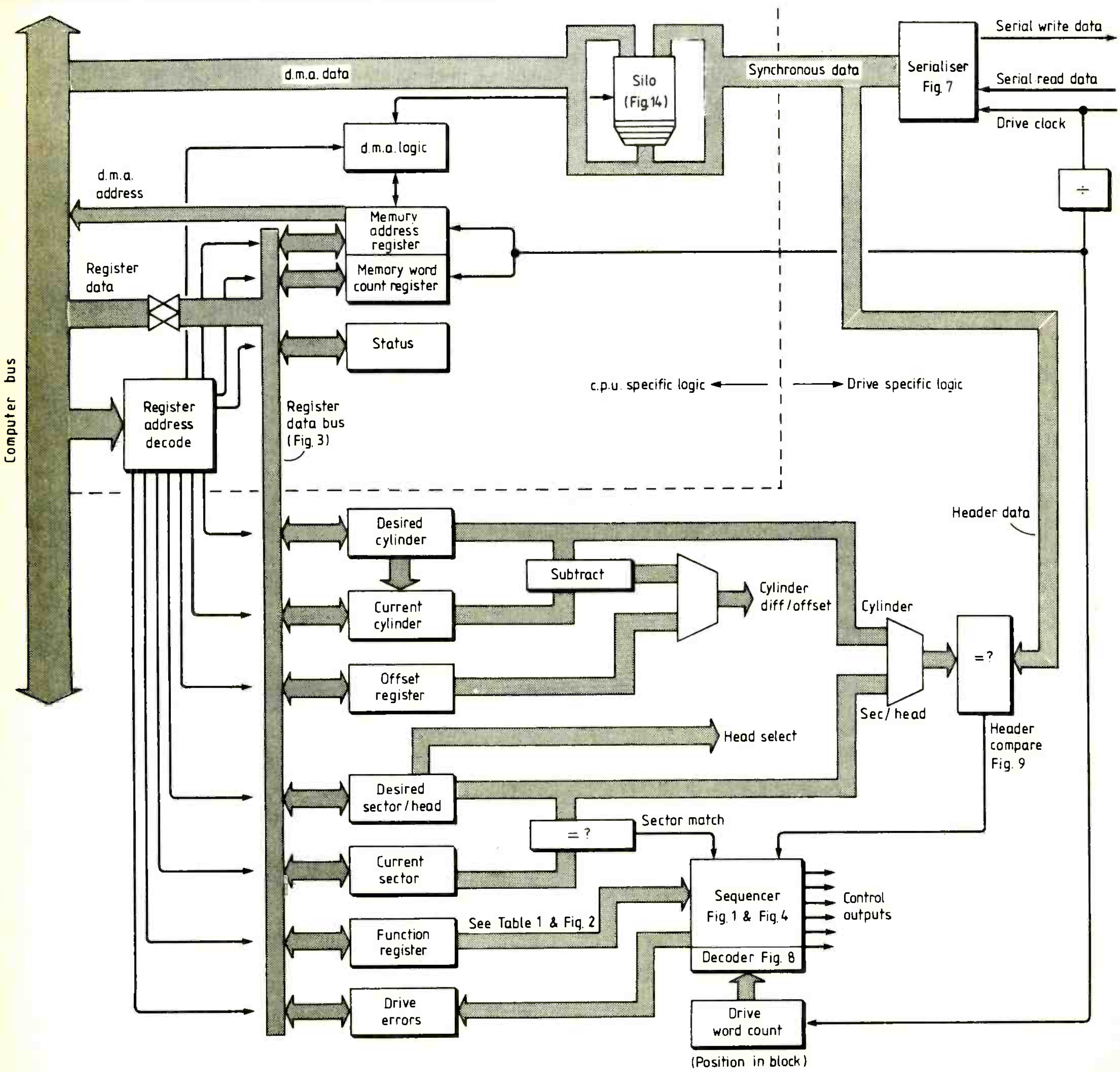


***Fig. 14.** An 18-bit silo with two parity bits constructed from five 4-bit f.i.f.o. devices. Strobe-in and strobe-out lines are connected in parallel but owing to a synchronous nature of f.i.f.o. devices, input and output ready signals have to be subjected to an AND function to ensure that all bits in the word can be loaded or read together.*



Scatter-gather data transfer. Swapping techniques are used in a time-sharing system whereby programs in use are temporarily put on disc to make room in immediate memory for programs being executed. In a real system, the incoming program will not necessarily be the same size as the outgoing one, and the memory management unit may have to map the program to non-contiguous memory pages.

A conventional disc controller with its automatically-incrementing memory-address register can only address contiguous memory with one function, so a separate transaction is required for every area of physical memory, Fig. 17(a). The solution is to provide the disc controller with a memory-management unit, so that the automatically incrementing register generates a virtual address which is contiguous and relocated to non-contiguous physical addresses if necessary.

If memory pages of the main c.p.u. memory-management system are the same size as blocks on the disc, the same set of relocation constants can be loaded into the disc controller, to swap in or out a program, and into the c.p.u. to execute it. The process whereby the disc controller takes non-contiguous memory data and makes it contiguous on disc is known as scatter-gathering. Fragmentation of physical memory by time sharing different sized programs ceases to be a problem, as both disc and c.p.u. have contiguous virtual memory for each program, regardless of the physical code distribution, Fig. 17(b).

'Intelligent' controllers. The disc controller described so far has required the physical disc address of stored data to be specified, whereas programmers request data in the form of named files. The conversion process relies on an area of the disc known as the directory, which is a cross reference table between file names and physical addresses, as well as a protection system that only lets authorised users access files. A part of the disc-operating system known as the device driver uses the directory to provide requested files. In the case of frequently used information, the memory may contain a copy of the directory to reduce access time. The device driver has to know the physical structure of each drive type, i.e. the number of cylinders, tracks and sectors, and must satisfy the protocol required by the drive when issuing functions.

In large systems it may be more effective to relieve the main c.p.u. of extra processing needed for file handling. The disc controller now becomes a computer in its own right, dedicated to the transfer of disc files, and the main c.p.u. asks for files by name only. The next and final topic in the disc series is data integrity.

◀ *Fig. 15. Block diagram reviewing disc-control logic. Logic can be split into two sections, one d.m.a. logic and data silo designed to suit the memory bus of the main processor, and the other drive-control circuits designed around the structure and format of the drive concerned.*

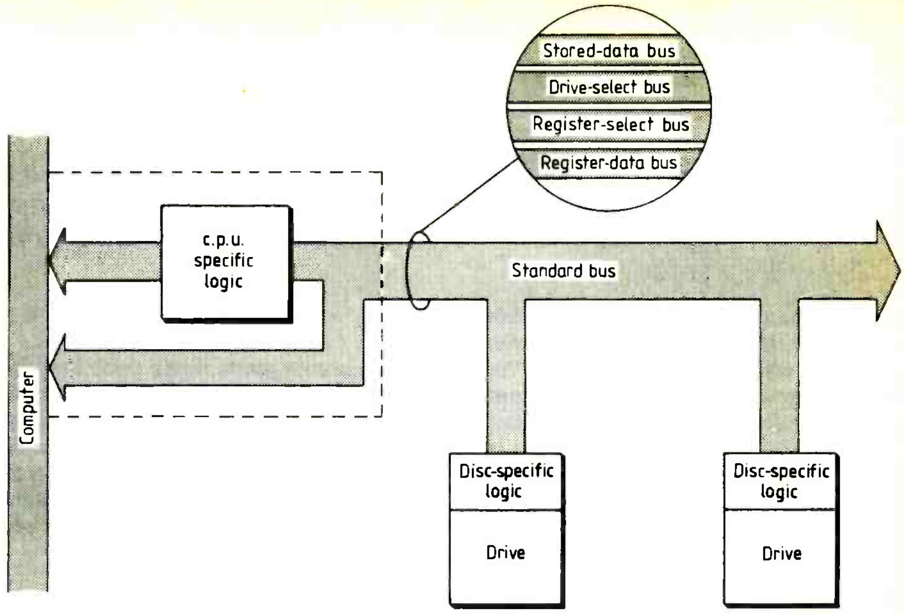


Fig. 16. This configuration, whereby processor-specific logic is implemented once only for several drives, is achieved by separating diagram of Fig. 15 along the dotted line. This makes for a more cost effective system. Only one drive can transfer data at a time but this is adequate for many microcomputer configurations. Where the main processor can tolerate high data rates two buses may be used in conjunction with dual-port drives.

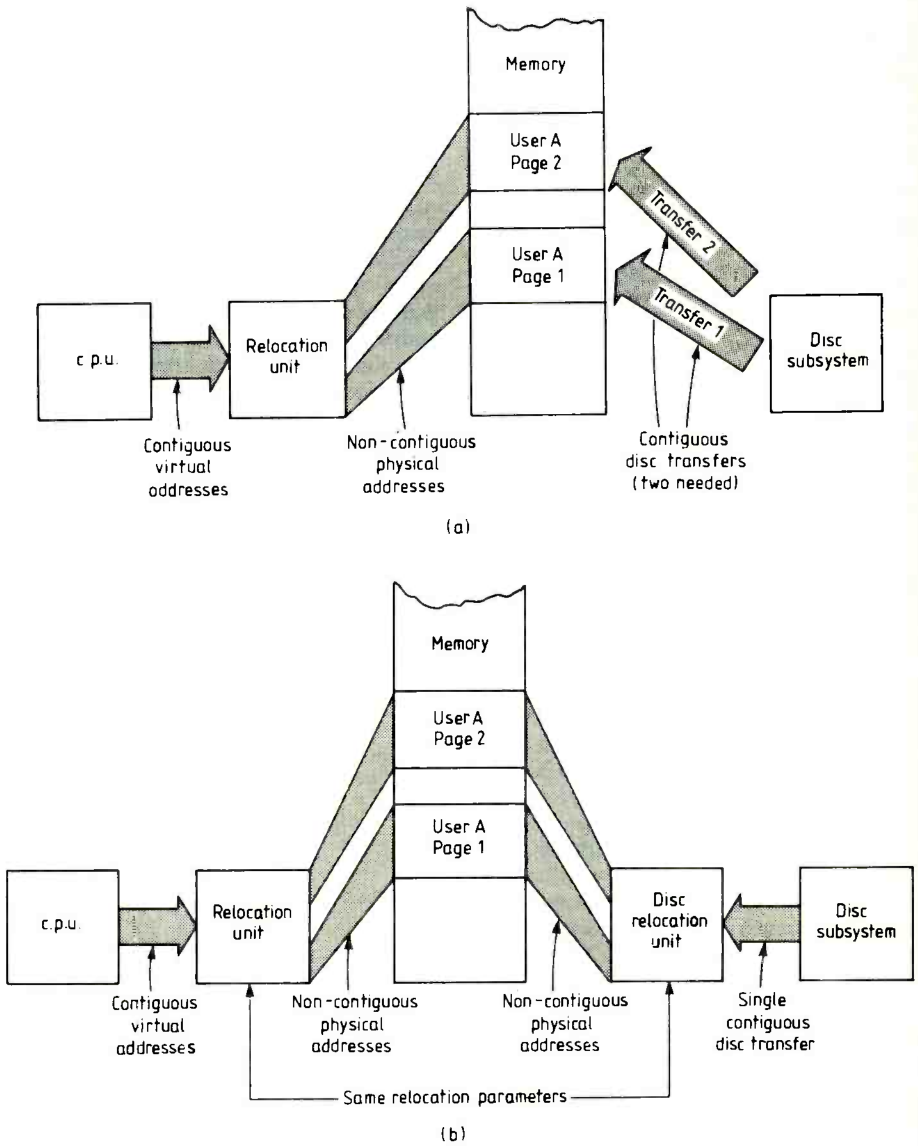


Fig. 17. In (a), where a particular program becomes non-contiguous in memory a separate disc transfer is required for each contiguous section. In (b), the addition of a relocation unit to the disc subsystem allows a single disc transfer to be mapped to non-contiguous memory.

INTRODUCTION TO VDUs

In the second part of his primer, the author discusses methods of gaining access to the video ram while maintaining a flicker-free display, and describes some of the integrated-circuit video-display controllers available.

by Colin Carson

In the simple video system described last month, there is bound to be conflict over what has access to the video ram. If the user's system can gain access at any time then, during that time, the video circuitry is unable to do so. The result of this is a noticeable flash on the character generator. The problem becomes severe when the user writes several lines of text or a whole screen in one go. In all but the lowest-cost systems, this form of free access is unacceptable and there are several ways round it.

Access during blanking. The easiest method to use is to give the video circuitry access to the video ram all the time it needs it, and restrict user access to the horizontal and vertical blanking periods. With this technique, the user has access for less than 25 per cent of the time. The actual implementation can be done by the video hardware or the user's software: with the latter, the display-enable line can be taken to a pin of an input port on the user's system. When the system wishes to access the video ram, it has to poll this input line until it is in a blanking state, when the ram can be addressed.

This has the advantage that, when a big output to the screen is required and the flash can be tolerated, it can be done without hardware alteration. To implement in hardware is more difficult: one method is to force the user's system-ready line inactive on attempted video-ram access, until blanking starts. Careful design is needed to avoid synchronization problems.

Shared access. It is possible to arrange the hardware so that the user can access the video ram at all times (Fig. 4) by sharing the time taken for each character clock between the video and the user. If the character clock has a period of 600ns, 300ns can be allowed for each of the two users. The negative edge of the character clock is used by the control circuitry to increment the video ram address, which is ready before the next positive edge of the clock. At that point, the multiplexer switches so that this memory address is fed to the address pins of the video ram. This switching takes a maximum of 27 nanoseconds for a 74LS157 device. If the video ram has a maximum access time of 150ns, then the data will be ready at the output of the video ram 124ns before the next negative clock edge. When the latter occurs, this data is clocked into the video latch, where it remains until the next negative edge – i.e. for a full 600ns. During the first half of this period, the user has access to the video ram, having 283ns to write data in, or clock data out into a user latch.

Shared access needs faster rams and, because the characters out of the character generator are delayed by 1½ character clocks, the cursor and display-enable signals have to be equally delayed. Shared access must be used for video systems where flash on screen and delays in processing cannot be tolerated.

