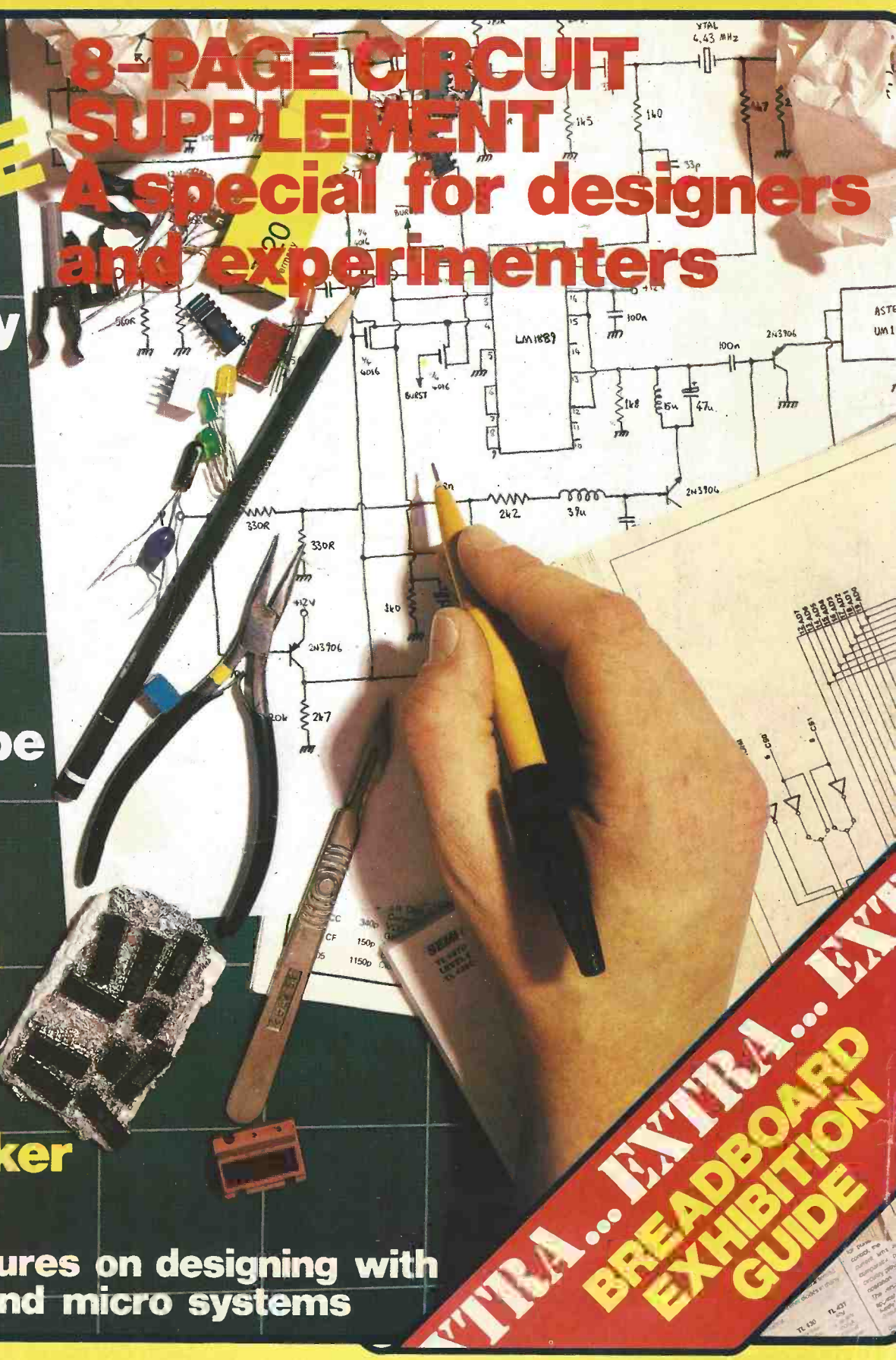
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DESIGNER'S NOTEBOOK 31
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CIRCUIT SUPPLEMENT 35
Not only all our usual circuit features and projects, this issue: there's also this eight page supplement, culled from manufacturers' data sheets with the help of copious midnight oil.

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How to get information into and out of your computer is our topic this month, including a description of handshaking.

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Matching a big preamp to a little amp, and a little preamp to a big amp, plus where to buy those elusive Curtis chips and the secret of Eric.

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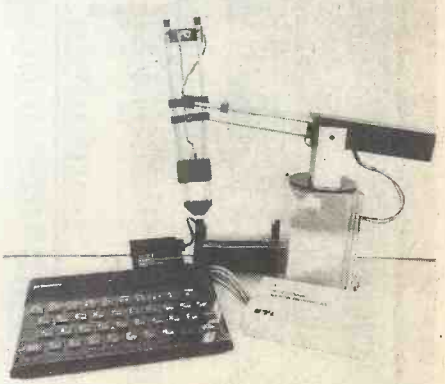
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40468	85
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40603	110
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40871/2	90

SIEMENS pcb Type Miniature poly Capacitors 250V
1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 12n, 15n 7p
18n, 22n, 27n, 33n, 39n, 47n 8p
39n, 56n 12p
82n, 100n 11p
100V
100n, 120n 10p
150n, 180n 12p
220n, 270n 15p
330n, 390n 20p
470n, 560n 26p
680n 30p
1uF 34p 2u2 50p

RF CHOKES Miniature PCB type
1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u 30p
1mH, 1m5, 2m2, 4m7, 10mH 35p
22m, 33m, 43m 60p
100m 75p

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Z5J 195p

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10A/200V	215
10A/600V	295
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW 8p each
Range: 3V3 to 33V. 1.3W 15p each

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	105
16A 800V	220
25V 500V	220
25A 800V	295
T2800D	120

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	150
75182/3	99
75188/9	55
75322	140
75324	360
75361/3	150
75365	150
75450	86
75451/2	52
75454	85
75491/2	65

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	95
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2 25

COMPUTER ICs

1702	350
1802CP	650
2102-2	100
2114-450n	85
2114L-300n	90
2114L-200n	95
2147	425
2532-450n	350
2564	£12
2708	225
2716-5V	215
2732-450n	350
2764	999
3242	590
4816-100nS	225
4027	190
4116-150n	85
4116-200n	80
4118-250	325
4164-200n	500
4334-3 = CMOS	
2114-3	325
4816-100nS	225
4864-364K	500
5101-450	220
6116-150nS	390
6116L 120nS	550
6117-100n	490
6502CPU	325
6503	600
6504 250	550
6505	600
6520PIA	100
6521	100
6522VIA	300
6530	£11
6352RRIOT	570
6545RTC	899
6551ACIA	650
6592PC	£20
6800	225
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	100
6821	100
68B21	220
6840	375
6843	£12
6845	685
6847	650
6850	110
6852	250
6854	599
6875	500
68000	£70
74C922	420
8080A	250
8085A	350
8118-10	250
8123	125
8155	350
8156	350
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8202	£25
8212	110
8214	425
8215	300
8216	100
8224	110
8225	£11
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256AC	£35
8257-5	400
8259	395
8271	£36
8279	385
8284	350
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26LS31	C125
AM26LS32	A125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1799	£28
FD1797	£28
1HD26501	75
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	690
MC14412	790
MC3446	250
MC3447P	315
MK3886-2M	£7
MM1702A	300
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	770
MM74C922	420
RO-3-2513L	850
RO-3-2513U	850
SFF9634E	800
TMS2716-3V	725
TMS6011	365
TMS9928	£30
ULN2003	90
UPD7002	440
Z80CPU 2.5	299
Z80ACPU	4M 300
Z80 CTC	250
Z80A CTC	260
Z80B	£11
Z80 DART	495
Z80A DART	550
Z80 DMA	675
Z80 DART	698
Z80 PIO	260
Z80A PIO	275
Z80 SIO-1	850
Z80A DIO	980

LINEAR ICs

555CMOS	80
702	75
709 14 pin	40
709C 8 pin	35
710	48
741 8 pin	14
747C 14 pin	65
748C 8 pin	35
753 8 pin	185
810	159
9400CJ	350
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	438
Booklet for AY-3-8910	150
AY-3-8912	625
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
AY-5-3500	350
AY-5-4007D	520
AY-5-8100	775
CA3011	130
CA3012	175
CA3014	275
CA3018	88
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	750
ICL7107	975
ICL7611	99
ICL7660	190
ICL8038CC	300
ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216A,J	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	440
LC7130	340
LC7120	300
LC7137	395
LF347	150
LF351	48
LF353	95
LF356	85
LF357	110
LF398	475
LM10	325
LM301AO	24
LM307	45
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM301	24
LM307	45
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M252AA	625
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	00
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5534A	150
OM335	750
RC4136D	69
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76003N	350
SN76013	350
SN76018	148
SN76023N	350
SN76023ND	240
SN76033N	350
SN76115N	215
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SN76660	120
SP8629	299
TA7210	150
TA7204	200
TA7205	90
TA7205A	225
TA7222	150
TA7310	160
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	85
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	120
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	325
TDA2002	325
TDA2004	495
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL061CP	40
TL062CP	80
TL064CN	98
TL071CP	24
TL072CP	45
TL074CN	100
TL081CP	24
TL082CP	45
TL083CP	75
TL084CN	90
TL091CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	85
ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	190
ZN423E	135
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	860

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74103	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	106p
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 46p
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

THUMBWHEEL Mini front mounting
Decade Switch Module 220p
B.C.D. Switch Module 276p
Mounting Cheeks (per pair) 76p

VEROBOARD 0.1in

	clad	plain
2½ × 3¼"	80p	
2½ × 5"	91p	—
3¾ × 3¾"	91p	—
3¾ × 5"	105p	97p
3¾ × 17"	360p	232p
4¾ × 17"	470p	—
Pkt. of 100 pins	50p	
Spot face cutter	135p	
Pin insertion tool	178p	

VERO WIRING
PEN + spool 340p
Spare spool 76p
Combs 8p

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

VQ Board	180
DIP Board	360
Vero Strip	374

PROTO-DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	620p
Bimboard 1	575p
Superstrip SS2	1350p

DALO ETCH RESIST PEN
Plus spare tip 90p

ULTRASONIC TRANSDUCER
40KHz 325 pr

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	18p	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	198p	200p
2 × 23 way	190p	—
2 × 25 way	225p	220p
2 × 28 way	210p	—
2 × 30 way	245p	—
2 × 36 way	285p	—
2 × 40 way	315p	—
2 × 43 way	385p	—
2 × 75 way	650p	—

IDC CONNECTORS

Female Header Socket	PCB Plugs with latch Pins Strt	PCB Plugs with latch Pins Angle	Female Header Plug	PCB Pins Angled
10 way	90p	99p	95p	95p
16 way	130p	150p	110p	79p
20 way	145p	165p	125p	90p
26 way	175p	200p	150p	110p
34 way	205p	239p	189p	135p
40 way	220p	250p	190p	150p
50 way	235p	270p	200p	175p
80 way	—	—	230p	220p

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	380p	395p	280p	400p

DIL (Headers) PLUG

	Solder	IDL
14pin	40p	99p
16pin	49p	105p
24pin	88p	178p
40pin	250p	255p

RIBBON CABLE price per foot Grey Color

10 way	12p 22p
16 way	18p 32p
20 way	25p 40p
24 way	35p 60p
34 way	49p 80p
40 way	65p 75p
50 way	85p 90p
64 way	85p 110p

ZIF DIL SOCKETS

24 pin	575p
28 pin	620
40 pin	975p

PANEL METERS

FSD
60 × 46 × 35mm

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

CRYSTALS

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	180
3.5794M	98
3.6864M	300
4.0MHz	160
4.032MHz	280
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	180
5.186MHz	300
5.24288M	380
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	180
8.08333M	395
8.86723M	175
9.00MHz	160
10.0MHz	175
10.24MHz	200
10.7	180
12.0NHz	175
12.628M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	180
20.0MHz	200
19.968MHz	160
24.0MHz	170
24.930MHz	325
26.69M	160
27.848M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

RELAYS

Miniature, enclosed, PCB mount. Our RL6 series.
S.P.C.O.
RL6-91 170Ω coil, 7V5 to 12V DC; 380V/6A AC; 1300VA/50W 210p
D.P.C.O.
430Ω coil, 4V2-7V DC; 250V AC; 5A; 1100VA/150W 218p
RL6-111 170Ω coil, 8V-14V; 250V AC 5A 220p
RL6-181 740Ω coil, 17V5-29V 250V 5A AC. 222p

AMPHENDL PLUGS

IEEE 24 Way	550
Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	550

BUZZERS, miniature, solid-state 6V; 9V & 12V 70p

LOUDSPEAKERS
Miniature, 0.3W: 8Ω
2in, 3¼in, 2¼in, 3in 80p
2¼in 400, 640 or 800Ω 80p

ASTEC UHF MODULATORS

Standard 6MHz	280p
Wideband 8MHz	425p

'WEMON' New Version WATFORD'S Ultimate Monitor IC

A 4K Monitor chip specially designed to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr A. A. Berk in Practical Electronics, June 1981.
Only £10 + 50p P&P

BBC MICRO UPGRADE

(Our B8C Micro Upgrade Kits will save you £ s s s . . .)

16K Memory (8 × 4816AP)	£18
Printer User I/O Port Kit	£8.20
SK10 with 36" Cable	£2
Complete Printer Cable 36"	£12
SK9 with 36" Cable	£3
Disc Interface Kit	£41
Analogue I/O Kit	£6.75
Serial I/O Kit	£7.50
Expansion Bus Kit	£8.50
SK11 with Cable 36"	£3
SK12 with Cable 36"	£3.75

Complete Upgrade Kit from Model A to Mod. B £45
range of Connectors & Cables available. Send SAE for list

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	188p	208p	300p	465p
12 inches	198p	218p	318p	480p
24 inches	210p	235p	345p	540p
36 inches	230p	260p	375p	595p

IDC Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	180p	200p	280p	300p
Double ended	290p	370p	480p	525p

ANTEX SOLDERING IRON

C-15W	460p	CX17W	476p
CCN-15W	485p	CX25W	500p
Spare tips, assorted sizes			85p
Spare Elements			210p
Iron stand with sponge			165p

Soldercon Pins

100 pins 70p
500 pins 325p

D CONNECTORS: Miniature

	9 way	15way	25way	37way
Plugs				
Solder lugs	80p	110p	160p	250p
Angle Pins W/Wrap	160p	210p	250p	355p
Pins	120p	130p	195p	295p
Sockets				
Solder lugs	110p	160p	210p	350p
Angled Pins W/Wrap	165p	215p	280p	440p
Pins	150p	180p	240p	420p
Covers	85p	95p	95p	110p

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

PIEZOI TRANSDUCERS
PB2720 55p

TRANSFORMERS: Prim. 240V

6-0-6V; 9-0-9V; 12-0-12V 100mA 98p

pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.26A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A 200p
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A 270p

Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A 220p
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A 295p (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A 330p (60p p&p)
80VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A 485p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A 920p (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

	+ve		Metal case	−ve	
1A	TO3				
5V	7805		145p	7905	220p
12V	7812		145p	7912	220p
15V	7815		145p	7915	220p
18V	7818		145p		
1A	TO220	Plastic casing			
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	TO92	Plastic casing			
5V	78L05		30p	79L05	60p
6V	78L62		30p		—
8V	78L82		30p		—
12V	78L12		30p	79L12	60p
15V	78L15		30p	79L15	60p

CA3085	95p
LM300H	170p
LM304H	170p
LM305H	140p
LM309K	135p
LM317K	320p
LM317KP	99p
LM317H	280p
LM323K	500p
LM325N	240p
LM326N	240p
LM337	176p
LM723	35p
TAA550	60p
TBA625B	75p
TDA1412	150p
78H05 + 5V/5A	550p
78H12 + 12V/5A	580p
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4001	10	4076	50	4543	99
4002	12	4077	13	4544	150
4006	50	4078	15	4548	40
4007	14	4081	13	4549	375
4008	32	4082	13	4553	245
4009	24	4085	80	4554	190
4010	24	4086	80	4555	35
4011	10	4089	125	4556	35
4012	16	4093	20	4557	320
4013	20	4094	70	4558	120
4014	48	4095	95	4559	395
4015	40	4096	70	4560	180
4016	20	4097	280	4561	104
4017	32	4098	75	4562	495
4018	45	4099	110	4566	185
4019	26	4161	99	4569	175
4020	42	4162	99	4572	30
4021	40	4163	99	4580	460
4022	40	4174	99	4581	250
4023	13	4175	105	4582	99
4024	32	4194	105	4583	99
4025	13	4408	750	4584	48
4026	80	4409	750	4585	99
4027	20	4410	725	4597	330
4028	38	4411	675	4598	280
4029	48	4412	775	4599	280
4030	15	4415	480	40085	90
4031	125	4419	280	40097	45
4032	80	4422	770	40098	193
4033	125	4435	850	40100	215
4034	140	4440	999	40101	130
4035	48	4450	350	40102	140
4036	275	4451	350	40103	175
4037	115	4490	350	40104	95
4038	110	4500	575	40105	110
4039	250	4501	28	40106	48
4040	40	4502	80	40107	80
4041	40	4503	40	40108	450
4042	40	4504	75	40109	100
4043	40	4505	185	40110	300
4044	40	4506	35	40114	240
4045	105	4507	35	40161	194
4046	48	4508	130	40163	85
4047	40	4510	48	40174	85
4048	40	4511	45	40175	75
4049	25	4512	50	40181	220
4050	25	4513	199	40182	90
4051	45	4514	115	40192	90
4052	80	4515	115	40193	88
4053	80	4516	55	40194	90
4054	85	4517	275	40195	72
4055	85	4518	40	40244	185
4056	85	4519	30	40245	195
4057	1815	4520	80	40257	195
4059	435	4521	110	40373	240
4060	45	4522	125	40374	245
4061	1185	4526	70	45106	595
4062	995	4527	85		
4063	85	4528	70		
4066	24	4529	150		
4067	345	4530	90		
4068	16	4531	130		
4069	16	4532	70		
4070	13	4534	455		
4071	13	4536	275		
4072	13	4538	90		
4073	16	4539	110		

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TIL322 .5" CC	115
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FND357 Red	120
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		4016	20	4034	140	4054	78	4081	12	40193	65	4528	50
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	125	4538	110
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	70
4006	50	4022	45	4043	40	4067	225	4094	68	4511	45	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	50	4553	245
4008	36	4024	33	4046	50	4069	13	4097	290	4514	120	4555	35
4009	24	4025	16	4047	45	4070	13	4098	70	4515	120	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	11	4027	20	4049	21	4072	13	40106	40	4518	40	4560	175
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	40
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

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		LS20	12	LS75	20	LS123	34	LS160	35	LS197	45	LS353	60
		LS21	12	LS76	17	LS125	24	LS161	35	LS221	50	LS365	28
		LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	LS26	14	LS83	35	LS132	35	LS163	35	LS241	60	LS367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	11	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	60
LS03	12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	LS390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	45
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
LS15	12	LS74	17	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

		7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
		7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	38		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

LINEAR

				LM339	45	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	175	▶NE567	100	TL071	30
				LM358	50	LM3915	195	▶NE570	370	TL072	50
555CMOS	80	ICL7106	700	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	95
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
AY-3-8910	370	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
AY-3-8912	625	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	215	LM10	360	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
CA3161E	100	LM324	40	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	110	LM335Z	125	▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

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				BC547	7	BFR40	23	TIP29A	30	ZTX109	12
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14
AC125	35	BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15
AC187	22	BC168C	10	BD115	80	BFX87	25	TIP31C	37	ZTX501	15
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25
AD161	40	BC172	8	BD135	50	BFY52	23	TIP33C	75	ZN697	20
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	ZN698	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	ZN706A	20
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	ZN708	20
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	ZN918	35
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	ZN1132	22
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	ZN1613	30
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	ZN2218A	45
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	ZN2219A	25
▶BC108	9	BC184L	7	BF180	35	BU206	200	TIP120	90	ZN2221A	25
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	ZN2222A	20
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	ZN2368	25
▶BC109	9	BC213	10	BF185	25	MJE340	50	TIP141	98	ZN2369	16
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	ZN2484	25
BC114	22	BC214	10	BF195	12	MJE521	95	TIP147	110	ZN2646	45
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	ZN2904	20
BC117	22	BC237	8	BF197	12	MPF102	40	TIP3055	55	ZN2904A	20
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	ZN2905	22
BC137	40	BC308	15	BF199	18	MPSA05	22	TIS44	45	ZN2905A	22
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	ZN2906	25
BC140	30	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	ZN2906A	25
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	ZN2907	25
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	ZN2907A	25
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	ZN2926	9
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55

2N3055	50										
2N3442	120										
▶2N3702	6										
2N3703	9										
▶2N3704	6										
2N3705	9										
2N3706	9										
2N3707	10										
2N3708	10										
2N3709	10										
2N3772	190										
▶2N3773	210										
▶2N3819	18										
2N3820	40										
2N3823	65										
2N3866	90										
2N3903	10										
2N3904	10										
2N3905	6										
2N3906	10										
2N4037	45										
2N4058	10										
2N4060	10										
2N4061	10										
2N4062	10										
2N5457	36										
2N5458	36										
2N5459	30										
2N5485	36										
2N5777	45										
2N6027	30										
40360	40										
40361	50										
40362	50										
40408	70										

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 1M . . . 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 . . . 2p each.
¼W 1% metal film E24 series 10 ohm - 1M . . . 6p each.

SOCKETS

	Low profile	Wire-wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	25p	80p
40 pin	25p	98p

Soldercon pins 60P/100

SWITCHES

Submin toggle:
SPST 55p, SPDT 60p, DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 12p.
Push to make 12p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

VERO

VEROBLOC◀	350
Size 0.1 matrix:	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	6

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	15
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	2	400mWzen	6

CABLES

20 metre pack single core connecting cable ten different colours.65p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p.
Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 63p each.
Preset submin. hor. 100 ohms -1M 7p each.
Cermet precision multiturn, 0.75W ¾" 100 ohms to 100K - 88p each.

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	LM338K	475
LM317T	120	78H05 5A	
LM323K	350	▶5V	550

SOLDERING IRONS

Antex CS 17W Soldering iron	460
2.3 and 4.7mm bits to suit	65
CS 17W element	450
Antex XS 25W	480
3.3 and 4.7mm bits to suit	65
Solder pump desoldering tool.	480
Spare nozzle for above	70
10 metres 22swg solder	100

PCB MATERIALS

Alfac transfer sheets – please state type (e.g. DIL pads etc.)	45
Dalo etch resist pen	100
Fibre glass board 3.75"x8"	80
Ferric chloride 250ml bottle.	100

TOOLS

Small trimming tool	22
Small pocket screwdriver	16
Large pocket screwdriver	13
6 piece precision screwdriver set in plastic case	170
Low cost side cutters	160
High quality side cutters	650
Low cost pliers	160
High quality pliers	650
Wire strippers	120
Expo reliant drill	695
Expo Titan drill	1025
Drill stand	1200
Reduced shank drill bits for above 0.8mm,	60

OPTO

▶3mm red	7	▶5mm red	8
▶3mm green	12	▶5mm green	12
▶3mm yellow	12	▶5mm yellow	12

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500		FND507	
0.5"	100	0.5"	100
TIL313 0.3"/115		TIL3120.3"/115	
TIL3220.5"/115		TIL321 0.5"/115	

LCD: 3½ digit 580p. 4 digit 620p.

TRIACS

		400V 8A	65
		400V 16A	95
400V 4A	50	BR100	25

COMPONENT KITS

An ideal opportunity for the beginner or the experianced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 480
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items) : 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ⅛" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ⅛" bolts	

TRANSFORMERS

Please add carriage charges to our normal post charges.

Miniature mains:
606V, 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature:
3VA 0-6, 0-6 @ 0.25A; 0-9, 0-9 @ 0.15A; 0-12, 0-12 @ 0.12A 200p each.
6VA 0-6, 0-6 @ 0.5A; 0 9, 0-9 @ 0.3A; 0-12, 0.12 @ 0.25A 270p each.
High quality. Split bobbin construction
6VA 0-6, 0 6 @ 0.5A; 0-9, 0-9 @ 0.4A; 0-12, 0-12V @ 0.3A 220p each.
12VA 0-6, 0-6 @ 1A, 0-9, 0-9 @ 0.8A, 0-12, 0-12 @ 0.5A; 0-15, 0-15 @ 0.4A 295p (plus 40p carriage).
25VA 0-6, 0 6 @ 1.5A; 0-9, 0-9 @ 1.2A; 0-12, 0-12 @ 1A; 0 15, 0-15 @ 0.8A 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0 15 @ 1.5A. 440p each (plus 75p carriage)

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25

BOXES

		Aluminium	
Plastic with		3x2x1"	70
lid + screws		4x3x1½"	85
3x2x1"	55	4x3x2"	100
4½x3x1⅛"	88	6x4x2"	120
7x4x2	160	6x4x3"	150

SCRs

		▶C106D	30
		400V 8A	70
		400V 12A	95

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . 60p
Socket with 2m lead . . 120p

MULTIMETERS

HT-120 4,000 opv
A smart looking 11 range pocket sized multimeter with an impressive spec. Complete with battery, etc. 650p each.
HT-320 20,000 opv.
Highly sensitive 19 range multimeter including transistor tester. Overload protection. DC volts – 1000, AC volts – 1000; DC current 0.25A, 4 resistance ranges. Complete with batteries, leads, etc. 1395p

NEW CATALOGUE * NEW CATALOGUE!!!!!!!!
Our latest catalogue has just been released containing over 2000 stock lines all at extremely competitive prices backed by Rapid's return of post service. Stocks include Denco coils, tools, Verocases, data sheets etc. etc. Send 45p for your copy now (sent free of charge with all orders over £10).

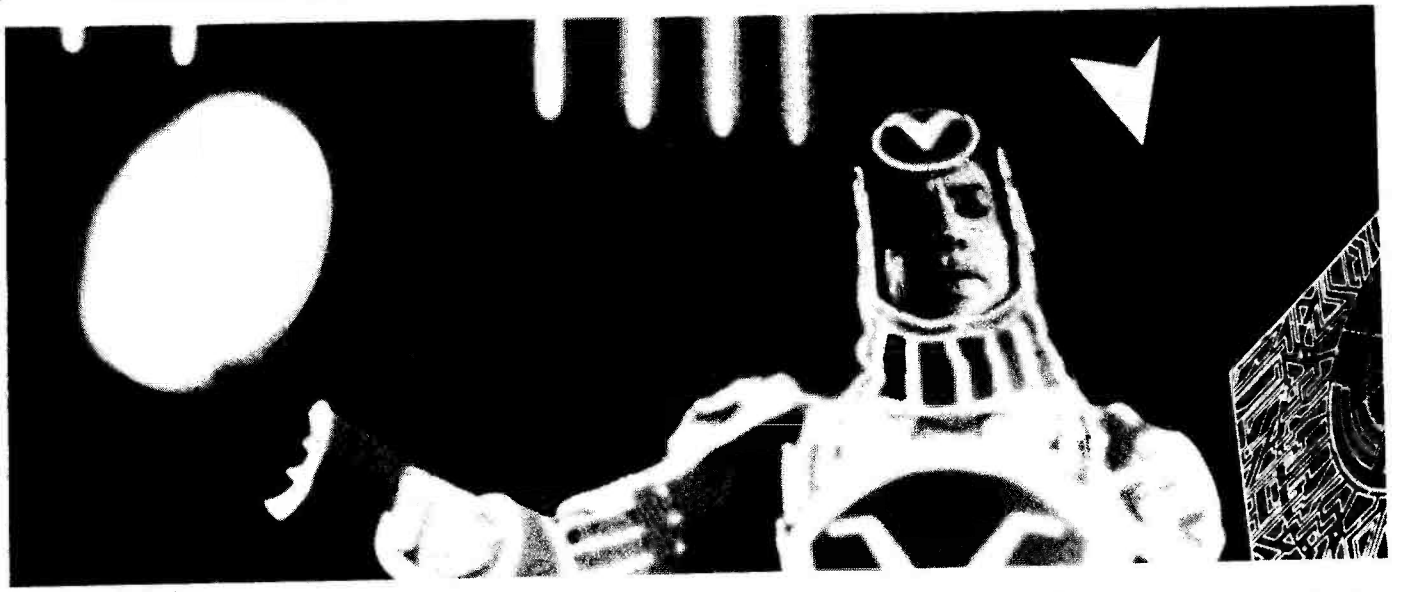
The Rapid Guarantee

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

ORDERING INFO All components brand new and full specification.
All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/P.O. or Access/Visa number with order. Our detailed catalogue costs 45p (free with orders over £10). Callers most welcome. Telephone orders welcome with Access and Visa. Official orders accepted from Colleges Schools, etc.

NEXT MONTH

electronics today INTERNATIONAL

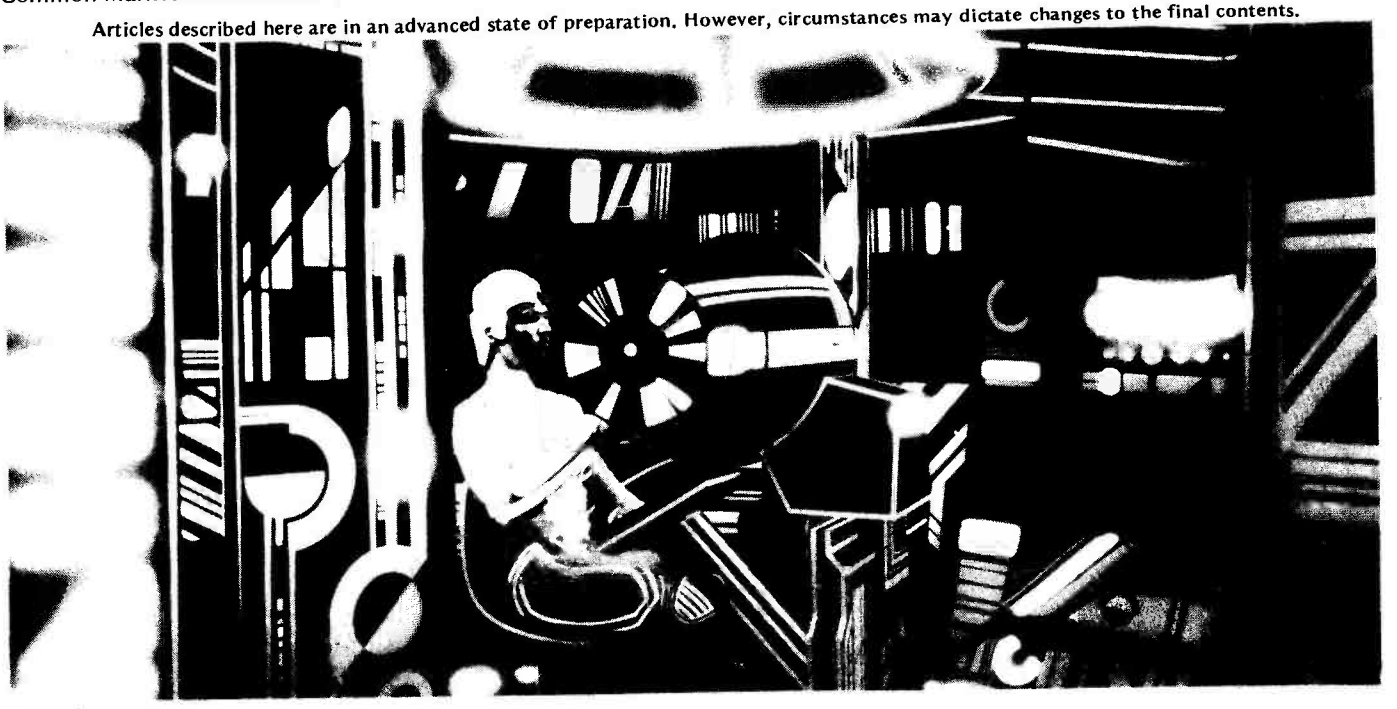


Walt Disney Productions

Well, there's this person called Sark, that's him up above with the electronic Frisbee, except he isn't really a person, he's a program, and a pretty evil one too, a really nasty piece of code. Then there's this other program, called Flynn, except he's really a person, and he's the good guy, but he's trapped with Sark inside a computer where he's fighting to the death against some video games that he wrote himself. That's Flynn's alter ego down below, called Clu, and he's driving around inside the computer in that art deco tank looking for Invader-like things to zap, except they zap him. Confused? You won't be after the next edition of ETI, where we'll be reviewing Tron, the big Christmas film from Walt Disney and a milestone in moviemaking. Sorry, I forgot about the Common Market and Eurometaphors: it's a kilometrestone in moviemaking. Stuffed full of computer animation and other clever and unique techniques, plus a lot of video gaming mythology, this is great entertainment.

Almost as great, that is, as our extensive review of as many video games as we can get our hands on, in our 'Buyer's Guide to Conquering the Universe'. This will be just in time to help you make up your mind before the Christmas spending spree, and containing our maximum scores so you can pit yourselves against us. We'll also be presenting all our usual features plus a bumper collection of excellent projects, including a digital stage lighting dimmer and a programmable power supply. You can't afford to miss the January edition of ETI, on sale December 3rd.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.



Walt Disney Productions

CRICKLEWOOD ELECTRONICS LTD.

40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET. Tel: 01-452 0161. TELEX: 914977 CRIKEL G

SUPERIOR QUALITY CARBON FILM RESISTORS, HI STAB LOW NOISE
¼W 10Ω-1MΩ 6% E24 2p
½W 10Ω-10MΩ 6% E24 3p
1W 10Ω-10MΩ 5% E12 6p
2W 10Ω-10MΩ 5% E12 16p

METAL OXIDE/FILM RESISTORS
Very high thermal & electrical stability. Extremely low noise.
0.4W 10Ω-1MΩ 2% E24 5p
0.4W 10Ω-1MΩ 1% E24 8p

LOW OHMIC VALUE RESISTORS
(½W OR ¼W)
0.22Ω-8.2Ω E12 11p

WIREWOUND RESISTORS 5%
2-3W 0.22Ω - 330Ω E12 28p
4-7W 0.47Ω - 6KΩ E12 33p
10-11W 1.0Ω - 33K E12 37p

LOW NOISE ROTARY POTS E3 Series
4.7K-2M Lin 32p
4.7K-2M Log 32p
DP ganged 4.7K-2M Lin 70p
DP ganged 4.7K-2M Log 70p
Stereo 4.7K-2M Lin 70p
Stereo 4.7K-2M Log 70p
Mini Vert 14p
Mini Horiz 14p
Standard Vert 17p
Standard Horiz 17p
Thumbwheel or ¼" Spindle for Standard Pre-sets only 8p

MICRO-MINI 100V CERAMIC PLATE CAPS
5% or better
E12 Series
1pF-10nF 7p
DISCOUNTS ON QUANTITY PLEASE PHONE

SIEMENS 63V MINI MONOLYTHIC CERAMIC
10nF 10p
22nF 10p
33nF 10p
47nF 10p
68nF 10p
100nF 14p
220nF 17p

SIEMENS POLY-C 5% 7.5mm 250V CAPACITORS E12
1nF-68nF 10p
82nF-150nF 15p

5% 7.5mm 100V CAPACITORS E12
100nF-180nF 12p
220nF, 270nF 15p
330nF, 390nF 20p
470nF, 560nF 27p
680nF 32p
1μF (10mm) 36p
Complete range of other voltages & spacings in stock. Please phone

SILVER MICA CAPS 1% 500V
Cement coated
Extremely stable
2.2pF, 3.3pF, 18pF 20p
20pF-100pF 20p
120pF-220pF 25p
250pF-470pF 30p
680pF-1nF 33p

TANTALUM BEADS

.1/35V	17p
.22/35V	17p
.33/35V	17p
.47/35V	17p
.68/35V	17p
1.0/35V	17p
2.2/16V	17p
2.2/35V	22p
3.3/35V	22p
4.7/16V	22p
4.7/35V	24p
6.8/25V	26p
6.8/35V	25p
10/16V	25p
10/35V	34p
15/10V	22p
15/16V	30p
15/25V	32p
22/6.3V	28p
22/16V	32p
33/10V	38p
47/6.3V	43p
100/3V	37p

Feedthrough Capacitor
1000pF 500V 7p

MINI FILM MULLARD TRIMMERS
1.4-5.5pF
(800MHz) 23p
2-10pF
(600MHz) 27p
2-22pF
(400MHz) 29p
5.5-65pF
(200MHz) 36p

630VDC 250VAC POLYESTER CAPS

10nF	12p
15nF	18p
22nF	18p
47nF	32p
100nF	35p
150nF	37p
220nF	40p

Fully enclosed Pihor Pre-sets E 3 Series
100Ω-10M 70p

Veroboard 0.1" Copper clad
2.5×3.75 90p
2.5×5 90p
3.75×3.75 90p
3.75×5 102p
2.5×17 280p
3.75×17 355p
4.79×17 465p
VQ Board 180p
Dip Board 376p
Track Cutter 135p
100 Pins 52p
Verobloc 399p

Vero Wiring
Pen + Spool 350p
Spare Spool 72p
Combs 6p

1000vdc Caps (300VAC) Axial
1nF, 2.2nF 23p
4.7nF, 6.8nF 26p
10nF 28p
22nF, 33nF 37p
47nF 45p
100nF 48p
220nF 74p
470nF 1.10

1500VDC Caps (300VAC) Axial
1nF, 2.2nF 30p
3.3nF, 4.7nF 32p

2000VDC Axial
100nF 20% 76p

Ceramic Hi Volt Disc Capacitors
100p/1KV 20p
100p/2KV 24p
100p/3KV 26p
100p/4KV 28p
220p/6KV 30p
470p/2KV 27p
470p/6KV 32p
1n/2KV 28p
1n/6KV 32p
2n2/2KV 30p
2n2/4KV 32p
2n2/5KV 33p
3n3/2KV 31p
3n3/4KV 32p
4p7/4KV 33p

400V Polyester Capacitors
1nF, 1.5nF, 2.2nF 18p
3.3nF, 4.7nF, 6.8nF 19p
10nF, 15nF, 22nF 20p
33nF, 47nF, 68nF 22p
100nF, 150nF 25p
220nF 38p
330nF 58p
470nF 66p

C280 or Equiv Polyester Caps Radial Long Leads
10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF 9p
150nF, 220nF, 330nF, 470nF 11p
680nF, 1μF 24p
1.5μF, 2.2μF 44p

Grade One Glass PCB Single Sided
178 × 240mm 95p
420 × 185mm 130p
420 × 245mm 195p

Ferric Chloride
60% Solution
250ml bottle £1.60

ETCH RESIST TRANSFERS
1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons
9. Mixture
Any sheet of above 30p
Set of 13 sheets £1.00

PHOTO SENSITIVE PCB
1st Class Epoxy Glass. For better results than spraying. Expose to UV.
Single sided
100 × 160 1.56
100 × 220 1.90
203 × 114 1.85
233 × 220 3.99
Double sided
100 × 160 1.66
100 × 220 2.15
203 × 114 2.21
233 × 220 4.89
Developer for above (do not use Sodium Hydroxide) 500ml 2.50

DALO ETCH RESIST PEN
+ spare nib 90p

ANTEX SOLDERING IRONS
C240 (15W) 4.59
X25 (25W) 5.99
Iron stand 1.65
C40 Element 1.99
X25 Element 2.06
Bits C240
No2 (Small) 65p
No3 (Med) 65p
No6 (Lge) 65p
Bits X25
No50 (Small) 65p
No51 (Med) 65p
No52 (Lge) 65p
SOLDER 125gms
18 swg 2.95
22 swg 3.10

Wire & Cable
Prices per metre
Solid Hook-up Wire
Any colour 5p

Quality Electrolytics
By Matsushita or Siemens
(other good makes may be sent only in the rare event of supply difficulty)

AXIALS

μFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	10p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	12p
10	40	14p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	20p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	30p
220	63	40p
220	100	49p
330	16	19p
330	25	24p
330	63	54p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	48p
1000	63	88p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	90p

Beautiful Mini Radial Low Voltage
Matsushita only

μFd	V	
10	16	6p
22	16	6p
47	10	7p
47	16	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

Mains/Speaker Cable (per metre)
Twin 1 amp 14p
Twin 2½ amp 16p
3 Core 2½ amp 18p
3 Core 6 amp 31p
3 Core 13 amp 56p

Solid Multicore
4 Core 33p
6 Core 39p
12 Core 46p
50 Core 1.37

Screened Cable
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 25p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p

Aerial Cable
50Ω RG58A 36p
75Ω UHF 36p
75Ω VHF 28p
300Ω Flat 14p

Rainbow Ribbon Cable
10 Way 65p
24 Way 150p
40 Way 210p

TRANSISTORS
Probably the largest retail variety in UK. If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	38p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	46p
2N1303	46p
2N1304	60p
2N1306	85p
2N1308	85p
2N1309	Sap
2N1420	68p
2N1483	2.85
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1890	50p
2N1893	30p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	25p
2N2218A	28p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	20p
2N2222A	26p
2N2223	2.60
2N2223A	4.16
2N2303	39p
2N2368	25p
2N2369	19p
2N2369A	18p
2N2405	85p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	80p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	2.90
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	28p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p
2N3055 CSF	60p
2N3055RCA	80p
2N3107	44p
2N3108	42p
2N3109	48p
2N3232	1.50
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2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N3393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442MOT	2.40
2N3444	1.70
2N3445	4.80
2N3446	6.08
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	25p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3807	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	16p
2N3663	18p
2N3691	18p
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2N3705	10p
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2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.46
2N3738	2.00
2N3740	2.36
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3794	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	46p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3866	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	36p
2N3900	25p
2N3901	30p
2N3902	6.86
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.47
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
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2N4061	10p
2N4062	10p
2N4064	1.16
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	27p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	96p
2N4234	45p
2N4236	45p
2N4237	1.21
2N4238	95p
2N4239	1.00
2N4248	3.00
2N4249	15p
2N4250	17p
2N4258	75p
2N4266	45p
2N4275	48p
2N4288	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4342	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	56p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.49
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	56p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	98p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
2N4967	25p
2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5035	1.80
2N5038	1.95
2N5039	3.90
2N5086	38p
2N5087	39p
2N5088	37p
2N5089	37p
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2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	88p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	28p
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2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5297	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
2N5358	73p
2N5386	25p
2N5367	28p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
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2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59
2N5543	5.80
2N5551	37p
2N5640	45p
2N5654	35p
2N5786	80p
2N5813	23p
2N6027	30p
2N6030	6.60
2N6082	11.99
2N6099	1.20
2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	89p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6263	1.45
2N6254	1.55
2SC 1406	95p
2SC 1444	2.50
2SC 2078	1.70
2SJ 49	3.98
2SK 134	3.99
3N128	1.12
3N135	3.50
3N139	3.30
3N140	2.37
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40250	96p
40251	2.77
40254	2.75
40264	2.63
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.69
40315	1.94
40316	95p
40324	1.88
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.98
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.80
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	95p
40408	1.99
40410	1.80
40411	2.85
40412	90p
40422	2.96
40673A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.48
40625	1.60
40626	3.20
40631	1.90
40632	2.12
40635	1.35
40637	2.00
40643	1.80
40673	93p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	7.90
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	79p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
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BC159C	18p
BC161	48p
BC167	10p
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BC170	15p
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BC170C	18p
BC171	12p
BC171A	15p
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BC172	12p
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BC172C	16p
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BC173C	16p
BC174	21p
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BC550C	33p
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BC558	14p
BC558A	15p
BC558B	16p
BC558C	17p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560C	34p
BC727	44p
BC737	60p
BCW32R	60p
BCY30	1.15
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BCY33A	1.00
BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY 66	1.80
BYC67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY 78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD 237	99p
BD 238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD241A	61p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD243C	85p
BD244A	82p
BD244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	56p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93

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ZTX503 17p
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Sensitive Gate Small Signal
2N4444 1.80
BT101-500R 1.40
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2N6083 37p
2N6084 40p
BR101 75p
BRY39 60p
BRY56-100 60p
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BRY56 50p
TIC44 35p
TIC47 90p

4, 8 & 12 Amps Texas TO220
Suffix: A = 100V B = 200V C = 300V D = 400V M = 500V
TIC106A 46p
TIC106B 47p
TIC106C 48p
TIC106D 53p
TIC106M 60p
TIC116A 66p
TIC116B 68p
TIC116C 71p
TIC116D 73p
TIC116M 80p
TIC126A 72p
TIC126B 72p
TIC126C 73p
TIC126D 77p
TIC126M 95p