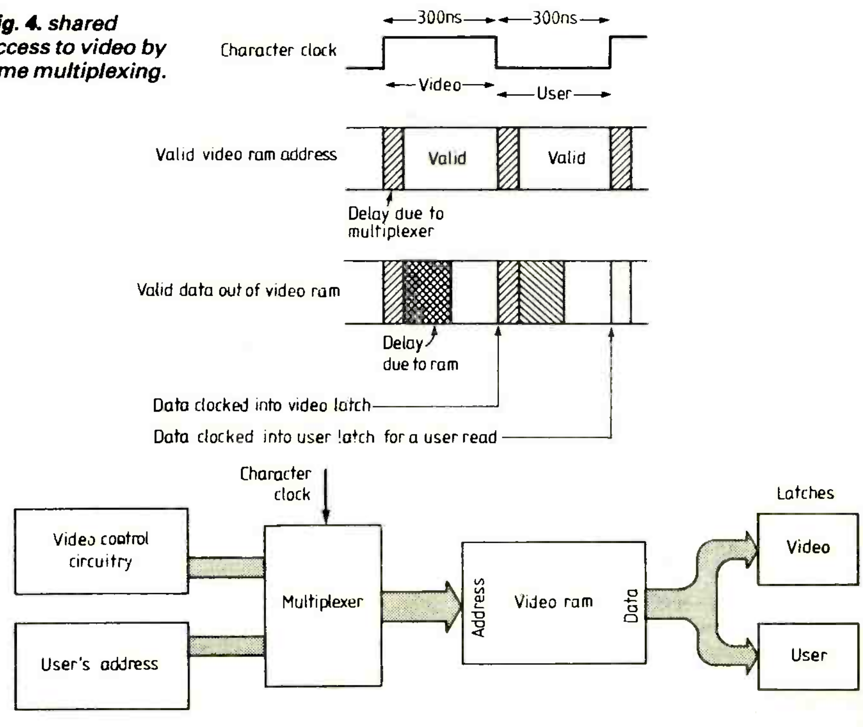
Control circuitry

Until recently, the control circuitry was normally built up from t.t.l. counters and gates, the screen format being fixed. With the advent of l.s.i., the c.r.t. controller came onto the market to replace the majority of the control logic. The first chips, such as the Thomson 96364, still had a fixed format, but the newer chips are fully programmable. Three different controllers will be considered here.

Thomson 96364. This chip has a fixed format of 16 lines of 64 characters, and runs at standard UK scan rates. Ten memory address lines are available to drive the 1024 bytes of video ram required to make up the chosen screen format, and three row address lines to drive a 5 × 7 matrix character generator, with one free scan line between each row of characters. Horizontal and vertical syncs are mixed internally and would have to be split for direct-drive monitors. Although there is an on-board oscillator driven by a crystal, character clock has to be provided and turned off whenever the INI pin requests. Normally the 96364 will scroll text at the bottom of the page, although by doubling the video ram, a two-display page system can be employed. The cursor flashes at 2Hz and can be moved in all four directions by issuing a code onto the cursor control lines. By strobing data into these pins, the 96364 can erase a page or line, as well as moving the cursor. Available for under ten pounds, the Thomson chip is now a little dated.

Intel 8275. this is a buffered video controller, its video ram being part of the user's system memory. There are two buffers inside the controller, each eighty bytes long. When the c.r.t. controller starts to generate a picture, it sends an interrupt to the user's processor which instructs the latter to fill up one of the buffers with the bytes from video ram which correspond to the first row of text. If there are 64 characters per row, then 64 bytes have to be written into the buffer. The c.r.t. controller proceeds to reissue each byte at character clock rate, for each of the scan lines making up the row of characters. Before the last scan line is reached a further interrupt ensures that the second buffer is filled with the bytes for the next row. Hence, each character row on the screen uses alternate buffers. Apart from buffer refills, the video ram and hence the user's bus is free – it is up to the user to ensure that the buffers are filled in as short a time as possible. The video interrupts have a

Fig. 4. shared access to video by time multiplexing.



high priority: the 8275 is programmed to know how many bytes it is expecting from each refill and, if this number is not achieved, the screen goes blank. The 8275 does have five programmable registers, but the waveforms it generates are not as flexible as those produced by a 6845.

Because it is up to the processor to fill the buffers, the processor can decide where to get the bytes from. Normally the software will keep a table of pointers, with the first pointer being the start address of the block of video ram making up the first line on the screen, the second pointer for the second line and so on. Changing the pointers is one easy way of scrolling, and setting all the pointers to be the same would generate a picture with every line on the screen the same.

Character and screen attributes.An 'attribute' is an enhancement, such as underline, which can be added to characters or the whole screen. Typical attributes are reverse video (where all that is black becomes white and vice versa), underline, varying intensities or colour, flash and combinations of these. The 8275 can implement most of these attributes automatically by recognizing special codes in the video ram. They are often called field attributes because all the characters following the attribute have that enhancement until a new field attribute is encountered. Suppose part of a text displayed was "A CAT" where cat was to flash, but all succeeding text is normal – the bytes corresponding to this might be:

41H 20H	F4H	43H 41H 54H	F8H
A SPACE	FLASH ATTRIBUTE	C A T	NORMAL ATTRIBUTE

When the c.r.t. controller recognizes an attribute, in this case by bit seven being set, it puts them into separate buffers. The software must ensure that the main buffers get their full quota or suffer screen blanking.

Motorola 6845. Unlike the Thomson chip, this c.r.t. controller can be programmed to run at scan rates other than that of standard television. Like most modern peripheral chips, its programmability is via internal registers, rather than pins on the chip, and is compatible with the 6800 processor bus. The simplest version of the 6845 has nineteen internal registers, mainly write-only, one of which is an address register. To access register five, say, 5 is written onto the address registers. Until that is changed, all further communication is with register five. On power-up, it is up to the user's system to initialize all the registers and, for this reason, programmable c.r.t. controllers can be clumsy to use in a system which does not use a microprocessor. Such a situation would need additional hardware, such as a small prom and counter which, on reset, loads bytes into the controller's registers, and would severely limit flexibility to what is in the initialization prom. The 6845 is extremely versatile – in the horizontal scan, the frequency, sync. width, number of characters and the time from end of sync. to start of video are all programmable. So are the number of rows, vertical sync. rate, time from the end of sync. to video and the number of scan lines per row. Two of the registers define the position of the cursor on the screen, and there is programmable height and flash rate. There is also a light pen input to the chip which, when activated, copies the contents of the memory address lines into two read-only registers.

Scrolling. The 6845 has twelve video-ram address lines and so can access 4K of memory, enough for two large pages of text. Bearing this in mind, scrolling can be implemented in two ways. Firstly the user's processor, on detecting that the screen is full, can copy each byte on the screen into a new video ram position – equivalent to the text scrolling up one line. This, however, places a heavy burden on the processor and should really be avoided.

The second technique is to tell the c.r.t. controller to start taking bytes from a different block of video ram rather than the block right at the beginning. Imagine that blocks of 80 characters were positioned in video ram, with the first byte of each row having the addresses 000H, 050H, 0A0H, etc. Before a scroll occurred, the c.r.t. controller would start taking bytes from address 000H at the top of each page. After one scroll that first address would become 050H, and so on. The 6845 can handle this, having two registers defining the address of the first byte. This considerably reduces processor overheads: to implement a scroll, four bytes (two address, two data) are issued to the c.r.t. controller. The video ram is considered as a sphere with the screen being a window on the surface of the sphere, movable in the north/south direction. Occasionally the microprocessor will have to clear areas of video ram, when a new clean line is needed for a scroll. The 6845 cannot be used when each line on the screen can be a number of contiguous bytes in the video ram. To cope with this, a different type of c.r.t. controller is needed, such as the Intel 8275.

Several manufacturers make the 6845 and updated versions which offer more facilities, and recently the price has dropped below £15 for one. It should be remembered that it is not easy to use the 6845 without a processor controlling it, and calculating the bytes with which it is to be loaded is not straight-forward. However, I consider the 6845 the most programmable and useful of all the c.r.t. controllers I have considered.

Although there are now a handful of c.r.t. controllers on the market, for a one-off design of a fixed format screen, discrete logic is still cheaper. WW

Continued from page 33

require the obscurely transverse waves of "electric force" of electromagnetic theory to account for the observed behaviour of a radio dipole or television H-aerial, but it explains the transverse induced current – that is, the transverse motion of photoelectrons – in a simple and natural way. The reception of radio energy, like the detection of all light, is seen to depend on the mechanical photoelectric mechanism; in accord with experiment there is no indication anywhere that light in transit *in vacuo* is influenced by electric or magnetic fields or that photons are electromagnetic. Finally, when the mechanism is applied to the Rutherford/Bohr/Sommerfeld model of the hydrogen atom it provides, for the first time, a mechanically-plausible description of what happens when an atom absorbs or radiates a light quantum.

As early products of the proposed photon-waves concept these examples may be thought to represent substantial successes. But one can't make scientific omelettes without breaking scientific eggs and we are now going to shatter an egg that has been around for a very long time. That same logic of particle mechanics and observance of the conservation laws which once explained the Compton effect, and which has now described the photoelectric mechanism of the detection of light and radio energy, leads equally surely to the inverse statement: *a photon cannot be radiated by an isolated electron,* but only by a "Planckian oscillator". This is likely to lead to a first-rate argument, because according to the electromagnetic theory an isolated "point charge" (ie, an electron) must radiate electromagnetic energy when it is accelerated, while according to the tale I have been telling you it does not and cannot.

This very long-standing prediction of the electromagnetic theory has never been tested in the laboratory, although the means for testing it have been available for half a century. The radiation due to electrons being accelerated in an ordinary electron gun (as in a television picture tube) should be detectable with a sensitive radio receiver – in fact it might be expected to interfere with radio reception – but no such interference has ever been reported. (To forestall a probable objection, let me say that neither the so-called synchrotron radiation nor man-made x-radiation seems to be due to the acceleration of *isolated* electrons.)

An experiment on these lines could be performed quite easily, and it might be thought very important. It would provide an opportunity to test the mechanical quantum concept against electromagnetic theory on an issue unclouded by the mystical arguments of wave/particle duality. If it should turn out that an electron circulating mechanically around an atomic nucleus has no tendency to lose energy and "run down" – as *electromagnetic theory* has predicted that it must run down – then one of the founding premises of modern *quantum theory* would turn out to have been a false lead.

It is time we took a look at quantization, which by itself is easy to understand, and at some of the very odd ideas that grew out of it when Alice re-visited Wonderland, during the years 1925 to 1930. WW

RANDOM ECHOES

By Chirp

ROBOTICS

I've just returned from one of those IERE lectures, this time on Robotics. Of course, real-life robots (if you will pardon the expression) are far removed from the science fiction, super intelligent, "Metal Mickey" facsimile of a human being. It also became evident that they are totally ignorant of those laws of robotics about not hurting human beings, etc.

The industrial robot is, in fact, usually more nearly comparable with a single human arm and possibly hand, operating under microcomputer control. It is, therefore, a fairly versatile system, capable of handling a variety of tools, ranging, for example, from a paint spray gun to a welding torch (with obvious distinction between light and heavy-duty types). Incidentally, it seems that the Japanese define the robot differently from the Europeans, including any computer-controlled or n.c. machine; perhaps that is how they claim to have more robots.

The lecture included several films of robots in the automotive industry. They were shown doing paint spraying and spot welding jobs, as well as carrying out more skilled functions such as precision cutting of glass-fibre panels, the fettling and shaping of castings and precision drilling of sheet metal pressings.

In each of these last three modes of operation the robot is programmed to perform its routine alternatively on work pieces in two separate work stations. The unused station is unloaded and reloaded by hand while the robot exercises its skill on the work piece in the other station.

During the course of the lecture and subsequent questions it became apparent that the major cost in setting-up the robot is that of getting the computer software just right. This can take a very long time, mainly in the correction of inertia errors when the system is run up to full speed. It seems that, in the later stages of proving the system, it is necessary to drive the robot at full speed with engineers/programmers in close attendance – inside the safety barriers.

In the event of a timing error in the digital feedback circuit or some similar malfunction, the robot arm may be waving a highly dangerous tool about at some speed and with superhuman strength. And remember, when you're inside a safety barrier it becomes an obstruction that makes escape more difficult. One may conclude, therefore, that essential qualifications for a robot programmer include considerable physical, as well as mental, agility and more than a fair share of courage.

As electro-mechanical devices, the robots are quite remarkable, simulating the action of a human arm and hand to a fascinating degree. But, compared with an actual human (or even a chimp) they show a marked lack of dexterity and versatility; moreover the human can be reprogrammed in a few minutes by simply persuading him or her to do something else. Is it not, therefore, something of an anomaly that the only human operators we saw in the films were doing the labouring jobs, such as loading and unloading work stations, while the skilled jobs were being done by the robots?

And here comes the punchline. Although we have machines that can perform almost any of the precision operations required in engineering production, designing a robot capable of grabbing a casting from a random barrow load, turning it round the right way and shoving it into the fettling jig is just a bit too difficult for the present state of the art.

From our lecture it would appear that personnel for the robotic production unit are the brave, athletic programmers and the labouring jig loaders. But, surely, the programmer's job finishes when the labourer's job starts. Are they the same chaps?

THE CASHLESS SOCIETY

We used to call them credit cards, but now they've been fitted with magnetic stripes it seems that there is no limit to what can be done with a plastic card and a computer.

We've become accustomed to the facility for drawing cash from the bank with a card-operated dispenser and the use of the magnetic stripe in point of sale operations; so nobody is surprised to see those frustrating card-operated pay 'phones at railway stations and airports – easily distinguished as the only ones available for use without queuing. We can obviously expect all sorts of card-operated vending machines and other automatic trading systems in the near future.

Until recent developments, however, possible electronic forgery has been a major problem, for the re-programming of two inches of tape track is child's play to those young computer wizards knocking about everywhere. Foreign systems have been announced with laser-readable data stores or embedded semiconductor memories based on ccd, eprom, ram, ewe, dog, cat or whatever initials take your fancy. But the highly secure card actually in your pocket is more likely to employ a special magnetic stripe based on a British system for permanently encoding an identity number in the mag. tape during its manufacture.

And it is these cards that are going to bring us the cashless society. I know that's so because Eddie Spinks explained it to me as he drove through a world famous tunnel now equipped with the very latest computer-controlled gate system.

"It's called a stored-value card," he said, taking the familiar-sized plastic rectangle from his waistcoat pocket and handing it to me.

"When you buy it, they stick it in an encoder," he went on, "and they load it up to the value you pay for. That one was twenty quid.

"At the toll gate you shove it in a slot at the front of the card reader, and the machine grabs it and checks both the permanent identity code and the stored value. If they are OK it deducts the toll charge from your card, indicates the new stored value on the led readout, gives you your card back and opens the gate."

I was going to ask what happens if the card runs out of money, when we rounded a bend and I realized that we were rapidly approaching the toll gates. Now for a demonstration.

My companion selected the 'automatic' bay with the shortest queue, and we approached the toll gate at an intermittent crawl as each car stopped to pay the toll. The driver in front of us overshot the card terminal and had to reverse. He then positioned his car more than an arm's length from the slot, so that he had to open the door, release his seat belt and lean far out to reach it. He inserted his card, which was returned to him in a second or so, and the toll gate opened. He thankfully drove off.

I could imagine myself in the same predicament. But not Eddie Spinks; he had already opened his window and was exactly on course. As we rolled slowly forward I proffered his card, with the conviction that he would stop in precisely the right position. He ignored the card, and the car did not actually come to standstill at all. With one smooth movement he tossed a handful of coins forward into the huge cash hopper beside the card terminal and the toll gate lifted just before the car bonnet reached it.

"As long as you throw in the correct toll charge the computer sorts it out," he told me as we accelerated away, "but it doesn't give change."

I felt cheated.

"But, what about this card?" I asked, handing it back to him more positively. He took it and returned it to his pocket.

"Sorry," he said. "Cash is quicker. I bought the card because I do occasionally get caught without change – and anyway it might help me develop the patience that we'll all need if that cashless society really happens."

NEW PRODUCTS

ELECTRICAL CONNECTORS FOR FIBRE-OPTIC LINKS

These connectors splice dual fibre-optic cables with transducers embodied within them and mate with nine-pole sub-miniature D-type connectors providing an optical link with electrical input/output. Depending on the version of connector used, the two plastic fibre-optic cables may transmit, receive or operate as a duplex line. According to the manufacturers, the connectors split, cut, finish and align the cable in a process taking about 30s for an untrained person. A key supplied with the connector then locks the reusable assemblies. A version of the connector without transmitters or receivers is also available. Thomas and Betts Ltd, Sedgwick Road, Luton, Bedfordshire LU4 9DT.

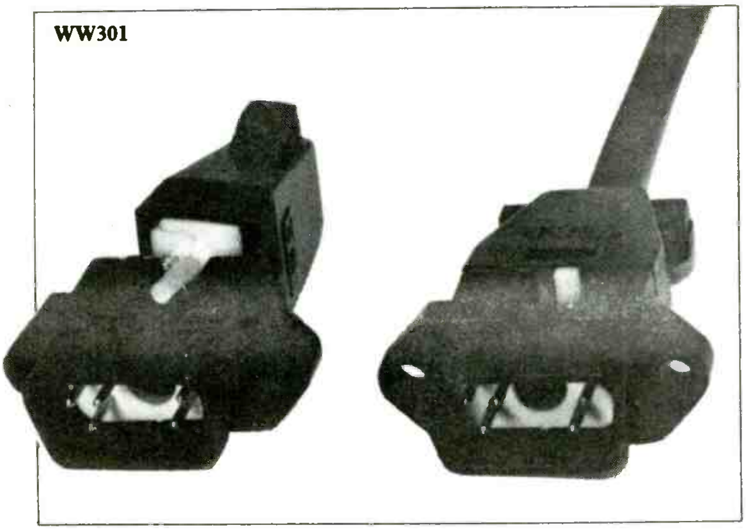
WW301

TELEPHONE-TO-VIEWDATA IC

Further integration of Mullard's viewdata system is provided by an i.c. for converting analogue telephone-line signals for use with their Lucy microprocessor peripheral i.c. Including an eighth-order receive band-pass filter, carrier-detection high-pass filter, fourth-order post-detection filter and transmit low-pass filter, this nmos device replaces six i.cs, 52 passive components and three transistors claims the manufacturer. As a result a viewdata decoder conforming to UK Prestel and CCITT V23 standards can be made using two i.cs – Lucy and this device dubbed Lucinda. Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.

WW302

WW301



TEST EQUIPMENT

Mobile transceiver, videotext and video test equipment has recently been added to the range offered by Rohde and Schwarz. First are the SMFP2 and SMFS2 mobile transceiver testers for performance checking, adjustment and repair of a.m., f.m. and p.m. sets. Fourteen measurements may be made on transceivers from 0.4MHz to 1GHz either manually, on the SMFS2, or under computer control through the IEC bus on the SMFP2. Videotext signal parameters such as eye height, half-eye height and amplitude – measurements required for the quality assessment of videotext signals – may be measured on the DZF tv-data distortion meter. Finally, two video-signal generators with v.i.t.s. inserters have been introduced to test studio tape recorders, domestic video recorders and tv sets. The first is the SPF2 model 8 for manual use and the second the SPF2 model 9 for automatic measurements. Rohde and Schwarz UK, Roebuck Road, Chessington, Surrey KT9 1LP

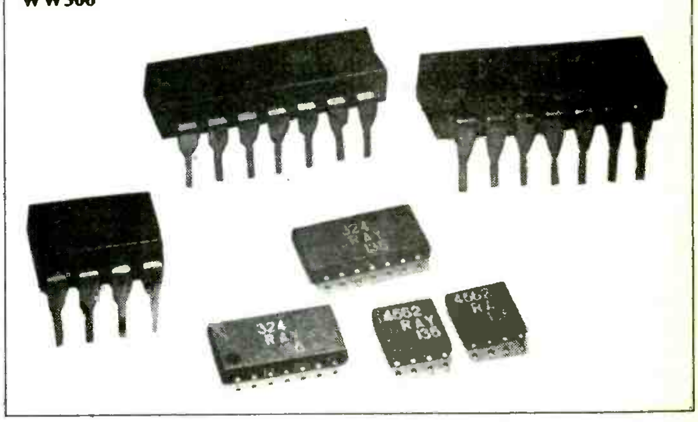
WW303 304 305

MINIATURE ICS

Eleven popular dual and quad op-amps and comparators and the 555 timer i.c. are manufactured in miniature packages by Raytheon. These devices may be used for hybrid circuits with the advantage that they are fully tested, as opposed to unencapsulated chips which are only partially tested in wafer form. They have preformed leads and lend themselves to flow-soldering techniques. Seven dual op-amps, two quad op-amps, two dual comparators and the timer mentioned above are currently available. Raytheon Semiconductor UK, Howard Chase, Pipps Hill Industrial Area, Basildon, Essex SS14 3DD.

WW306

WW306

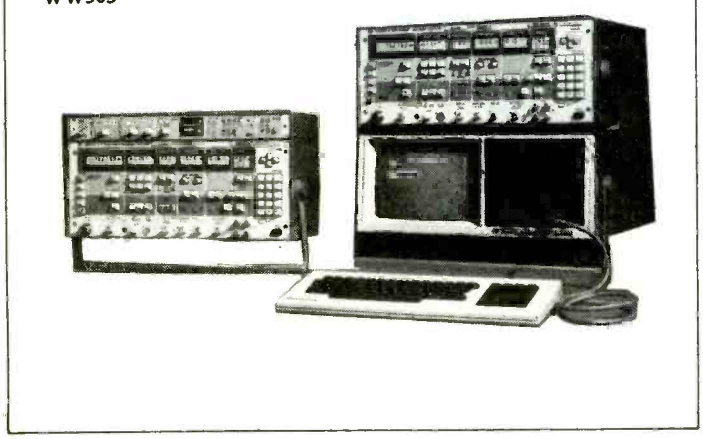


HAND-HELD THERMOMETER WITH NEEDLE THERMOCOUPLE

Readings between −50 and +500°C are given on a small temperature meter from Thermocouple Instruments which costs around £50 (excluding vat) complete with a needle-type probe. Model 505 gives readings to within 1% on a 31/2-digit l.c.d. for about 600 hours between changes of the PP3-type battery used. Optional thermocouples include ones for measuring air temperature and flexible types for surface temperature measurement. Also included in the price is a "strong, purpose-designed cardboard storage case". Thermocouple Instruments Ltd, Pentwyn, Cardiff CF2 7XJ.

WW307

WW303



WW307

NEW PRODUCTS

TORQUE METER

Telemetry techniques are used in Torqtel, transmitting data from strain gauges clamped on the shaft to an adjacent antenna. Designed by Loughborough consultants, the set consists of clamp-on torque sensors, transmitter and battery packs and a telescopic receiving antenna and receiver with analogue meter. Outputs for tape and chart recorders are provided. RDP Electronics Ltd, Grove Street, Heath Town, Wolverhampton WV10 0PY.
WW308

FUNCTION GENERATOR

Arbitrary-form, sine, square and triangle waves from 1mHz to 20MHz can be generated on the Hewlett Packard HP3314A. Inputs are provided for amplitude and frequency/v.c.o. modulation and the output may be phase-locked to a reference. The signal may be continuous or gated and bursts of up to 2000 waveforms in integer steps made. Microprocessor control provides automatic calibration, self test, and coordination of either manual or HP-IB control. Arbitrary waveforms, set manually using one knob and a external oscilloscope, are compiled using up to 150 vectors which can be individually modified. Hewlett-Packard Ltd, Nine Mile Ride, Easthampstead, Wokingham, Berkshire RG11 3LL
WW309

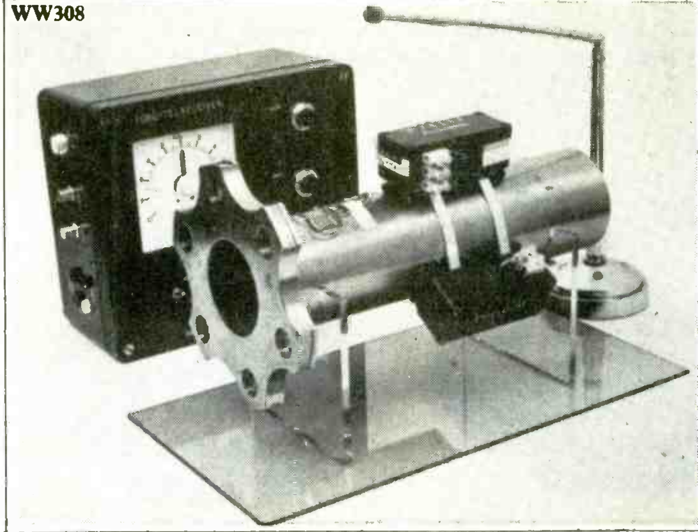
INTERFERENCE FILTERS

Mains born interference suppression is provided by a series of IEC sockets with filters intended to protect electronic equipment. Versions of the FN326 filters are available for 1, 3, 6 or 10A loads and with solder tags, flying leads or blade tags. Lyons Instruments, Ware Road, Hoddesdon, Herts EN11 9DX.
WW310

SAMPLE-AND-HOLD IC

Acquisition time for this 12-bit accuracy sample-and-hold i.c. is 1µs for a 10V signal. The 14-pin HA5320, from Harris Semiconductor, includes a hold capacitor and costs £7.51 in quantities of 100 or more for commercial applications. Harris Semiconductor, 153 Farnham Road, Slough, Berkshire SL1 4XD.
WW311

WW308



WW309

WW312

ELECTRONIC FILTERS

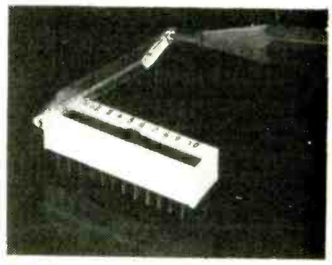
Two modules in the Barr and Stroud EF5 range can be combined in one frame to act as independent high or low-pass filters or as one band-pass or band-stop filter. Current modules, on which high/low-pass filtering is switch selectable, cover digitally-selected frequencies from 0.01Hz to 99.9kHz with either Butterworth 48dB/octave or elliptic 80dB/octave responses. An adapter for controlling all functions through the IEEE-488 bus is available. Barr and Stroud Ltd, 4 Saville Row, London W1X 1AF.
WW312

LOGIC SWITCHES

Enclosed rotary switches with contacts representing binary and binary complement words are available from NSF with a variety of terminations including solder connections, pins for p.c.b. mounting, pins for wire wrapping

and a standard Scotch-flex connector. Model CBS switches, with 3VA resistive-load ratings, can be obtained in 12, 16, 24 or 32 position form and stops may be adjustable or as specified by the customer. NSF Ltd, Keighley, Yorkshire BD21 5EF.
WW313

Single-pole 10-way dil switches are available from ERG Components. These are break-before-make switches with contact ratings of



7.5VA, which may flow soldered and cleaned with solvents. ERG Components, Luton Road, Dunstable, Bedfordshire LU5 4LJ.
WW314

OP-AMP WITH VMOS OUPUT

Inductive and capacitive load-driving capabilities are claimed for the 1461 vmos-output op-amp from Teledyne Philbrick. A slew rate of 1.2kV/µs and 115dB open-loop voltage gain make the device suitable for use as an accurate audio amplifier and in video applications including yoke driving and signal distribution. Output voltage and current ratings are ±34V and ±750mA respectively; maximum input-bias current is 100pA. The amplifier unity-gain bandwidth is 15MHz. Teledyne Philbrick, Heathrow House, Bath Road, Cranford, Middlesex TW5 9QQ.
WW315

Professional readers are invited to request further details on items featured here by entering the appropriate WW reference number(s) on the mauve reply-paid card.