SIEMENS THRISTORS
1.2 amp plastic
Bst B0106 (100V) 60p
Bst B0113 (200V) 70p
Bst B0146 (700V) 1.12
4.7 amp plastic
Bst B0208 (100V) 80p
Bst B0213 (200V) 1.10
Bst B0246 (700V) 2.00

TV Thyristors
2N4444 1.90
BT101-500R 1.40
BT106 1.50
BT116 Use TIC116M 2.00
BT119 1.70
BT120 1.85
BT121 1.30

TRIACS
Texas 400V
TO220 Case
TIC206D(4A) 66p
TIC225D(6A) 74p
TIC226D(8A) 88p
TIC236D(12A) 1.16
TIC246D(16A) 1.22
TIC253D(20A) 1.90
TIC263D(25A) 2.11

Other Triacs
2N5756 (TO5) 1.44
2N6155 (TO127) 3.39
40432 (Quadrac) 2.23
40486 (TO5) 1.65
40612 2.70
40676 (TO66) 3.33
40842 1.92

DIODES
1N34A 30p
1N821 70p
1N823 92p
1N914 08p
1N916 10p
1N1190 1.47
1N1192 1.75
1N1194 1.65
1N1194A 1.80
1N1196A 2.41
1N1198A 2.65
1N1201A 97p
1N1204A 1.09
1N1206 1.20
1N3063 38p
1N3065 48p
1N3492 1.85
1N3493 2.20
1N3494 2.20
1N3602 36p
1N3604 45p
1N3766 3.00
1N3768 4.80
1N3768R 4.50
1N4001 4p
1N4002 4½p
1N4003 5½p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 6p
1N4150 16p
1N4448 22p
1N4517 22p
1N5172 30p
1N5176 94p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 16p
1N5405 17p
1N5406 18p
1N5407 18p
1N5408 20p
1N5624 62p
1N5625 66p
1N5626 62p
1N5627 68p 1.25
1S44 10p
1S131 40p
1S134 56p
1S421 1.00
1S421R 1.00
1S940 10p
1S941 11p
1S961 22p
AA118 28p
AA129 57p
AA144 25p
AAY30 44p
AAY33 46p
AAZ17 27p
BA100 22p
BA102 25p
BA115 25p
BA133 40p
BA136 30p
BA142 25p
BA144 15p
BA155 15p
BA156 38p
BA182 40p
BA201 18p
BA202 25p
BA204 25p
BA217 25p
BA318 30p
BAV10 18p
BAV19 15p
BAV20 15p
BAV49 15p
BAX13 10p
BAX16 11p
BAY38 20p
BAY44 15p
BAY93 10p
BB103B 70p
BB103G 70p
BB104B 80p
BB104G 80p
BB105 52p
BB105A 57
BB105B 58p
BB109G 65p
BBY26 20p
BBY27 22p
BBY34 52p
BBY82 1.26
BBY88A 65p
BBY206 38p
BBY207 36p
BBY23 1.56
BBY297 45p
BBY299 55p
BYW11-800 1.40
BYW11-1000 1.50
BYW12-100 1.30
BYW12-200 1.40
BYW12 400 2.00
BYX10 38p
BYX50-200R 2.00
BYX55-350 62p
BYX71-350 1.10
BYX71-600 1.52
ITT33 15p
ITT44 10p
ITT921 10p
ITT923 15p
ITT2002 27p
MZ2361 1.80
OA10 70p
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p
OA5508AF 75p
SPD9000 75p
SPD9002 95p

BRIDGE RECTIFIERS
/PIV shown in brackets)
1|amp type Square with hole
W01 (100) 20p
W02 (200) 28p
W04 (400) 28p
W08 (800) 40p

2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 56p

6 amp type Square with hole
PW01 (100) 50p
PW02 (200) 75p
PW04 (400) 90p
PW06 (600) 90p

25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40

Proprietory Bridges
B40C1500 1.20
B80C3700 1.80
B80C1A64 55p
BY179 92p

ZENER DIODES
400-500mW E24 Series
2.4-47V 8p

1.3 Watt E24 Series
3.3-82V 15p

2.5 Watt E24 Series
7.5-75V 1.10

5W wire ended following voltages only
3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V 1.25

10W Pos. Stud
Following voltages only
7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.25

20W Pos. Stud
(BZY93 series)
E24 values
7V5-75V 2.00

OPTO ELECTRONICS
2N5777 78p
2N5778 85p
2N5779 1.09
4N25 1.10
BP100 1.40
BP104 1.00
BPX25 2.47
BPX29 2.47
BPX48 6.76
BPX60 4.75
BPX61 3.48
BPX63 2.93
BPX79 4.60
BPX86 4.15
COX13 40p
COX23 53p
COX33 46p
LD30A 10p
LD36A 12p
LD37A 12p
LD52A 12p
LD56A 15p
LD57A 15p
LD57C 30p
LD57C 30p
LD80A 18p
LD86A 22p
LD87A 22p
LD242 75p
LD271 40p
LD461 25p
LD466 1.45
LD468 1.65
LD471 27p
LD476 1.20
LD478 1.45
LD479 1.65
LD481 27p
LD486 1.25
LD488 1.70
LD489 1.89
LD599 81p
ORP12 1.20
RPY60 2.65
RPY63 2.65
TIL32 71p
TIL63 1.95
TIL64 1.95
TIL65 2.25
TIL66 2.30
TIL67 2.35
TIL78 60p
TIL81 1.60
TIL99 1.35
TIL116 1.10
TIL138 2.40
TIL139 2.40
TIL209 15p
TIL211 19p
TIL212 19p
TIL224 32p
TIL228 42p
TIL312 1.65
TIL313 1.65
TIL401 3.50
TIL403 3.80
TIL406 4.10

NEW OPTO DEVICES
Inc. Superbright
see next column

D CONNECTORS 25 WAY
Solder type
Male 1.60
Female 2.05
Angled PCB
Male 2.45
Fmale 2.90
Covers 99p

POWERFET AMP MODULES FROM PANTECHNIC
now available from LONDON. See Pantechnic ad in this mag for specs.
PFA 100 16.00
PFA 200 22.95
10,000 mF 80V 4.10

ICE MULTI-METERS
Microtest 80 £16.00
Supertest 680R £32.00

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow
Large diffused
1+ 50+
R5D 8p 7p
G5D 16p 12p
Y5D 16p 12p
Small diffused
R2D 8p 8p
G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 26p 22p
G1O 27p 25p
Y1D 27p 25p
Large clear
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright
Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Tri-colour flat
RGY8 83p 76p

LINEAR ICs
AN103 2.20
AY1-0212 2.60
AY3-0215 7.95
AY1-1320 2.20
AY1-5050 95p
AY1-1270 7.28
AY3-8910 5.39
AY3-8912 5.58
AY5-2376 6.95
CA3000 4.80
CA3001 4.95
CA3002 4.80
CA3005 3.15
CA3007 4.92
CA3010 1.30
CA3012 1.75
CA3013 4.12
CA3014 2.35
CA3015 2.62
CA3018 76p
CA3018A 2.00
CA3020 2.00
CA3020A 3.90
CA3021 3.20
CA3022 3.12
CA3026 1.52
CA3028A 1.21
CA3028B 2.53
CA3035 1.44
CA3040A 2.97
CA3043 5.44
CA3046 5.18
CA3047 3.47
CA3047A 3.47
CA3048 4.60
CA3052 2.92
CA3053 1.00
CA3054 1.64
CA3059 2.80
CA3060 4.09
CA3062 13.94
CA3065E 2.85
CA3068 4.23
CA3070 3.20
CA3071 3.30
CA3075 2.25
CA3076 3.42
CA3078T 2.25
CA3080 1.89
CA3080A 3.95
CA3080E 70p
CA3081 1.90
CA3085 1.35
CA3086 95p
CA3088E 2.35
CA3089E 1.88
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 95p
CA3140T 85p
HA1366W 2.40
HA1388 2.64
ICL7106 7.40
ICL7107 9.60
ICL8038 2.99
ICM7555 80p
LC7120 3.20
LC7130 3.20
LF351 47p
LF353 92p
LF356 83p
LF356 92p
LF357 1.09
LF13201 2.99
LF13331 3.30
LF13741H 99p
LF13741N 88p
LM10CH 4.25
LM11CH 4.80
LM114 6.75
LM137K 11.52
LM301AH 1.00
LM301AN 25p
LM305AH 2.90
LM305H 88p
LM307H 1.05
LM307N 55p
LM308AH 3.15
LM308AN 2.14
LM308H 95p
LM308N 88p
LM309K 2.80
LM310H 1.95
LM310N 1.89
LM311H 1.04
LM311N 70p
LM317K 2.80
LM317MP 1.04
LM317T 1.50
LM318H 2.40
LM318N 1.49
LM319H 2.48
LM319N 2.10
LM320 — See 78XX Series Volt. Regulators
LM324N 29p
LM337K 4.75
LM337MP 1.66
LM337T 1.98
LM338AN 1.80
LM339N 47p
LM340 — See 78XX Series Volt Regulators
LM345K 8.80
LM348N 62p
LM349N 1.14
LM350K 4.80
LM359N 1.44
LM360N 3.88
LM376N 65p
LM377N 1.66
LM378N 3.40
LM379S 4.75
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386N1 88p
LM386N4 1.20
LM388N 2.43
LM391N60 1.70
LM391N80 1.83
LM392N 76p
LM393N 96p
LM394H 3.80
LM396K 13.52
LM709N8 64p
LM709CH 1.00
LM710CH 89p
LM710CN 52p
LM711CN 1.38
LM711CN 70p
LM723CH 1.21
LM723CN 40p
LM725CH 3.40
LM725CN 3.19
LM733CN 1.50
LM741CH 96p
LM741CN 15p
LM741CN14 80p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1303N 1.20
LM1304N 2.50
LM1305N 1.10
LM1307N 2.75
LM1310N 1.45
LM1330N 2.25
LM1458 44p
LM1496 1.00
LM1800 3.24
LM1801 2.99
LM1812 8.00
LM1818 2.99
LM1820 2.15
LM1828 4.79
LM1830 2.44
LM1845 4.12
LM1848 2.89
LM1850 2.75
LM1871 4.38
LM1872 4.38
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.88
LM2917N8 1.88
LM3524 6.77
LM3301 1.90
LM3302 74p
LM3401 85p
LM3403 75p
LM3405 1.45
LM3405 1.20
LM3900 48p
LM3905 1.25
LM3909 79p
LM3911 1.20
LM3914 1.79
LM3915 1.98
LM3916 2.19
MA2526CH 2.63
MA4250N 2.39
LM13600 1.09
MB3712 1.99
MB3756 3.80
MB8719 7.95
MS3200 8.64
MC1303 =
LM1303N
MC1304 =
LM1304N
MC1305 =
LM1305N
MC1307 =
LM1307N
MC1310 =
LM1310N
MC1330 =
LM1330N
MC1352 1.75
MC1456 1.80
MC1458 =
LM1458
MC1466L 6.77
MC1495L 3.75
MC1496 =
LM1496
MC3340 1.45
MC3401 =
LM3401
MC3403 =
LM3403
MC3405 =
LM3405
NE531N 1.38
NE543N 2.80
NE544N 1.80
NE555 16p
NE556 45p
NE558 1.88
NE560 3.25
NE562 4.00
NE565 1.18
NE5661.49
NE567 1.37
NE570 3.75
NE571 3.75
NE5634A 1.25
PLL02A 4.85
RC4136 55p
S566B 2.59
SAD 1024A pos
SAS560 2.68
SAS570 2.80
SAS580 2.68
SAS590 2.68
SFF96364 7.99
SL610C 4.00
SL611C 4.00
SL612C 4.00
SL620C 6.00
SL621C 6.00
SL623C 10.00
SL630C 6.00
SL640C 6.00
SL641C 6.00
SN76001N 2.80
SN76008 3.90
SN76018 3.90
SN76003N 2.95
SN76013N 2.95
SN7023N =
SN76033N
SN76033N 2.95
SN76110 2.25
SN76116 2.65
SN76226 3.45
SN76228 2.90
SN76477 4.49
SN76530 1.80
SN76550 80p
SN76666 2.90
SO41P 1.60
SO42P 1.60
TA7210 4.95
TA7204 1.95
TA7205 89p
Ta7222 1.45
TA7310 1.49
TAA263 1.50
TAA300 3.95
TAA320 2.00
TAA350 3.80
TAA521 1.50
TAA522 2.47
TAA550 73p
TAA560 2.35
TAA570 2.35
TAA621AX1 2.75
TAA661A 1.50
TAA661B 1.70
TAA700 2.80
TAA 930 2.50
TAA930B 2.63
TAA970 2.45
TAA991D 2.40
TAD100 2.00
TBA120AS 75p
TBA331 1.60
TBA341 2.06
TBA395 1.65
TBA396 1.50
TBA460 1.53
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.56
TBA530Q 2.78
TBA540 2.72
TBA540Q 2.74
TBA551 3.25
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TBA581 3.11
TBA641 1.80
TBA651 1.90
TBA673 4.15
TBA700 2.38
TBA700Q 2.47
TBA720AQ 2.60
TBA750 2.25
TBA750Q 2.46
TBA790A 2.11
TBA800 78p
TBA810 95p
TBA820 75p
TBA820M 76p
TBA920 1.95
TBA950 2.25
TBA990 2.65
TBA990Q 2.74
TCA105 3.00
TCA160C 2.67
TCA220 3.44
TCA270 2.44
TCA440 2.20
TCA450 2.65
TCA640 4.15
TCA650 4.15
TCA660B 4.15
TCA730 1.80
TCA740 4.80
TCA750 4.85
TCA760 2.76
TCA800 3.50
TCA800Q 3.65
TCA830S 1.95
TCA910 2.19
TCA940 1.89
TDA1002 3.39
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA1024 1.19
TDA1034 3.20
TDA2020 2.85
TDA2522 4.20
TDA2530 3.30
TDA2540 4.10
TDA2541 4.10
TDA2560 4.10
TDA2571 4.40
TDA2581 3.75
TDA2590 5.20
TDA2591 4.73
TDA2600 6.15
TDA2610 3.90
TDA2611A 2.50
TDA2640 3.64
TDA3000 2.76
TL061 40p
TL082 60p
TL064 88p
TL071 38p
TL072 50p
TL074 1.30
TL081 50p
TL082 75p
TL083 85p
TL084 88p
TL170 48p
TL430 88p
UAA170 1.60
UAA180 1.69
ULN2003 95p
UPC575C2 2.65
UPC1156 2.75
XR2206 2.92
ZN414 79p
ZN419 2.25
ZN1034 1.99
ZN1040 6.69
ZTK22 89p
ZTK33 89p

TTL
7400 10½p
7401 11p
7402 11p
7403 12p
7404 12p
7405 16p
7406 16p
7407 16p
7408 14p
7409 14p
7410 14p
7411 18p
7412 14p
7413 16p
7414 17p
7416 17p
7417 17p
7420 14p
7421 20p
7422 20p
7423 20p
7425 18p
7426 18p
7427 18p
7428 18p
7430 14p
7432 17p
7433 21p
7437 19p
7438 19p
7440 15p
7441 85p
7442 27p
7443 65p
7444 65p
7445 46p
7446 50p
7447 36p
7448 41p
7450 16p
7451 15p
7453 15p
7454 14p
7460 16p
7470 22p
7472 25p
7473 23p
7474 18p
7475 22p
7476 24p
7480 40p
7481 1.19
7482 83p
7483 36p
7484 63p
7485 60p
7486 18p
7489 1.70
7490 20p
7491 35p
7492 25p
7493 34p
7494 24p
7495 34p
7496 34p
7497 85p
74100 80p
74104 50p
74105 55p
74107 20p
74109 25p
74110 28p
74116 60p
74118 53p
74119 57p
74120 58p
74121 25p
74122 30p
74123 34p
74125 30p
74126 29p
74128 35p
74132 42p
74136 27p
74141 55p
74142 1.75
74143 1.95
74144 1.95
74145 38p
74147 88p
74148 55p
74150 49p
74151 35p
74153 35p
74154 49p
74155 40p
74156 40p
74157 30p
74159 75p
74160 40p
74161 40p
74162 40p
74163 40p
74164 40p
74165 40p
74166 48p
74170 1.17
74172 2.50
74173 48p
74174 54p
74175 48p
74176 38p
74177 45p
74178 88p
74180 40p
74181 1.15
74182 65p
74184 90p
74185 80p
74186 4.80
74188 2.80
74190 45p
74191 45p
74192 45p
74193 45p
74194 40p
74195 45p
74196 40p
74197 48p
74198 77p
74199 77p
74221 53p

74LS TTL
74LS00 11p
74LS01 11p
74LS02 11p
74LS03 12p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 19p
74LS14 22p
74LS20 12p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 12p
74LS32 13p
74LS33 14p
74LS37 14p
74LS38 12p
74LS40 12p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 18p
74LS76 18p
74LS78 18p
74LS80 1.20
74LS83 33p
74LS85 39p
74LS86 18p
74LS89 3.50
74LS90 22p
74LS92 25p
74LS93 24p
74LS95 36p
74LS96 50p
74LS107 20p
74LS109 23p
74LS112 20p
74LS113 22p
74LS114 22p
74LS122 25p
74LS123 34p
74LS124 89p
74LS125 24p
74LS126 25p
74LS132 33p
74LS136 24p
74LS138 24p
74LS139 27p
74LS145 70p
74LS147 89p
74LS148 89p
74LS151 30p
74LS153 39p
74LS154 79p
74LS155 29p
74LS156 39p
74LS157 28p
74LS158 28p
74LS160 30p
74LS161 35p
74LS162 35p
74LS163 35p
74LS164 40p
74LS165 50p
74LS168 84p
74LS169 85p
74LS170 70p
74LS173 55p
74LS174 39p
74LS175 39p
74LS181 1.20
74LS183 1.20
74LS190 38p
74LS191 38p
74LS192 38p
74LS193 37p
74LS194 38p
74LS195 32p
74LS196 45p
74LS197 48p
74LS221 60p
74LS240 95p
74LS241 68p
74LS242 68p
74LS243 65p
74LS244 65p
74LS245 70p
74LS247 60p
74LS248 85p
74LS249 85p
74LS251 30p
74LS253 32p
74LS257 29p
74LS258 33p
74LS259 85p
74LS261 89p
74LS273 63p
74LS275 1.25
74LS279 30p
74LS280 95p
74LS283 40p
74LS289 4.70
74LS290 45p
74LS293 40p
74LS295 75p
74LS298 79p
74LS299 1.55
74LS323 1.85
74LS324 1.45
74LS325 2.40
74LS326 2.30
74LS327 2.30
74LS347 95p
74LS348 88p
74LS352 59p
74LS353 59p
74LS362 7.25
74LS365 27p
74LS366 27p
74LS367 27p
74LS368 27p
74LS373 59p
74LS378 80p
74LS388 1.14
74LS390 42p
74LS393 42p
74LS395 87p
74LS396 1.90
74LS398 2.70
74LS399 1.60
74LS445 1.30
74LS490 1.85
74LS540 88p
74LS541 88p
74LS640 99p
74LS641 99p
74LS643 98p
74LS644 98p
74LS668 1.19
74LS669 99p
74LS670 99p
74LS673 5.60
74LS674 9.99

74S TTL
74S00 30p
74S02 32p
74S04 32p
74S08 75p
74S20 60p
74S30 60p
74S32 70p
74S38 1.00
74S40 1.45
74S64 1.02
74S65 1.02
74S74 75p
74S85 2.98
74S86 1.75
74S112 90p
74S124 2.25
74S132 1.09
74S133 60p
74S138 1.25
74S139 1.49
74S140 2.50
74S153 7.95
74S157 2.75
74S163 3.00
74S174 2.50
74S175 3.20
74S188 3.50
74S189 3.50
74S194 3.50
74S200 4.00
74S201 4.00
74S225 5.25
74S261 3.00
74S262 8.50
74S287 2.99
74S288 1.89
74S289 1.57
74S301 4.20
74S470 3.25
74S471 6.25
74S473 12.50
74S474 3.88
74S475 8.25
74S571 9.00
74S573 9.00

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74H00 1.45
74H01 1.45
74H04 1.55
74H05 1.55
74H10 1.45
74H11 1.45
74H20 1.45
74H21 1.45
74H30 1.45
74H40 1.55
74H51 1.45
74H55 1.40
74H60 1.70
74H62 1.75

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74L10 1.70
74L47 3.27
74L74 1.20
74L85 4.20
74L86 1.50
74L93 2.30
74L98 2.99

74C CMOS/TTL
74C00 27p
74C04 29p
74C10 28p
74C14 89p
74C20 28p
74C30 38p
74C42 95p
74C48 1.40
74C73 54p
74C76 87p
74C83 1.74
74C85 1.34
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74C90 1.05
74C93 1.44
74C95 1.00
74C107 80p
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4001 11p
4002 11p
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4007 15p
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4009 24p
4010 24p
4011 10p
4012 10p
4013 20p
4014 46p
4015 20p
4016 20p
4017 32p
4018 46p
4019 32p
4020 44p
4021 39p
4022 32p
4023 12p
4024 32p
4025 12p
4026 37p
4027 20p
4028 43p
4029 14p
4030 43p
4031 1.19
4032 80p
4033 80p
4034 1.29
4035 58p
4036 2.49
4037 1.30
4038 39p
4040 40p
4041 39p
4042 46p
4043 41p
4044 39p
4045 99p
4046 44p
4047 39p
4048 39p
4049 23p
4050 44p
4051 44p
4052 49p
4053 83p
4054 49p
4055 83p
4056 4.35
4059 42p
4060 78p
4063 22p
4066 2.22
4067 14p
4068 13p
4069 13p
4070 13p
4071 13p
4072 13p
4073 13p
4075 44p
4076 13p
4077 13p
4078 12p
4081 12p
4082 12p
4085 68p
4086 53p
4089 1.20
4093 89p
4094 89p
4095 75p
4096 75p
4097 2.99
4098 74p
4099 90p

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4503 29p
4507 33p
4508 1.19
4510 46p
4511 48p
4512 39p
4514 1.10
4515 1.10
4516 59p
4518 39p
4519 29p
4520 48p
4521 90p
4522 89p
4527 69p
4528 46p
4532 88p
4534 4.29
4536 2.89
4538 95p
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74LS288 1.60

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7805M 47p
7812M 47p
7815M 47p
7824M 47p
1 Amp TO220
7805T 38p
7812T 38p
7815T 38p
7824T 38p
1.5 Amp T03
7805K 1.39
7812K 1.39
7815K 1.39
7924K 1.39
– Negative –
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79L05 89p
79L12 89p
79L15 89p
500mA TO202
7905M 55p
7912M 55p
7915M 55p
7924M 55p
1 Amp TO220
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7912T 44p
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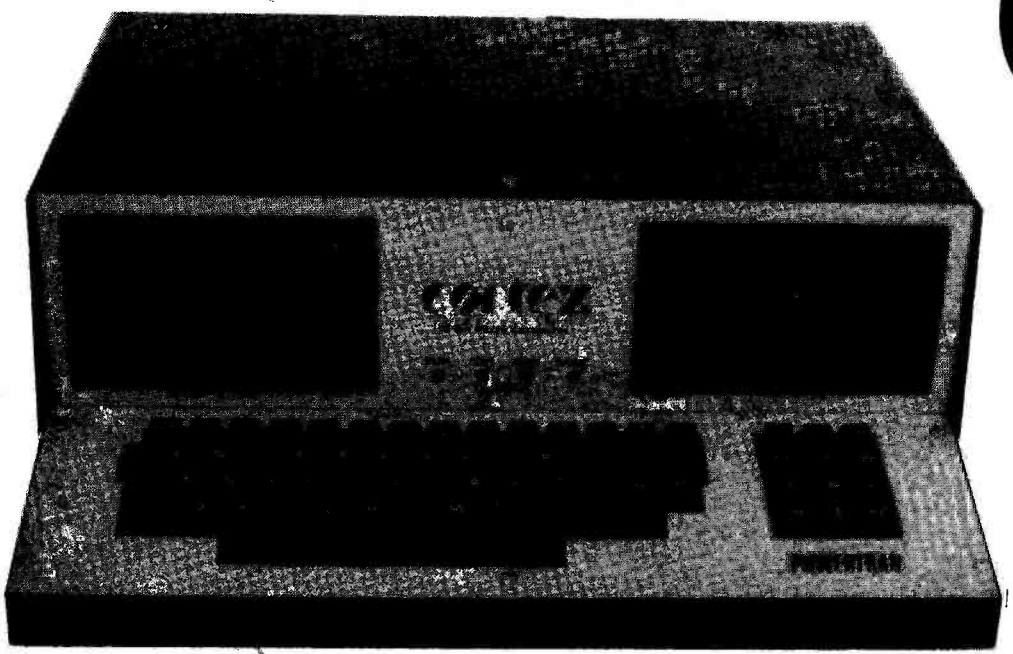
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SIZE	SQR		*	ENTER	MAG
CONT	SYS	STATEMENTS	UNIT	LIST	TOF
MON	TIC	IF	BAUD	PURGE	TON
	SQN	ELSE	CALL	NUMBER	DIM
	BIT	ON	DATA	RENUM	DEF
FUNCTIONS	CRB	GOTO	READ	BOOT	NEW
ABS	CRF	GOSUB	RESTOR	GRAPH	END
ADR	MEM	POP	RETURN	TEXT	BIT
ASC	MWD	REM	STOP	PLOT	CRB
ATN	LEN	FOR	TIME	UNPLOT	CRF
SIN	MCH	NEXT	WAIT	COLOUR	MEM
COS	POS	ERROR	SAVE	CHAR	MWD
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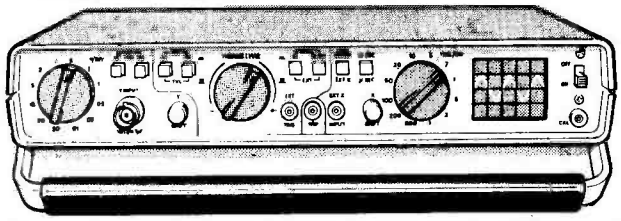
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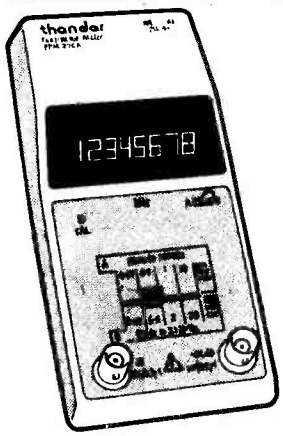
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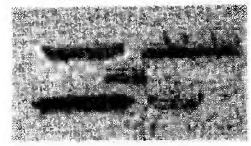
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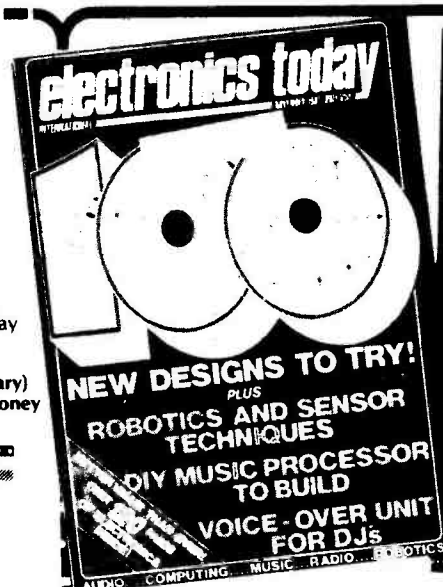
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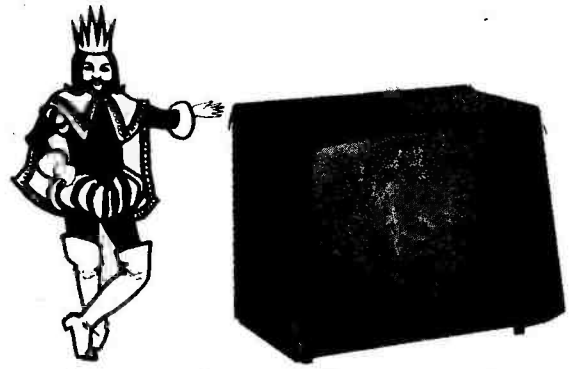
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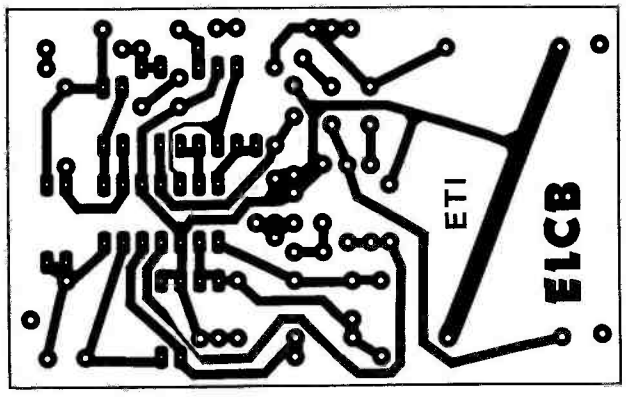
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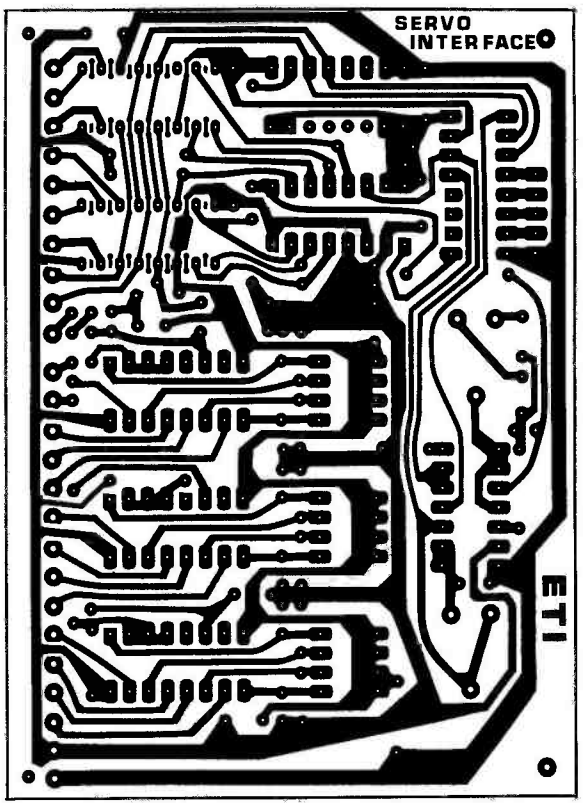
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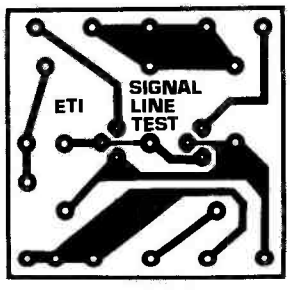
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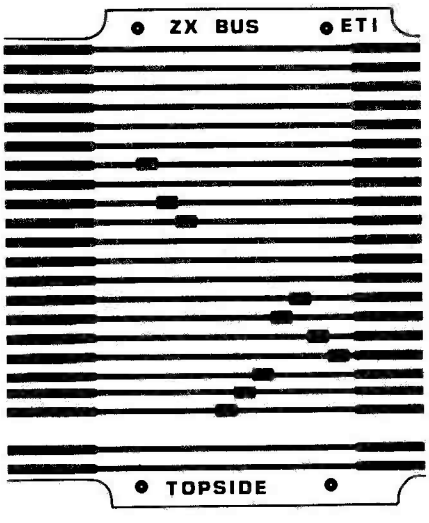
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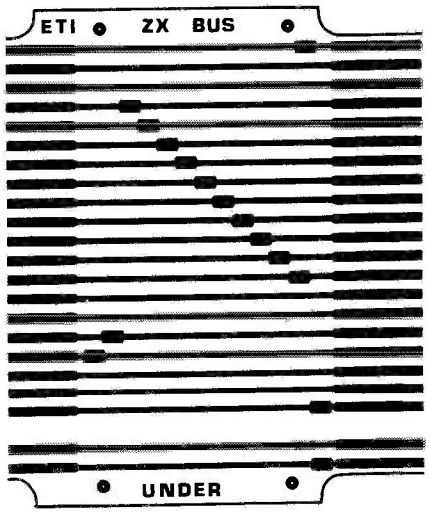
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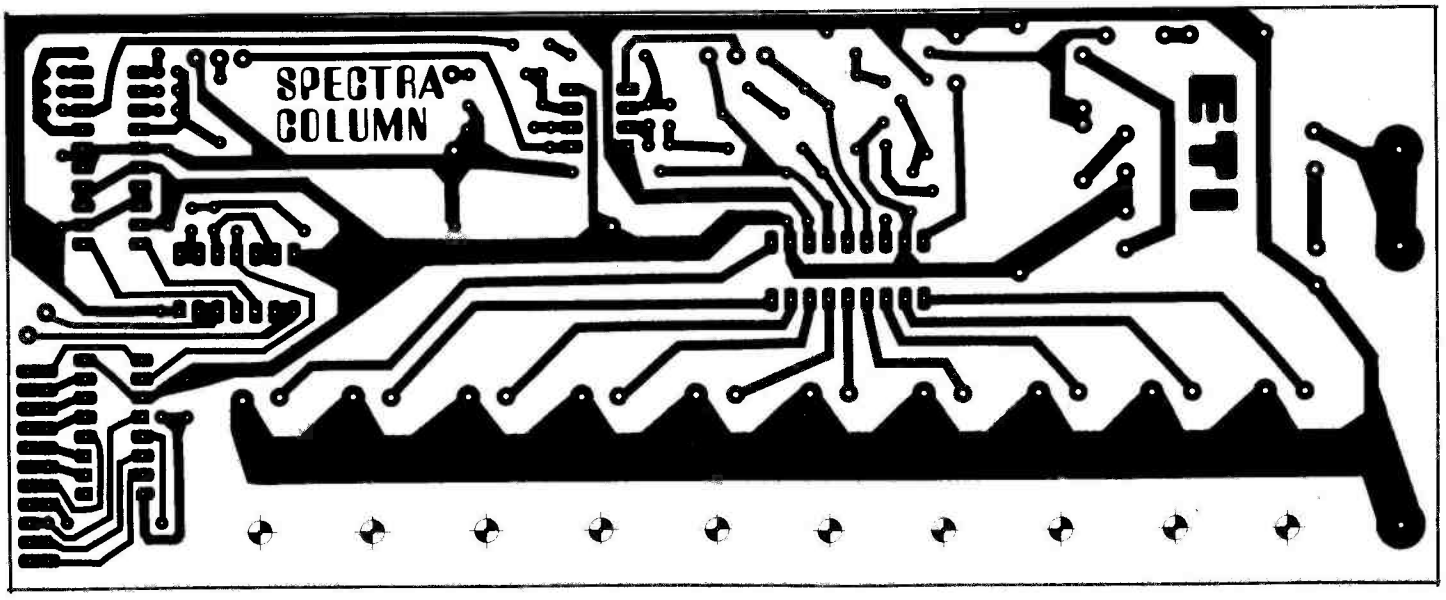












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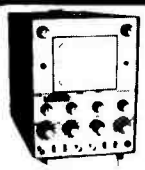
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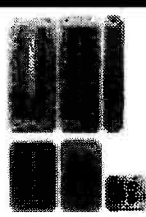
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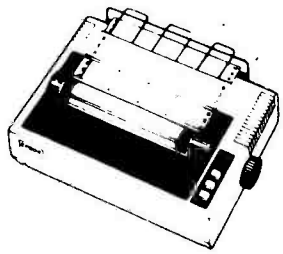
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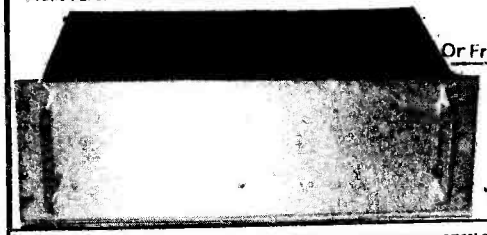
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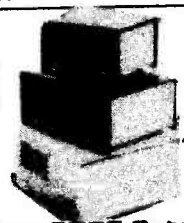
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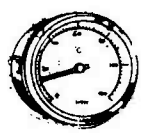
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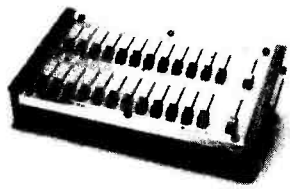
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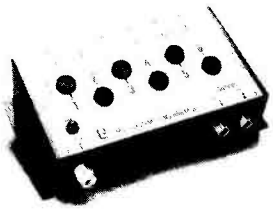
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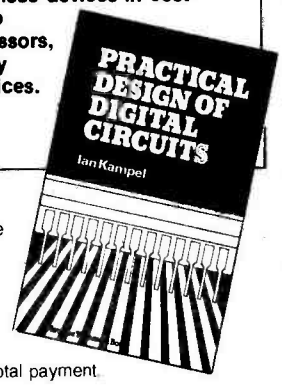
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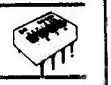
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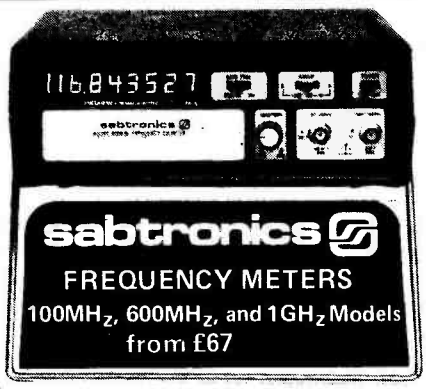
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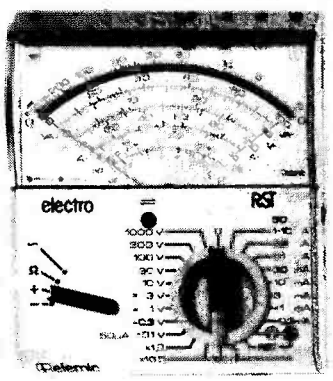
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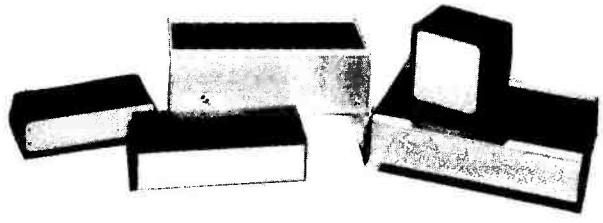
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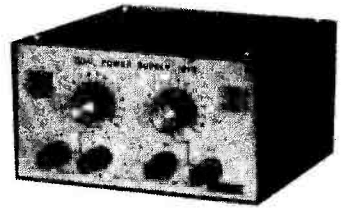
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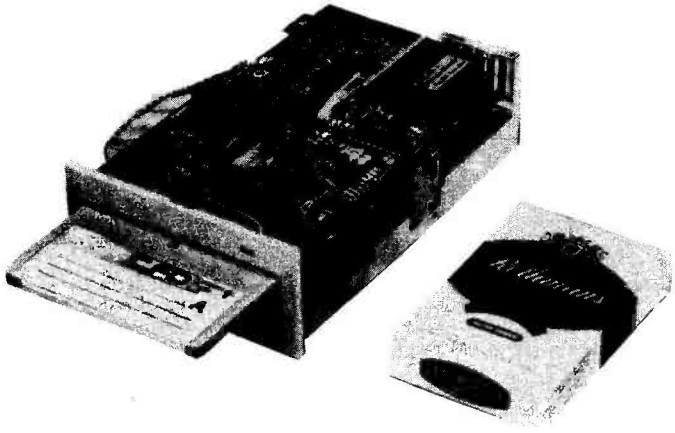
DIGEST

Will Industry Standardise on the 3" Floppy?

Hitachi think it will, and they have launched a new disc drive on to the UK market to cater for the projected demand. Their product is called the Model HFD 306S, and it's pretty small as you can see from the photograph. The recording speed, recording capacity per track and other specifications are claimed to be exactly similar to those of a standard 5¼" floppy disc driver, so that existing disc controllers can be used to handle it. Single and dual drive units will be available, and they will accept single or double density double-sided discs.

The disc itself will be housed in a rigid plastic case with a sliding metal shutter to protect it against contamination. While prices have yet to be decided, Hitachi say that both the drive units and the discs will be considerably cheaper than the 5¼" equivalents. How long this unit will take to find its way on to the hobbyist scene remains to be seen, but if it lives up to its maker's claims, we look forward to its arrival.

Meanwhile, four other manufacturers — Dysan, Tabor, Shugart and Verbatim — are trying to establish an industry standard for *three to four inch* discs. Their idea is to create a standard that will accommodate future technological advances rather than just accepting and standardising what is around at the time.



Pac-Man Champ

The Under-25 UK Pac-Man Champion, 16-year-old Craig Heap, with BBC TV presenter John Craven, and Pac-Man (he's the furry one), photographed at the National Finals of the UK Pac-Man Championship held at the Barbican Centre, London on 30 August 1982. Craig's winning score was 14,174.



Scope for a Multiplexer?

A multiplexing device which converts a general-purpose single- or dual-channel oscilloscope into an eight-channel instrument has been developed by GSC. The new Model 8001 multiplexer which functions in the same way as a simple logic analyser minus its memory, and allows simultaneous events on different channels to be compared and displayed in direct relationship to one another. The UK price is £225.

The instrument allows oscilloscope users to view events occurring synchronously or asynchronously, and the user can observe all eight channels at once or one of two 4-channel combinations. Details from Gobal Specialties Corp, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

Easy-To-Use Fuse

A new high performance, low profile fuse mounting system is now available from Littlefuse-Olvis. Designated OMNIBLOCK, the system provides fuse mountings for three different terminal styles, comprising solder type and quick connect blade type for 0.25" (6.35 mm) and 0.187" (4.78 mm) receptacles. These low height fuse mountings feature a one-piece, high amperage, self-aligning fuse clip/terminal design which eliminates resistance build-up and allows for operation at high current levels of up to 30 amps. They come in one through 12 pole units with individual pole barriers to prevent clip damage and provide electrical protection. Standard colour is grey but optional colours are available to special order including blue, green, red, white, black or yellow. In addition, two different style clip types can be supplied for circuit identity or polarisation as well as an anti-rotation boss device for single pole units only. For further information contact Littlefuse-Olvis, Crowther District 3, Washington, Tyne & Wear NE38 0AH.

Doctoring Your Memory

New from Dataman Designs is the Microdoctor; it can be plugged into your micro in place of the MPU (or clipped in over the MPU with the latter in DMA or RESET mode). The Microdoctor will 'look' around in address space, and report what it finds via the printer. Memory map, data tables, peripheral driving routines can all be located, and if your system is Z80-based, the disassembler can be used to check them. All form of memory, including dynamic RAM can be checked. The Microdoctor costs £295 plus VAT from Dataman Designs, Lombard House, Cornwall Road, Dorchester DT1 1RX, or from retailers.



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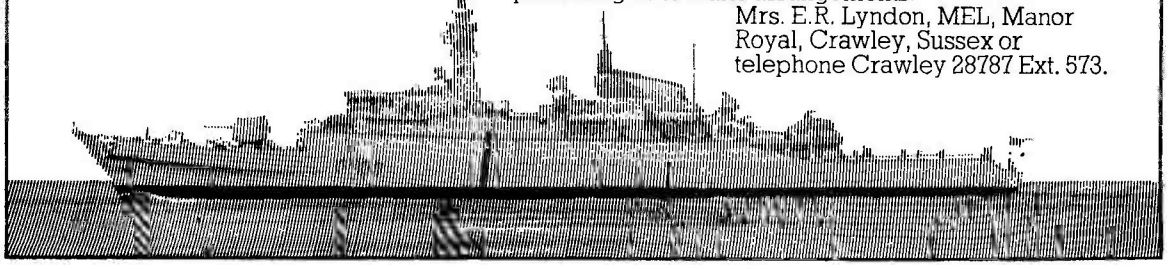
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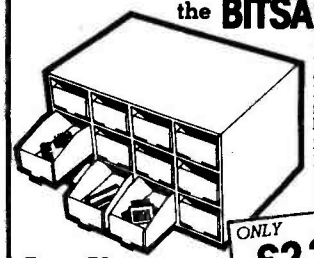
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Once again it's time to tread boldly into word-processor-land and sort out our year's offerings into alphabetical order. Everything we've done is listed (sometimes more than once under alternative names or alternative sections) with the exception of Digest (always up front), Foil Patterns (always up back) or Read/Write (why would you want to know where *that* was?)