74 SERIES

7400 11p, 7401 11p, 7402 11p, 7403 12p, 7404 12p, 7405 15p, 7406 18p, 7407 18p, 7408 14p, 7409 14p, 7410 14p, 7411 16p, 7412 14p, 7413 16p, 7414 18p, 7416 18p, 7417 18p, 7420 14p, 7421 18p, 7422 20p, 7423 18p, 7425 18p, 7426 18p, 7427 18p, 7428 18p, 7430 14p, 7432 18p, 7433 22p, 7437 22p, 7438 22p, 7439 25p, 7440 15p, 7441 55p, 7442A 30p, 7443 70p, 7444 70p, 7445 50p, 7446A 50p, 7447A 38p, 7448 45p, 7450 15p, 7451 15p, 7453 15p, 7454 15p, 7460 15p, 7470 30p, 7472 25p, 7473 25p, 7474 18p, 7475 22p, 7476 25p, 7480 48p, 7481 120p, 7482 65p, 7483A 38p, 7484A 60p, 7485 60p, 7486 18p, 7489 170p, 7490A 20p, 7491 35p, 7492A 25p, 7493A 24p, 7494 35p, 7495A 35p, 7496 35p, 7497 90p, 74100 80p, 74104 50p, 74105 55p, 74107 22p, 74109 25p, 74110 30p, 74111 55p, 74112 170p, 74116 50p, 74118 55p, 74119 60p, 74120 60p, 74121 25p, 74122 30p, 74123 36p, 74125 30p, 74126 30p, 74128 36p, 74132 30p, 74136 28p, 74141 55p, 74142 175p, 74143 200p, 74144 200p, 74145 40p, 74147 75p, 74148 60p, 74150 50p, 74151A 36p, 74153 36p, 74154 50p, 74155 36p, 74156 40p, 74157 30p, 74159 75p, 74160 40p, 74161 40p, 74162 40p, 74163 40p, 74164 45p, 74165 45p, 74166 48p, 74167 150p, 74170 120p, 74172 250p, 74173 50p, 74174 55p, 74175 50p, 74176 40p, 74177 45p, 74178 70p, 74179 70p, 74180 40p, 74181 115p, 74182 40p, 74184 90p, 74185A 90p, 74186 470p, 74188 250p, 74190 45p, 74191 45p, 74192 45p, 74193 45p, 74194 40p, 74195 40p, 74196 40p, 74197 40p, 74198 60p, 74199 80p, 74221 55p, 74251 45p, 74259 100p, 74265 45p, 74273 120p, 74276 90p, 74278 100p, 74279 40p, 74283 50p, 74284 160p, 74285 160p, 74290 75p, 74293 80p, 74298 100p, 74351 150p, 74365A 30p, 74366A 30p, 74367A 30p, 74368A 30p, 74376 100p, 74390 75p, 74393 90p, 74490 95p

74LS SERIES

74LS00 11p, 74LS01 11p, 74LS02 11p, 74LS03 12p, 74LS04 12p, 74LS05 12p, 74LS08 12p, 74LS09 12p, 74LS10 12p, 74LS11 13p, 74LS12 12p, 74LS13 15p, 74LS14 25p, 74LS15 12p, 74LS20 12p, 74LS21 12p, 74LS22 12p, 74LS26 12p, 74LS27 13p, 74LS28 14p, 74LS30 12p, 74LS32 13p, 74LS33 14p, 74LS37 14p, 74LS38 15p, 74LS40 12p, 74LS42 30p, 74LS47 38p, 74LS48 45p, 74LS51 14p, 74LS54 14p, 74LS55 14p, 74LS63 120p, 74LS73 18p, 74LS74 16p, 74LS75 18p, 74LS76 17p, 74LS83 38p, 74LS85 48p, 74LS86 18p, 74LS90 22p, 74LS91 60p, 74LS92 35p, 74LS93 22p, 74LS95 40p, 74LS96 50p, 74LS107 25p, 74LS109 27p, 74LS112 20p, 74LS113 22p, 74LS114 22p, 74LS122 28p, 74LS123 34p, 74LS124 90p, 74LS125 24p, 74LS126 25p, 74LS132 34p, 74LS133 25p, 74LS136 25p, 74LS138 27p, 74LS139 27p, 74LS145 70p, 74LS147 120p, 74LS148 75p, 74LS151 40p, 74LS153 40p, 74LS154 80p, 74LS155 36p, 74LS156 38p, 74LS157 25p, 74LS158 30p, 74LS160 38p, 74LS161 38p, 74LS162 38p, 74LS163 38p, 74LS164 40p, 74LS165 50p, 74LS166 80p, 74LS168 85p, 74LS169 85p, 74LS170 70p, 74LS173 55p, 74LS174 40p, 74LS175 40p, 74LS181 90p, 74LS183 120p, 74LS190 38p, 74LS191 38p, 74LS192 38p, 74LS193 38p, 74LS194 36p, 74LS195 36p, 74LS196 45p, 74LS197 45p, 74LS221 50p, 74LS240 55p, 74LS241 55p, 74LS242 55p, 74LS243 55p, 74LS244 55p, 74LS245 70p, 74LS247 50p, 74LS248 55p, 74LS249 55p, 74LS251 30p, 74LS253 30p, 74LS257 30p, 74LS258 35p, 74LS259 65p, 74LS261 138p, 74LS260 20p, 74LS266 20p, 74LS273 60p, 74LS275 225p, 74LS279 30p, 74LS280 100p, 74LS283 40p, 74LS290 45p, 74LS293 40p, 74LS295 90p, 74LS297 900p, 74LS298 90p, 74LS299 180p, 74LS323 180p, 74LS324 150p, 74LS348 90p, 74LS352 80p, 74LS353 80p, 74LS356 250p, 74LS363 140p, 74LS364 140p, 74LS365 27p, 74LS366 27p, 74LS367 27p, 74LS368 27p, 74LS373 56p, 74LS374 56p, 74LS375 45p, 74LS377 80p, 74LS378 80p, 74LS390 45p, 74LS393 45p, 74LS395 90p, 74LS399 180p, 74LS445 100p, 74LS490 200p, 74LS467 90p, 74LS540 90p, 74LS541 80p, 74LS610 £19, 74LS624 90p, 74LS629 90p, 74LS640 100p, 74LS641 100p, 74LS643 100p, 74LS644 100p, 74LS645 100p, 74LS668 120p, 74LS669 120p, 74LS670 140p, 74LS678 550p, 74LS682 400p, 74LS684 400p

74S SERIES

74S00 30p, 74S02 30p, 74S04 30p, 74S05 60p, 74S08 60p, 74S10 40p, 74S11 50p, 74S20 40p, 74S22 50p, 74S30 40p, 74S32 70p, 74S37 60p, 74S74 75p, 74S85 450p, 74S86 90p, 74S112 90p, 74S113 90p, 74S114 90p, 74S124 300p, 74S132 110p, 74S133 60p, 74S138 120p, 74S139 120p, 74S157 250p, 74S158 195p, 74S163 300p, 74S174 250p, 74S175 320p, 74S194 320p, 74S195 500p, 74S225 510p, 74S241 300p, 74S244 300p, 74S251 250p, 74S257 250p, 74S258 250p, 74S260 70p, 74S261 350p, 74S262 850p, 74S373 400p, 74S374 400p

4000 CMOS

4000 10p, 4001 10p, 4002 12p, 4006 50p, 4007 14p, 4008 36p, 4009 24p, 4010 24p, 4011 11p, 4012 16p, 4013 20p, 4014 48p, 4015 40p, 4016 20p, 4017 32p, 4018 45p, 4019 25p, 4020 48p, 4021 40p, 4022 45p, 4023 13p, 4024 32p, 4025 13p, 4026 80p, 4027 20p, 4028 40p, 4029 45p, 4030 15p, 4031 125p, 4032 80p, 4033 125p, 4034 140p, 4035 45p, 4036 275p, 4037 110p, 4038 110p, 4039 290p, 4040 40p, 4041 40p, 4042 40p, 4043 40p, 4044 40p, 4045 105p, 4046 50p, 4047 45p, 4048 50p, 4049 24p, 4050 24p, 4051 45p, 4052 80p, 4053 50p, 4054 90p, 4055 90p, 4056 90p, 4059 450p, 4060 55p, 4063 80p, 4066 27p, 4067 225p, 4068 14p, 4069 14p, 4070 14p, 4071 14p, 4072 14p, 4073 14p, 4075 14p, 4076 48p, 4077 18p, 4078 18p, 4081 14p, 4082 15p, 4086 55p, 4089 125p, 4093 24p, 4094 90p, 4095 75p, 4096 70p, 4097 290p, 4098 90p, 4099 100p, 4500 575p, 4502 60p, 4503 45p, 4504 75p, 4505 400p, 4506 35p, 4507 35p, 4508 130p, 4510 45p, 4511 45p, 4512 48p, 4514 120p, 4515 110p, 4516 55p, 4518 40p, 4520 50p, 4521 90p, 4522 120p, 4526 80p, 4527 80p, 4528 50p, 4532 70p, 4534 400p, 4536 270p, 4538 90p, 4539 70p, 4543 75p, 4553 245p, 4555 35p, 4556 35p, 4557 300p, 4560 120p, 4566 180p, 4568 250p, 4569 170p, 4572 30p, 4583 90p, 4584 40p, 4585 75p, 40014 40p, 40085 90p, 40097 45p, 40102 140p, 40103 170p, 40105 110p, 40106 40p, 40109 100p, 40110 275p, 40163 60p, 40174 50p, 40175 75p, 40193 75p, 40244 195p, 40245 195p, 40257 180p, 40373 180p, 40374 180p, 14495 300p, 14500 700p, 14568 200p, 14569 250p, 14599 290p

COUNTERS

74C925 £4, 74C928 £6, 72168 £16, ZN1040 670p

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4 way 70p, 6 way 85p, 8 way 90p, 10 way 145p

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VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		-ve	
5V	7805	43p	7905	45p
6V	7806	43p	7906	45p
8V	7808	43p	7908	45p
12V	7812	48p	7912	45p
15V	7815	48p	7915	45p
18V	7818	48p	7918	45p
24V	7824	48p	7924	45p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	60p
15V 100mA	78L15	30p	79L15	60p

OTHER REGULATORS

LM309K 1A 5V 140p, 78HGKC 600p, LM317K TO3 325p, 79HO5KC 550p, LM317T 200p, 73GUIC 200p, LM337T 225p, 73GUIC 225p, LM323K 3A 5V 450p, 79HGKC 700p, LM723N 30p, ICL7660 200p, TL494 400p, T497 300p, TL497 300p, LM305AH 250p, 78S40 225p, 78H12 600p, 78P05 900p, SG3524 300p

OPTO-ELECTRONICS

2N5777 40p, TIL32 55p, OCP71 180p, TIL78 55p, ORP12 120p, TIL31A 120p, ORP60 120p, TIL81 90p, ORP61 120p, TIL100 75p

OPTO-ISOLATORS

ILD74 130p, TIL111 70p, MCT26 100p, TIL112 70p, MCS2400 190p, TIL113 70p, MOC3020 150p, TIL116 70p, ILQ74 240p

LEDS

0.125": TIL209 Red 10p, TIL211 Gr 12p, TIL212 Yel 15p

0.2": TIL220 Red 10p, TIL222 Gr 12p, TIL228 Yel 15p

Rectangular LEDs R,G,Y 30p

DISPLAYS

DL704 140p, DL707 Red 140p, FND357 120p, FND500 90p, FND507 90p, MAN3640 200p, MAN4640 200p, NSB5881 570p, TIL311 600p, TIL312/3 110p, TIL321/3 130p, TIL330 140p, 7750/60 200p, Barograph 225p

DRIVERS

9368 250p, 9370 300p

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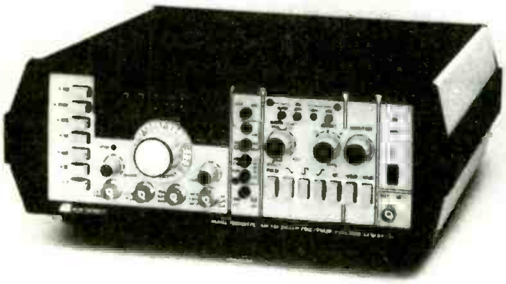

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Switchable 1W & 10W FSD. Internal 3.5 & 8 Ohm load impedances. Housed in grey enamelled case 6×6×3". Large easy to read 3" sq. meter. Scope output provision. **£10** (+£1).
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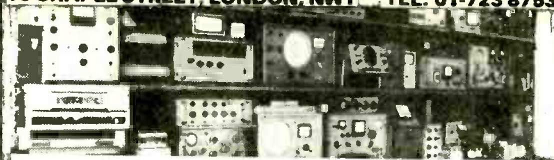

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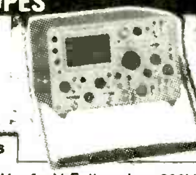

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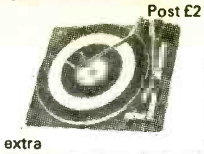

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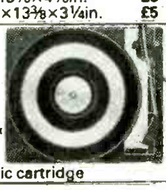
BSR SINGLE PLAYER DECKS



BSR P170 RIM DRIVE QUALITY DECK **£20** Post £2

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"Final Clearance". **Sale Price** **£8**
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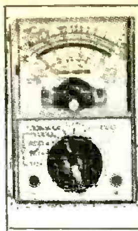

De luxe pocket size precision moving coil instrument. Impedance + Capacity – 4000 o.p.v. Battery included.
11 instant ranges measure:
DC volts 5.25, 250, 500.
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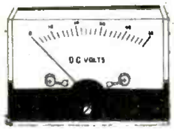

50μa, 100μa, 500μa, 1ma, 5ma, 50ma, 100ma, 500ma, 1 amp, 2 amp
25 volt, VU Meter.
2¼×2×1¼ Post 50p
Stereo VU meter
3¼×1⅝×1in.

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2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£10.50	£2
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50	£2
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16.00	£2

5-8-10-16V. ½ amp.	£2.50	80p	15-0-15V. 2 amps	£3.75	£1
6V. ½ amp.	£2.00	£1	20V 1 amp	£3.00	£1
6-0-6V. 1½ amp.	£3.50	£1	20-0-20V 1 amp	£3.50	£1
9V. 250ma.	£1.50	80p	20-40-60V 1 amp	£4.00	£2
9V. 3 amp	£3.50	£1	25-0-25V 2 amps	£4.50	£1
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10-30-40V. 2 amps	£3.50	£1	30V 5 amp and 17-0-17 2a	£4.50	£2
12V. 100ma	£1.50	80p	35V 2 amps	£4.00	£1
12V. 750 ma	£2.00	80p	TOROIDAL 30-0-30V 4a		
12V 3 amps	£3.50	£1	and 20-0 20V ½a	£10.00	£2
12-0-12V. 2 amps	£3.50	£1			

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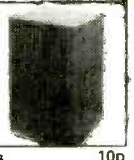

TEAK VENEERED CABINET
11×8½×7in, 15 watts
50 to 14,000 cps. 4 ohm or 8 ohm
OPUS TWO 15×10½×7¾in 25 watt 2-way system **£39 pair.** Post £3

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.001, .002, .003, .005, .01, .02, .03, .05 mfd 400V 5p.
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Size 11×9×⅛in. Operating voltage 240V, 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, Propagation, etc. Must be clamped between two sheets of metal or ceramic, etc.
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high power full range quality loudspeakers British made exceptional reproduction. Ideal for Hi-Fi, music P.A. or discotheques. These loudspeakers are recommended where high power handling is required with quality results. The high flux ceramic magnet ensures clear response.

MODEL	INCHES	OHMS	WATTS	TYPE	PRICE	POST
MAJOR	12	4-8-16	30	HI-FI	£14	£2
DELUXE MK II	12	8	15	HI-FI	£14	£2
SUPERB	12	8-16	30	HI-FI	£24	£2
AUDITORIUM	12	8-16	45	HI-FI	£22	£2
AUDITORIUM	15	8-16	60	HI-FI	£34	£2
GROUP 45	12	4-8-16	45	PA	£14	£2
GROUP 75	12	4-8-16	75	PA	£18	£2
GROUP 100	12	8-16	100	Guitar	£24	£2
DISCO 100	12	8-16	100	Disco	£24	£2
GROUP 100	15	8-16	100	Guitar	£32	£2
DISCO 100	15	8-16	100	Disco	£32	£2

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4 channel 8 inputs, dual impedance, 50K-600 ohm 4 channel mixing, volume, treble, bass. Presence controls, Master volume control, echo/send/return socket. Slave sockets. Post £3.