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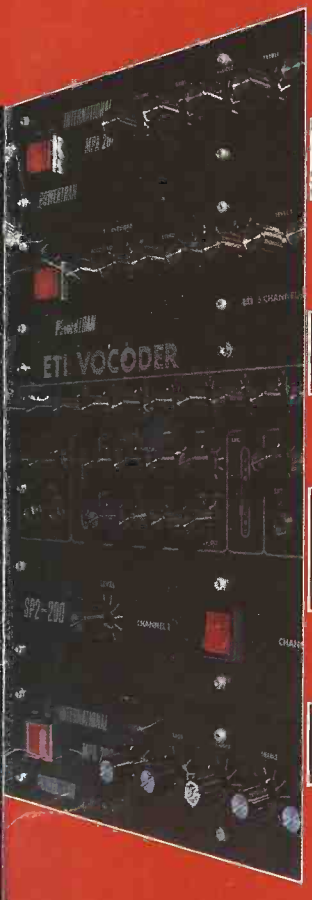
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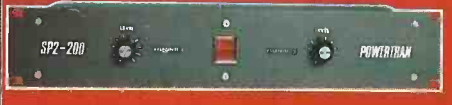
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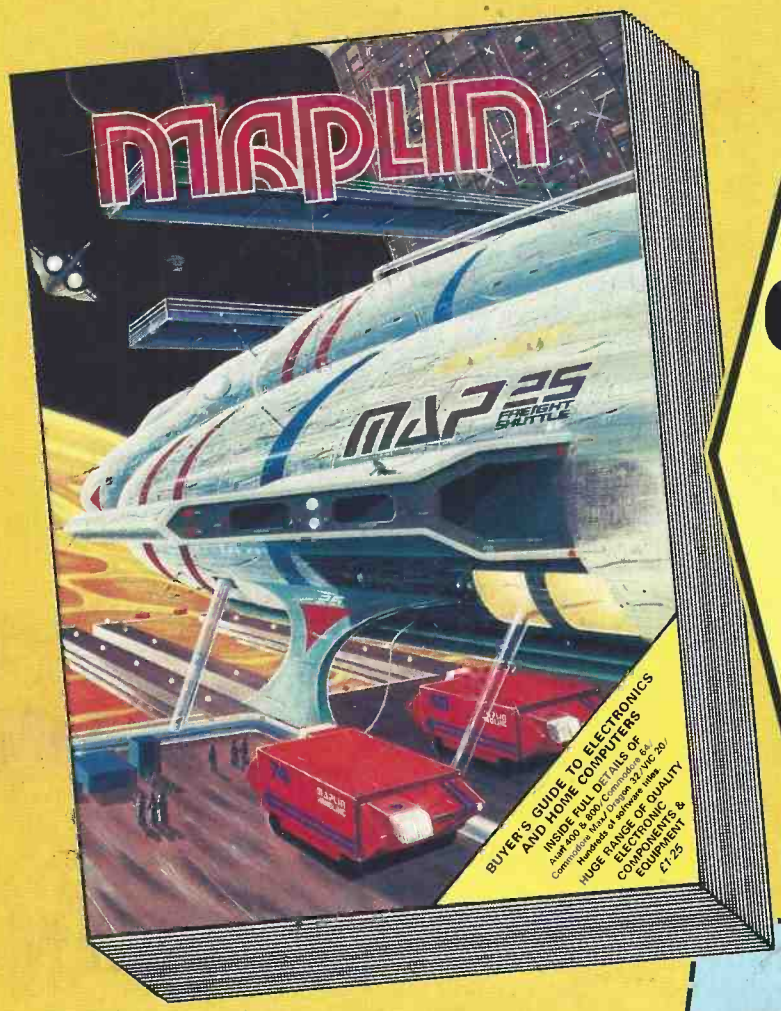


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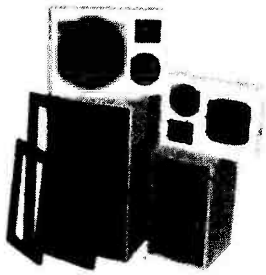
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MULLARD SPEAKER KITS

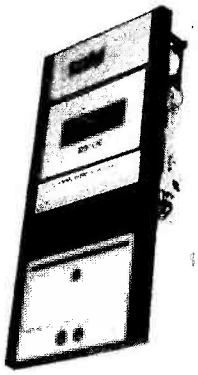


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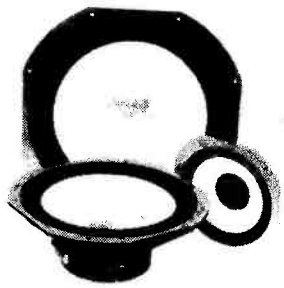
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6 piano type keys

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Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
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Specification and Price:



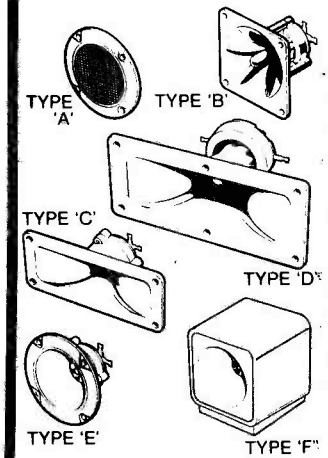
15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet. 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. **Price £32 each** £3.00 Packing and Carriage each.

12" 100 watt R.M.S. Impedance 8 ohm, 50 oz magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. **Price £23.70 each.** £3.00 Packing and Carriage each.

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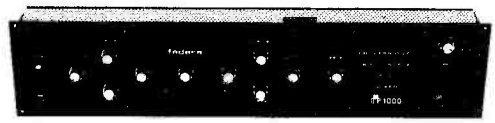
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P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
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Frequency Response: 20Hz — 25KHz ±3dB.
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500mV at 10K (OMP 100) 1V at 10K (OMP 300)
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Supply: 240V 50Hz
Sizes: OMP 100 360 x 115 x 72mm
OMP 300 460 x 153 x 66mm
Prices: OMP 100 **£31.50 each + £2.00 P&P**
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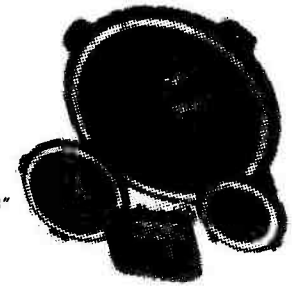
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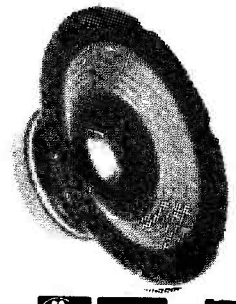
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Flashy New Portable

A new portable computer is being introduced into the UK by Epson, a Japanese manufacturer well known for its dot matrix printers and LCD displays. The computer, the HX 20, is designed to be used anywhere, anytime. About the size of an A4 notepad, it is claimed to offer computing power and capabilities comparable to many desk-top computers.

Language is an extended version of Microsoft BASIC, operating from a 32K RAM (expandable to 72K). Standard memory is 16K, expandable to 32K, but just under 4K is taken up by the operating system, leaving 12.6K and 28.6K respectively. Keyboard is full size ASCII-encoded, with 10 special function keys.

To those of you who remember as far back as October, the LCD display may look familiar. It can display four lines of 20 characters at any one time; however, there is a virtual screen area of 255 lines by 255 characters that the real screen can be used to window. There is scope for the use of a CRT as a monitor.

Finally, there are the integral micro-cassette tape deck and dot matrix printer — fairly standard items in themselves but useful to have on board. The whole system is powered by four nicads that give a total typical operating time of 40 hours, and are rechargeable from the household supply.

The HX 20 is expected to be hitting the shops around the new year at a cool £500 or so.

Shorts

● From November 1st, viewers in the LWT and Thames area will be able to receive a 100-page local teletext service. There are already local services operating in the STV and Channel areas.

● Just published by Northwood Books: Cipher Systems, the Protection of Communications, by Henry Becker and Fred Piper. It's all about cryptology, and no, you should be able to read ETI without it.

● Over fifteen million US homes will have roof-top direct broadcast satellite terminals by the end of the decade, predicts a report from International Resource Development Inc. The report goes on to say that the likely price will be $350–$500, and that only the largest equipment manufacturers will be able to compete at this cut-throat price.

● The dotty display (made by Epson) featured in Digest, October is available from Norbain Displays Ltd, Norbain House, Arkwright Road, Reading, Berks, RG2 0LT, and from Datac Ltd, Tudor Road, Altrincham, Cheshire WA14 5TN.

● While we're on the topic of Norbain, they tell us that they have started selling Vactec discrete phototransistors, photodarlingtons, and matched GaAs LED/sensor pairs.

● Sifam have launched a new range of test equipment including a low-cost DMM and a digital logic probe. Sifam Ltd, Woodland Road, Torquay, Devon TQ2 7AY.

● Ross Electronics, 49/53 Pancras Road, London NW1 2QB have just issued a new catalogue, containing their ranges of microphones, leads, intercoms, headphones, multimeters, cassette tapes and other goodies.

● Another new catalogue, this time from Draper Tools. At £6.50, it's a bit pricey for the hobbyist (the Ross cat is free).

● Why can't all suppliers make their catalogues free — there are even some people who think their's is a magazine, believe it or not. Luckily, Bernard Babani Ltd have resisted the urge to turn their catalogue into a book, even though they publish plenty of the latter in subjcts that would be of interest to ETI readers. Oh yes, the cat is free, from Bernard Babani Ltd, The Grampians, Shepherds Bush Road, London W6 7NF.

● Thandar have introduced a prescaler for use with the TF100 frequency meter. It will extend the upper frequency limit of the counter to 1 GHz. Called the TP1000, the unit costs £65 plus VAT.

● Philips have launched a twice-yearly magazine for business systems users; it's called 'Connections', but, so far as we can see, it doesn't have anything to do with either James Burke or John Julius Norwich.

● Crunchie bars to be computerised — official. Ferranti Computer Systems will be supplying the hard and software to monitor the production line of this computerised confectionery.

● Is electronics all hot air? Cooper Tools have just unveiled a new soldering or desoldering tool that uses hot air rather than a bit to heat the job. Cooper Tools Limited, Sedling Road, Wear, Washington, Tyne & Wear NE38 9BZ.

● NEC Electronics Ltd have developed a 1 megabit mask ROM; the device should be available in the UK this autumn.

● FREDs (fast recovery epitaxial diodes — bet it took quite a lot of head-scratching to think of a product with that acronym) are being produced by Siemens Ltd. Reverse recovery times are claimed to be better than 35 nS.

● Yet another catalogue, this time from Aries Electronics, Eastways, Witham, Essex, CM8 3YQ; this one's full of sockets and DIP switches and jumpers.

● British Telecom have placed a firm order for 8,600 Cardphones (the type that uses bits of plastic rather than real money). It seems that the old style of 'phones can't take the money off you fast enough .....

● Read/Write ROM? Surely some mistake? No, the unit in question is from Camel Products, and is a two kilobyte RAM with battery support (for when your computer is switched off) and function switches so that the memory can be written to, then further write operations locked out. The battery allows several years of data retention. It's available for £29.95 inclusive, from Cambridge Microelectronics Ltd, One Milton Road, Cambridge CB4 1YU.

Inexpensive 'Scope

A 5 MHz oscilloscope for £115.72 plus VAT? New, via Verospeed, from Trio is the CO-1303D with DC to 5 MHz bandwidth and a sensitivity of up to 10 mV per division. With direct access to the deflection plate terminals, the 'scope can be used at higher frequencies. There is also a 10 MHz dual-beam version at £249.65 plus VAT. Details from Verospeed, Stanstead Road, Boyatt Wood, Eastleigh, Hants SO5 4ZY.

Digital Noise Source

Using entirely digital techniques, the DNS03 digital noise source developed and manufactured by Marconi Space and Defence Systems produces a true random digital output. The device, produced as a metal case thick film hybrid measuring 1.3" × 1.0" × 0.2", is extremely versatile and is claimed to overcome the problems of existing noise-sources based on noise diodes.

The device will operate at any supply voltage between 4 volts and 15 volts and typical consumption at 5 volts is 2mA. A disable control reduces this consumption yet further permitting its use in battery powered equipments. The hybrid will operate over the full military temperature range of −40°C to 125°C. For further information contact: Marketing Department, Military Communications Division, Marconi Space and Defence Systems, Brown's Lane, The Airport, Portsmouth, Hampshire, PO3 5PH.

Computer Talk

Talking computers, what will they think of next? Using the Votrax SC-01 IC, the ADS Synthetalker is an IEEE 696/S-100 compatible speech synthesis board. Available from Appledore Electronics, you have the choice of bare board and IC, or kit, or fully assembled and tested versions. Details and data are available from Appledore Electronics (see ads index).

Another entry into this field is from DCP Microdevelopments Ltd, who have introduced a speech unit for the ZX81. Designated the DCP Speech Pack (hard to remember, that one), it plugs straight into the back like so many of the Sinclair add-ons, and costs a princely £49.95 including VAT and p&p. (A Spectrum adapter is available for £2.95.) DCP Microdevelopments Ltd, 2 Station Close, Lingwood, Norwich NR13 4AX.

(PS: Neither of these suppliers mention whether their units have an American or English accent!)

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Quite Dishy

A new small-dish aerial hoisted on to the roof of a British Telecom building in the City of London, will be the first to be shared between a number of users. The aerial and its associated equipment will be used in further trials of British Telecom's SatStream — a satellite-based X-Stream digital service which is to be offered to UK businessmen in 1984 to provide specialist private communications within the UK and to Europe. It will subsequently serve in this location as one of the first SatStream small-dish terminals in commercial service. SatStream will offer three main benefits to its users:

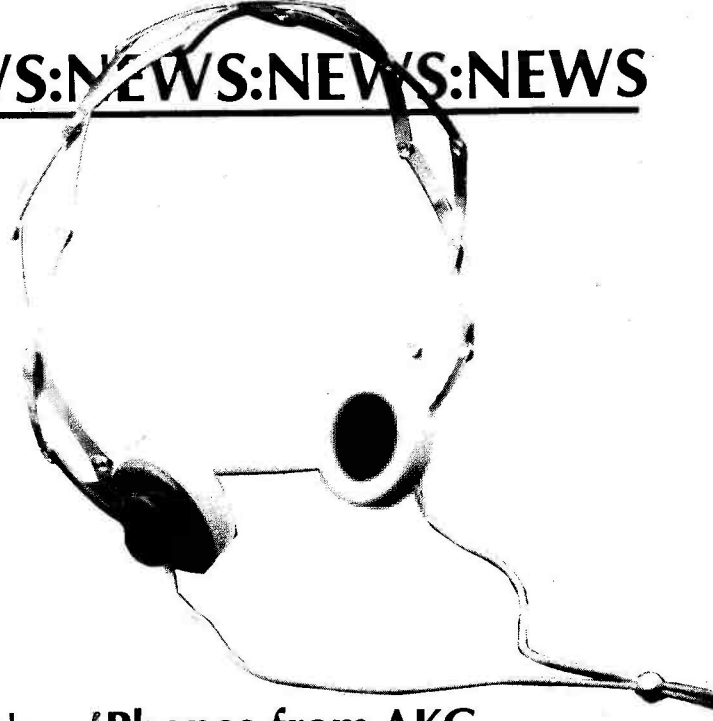
- flexibility: service can be introduced at very short notice and expanded or reconfigured equally quickly
- diversity: digital operation allows many different services, such as speech, telex, facsimile or data, to be integrated on the same transmission path while advanced services can be added quickly at comparatively little extra cost
- multi-destination broadcasting: of particular advantage for one-way information flow, such as news dissemination to branch offices for local distribution.

Trials of SatStream began last year with the aim of proving the service, and of creating a solid base of installation and operational experience on which British Telecom can draw when establishing a commercial service early in 1984. To provide such a service, small-dish aerials, from 3.7 to 5 m (12 to 17ft) in diameter, would be installed at rooftop level on or near customers' premises. While a single terminal may be dedicated solely for a particular customer's use, it is probably that in City centres where demand is likely to be concentrated they will be shared between several users. This would help to spread the cost.

The new 3.7 m aerial hoisted into position last weekend will provide British Telecom International — the division of British Telecom marketing SatStream — and its users with valuable first-hand experience of shared use. Trials are expected to start in a few weeks' time. The first organisations taking part will be mainly multinational, engaged in news disemination and in the oil and chemical industries. They will use the dish aerial simultaneously to communicate between offices in London and in other European cities. Experimental activities are likely to include video-conferencing and integration of a variety of services. Each user will have its own dedicated link to the aerial.

The trials will be conducted using Europe's orbital test satellite (OTS). When they are completed, the equipment will be modified to enable the aerial to work to one of the satellites to be used for commercial service — the European Communications Satellite (ECS) or Telecom 1, a French government project. It will then serve as one of SatStream's strategically located earth stations.

The first small-dish trials involved an international newspaper, providing a digital link used to transmit facsimile pages for printing its European edition. More recently small-dish terminals were installed at University College, London, and at Cambridge and Loughborough universities, for Project Universe, and experiment in computer communications by satellite.



New 'Phones from AKG

The 'phones pictured above are the K1 (yes, they really do fold up like pieces of garden trellis); they're claimed to give hi-fi performance and should sell for around £17.25 inc VAT. The K4 phones are the super-fi versions, and have a slightly more conventional headband. However, they'll set you back about £62. AKG Acoustics Limited, 191 The Vale, Acton W3 7QS.

First Plastic Packaged 10-Bit A/D Converter?

Ferranti Electronics has introduced the ZN432E — believed to be Europe's first 10-bit converters to not need a ceramic package, with the attendant expense of both ceramic and gold materials. Now Ferranti Electronics has developed a new moulded packaging technique which results in the price of the ZN432E being less than half that of its ceramic equivalent.

The ZN432E operates over the commercial temperature range (0-70°C) and is available in a 28-pin D.I.L. moulded package. A conversion time of 20μs is guaranteed, with no missing codes. The device is TTL/CMOS compatible and includes an on-chip 2.5 volt reference.

Full details of this and all of the Ferranti Electronics range of monolothic data converters can be obtained from the Publicity Department, Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham, Lancashire, OL9 8NP. Tel: (061) 624 0515.



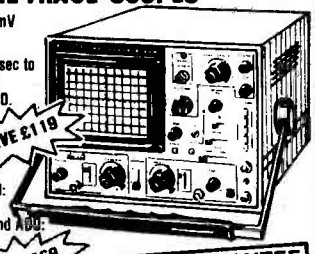
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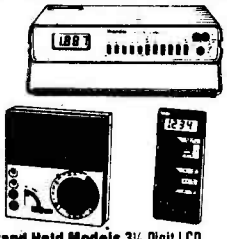
CS 1566A NOR. AUTO. VIDEO: 0.5μsec to 0.5 sec sweep: Modes CH1, CH2, ALT, CHOP and ADD:
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2 YEAR GUARANTEE

Optional probes – see below.

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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% (Paniec) £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 (Kaithley) £79.35
130 as model 129 but 0.5% basic (Also see above) £102.35
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TG100 1HZ - 100KHZ (THANDAR) £90.85
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PULSE
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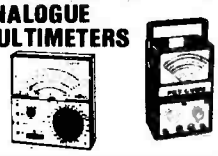
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ANALOGUE MULTIMETERS



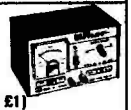
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HM307 Single trace 10MHZ 5mV:0.5 micro sec. Plus built in component tester 6 x 7 cm display (HAMEG) £158.70
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HM203/4. As above but 2mV + Algebraic add (HAMEG) £278.00
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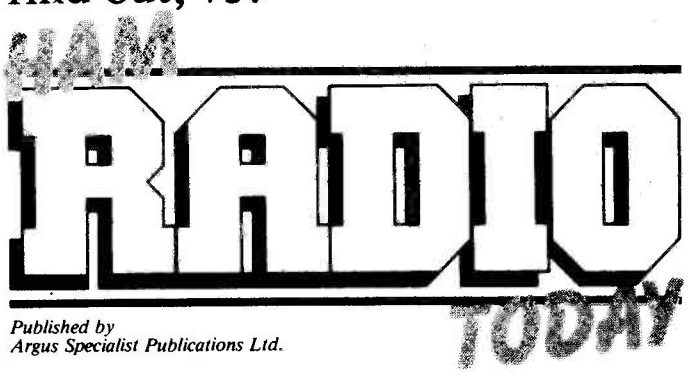
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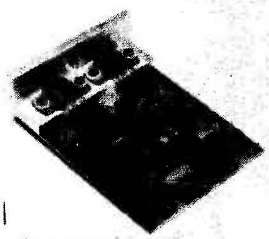
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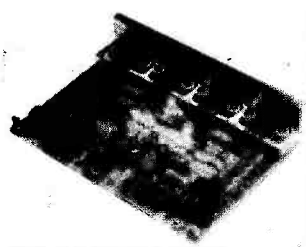
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THD (1KHz at 100W)	0.004% typ.
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Slew rate	>30 V/uS
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Rin	30K
Vs max	± 70V

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PFA100 120W into 8Ω



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PFA200 Specification

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Output power into 8Ω	150W (Vs ± 60V)
THD (20Hz-20KHz)	<0.005%
THD (1KHz at 150W)	0.002% typ
SNR	120dB
Slew rate	>30 V/uS
Gain	x 23
Rin	30K
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CE 3004	Power Amplifier Module	42.60	6.40	49.00	0.40
BD 1	Bridge Driver Module	7.13	1.07	8.20	0.06
TR 80	Toroidal Transformer 80VA	18.00	2.70	20.70	2.00
TR 150	Toroidal Transformer 150VA	20.07	3.01	23.08	2.35
TR 250	Toroidal TRansformer 250VA	25.43	3.81	29.24	3.35
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CPS 150D	Dual Power Supply	31.65	4.75	36.40	2.80
CPS 250	Power Supply	32.03	4.80	36.83	3.50
CPS 250D	Dual Power Supply	39.43	5.91	45.34	3.65
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HS 50	50mm Heatsink	1.60	0.24	1.84	0.15
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FM 1	Fan Mounted on 2 × HS 100	32.13	4.82	36.95	1.20
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4006	60p
4007	13p
4008	50p
4010	30p
4011	13p
4012	13p
4013	22p
4014	50p
4015	45p
4016	25p
4017	40p
4019	35p
4020	48p
4021	46p
4022	55p
4023	13p
4024	42p
4025	13p
4027	26p
4028	40p
4029	60p
4030	13p
4035	66p
4040	50p
4042	40p
4044	46p
4047	50p
4049	20p
4050	20p
4051	50p
4052	60p
4053	50p
4066	28p
4067	447p
4069	13p
4070	13p
4071	13p
4076	50p
4081	13p
4086	45p
4093	30p
4098	70p
4503	42p
4510	52p
4511	45p
4512	50p
4516	60p
4518	40p
4520	60p
4528	64p
4539	64p
4555	45p
4556	45p
40014	50p
40085	70p
40097	60p
40098	60p
40161	55p
40163	55p
40175	60p
40193	60p

TTL	
7400	13p
7401	13p
7402	13p
7403	13p
7404	13p
7405	14p
7406	20p
7407	24p
7408	14p
7409	14p
7410	14p
7411	14p
7412	18p
7413	22p
7414	26p
7416	18p
7417	22p
7420	15p
7421	20p
7425	20p
7426	27p
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7430	15p
7432	18p
7437	18p
7438	18p
7439	24p
7440	16p
7442	24p
7445	50p
7446	68p
7447	55p
7448	55p
7450	15p
7451	15p
7453	15p
7454	15p
7470	30p
7472	25p
7473	25p
7474	22p
7475	23p
7476	22p
7483	47p
7485	60p
7486	25p
7490	26p
7491	45p
7492	38p
7493	28p
7495	50p
7496	45p
74107	25p
74121	20p
74122	35p
74123	40p
74125	38p
74126	38p
74132	30p
74145	50p
74150	90p
74151	40p
74153	45p
74154	75p
74155	45p
74157	35p
74158	30p
74161	45p
74163	45p
74164	60p
74165	65p
74166	70p
74167	120p
74170	120p

TTL contd.	
74173	60p
74174	50p
74175	50p
74180	50p
74190	60p
74191	60p
74192	70p
74193	60p
74194	60p
74195	46p
74196	46p
74197	50p
74221	75p
74279	40p
74290	60p
74298	60p

TTL LS	
74LS00	14p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	14p
74LS05	14p
74LS08	14p
74LS09	14p
74LS10	14p
74LS11	14p
74LS13	21p
74LS14	21p
74LS15	14p
74LS20	14p
74LS21	14p
74LS26	14p
74LS27	14p
74LS28	22p
74LS30	14p
74LS32	14p
74LS33	14p
74LS37	19p
74LS38	14p
74LS40	19p
74LS42	40p
74LS47	44p
74LS48	44p
74LS51	14p
74LS54	14p
74LS74	18p
74LS83	42p
74LS86	14p
74LS90	30p
74LS92	30p
74LS93	30p
74LS95	40p
74LS109	40p
74LS112	30p
74LS113	30p
74LS125	28p
74LS126	28p
74LS132	40p
74LS133	25p
74LS136	20p
74LS138	30p
74LS139	30p
74LS151	40p
74LS153	40p
74LS155	45p
74LS156	45p
74LS157	30p
74LS158	30p
74LS160	35p
74LS161	35p

TTL LS contd.	
74LS162	35p
74LS163	35p
74LS164	45p
74LS165	50p
74LS168	60p
74LS169	60p
74LS170	70p
74LS173	40p
74LS174	45p
74LS175	45p
74LS181	110p
74LS190	45p
74LS191	45p
74LS192	45p
74LS193	45p
74LS194	50p
74LS196	35p
74LS197	50p
74LS240	70p
74LS241	70p
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74LS251	40p
74LS253	35p
74LS256	55p
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74LS266	22p
74LS273	60p
74LS279	40p
74LS283	40p
74LS290	34p
74LS293	34p
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74LS299	111p
74LS322	90p
74LS323	130p
74LS347	55p
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74LS373	75p
74LS374	75p
74LS375	40p
74LS377	70p
74LS378	60p
74LS379	60p
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TCA940	175p
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BZY88C12	8p
BZY88C15	8p
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BC107A/B	11p
BC108A/B/C	11p
BC109A/B/C	12p
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BC183	9p
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8CY70	17p
BCY71	18p
8CY72	18p
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THE ZOOM MICROPHONE

Zoom lenses have been around a long time and are standard issue on video cameras; but matching zoom microphones? How can such a thing be possible, you ask — and Vivian Capel answers.

Video sound is not much to write home about at present. This is because the track is recorded in linear fashion along one edge of the tape, unlike the video tracks which are laid down at a high writing speed diagonally across the tape by heads on a rotating drum. Slow tape speed means a low writing speed for the sound track, so it produces a poor frequency response and noise factor.

Efforts are being made to counter this, and there is a report that Sony have a prototype Beta recorder that modulates the sound on a low-frequency FM carrier and records it along with the video signal. As low recorded frequencies penetrate deeper into the tape coating, while high frequencies remain near the surface, the sound and vision recorded signals are physically separated and so do not interact. It seems that the existing audio linear track is retained so that the tapes will be compatible and will be playable on existing machines. There is little doubt that, not wanting to be outdone, the VHS camp will do something similar, so it looks as if video sound will be much improved in the new generation of machines.

Microphone Characteristics

All video cameras have zoom lenses and, to be realistic, the sound should change according to the lens setting. At the wide-angle setting, we should hear the general sounds of the surroundings, but at maximum telephoto, the ambient sound should diminish and the sounds originating in the field of view should stand out. As the lens zooms in, the transition should be gradual between the two different acoustics.

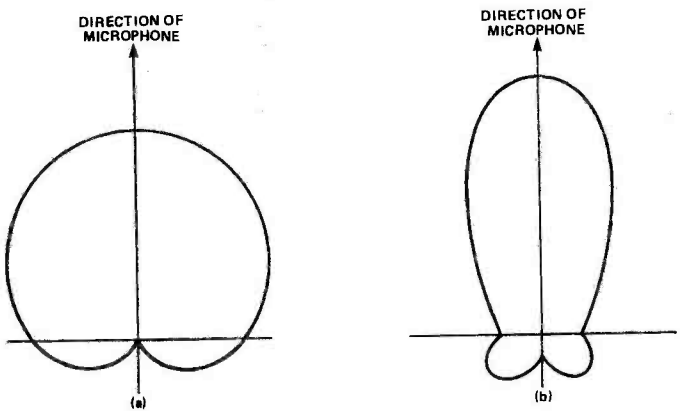


Fig. 1 Cardioid polar response (a) and super-directional response (b) obtained from a pair of out-of-phase cardioids. The response is at a nominal 1 kHz and changes for other frequencies.

In practice, nothing happens to the sound field at all, because the microphone is fixed to the camera and is not affected by anything done to the zoom lens. Professional camera teams overcome this by following the changes in the field of view with a microphone on a boom. Keeping the microphone out of camera shot is one of the ever-present problems.

Most video camera microphones are of the omni-directional type; they pick up sound equally from all directions. These are used because they are less prone to handling noise than the directional type, although the latter could be used to advantage if shock-proof mountings were employed.

To overcome the incongruity of a fixed sound acoustic at different zoom lens settings, JVC have produced a breakthrough in the field of microphone technology; a microphone that zooms with the lens and gives an appropriate acoustic for all settings. Before we can understand just how it works, we must consider the elements of microphone polar response.

Omniscient?

An omni-directional microphone has a diaphragm which is exposed to the environment at the front, but sealed at the back by an airtight chamber. Pressure fluctuations produced by the sound wave exert force in all directions (not merely along the axis of propagation) and this leads to pressure differences across the diaphragm that make it move backward or forward in sympathy, irrespective of the direction of the sound source.

Direct particle velocity, caused by the backward-and-forward movement of air molecules along the axis of propagation, has little effect on the diaphragm because of the damping effect of the trapped air. There is a small effect though, and this gives the omni microphone a not quite equal response all around it, but the deviation is small enough to ignore for most purposes.

The Heart of the Matter

If vents are made in the rear chamber, local air pressure can reach both sides of the diaphragm so the microphone is not pressure sensitive. However, the damping has been removed, so it is sensitive to particle velocity.

Also there is a secondary effect due to slight pressure differences that exist because of the phase difference between sounds arriving at the front and rear of the diaphragm. This is dependent on frequency, and when the physical path through the vents to the rear of the diaphragm equals a wavelength, there is pressure cancellation. At half a wavelength there is reinforcement,



This picture shows the MZ-500 zoom microphone attached to the JVC GX88E video camera. The mike also fits the GX77 and S100 cameras from the same company.

and below this the phase difference decreases all the way down. If the main force on the diaphragm were the pressure differences, as is sometimes erroneously stated, there would be a high peak in the treble frequency response with continual downward slope toward the bass.

Being sensitive to direct particle velocity yet relatively insensitive to pressure, the microphone responds in a directional fashion, favouring sounds coming from the front. The variation of output with angle of incidence, θ, is proportional to $1 + \cos \theta/2$; plotting a polar response curve gives a heart shape (Fig. 1a), hence the term *cardioid* which is used to describe microphones of this type.

If we were to place two cardioid units back-to-back we would have an omni-directional response. There seems little practical point in doing this, but as we shall see later, it does have an application.

Super Directivity

A marginal improvement in directivity can be obtained by modifying the vents to produce the hyper-cardioid, which has less response to sound from the sides, but a pair of small lobes with a high-ish response at the rear (Fig. 1b).

It is sometimes convenient to use a distance factor to describe directional microphones. This is the scaled distance from a wanted source at which the microphone will give the same results as an omni in terms of proportion of wanted to ambient sound. A cardioid can be placed 1.75 times further from the source than an omni, and a hypercardioid, two times.

For greater directivity, there is the gun microphone, which relies on interference and cancellation of sound waves coming from the sides. It is only effective down to the frequency at which a half-wavelength is equal to the length of the tube. Short tubes are not particularly directional other than at the high and mid-high frequencies, while long ones are unwieldy when fixed to a camera and could intrude on the camera shot. Distance factors of around three times are obtainable, depending on length.

1 – 1 = ?

Supposing we mount two cardioid capsules one behind the other and connect them in opposite phase. Sound waves coming from the sides affect both equally so their electrical signals cancel and there is no output.

For sounds arriving from the front, there is a phase delay between the outputs from the two units. When the microphone spacing is equal to a half wavelength, the outputs reinforce to produce a maximum signal. At shorter wavelengths (higher frequencies) the net output drops towards complete cancellation at a one wavelength spacing. At lower frequencies (longer wavelength), output slowly falls linearly to zero at zero frequency (see Fig. 2). This double microphone is super-directional with similar polar response to the gun and the net output varies as $(1 + \cos \theta) \cos \theta$. However there are two major snags. One is that the capsules must be closely spaced as this establishes the upper frequency limit above which the output drops rapidly. Moving-coil units are too bulky to get close enough, but electret capsules are quite suitable. Closely spaced anti-phase units, though, tend to give low output.

The other snag is the falling low-frequency response. This can be equalised electronically, but the amount of lift needed at the lower end will greatly emphasise thermal and handling noise.

Fiddling With Phase

However, it is possible to trade directivity for response at low frequencies. This would then be no worse than a gun microphone in which low frequency directivity reverts to just that of the cardioid unit at the bottom of the barrel. This can be done by combining the signals from the two capsules through a frequency-dependent phase-processor. At the highest frequencies, the units are in anti-phase and function as described to give maximum directivity. They continue in this fashion down to the mid-frequency range, when the phase begins to rotate until in the bass region the capsules are in phase.

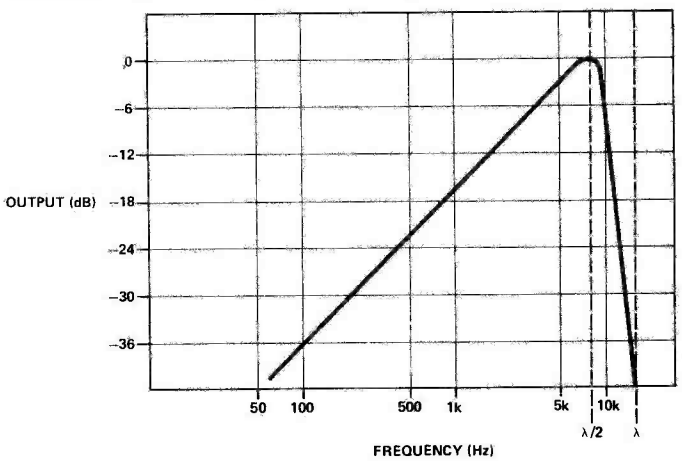


Fig. 2 The frequency response for a pair of out-of-phase cardioids (mounted in line) peaks at the frequency at which the half-wavelength equals the spacing between them. Below, it decreases at 6 dB/octave, requiring high gain at low frequencies to equalise. Above, the response drops rapidly to zero at the frequency corresponding to a one-wavelength spacing.

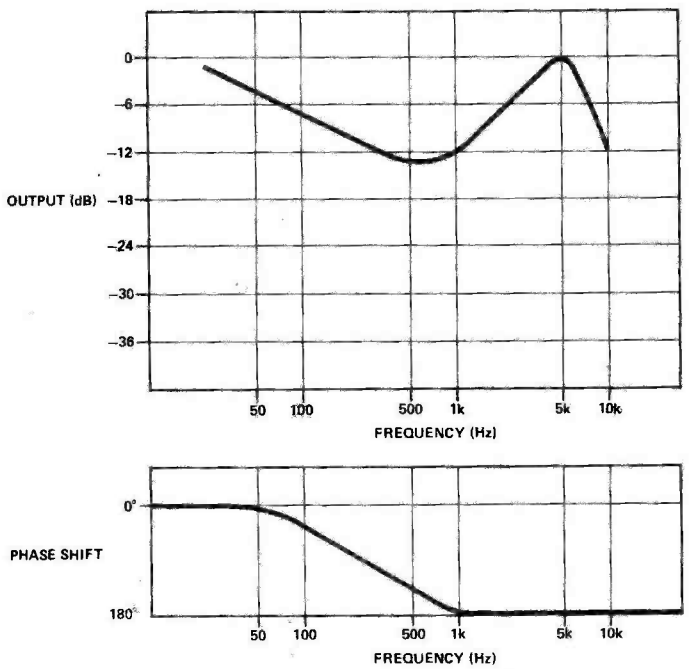


Fig. 3 The response of a cardioid pair when the phase is progressively rotated from 180° to 0° below the mid-range. The bottom chart shows the phase rotation.

Directivity is maintained down to the phase change point and then it degrades until it is that of a cardioid in the bass register. Figure 3 shows the frequency response, which falls from the treble to mid-range, then picks up to full amplitude again in the bass. The other graph indicates the phase change. This can be equalised without too much trouble, as no boost is required in the low frequencies, and so handling and thermal noise are not accentuated.

This principle is used by JVC, and the mid-frequency phase-change point is around 500 Hz. By using a potentiometer in the adding ciruit, the polar response can be continuously varied. When at maximum, both outputs are combined to give the super-directional characteristic; when turned fully down, the second capsule is off, and only the first works to give a normal cardioid response.

While this would give a useful acoustic variation, it is not enough for the purpose of changing to correspond with a wide change of zoom lens setting. Earlier, though, we saw how an omni pattern could be obtained by mounting two cardioids back-to-back. Hence in the JVC microphone, a third unit is introduced directly behind the second and facing forwards. Thus we have all the necessary elements for the maximum possible change in polar response, from omni right through to super-directional.

Control is effected by a pair of ganged potentiometers with centre taps, which neatly avoids the use of multiple-ganged components. The operation can be seen by reference to the circuit diagram (Fig. 4). To make life easier, we will consider the two extreme potentiometer positions, A and C, and the intermediate position B. At A, the adder receives the full output from the third capsule, and also that of capsule no. 2. Signals from capsule no. 1 pass through the opposite side of the pot to earth via the centre tap. With only capsules 2 and 3 'live', the result is the omni-directional response.

Moving to the B position, the wiper is earthed through the centre tap, so the adder never receives the output from capsules 1 or 3, leaving number 2 on its own to provide the cardioid pattern. In the position C, the adder receives output from capsules 1 and 2, which produces the super-directional characteristic.

In addition to changing the outputs between the three capsules, it is also necessary to vary the gain so that maximum gain is obtained for close-ups with the super-directional pattern, and to take the equaliser out of circuit for cardioid and omni operation. All this is done by the second potentiometer which is connected in a negative feedback loop across the preamplifier.

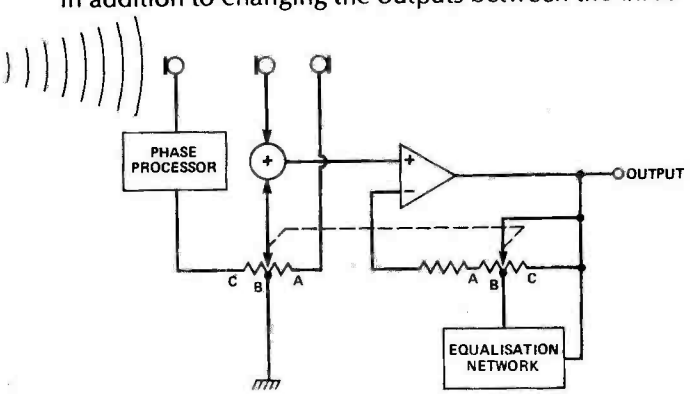
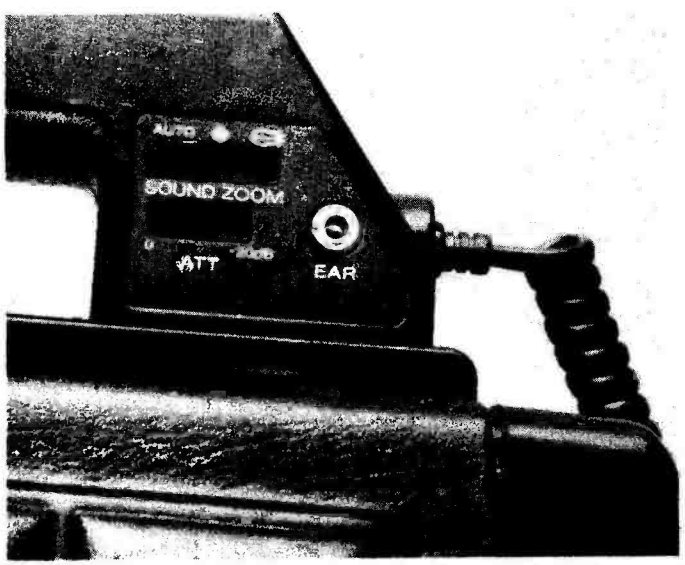


Fig. 4 Block diagram of the JVC zoom microphone.

In position A the potentiometer is shorted out and so is the equalisation network, so the amplifier is at minimum gain and the frequency response is flat: these are the conditions required for the omnidirectional operation. When in the central B setting, the gain is increased but the frequency response is still flat. When at the opposite extreme, position C, there is maximum resistance in the loop and hence minimum feedback and maximum gain. The equalisation network is now in circuit, so we have the required circuit conditions for the super-directional characteristic.

Of course there are an infinite number of intermediate positions afforded by the potentiometer, so an acoustic is obtained which is appropriate for all zoom lens settings. The control is linked to the lens control, so the setting is automatic and the user needs to give no thought to it.

The microphone described (type MZ-500) has been specifically designed for the S100 and GX77/88 colour cameras, but undoubtedly it, or future versions of the principle, will find an application in many audio fields where a continuously variable polar response between two extremes is required.



Close-up of the S100 camera controls, showing the auto, omni and super-directional settings.

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Games pack 7 (Life Forms, Ballistics, Snake) (AC113)	10.00
Games pack 8 (Stargate, Go Moku, Robots) (AC114)	10.00
Games pack 9 (Snapper, Babies, Minotaur) (AC115)	10.00
Games pack 11 (Missile base, Snooker Dominoes) (AC116)	10.00
Atom Adventures (Dungeon, Intergalactic House) (AC117)	10.00
Atom Chess (AC118)	10.00
Atom Calc (AC119)	34.00
Atom Lisp (AC120)	15.00
Lisp Theory & Practice (AC121)	8.00

ACORNSOFT FOR THE BBC MICROCOMPUTER

Graphs & charts on the BBC Micro (AC122)	7.50
Graphs & Charts Cassette (AC123)	7.50
Algebraic manipulation pk (AC124)	8.65
Forth on BBC Micro (AC125)	7.50
Forth pack (AC126)	14.65
Lisp on BBC Micro (AC127)	7.50
Lisp pack (AC128)	14.65
Games-Philosophers quest (AC129)	8.65
Games-Defender (AC130)	8.65
Games-Monster (AC131)	8.65
Games-Snapper (AC132)	8.65

NEW EPROM PROGRAMMER FOR BBC MICROCOMPUTER

- ★ Programs 2516, 2716, 2532, 2732 Industry Standard EPROMS
- ★ No external power supply required
- ★ Plugs straight into expansion socket
- ★ Easy to use
- ★ Includes all Software required

EPROM Programmer (Kit)	49.95
EPROM PROGRAMMER (Assembled)	57.95

ACORN & BBC MICRO COMPONENTS

2114 Low Power 200ns	0.80
4516/4816 100ns	2.99
6522	3.19
74LS244	0.59
74LS245	0.89
81LS97	0.90
DP8304	4.50
DS3691N	4.50
DS88LS120N	4.50
20 way Right Angle IDC Header	2.46
26 way Right Angle IDC Header	3.24
34 way Right Angle IDC Header	3.60
15 way Right Angle D SKT	3.50

NEW CATALOGUE NOW AVAILABLE
Please send **0.25** + SAE

SPECIAL OFFERS

Z80ACPU	3.45
6821	0.74
6522	3.19
UPD7002	4.35
DP8304	4.50

MEMORIES

2114 Low Power 200ns	0.80
2708 450ns	2.79
2716 450ns (+5V)	2.10
2716 350ns (+5V)	3.59
2716 450ns 3 Rail	5.95
2732 350ns	4.40
2732 450ns	3.75
2532 450ns	3.60
2564 450ns	9.99
2764 450ns	9.99
4116 150ns	1.10
4116 200ns	0.70
4118 150ns	3.39
4164 200ns T.I.	4.85
4164 200ns NEC	4.95
4516/4816 100ns	2.99
5516 250ns	9.38
6116 P3 150ns	3.85
6116 LP3 150ns	5.75

★ SPECIAL LOW PRICES FOR QUANTITIES ★

NEW JOYSTICKS AND CONTROLLER FOR ZX81 AND SPECTRUM

- ★ Controls 1 or 2 Joysticks
- ★ Fire Button FAcility (1 or 2)
- ★ Easy to use
- ★ Plugs straight into Expansion Slot
- ★ Edge Connector provided for RAM Pack Discs etc

Joystick Controler (kit)	19.95 ea
Joystick Controller (Assem)	24.95ea
Joysticks (uncased)	3.00ea
Fire Buttons (uncased)	1.80ea

(All Kits supplied with full assembly instructions)

NEW DATASHEETS & DATABOOKS

MEMORIES

2114	0.50
2708	1.10
2716	1.10
2716 3 rail	1.00
2732	1.40
6116	0.80
2532	0.90
4116	1.10
4118	0.90
4164 (TI)	1.60
4164 NEC	1.00
4816	0.90
5516	1.10

Z80 FAMILY

Z80 CPU	0.80
Z80CTC	0.80
Z80ADART	0.80
Z80ADMA	1.10
Z80PIO	0.90
Z80ASIO	2.00
MK3886	0.75

6500 FAMILY

6502	1.60
6520	0.65
6522	2.80
6532	1.10

8080 FAMILY

8085A	2.00
8251	2.40
8255	1.00

DATA CONVERTERS

ZN425	0.75
ZN427	0.75
ZN428	0.75
ZN432	0.75
ZN433	0.75
ZN447/8/9	0.75
UPD 7002	0.75

MISC. SUPPORT CHIPS

AY-3-1015	1.20
AY-3-1270	0.50
AY-3-8910	1.00
AY-5-1013	1.30
AY-5-3600	3.25
AY-5-2376	3.25
DP8304	0.85

6800 FAMILY

6800	4.50
6802	2.80
6803C	1.00
6809	3.50
6810	0.85
6821	1.50
6840	2.00
6845	2.80
6850	1.10
68488	1.50

UHF MODULATORS

UM1111	0.40
UM1233	0.40

FLOPPY DISC CONTROLLERS

FD1771	2.80
FD179X	3.00
WD2143	1.00
WD1691	1.10
WD Kits	5.10

MISC. SUPPORT CHIPS

MC1488	0.90
MC1489	0.90
MC3446	0.80
MC3448A	0.90
MC3480	2.20
MC3487	0.85
MC14411	0.85
RO-3-2513X	0.80

DVM CHIPS

	0.75

TI DATA BOOKS

Linear Control Circ. Voltage Regulators	4.00
	4.50
MOS/Memory Interface Circuits	3.85
	7.00
TTL 5th Edition	
	8.50
Bipolar Microcomp	
	4.50

TI POCKET GUIDES

TTL 1st Edition	3.50
Linear & Interface	2.50

Device	Price
Z80 FAMILY	
Z80CPU	2.95
Z80ACPU	3.45
Z80CTC	2.64
Z80ACTC	2.95
Z80ADART	5.70
Z80ADMA	11.95
Z80PIO	2.75
Z80APIO	2.95
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
6845	8.75
6850	1.40
6880	1.07
6887	0.80
68488	9.11
6875	5.82
6843	13.99
68B00	8.30
68B02	19.11
68B21	2.29
68B10	2.00
68B40	4.70
68B50	2.86
8500 FAMILY	
6502	3.45
6520	2.99
6522	3.19
6532	5.95
8080 FAMILY	
8085A	4.40
8212	1.55
8216	0.80
8251A	3.19
8255A	2.95
BUFFERS	
81LS95	0.90
81LS97	0.90
81LS98	0.90
8T26A	1.20
8T28A	1.20
8T95	1.35
8T97A	1.35
8T98	1.45
DATA CONVERTERS	
ZN425	3.45
ZN426	3.00
ZN427	5.99
ZN428	4.75
ZN429	2.10
ZN432	13.00
ZN433	25.00
ZN435	4.40
UPD7002	4.35
ZN447	72.9
ZN448	5.48
ZN449	2.55
ZN440	58.63
FLOPPY DISC CONTROLLERS	
ED1771	17.12
WD1391 KIT	45.50
WD1393 KIT	48.50
WD1395 KIT	45.50
WD1397 KIT (KITS INCLUDE FD179X + WD2143 + WD1691)	45.50
MISC SUPPORT CHIPS	
AY3-1015	2.99
AY3-1270	7.95
AY3-8910	5.99
AY5-1013	2.99
AY5-3600	7.95
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
R03-2513L	6.99
R03-2513U	6.99
6402	4.45
4702	7.45
7660	2.50
LF398N	5.50
NEW VOLTAGE REFERENCES	
ZN404 2.45V	0.49
ZN423 1.26V	1.00
ZN4588 2.45V	1.08
ZN Ref 025 2.49V	1.80
ZNRef 040 4.10V	1.80
ZNRef 062 6.17V	1.80
ZN Ref 100 1.96V	2.56
DVM CHIPS	
ZN450E	7.81
ZN450 KIT	17.35
LINEARS	
LM301AN	0.25
LM308N	0.80
LM311N	0.68
LM319N	2.14
LM324N	0.30
LM348N	0.50
LM555N	0.10
LM556CN	0.45
LM741 (8 PIN)	0.14
LM474CN	0.64
LM748 (8 PIN)	0.34
LM725CN	3.20
REGULATORS	
7805	0.30
7812	0.30
7815	0.30
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
LM309K	0.90
LM317K	3.20
LM323K	4.95
LM338K	POA
UHF MODULATORS	
6MHZ(UM1111)	3.70
8MHZ(UM1233)	4.40
CRYSTALS	
1MHZ	2.90
1.008MHZ	2.90
1.8432MHZ	2.20
2.4576MHZ	2.45
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	0.85
4007	0.15
4008	0.80
4009	0.34
4010	0.30
4011	0.11
4012	0.15
4013	0.24
4014	0.74
4015	0.49
4016	0.19
4017	0.37
4018	0.57
4019	0.41
4020	0.49
4021	0.80
4022	0.85
4023	0.15
4024	0.31
4025	0.15
4026	1.29
4027	0.23
4028	0.49
4031	1.69
4033	1.84
4034	1.90
4035	0.94
4040	0.49
4041	0.77
4042	0.44
4043	0.80
4044	0.84
4045	1.69
4046	0.84
4047	0.49
4048	0.54
4049	0.24
4050	0.24
4051	0.44
4052	0.50
4053	0.77
4054	0.84
4055	0.84
4060	0.50
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	0.84
4086	0.51
4093	0.25
4502	0.89
4507	0.38
4508	1.29
4510	0.45
4511	0.44
4512	0.49
4514	1.14
4515	1.14
4516	0.54
4518	0.39
4519	0.22
4520	0.49
4521	1.09
4522	1.24
4526	0.89
4527	0.84
4528	0.89
4532	0.89
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	0.80
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	0.30
136	0.23
138	0.27
139	0.29
145	0.70
148	0.80
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	0.30
165	0.54
166	0.83
173	0.54
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	0.85
242	0.84
243	0.84
244	0.59
245	0.80
247	0.40
248	0.40
249	0.68
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	0.54
377	0.99
378	0.45
379	0.85
386	0.34
390	0.49
393	0.41
629	1.21

DIL sockets low profile

Pins	Tin	Gold	W/W
8	7	22	25
14	9	29	35
16	9	31	35
18	13	33	52
20	14	35	60
22	17	40	70
24	19	42	79
28	25	54	80
40	29	81	99

DIL JUMPERS

Single ended 24"	
14 PIN	1.40
16 PIN	1.80
24 PIN	2.35
40 PIN	3.25
Double Ended 6"	
14 PIN	1.90
16 PIN	2.05
24 PIN	3.10
40 PIN	4.85
Double Ended 12"	
14 PIN	2.00
16 PIN	2.15
24 PIN	3.25
40 PIN	5.10
Double Ended 18"	
14 PIN	2.65
16 PIN	2.25
24 PIN	3.40
40 PIN	5.25

ZERO INSERTION FORCE SOCKETS

24 PIN	5.95
28 PIN	7.40
40 PIN	8.80

25 WAY 'D' CONNECTORS

MALE-MALE (36" CABLE)	10.15
MALE-FEMALE (36" CABLE)	10.13
MALE S ENDED (18" CABLE)	5.83
FEMALE S Ended (18" CABLE)	6.25

NEW IDC CONNECTORS

SHROUDED HEADERS (WITH EJECTORS) (Right Angle PCB MTG)

10 PIN	0.96
14 PIN	1.22
16 PIN	1.34
20 PIN	1.48
26 PIN	1.76
34 PIN	2.06
40 PIN	2.32
50 PIN	2.70
60 PIN	3.20

IDC Sockets inc 36" Ribbon Cable

10 PIN	1.40
14 PIN	1.82
16 PIN	2.10
20 PIN	2.46
26 PIN	3.24
34 PIN	3.90
40 PIN	4.90
50 PIN	5.48
60 PIN	6.36

NEW VIDEO MONITORS NEC GREEN SCREEN

9" and 12" — Tel. Sales Office for price and deal.

NEW CP INDUSTRIAL EPROM Programmers & Erasers

EP4000	545.00
P4000	645.00
UV141	78.50

24 Hour Telephone order service for credit card holders. All prices exclude VAT and carriage (0.75 on orders under £10 nett). Official orders from educational and governmental establishments, and public companies accepted. Credit accounts available to others (subject to status). All orders despatched on day of receipt. Out of stock items will follow on automatically at our discretion or a refund will be given if requested.
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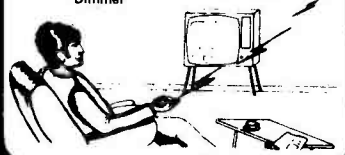
MIDWICH COMPUTER COMPANY LIMITED

DEPT ETI, RICKINGHALL HOUSE, RICKINGHALL, SUFFOLK IP22 1HH
TELEPHONE (0379) DISS 898751

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£4.20
TD300K	Touchdimmer	£7.00
TDE/K	Extension kit for 2-way switching for TD300K	£2.00
LD300K	Rotary Controlled Dimmer	£3.50



HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.

Order as XK112. £42.00

Additional Recievers XK111 £10.00

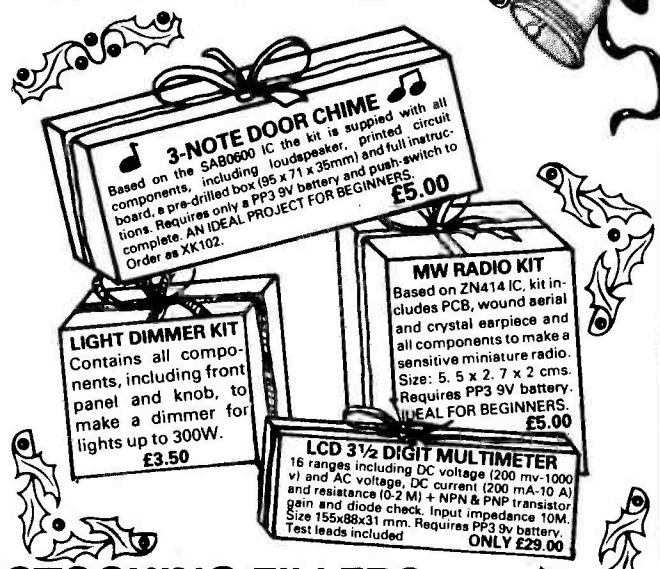
ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a pre-wired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied.

ONLY £10.50

Electric lock mechanism for use with latch locks and above kit £13.50

CHRISTMAS PRESENTS GALORE



STOCKING FILLERS

PACK (1) 650 Resistors 47 ohm to 10 Mohm - 10 per value £4.00
PACK (2) 40 x 16V Electrolytic Capacitors 10uF to 1000uF - 5 per value £3.25
PACK (3) 60 Polyester Capacitors 0.01 to 1 uF/250V - 5 per value £5.55
PACK (4) 45 Sub-miniature Presets 100 ohm to 1 Mohm - 5 per value £2.90
PACK (5) 30 Low Profile IC Sockets 8, 14 and 16 - pin - 10 off each £2.40
PACK (6) 25 Red LEDs (5mm dia.) £1.25
PACK (7) 20 BC182 NPN General Purpose Transistors £1.20
PACK (8) 20 BC212 PNP General Purpose Transistors £1.20

All full spec. branded devices

BUY ANY 5 PACKS AND WE WILL SEND YOU 10 RED LEDs FREE

ALL PRICES EXCLUDE VAT

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (–50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

DISCO LIGHTING KITS

DL 1000K

This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DLZ100K

A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum.

Optional opto input DLA1 Allowing audio ("beat") —light response. **Only £8.00**

DL3000K 60p

This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply & lamps. **Only £11.95** (1Kw/Channel)

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxillary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The Kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery **£4.20**

MK7 INFRA RED RECEIVER
Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. **£9.00** (RC500K –Special Price for MK6 and MK7 together **£12.50**

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms **£5.90**

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**

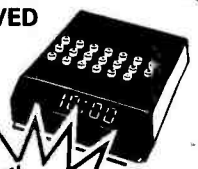
MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

THE MULTI-PURPOSE TIMER HAS ARRIVED

Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.



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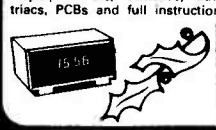
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EARTH LEAKAGE CIRCUIT BREAKER

Earth-fault currents from mains-operated equipment can kill you. Circuit breakers have featured in house-mains installations for some years: now this portable ELCB lets you take your protection anywhere. Design by Phil Walker.

If a fault occurs in a piece of mains-operated equipment, any external metal parts may be placed at earth potential. Should you complete a path to earth from the appliance, the statisticians could well be chalking up another death from electrocution. A more subtle but equally lethal danger is caused when inflammable material creates the path to earth — current flowing to ground might then generate enough heat to start a fire.

Even if no faults are present, building, servicing or tinkering with mains equipment is a dangerous pastime. One slip with a screwdriver . . . Our easy familiarity with electricity not only breeds contempt but a steady stream of fatalities. Many of these could be avoided if earth leakage circuit breakers were used more often (in an ideal world, of course, they'd be built into every piece of mains equipment by the manufacturer).



IMPORTANT!

Used properly, this project could help to make your home a safer place by providing added protection against electric shock. However, this doesn't mean that you can forget about all the precautions that you would normally take, because, like any piece of safety equipment, you shouldn't trust it to be your sole protection from the great hereafter. Belt and braces is the order of the day where human life is concerned! In any case, it won't protect you against shocks from most types of high-voltage generator or from a shock between live and neutral. Nevertheless, this device will considerably improve protection against the most common electric shock, from live to earth.

Your home may have ELCBs fitted at the fusebox, or you may have installed special ELCB sockets such as the MK Sentrysocket. But for portable protection and peace of mind, we've designed this earth leakage circuit breaker (or residual current device, as they're sometimes known), which can sense earth-leakage currents of about 25 mA and disconnect the mains within about 40 mS. The device relies on the fact that a fault current flowing to earth will cause a difference between the currents flowing in the live and neutral lines (Kirchhoff rules OK). The current difference is sensed and trips out a relay.

Standard Solution?

Curiously, we could find no legislation or regulations governing the specification of ELCBs in this country, despite calls to the British Safety Council, IEE, etc; although foreign standards *do* exist and provide a useful guideline. There is a British Standard in preparation, but it has yet to be made public. Hence our project has a disconnection time of less than 50 mS, and is built into a plastic box using nylon bolts so as to provide double insulation between the outside of the case and the circuitry.

The ELCB is designed to be plugged into a normal 13 A wall socket. Any normal household or small workshop device may then be plugged into the integral socket. The ELCB continuously monitors the current flowing to and from the device along the live and neutral wires; if at any time the amount of current flowing in these wires differs by more than a (small) pre-set amount, the ELCB will assume there is a fault and quickly disconnect the power from both lines. Thus any current flowing to earth (possibly via you) will trip the device, as will an

accident like running an electric mower over the power cable.

The particular method of fault detection we used ensures that the very hazardous condition of a person's body making contact between the mains supply and an independently earthed object can be acted upon immediately; it is also independent of the integrity of the mains earth supply at the normal outlet. The trip point of the device is set so that a net out-of-balance current of about 25 mA will trigger it.

The Current Transformer

The transformer used to sense the difference between the live and neutral currents, T1, can be made from a standard toroidal transformer with extra windings added, and what would normally be the primary used as the secondary. We used a miniature 10 VA transformer supplied by RS Components, but this type is potted, and to accommodate the extra windings we had to drill through the potting in the middle. A better approach would be to use a type that is taped, such as the OT 226 made by ILP. In any case, ILP products are more readily available to the home constructor.

With the transformer we used, we found that a primary consisting of a single pass of both mains input wires through the centre of the transformer was quite sufficient. What would normally be the 110 V primary winding was used as the secondary. (The mains input wires should be passed through in the same direction).

If you use the ILP transformer, two passes of the mains input wires may be necessary to achieve the required sensitivity (note that the transformer is operated as a current transformer and not a voltage transformer), as the OT 226 has only a 240 V primary. If you use a similar transformer with a 110 V primary, a single pass may be sufficient for the primary. **In any case, the test winding conductor must have the same number of turns as the other new primaries.** To find out if the transformer is working satisfactorially, follow the procedure given in the setting up section.

The transformer must be a toroidal type to avoid spurious tripping. We tried using the older laminated type, but we found that it was much too sensitive to fluctuations in the ambient magnetic field; obviously a severe disadvantage!

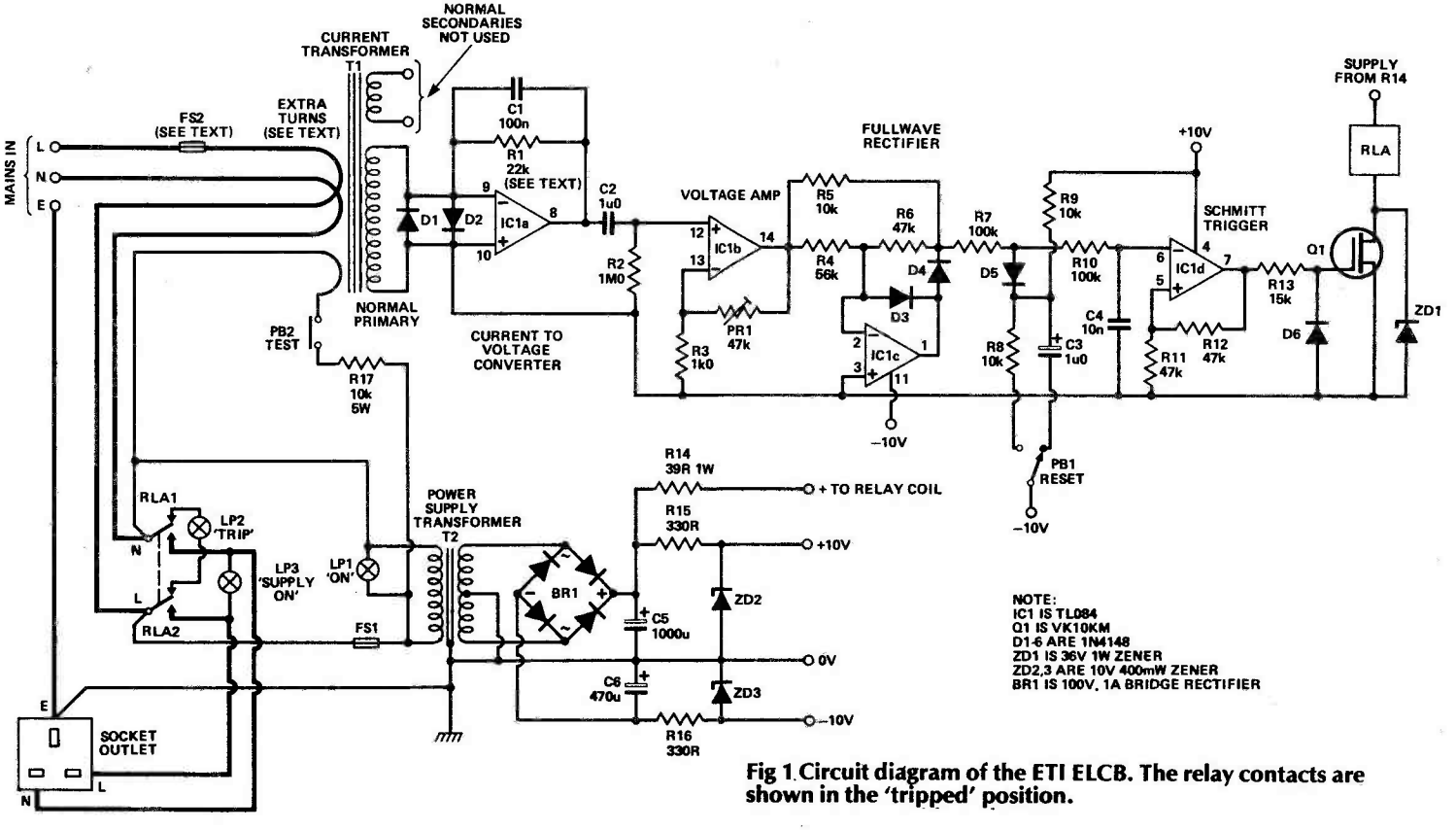


Fig 1. Circuit diagram of the ETI ELCB. The relay contacts are shown in the 'tripped' position.

The Relay

Because the relay is central to the operation of the ELCB, it is vital that it is of the highest quality. In particular, the relay drop-out time should be a maximum of 30 milliseconds, and together with a maximum possible delay of 10 milliseconds from the electronics, this will guarantee a maximum operating time of 40 miliseconds (two whole mains cycles). The current switching capacity of the relay should not be exceeded at any time, as this could damage the contacts and increase the switching time, so it's best to use a relay that is capable of switching the full 13 A maximum that you will ever draw from a socket. Alternatively, if you do use a relay with a lower current switching capacity, then we advise including a fuse in the current path, shown as FS2 in the circuit diagram. Apply a de-rating factor of at least 50% to inductive loads, eg electric motors: if you are using an electric drill with a 500 W motor, then the relay should be capable of switching at least 4 A.

Construction

Assembly of the PCB should be quite straightforward provided that component polarities are carefully observed. Before assembling it into the case, attach short lengths (about

HOW IT WORKS

The live and neutral mains wires from the mains supply pass through the centre of the current transformer T1 (twice — see later) in the same direction to form the primary. As the current flow through these wires is in opposition, the net current in T1 primary is zero under normal conditions. Any unbalance in these currents caused by a fault condition will result in a current lowing in the secondary side (the original primary) of T1.

By normal op-amp action in IC1a, the output of IC1a will change in voltage in such a way that all the current will be shunted away via R1 and C1 and the voltage at the inverting input will remain constant. This is equivalent to a very low resistance across the output of T1, and sets up the correct conditions for current transformer operation. D1 and D2 are present purely to prevent damage from very large currents that might be caused by a short circuit, for example. The output of IC1a is a voltage which is proportional to the input current, and this is further amplified by IC1b before being full-wave rectified in IC1c.

When the input to IC1c via R4 is positive the output of IC1c will be negative, D4 will be non-conductive and the inverting input of IC1c will be 0 V due to op-amp action via D3. The output from this part of the circuit (junctions of R5, R6, R7, D4) will be positive.

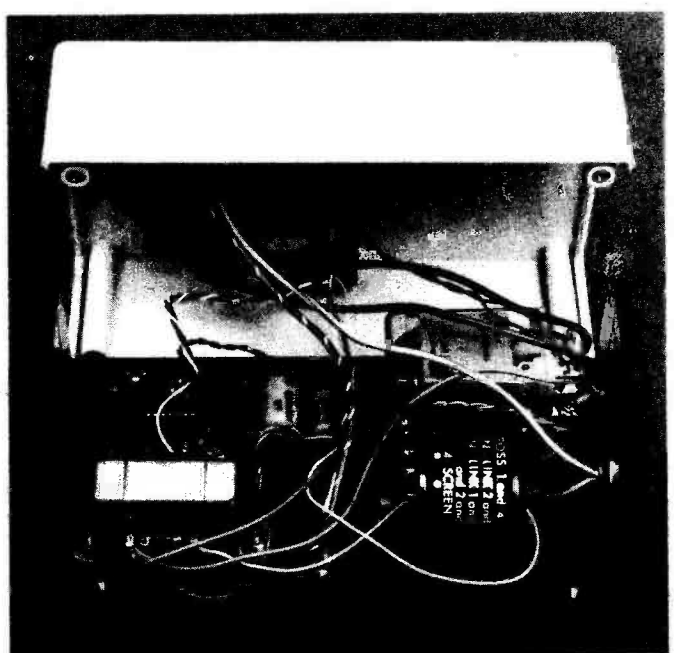
When the input to IC1c is negative the output of IC1c will be positive, D3 is now non-conducting and the inverting input of IC1c will again be held at 0 V, but this time via R5 and R6: the output from the circuit will again be positive. The values of R4, 5 and 6 are chosen to give approximately equal response for positive and negative inputs.

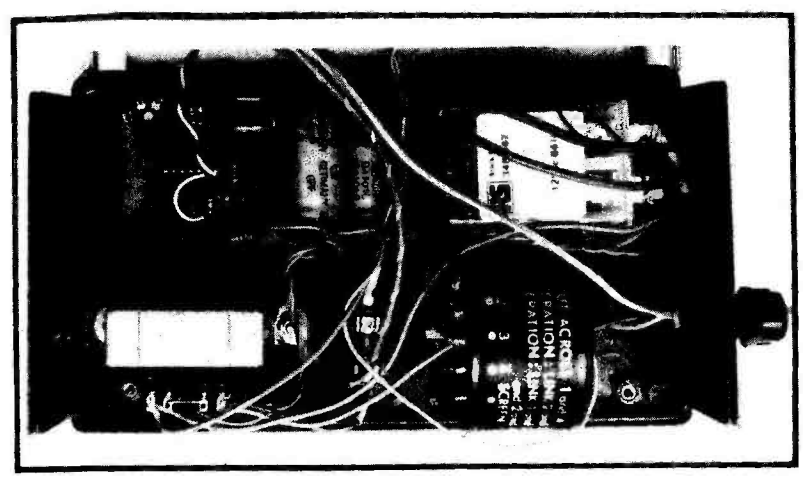
The output from the rectifier circuit passes via R7 and R10 to the inverting input of IC1d. This section of IC1 is connected as a Schmitt trigger. Its function is to stay in one of two states until the input reaches a voltage level sufficient to change it to the other.

At switch-on, if PB1 is operated, C3 (via D5 and R8) holds the input to IC1d low and sets it to the 'on' state. C3 then charges via R9 and will have no further effect until PB1 is operated or the unit switched off and on again. If at any time the output of the rectifier circuit goes positive enough, IC1d output will change to the 'off' state and stay there until it is reset or the whole unit is disconnected from the mains and reconnected again. The output of IC1d drives Q1 via R13 and D6. These latter components are present to prevent damage to the gate of Q1, from positive and negative voltages. Q1 is a MOS device which has a resistance as low as 5 ohms when fully on. This activates the relay via R14 from the raw supply rail.

The transient voltage spike, which occurs when the relay is switched off, is absorbed by ZD1. This is somewhat different to the normal mode of diode suppression but has the advantage that the flux in the relay core will collapse more rapidly and speed up release, as there is a higher voltage across the coil than would be the case with a simple diode.

The power supply circuitry is straightforward. T2 is a normal mains transformer giving 12-0-12 V AC output. This is rectified by BR1 and smoothed by C5 and C6. The voltages across C5 and C6 are about 18 V and this is regulated to give +10 V and −10 V supplies for the quad op-amp, IC1. R14 provides power to the relay coil and is present to drop some of the difference between the 18 V on C5 and the 12 V required by the relay.





At left and above are two internal views of the Earth Leakage Circuit Breaker. With two transformers and a power relay, things are a bit cramped so take care when wiring up. The toroidal current transformer is mounted on its side at the right of the case: the power supply transformer is on the left. The mains fuse, FS1 is fixed between the transformers, while the test resistor R17 is mounted directly between PB2 and the outlet socket.

15 cm) of thin flexible wire to connect to the transformer, relay coil, reset switch and current transformer.

Before fitting the relay into the box base, it will be helpful to attach some thick wires to the normally-open relay contacts to take the output current to the socket outlet, and also some thinner wires to the same point to supply the power transformer. The PCB, relay, power transformer and current transformer can now be fitted into the bottom of the case and wired up. The mains input should enter the box through a suitable sized cable gland; pass the live and neutral conductors immediately through the centre of the current transformer before connecting them to the pole contacts of the relay.

Be sure to use sufficiently thick mains flex for the wiring: for 13 A capability, this means 1.5 mm^2 flex (1.0 mm^2 for up to 10 A). Pass an extra piece of thin flex through the centre of the current transformer for use as a test conductor. One end of this wire should be connected to the live side of the power supply transformer, together with the wire from one side of FS1; the other side of the fuse should be connected to the live pole of the relay. The other side of the transformer primary should be connected to the neutral pole of the relay.

At this stage the components can be mounted into the lid of the

BUYLINES

The transformer used for T1 is not an ILP standard component, so you have to be specific when ordering. Ask for the OT 226, 12 V + 12 V secondary, 240 V primary, taped finish (not potted). We suggest you ring ILP for the exact price; their address and phone number can be found in their ads elsewhere in this issue. The case we used is available from West Hyde, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks. The PCB Service order form is on page 99.

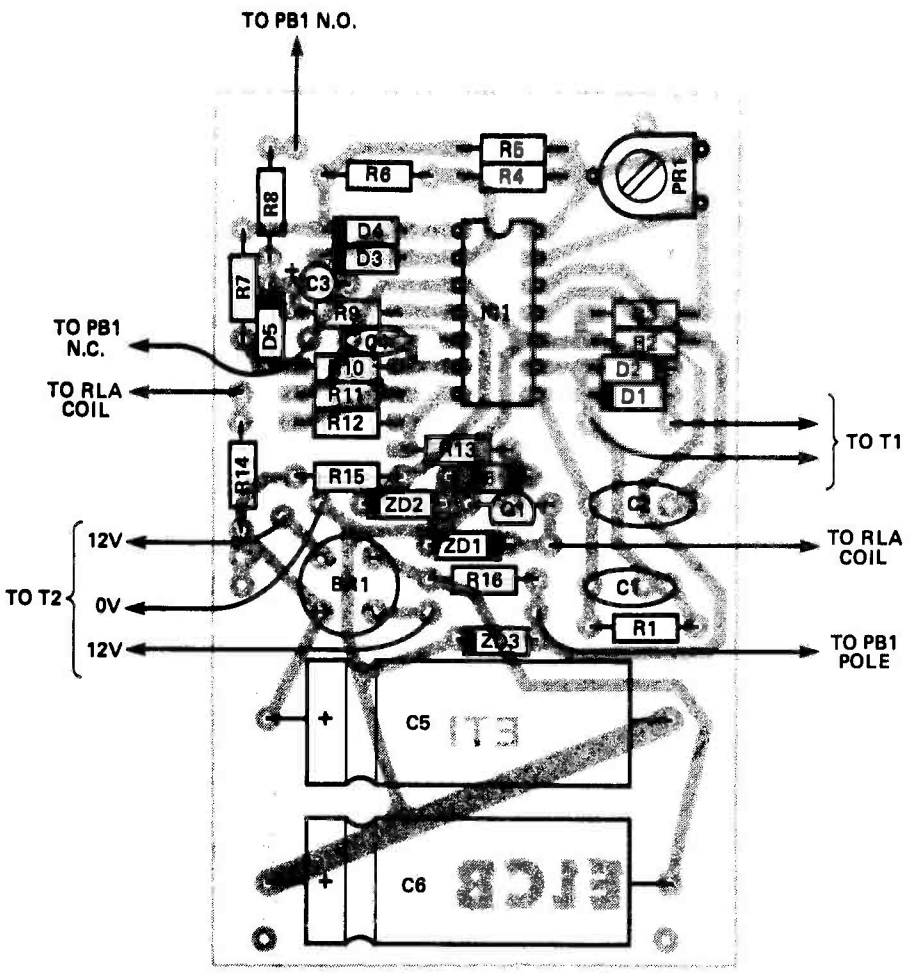


Fig. 2 Component overlay for the ELCB.

PARTS LIST

Resistors (all ¼W, 5%, except where stated)	
R1	22k (see text)
R2	1M0
R3	1k0
R4	56k
R5, 8, 9	10k
R6, 11, 12	47k
R7, 10	100k
R13	15k
R14	39R 1 W (or four 150R ¼W in parallel)
R15, 16	330R
R17	10k 5 W wirewound
Potentiometer	
PR1	47k miniature horizontal preset
Capacitors	
C1	100n miniature ceramic
C2	1u0 miniature polycarbonate
C3	1u0 35 V tantalum bead
C4	10n miniature ceramic
C5	1000u 40 V axial electrolytic
C6	470u 40 V axial electrolytic
Semiconductors	
IC1	TL084
Q1	VN10KM
D1-6	1N4148
ZD1	36 V 1 W zener
ZD2, 3	10 V 400 mW zener
BR1	100 V, 1 A miniature potted bridge rectifier
Miscellaneous	
T1	toroidal mains transformer with extra windings (see text)
T2	12-0-12 6 VA transformer
PB1	one-pole changeover momentary action push-button
PB2	one-pole push-to-make momentary-action push-button
FS1	250 mA 20 mm fuse and chassis-mounting fuseholder
RLA	two-pole relay, 12 V coil, contacts rated at 250 V, 10 or 20 amps (see text)
LP1	amber mains neon (panel-mounting)
LP2	red mains neon (panel-mounting)
LP3	green mains neon (panel-mounting)

PCB (see Buylines): flush-mounting mains wall outlet socket; cable gland to suit mains cable; case, West Hyde BOC 450 (188 × 110 × 70 mm), nylon bolts, wire, cable ties, hardware etc.

box. This must be done with some care to avoid fouling the components in the bottom of the box. In our device the normally-closed contacts of the relay were accessible when it was in the box and connecting the wires for the red neon was easily done. The free end of the test conductor is connected together with one of the wires from the yellow neon to the test switch (which is normally open). The 10k test resistor is fitted to the other side of the test switch. In our model this resistor is self-supporting between the switch and an insulated terminal. The other wire from the yellow neon, together with a wire from the neutral side of the power transformer, is connected to this terminal.

The wires to the reset switch can now be attached, making sure that the normally-closed terminal goes to the negative supply on the PCB, the normally-open terminal goes to the resistor and the pole goes to the capacitor.

Finally the thick output wires can be fitted into the outlet, together with the wires from the green neon. The earth conductor from the input cable is taken direct to the earth contact on the outlet and an extra wire then goes from here to the power transformer frame and to the centre tap on its secondary winding.

With a bit of luck it should now be possible to fit the box lid and base together and secure them with the bolts provided.

Setting Up

Once the device has been assembled there is very little more to be done. It should be possible to adjust PR1 so that when the TEST button is pressed the relay immediately opens. If this cannot be set up or if there is very little adjustment to spare on PR1, then to increase the sensitivity R1 may be increased in value: conversely, reduce it to reduce the sensitivity. If the sensitivity is still low when R1 is up to 47k then take the mains (and test) wires through the centre of T1 twice instead of once.

Once this has been done the device is set up to trip at about 24 mA. Note that it responds only to the out-of-balance current flowing through T1 on the mains wires and will not protect against contacts between live and neutral which result in balanced currents.

If you want to test the device we recommend that you use another 10k resistor and NOT YOURSELF . . . **ETI**

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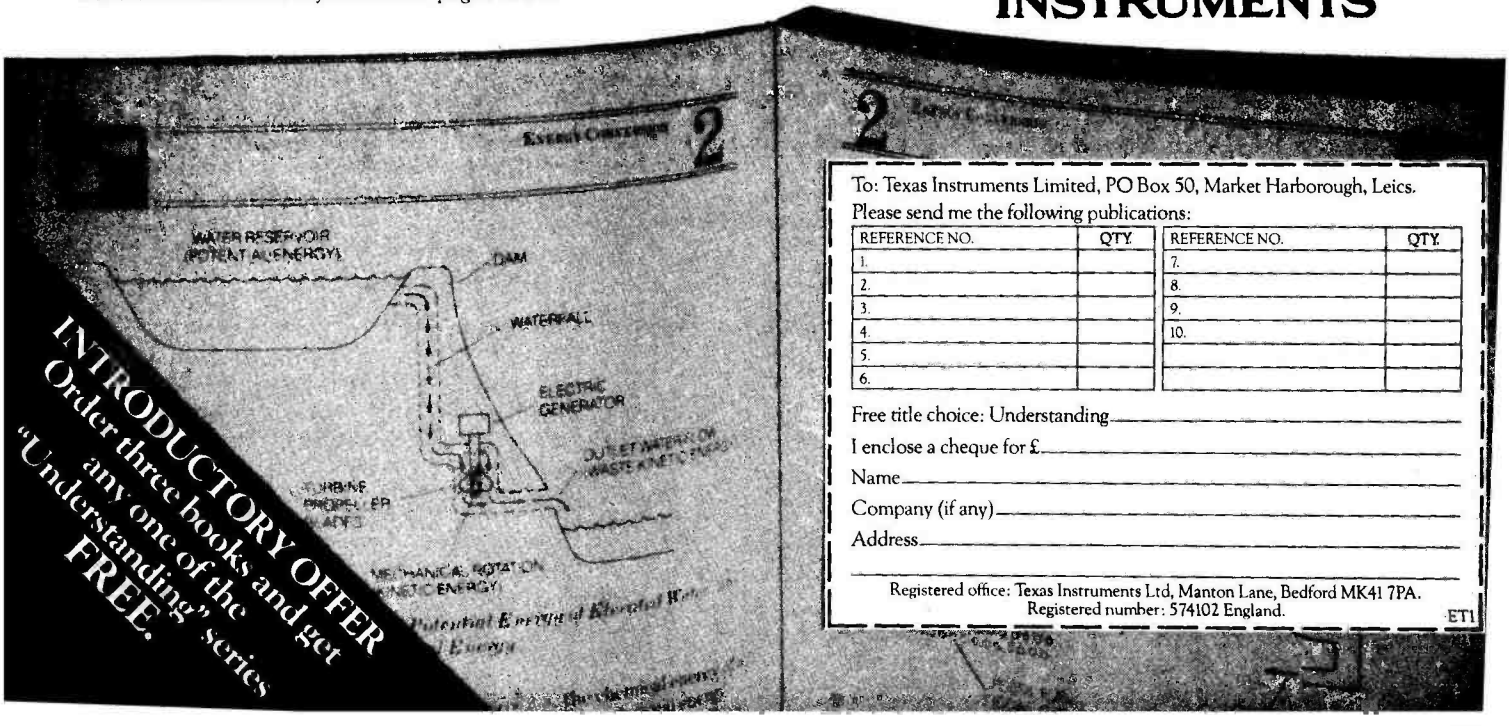
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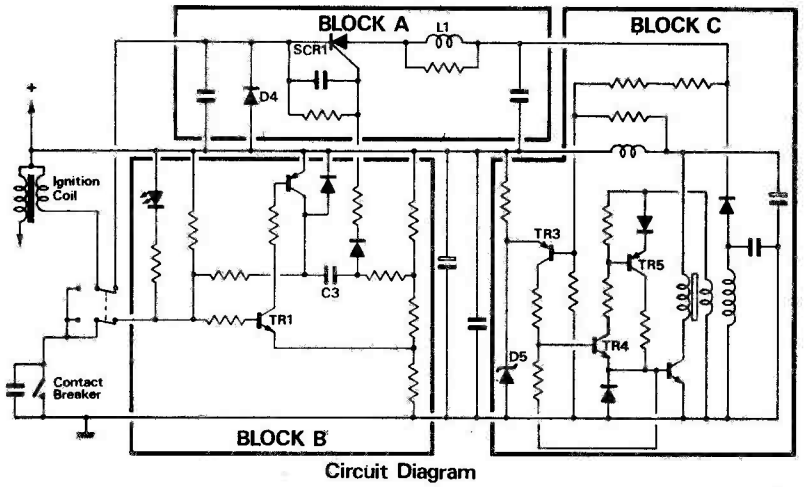
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Circuit Diagram

The discharge circuit in block A is the heart of the system. It looks simple but outperforms any other by far. A 2 µF storage capacitor (twice the usual size) charged to + 370 volts, is discharged into the ignition coil primary by SCR1, providing a high energy pulse of the correct polarity. Long after the storage capacitor is discharged, the current in the ignition coil is sustained by 'flywheel' diode D4, preventing energy flowing back to the capacitor and giving 3½ times the spark energy and duration. Instead of relying on the effects of coil 'ringing', inductor L1 commutates the SCR, giving complete freedom from the usual latching problems and allowing the storage capacitor to be recharged whilst the discharge current is still flowing in the coil.

Block B is the trigger circuit and provides faultless spark timing. The emitter of TR1 is biased from the supply to provide a variable trigger threshold, allowing triggering with the supply down to about 3.5 volts but rejecting noise and signals from contact shuffle and vibration. Capacitor C3 and its associated resistors provide a variable inhibit period, after the contacts close, which filters out extreme contact bounce on 4 cylinder engines yet still allows 8 cylinder operation to over 7500 rev/min. In effect the longer the contacts stay open the longer they must remain closed before the next spark can be triggered. (Be warned:- untimed sparks can seriously damage your engines health).

Block C is the inverter, the power behind the spark. It's a 'ringing choke' type. Well designed, this type can not only be regulated and charge the capacitor from zero volts, effectively a short circuit, but is also more efficient than the traditional push-pull type. Even though it provides around 3 times the power, it still doesn't need the usual finned heat sink. Transistors TR4 and TR5 regulate the invertor output, by controlling the amount of feedback, and are in turn controlled by TR3 which compares the voltage on the storage capacitor with the reference zener D5. The output voltage is set by the zener voltage so the full output is available over the whole supply voltage range, a powerful spark is produced even with the battery down to 4 volts.

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fouled spark plug	26kV	17kV
Voltage Rise Time to 20kV	25µS	30µS

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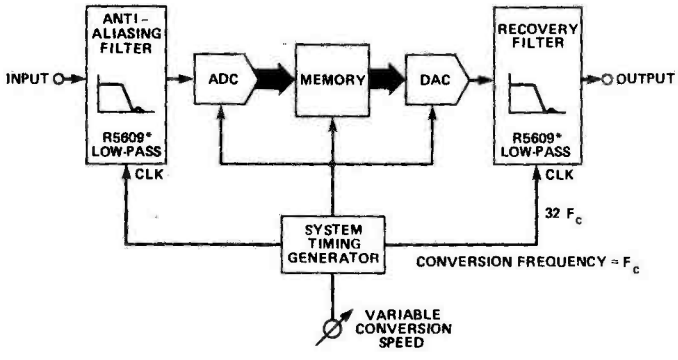
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DESIGNER'S NOTEBOOK

Last month, we looked at some of the new switched capacitor ICs. This month, Tim Orr gets down to some circuits using them.

Seven-Octave Audio Analyser

The R5606 is a single octave filter. Each R5606 is clocked with a square wave generated by a seven-stage binary divider, so that successive filter break-points are spaced at exactly one octave intervals. The resulting circuit is very simple and may be used as a real-time audio analyser or as an audio equaliser with a steep filter roll-off. Half-octave or even $\frac{1}{3}$ octave resolution could be obtained by using the R5605 or the R5604 respectively. The output signal is filtered by a simple single-pole low-pass filter to remove the effects of the sampling and the residual clock breakthrough. A simple anti-aliasing filter can also be used at the input to each filter, but this may not be considered necessary. A dynamic range of about 76 dB per channel should be obtained.