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MONO SLAVE VERSION £75. 100 Volt Line Model £104. Post £2.
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BAKER £69 Post £2
50 WATT AMPLIFIER

Ideal for PA systems, Discos and Groups. Two inputs, Mixer, Volume, Controls, Master Bass, Treble Gain.

RCS offers MOBILE PA AMPLIFIERS. Outputs 4-8-16 ohms
20-watt RMS 12v DC, AC 240v, 3 inputs. 50K **£46** PP £2.
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Mic 1; Mic 2; Phono; aux. outputs 4 or 8 or 16 and 100v line
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Battery only Portable PA Amplifier 10w max. Includes mike and speaker, OK for meetings, crowd control, stalls, fetes, traders, parties, etc. Batteries included (6 of U2) **£27.50** post £2.

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4 Channel mixing. Master treble, bass and volume controls. 5 Speaker outlets, suits 4, 8, 16 ohm. Disco group. **£125.** Carr. & ins. £15.

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MAKE	MODEL	SIZE	WATTS	OHMS	PRICE	POST
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GOODMANS	TWEETER	3½in	25	8	£4	£1
AUDAX	TWEETER	4in	30	8	£6.50	£1
SEAS	MID-RANGE	4in	50	8	£7.50	£1
SEAS	MID-RANGE	5in	80	8	£12	£1
SEAS	MID-RANGE	4½in	100	8	£12.50	£1
GOODMANS	HIFAX	7½×4¼	100	4/8/16	£27	£2
GOODMANS	WOOFER	8in	25	4/8	£6.50	£1
GOODMANS	HB	8in	60	8	£12.50	£1
RIGONDA	GENERAL	10in	15	8	£5	£2
AUDAX	WOOFER	10in	50	8	£16	£2
GOODMANS	HPG	12in	120	8/15	£29.50	£2
GOODMANS	GR12	12in	90	8/15	£27.50	£2
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LOUDSPEAKER BARGAINS
3 ohm, 5in, 7×4in, **£2.50;** 6½in, 8×5in, **£3;** 8in, **£3.50.** 10in, **£5.**
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15 ohm, 2¼in, 3½in, 5×3in, 6×4in, **£2.50.**
25 ohm, 3in, **£2;** 5×3in, 7×4in, **£2.50.** **120 ohm,** 3¼in dia. **£1.**
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8212	155p
8216	100p
8224	160p
8226	195p
8228	250p
8243	210p
8251	300p
8253	480p
8255	280p
8257	450p
8259	450p
8279	450p
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78M08	55p
78M12	50p
78M15	50p
78M18	55p
78M24	55p
1A	
7805	45p
7806	65p
7808	65p
7812	45p
7815	45p
7818	65p
7824	65p
–Ve 100mA	
79L05	35p
79L12	35p
79L15	35p
1A	
7905	80p
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7908	70p
7912	80p
7915	80p
7918	80p
7924	80p

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BC108B	15p
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BC109C	15p
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BC157	9p
BC158	8p
BC177	25p
BC178	25p
BC179	25p
BC182	10p
BC182A	10p
BC182B	10p
BC183A	10p
BC183C	10p
BC184	10p
BC184C	10p
BC212	10p
BC212A	10p
BC212B	10p
BC213A	10p
BC213C	10p
BC214	10p
BC214C	10p
BC237A	12p
BC237C	12p
BC238	12p
BC238A	12p
BC238B	12p
BC238C	12p
BC239	12p
BC307A	15p
BC307C	15p
BC308	15p
BC308A	15p
BC308B	15p
BC308C	15p
BC309	15p
BC309C	15p
BC327	15p
BC328	15p
BC337	15p
BC338	15p
BC477	28p
BCY70	18p
BCY71	20p
BCY72	20p
BD135	42p
BD136	45p
BD139	40p
BD140	40p
BD165	45p
BD166	45p
BD169	45p
BD170	45p
BD538	95p
BD677	80p
BD678	80p
BD679A	80p
BD680A	85p
BFY50	24p
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BFY90	85p
BF244A	30p
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MJE251	80p
MJE340	50p
MJE350	80p
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MJE2955	90p
MJE3055	85p
MPF102	45p
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MPS3640	30p
MPS3646	30p
MPSA06	20p
MPSA12	35p
MPSA13	20p
MPSA14	20p
MPSA18	20p
MPSA27	45p
MPSA42	25p
MPSA56	25p
MPSA63	30p
MPSA64	45p
MPSA77	50p
MPSA92	30p
TIP29	35p
TIP29A	35p
TIP29B	55p
TIP29C	40p
TIP30	50p
TIP30A	35p
TIP30B	50p
TIP30C	40p
TIP31A	40p
TIP31B	42p
TIP31C	45p
TIP32	50p
TIP32A	45p
TIP32B	80p
TIP32C	45p
TIP33	85p
TIP33A	85p
TIP33B	70p
TIP33C	75p
TIP34	75p
TIP34A	75p
TIP34B	80p
TIP34C	80p
TIP35	190p
TIP35A	185p
TIP35B	170p
TIP35C	185p
TIP36	170p
TIP36A	175p
TIP36B	185p
TIP36C	190p
TIP41	50p
TIP41A	50p
TIP41B	80p
TIP41C	50p
TIP42	58p
TIP42A	80p
TIP42B	75p
TIP42C	65p
TIP47	50p
TIP48	60p
TIP49	50p
TIP50	48p
TIP110	30p
TIP111	75p
TIP112	50p
TIP115	40p
TIP116	73p
TIP117	45p
TIP120	39p
TIP121	80p
TIP122	75p
TIP125	45p
TIP126	80p
TIP140	130p
TIP141	140p
TIP142	180p
TIP145	140p
TIP146	180p
TIP147	170p
TIP2955	70p
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TIS43	30p
TIS88A	48p
TIS151	50p
2N1613	25p
2N1711	25p
2N1893	35p
2N2218A	45p
2N2219	25p
2N2221	30p
2N2221A	30p
2N2222	25p
2N2222A	25p
2N2369A	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906A	25p
2N2907A	25p
2N3053	30p
2N3054	70p
2N3055	45p
2N3439	80p
2N3440	80p
2N3771	180p
2N3772	180p
2N3773	250p
2N3819	25p
2N3821	120p
2N3822	120p
2N3823	95p
2N3824	95p
2N3866	80p
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N4123	25p
2N4125	25p
2N4391	70p
2N4392	70p
2N4400	20p
2N4401	25p
2N4402	25p
2N4403	25p
2N4410	45p
2N4416	95p
2N4856	80p
2N4857	80p
2N4918	95p
2N4919	120p
2N4920	130p
2N4921	105p
2N4922	95p
2N4923	95p
2N5190	75p
2N5191	75p
2N5192	75p
2N5193	80p
2N5194	90p
2N5195	90p
2N5400	40p
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EC952/1 0.031" 30°, 45°, 60° Bends
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EC910 0.094" Pads
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COMPUTER APPRECIATION

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PDP 11/10 COMPUTER SYSTEM comprising 28KW processor with switch console, 3 x RK05/J 2.5 megabyte removable disc drives with RK11-D, 2 x Model VT50 VDU Terminals (12 lines x 80), TALLY Model 2000 200 lpm line printer, bootstrap and console emulator card. The whole system is contained in two four foot DEC cabinets and is in immaculate condition. Software includes RT11, BASIC, FORTRAN, etc. Manufactured 1977 .... £2900

PDP 11V03 MICRO COMPUTER SYSTEM comprising LSI 11 processor in BA11 MF box with 64KB memory, DLV11J quad serial interface REV11 bootstrap and diagnostic ROM card, RX01 dual floppy disc drive, SYSTIME VDU Terminal with 24 x 80 U/L case display and cursor addressing, Model LA120 DECwriter (120 cps bi-directional U/L case). The processor and disc drives are contained in a 24-inch high DEC cabinet. Software includes RT11 with BASIC, etc. £1950

LSI-11 MICROPROCESSOR with integral 8KByte memory £50

NCR Model 8130 MICROCOMPUTER SYSTEM. INTEL 8080 based machine with 64KB memory (and battery back up), twin dual-density floppy disc drives, VDU and keyboard, Model 4501 180 cps bi-directional nine wire matrix printer and facilities for reading bar coded ledger cards. The system is under 2 years old and full software and maintenance support is available from NCR £950

RAYTHEON Model PTS100 System. Comprising 16-bit processor with 64KB MOS memory, 2 VDU terminals, cassette drive and numerous option, terminal multiplexor and interface cards. A test set is included. Contained in a six foot rack. Manufactured 1978 .... £250

DEC Model VT50 VDU. 12 lines x 80, upper case only. With 20mA current loop interface to 9600 Baud £165

MEMOREX Model 2278 VDU. EBCDIC coded VDU, 24 lines x 80. These modern (1979) VDUs are particularly suitable for rebuilding around a single board computer or as a low-cost terminal. Each attractively cased unit comprises: a detached Micro Switch inc. keyboard with single chip encoder, either of a standard type MOTOROLA or BALL BROS. 12" monitor, Microprocessor (8008) controlled electronics with firmware in 2708 EPROM, and power supplies (5V at 15A, + and – 12V at 3A) £65

IBM Selectric (golfball) terminal. Keyboard printer similar to Model 735, but complete with keyboard and solenoid driver electronics £125

LOGABAX Model LX 180 keyboard printer with serial interface. 180 cps dot matrix printer £450

DIABLO HyType II 45 cps daisy wheel printer £450

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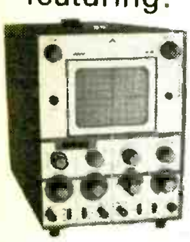

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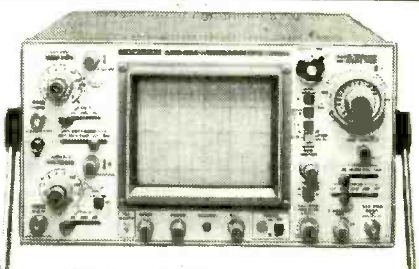

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AC141K	0.35
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BC108	0.16
BC109	0.16
BC113	0.15
BC114	0.15
BC115	0.18
BC116	0.19
BC117	0.23
BC118	0.18
BC125	0.18
BC126	0.18
BC135	0.15
BC136	0.19
BC137	0.19
BC147	0.12
BC148	0.12
BC149	0.13
BC157	0.13
BC158	0.13
BC159	0.13
BC167	0.11
BC170	0.11
BC171	0.11

BC172	0.11
BC173	0.11
BC177	0.28
BC178	0.28
BC179	0.28
BC182	0.11
BC183	0.11
BC184	0.11
BC212	0.11
BC213	0.11
BC214	0.11
BC237	0.11
BC238	0.11
BC301	0.33
BC303	0.34
BC307	0.11
BC308	0.11
BC327	0.12
BC328	0.12
BC337	0.12
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BCY33	1.10
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BF153	0.16
BF154	0.17
BF159	0.17
BF160	0.17
BF167	0.24
BF173	0.30
BF177	0.35
BF178	0.35
BF179	0.35
BF180	0.28
BF181	0.28
BF182	0.30
BF183	0.28
BF184	0.28
BF185	0.30
BF194	0.14
BF195	0.12
BF196	0.13
BF197	0.14
BF200	0.40
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OC35	1.50
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OC71	0.55
OC72	1.00
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T1S43	0.43
ZS140	0.25
ZS170	0.21
ZS178	0.54
ZS271	0.23
ZS278	0.57
ZTX107	0.12
ZTX108	0.12
ZTX109	0.12
ZTX300	0.13
ZTX301	0.14
ZTX302	0.18
ZTX303	0.18
ZTX304	0.20
ZTX311	0.13
ZTX314	0.25
ZTX500	0.14
ZTX501	0.14
ZTX502	0.18
ZTX503	0.19

ZTX504	0.21
ZTX531	0.24
ZTX550	0.25
1N914	0.05
1N916	0.09
1N4001	0.06
1N4002	0.06
1N4003	0.06
1N4004	0.07
1N4005	0.09
1N4006	0.11
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1N4009	0.07
1N4148	0.04
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1S920	0.08
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2G301	1.00
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2N696	0.32
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2N2905	0.32
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2N2907	0.21
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2N3710	0.10
2N3711	0.10
2N3771	1.40
2N3772	1.60
2N3773	1.80

2N3819	0.30
2N3820	0.39
2N3823	0.60
2N3866	1.00
2N3904	0.17
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2N3906	0.17
2N4058	0.20
2N4059	0.20
2N4060	0.16
2N4061	0.16
2N4062	0.16
2N4124	0.16
2N4126	0.16
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ECL83	3.00
ECL84	1.50
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KTW63	2.50
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M8080	8.25
M8081	9.82
M8082	9.69
M8083	8.58
M8091	10.43
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M8097	8.10
M8098	6.15
M8099	8.00
M8100	9.52
M8136	10.23
M8137	10.23
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	10.40
M8163	8.25
M8190	5.00
M8195	10.85
M8196	7.50
M8204	7.05
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M8248	14.03
MD2901	60.00
MU14	2.50
MX119	55.00
MX123	72.00
MX145	56.70
MX151	17.25
MX152	131.25
MX161	152.25
MX163	20.25
MX164	25.52
MX166	147.00
N78	15.00
OA2	3.25
OA3	2.50
OA4	6.00
OB2	4.35
OB3	2.50
OC2	4.35
OC3	2.50
OD3	2.50
OZ4	3.50

PC86	2.50
PC88	2.50
PC95	1.75
PC97	1.75
PC900	1.75
PCC84	1.50
PCC85	1.50
PCC88	2.00
PCC89	1.75
PCC189	2.50
PCC805	1.60
PCC806	1.60
PCE82	2.00
PCF80	2.00
PCF82	1.50
PCF86	2.50
PCF87	2.00
PCF200	3.25
PCF201	3.25
PCF801	2.50
PCF802	2.50
PCF805	1.70
PCF806	1.70
PCF808	1.70
PCL82	2.00
PCL83	3.00
PCL84	2.00
PCL85	2.50
PCL86	2.50
PCL805/85	2.50
PD500	6.00
PE06-40N	30.00
PFL200	2.50
PL36	2.50
PL81	1.75
PL81A	2.00
PL82	1.50
PL83	2.50
PL84	2.00
PL504/5	2.50
PL508	2.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PPV03-10	14.00
PY33	2.50
PY81	1.75
PY82	1.50
PY83	2.50
PY88	2.00
PY500A	3.00
PY800	1.50
PY801	1.50
QQV02-6	16.50
QQV03-20A	48.38
QQV06-40A	48.38
QQV07-50	66.90
QQZ06-40A	62.20
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QV08-100	136.85
QY3-65	54.26
QY3-125	60.40

QY4-250	73.15
QY4-400	76.80
QY5-500	175.00
QY5-3000A	335.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-250	32.68
RG3-250A	32.68
RG3-1250	59.50
RG4-1250	61.60
RG4-3000	99.45
RR3-250	40.00
RR3-1250	45.75
S11E12	65.00
S130	6.00
S130P	6.00
STV280-40	14.00
STV280-80	21.00
SU41	5.00
SU42	10.00
TD03-10	35.00
TD03-10F	35.00
TT15	35.00
TT21	23.00
TT22	23.00
TT100	60.00
TY2-125	60.00
TW4-400	71.40
TY4-500	98.35
TY5-500	175.00
TY6-800	188.00
TY6-5000A	375.00
TY6-5000B	395.00
TY6-5000W	325.00
TY7-6000A	374.00
TY7-6000W	303.60
TZ40	25.00
U18-20	3.50
U19	13.75
U25	2.50
U26	2.50
U37	12.00
UABC80	1.25
UAF42	2.50
UB41	3.00
UBC41	2.25
UBF89	1.50
UCC84	1.75
UCC85	1.85
UCF80	2.00
UCH42	2.50
UCH81	1.50
UCL82	1.75
UCL83	2.75
UF41	2.00
UF42	2.10
UF80	1.75

UF85	1.75
UF89	2.00
UL41	3.50
UL84	1.75
UM80	2.00
UY41	2.25
UY85	2.25
VLS631	15.00
XG1-2500	45.80
XG2-6400	141.90
XG5-500	26.60
XG2-6400	162.00
XR1-1600A	53.75
XR1-3200	81.97
XR1-3200A	
XR1-6400	102.00
YD1120	395.00
YD1240	351.00
Z759	25.00
ZM1000	8.00
ZM1001	8.00
ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
2J42	98.00
2J55	175.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3-400Z	85.00
3-500Z	85.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.00
3B240M	17.50
3B241M	17.50
3C23	25.00
3C45	24.50
3CX100A5	47.00
3E29	45.00
3S4	2.00
3V4	1.75
465A	60.00
4-125A	60.00
4-250A	80.00
4-400A	87.00
4B32	20.00

4C35	78.00
4CX250B	40.00
4CX350A	73.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5J180E	1650.00
5R4GY	3.50
5U4G	3.00
5U4GB	2.50
5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	7.10
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.00
6AN5	4.75
6AN8A	3.50
6AQ5	2.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
6AU6	2.50
6AV5GA	4.50
6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
6BZ6	2.75
6C4	1.25
CB6A	2.50
6CD6GA	5.00
6CG7	2.50
6CH6	13.00
6CL6	3.75

6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EB8	2.50
6EW6	2.25
6F6	3.00
6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
6J4	5.50
6J6	8.93
6J7	4.75
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	2.25
6L6GT	2.25
6L6GC	2.25
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50
12AU7	1.75
12AV6	2.50
12AV7	3.50
12AX7	1.75
12AY7A	4.00
12B4A	3.50

12BA6	2.50
12BE6	2.50
12BH7	1.50
12BY7	3.00
12E1	20.00
12E11TT	170.00
12E14	35.00
13E1	20.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	3.50
85A1	7.50
85A2	4.45
90AG	12.96
90AV	12.96
90C1	3.20
90CG	14.54
90CV	15.45
92AG	12.96
92AV	12.96
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	4.05
211	35.00
723AB	125.00
803	25.00
805	45.00
807	3.75
811A	28.33
812A	28.33
813	125.86
833A	193.16
866A	20.03
872A	20.00
922	6.00
931A	18.52
1624	4.00
1625	3.50
2050	17.46
4212E	3.00
4212H	300.00
5544	81.97
5545	102.00
5551A	114.90
5552A	155.35
5642	9.00
5654	3.00
5651	4.45

5670	4.50
5675	28.00
5687	6.00
5696	4.50
5718	7.50
5725	5.50
5726	11.37
5727	7.05
5749	2.50
5751	4.00
5763	4.50
5814A	4.00
5840	4.00
5842	12.00
5876A	31.50
5879	5.00
5886	12.50
5963	2.50
5965	3.50
6005	2.25
6021	4.50
6057	10.23
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	8.58
6067	10.23
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	8.25
6146B	8.25
6159B	19.00
6189	9.55
6201	11.40
6442	20.00
6883B	17.54
6973	4.00
7025	3.00
7551	6.25
7586	12.00
7587	18.50
7609	56.00
7868	6.00
7895	12.00
8005	110.49
8068	14.00
8122	90.00
8136	2.50
8417	6.00
18042	11.53
18045	10.49

Tested Ex-Equipment

4CX250B	6.50

BASES

B7G unskirted	0.22
B7G skirted	0.30
B9A unskirted	0.22
B9A skirted	0.30
Int Octal	0.35
Loctal	0.55
Nuvistor base	0.75
8 pin DIL	0.15
14 pin DIL	0.15
16 pin DIL	0.17
Valve screening cans all sizes	0.30

CRTs

2AP1	8.50
2BP1	9.00
3BP1	10.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00

5ADP1	35.00
5BP1	10.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00

VCR517A	10.00
VCR517B	10.00
VCR517C	10.00

Tube Bases Prices on application

INTEGRATED CIRCUITS

7400	0.16
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.43
7407	0.43
7408	0.20
7409	0.20
7410	0.17
7412	0.29
7413	0.32
7416	0.32
7417	0.32
7420	0.18
7422	0.20

7423	0.33
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.40
7437	0.32
7438	0.32
7440	0.32
7441	0.90
7442	0.72
7447AN	1.17
7450	0.18
7451	0.18
7453	0.18
7454	0.18

7460	0.18
7470	0.38
7472	0.33
7473	0.38
7474	0.38
7475	0.54
7476	0.42
7480	0.56
7482	0.75
7483	1.00
7484	1.05
7486	0.39
7490	0.60
7491	0.82
7492	0.60
7493	0.60
7494	0.82

7495	0.73
7496	0.82
7497	3.15
74100	1.54
74107	0.45
74109	0.73
74110	0.51
74111	0.71
74116	1.85
74118	1.00
74119	1.54
74120	0.83
74121	0.43
74122	0.62
74123	1.18
74125	0.58
74126	0.58
74128	0.63
74132	0.72

74136	0.51
74141	0.89
74142	2.30
74143	2.60
74144	2.60
74145	1.00
74147	2.00
74148	1.76
74150	1.80
74151	0.94
74154	1.80
74155	0.90
74156	0.90
74157	0.75
74159	2.20
74170	2.40
74172	4.40
74173	1.42
74174	1.60

74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
74195	1.20
74196	1.35
74197	1.35
74198	2.70
74199	2.30
76013N	1.76
TAA570	2.30
TAA630S	3.50
TAA700	3.90

TBA480Q	1.84
TBA520Q	2.30
TBA530	1.98
TBA540Q	2.30
TBA550Q	3.22
TBA560CQ	3.22
TBA673	2.20
TBA700	1.52
TBA720Q	2.30
TBA750Q	2.07
TBA800	1.20
TBA920	2.90
TBA920Q	2.90
TBA990Q	2.90
TCA270Q	2.90
TCA760A	1.38

Terms of business: CWO. Postage and packing valves and semiconductors 50p per order. CRTs £1.50. Prices excluding VAT, add 15%.
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A2087	11.50
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A2426	17.50
A2521	21.00
A2599	37.50
A2900	11.50
A3042	24.00
AC/HL/DD	4.00
ACP	4.00
AC/PEN	4.00
AC/THI	4.00
AC/VP1	4.00
AC/VP2	4.00
AC2/PENDD	6.00
AH221	39.00
AH238	39.00
AL60	6.00
ARP12	0.70
ARP34	1.25
ARP35	2.00
AZ31	2.00
BL63	2.00
BS450	67.00
BT5	49.50
BT19	32.50
BT79	12.50
CIK	16.00
C3JA	16.00
C1108	55.00
C1134	17.50
C1148A	60.00
C1149/1	89.00
C1534	32.00
CBL31	2.00
CCA	2.60
CL30	2.00
CL33	2.00
CMG25	9.00
CV Nos Prices on request	
D63	1.20
DAF91	0.45
DAF96	0.65
DC70	1.75
DC90	1.20
DCX4-1000	12.00
DCX4-5000	25.00
DET10	6.00
DET22	28.00
DET24	39.00
DET25	22.00
DF91	0.45
DF92	0.60
DF96	0.65
DH63	1.20
DH77	0.90
DH79	0.56
DH149	2.00
DK91	0.90
DK92	1.20
DK96	2.50
DL35	1.00
DL63	1.00
DL70	2.50
DL73	2.50
DL91	1.50
DL92	0.60
DL93	1.10
DL96	2.50
DLS10	8.00
DLS16	10.00
DM70	1.10
DM160	2.75
OY51	1.00
DY80	1.30
DY86/87	0.56
DY802	0.60
E1T	9.00
E55L	21.50
E80CC	7.00
E80CF	10.00
E80F	9.50
E80L	9.50
E81CC	3.50
E81L	12.00
E82CC	3.50
E83CC	3.50
E83F	3.50
E86C	9.50
E88C	6.00
E88CC	2.60
E90CC	5.00
E92CC	2.00
E90F	9.00
E91H	3.50
E92CC	2.50
E130L	13.00
E180CC	6.50
E182CC	9.00
E180F	6.25
E186F	8.50
E280F	19.50
E283CC	7.50
E288CC	13.50
E810F	16.00

E1148	1.00
EA50	1.00
EA76	1.95
EA79	1.95
EAA91	0.60
EABC80	0.80
EAC91	2.50
EAF42	1.20
EAF801	1.40
EB34	1.50
EB41	2.00
EB91	0.52
EBC33	2.50
EBC41	1.15
EBC81	0.85
EBC90	0.75
EBC91	0.75
EBF33	2.50
EBF80	0.50
EBF83	0.50
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	1.50
EBL21	2.00
EC52	0.75
EC80	4.25
EC81	4.50
EC86	1.00
EC88	1.00
EC90	0.70
EC91	7.00
EC92	1.25
EC93	0.80
EC95	7.00
EC97	1.10
EC8010	6.00
ECC32	3.00
ECC33	3.50
ECC35	3.50
ECC40	2.00
ECC81	0.85
ECC81 Mullard	1.10
ECC82	0.55
ECC82 Philips	1.10
ECC83	0.85
ECC83 Mullard	1.35
ECC83 Philips	1.10
ECC84	0.50
ECC85	0.60
ECC86	1.45
ECC88	0.85
ECC88 Mullard	1.85
ECC91	2.00
ECC180	0.72
ECC189	0.78
ECC801S	3.50
ECC803S	3.50
ECC804	0.80
ECC807	1.95
ECC808	2.25
ECC2000	12.00
ECF80	0.72
ECF82	0.60
ECF86	1.25
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	1.80
ECH42	1.00
ECH81	0.58
ECH83	0.78
ECH84	0.69
ECH2000	1.50
ECL80	0.60
ECL82	0.65
ECL83	1.15
ECL84	0.74
ECL85	0.69
ECL86	0.74
ECL805	0.69
ED5100	3.50
EF22	2.50
EF37A	2.00
EF39	1.00
EF41	3.50
EF42	2.50
EF50	1.50
EF55	2.25
EF71	1.50
EF72	1.20
EF73	1.00
EF80	0.56
EF83	3.50
EF85	0.50
EF86	0.70
EF86 Mullard	1.50
EF89	0.85
EF91	1.25
EF92	2.50

EF93	0.85
EF94	0.55
EF95	1.00
EF97	0.90
EF98	0.90
EF183	0.65
EF184	0.65
EF731	1.80
EF732	1.80
EF800	11.00
EF804S	9.85
EF805S	9.85
EF806S	9.85
EF812	0.65
EFL200	1.50
EH90	0.72
EK90	0.72
EL32	0.95
EL33	4.00
EL34	1.95
EL34 Mullard	2.95
EL36	1.50
EL37	9.00
EL38	6.00
EL41	2.00
EL42	2.00
EL81	3.35
EL82	0.58
EL83	3.50
EL84	0.69
EL85	4.50
EL86	0.85
EL90	0.82
EL91	6.00
EL95	0.70
EL183E	3.50
EL183P	3.50
EL360	7.95
EL500	1.40
EL504	1.40
EL508	1.90
EL509	3.75
EL519	4.50
EL802	1.40
EL821	10.35
EL822	10.35
EM1	4.00
EM4	9.00
EM34	7.50
EM35	1.50
EM80	0.70
EM81	0.70
EM84	1.10
EM85	1.10
EM87	1.10
EMM803	2.50
EN10	8.00
EN32	10.50
EN91	0.95
EN91(SQ)	2.50
EN92	4.50
ES1500	115.00
ET1	11.00
EY51	0.80
EY81	0.60
EY83	1.50
EY84	8.00
EY84W	10.00
EY86/87	0.50
EY88	0.60
EY91	3.50
EY500A	1.50
EY802	0.70
EZ35	0.50
EZ40	1.25
EZ41	1.25
EZ80	0.75
EZ81	0.56
EZ90	0.95
FW4/500	2.00
FW4/800	2.00
G1/371K	30.00
G55/1K	9.00
G180/2M	9.00
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
GR10J	4.00
GS10C	12.00
GS10H	12.00
GS12D	12.00
GT1C	17.00
GT1C S/S	13.00
GTE175M	8.00
GTR150W	1.00
GU20	70.00
GU50	11.50
GXU1	13.50
GXU3	24.00
GXU50	12.50