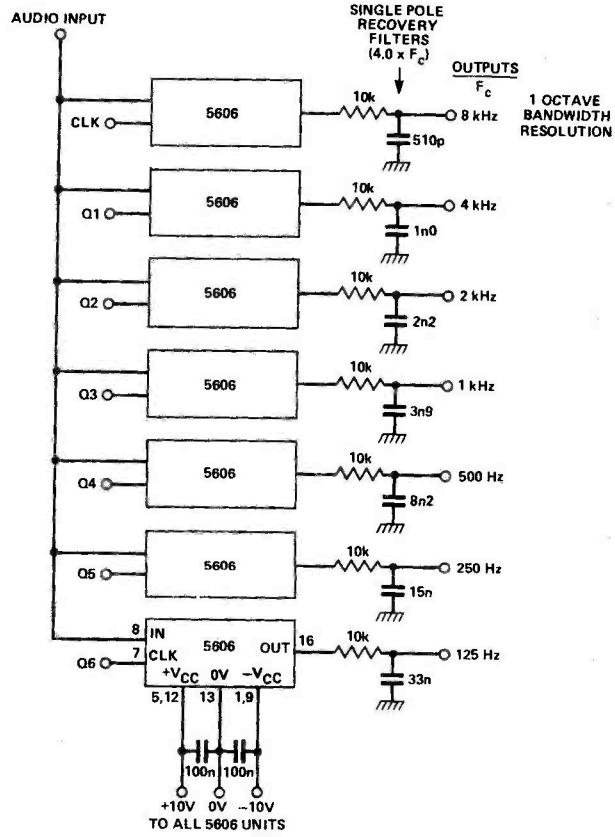
* The R5609 has a rolloff slope of 100 dB/octave.

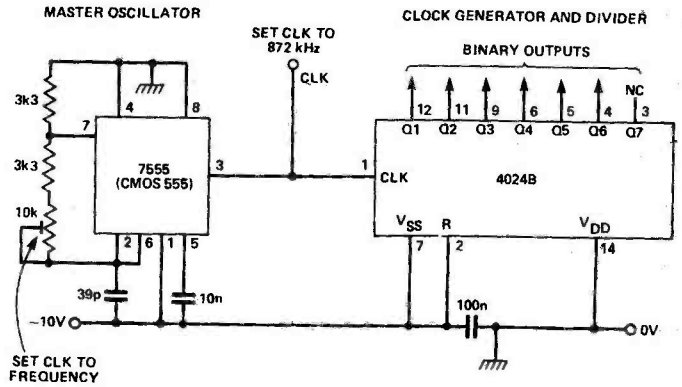
System bandwidth = $\frac{32 \times F_c}{100} = 0.32\ F_c$

Maximum theoretical bandwidth, as predicted by the sampling theorum = 0.5 F_c

Audio Converter With Tracking Filter

The R5609 is a steep low-pass filter which can be used as an anti-aliasing filter and recovery filter in an audio converter, such a digital delay line. If the clock for the filter is derived from the system clock and the A-to-D converter, then the low-pass filter frequency will track any changes in the conversion speed.





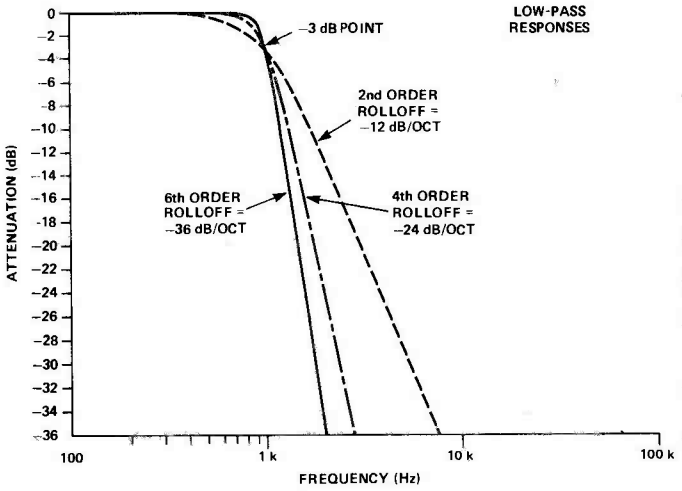
Low-Pass Response Using the MF10

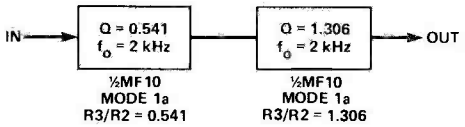
The frequency responses of second, fourth and sixth order maximally-flat low-pass filters are shown in the graph. These can be realised by cascading second order low-pass filter sections together. The table shows the break frequencies and Q factors for both maximally flat (Butterworth) and 3 dB ripple (Chebychev) responses. The maximally flat responses are easy to realise because all stages use the same clock frequency. The 3 dB ripple response requires awkward clock frequencies. A simple design example will illustrate how to use the filter.

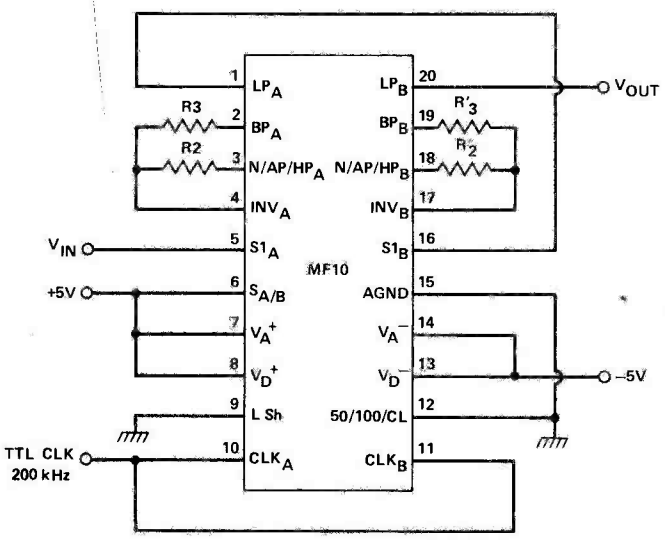
The figure shows a design for a fourth-order 2 kHz maximally-flat low-pass filter with an overall gain of 1 in the pass band. From the table, the first stage should have a Q of 0.54 and a frequency of 2 kHz, the second stage a Q of 1.306 and a frequency of 2 kHz. Mode 1a is the most simple realisation of the second order low-pass filter. For the first section let R3 = 10k. Then R2 = 18.48k (15k + 3k6 would do). For the second stage let R2 = 10k, then R3 = 13.06k (9k1 + 3k9 is near enough). Both clock pins can be tied together and driven with a single 200 kHz clock (pin 12 grounded gives a clock-to-filter frequency ratio of 100 to 1).

LOW-PASS FILTER RESPONSE	1st STAGE		2nd STAGE		3rd STAGE	
	f_o	Q	f_o	Q	f_o	Q
2nd ORDER BUTTERWORTH (FLAT RESPONSE)	1.0 F	0.707				
2nd ORDER CHEBYCHEV (3dB RIPPLE)	0.84 F	1.304				
4th ORDER BUTTERWORTH	1.0 F	0.54	1.0 F	1.306		
4th ORDER CHEBYCHEV	0.443 F	1.076	0.95 F	5.58		
6th ORDER BUTTERWORTH	1.0 F	0.518	1.0 F	0.707	1.0 F	1.931
6th ORDER CHEBYCHEV	0.298 F	1.044	0.722 F	3.46	0.975 F	12.78

* For the equivalent highpass response, use the same Q factor but use the reciprocal of the frequency multiplier.

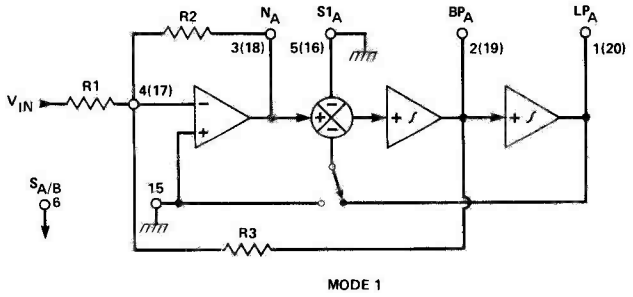


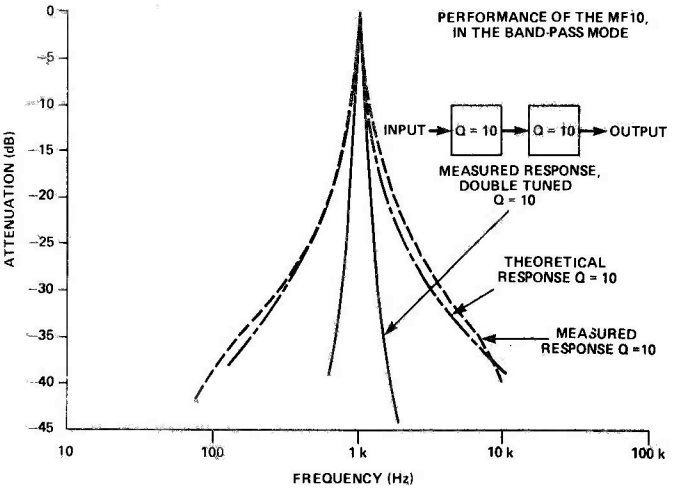




Band-Pass Response Using The MF10

A simple band-pass filter can be constructed using the circuit shown as mode 1 in the first article on switched capacitor ICs, and shown again to jog your memory! For a Q of 10, R3 = 100k and R2 = 10k. To give the filter unity gain at resonance, R1 = R3 = 100k. The external clock frequency determines the resonant frequency. By cascading two filters with a Q of 10, a very sharp resonance curve is producedasyou can see in the graph below. If the Q factor of each filter is increased further then an even sharper response can be obtained, although this may result in a double peak if the relative resonant frequencies of the two filters deviate.





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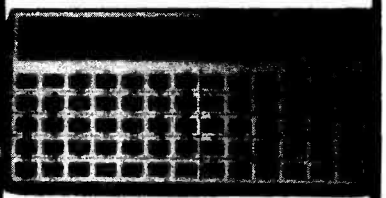
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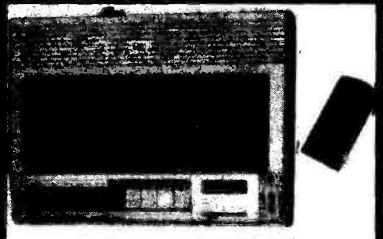
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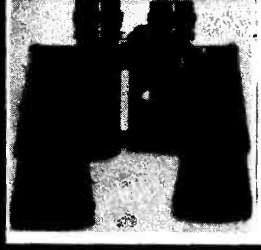
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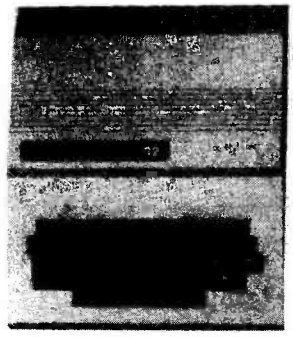


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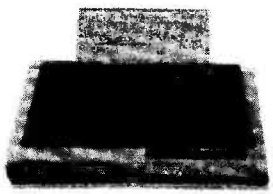
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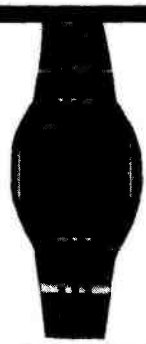
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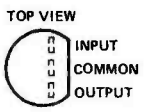
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TL011, TL012, TL014, TL021 (Texas Instruments) Fixed ratio current mirrors

- Wide inpute range, 1 nA to 1 mA
- 35 volt output capability
- high output impedance
- typically less than ±1% error at 25 deg C



Ratio of input current to output current varies with device code.

OUTPUT TO INPUT CURRENT RATIO	DEVICE
1:1	TL011
2:1	TL012
4:1	TL014
1:2	TL021

Types with different sufix have different temperature ranges and guaranteed current ratio tolerances over those ranges.
C suffix: 0 to 70 deg C, ±10% over full range
I suffix: −40 to 85 deg C, ±8% over full range
M suffix: −55 to 125 deg C, ±7% over full range

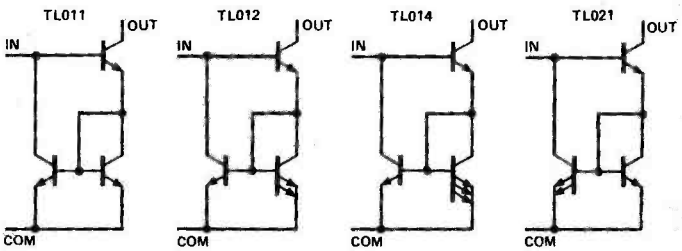


Fig. 1 Pin out and simplified internal circuitry of the TL011, TL012, TL014, TL021.

Electrical characteristics: TL011, etc	min	typ	max
Input voltage (V) (note 1) I_{IN} = 1 uA	0.4	1.0	1.5
I_{IN} = 1 mA	0.9	1.4	1.75
Input current (mA)			5 (note 2)
Output voltage	1.2 (note 3)		45 (note 2)
Output to input isolation (dB)	80		
Output resistance (M) I_{IN} = 1 uA	1000		
I_{IN} = 1 mA	1		
Maximum operating frequency (MHz)		10	
Continuous power dissipation (mW)			775 (note 2)

Key to footnotes
Note 1: figures for M suffix; I and C suffix types will have slightly higher voltages all round
Note 2: absolute maximum rating
Note 3: this is the guaranteed maximum minimum necessary to maintain current ratio.

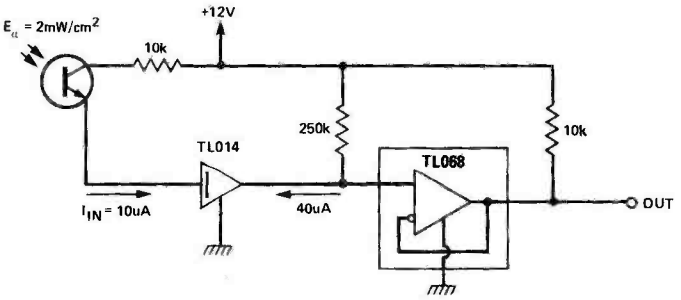


Fig. 2 A phototransitor amplifier using a TL014.

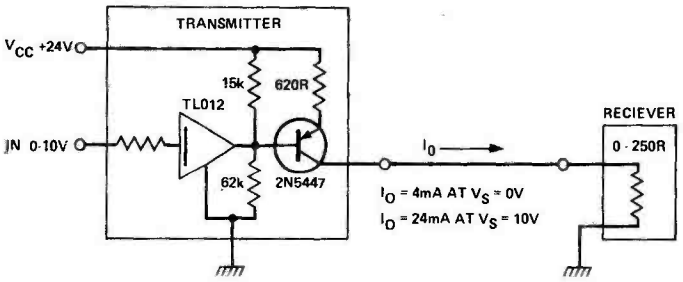


Fig. 3 A two wire current-mode transmitter using the TL012.

AD536, AD636 (Analogue Devices) RMS to DC Convertors

- true RMS to DC conversion
- dB output with 60 dB range (50 dB 636)
- low power consumption: 1 mA 536, 800 uA 636
- dual or single supply operation over a wide range of supply voltages
- current output available
- available in DIL or TO 100 packages.

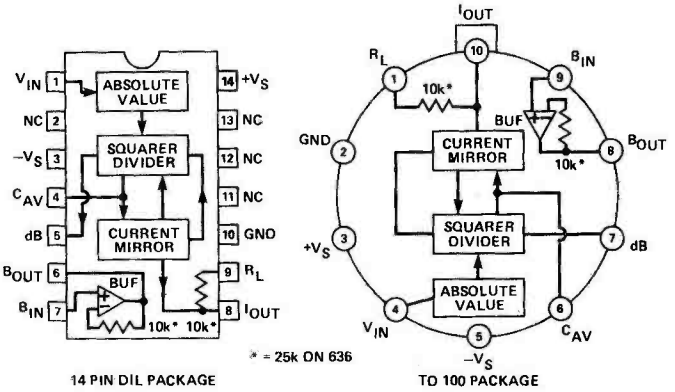


Fig. 4 (right) Pin out of the AD536 and AD636.

Electrical characteristics		AD536 (note 1)	AD636 (note 1)
Input	peak max. for rated performance	±20 V for ±15 V supply ±5 V for +5 V supply	±5 V for ±5 V supply ±5 V for ±2V5 supply
	max safe input	±25 V	±12 V
	input resistance	approx 17 kΩ	approx 7 kΩ
Accuracy	without ext. trim	+5 mV ±0.5% (7 V RMS	+5 mV ±1% (200 mV RMS
	with ext. trim	±3 mV ±0.3% input)	±3 mV ±0.3% input)
Frequency response (note 2)	V_{IN} = 10 mV	6 kHz	12 kHz
	V_{In} = 100 mV	40 kHz	80 kHz
	V_{IN} = 1 V	100 kHz	130 kHz (V_{IN} = 200 mV)
Averaging time const.	multiply by value of C_{AV} in uF	25 mS per uF	25 mS per uF
Output from buffer	max output voltage (min = 0)	+10 V (±15 V supply) +2 V (±5 V supply)	+1V4 (±3 V supply) 1V (+3, −5 V supply)
	current	+5 mA, −130 uA	+5 mA, −130 uA
I_{OUT}	scale factor	40 uA per volt RMS (+25%)	100 uA per volt RMS (+20%)
	voltage compliance	$-V_S$ to $+V_S-2$ V	$-V_S$ to $+V_S-$ V
dB output	scale factor	−3 mV per dB (1 V RMS = 0 dB)	−3 mV per dB (0V1 RMS = 0 dB)
	error	±0.5 dB	±0.5 dB
	I_{REF} range	5 uA to 80 uA	2 uA to 8 uA
Crest factor	error with 3:1 peak: average signal level	−0.1%	−0.2%
Power supplies	minimum voltage	±3 V or +5 V	+3/−5 V (note 3) or +5 V
	maximum	±18 V or +36 V	±12 V or +24 V
	current (quiescent)	1 mA (max 2 mA)	800 uA (max 1 mA)

Key to footnotes
Note 1: higher specification versions available
Note 2: this is for 1% additional error over DC error
Note 3: may be operated on +2 V/−2V5 but will not give specified performance.

Normal Mode of Operation

Only one external component, C_{AV} is needed. For 50 Hz operation, C_{AV} should be at least 0u7. C_F is an optional output ripple filter, and would normally be twice the capacity of C_{AV} if used, though this will increase the setting time.

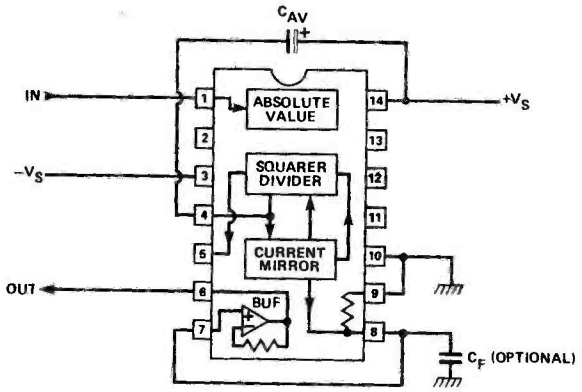


Fig. 5 Normal mode of connection of the AD536 and AD636.

Circuit for dB Output

VR1 should be adjusted to give the correct 0 dB point, and I_{REF} should be within the range quoted in the main specifications table. An inverting and amplifying stage could be used to obtain a positive-going suitably scaled output, and also to compensate for temperature drift.

Component Values	AD536	AD636
R1	27k	22k
BR1	470k	100k
C1	1n	10n
V_{REF}	2V5	1V2

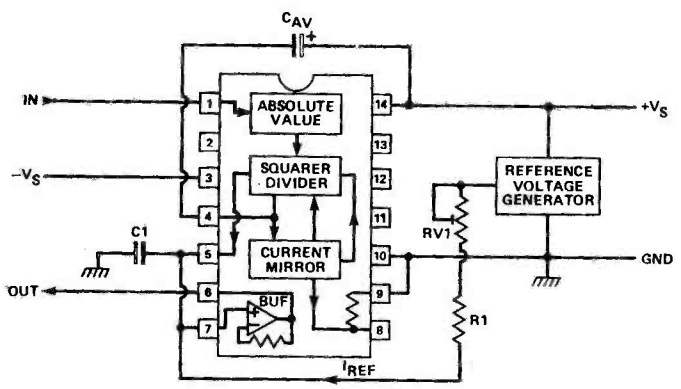


Fig. 6 Output connections for dB output.

Single Supply Connections

Note that only AC signals can be measured in this mode.

Component values	AD536	AD636
R1	20k (10k+10k)	20k
R2	10k	39k
R_L	10k to 1k	10k to 1k
C1	1u	3u3
C2,C3	100n	100n

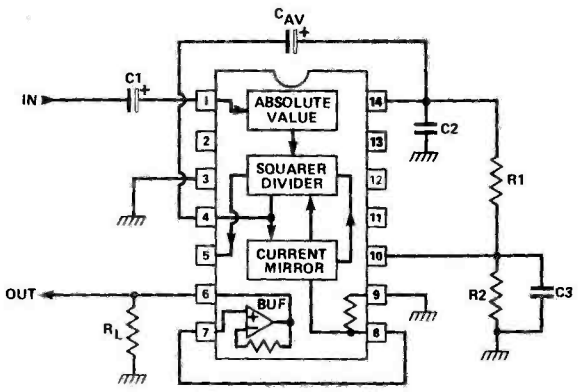


Fig. 8 Connections for a single supply rail.

Connections to trim errors

VR2 adjusts the total offset; ground the input and adjust VR2 to obtain zero output.

VR1 adjusts the gain; after adjusting VR2, apply a DC input of full scale and adjust VR1 to give the same output.

Component Values	AD536	AD636
R1	249 (180+68)	100
R2	470k	470k
VR1	470	220
VR2	47k	470k

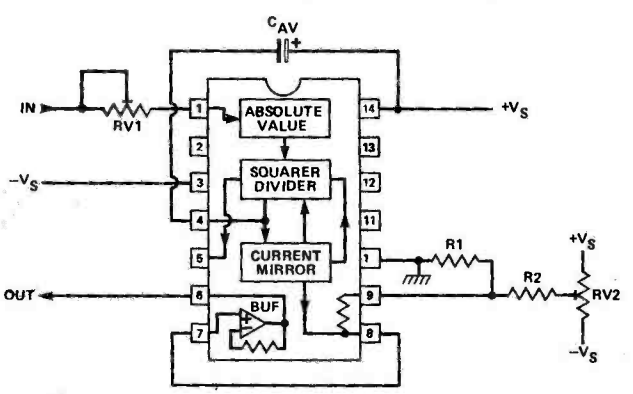


Fig. 9 Connections necessary to trim out errors.

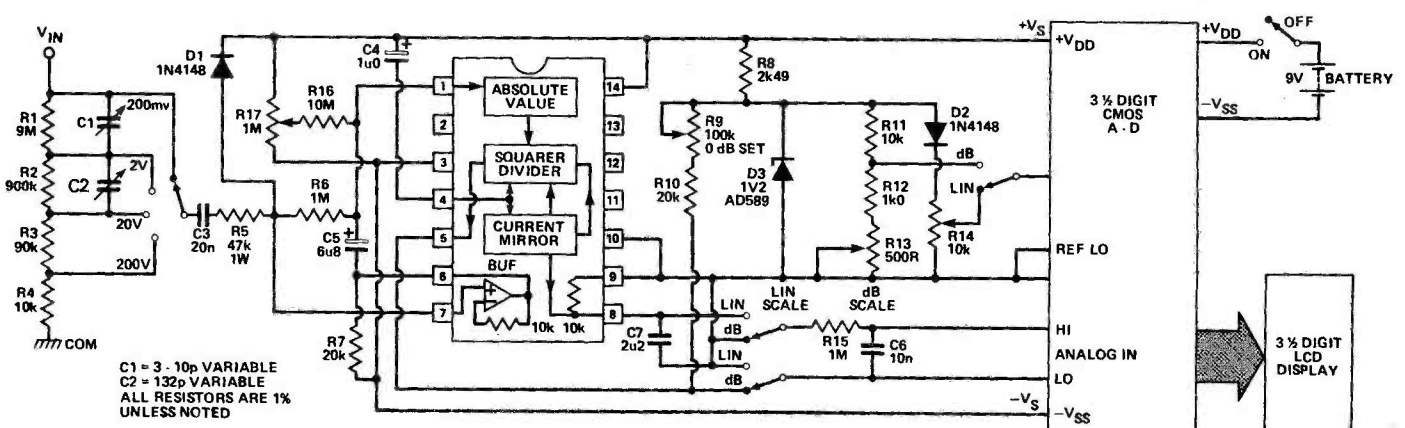


Fig. 7 A complete AC digital voltmeter using the AD636 and a 7106 (or similar) ADC/LCD driver.

CEM 3350 (Curtis) dual VCF

- Dual state variable filters with independent exponential frequency and Q control
- Wide frequency range: 15 octaves typical
- Choice of two simultaneous outputs: low-pass, band-pass, or high-pass
- Wide supply voltage range: ±3 V to ±18 V

Definition of terms

V_{IF}	fixed gain input
V_{IV}	variable gain input
V_{LP}	low-pass output
V_{BP}	band-pass output
V_{CQ}	Q control voltage input
V_{CF}	pole frequency control input
V_{CC}, V_{EE}	positive and negative supplies
I_{REF}	reference current input

Application notes

The transconductors inside the IC are NPN differential pairs with current mirror active loads (similar to CA3089) so input levels must be kept low (20–80 mV) for acceptable distortion. Inputs must normally be attentuated and output level should be restored using a BIFET op-amp to avoid problems with input offset currents that might be caused by the transconductors' high output impedance.

Note that applying increasing negative V_{CQ} will increase Q, and that pole frequency decreases with increasingly positive V_{CQ}. For negative V_{CF}, g_mF (and hence pole frequency) is approximately linear, but becomes exponential when V_{CQ} is positive.

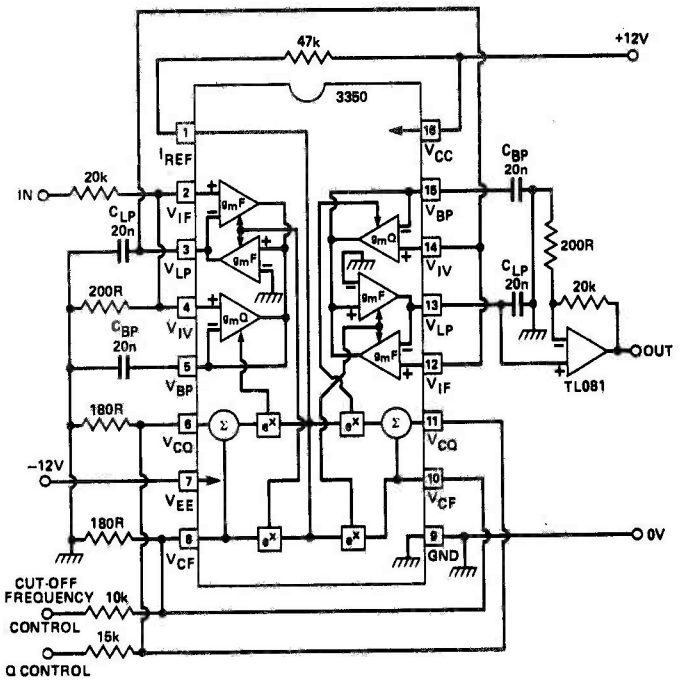


Fig. 10 CEM 3350 pin out and configuration as voltage controlled four-pole low-pass filter. Band-pass outputs could be cascaded by connecting V_{IV} and V_{IF} in the second section to V_{BP} in the first section, and taking the output to the op-amp from V_{BP}.

Electrical characteristics: CEM 3350 (Supplies ±12 V, I_{REF} 400 uA)	**min**	**typ**	**max**
Pole frequency control range	4000:1	12000:1	
Sensitivity of pole frequency control scale, midrange (mV/decade)	57	60	63
Exponential error of frequency and Q control scale (%) (note 1)		1.0	3.0
Transconductance of Q transconductors (mmho) (note 2)	4.5	6.9	9.3
Maximum transconductance of pole and Q transconductors (mmho)	11.0	14.2	16.0
Distortion in passband (%) (note 3)		1.0	5.0
Maximum Q without enhancement transconductance output impedance (MΩ) (note 2)	50 1.0	150 4.0	
Supply voltages (V)	±3		±18 (note 4)
Supply currents (mA): positive negative		2.5 6.5	3.0 7.5

There is a choice of fixed gain and variable gain inputs on both filters in the IC. The difference between these inputs is shown in Fig. 14. Signals applied to the fixed gain input will have gain Q at the resonant peak and unity elsewhere in the pass-band. Signals applied to the variable gain input will have unity gain at the resonant peak, while the gain in the pass-band will by 1/Q. Thus the fixed gain input can give overload problems, while the variable gain input will lead to changes in output volume as Q is adjusted. One way of trying to reach the best compromise is to aportion the input between the two inputs using an attenuation network (or, in more simple circuits such as Fig. 10, feeding the signal to both inputs). Another method would be to use the fixed gain input only, and to reduce the Q if a certain signal output level is exceeded.

Q is given by:

$$Q = \frac{3}{2}\sqrt{\frac{C_{LP}}{C_{BP}}}\exp\left(-V_{CQ}/V_T\right)$$

where $V_T \sim 25$ mV at room temperature.

Key to footnotes

Note 1: $+60\text{ mV} < V_{CF} < +240\text{ mV}$
Note 2: control voltage = 0
Note 3: V_{IF} or $V_{IV} = 40$ mV p-p
Note 4: maximum total differential supply for guaranteed operation is 26 V.

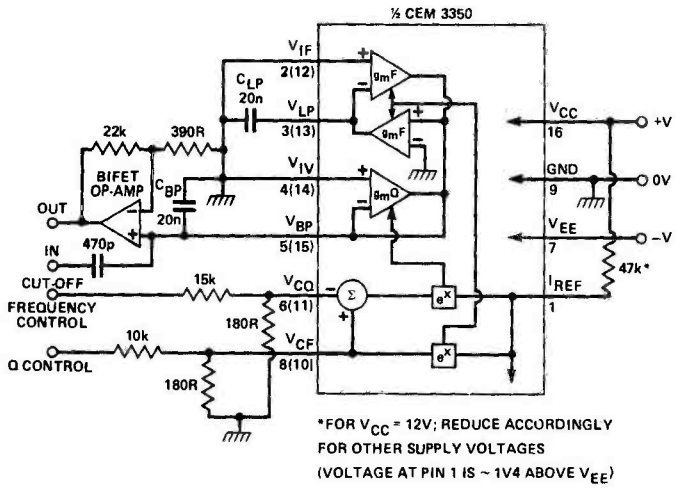
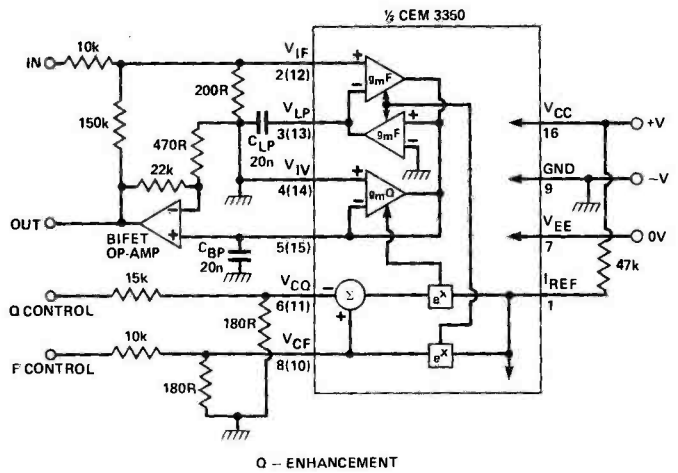


Fig. 11 High-pass filter using CEM 3350: response will fall by 12dB per octave below the cut-off frequency.



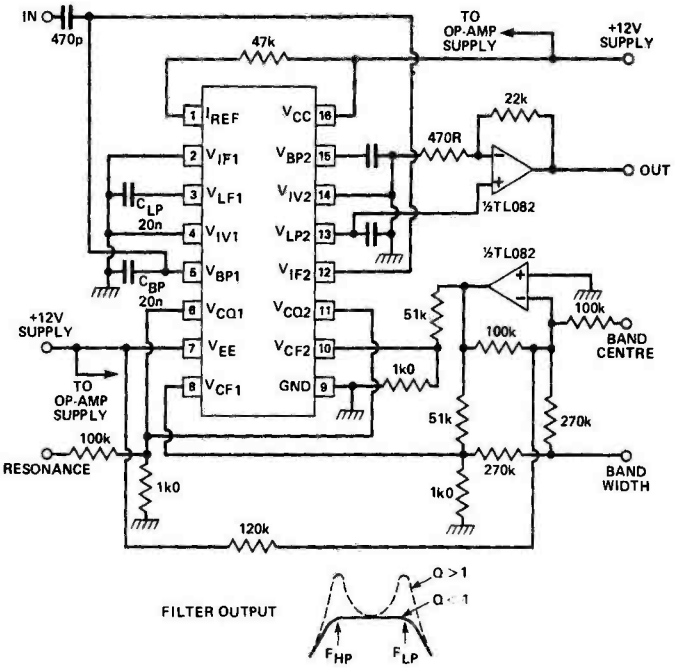
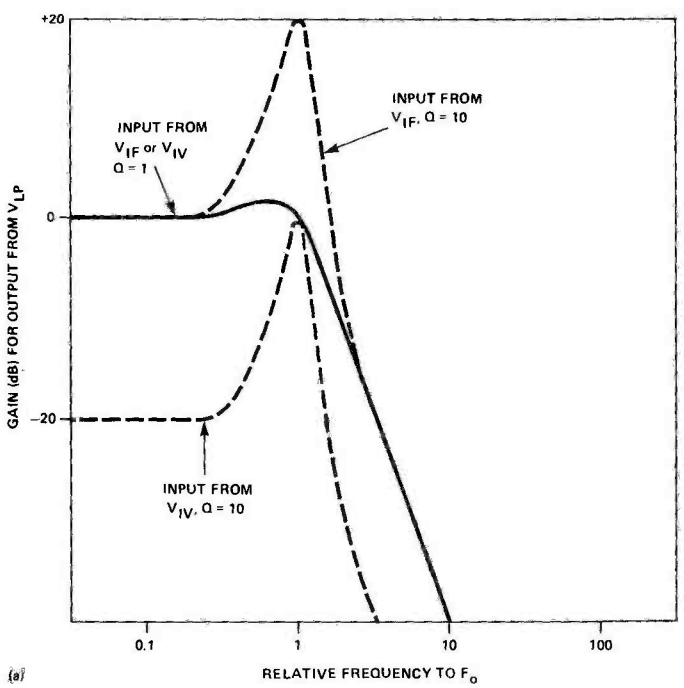


Fig. 12 (above) Low-pass and a high-pass filters can be combined to give a band-pass filter with a voltage-controlled band width. The circuit shown is an example of series interconnection; parallel interconnection is also possible.

Fig. 13 (left) The Q of the circuit may be enhanced above the normal maximum of 100–200 by applying regenerative feedback as shown: but beware too much feedback, as this will cause oscillation at the resonant frequency.

Available from Digisound Ltd.



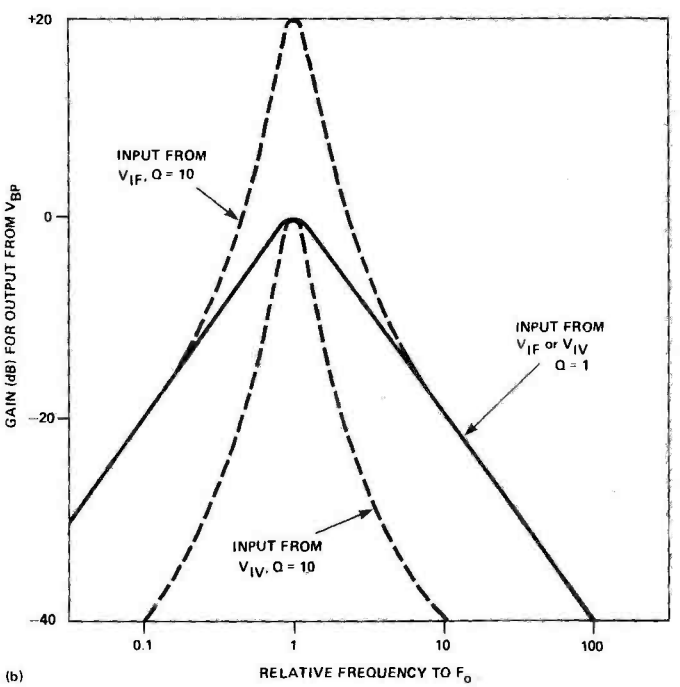


Fig. 14 Low-pass (a) and band-pass (b) responses for sections, with Q = 1 and Q = 10. In the case of curves with V_{IF} or V_{IV} input, other input has been grounded.

ZN428E-8 (feranti) Eight-bit D-to-A convertor

- D-to-A convertor, data latch and reference voltage in a single package
- single supply operation
- CMOS and TTL compatible
- 800 uS setting time

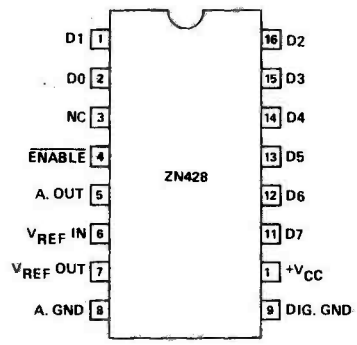


Fig. 15 ZN428 pin out.

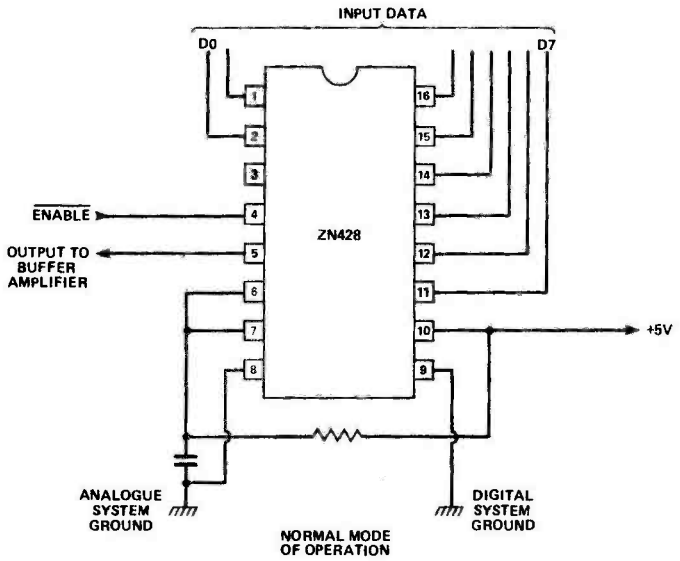


Fig. 16 (above) Normal mode of operation of the ZN428.

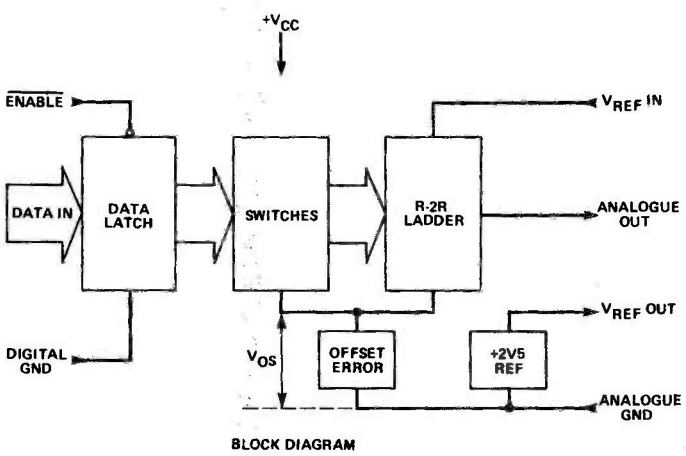


Fig. 17 (left) Block diagram of ZN428.

Operational notes

When $\overline{\text{ENABLE}}$ is low, the data inputs drive the D-to-A directly. When $\overline{\text{ENABLE}}$ goes high, the data is held in the latch until $\overline{\text{ENABLE}}$ next goes low.

Internal reference voltage source is a band gap diode circuit and it needs an input current to operate. Using a decoupling capacitor is recommended. There is no internal connection between the internal reference voltage source (V_{REG} OUT) and the reference input to the R-2R ladder (V_{REF} IN).

Electrical characteristics: ZN428E-8		min	typ	max
Supplies	voltage (V)	4.5	5.0	5.5 (note 1)
	current (mA)		20	30
Internal reference	voltage output (V)	2.475	2.550	2.625
	current (mA)	4		15
D-to-A convertor	linearity error (note 2)			0.5
	offset voltage, V_{OS} (mV)		2	5
	reference voltage input (V)	0		3.0 (note 3)
	settling time to 0.5 of LSB (uS)		0.8 (note 4)	1.25 (note 5)
	output resistance (kΩ)		4	
Logic	enable pulse width (nS)	100		
	data set-up time (nS)	150		
	data hold time (nS)	10		
Ground	max. discrepancy between an. and dig. gnd (mV)			200

Key to footnotes

Note 1: absolute maximum is 7 V
Note 2: expressed as fraction of least significant bit
Note 3: absolute maximum $+V_{CC}$
Note 4: average after one LSB transition, $R_L = 10$ M, $C_L = 10$ pF
Note 5: average after all bits switching, R_L, C_L as before.

LF 347 (National Semiconductor) quad JFET op-amp

- pin-for-pin replacement of LM148
- approximately full gain and band width down to ±4V5 supply voltage
- no special anti-static handling of op-amp required
- internally trimmed offset voltage.

Absolute maximum ratings:

Supply voltage:	±22V
Input voltage range, per input (note 1)	±19V
Output short circuit deviation (note 2)	continuous
Power dissipation (whole IC)	900mW

Available from Rapid Electronics, and other suppliers.

Electrical Characteristics: LF 347 (supply voltages: ±15V)	**min**	**typ**	**max**
DC voltage gain (V/mV)	50	100	
Slew rate (V/uS)		13	
Output voltage swing, load = 10k (V)	12	13.5	
Gain-bandwidth product (MHz)		4	
Input resistance (ohms)		10^{12}	
Common mode rejection ratio (supply voltage ±20V) (dB) over input voltage range (V)	80 ±11	100 +15/−12	
Supply voltage rejection ratio (note 3) (dB)	80	100	
Input offset voltage (mV)		1	5
Amplifier to amplifier coupling (frequency range 1Hz to 20kHz, supply voltage ±20V) (dB)		−120	
Supply current (all four op-amps — but no load)(mA)		7.2	11

Key to footnotes

Note 1: input voltages should not be allowed to go below negative supply voltage, otherwise op-amp may be destroyed.

Note 2: only one op-amp output should be shorted at anytime, otherwise IC may overheat.

Note 3: measured for both supply voltages decreasing and increasing simultaneously.

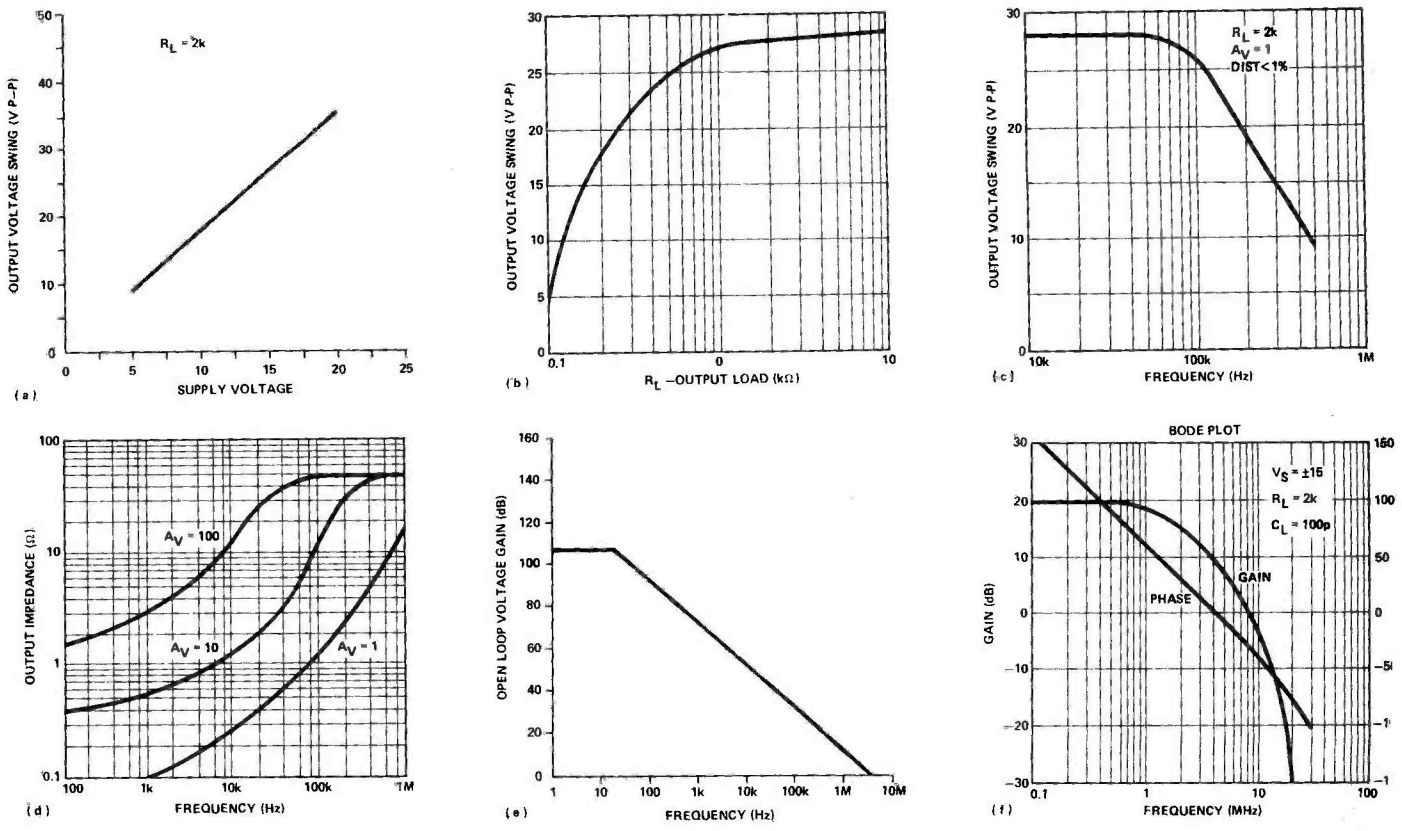


Fig. 18 Output voltage swing vs. supply (a) and output load (b), undistorted output vs. frequency (c), output impedance vs. frequency (d), open loop frequency response (e), and bode (f) plot for LF347.

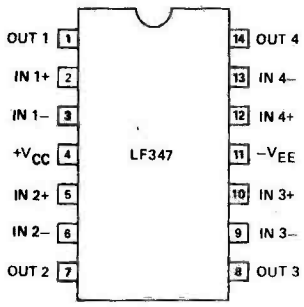


Fig. 19 Pin out of LF347.

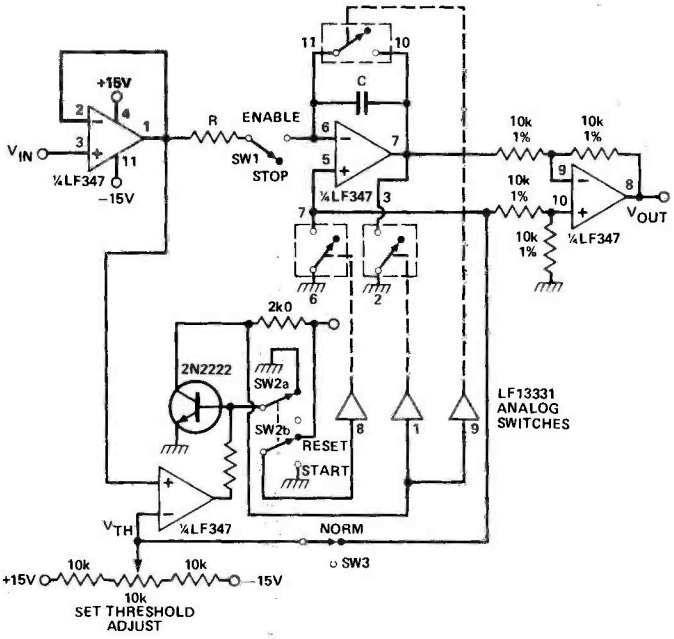
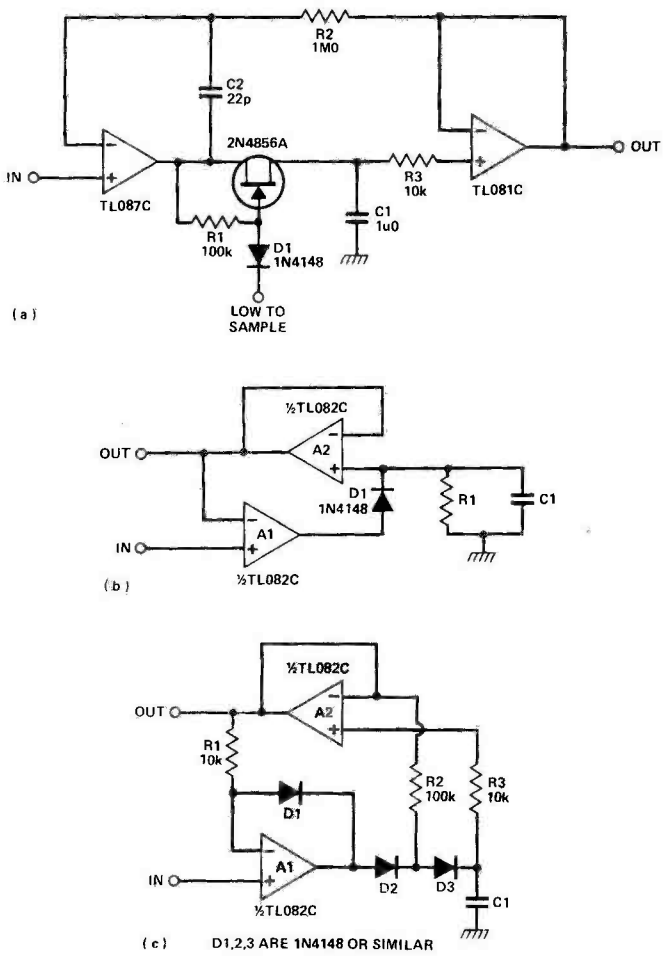


Fig. 20 Example of a long-time integrator, with reset, hold and starting threshold adjustment, using LF347s.

Fig. 21 We've used BIFET op-amps so much with the CEM 3350, it seems unjust that they shouldn't have a circuit or two to themselves; so here they are: a) a high accuracy sample-and-hold, b) a peak detector, and c) a low-drift peak detector.



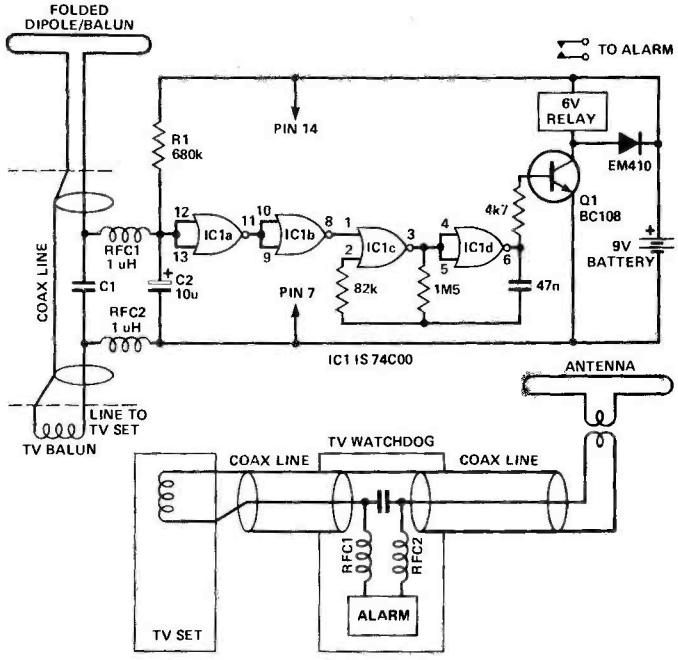
TV Alarm

Our final circuit is intended to make it harder for a thief to walk off with your TV. The basic idea is to use the aerial as the detector of the TV's non-presence. This is done by sending a small DC signal round the loop formed by the aerial pick-up loop (or the signal transformer for the aerial) and the signal transformer (or balun) in the TV. The circuit is isolated from TV signals by RF chokes RFC1 and RFC2, and C1 is inserted into the signal path to block the DC.

When the TV is disconnected, there is a 10 second delay (set by the values of R1 and C2) before the alarm goes off, so that an unwitting burglar will not know what has turned on the alarm.

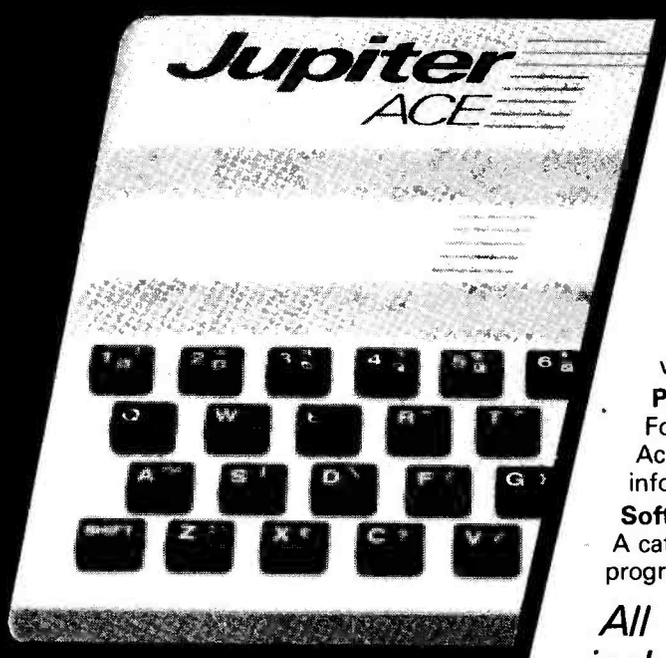
This circuit is not suitable for use with TVs that have live chases. Also, there must be DC path through the TV's aerial circuit for the alarm to work.

The idea for this circuit originated in Australia. This doesn't mean that you have to turn your TV upside-down for the circuit to work. However, so doing may help with your appreciation of 'Blankety-Blank'.



ETI would like to thank the manufacturers of the ICs featured for their help.

Jupiter ACE



The Jupiter Ace uses FORTH

The Jupiter Ace personal computer runs in FORTH, an easily understood language, typically four times as compact and ten times as fast as BASIC. Before the Ace all personal computers used BASIC and FORTH was only available to a privileged few. The Jupiter Ace also features a full-size moving-key keyboard, high-resolution graphics, sound, floating point arithmetic, a fast and reliable cassette interface and 3K of RAM.

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Even if you are a complete newcomer to computers, the manual will guide you step by step from first principles to confident programming.
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BAR HILL, CAMBRIDGE CB3 8EP

Technical Information

Hardware
Z80A running at 3.25 MHz.
8K bytes ROM
3K bytes RAM

Keyboard 40 Moving-key keyboard with auto repeat on every key and Caps Lock.

Screen Memory mapped 32 column x 24 line flicker-free display with upper and lower case ascii character set.

Graphics Chunky graphics (64 x 46 pixels) may be plotted, unplotted or over-plotted (XOR operation). Also, the entire character set (128 characters and their video inverses) may be redefined allowing intricate shapes to be drawn with a resolution equivalent to 256 x 192 pixels.

Sound Internal loudspeaker may be programmed to operate over the entire audio spectrum.

Cassette Programs and data in the compact dictionary format may be saved, verified, loaded and merged. Blocks of memory can be saved, verified, loaded and relocated. All tape files are named. Running at 1500 baud, the Ace will connect to most portable tape recorders.

Expansion Port Contains D.C. power rails and full Z80 Address, data and control signals. May be used to connect extra memory and other peripherals. IN and OUT words allow port-based peripherals to be addressed.

Data Structures Integer, Floating point and String data may be held as constants, variables or arrays with multiple dimensions and mixed data types. There are no restrictions on names.

Control Structures **IF–ELSE–THEN, DO–LOOP DO–+LOOP, BEGIN–WHILE–REPEAT, BEGIN–UNTIL,** all may be mixed and nested to any depth.

The Jupiter Ace closely follows the FORTH 79 standard with extensions for floating point, sound and cassette. It has a unique and remarkable editor that allows you to list and alter words that have been previously compiled into the dictionary. This avoids the need to store screens of source, allowing the dictionary itself to be saved on cassette. Comprehensive error checking removes the worry of accidentally crashing your programs.

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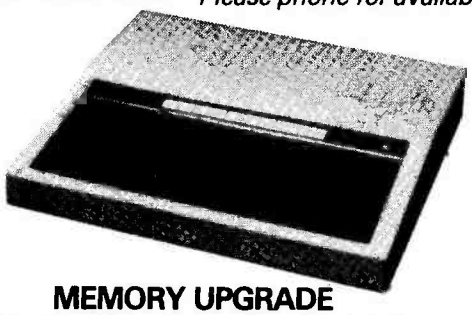
Designed by Jupiter Cantab

Computer Designers Steven Vickers and Richar Altwasser played a major role in creating the ZX Spectrum and then formed Jupiter Cantab to develop advanced ideas in personal computing. The Ace is the result, another all-British computer to lea the world.

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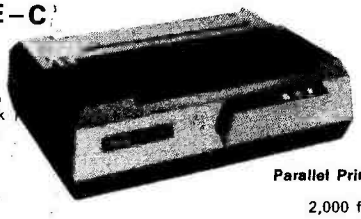
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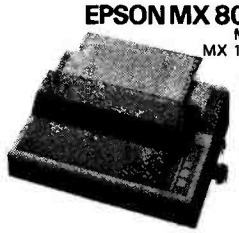
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RUGBY ATOMIC CLOCK

This Z80 micro controlled clock/calender receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided. See July/August ETI for details. Complete Kit **£120 + £2.00 p&p**

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

No of ways	Header Plug	Recep-tacle	Edge Conn.
10	90p	90p	200p
20	145p	125p	240p
26	175p	150p	300p
34	200p	180p	380p
40	220p	190p	550p
50	235p	200p	600p

JUMPER LEADS

24" Ribbon Cable with headers

	14 pin	16 pin	24 pin	40 pin
1 end	145p	165p	240p	380p
2 ends	210p	230p	345p	540p

24" Ribbon Cable with sockets

	20 pin	26 pin	34 pin	40 pin
1 end	160p	210p	270p	380p
2 ends	290p	385p	490p	540p

24" Ribbon Cable with D. Conn.
25 way Male 500p Female 550p

DIL HEADERS

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

RIBBON CABLE (Grey)

10 way	80p
14 way	80p
16 way	90p
20 way	105p
26 way	140p
34 way	220p
40 way	265p
50 way	330p
64 way	370p

MICROTIMER

6502 Based Programmeable clock timer with
- ★ 224 switching times/week cycle
- ★ 24 hour 7 day timer
- ★ 4 independent switch outputs directly interfacing to thyristor/triacs
- ★ 6 digit 7 seg. displays to indicate real time, ON/OFF and Reset times
- ★ Output to drive day of week switch and status LEDS.

Full details on request. Price for kit £57.00

D-CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
Solder	90p	130p	180p	250p
Angled	160p	230p	265p	425p
FEMALE				
Solder	110p	160p	210p	350p
Angled	175p	240p	310p	500p
Hood	95p	95p	125p	125p

36 way Centronix Type Conn. £5.50
25 way IEEE Type Conn. £5.50

RS232 CONNS
(25 way D)

24" Single end Male	£5.50
24" Single end Female	£6.00
24" Female-Female	£11.00
24" Male-Male	£10.00
24" Male-Female	£11.50

EURO CONNECTORS
(Indirect Edge Conn.)

DIN STD	Plug	Skt
41617 21 way	170p	170p
41617 31 way	180p	180p
41612 2 x 32 way	250p	320p
Angled 2 x 32 way	325p	375p
41612 3 x 32 way	275p	380p
Angled 3 x 32 way	–	480p
2 x 32 way IDC a+c	–	525p

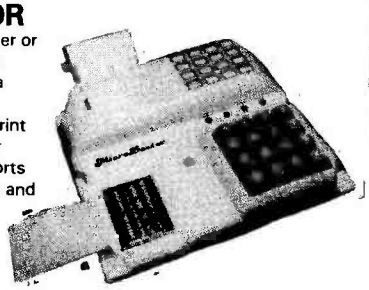
(for 2 x 32 way specify a+b or a+c)

EDGE CONNECTORS

	0.1"	0.156"
2 x 18 way	–	140p
2 x 22 way	200p	170p
2 x 23 way	210p	–
2 x 25 way	225p	220p
1 x 43 way	280p	–
2 x 43 way	395p	–
2 x 50 way	–	–
1 x 77 way	700p	–
S100 Conn.	–	600p

MICRODOCTOR

This is not a logic analyser or an oscilliscope. It tests a microsystem and gives a printed reprint on RAM, ROM and 1/0 – it will print memory map, search for code, check dataline shorts and operates peripherals and even disassembles the ROM. Microdoctor complete with PSU, Printer, probe cable and two configuration boards. **£295.**



NEW COMPREHENSIVE CATALOGUE AVAILABLE

SOFTY II INTELLIGENT PROGRAMMER

The complete micro processor development system for Engineers and Hobbyists. You can develop programs, debug, verify and commit to EPROMS or use in host computer by using softy as a romulator. Powerful editing facilities permit bytes, blocks of bytes changed, deleted or inserted and memory contents can be observed on ordinary TV. Accepts most + 5v Eproms.
Softy II complete with PSU, TV Lead and Romulator lead **£169**

SPECIAL OFFER

2114L	80p
2716 (+5v)	250p
2532	350p
4116-2	80p
4164-2	450p
6116P-3	350p

UV ERASERS

UV1B up to 6 Eproms	£47.50
UV1T with Timer	£60.00
UV140 up to 14 Eproms	£61.50
UV141 with Timer	£78.00

(Carr £2/eraser)
All erasers are fitted with mains switches and safety interlocks

TRAINER KITS

6502 Junior Computer	£85.00
6802 Nancomp I	£80.00
6809 Nancomp II	£80.00
1802 Micro Trainer	£84
E80 Manta	£115

(fully built and documented)
Full details on request

BOOKS (No VAT p&p £1)

CMOS Cook Book	£7.75
CRT Controller H/Book	£5.95
Programming the Z80	£11.50
Z80 Microcomp. handbook	£6.95
Programming the 6502	£10.25
6502 Assy. Lang.	£12.10
6502 Applications	£10.20
6502 Software Design	£9.05
6502 Games	£10.52

Large selection of databooks, interfacing books, books on BBC, etc in stock. As for our list.

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7412	14p
7413	16p
7414	18p
7416	18p
7417	18p
7420	14p
7421	18p
7422	20p
7423	20p
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	36p
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	36p
7484	85p
7484A	60p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7494A	35p
7496	40p
7497	90p
74100	80p
74107	22p
74109	25p
74110	30p
74111	55p
74112	70p
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
74182A	60p
74184A	90p
74185	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
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
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74366	30p
74367	30p
74368	30p
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74LS10	12p
74LS11	13p
74LS12	12p
74LS13	15p
74LS14	25p
74LS15	12p
74LS20	12p
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74LS26	12p
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74LS33	14p
74LS37	14p
74LS38	15p
74LS40	12p
74LS42	30p
74LS47	36p
74LS48	45p
74LS51	14p
74LS54	14p
74LS55	14p
74LS63	120p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	17p
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	22p
74LS91	66p
74LS92	32p
74LS93	22p
74LS95	40p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	28p
74LS123	34p
74LS124	90p
74LS125	24p
74LS126	25p
74LS132	34p
74LS133	30p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	120p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	60p
74LS155	30p
74LS156	36p
74LS157	25p
74LS158	30p
74LS160	36p
74LS161	36p
74LS162	36p
74LS163	36p
74LS164	40p
74LS165	50p
74LS166	60p
74LS168	85p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS183	120p
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74LS192	36p
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74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	35p
74LS253	35p
74LS257	30p
74LS258	35p
74LS259	55p
74LS260	20p
74LS261	138p
74LS266	20p
74LS273	80p
74LS275	225p
74LS279	30p
74LS280	100p
74LS283	40p
74LS290	45p
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74LS295	90p
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74LS299	180p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS356	250p
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74LS644	100p
74LS645	100p
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74LS670	140p
74LS678	550p
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74S SERIES

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74S02	30p
74S04	30p
74S05	60p
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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	160p
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	300p
74S262	850p
74S373	400p
74S374	400p
74S387	250p
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4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	35p
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
4035	45p
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4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
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4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4078	16p
4081	14p
4082	15p
4086	55p
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4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
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4502	60p
4503	45p
4504	75p
4505	400p
4506	35p
4507	35p
4508	130p
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4511	45p
4512	48p
4514	120p
4515	110p
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4522	120p
4526	60p
4527	60p
4528	50p
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4534	400p
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4566	160p
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
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40193	75p
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40245	195p
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40373	180p
40374	180p
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14500	700p
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COUNTERS

74C925	£4
74C926	£6
72168	£16
ZN1040	670p

LINEAR ICs

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CA3090AQ	375p
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LF351	48p
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LF356P	95p
LF357	110p
LF13331	150p
LM10C	325p
LM301A	25p
LM310	120p
LM311	70p
LM318	150p
LM319	215p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	50p
LM348	65p
LM358P	80p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM386	90p
LM387	120p
LM389	95p
LM391	150p
LM392N	80p
LM393	100p
LM394CH	300p
LM709	36p
LM710	50p
LM711	70p
LM725	300p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	450p
LM1872	450p
LM1886	700p
LM1889	350p
LM2917	200p
LM3302	75p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
M51513L	230p
M51516L	530p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	75p
MC1445	250p
MC1458	36p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3401	50p
MC3403	75p
MFIO	250p
MK50380	635p
ML920	800p
NE510	620p
MN6221A	600p
NE531	140p
NE544	150p
NE555	16p
NE555	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE570	410p
NE571	400p
NE592	80p
NE5534P	110p
NE5534AP	120p

VOLTAGE REGULATORS FIXED PLASTIC

1A	+ve		−ve	
5V	7805	40p	7905	45p
6V	7806	40p	7906	45p
8V	7808	40p	7908	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p	7924	45p

5V 100mA 78L05 30p 79L05 60p
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	78HO5KC	550p
LM317T	200p	79GUIC	200p
LM337T	225p	79GUIC	225p
LM323K 3A 5V	450p	79HGKC	700p
LM723 150mA Adj		ICL 7660	200p
	30p	TL497	300p
TL494	400p	LM305AH	250p
78S40	225p	78H12	600p
78P05	900p	SG3524	300p

OPTO ELECTRONICS

2N5777	40p	TIL78	55p
OCP71	180p	TIL31A	120p
ORP12	120p	TIL32	55p
ORP60	120p	TIL81	90p
ORP61	120p	TIL100	75p

OPTO ISOLATORS

ILO74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
ILQ74	240p	TIL116	70p
MOC3020	150p		

LEDS

0.125"		0.2"	
TIL209 Red	10p	TIL220 Red	10p
TIL211 Gr	12p	TIL222 Gr	12p
TIL212 Yel	15p	TIL228 Ye	15p
		Rectangular	
		LEDs (R,G,Y)	30p

DISPLAYS

DL704	140p	TIL311	600p
DL707 Red	140p	TIL312/3	110p
FND357	120p	TIL321/3	130p
FND500	80p	TIL330	140p
FND507	90p	7750/60	200p
MAN3640	200p	Bargraph	225p
MAN4640	200p	**DRIVERS**	
NSB5881	570p	9368	250p
		9370	300p

PLL02A	500p
RC4136	60p
RC4151	200p
S566B	225p
SAA1900	1600p
SAD1024A	900p
SFF9634	800p
SL490	350p
SN76115N	215p
SN76131	125p
SN76477	450p
SN76488	450p
SN87489	400p
SN76495	400p
SN76660	120p
SP8515	750p
TA7120	150p
TA7130	150p
TA7204	200p
TA7205	80p
TA7222	150p
TA7310	150p
TBA641AX1	300p
TBA641BX1	400p
TBA800	80p
TBA810	100p
TBA820	90p
TBA920	200p
TBA950	225p
TC9109	900p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TCA965	120p
TDA1004A	300p
TDA1008	320p
TDA1010	200p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2003	325p
TDA2002V	325p
TDA2006	350p
TDA2020	320p
TL064	100p
TL071/81	25p
TL072/82	45p
TL074	100p
TL083	75p
TL084	90p
TL094	200p
TL170	50p
TL430C	70p
UA1003-3	935p
UA2240	150p
UAA170	170p
ULN2003A	75p
ULN2004	75p
ULN2068	280p
ULN2802	200p
ULN2804	150p
UPC575	275p
UPC592H	200p
UPC1156H	275p
UPC1885H	500p
XR2206	300p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN414	80p
ZN419C	180p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	590p
ZN428E	410p
ZN1034E	200p
ZN1040E	670p
ZNA134	230p
ZNA234	650p

TRANSISTORS

AD161/2	45p	BFX84/5	40p
BC107/8	13p	BFX86/7	27p
BC109C	14p	BFX88	27p
BC117	20p	BFX89	108p
BC147/8	9p	BFY51/2	24p
BC149	10p	BFY56	33p
BC157/8	10p	BFY90	80p
BC159	11p	BRY39	45p
BC169C	12p	BSX19/20	24p
BC172	12p	BU104	225p
BC177/8	17p	BU105	190p
BC179	18p	BU108	250p
BC182/3	10p	BU109	225p
BC184	11p	BU126	150p
BC187	30p	BU180A	120p
BC212/3	11p	BU205	200p
BC214	12p	BU208	200p
BC237	15p	BU406	145p
BC327	16p	BUX80	600p
BC337	16p	BUY69C	350p
BC338	16p	E310	50p
BC461	25p	MJ802	400p
BC477/8	30p	MJ2955	90p
BC516/7	40p	MJ3001	225p
BC547B	14p	MJ4502	400p
BC548C	12p	MJE340	60p
BC549C	16p	MJE2955	100p
BC557B	14p	MJE3305	70p
BC559C	16p	MPF102	40p
BCY70	18p	MPF103/4	30p
BCY71	22p	MPF105	30p
BD131	75p	MPSA06	30p
BD132	50p	MPSA12	50p
BD135/6	40p	MPSA13	50p
BD139	40p	MPSA20	50p
BD140	40p	MPSA42	50p
BD189	60p	MPSA43	50p
BD232	60p	MPSA56	32p
BD233	75p	MPSA70	50p

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	350p
6502A	500p
6800	225p
6802	250p
6809	650p
68B09	£12
6809E	£12
8035	350p
8039	300p
8080A	280p
8085A	350p
INS8060	£11
TMS9980	£20
Z8	£24
Z80	290p
Z80A	320p
Z80B	£12
8088	£18

SUPPORT DEVICES

3242	800p
3245	450p
6520	280p
6522	310p
6522A	550p
6532	550p
6551	650p
6821	100p
68B21	220p
6829	£12.50
6840	375p
68B40	800p
6850	110p
68B50	220p
6852	250p
6854	700p
68B54	800p
6875	5700p
8154	950p
8155	350p
8156	350p
8205	225p
8212	110p
8216	100p
8224	110p
8226	250p
8228	220p
8243	280p
8250	850p
8251	250p
8253	390p
8255	250p
8256	£36
8257	400p
8259	400p
8271	£36
8279	440p
8284	350p
8288	£11
8755	£16
9902	£3
TMS4500	£14
TMS9928	£30
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80ACTC	280p
Z80ADART	700p
Z80ADMA	£10
Z80S10/1/2	£9

RAMs

2101-4A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	100p
2147	450p
4027-3	300p
4044-45	450p
4116-15	£8
4116-20	80p
4118-3	450p
4164-2	500p
4816AP-3	270p
5101	300p
5516	950p
6116-3	420p
6116LP-3	750p
6514-45	300p
6810	120p
7489	210p
74S189	225p
74S201	350p
74S289	175p
93415	600p
93425	600p

ROMs PROMs

74S188	325p
74S287	350p
74S288	225p
74S387	325p
74S471	650p
74S473	650p
74S474	650p
74S570	650p
74S571	650p
74S573	950p

EPROMs

2516(+5v)	250p
2532	370p
2564	£12
2708	250p
2716(+5v)	250p
2732 (350ns)	£8
2716(350ns)	500p
2764	£11
2732(350ns)	750p
TMS2716	750p

CRT CONTROLLER

CRT6545	900p
CRT5027	£18
CRT5037	£18
EF9365/6	£46
MC6845	850p
MC6847	850p
SFF96364	£8
TMS9918	£80
TMS9927	£18
TMS9928	£30
TMS9929	£36
TMS9995	£11

INTERFACE ICs

AD558CJ	775p
AD561J	£14
AM25S10	350p
AM25LS2521	£2
AM26LS31	125p
AM26LS32	125p
COM8116	800p
D7002	480p
DAC80	£28
DM8131	375p
DP8304	460p
DS3691	400p
DS8830	140p
DS8831	140p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	675p
MC14412	750p
75107	90p
75110/12	180p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	65p
75453/4	72p
75491/2	70p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
81LS95/96	90p
81LS97/98	90p
9602	Z20p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	800p
ZN428E-8	500p

DISC CONTROL ICs

FD1771	£20
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
8271	£36
WD1691	£15
WD2143	550p

CHARACTER GENERATORS

RO-3-2513UC	750p
RO-3-2513LC	700p
SN74S262AN	£10
MC66760	750p
DM86564	£12

KEYBOARD ENCODER

AY5-2376	700p
74C922	420p
74C923N	500p

BAUD RATE GENERATORS

MC14411	675p
COM8116	700p
4702B	750p

UARTs

AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	450p
TR1602	300p

ZIF SKTs

(TEXT TOOL)

24 pin	600p
28 pin	800p
40 pin	£10

LOW PROFILE SOCKETS BY TI

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

WIRE WRAP SOCKETS BY TI

8 pin	25p	18 pin	50p	24 pin	80p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

BD235	85p	MPSA93	40p
BD241	60p	MPSU06	63p
BD242	60p	MPSU07	60p
BD379	60p	MPSU45	90p
BD380	60p	MPSU65	78p
BD677	40p	TIP29A	35p
BF244B	35p	TIP29C	40p
BF256B	50p	TIP30A	35p
BF257/8	32p	TIP30C	40p
BF337	30p	TIP31A	42p
BFR39	25p	TIP31C	45p
BFR40/1	25p	TIP32A	40p
BFR79	25p	TIP32C	40p
BFR80/1	25p	TIP33A	70p
BFR96	180p	TIP33C	80p
BFX29	40p	TIP34A	90p
BFX30	27p	TIP34C	120p
BFX84/5	40p	TIP35A	120p
BFX86/7	27p	TIP35C	140p
BFX88	27p	TIP36A	140p
BFX89	108p	TIP36C	150p
BFY51/2	24p	TIP41A	50p
BFY56	33p	TIP41C	55p
BFY90	80p	TIP42A	60p
BRY39	45p	TIP42C	65p
BSX19/20	24p	TIP54	160p
BU104	225p	TIP120	75p
BU105	190p	TIP121	75p
BU108	250p	TIP122	80p
BU109	225p	TIP142	120p
BU126	150p	TIP147	120p
BU180A	120p	TIP2955	78p
BU205	200p	TIP4055	70p
BU208	200p	TIS93	30p
BU406	145p	ZTX108	12p
BUX80	600p	ZTX300	13p
BUY69C	350p	ZTX452	45p
E310	50p	ZTX500	15p
MJ802	400p	ZTX502	16p
MJ2955	90p	ZTX504	18p
MJ3001	225p	ZTX552	55p
MJ4502	400p	ZTX652	60p
MJE340	60p	ZTX752	70p
MJE2955	100p	VN66AF	72p
MJE3305	70p	VN10KM	60p
MPF102	40p	VN66	80p
MPF103/4	30p	2N697	25p
MPF105	30p	2N698	45p
MPSA06	30p	2N706A	30p
MPSA12	50p	2N708	30p
MPSA13	50p	2N918	45p
MPSA20	50p	2N930	18p
MPSA42	50p	2N1131/2	38p
MPSA43	50p	2N1613	25p
MPSA56	32p	2N1711	25p
MPSA70	50p	2N2102	70p
		2N2160	350p

2N2219A	25p
2N2222A	25p
2N2369A	17p
2N2484	25p
2N2648	40p
2N2904/5	25p
2N2906A	25p
2N2907A	25p
2N2926	9p
2N3053	25p
2N3054	65p
2N3055	35p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	9p
2N3704/5	10p
2N3706/7	10p
2N3708/9	10p
2N3773	200p
2N3819	20p
2N3820	40p
2N3823	30p
2N3866	90p
2N3902	700p
2N3904	16p
2N3906	16p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	80p
2N5459	30p
2N5460	60p
2N5485	38p
2N5875	250p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	85p
2N6277	190p
2N6254	130p
2N6290	85p
2SC1306	100p
2SC1307	160p
2SC1957	90p

DESIGNING MICRO SYSTEMS PART 5

So far we've covered the brains of a computer, but it's still deaf and dumb, electronically. This month Owen Bishop takes on the role of ear, nose and throat specialist.

The CPU, its ROM and its RAM, the subjects of previous parts of this series, are a tightly-knit section of all computer systems. In most micros, they are mounted together on a single computer board. This month, we are concerned with the way in which this section of the computer circuit communicates with the rest of the circuit and with devices outside the computer proper. This aspect of computer design is known as **Input/Output,** or I/O for short.

In The Right Key

Leaving aside special-purpose computers such as those used in control applications, the most important source of input to the computer is its keyboard. This is where our finger-tips send information (instructions on what to do, and data to do it with) to the computer. As I write this sentence, my fingers are pressing keys on a computer keyboard. Each key is marked with a letter of the alphabet, a numeral or other symbol. There are also a space bar and two shift keys. How does the computer know which keys I have pressed? If I press the fifth key from the left of the second row down, I want it to put 'r' on the screen. If I also press a shift key, I want 'R'. How does it know which key means which letter?

If a keyboard is to provide input to the CPU, it must somehow place information on the data bus. The keyboard of the computer which I use for word-processing does this in a simple way. The method is one which is commonly used in micros at the lower end of the price range. Figure 1 shows the main features of the circuit. The first point to note is that there is a bank of eight **buffers** between the keyboard circuit and the data bus. It would be no good if data were put directly on to the bus every time I happened to touch a key. That might be just the moment when the MPU is reading from RAM. My pressing key 'r' just then could have disastrous results! It is essential that there is *something* between the keyboard and the data bus. This is the function of the buffers.

The buffers are under the control of the MPU. Each buffer has a data input, a data output and an enable input. The keyboard uses eight such buffers and they are all enabled together. When the enable input is held high (+5 V) the buffers are in the high-impedance state: in effect, the outputs are disconnected from the data bus. The buffers are held in this state when the MPU is busy reading RAM, or, for any other reason, does not want to know what is happening at the keyboard. When the enable input is made low (0 V) the outputs of the buffers take the states opposite to their data inputs (they are inverting buffers). The data present at the inputs appears inverted on the data bus lines.

Addressing The Problem

Enabling is under the control of a logical circuit, an address decoder. In Part 3 we described how an address is decoded in order that a particular memory cell in ROM or RAM can be read from or written to. The same technique is used here. Although the keyboard is not memory in the sense that it stores information, it is addressed in the same way as memory. Most addresses are allocated to RAM or ROM, but a few are allocated to the keyboard.

In my computer, the keyboard is addressed at 3800 to 38FF, though only a few of these addresses are actually used. The address-decoding logic gives a low output (to enable the buffers) whenever '0011 1000' appears on the upper eight address lines (A15 to A8). The lower eight address lines (A7 to A0) go to the keyboard matrix. As it

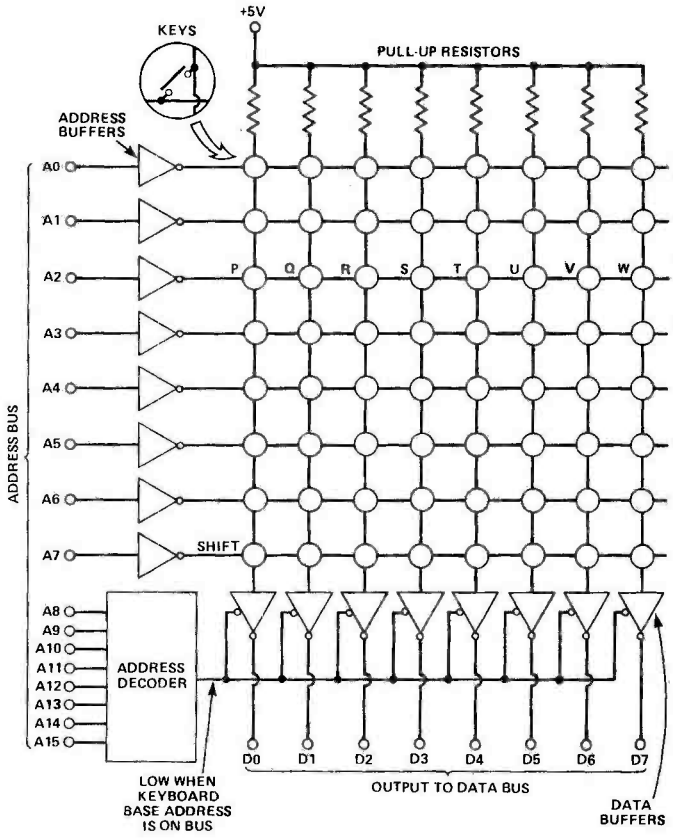


Fig. 1 A typical keyboard circuit. To simplify this, only one row of keys has been drawn.

enters the matrix, each line goes to a buffer. These are inverting buffers with open-collector outputs.

You will see from Fig. 1 that the matrix consists of eight address buffer output lines crossed by eight data buffer input lines. The keys are simple press-to-make push-buttons, joining an address output to a data input. The buffer input lines are normally held high because of the resistors connecting them to the +5 V supply line. When a key is pressed, an address buffer output becomes connected to a data buffer input. The fact that the address buffers have open-collector outputs means that if a buffer has a low output, it pulls the level down to 0 V. Otherwise the level remains at +5 V.

The Soft Solution

The rest of the input procedure depends on software: the monitor program in ROM contains a routine for reading the keyboard. The MPU addresses the keyboard by putting '0011 1000' (=38 in hex) on the high address lines (A15 to A8) and putting '1' on *only one* of the remaining address lines. For example, to address the first row of keys, the full address is '0011 1000 0000 0001' (=3801). For the next row we have '0011 1000 0000 0010' (=3802), then '0011 1000 0000 0100' (=3804) and so on through 3808, 3810, 3820 and 3840 to 3880 (all hex numbers, remember). The MPU puts these eight addresses in rotation on the address bus. When *any* one of these addresses is on the bus, the address decoder circuit enables all the data buffers. If no key is being pressed at that moment, all data outputs are low. But if one of the keys is being pressed at the same time as its address buffer output is low, a 'high' appears on one of the data lines. Thus if I press key 'r' when the MPU is addressing 3802, line A2 is high, so its buffer output is low. Since key 'r' connects this output to the buffer for data line D2, '0000 0010' (=02 in hex) appears on the data bus. The MPU now has to go to a monitor routine to interpret this data. Using this routine, it finds out that if the data is '02' when the address is 3802, then key 'r' has been pressed. An instant later, it will be addressing 3880 and, if the data becomes '0000 0001' (=01) it can then tell that the shift key also has been pressed, and that the upper-case 'R' is intended.

The MPU continually scans the keyboard in this way when waiting for input, decoding the data according to which address is in force at that instant. This approach to input relies heavily on software, and it takes several operations to detect and decode each key-stroke. Response is relatively slow. The routine required is further complicated by the need to deal with two keys being pressed simultaneously or in very rapid succession. It is necessary to check that a pressed key has been released before attempting to decode the next key that is pressed. This feature is known as two-key rollover. Fortunately, microprocessors work so quickly that even an experienced touch-typist is not able to outpace the keyboard decoding routines.

Encoding Made Easy

Although the circuit described above is simple and cheap to build, the MPU is required to do a lot of work. If this work could be done elsewhere, it would leave the MPU with more time to spend on other and perhaps less routine jobs. The alternative approach to keyboard decoding is to employ a special decoder IC (Fig. 2). Again, the keys are connected at the intersections of a matrix, but now both sets of lines come from the encoder IC. The IC has its own clock circuit and scans the matrix rapidly to find which X line and which Y line have been connected by a pressed key. Having detected a key-press, the output latches of the IC are set to produce a seven-bit code corresponding to the pressed key, taking into account whether or not the shift key or possibly the 'control' key has been pressed at the same time.

You can think of the keyboard encoder as having some of the features of a ROM. When a set of eight memory cells in ROM is addressed for reading by the MPU, its output latches deliver to the data bus the byte stored in that cell. Similarly, the memory cells of the keyboard encoder each contain one code byte. The X and Y lines from the keyboard correspond to address lines. When a particular address is set up by pressing a particular key or combination of keys, the corresponding memory cells place their stored byte in the output registers of the IC. The data stored in the registers remains there until the MPU addresses the encoder. Then its register puts the stored code on the data bus and the MPU reads the code. Note that the MPU only has to perform *one* addressing operation: the keyboard address in the Apple II, for example, is C000. This operation is much quicker than the laborious scanning operation described earlier. The only other thing the MPU has to do is to address the encoder reset (address C001) to reset the latches, ready for them to be set by the next key-press. Note that the encoder *holds* the code until the MPU requests it. In the previously described system, if the MPU is expecting input from the keyboard, it must continually scan the keyboard in case it should miss a key-press.

Ask Me In ASCII

Whereas the code generated by the circuit of Fig. 1 depends on how the circuit is wired, the code generated in Fig. 2 depends on the codes programmed into the memory of the IC during manufacture. In order to promote good communication between keyboards, MPUs and other I/O devices, a standard code has been drawn up for use in computer systems. This is the American Standard Code for Information Interchange, known as the ASCII code (Table 1). Most keyboard encoders produce ASCII code and most computers understand it!

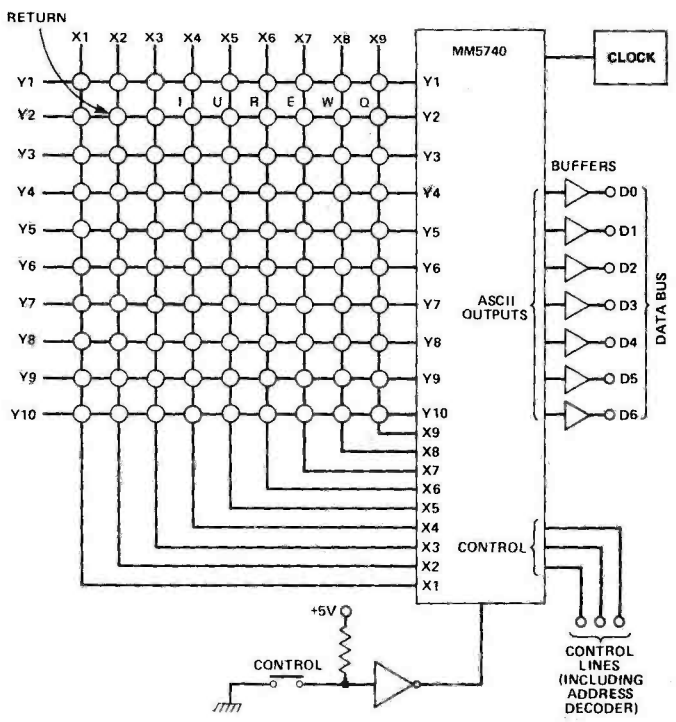


Fig. 2 A keyboard circuit using an ASCII encoder (simplified circuit; only a few keys drawn).