GY501	1.20
GY802	1.00
GZ30	1.00
GZ31	1.00
GZ32	1.00
GZ33	4.50
GZ34	2.15
GZ37	4.50
HAA91	1.00
HABC80	0.90
HBC90	0.75
HBC91	0.80
HF93	0.75
HF94	0.60
HK90	1.05
HL2K	3.50
HL23DD	4.00
HL41	3.50
HL41DD	3.50
HL42DD	3.50
HL90	0.70
HL92	1.50
HL133/DD	3.50
HR2	4.00
HY90	1.00
HVR2	3.00
KT8C	7.00
KT33C	3.50
KT36	2.00
KT41	4.00
KT44	4.00
KT45	4.00
KT61	3.50
KT63	2.00
KT66 USA	6.00
KT66 GEC	9.00
KT67	15.00
KT77 Gold Lion	9.50
KT81	7.00
KT88 USA	7.00
KT88 GEC	11.50
KT88 Gold Lion	12.50
KTW61	2.00
KTW62	2.00
KTW63	1.50
KTZ63	1.25
L63	1.00
L102/2K	8.00
L120/2K	12.00
LCF801	1.35
LCF200	1.35
LCH200	1.35
LF184	1.00
LFL200	1.35
LY500A	1.75
M502A	135.00
M537A	160.00
M5143	155.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	3.20
M8099	4.00
M8100	2.85
M8136	7.00
M8137	5.50
M8161	6.50
M8162	5.50
M8163	3.85
M8190	3.85
M8195	3.00
M8196	3.25
M8204	2.00
M8223	2.00
M8224	2.00
M8225	2.00
ME1400	4.00
ME1401	29.50
ME1403	29.50
ME1501	14.00
MS4B	5.50
MU14	1.50
N37	13.50
N78	16.50
OA2	0.80
OA2WA	1.50
OA3	3.95
OB2	0.80
OB2WA	1.25
OC2	2.50
OC3	1.50
OD3	1.70
OM4	1.00
OM5B	3.00
OM6	1.75
OM9	4.00
ORP43	2.50
ORP50	3.95
P61	2.50
P41	2.50
PABC80	0.50
PC86	0.75
PC88	0.75
PC92	0.85
PC97	1.10
PC800	1.10
PC900	0.75
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	1.35
PCF201	1.35
PCF800	0.40
PCF801	1.35
PCF802	0.60
PCF805	1.48
PCF806	1.00
PCF808	1.25
PCH200	1.10
PCL82	0.80
PCL83	2.50
PCL84	0.75
PCL85	0.80
PCL86	0.85
PCL200	1.50
PCL800	0.80
PCL805	0.80
PD500	3.50
PD510	3.85
PEN4DD	2.00
PEN25	2.00
PEN40DD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	1.25
PL21	2.50
PL33	1.25
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.80
PL88	1.00
PL95	1.00
PL302	1.00
PL345	12.50
PL500	0.95
PL504	0.95
PL508	1.75
PL509	4.50
PL519	4.95
PL802	3.25
PL820	2.95
PY32	0.60
PY33	0.50
PY81	0.70
PY82	0.70
PY83	0.70
PY88	0.52
PY500A	1.79
PY800	0.69
PY801	0.69
Q13-110BA	47.50
QB3-300	30.50
QEO3-10	3.50
QEO8-200	130.00
QP25	1.00
QQEO2-5	12.75
QQEO3-12	5.50
QQEO3-20	27.00
QQE06-40	39.50
QQVO2-6	12.75
QQVO3-10	5.50
QQVO3-20	17.00
QQVO3-20A	17.00
QQVO3-20B	32.00
QQVO6-40A	18.00
QQZO3-20	42.50
QQZO6-40A	46.25
QS72/20	1.50
QS75/40	3.00
QS92/10	5.00
QS95/10	4.85
QS108/45	4.00
QS150/15	5.00
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	11.50
QVO3-12	3.50
QVO5-25	1.75

QVO6-20	29.50
QVO8-100	118.50
QY3-125	30.50
QY4-250	65.00
QY4-400	66.00
QY5-500	115.00
QZ06-20	32.50
R10	4.00
R16	12.00
R17	1.50
R18	4.00
R19	1.20
R20	1.20
RG1-125	3.50
RG1-240A	11.75
RG3-250A	25.00
RG3-1250A	52.50
RK2K25	82.50
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	37.00
RR3-1250	65.00
RS613	45.00
RS685	30.50
RS688	52.15
S6F17	9.00
S6F33	36.00
S11E12	38.00
S30/2K	12.00
S104/1K	10.00
S109/1K	15.00
S130	3.00
SC1/800	5.00
SC1/1200	5.00
SC1/1400	12.00
SC1/2000	9.00
SP2	1.50
SP41	5.00
SP42	3.00
ST11	1.50
STV280/40	18.00
STV280/80	30.00
SU42	3.50
TB2.5/3000	80.00
TB2-300	45.00
TD1-100A	19.00
TDO3-10F	28.00
TD3-12	4.00
TP25	1.50
TSP4	7.00
TT11	1.50
TT21	14.50
TT22	14.50
TY2-125A	45.00
TY4-400	65.00
TY7-6000A	250.00
TY8-600W	250.00
TYS2/250	375.00
U18-20	2.00
U19	11.95
U22	1.00
U24	2.00
U25	0.68
U26	0.90
U37	9.00
U41	0.70
U50	2.00
U54	4.50
U82	3.00
U191	0.70
U192	1.00
U193	0.85
U251	1.00
U291	0.60
U301	0.55
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.80
UBC41	1.25
UBC81	1.00
UBF89	0.60
UBL21	1.25
UC92	0.85
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	1.20
UCH42	1.35
UCH81	0.80
UCL82	0.80
UF41	1.15
UF42	1.15
UF80	0.80
UF89	1.10
UL41	2.25

UL84	0.85
UU5	2.50
UU7	8.00
UY41	3.50
UY85	0.70
V339	3.50
VLS631	12.00
VP2B	2.50
VP4A	4.50
VP4B	4.50
VP6	2.50
VP41	2.50
VP133	2.00
VR37	1.50
VR75/30	3.00
VR91	1.50
VR101	2.00
VR105/30	1.50
VR150/30	1.05
VT52	2.50
VU39	1.50
VX6120	5.00
VX9133	5.00
VX9181	5.00
W77	5.00
W729	1.00
W739	1.50
X24	1.00
X79	3.50
XC12	1.50
XC15	1.50
XC25	0.50
XC900	1.35
XE3P	2.50
XFW47	1.50
XFW50	1.50
XG5-500	19.50
XL1-5V	1.50
XL509	4.95
XNP12	2.50
XNP28	2.50
XP1002	29.00
XR1-1600A	35.00
XR1-3200A	69.00
XR1-6400A	128.00
XSG2-0	3.00
Y63	1.50
Y602	12.00
YJ1060	265.00
YL1020	29.00
YL1060	15.00
YL1070	115.00
YL1071	109.00
YL1370	6.50
YL1371	8.50
Z77	1.20
Z300T	5.00
Z302C	12.00
Z303C	9.00
Z505S	15.00
Z520M	4.00
Z521M	8.00
Z700U	3.00
Z749	0.60
Z759	19.85
Z800U	3.00
Z801U	3.00
Z803U	18.95
ZA1000	9.00
ZA1001	1.50
ZA1002	1.50
ZC1040	8.00
ZM1001	5.00
ZM1005	8.00
ZM1020	8.00
ZM1021	8.00
ZM1023	6.00
ZM1041	14.00
ZM1050	14.00
ZM1080	12.50
ZM1084	10.00
ZM1202	65.00
ZM1263	4.00
ZM1612	3.00
2T1011	29.00
1AC6	1.20
1B3GT	1.50
1B5	2.50
1B22	10.00
1B24	10.00
1C1	1.20
1C5GT	1.00
1D5	1.00
1FD1	0.90
1G3GT	1.00
1L4	0.60
1L6	1.50
1LA6	1.00
1N5GT	2.50
1S2	0.65
1T4	0.45
1U5	1.00
1X2B	1.15
2AS15A	10.00
2C21	1.00
2C39A	14.50
2C39WA	24.00
2C40	37.00
2C40A	55.00
2C42	17.00
2C43	17.00
2C51	0.75
2C53	32.00

2B7	1.50
2D21	0.95
2D21W	2.50
2E26	12.00
2J42	93.00
2K25	17.50
3A/147J	7.50
3A/167M	10.00
3A2	3.00
3A3A	3.00
3A4	1.10
3AL5	0.95
3AT2	1.75
3AW2	3.35
3B2	3.00
3B7	4.50
3B24	7.50
3B28	12.00
3C4	1.00
3C45	12.50
3CN3A	2.50
3CX3	2.50
3D21A	24.00
3J187E	398.00
3J187G	398.00
3W4GT	2.50
4B551B	115.00
4-250A	36.50
4C27	25.00
4C28	25.00
4CX250B	37.50
4CX250R	48.50
4CX350A	63.75
4GS7	2.25
4GV7	2.25
4X150A	18.95
5A152M	9.00
5A163K	10.00
5A170K	6.25
5AN8	1.20
5AR4	2.00
5AU4	1.50
5B.110M	10.00
5B-254M	14.50
5B-255M	14.50
5B-257M	9.00
5B-258M	14.50
5C22	40.00
5R4GB	2.80
5R4GY	2.80
5U4G	0.75
5U4GB	2.50
5V4G	0.75
5Y3GT	0.80
5Z4GT	0.85
6/30L2	0.70
6A/203K	9.00
6A8G	1.50
6AB7	0.60
6AB8	0.66
6AC7	1.00
6AF4A	1.20
6AG5	1.50
6AG7	1.20
6AH6	1.00
6AJ4	2.00
6AJ7	2.00
6AK5	1.00
6AK6	2.00
6AL5	0.52
6AM4	2.50
6AM5	6.00
6AM6	1.20
6AN5	3.00
6AN8A	2.15
6AQ5	0.82
6AQ8	0.85
6AR5	2.00
6AR8	2.00
6AS5	1.50
6AS6	1.50
6AS7G	7.50
6AT6	0.75
6AU4	2.00
6AU6	0.56
6AV6	0.72
6AW8A	2.50
6B8G	0.75
6BA6	0.50
6BA6W	1.50
6BA7	4.50
6BA8A	3.50
6BC8	1.00
6BD4	1.00
6BD6	1.00
6BE6	0.72
6BF5	1.10
6BG6G	1.25
6BH5	1.60
6BH6	1.50
6BH8	1.00
6BJ6	1.05
6BK4	3.50
6BK7A	1.50
6BM8	0.58
6BN4	1.25
6BN6	1.30
6BN7	3.50
6BN8	2.00
6BQ5	0.60
6BQ7A	0.72
6BL8	0.65
6BR5	0.70
6BR7	3.75
6BR8	1.50
6BR8A	1.50

6BS7	3.75
6BS8	1.88
6BW4	1.30
6BW6	4.50
6BW7	0.85
6BW8	4.00
6BX6	0.48
6BX7GT	3.00
6BZ6	2.00
6BZ7	2.50
6BZ8	0.95
6C4	0.80
6C6	0.50
6C8G	1.25
6C11	2.50
6C15	2.50
6C18	2.50
6CA4	0.60
6CA7	4.50
6CB6	1.50
6CD6GA	4.00
6CF6	1.50
6CH6	10.35
6CL6	3.50
6CL8A	2.00
6CM5	1.60
6CS6	0.75
6CW4	7.50
6CY5	1.00
6DC6	2.00
6DK6	0.85
6DQ5	2.30
6DR7	2.00
6EA8	2.50
6EB8	1.75
6EU8	1.75
6EW6	1.25
6F1	2.00
6F6G	2.00
6F12	1.50
6F13	3.00
6F14	1.00
6F17	3.00
6F18	1.50
6F19	0.48
6F21	2.50
6F22	0.70
6F23	0.48
6F24	1.25
6F25	1.25
6F28	1.25
6F33	11.00
6FG5	1.50
6GH8A	0.80
6GK5	1.00
6GK6	2.00
6GV7	2.50
6H3N	0.70
6H6	1.35
6H6GT	1.20
6J4	1.10
6J5	1.95
6J5GT	0.75
6J6	0.55
6JB6A	3.95
6JE6C	3.50
6JS6A	3.50
6JS6C	3.50
6K7G	0.70
6KD6	4.50
6L1	2.50
6L6GC	2.50
6L6GT	1.15
6LD20	0.60
6LF6	2.95
6LQ6	2.95
6N7GT	1.50
6P15	0.80
6P25	3.00
6P28	2.00
6Q7	1.20
6S7	1.10
6SA7GT	1.00
6SC7	1.20
6SG7	1.20
6SH7	1.20
6SJ7GT	1.20
6SK7	0.80
6SK7GT	1.20
6SL7GT	0.72
6SN7GT	0.69
6SQ7	0.80
6SS7	1.50
6U4GT	1.75
6U5G	1.50
6U8	0.60
6U8A	1.50
6V6GT	0.80
6X2N	1.00
6X4	0.96
6X5GT	0.50
6X5GTY	1.00
6X8A	2.25
7A7	2.00
7AD7	1.75
7B7	1.40
7C5	3.00
7C6	2.50
7H7	2.00
7Q7	2.00
7S7	3.00
7Y4	1.50
10C1	5.50
10C2	0.70
10D2	1.25
10F1	0.75

10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E2	18.50
11E3	65.00
12AE6	0.85
12AG8	1.50
12AL5	1.00
12AT6	0.59
12AT7	0.65
12AT7WA	2.50
2AU6	1.50
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AYZ	4.00
12AZ7A	1.50
12BA6	0.90
12BE6	1.05
12BH7	1.50
12BH7A	1.50
12BL6	0.70
12BY7A	2.75
12CX6	1.20
12E1	18.95
12E14	28.00
12GN7	3.95
12HG7A	3.95
12J7GT	0.70
12K5	1.00
12K7GT	0.60
12K8	1.10
12Q7GT	0.50
12SA7GT	1.00
12SH7	1.00
12SK7	1.00
12SJ7	0.60
12SN7GT	1.85
12U7	1.50
13D3	3.20
13D7	3.20
13E1	115.00
14S7	1.00
15E	1.00
17DW4A	1.75
17JZ8	1.80
18D3	1.60
19AQ5	0.70
19H4	23.95
19Q6	9.00
20A2	10.50
20D1	0.70
20D4	1.75
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.05
20P5	1.15
25L6GT	1.75
25BQ6	1.75
29C1	19.50
30	2.85
30C1	0.70
30C15	0.40
30C17	0.40
30C18	1.48
30F5	0.95
30FL1	0.95
30FL2	0.95
30FL12	1.10
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	0.80
30PL14	1.75
31JS6A	2.95
35A5	4.50
35L6GT	2.00
35W	0.70
35Z3	1.85
38HE7	4.50
47	6.00
50B5	1.50
50C5	0.95
50CD6G	1.15
52KU	2.00
61SPT	4.50
75B1	1.50
75C1	1.35
76	1.50
83A1	7.00
84	3.00
85A1	6.50
85A2	2.00
90AV	10.00
90C1	2.70
90CG	13.50
91AG	9.00
92AG	11.85
92AV	10.00
95A1	5.50
108C1	1.50
150B2	3.35
150C2	1.50

150C4	1.50
155UG	25.00
185BT	1.50
205F	12.00
257A	8.00
307	5.00
329	5.00
388A	17.50
408A	4.00
425A5	8.00
431U	2.00
572B	35.00
705A	8.00
708A	8.00
715A	8.00
715C	45.00
801A	2.00
803	10.00
807	1.50
810	55.00
811A	9.00
813	18.50
813 USA	59.50
833A	115.00
866A	3.95
782A	16.00
873	60.00
884	6.50
954	0.50
955	0.90
958A	0.90
1299A	0.80
2050	7.00
3545	4.00
4212E	170.00
4313C	4.00
5642	5.50
5651	3.20
5654	1.95
5670	3.50
5675	15.00
5687	3.50
5692	3.50
5696	2.55
5718	6.50
5725	2.50
5726	1.50
5727	2.00
5749	2.50
5750	2.00
5751	1.50
5763	3.50
5814A	2.75
5840	3.50
5842	6.50
5879	3.90
5881A	4.60
5894	39.50
5899	4.50
5963	2.00
5965	2.25
5993	8.00
6005	3.50
6012	6.00
6021	3.95
6057	2.50
6059	3.75
6060	1.50
6062	4.50
6063	2.00
6064	3.25
6067	1.50
6072	4.20
6080	4.50
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146A	4.99
6146B	4.99
6201	5.50
6211	2.50
6267	1.50
6350	2.00
6360	4.50
6386	14.50
6545	8.50
6550	7.00
6550A	7.00
6870	11.50
6883B	10.50
7025	2.15
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7032	2.00
7059	2.50
7189	2.50
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7558	11.50
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7586	9.00
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9001	0.90
9006	0.90
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7 Watt	R47-4K7	0.18
	5K6-12K	0.19
	15K-22K	0.20
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	15K-22K	0.24
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WW-2

BASES ETC.