A quick glance at Table 1 reveals that the seven-bit codes cover more than the printable alphabetical and numerical characters and symbols. The first two columns contain what are usually termed **control codes.** These are instructions for the control of peripheral devices, especially printers. They are generated when the CONTROL key is pressed at the same time as one of the alphabetical keys. The code BS, for example, is generated by pressing CONTROL and H, and means 'backspace'. Since this is a frequently used command, many keyboards have a special 'backspace' key (←) which generates this command with a single keystroke. CR means 'carriage return'. When you press the RETURN (or ENTER) key, the keyboard sends a CR code (000 1101) to the computer. This can be used, for example, to tell the computer that the program line which has just been typed in is complete and ready to be stored in program RAM. If the MPU sends such a signal to a printer, it instructs the print-head to return to the left-hand edge of the page. The DC1 to DC4 codes are Device Control codes, available for miscellaneous functions differing from one machine to another. On the TRS-80, code DC4 instructs the line printer to print at 16.7 cpi, whereas on the Apple II it is a toggle instruction to the Silentype printer to echo its printout to the monitor screen.

A further refinement found on some systems is a FIFO, or **first-in-first-out** device. It is wired between the encoder IC and the data line buffers. As each key is pressed, the encoder sends the corresponding ASCII code to the FIFO, which stores it. Typically, it can store up to 16 ASCII codes. The codes are sent out to the buffers in the same order as they are fed in. When the MPU is ready to read a code, a strobe signal to the FIFO results in the next available code being sent to the buffers. In this way, we have **asynchronous transfer** of data between keyboard and CPU. 'Asynchronous' means that the MPU and keyboard do not have to keep in step. If the MPU is temporarily busy and not able to accept input from the keyboard, the data queues up in the FIFO until the MPU is ready to accept it.

Plugging In Peripherals

Now that micros are becoming more commonplace, people are beginning to recognise that they are capable of far more than just playing arcade games or taking charge of the book-keeping. There is an increasing interest in being able to connect external devices to the micro — anything from a simple games control to a robot arm. The more recently made micros, even those in the lower price range, now incorporate ICs which allow a variety of peripherals to be attached. These I/O channels are often referred to as 'ports'.

There are two main types of port IC. The **parallel I/O** device (or PIO) allows data to be transferred between the computer and the peripheral several bits at a time. Commonly there are eight lines, allowing transfer of one byte at a time. The **serial I/O** device (SIO) transfers data a bit at a time, but groups bits into eights (usually) so that a byte is transmitted as a series of eight bits. We will deal with SIOs in a later issue.

Parallel Lines

Although it is only recently that PIOs have become standard on many low-cost micros, they have always been an almost essential feature of the simple computers intended principally for control applications. A well-known example of a PIO is the INS8154 (Fig. 3). Our old favourite, the Sinclair MK-14, had a socket to take an 8154, though the MPU used in this system (the 8060 or SC/MP) has a few direct I/O terminals of its own. Its three 'Flag' outputs can be programmed to have high or low outputs, giving a three-bit data output. The MPU also has

TABLE 1 : THE ASCII CODE

High nibble	0	1	2	3	4	5	6	7
Low nibble								
0	NUL	DLE		0	@	P	`	p
1	SOH	DC1	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	EXT	DC3	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	↑	n	~
F	SI	US	/	?	O	←	o	DEL

The code is obtained by combining the high nibble (top margin) with the low nibble (left margin) to make a byte. For example the code for upper case W is '57'. The code '20' represents a space.

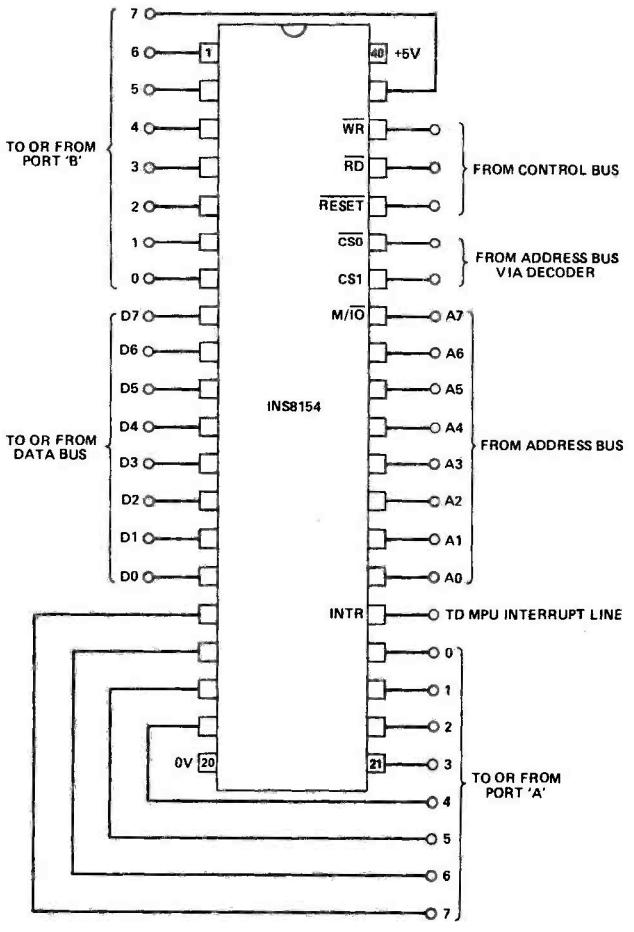


Fig. 3 Pin connections for the INS8154 I/O device.

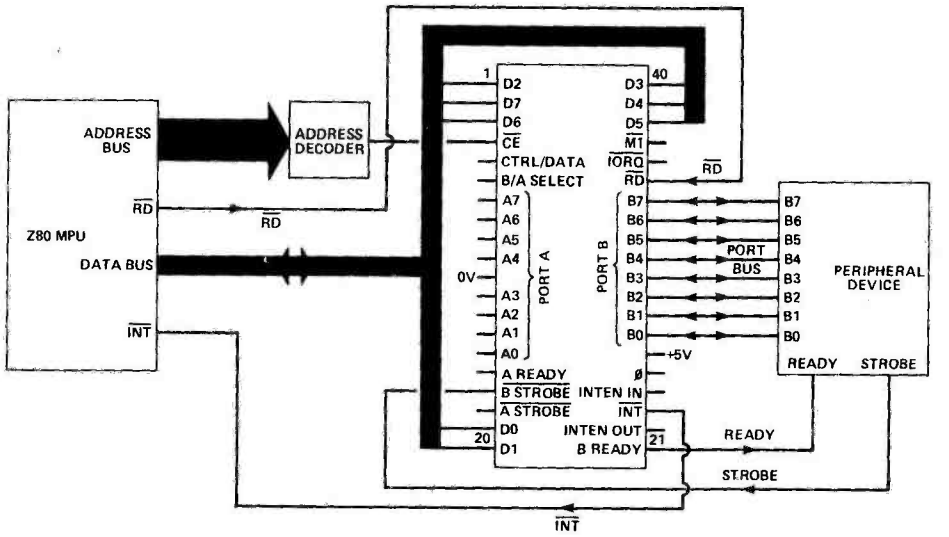


Fig. 4 The Z80 PIO, showing its main connections when linking the Z80 to a peripheral device.

two 'Serial' inputs which allow two sets of input data to be fed directly to the MPU. This feature of built-in I/O is quite enough for simple control applications and may dispense with the need for a separate I/O IC.

The Acorn System 1 is a well-established control computer. It has sockets for two 8154s, the second of which is used for I/O between the CPU and the cassette recorder. As with the keyboard, an I/O device has to be 'located' in a certain part of memory: we say that it is 'memory-mapped'. When addressing the 8154, the top eight address bits (A15 to A8) are used for establishing the base address of the IC in the way we have already described. The IC has two chip-select inputs, one of which (CS1) is active-high, and the other ($\overline{CS0}$) is active-low. Either or both inputs can be used to enable the chip, making it easier to work out an economical address-decoding circuit.

The M/$\overline{IO}$ input is unusual, for as well as being an I/O device, the 8154 carries 128 bytes of RAM. This memory/IO combination is handy for control systems, for which 128 bytes may be all the RAM that is needed. The M/$\overline{IO}$ input is usually controlled by line A7. The remaining lines (A6 to A0) are decoded inside the 8154. To operate the 8154 as RAM, the M/$\overline{IO}$ input is made high. If the base address is A000 (as in the Acorn System 1), RAM extends from A080 to A0FF (bit A7 always high for memory operations). To use the IC for I/O the M/$\overline{IO}$ input is made low (bit 7 always low for I/O). This section of the IC thus comes in the range A000 to A0FF. Actually, only a few of these addresses are used. Some of the addresses are used to initiate certain modes of operation; others are used when sending or receiving data. The method of programming the IC is too complex to go into here, but we can outline what it is possible to do.

Data is passed between the CPU and the IC by way of the eight-bit data bus. Data is passed between the IC and the outside world (TTL levels only) by the 16 I/O lines. These are organised as two eight-bit ports, A and B. Each port can be controlled and addressed separately. Reading and writing to the device is totally under the control of the MPU. The registers in each port can be instructed by the MPU to act as outputs, or as inputs. It is also possible to control each line of a port individually, so that some of them are inputs and others are outputs.

When data is being output, it is transferred to the IC and appears on those lines which have been selected as outputs. The data stays there, even though the original signals may have been removed from the data bus and the MPU is busy doing something else. The data can remain until the external device is ready for it, allowing the asynchronous transfer of data, as mentioned earlier. When the CPU reads from input lines, the data it receives is that which is being transmitted from the peripheral at that instant.

The Hardware Handshake

Obviously there can be problems in transmitting data through an I/O. How does the MPU know that the peripheral has received the data which has been sent to it? It is no use for the MPU to send a new set of data until it is sure that the peripheral has actually received the previous set. Conversely, how does the MPU know that there is a set of data waiting at the input port? How does the peripheral know when this data has been read by the MPU? Again, it is no good the peripheral inputting data to a port if the CPU has switched that port to the output function.

In some systems the sequence of operations and their timing may be such that complete transfer of data is assured. In other systems it is necessary to provide for signals to be sent between the MPU and a peripheral to control the flow of data. This is known as 'handshaking'.

The Z80-PIO (Fig. 4) has special control inputs and outputs and the necessary logic circuits to provide for handshaking. Like the 8154, it has two eight-bit ports, each of which can be individually programmed to act as an input port or an output port. Port A can also be programmed as a bidirectional port, allowing direct communication between the peripheral and the data bus. Alternatively, the individual lines of the port can be set for input or output, as described for the 8154. Figure 5a shows how data is sent from the MPU to a peripheral. As soon as data has been written to the IC and has appeared at an output port, the READY output goes high: this is a signal to the peripheral. When the peripheral receives this signal it knows that it must read the data. As soon as it has read the data, the peripheral puts a low pulse on the $\overline{STROBE}$ line. This causes the IC to generate a low pulse on the $\overline{INT}$ line. This goes to the MPU, telling it that the data has been read. The MPU may now send a further byte of data to the peripheral.

When inputting data (Fig. 5b), the peripheral begins by making $\overline{STROBE}$ low. The $\overline{INT}$ pulse generated by the I/O device interrupts the MPU to tell it that there is data to

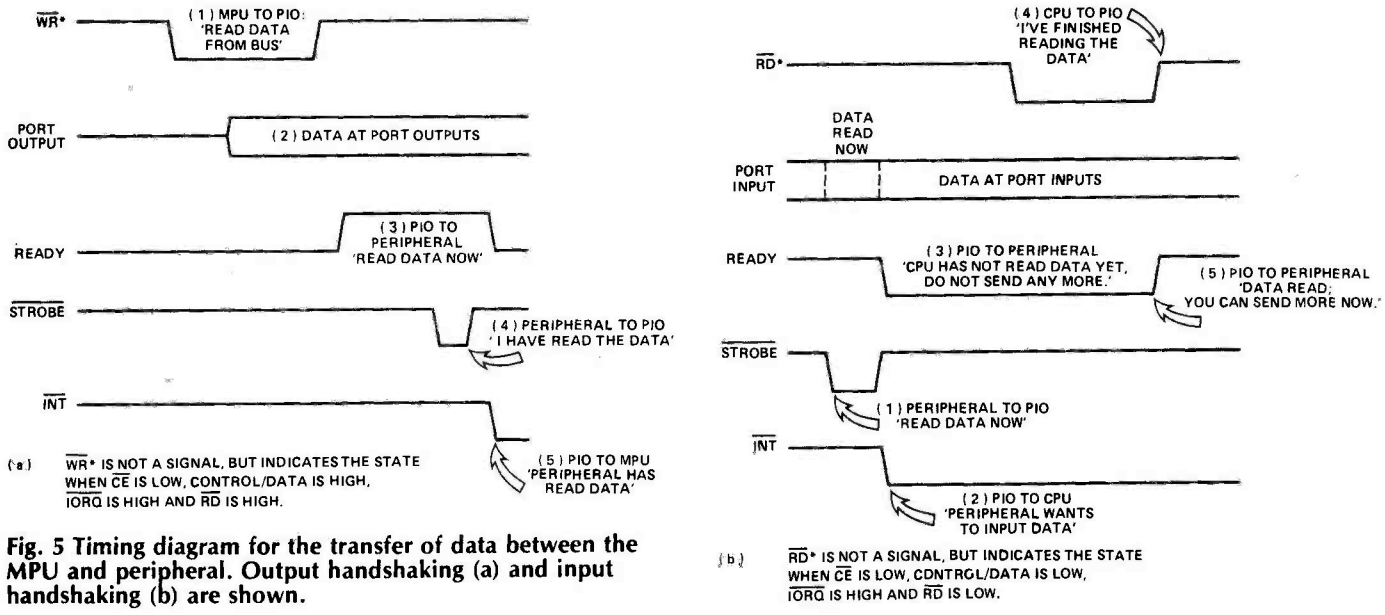


Fig. 5 Timing diagram for the transfer of data between the MPU and peripheral. Output handshaking (a) and input handshaking (b) are shown.

be read. At the same time, the READY output goes low, indicating to the peripheral that the data is being held, waiting for the MPU to read it, and that no more data should be sent in the meantime. As soon as the computer has read the data, the end of the $\overline{RD}$ pulse resets READY, so that the peripheral knows that reading is complete and more data can be sent. Thus the sender and receiver each know which stage the other has reached. Data is transferred between them in either direction without loss.

The 8154 has a similar handshaking procedure but this is limited to port A. The $\overline{INTR}$ line has the same function as the $\overline{INT}$ line, but Fig. 3 shows that there are no special control lines to correspond with READY and $\overline{STROBE}$. Instead, two of the lines of port B are taken over for this purpose when port A is to be used in the handshake mode. The remaining six lines of port B can be used independently, in the usual way.

Dealing With Interruptions

We have seen how the interrupt is an essential part of handshaking by PIO devices. The interrupt may also be used when other peripherals want to communicate with the MPU, either through an I/O device or directly to the data bus. Often, there are several peripherals connected to a system yet all give the same interrupt signal. How is the MPU to know which one of these peripherals it is dealing with?

One method is 'device polling'. Each device has a latch circuit which gives a high output when the device is trying to input data to the MPU. The latches are enabled by an address decoder, and each is separately addressed. When interrupted, the MPU goes to its interrupt routine program, disabling the interrupt function for the time being: this prevents it being interrupted again while it is attending to the current interrupt. The interrupt routine instructs it to read each register in turn to find out which device is interrupting and to jump to a particular subroutine according to which device has interrupted. Note that this program polls the devices one at a time *in a pre-determined order*. We can program the MPU to test first the registers of devices which cannot wait long to be serviced, leaving other less urgent devices until later. In this way the software establishes a system of **priorities.**

The Z80 has a vectored interrupt mode which simplifies the process of finding out which device is interrupting: at the same time as the device interrupts, it puts certain data on the bus. This data is read by the MPU and combined with other data already in memory to form the address where the appropriate interrupt routine begins. Each peripheral identifies itself by putting this particular set of data on the bus, causing the MPU to jump to the corresponding servicing subroutine.

Who's Shouting The Loudest?

Most I/O devices have two ports, some have three, and many computers have more than one I/O device. If the MPU has two or more peripherals and all are trying to communicate with it at the same time, the situation is like a political meeting with everyone trying to shout at once! There must be a system of priorities so that, when one of the more important peripherals is communicating, the less important ones are ignored. We have seen that software provides priority, but only after the interrupt has occurred. Hardware priority ensures that a high-priority peripheral will always get preference whenever it interrupts. The most commonly used method is known as daisy-chaining.

Daisy-chaining works like this. All the PIOs or other peripherals are connected to the $\overline{INT}$ line by open-collector outputs. The line is normally held high by a pull-up resistor connected to +5 V, but when any one or more interrupt outputs goes low, the voltage on the line is pulled down and the MPU goes into its interrupt routine. In order to be able to generate an interrupt output, a peripheral must be receiving a high voltage level at its interrupt enable input (IEI). Normally, the interrupt enable output (IEO) of the peripheral has the same level as its interrupt

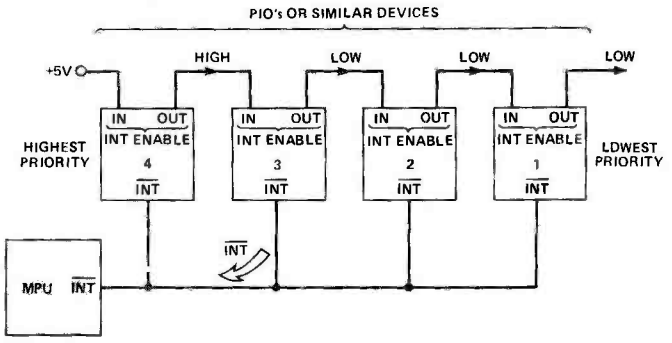


Fig. 6 Daisy-chain priority control: all PIOs are connected to the $\overline{INT}$ line. PIO no. 3 is interrupting and passing a low signal to nos. 2 and 1 to prevent them interrupting.

input. The IEI on a peripheral receives its input from the IEO of the peripheral with the next higher priority. In Fig. 6, if none of the PIOs are interrupting, every one of them is receiving a high level at its IEI from the PIO next above it in the chain. Every one of them is able to initiate an interrupt when it wants to do so. When a peripheral is interrupting or is waiting for the MPU to respond to its interrupt request, its IEO becomes low. All peripherals below it (with lower priority) then have the low level fed down to them, and are then unable to generate interrupts.

Another method involves the use of a special priority encoder IC such as the CD4532. It is the hardware equivalent of the device-polling software mentioned above. It has eight inputs, each of which is connected to a peripheral. When any peripheral is causing an interrupt, it also puts a high level on its own encoder input. The encoder also has four outputs which can be connected to the data bus through buffers which are enabled whenever the MPU wants to read the encoder. Their outputs indicate in binary code which peripheral is interrupting. For example, if peripheral no. 6 (connected to input 6) is interrupting, the outputs put binary code 6 (0110) on the data bus. By reading the bus, the MPU can find out which device is interrupting. If more than one peripheral is interrupting at the same time, the binary code for that with the higher priority (highest number) appears at the output.

Sending A Cable

We have been so preoccupied with logic that we have largely ignored one of the main problems of the input and output of data — the wiring between the computer and the peripheral. If this is to be long, special line-driving buffers must be employed though, if the computer and equipment are in the same room, this is rarely necessary. Computers work so fast that electrical signals can travel only a few centimetres during one cycle of operation. If wires are long, it may be impossible for the computer and its peripherals to remain perfectly in step with one another. This is one of the reasons for employing I/O ports with asynchronous interchange of data, as described above.

A more practical problem is the sheer number of conductors required. An eight-bit connection (the minimum commonly use) requires eight lines, plus a ground line and probably several control lines as well. There is a wide variety of multi-way connectors available for joining cables to computers and peripherals. Most are designed for use with ribbon cable.

Electromagnetic interference between adjacent conductors is a serious problem, especially with long runs of cable, and can lead to errors in the data being transferred. The data signals themselves are not so likely to interfere with each other, since they are all put on to the lines at the same instant, and there is a short period before they are read (again, all at the same time) during which switch-on and switch-off disturbances can settle. However, if the cable carries control signals, which are generally *not* turned on and off at the same time as data signals, these may interfere with the data carried in adjacent conductors. One solution is to ground alternate conductors, and use only those between them. A better solution is to use twisted pairs: one wire of a pair is used for the signal and the other wire is grounded. Special ribbon cable is made with twisted pairs with untwisted regions spaced along it, where it may be cut and linked to connectors using insulation-displacement. **ETI**

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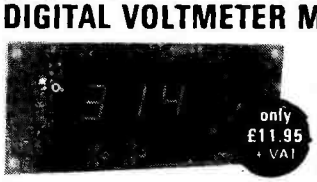


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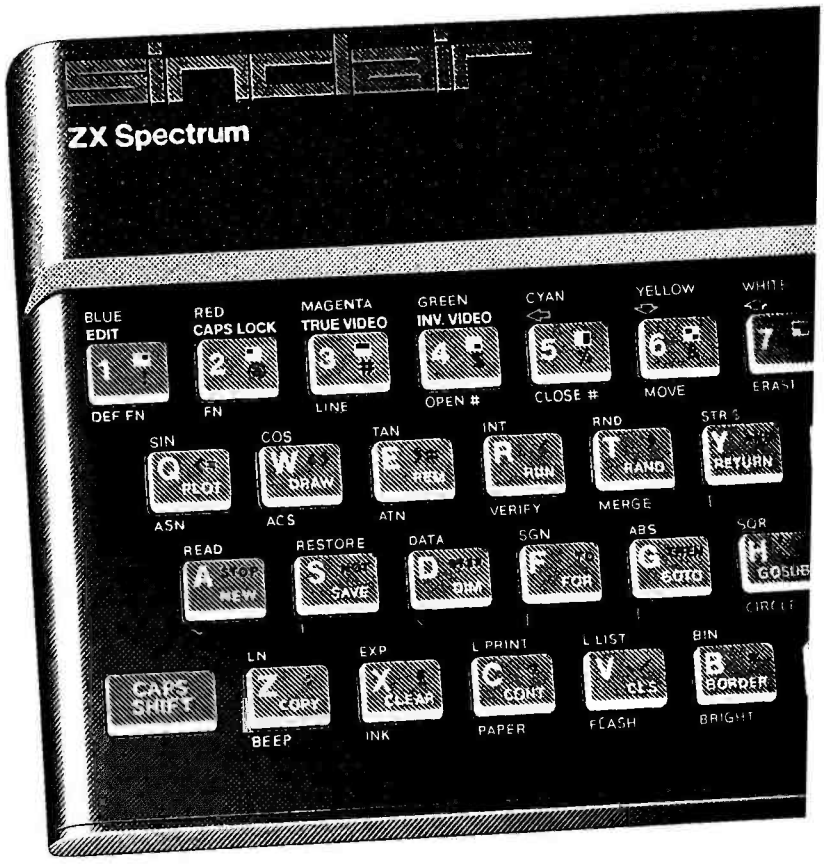
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The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

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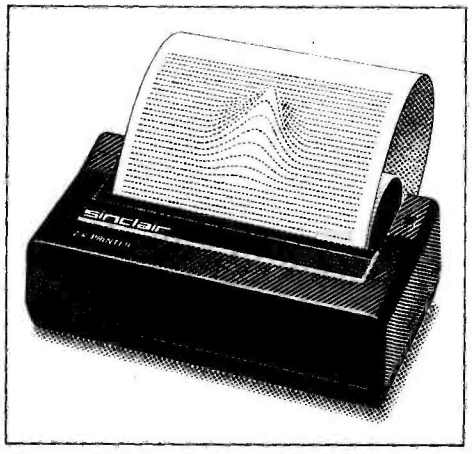
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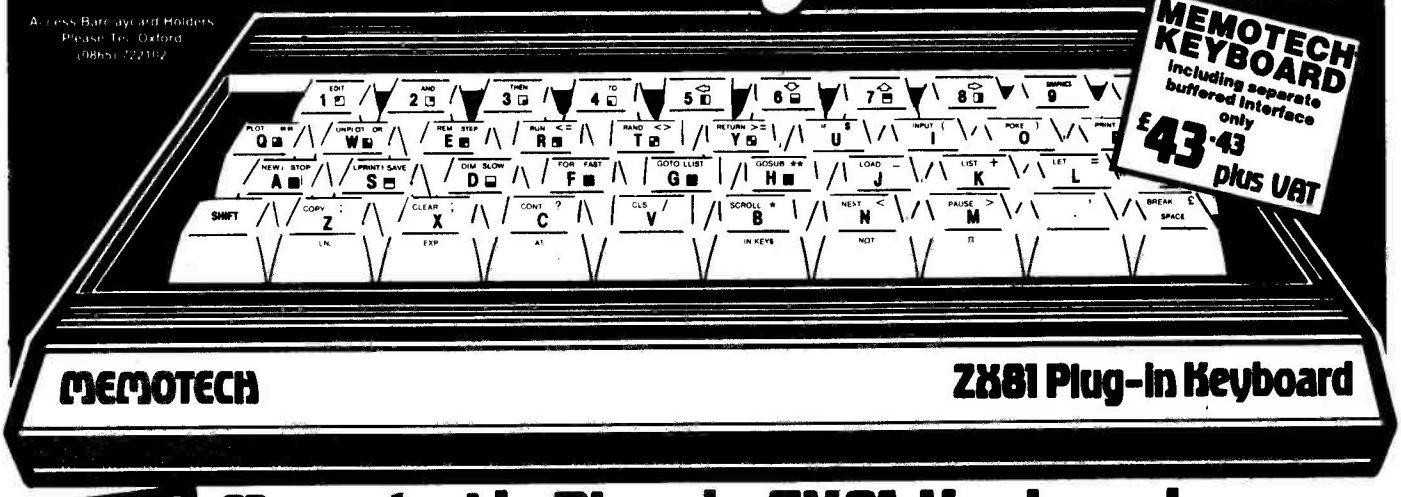
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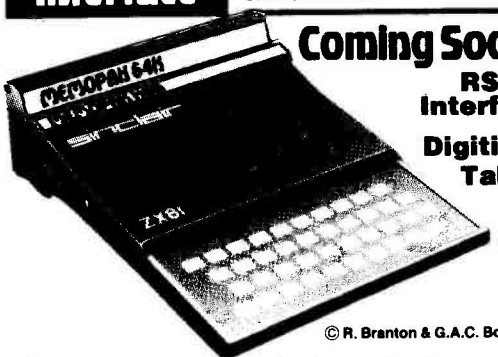
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CORTEX PART 2

Build yourself a better brain: this month we explain the remaining Cortex circuitry and the construction of the main board.

Serial I/O on the Cortex is handled by a versatile UART, the 9902. The CPU communicates with the UART via its serial I/O bus, based on the Communication Register Unit or CRU, which requires only three wires; thus the device fits easily into an 18-pin package. The 9902 is fully programmable and the range of variations is so great that it's outside the scope of this article. In the Cortex the chip is configured to handle RS232 eight-bit codes with even parity and 1½ stop bits; the communication rate can be set from BASIC using the BAUD command and the device is activated using the UNIT statement. The parameter for UNIT is a 16-bit word, each bit corresponding to a channel that can be either on (1) or off (0).

Channel 0 is the keyboard/screen channel; channel 1 is the 9902 that is already wired into the PCB. Channels 2–15 are implemented in software and only require the addition of extra 9902s on the CRU bus. The Cortex powers up set to UNIT 1. Executing UNIT 2 disables the keyboard and passes control to the 9902. UNIT 3 enables both simultaneously.

TABLE 1

SIZE	DDEN	TRANSFER RATE (kHz)	DIVISION RATIO (IC87)	MONOSTABLE PERIOD (uS)	COMMENTS
0	0	125	12	3.0	5¼" single density
1	0	250	6	1.5	5¼" double density
0	1	250	6	1.5	8" single density
1	1	500	3	0.75	8" double density

BUYLINES

Powertran are supplying complete kits of parts and component packs for the Cortex. A complete 64K Cortex kit will cost £295 plus VAT, carriage free A ready-built 64K Cortex will cost £395 plus VAT, carriage free. Prices for add-ons (eg floppy discs, RS232C interface, memory expansion etc) and for component packs (eg PCB, semiconductors etc) can be found in Powertran's brochure. Powertran Cybernetics, Portway Industrial Estate, Andover, Hants SP10 2NM. Telephone 0264 64455.

HOW IT WORKS—I/O

The I/O map space is split into two regions; the bottom region is for on-board I/O devices and the top region causes an off-board access. (The CPU has an internal I/O area of 16 bits, some of which is reserved for specific hardware functions; the rest is free for the user.) The on-board I/O area of the Cortex is decoded by IC34 into eight 32-bit slots, of which only four are used. Two slots (CS A and CS C) are used for the Asynchronous Communications Controllers (ACCs), the third (CS B) for the parallel I/O for the keyboard data, flags and control lines (such as 'ROM', mentioned in the Memory section), and the fourth for the DMA controller IC8 (CS D).

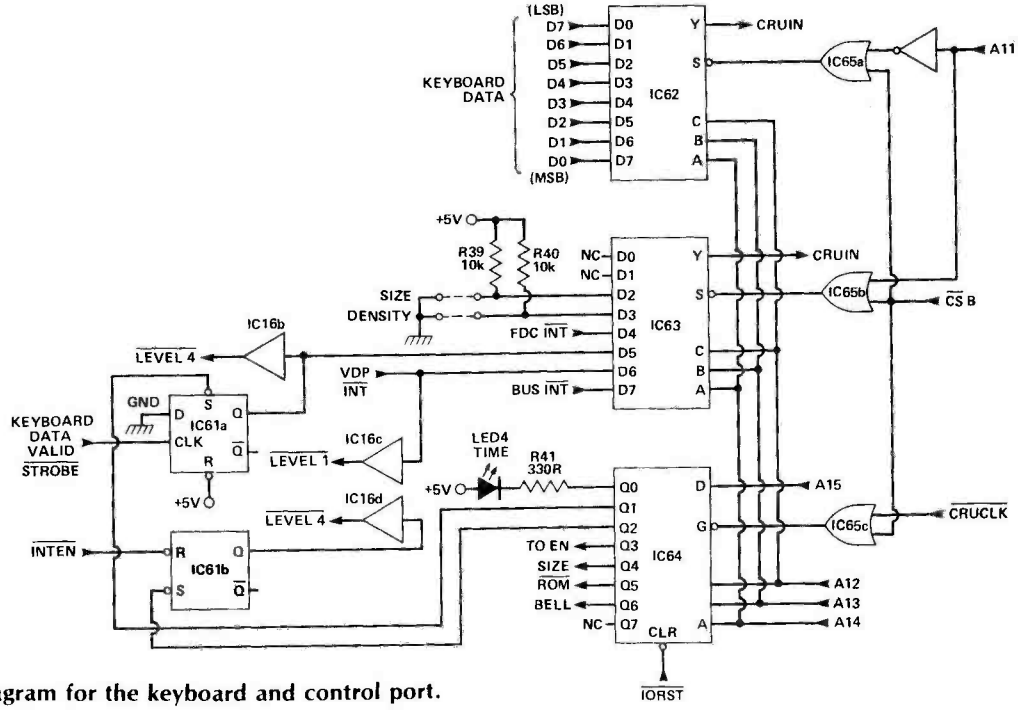


Fig. 1 Circuit diagram for the keyboard and control port.

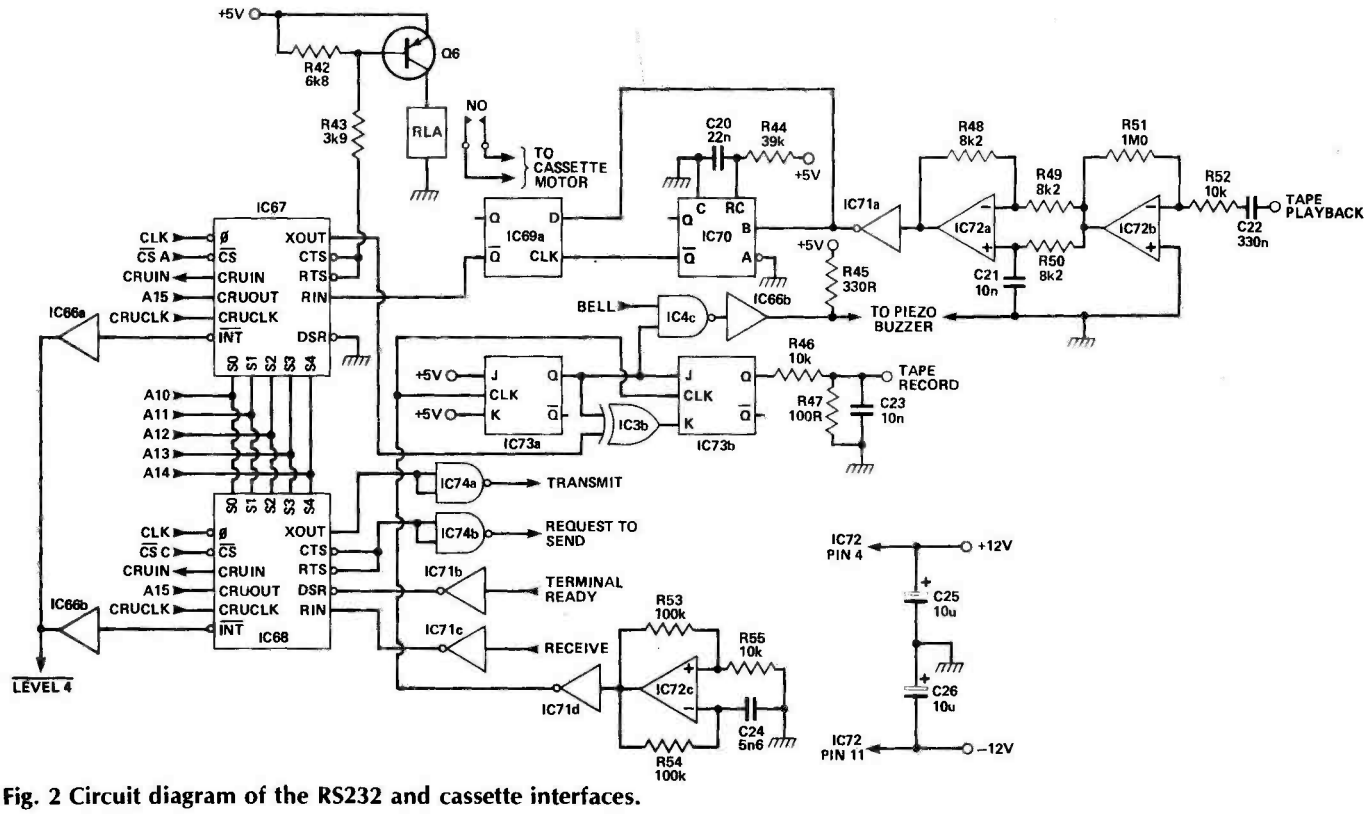


Fig. 2 Circuit diagram of the RS232 and cassette interfaces.

HOW IT WORKS — RS232 AND CASSETTE PORT

The RS232 port consists of IC68, a TMS9902 Asynchronous Communications Controller (ACC) and the TTL-to-RS232 signal level shifters (IC74a,b and IC71b,c). IC68 is a completely software-controlled device; its baud rate can be set at anything from 46 baud to over 100,000 baud. The number of bits to be transmitted or received can also be changed, as can the type, the parity and number of stop bits. The CPU drives the ACC through the serial I/O (CRU) bus. The ACC is decoded as a 32-bit block, each bit being selected by the five address lines A10–A14.

The cassette interface uses another ACC, IC67. First a 4.8kHz op-amp oscillator (IC72c) drives a level shifter (IC71d) before being divided by two in the first flip-flop (IC73a). This ensures that the waveform has a unity mark-space ratio. The serial output from IC67 then controls the action of the second flip-flop, IC73b, via the EXOR gate IC3b. When the output is high, IC73b acts as a shift register, passing through the 2.4kHz tone; however, when the ACC output goes low then synchronously at the next clock pulse, IC73b starts to divide by two, hence generating 1.2kHz. The key point here is the synchronous switch from one tone to the other. The signal is high-pass-filtered and attenuated by R46, R47 and C23 before passing to the tape recorder.

On playback the signal is first amplified by a factor of 100 and buffered in IC72b before going through an all-pass filter, IC72c. This is necessary because of the nature of tape recording. When square waves are recorded on tape they are accurately captured; however, on playback frequency equalisation is carried out in the tape recorder but the phase relationship is destroyed, resulting in a 'spiky' sine wave. This is corrected by the linear phase-shift-versus-frequency characteristic of the all-pass filter. Thus the original square wave shape is recovered at the output of IC72a. This is then level-shifted by IC71a and used to trigger a monostable (IC70a). At the end of the monostable period (312.5uS) the state of the signal is sampled by the D-type flip-flip IC69a. As the half-periods of the two tones lie either side of the monostable period, each tone generates the opposite logic level at the sample point.

HOW IT WORKS — FLOPPY DISC CONTROLLER

The TMS9909 (IC76) is a highly complex micro-controller, designed to work in conjunction with the TMS9911 DMA controller to transfer data from floppy discs. The FDC can control up to four drives which can be a mixture of two sizes or types.

All signals that go to the drives are open-collector buffered by IC80,82,83 and terminated by a resistor pack on the last drive in the chain. The signals from the drives are terminated on the board by a resistor pack and then buffered by IC84.

The raw data pulses from the drive, after being buffered by IC84a, are stretched by a monostable (IC70b) by an amount dependent on the data transfer rate selected by the 'SIZE' I/O bit and the 'DDEN' (double density enable) signal (see Table 1). The output of the monostable is used to control IC77, a digital phase-locked loop. The output of IC77 is, in the unlocked state, half the input clock frequency. When the loop is locked to a signal then the PLL inserts or deletes clock pulses in the pulse stream, thus shifting the average frequency. The programmable divider IC87 and divider IC69b are controlled by the 'SIZE' and 'DDEN' signals to select the correct clock frequency. The raw data is synchronised by IC88 to the PLL clock and then fed to the FDC. The FDC separates the interleaved clock and data bits from the pulse stream and sends data bytes via single byte DMA transfers to main memory.

Mini-floppy (5¼") drives require a motor control signal to start and stop the disc rotating. Upon starting, the disc will not be ready for data transfers for one second while the disc gets up to speed. To reduce the time required to access the disc repeatedly IC79b keeps the motor running for five seconds after it is de-selected and IC79a provides the initial one second 'not ready' signal to the FDC. For standard (8") drives that don't generate a 'ready' signal there is a set of four jumpers.

The BASIC interpreter has a 'BOOT' command which causes the FDC to read the first track from disc 1 and execute it as a machine code program. This could, for example, then search for and load the UCSD interpreter. In order that the system can boot from any type of disc there are two jumpers called 'SIZE' and 'DENSITY' which are read by IC63. This enables the BASIC interpreter to set up the FDC correctly.

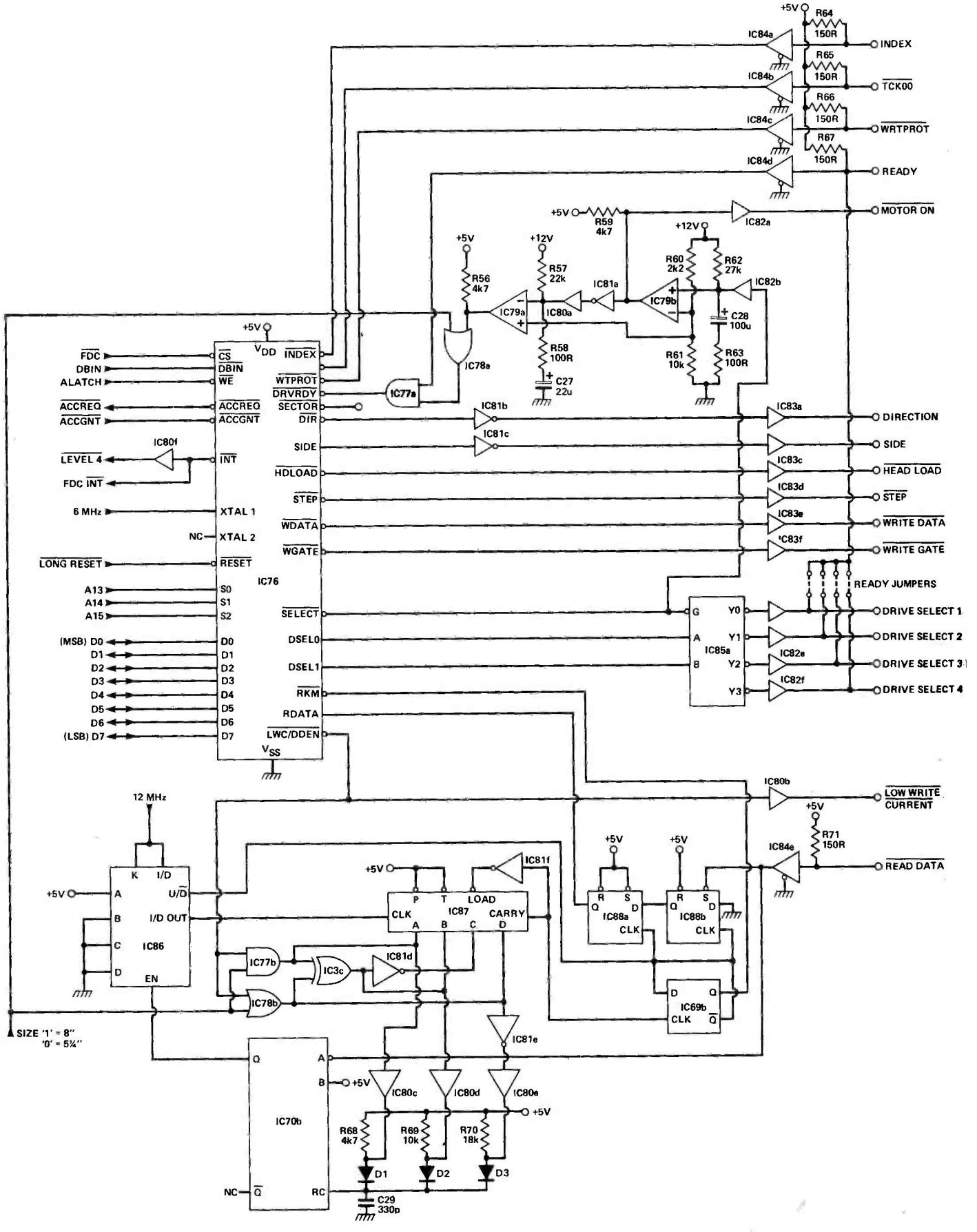


Fig. 3 Circuit diagram for the floppy disc controller section.