B7G	0.15
B7G Skirted	0.30
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B9A	0.20
B9A Skirted	0.30
B10B	0.16
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14 Pin DIL	0.12
14 Pin DIL/Q	0.30
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2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1 5V6 6V2 6V8 7V5 8V2 9V1 10V 11V 12V 13V 15V 18V 20V 24V 27V 30V

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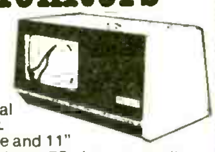

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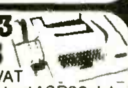

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(1883)

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Telephone: Plymouth (0752) 772773

WG

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If you are experienced in both digital and analogue testing techniques, particularly with a television background and are seeking an exciting future in a stimulating engineering environment, we'd like to hear from you.

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For an application form, please write to the **Recruitment Officer, (Dept. W/W12), HM Government** Communications Centre, Hanslope Park, Milton Keynes, MK19 7BH.

(1589)

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ITN

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The successful candidate will join an expanding team of specialists responsible for the maintenance of VPR2B, ACR25B, VR1200C and BVU800 machines, together with associated control and editing systems.

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(1847)

BBC

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(1876)

FIELD MAINTENANCE ENGINEER

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Please apply, in writing, to David Payne, Managing Director, Bacchus International Discotheque Services, 64-66 Glentham Road, London SW13.

(1848)

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Further details of the post are available from the Chief Engineer's Office at the Television Centre (622 9966).

Application forms from the Education Officer (EO/Estab. 1B), Room 365, The County Hall, London SE1 7PB. Please enclose a stamped and addressed foolscap envelope. Completed forms to be returned by 1st December 1982.

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(1860)

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CLOSING DATE 29th November 1982

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Daresbury Laboratory,
Science and Engineering
Research Council,
Daresbury,
Warrington,
Cheshire, WA4 4AD.

Daresbury
SCIENCE & ENGINEERING
RESEARCH COUNCIL

(1865)

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QUALIFICATIONS You should have a TEC Certificate in Telecommunications, or acceptable equivalent, plus 2 years' practical experience.

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HOW TO APPLY For full details on this and information on our special scheme for those lacking practical experience, write now to

Recruitment Office
GCHQ, Oakley, Priors Road, Cheltenham
Glos. GL52 5AJ
or ring
0242 21491
ext 2269

GCHQ

(1530)

NATIONAL BROADCASTING SCHOOL

DEPUTY CHIEF ENGINEER

The national broadcasting school, which provides training for Independent Broadcasting under the auspices of the IBA, seeks a Deputy Chief Engineer.

The Engineering Department, as well as maintaining the schools six broadcast capable studios and ancillary areas teaches engineering and technical operations.

We are looking for applicants aged between 25 and 40, with a recognised technical qualification, several years experience in operating and maintaining modern sound broadcasting equipment and the ability to pass on this knowledge. Previous experience in local radio and teaching would be an advantage.

Applications, in confidence, to the chief engineer, NBS, 14 Greek Street, London W1.

(1877)

ELECTRONIC DESIGN ENGINEERS

We are a small highly successful manufacturing company specialising in RF communications, digital and low frequency analogue equipment.

We require young highly motivated engineers wishing to develop their experience. The ideal candidate must have complete confidence in his ability.

- Starting salary £10K + (neg).
- 37½ hour week. Overtime available.
- Pay reviews every 6 months.
- Pleasant working environment.
- Location near City of London.

Contact Keith Penny on (01) 250 0894

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Call us now for posts in Design, Test, Sales or Field Service, at all levels from £6,000-£16,000.

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£9,000 plus Company Car and Annual Bonus

W & G Instruments Limited are among the world leaders in the supply of Telecommunication Measurement and Test Equipment.

To maintain their high level of customer service in an expanding business, they need more Test and Service Engineers based at their Greenford Office.

Applicants should have an HNC/HND or equivalent plus a minimum of 4 years' experience in fault diagnosis and repair of analogue and digital equipment.

The position will involve some travel to customers' installations in the U.K. for service and calibration work.

Good working conditions and opportunities for career development.

Apply to:
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Progress House,
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A member of the Wandel & Goltermann Group of Companies

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Engineering Technicians

CBS/Fox Video, a world leader in the pre-recorded video cassette market, has established the largest tape duplication facility outside the USA at Perivale, West London.

Significant growth has created additional openings for video engineers and technicians. Initially, you will be involved in the maintenance of ½" video recorders but can expect to move on to broadcast standard equipment. Training, both on-the-job and external, will be given where necessary.

Salary will be negotiated in line with qualifications and experience. You could be a recent college leaver who has completed an ONC/HNC in electronics or a similar subject, a television repair engineer, or an experienced video engineer.

Please send a detailed cv, including a telephone number for contact purposes, to Harry Lister, CBS/Fox Video, Unit 1, Perivale Industrial Park, Greenford, Middlesex UB6 7RU.

CBS FOX VIDEO

TRINITY HOUSE LIGHTHOUSE SERVICE, LONDON
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GRADE PTO II SALARY £9,021-£10,328 p.a.

Applicants must have had a sound training in radio and light current work associated with UHF, VHF and MF communications, remote monitoring and control systems. Experience in detailed planning, preparation of procurement specifications and drawings, manufacturers' acceptance testing, field trials and commissioning is essential.

Some knowledge of landline signalling techniques, simple computer programming and micro-technology would be an advantage.

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(1812)

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This position will appeal to an engineer who whilst having a good knowledge of analogue circuitry (DC-300MHz) to Degree/H.N.D. level, enjoys a practical hands on approach and is highly self motivated. He will be responsible for the support of the existing product and the development of new products that contain a high degree of innovation.

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An experienced engineer who will not only build and test the prototype models but must be capable of identifying any design problems as they occur. Although academic qualifications are not important it is unlikely that the successful applicant will be under 30. A top-grade analogue technician, ready to move into development work will probably handle this demanding task.

Initial interviews will be held at our Windsor office and therefore in the first instance write or telephone

Roger Howard, C.Eng., M.I.E.E.
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Application forms obtainable from:
Personnel Officer, Laser-Scan Laboratories Ltd, Cambridge Science Park, Milton Road, Cambridge CB4 4BH. Telephone: (0223) 69872.

(1800)

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Post Production Engineer

required to be our number two engineer on weekly Channel Four alternative news programme. We are looking for someone with an interest in computer technology and graphics, in addition to previous television engineering experience at same level.

ACTT rates will apply

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Diverse Production Ltd.
6 Gorleston Street, London, W.14
Telephone: 01-602 4102
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Applications are invited for this new post in the Department of Computer Studies. The successful candidate should have HNC, HND or equivalent, and 6-10 years' experience in the field of microprocessors, electronics or digital systems.
Salary on Grade 6 scale £6532-£7802 (under review). The appointment is for three years.
Requests for further particulars and application forms to Dr C. H. Machin, Department of Computer Studies, University of Technology, Loughborough, Leics. LE11 3TU.
Loughborough *Leicestershire*

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£7500 TO £10500
ACCORDING TO EXPERIENCE, OXFORD BASED

Research Machines is a leading UK manufacturer of microcomputer systems, selling mostly to the education and scientific market sectors.

We are expanding the groups which develop new products for our chosen market areas, and wish to recruit programmers with first hand knowledge of at least one of those areas. The successful applicants will work on the implementation of new application-related software tools for our current and future microcomputer systems. General requirements are:

- ☐ at least 2 years programming experience, preferably on microcomputers;
- ☐ experience of at least one high-level language (e.g. Pascal) and assembler;
- ☐ successful completion of at least one software implementation project;
- ☐ degree, or equivalent desirable;
- ☐ understanding of microcomputer hardware would be an advantage.

Specific vacancies, and their particular requirements, are:

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(please quote Ref. EP5)

Two vacancies exist for people interested and experienced in the use of microcomputers in schools and colleges. We will be developing further our range of software tools to assist the growing number of people producing educational software as well as providing software for use in the classroom. Knowledge of BASIC and teaching experience is desirable.

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(please quote Ref. LP5)

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We offer a particularly attractive range of benefits, including good salary, 25 days paid holiday, free BUPA, life and disability insurance, pension scheme, and help with relocation expenses where relevant.

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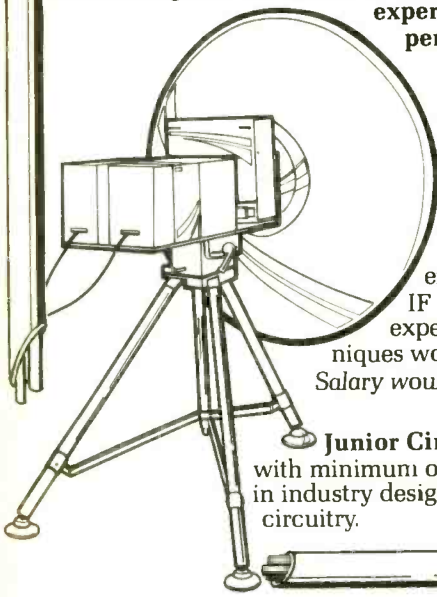

DEVELOPMENT

Senior Circuit Design Engineer – ideally mid 20's to mid 30's with a minimum HNC level qualification – must have several years relevant design experience in Baseband IF and RF circuitry. Some experience in digital techniques would be advantageous.
Salary would not be a limitation for the right applicant.

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Production Engineers with several years experience of production problems on Video and or Telephony Microwave Systems. Experience with production control methods would be an advantage.
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PERSONNEL MANAGER
MICROWAVE COMMUNICATIONS LIMITED
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TEL: 0582 601441

If you would like to know more about these opportunities or our company, please telephone our Chief Engineer Tony Tooley on 0582 872385 or our Marketing Director Brian Meade on 044285 470, outside office hours.

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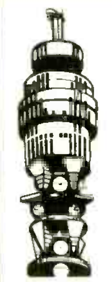

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Applications should be addressed to: Mr. R. Browning, Acron Video, Unit 3, Lovelace Road, Bracknell, RG12 4YT. Telephone: Bracknell 55625.

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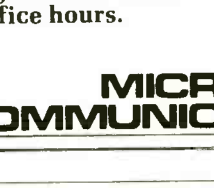

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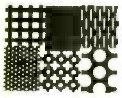

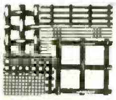

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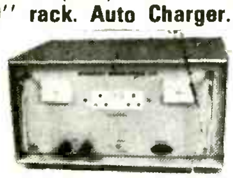

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Applicants, male or female, must be qualified to at least City & Guilds Intermediate Telecommunications standard, and possess a current driving licence. (Some travelling will normally be involved.) Registered disabled people can, of course, apply.

Salary will be on a scale of £5,972 - £8,058, with generous leave and non-contributory pension scheme. (Unfurnished rented accommodation may be available in certain circumstances.) Good prospects for promotion.

If you are interested in working with us, please write or telephone for further details and application form to: Miss M. Andrews, Home Office, Directorate of Telecommunications, Horseferry House, Dean Ryle Street, London SW1P 2AW. Tel: 01-211 8515.

(1868)

Home Office

"LIKE HENS' TEETH"

So our clients commented recently in relation to RF Engineers –

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The client in question are not actually involved in the field of poultry detection, but do offer some excellent opportunities in job content and value and in remuneration and benefits.

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(1629)

The Electronics Recruitment Company
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£9,000 plus car

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We would expect a C & G or equivalent qualification in Electronics, and at least 4 years' experience in the design of complex aerial distribution systems.

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Linda McBreen, Dixons Photographic UK Ltd., Camera House, Cartwright Road, Stevenage, Herts. Telephone Stevenage (0438) 4371.

Dixons

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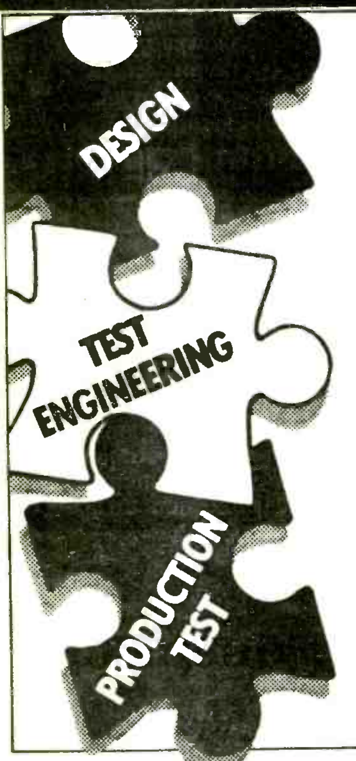

ELECTRONIC TEST ENGINEERING

Having introduced an extended new product range many of which are micro-processor based, Marconi Instruments has once again confirmed itself as Europe's leading manufacturer of measurement systems and automatic test equipment. Our products are selling throughout the world to all leading users in the electronics and aerospace industries and we are naturally developing further innovated designs.

A key role in our organisation is that of test engineering, where a group of professional engineers are responsible for the development of sophisticated methods and software for the manufacture of our products. We are now looking for experienced Engineers and are particularly interested if you have experience in the following disciplines:

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For further details contact Mr. J. Prodger, Recruitment Manager, Marconi Instruments Limited, Longacres, St. Albans, Herts. Telephone: St. Albans (0727) 59292 ext. 369.

marconi instruments

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