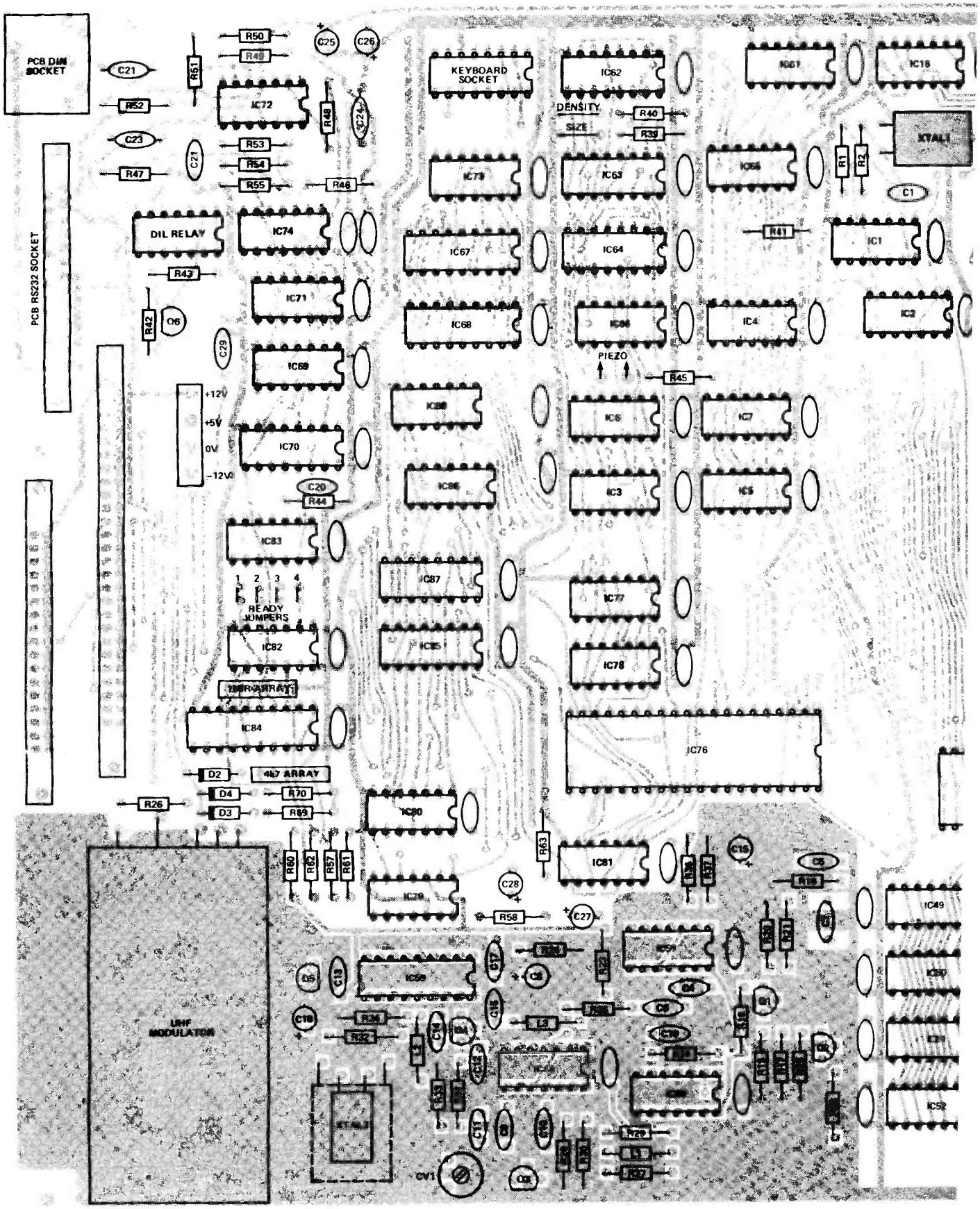
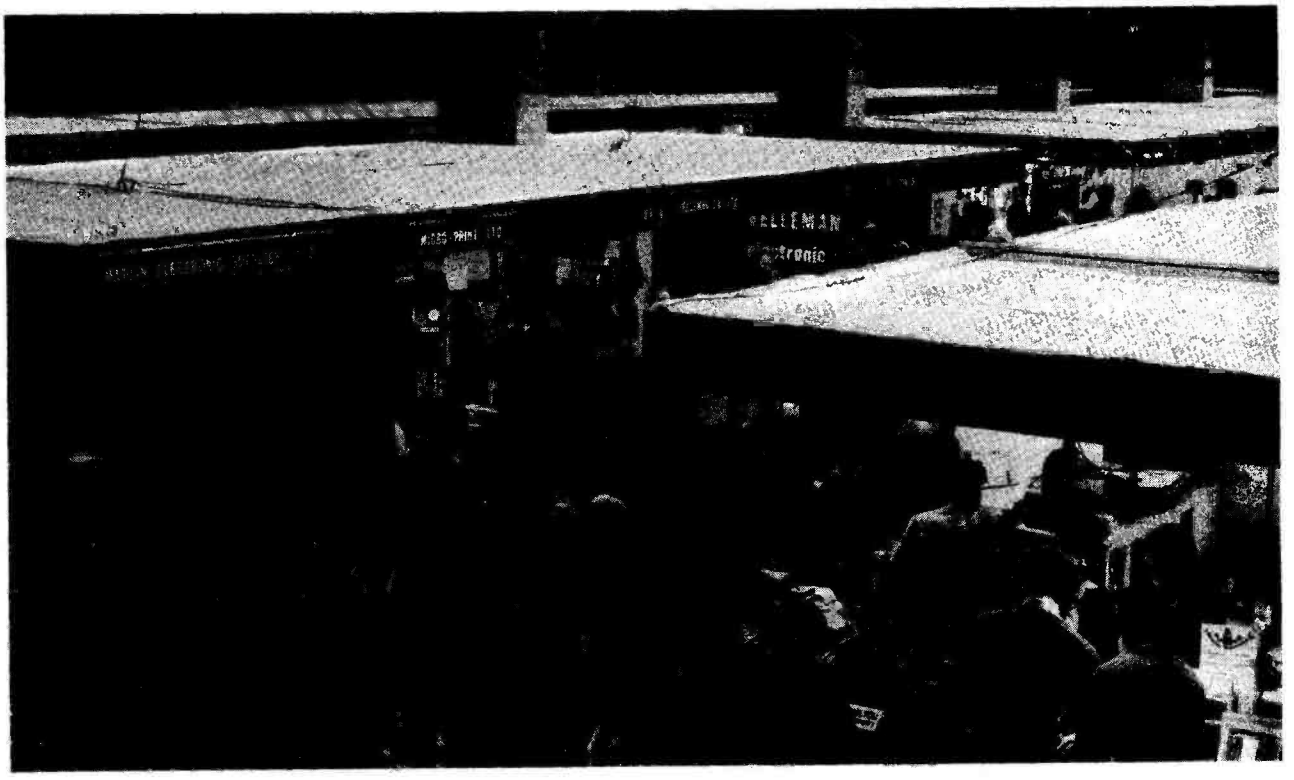


Fig. 4 Component overlay for the Cortex main board. Note that the numerous unmarked capacitors are for supply decoupling and are 47n ceramics. The grey tracks are those on the top (component) side of the board. Some changes in the IC numbering have occurred since last month due to a board redesign. To make last month's circuits agree with the above overlay, alter the

BREAD BOARD 82

THE EXHIBITION YOU CAN'T AFFORD TO MISS



EXHIBITION GUIDE

Introduction

BREADBOARD exhibition has now been on the scene for five years and has proved that there is a place for an exhibition for the serious electronics hobbyist. We normally use the term electronics enthusiast but one must remember that often beginners are as enthusiastic as those of us with many years experience — often more enthusiastic!

Various local exhibitions or club shows occur during the year, all of which offer something of interest to see and often to buy. Breadboard, being a centralised exhibition professionally run, can offer facilities a local club show cannot. As well as having the venue and stands that you'd expect at the premier amateur exhibition, we are fortunate in being able to attract exhibitors more used to professional exhibitions, and who are perhaps unwilling, for whatever reason, to attend the smaller shows.

Breadboard '82 not only has the stands you would expect with components, books, magazines, computers, kits etc, but also there will be a series of lectures and demonstrations for those that wish to improve their minds (or rest their feet!).

We will also be introducing a **Computer Forum** for the newcomers to computing, where some of the more popular home computers will be available for you to try out. Our staff wil be on hand to help you understand those areas that are giving you a late-night nervous breakdowns!

This year we are fortunate in having two particularly interesting exhibitions/demonstrations. One is a computer moderated wargame using computers together with a scale terrain, troops, etc., that enables the visitor to assume command of the overall tactics of a modern battlefield. Should be interesting to see if Ruritania really could be next years number one super-power! Secondly we will be having a fascinating exhibition of holograms. These will be supplied by Light Fantastic and really have to be seen to be believed. For not even an arm or a leg could you buy one for your own home.

For those parts that need special restoration we will have the usual bar and restaurant open for your use beneath the exhibition hall. Don't miss Breadboard '82, you could even save yourself some money on some of the exhibition's special offers!

Peter Freebrey, Exhibition Manager

SPECIAL ATTRACTIONS

COMPUTER MODERATED WAR-GAMES

Dave Rotor sponsored by Amplicon Micro Systems, Brighton; figures supplied by Adventure Worlds, London, SW1

Wargames give you the chance to be your own general! The game that will be played at the exhibition is based on a small-scale encounter somewhere in Europe during World-War II. The players each have a small force at their command — made up of infantry, tanks and/or artillery — and have to fight out their encounter on the terrain of the board. Each game turn represents a relatively small interval of time (eg, 3 minutes) and during one move, the commander of each side can tell any or all of his forces to move or fire selected weapons. The men and machines involved in the conflict will be represented by 1:1/200 scale models specially for the humans, however the computer will have an 'image' of the battle-field stored in memory.

Fed with each players' move, the computer works out the practical consequences, governed by data on the weapons in the possession of each side, the conditions of the terrain, the men, the weather, etc. The performance of the weapons, and even the men, is deduced from known details of real-life battlefield performance.

Suppose you have a squad of ten men and you decide to move them into battle; it's known that armed men can travel at 3 miles an hour in reasonable conditions. Depending on the time that each move represents, the squad will move a proportional scaled distance (worked out by he computer) in the direction you specify. If you order them to fire their weapons (or if your opponent's tank fires at them, for instance), the effectiveness will be gauged by the distance, the known effectiveness of the weapons against the type of target they are firing on, and all the other factors programmed. The computer will then tell you what degree of damage you have inflicted on each other.

The sort of calculation involved in the evaluation of the tables, etc, used to take human moderators some considerable time; now a fair sized home-computer can do the calculations involved in less than a second. During the exhibition, both war-gamers and computer programmers will be on hand to give detailed explanations of the programming and the theory behind the game.

HOLOGRAMS

Light Fantastic Gallery, Covent Garden, London.

Light Fantastic is the first permanent gallery of holography in Britain, and was set up after the success of the 1977 and 1978 Light Fantastic exhibitions at the Royal Academy.

Holography itself has progressed a long way since the first indistinct three-dimensional images were produced in 1947 by Gabor, a scientist working at the Rugby Electrical Company in Scotland. Gabor was subsequently awarded a Nobel Prize for his invention.

The invention of lasers in 1960 made holography much more of a practical proposition. Most of the early laser-produced holograms had to be lit by laser in an area with low ambient light level. Later in the 1960s, the technique was improved to allow holograms to be lit with a standard tungsten halogen light source. The development continued from here, now allowing low cost high-volume production in acceptable commercial quality.

Holographic Exhibitions Ltd (holding company for Light Fantastic) provide a total design to installation service for commercial holography.

Light Fantastic will be showing a selection of some of the most striking items from their permanent collection.

EXHIBITORS

Here are just a few of the many leading companies who will be exhibiting their latest lines. More and more companies are booking all the time, and electronics is a rapidly changing field, so we won't have full details of all the exhibitors until the last minute — this is just a foretaste of what is to come. A full catalogue will be available at the exhibition.

ELECTRONICS TODAY INTERNATIONAL

You've read the magazine, you've built the projects, now visit the stand and meet the people who are responsible for it all.

On display will be a large number of our projects, including the brand new 16-bit home computer, the robot arm, and many, many more, all springing into action before your very eyes! Besides this, you'll be able to put your questions to us, and we'll do our best to help. So come and see us on our stand.

HOBBY ELECTRONICS

An intelligent robot in a plastic basin is but one of the marvels on show to those of you who come to visit the Hobby Electronics stand at this year's Breadboard Exhibition.

As well as being able to see some of our best projects at close quarters — yes, they really do exist — you will get the chance to meet the people who produce HE. So, if you've been having some problem with getting your prototypes to work, or you'd just like to air your views on the mag, then pop along and we'll do our best to enlighten you. Even if you're the shy retiring type, don't be discouraged, just stroll up and play with something that takes your fancy — there's so much to choose from amongst test gear, audio, RF, gadgets, games and the like, that we'll be surprised if you *want* to look at any of the other exhibitors. Though, of course, there are plenty of others around, should you be that way inclined!

COMPUTING TODAY

Computing Today is the leading magazine for the serious home computer user looking for the professional approach. Written by micro users for micro users, inside each issue you will find feature articles, projects, general topics, software listings, news and reviews. You'll also be able to buy copies of the current magazine (as well as back issues where available) and any of our popular range of CT Software. So, if you're a committed micro user, come and meet the editorial staff and we'll show you a truly personal approach to microcomputing.

PERSONAL COMPUTING TODAY

Since its first issue in August of this year, PCT has become **the** magazine for the not-so-experienced computer enthusiast. We provide lots of helpful advice on choosing and using a home computer and associated peripherals, a directory of off-the-shelf software, plus lots and lots of programs from the very simple to the stunningly sophisticated. Come and visit our stand, and see how we can help you find your way through the maze of computing.

ETI, HE, CT and PCT are all magazines published by ARGUS SPECIALIST PUBLICATIONS LTD. Other magazines include **Electronics Digest, ZX Computing** and **Personal Software.**

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BRADLEY MARSHALL LTD

Bradley Marshall is one of the leading electronic component distributors in the UK, building a reputation for the highest quality items in every area of the micro-electronics business. At Breadboard '82 they will be exhibiting a select range of items from their diverse spectrum covering over 3,000 individual product categories.

Whilst it is almost impossible to keep pace with change in the electronic market, Bradley Marshall feel confident that their new 1983 catalogue is as up-to-date as it is possible to be. As well as the complete range of Bradley Marshall components, the catalogue contains a great deal of component data to aid the hobbiest. Bradley Marshall are delighted to be able to make available advance copies of the catalogue exclusively for Breadboard '82 at a special exhibition price of 50p.

Bradley Marshall are the sole London distributors of **Crimson Electrik** Professional Audio Amplifier Modules. Crimson Electrik Modules are internationally renowned with a reputation based on quality, reliability and value for money as witnessed by the BBC, IBA and KEF to name but three. Bradley Marshall will be displaying the complete range of these extraordinary amplifiers at Breadboard '82.

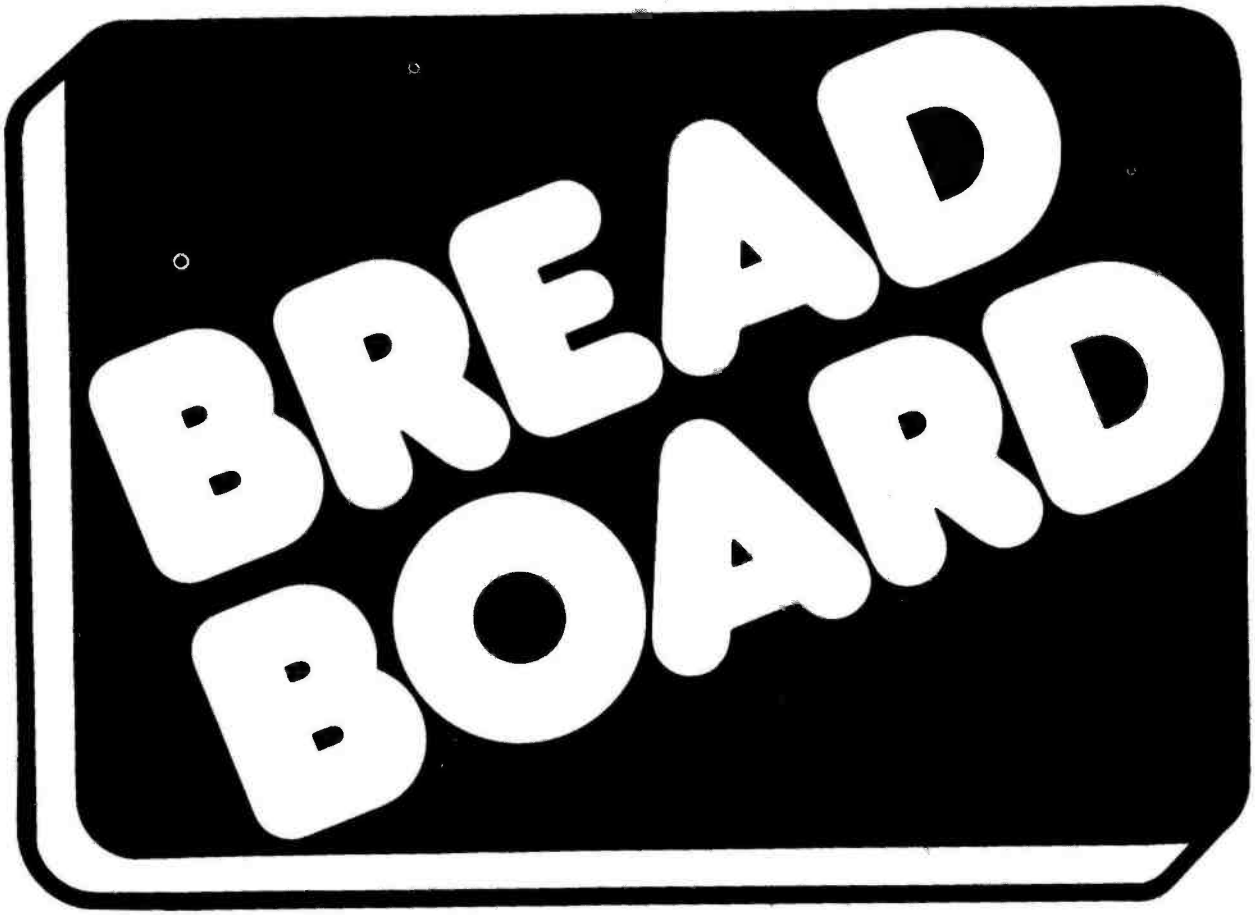
Thandar and **Leader** are names that need no introduction to either the professional engineer or dedicated hobbyist as makers of some of the finest precision test equipment and accessories on the market today. Bradley Marshall will be displaying and demonstrating a selection from this high quality range.

They say a bad workman blames his tools — but not **Bahco,** the foremost quality tools from Sweden. The complete range is available from Bradley Marshall and will be on display at the exhibition.

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Booking If your company would like to take a stall at the exhibition, ring Colin Mackenzie on 01-286 9191 **soon.**

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CT-403



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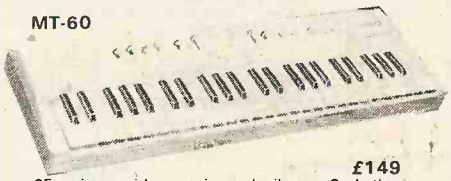
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The MT-31 does not have a bass keyboard, auto function or rhythm accompaniment but it is otherwise identical to the MT-40. Weight 4.4lbs.

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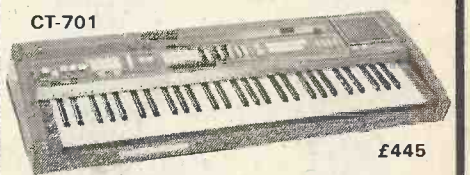
Tens of thousands of this little marvel sold. 29-note mono keyboard. 100-note tune memory. 5 preset sounds plus ADSR selector. 10 auto rhythms. One-Key-Play button. Calculator. 1⅛ x 11¾ x 3 inches. Weight 15.4oz.

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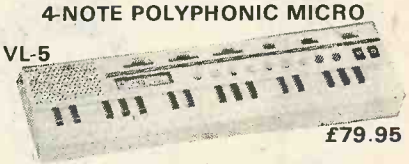
MINI PROGRAMMABLE
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PC-3 hard case. MT-60/70	£13.00
HC-A hard case. CT-101/403	£30.00
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GM-30 Destroyer/submarine sea battle game.
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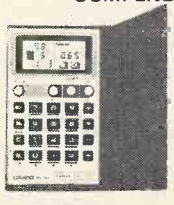
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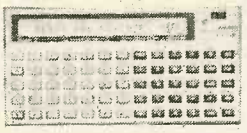
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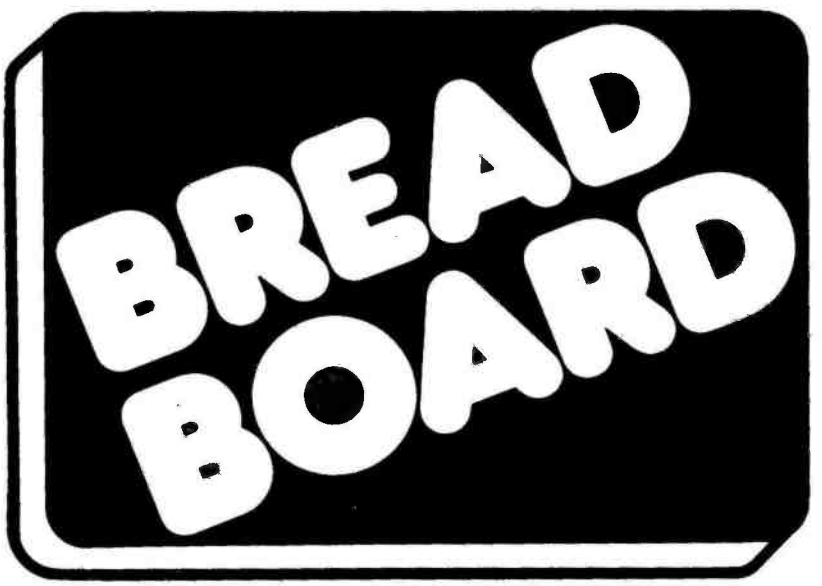
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Velleman will have a large selection of their kits available at Breadboard for inspection and sale, and an engineer will be on hand for most of the time to advise and answer questions. Their illustrated catalogue will be obtainable from the stand and is always available on request from the UK office.

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Saturday	1100	Electronic Music Techniques
13th November	1200	The Digital Solution
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	1500	Electronic Music Techniques
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Music projects that have appeared in ETI over the past few years will be put through their paces by a professional musician. This is a good opportunity to decide, with your ears, which synthesiser or fuzz-box to build.

Cable TV – G. Brant, BSc
Cable and satellite TV systems are the newcomers to the broadcasting world of the '80s. A brief description of the existing transmission network will be given, followed by a look at these new media.

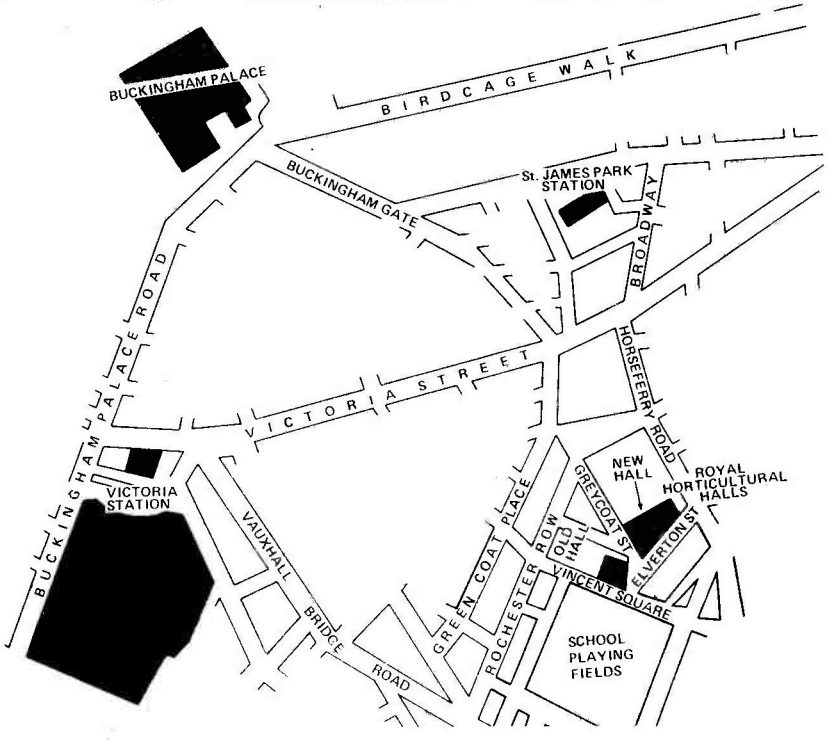
BICC-Vero
BICC-Vero Electronics will be giving audio-visual demonstrations of their new insulation displacement system called Speedwire, ideal for fast positive contacts. On alternate days, there will be lectures on wire-wrapping, an alternative system for solderless connections.

Gateway to Electronics – Dave Bradshaw, MSc
This is a lecture for beginners in electronics, and will offer a mixture of very basic circuit theory and practical advice.

The Digital Solution – Owen Bishop, BSc
In these lectures I propose to cover the whole range of applications of digital electronics, including digital computing, D–A conversion, digital recording, remote control, etc. There will be a selection of working demonstration circuits to illustrate points made in the lectures.

Electronic Music Techniques – Tim Orr, BSc
The lecture demonstration will consist of a technical explanation coupled with a musical demonstration of a polyphonic music synthesiser, a digital delay line and a vocoder: all these have been designed by the lecturer.

Holography – Andrew Pepper
This will be an introduction to the principles, methods and techniques of practical holography.

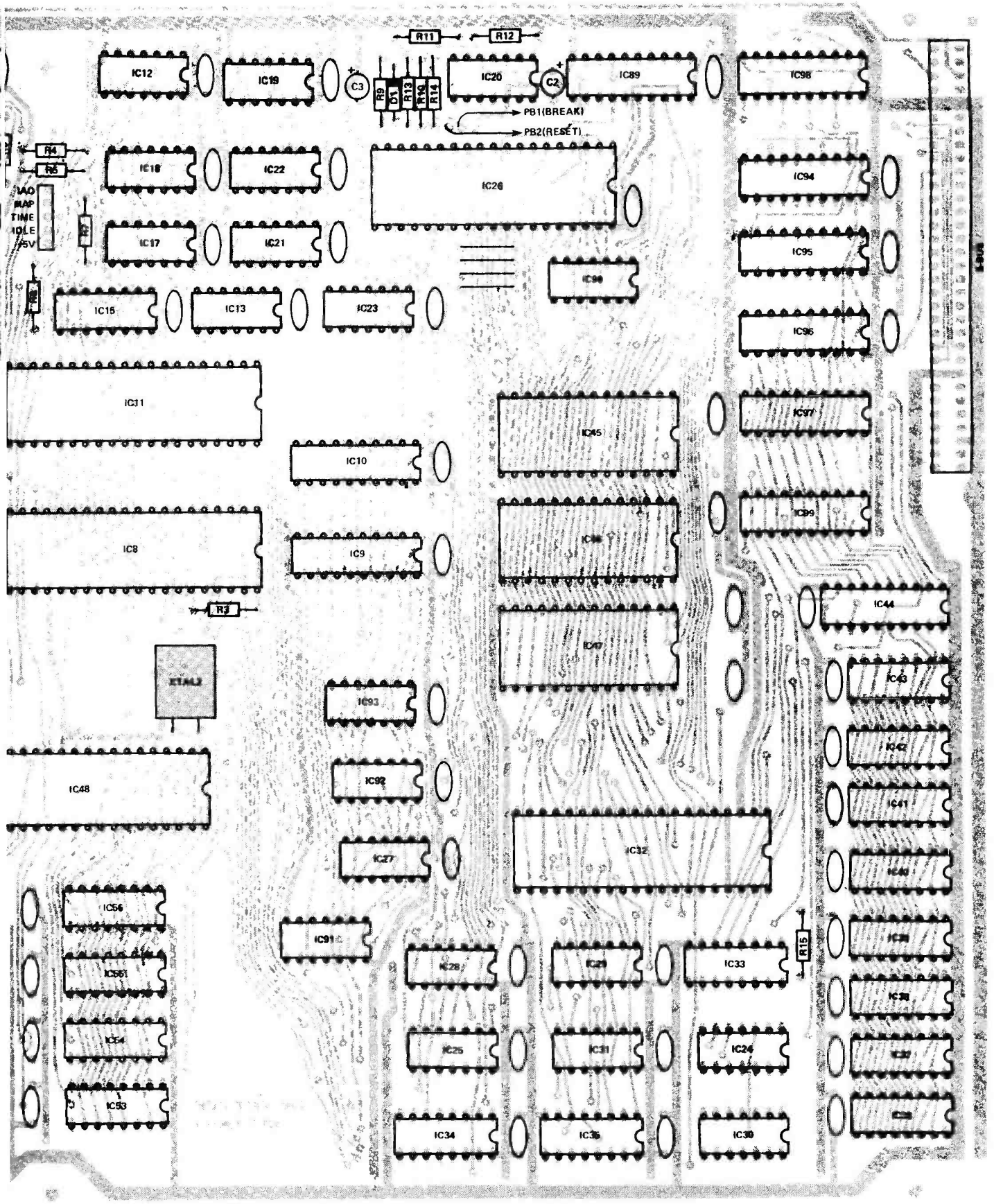


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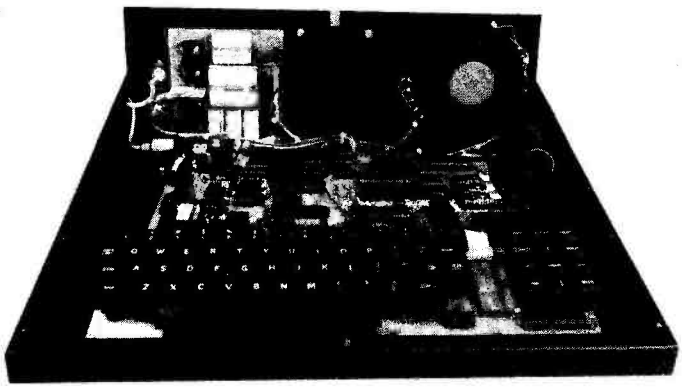
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and many more.

BREADBOARD 82



labelling thus: IC6a to IC1c, IC6b to IC1d, IC6e to IC1e, IC12a to IC2b, IC1c to IC6c, IC1d to IC12a, IC1e to IC12b, IC1f to IC12c, IC14a to IC4b, IC2b to IC17b. IC14 and IC75 are not used in the new numbering. R26 is not needed in the PAL circuit, but the modulator needs a 10k pull-up to +5 V, so we've called this R26. IC60b clock goes to 0 V, IC60b SET goes to SYNC.



Construction

The main board and the keyboard both have plated-through PCBs, ie there are tracks on both sides and connections between the sides are made by the copper that has been plated onto the sides of each hole. There are therefore no track-link pins; it is, however, good practice to apply solder to EVERY hole to reinforce the connections which in some cases carry power. This happens automatically when boards are 'flow soldered' by passing over a wave of solder in a solder bath during factory assembly. With plated-through boards it is particularly important not to make errors of construction as removal of soldered-in parts is more difficult than on conventional boards and

Fig. 5 Circuit diagram for the E-BUS interface.

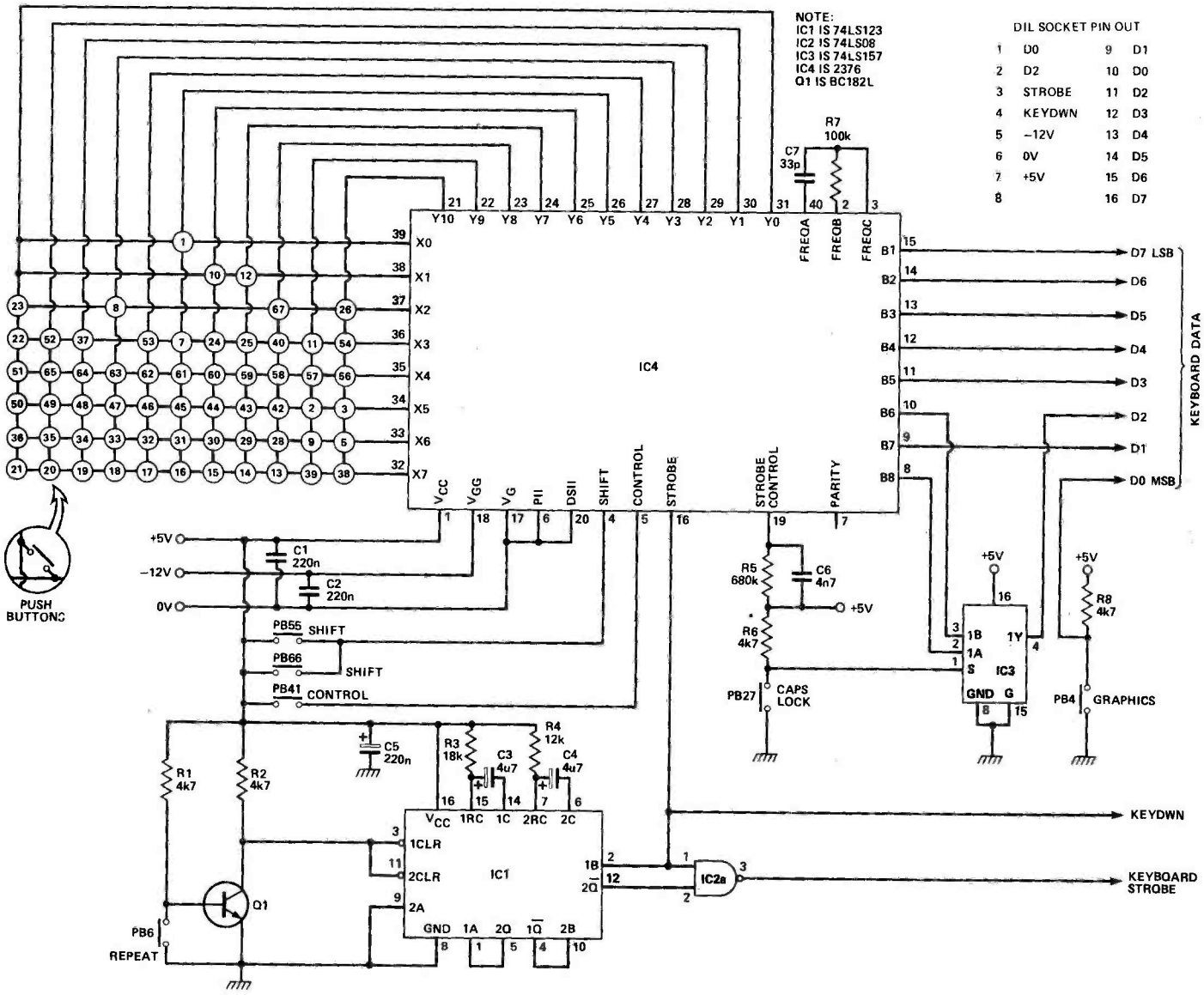


Fig. 6 Circuit diagram for the keyboard.

HOW IT WORKS — E-BUS

The E-BUS is a powerful and compact bus which allows many intelligent cards to share a common resource of memory and I/O cards. In order to share out the resources on the bus, each card has a priority according to its position. This is done by passing a signal down the bus which goes into each card as GRANTIN and comes out as GRANTOUT to form the GRANTIN of the next card. A second signal, BUSY, tells each card if the bus is in use or free. If the bus is free and a card requires the bus, it disables the lower priority cards with the GRANTOUT signal and if the GRANTIN signal and BUSY are OK it asserts BUSY and enables its data and address bus buffers.

Once the bus transfers are complete or if a higher priority card requires the bus, then the card will relinquish control. All these events are synchronised by a backplane clock, BUSCLK. Each data transfer that takes place must signal its completion using $\overline{\text{READY}}$.

The 74LS2001 gate array (IC89) contains the bus arbitration and control logic to gain and release the bus with timeouts upon error conditions. If the card cannot gain control of the bus after 128 clock cycles, it aborts with a timeout interrupt. Also, if after 16 clock cycles the transfer has not been signalled as complete using the $\overline{\text{READY}}$ line, the controller completes and issues a timeout interrupt.

The E-BUS has provision for a multibit interrupt code signalled by the $\overline{\text{INTEN}}$ signal. This interface only provides a single interrupt level using the $\overline{\text{INTEN}}$ signal. The data, address and interrupt signal are multiplexed onto the same pins to conserve connections. The ALATCH signal is used to enable the address latches when the address is on the bus. Then either $\overline{\text{DEN}}$ or $\overline{\text{WE}}$ will be signalled, to show that either a data read or write is occurring and that data is now on the bus. The $\overline{\text{INTEN}}$ signal can be used to latch the interrupt code.

KEYBOARD

The keyboard is a separate unit providing a fully encoded output. Most of the work is carried out by the 2376 keyboard encoder (IC4). This IC contains a 50 kHz oscillator and two ring counters of eight and 11 stages, the outputs of which form an XY matrix across which the switches are connected. By this means each key is sequentially scanned. The closing of one of the switches for a sufficient length of time for switch bounce to be completed causes the scanning to stop; a 'valid' signal now appears on the strobe output. The encoder also contains a 2376-bit ROM (hence the IC name) arranged as three groups of 88 words of nine bits. The shift and control inputs select one of the three groups and the individual word is addressed by the ring counters.

IC3 is a data selector. D2 is either the output B6 or B8 depending on whether upper or lower case characters are selected by the CAPS LOCK switch. Repeated entry of a character is accomplished by multiple strobe signals from IC1, which is a dual monostable arranged as an oscillator and is enabled by a high level on the clear inputs.

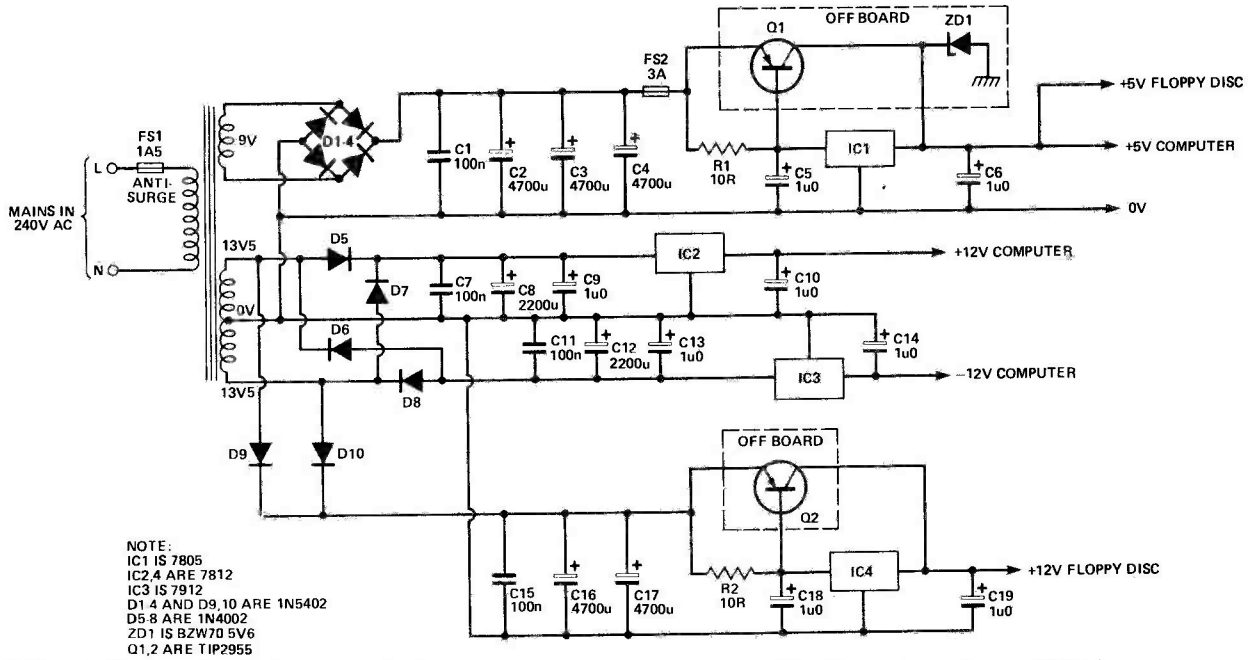


Fig. 7 Circuit diagram for the power supply.

the chances of this being required are much reduced by fitting ALL parts before soldering — if the last part left for fitting is not the one required for the last space you can be pretty sure that the required part is in the wrong holes! IC sockets should be regarded as essential; these are provided with the kits and should be fitted with the index mark corresponding with the index mark on the overlay.

The final part appears next month.

HOW IT WORKS — PSU

The computer main board and keyboard together require a 5 V at 3 A supply, together with low current ± 12 V rails. One amp plastic voltage regulators on small finned heatsinks are used for the 12 V supplies; for the 5 V supply a 1 A regulator is also used but the current-carrying capacity is boosted by bypassing it with a 15 A power transistor, the base current of which passes through the regulator. R1 prevents the off-load input current of the regulator from turning on the transistor when there is no load during testing. The resistor also increases the speed of operation of the transistor. The 1uf capacitors are for the stability of the regulator and the 100nF capacitors are used to remove fast transients orginating from the mains. The zener will clamp any spikes that reach the output.

To simplify the addition of floppy discs these are powered from the same board. The drivers require about 0A7 at 5 V which is also supplied by Q1; they also require + 12 V at 1A6 with higher surges at switch-on, and this is provided by a separate section using Q2 controlled by IC4.

PARTS LIST — MAIN BOARD

Resistors (all ¼W, 5% except where stated)

R1,2	470R
R3-5,11,32	4k7
R6-8,20,21, 28,37,41,45	330R
R9,12,13,15, 39,40,46,52, 55,61,69	10k
R10,14,47, 58,63	100R
R16-19	560R
R22	120k
R23,24,31, 36	1k0
R25,29,33	2k7
R27	390R
R30	1k5
R34	1k8
R35,60	2k2
R38,53,54	100k
R42	6k8
R43	3k9
R44	39k
R48-50	8k2
R51	1M0
R56,59,68	4k7 resistor array
R57	22k
R62	27k
R64-67,71	150R resistor array
R70	18k

Capacitors

C1	1n0 ceramic
C2	4u7 16 V PCB electrolytic
C3,25,26	10u 16 V PCB electrolytic
C4-6,9,10, 17	100n ceramic
C7	470n ceramic
C8	33u 16 V PCB electrolytic
C11,12,16	33p ceramic
C14	47p ceramic
C15,18,27	22u 16 V PCB electrolytic
C19	100p ceramic
C20	22n ceramic
C21,23	10n ceramic
C22	330n ceramic
C24	5n6 ceramic
C28	100u 16 V PCB electrolytic
C29	330p ceramic
CV1	6-30p trimmer

Semiconductors

IC1,6,12,27, 81	74LS04
IC2,17,18, 61,69,88,92	74LS74
IC3	74LS86
IC4,21,31,93	74LS00
IC5,22,30	74LS02
IC7,24	74LS10
IC8	TMS9911
IC9,10,84, 94-96,98,99	74LS244
IC11	TMS9995
IC13,77,90	74LS08
IC15,34,35	74LS138
IC16,66,80, 82,83	74LS07
IC19	74LS164
IC20,79	LM339
IC23	74LS20
IC25,65,78, 91	74LS32
IC26	74LS612
IC28,29	74LS27
IC32	TMS4500
IC33,85	74LS139
IC36-43	TMS4164
IC44,97	74LS245
IC45-47	TMS2564
IC48	TMS9929
IC49-56	TMS4116
IC57,58	4016B
IC59	LM1889
IC60	4013
IC62,63	74LS251
IC64	74LS259
IC67,68	TMS9902
IC70	74LS123
IC71	75189A
IC72	TL084
IC73	74LS73
IC74	75188
IC76	TMS9909
IC86	74LS297
IC87	74LS163
IC89	74LS2001
Q1,3,4	2N3904
Q2,5	2N3906
Q6	BC212
D1-4	1N4148
LED1-4	LEDs to choice

Miscellaneous

PCB (see Buylines); case (see Buylines); IC sockets; I/O connectors to suit; UHF modulator (UM1233 or UM1286).

ETI

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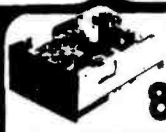


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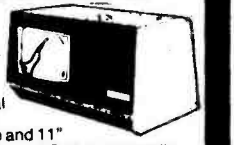
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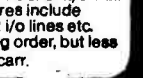
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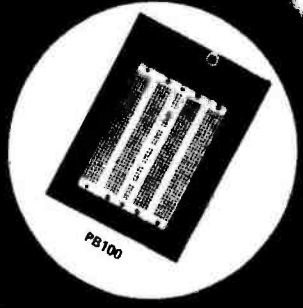
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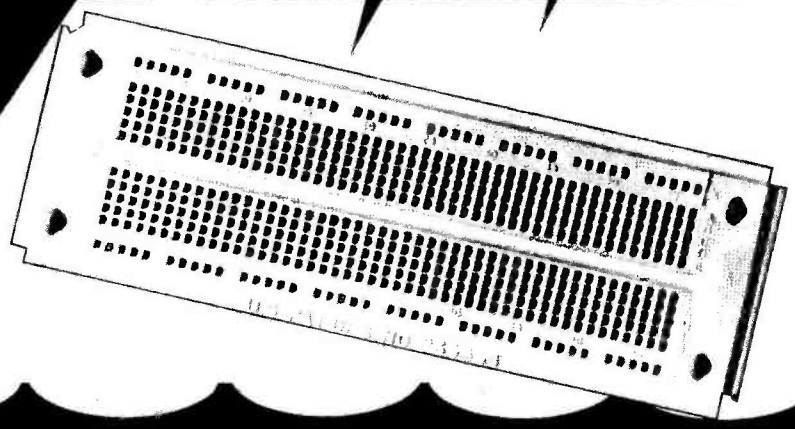
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SPECTRACOLUMN

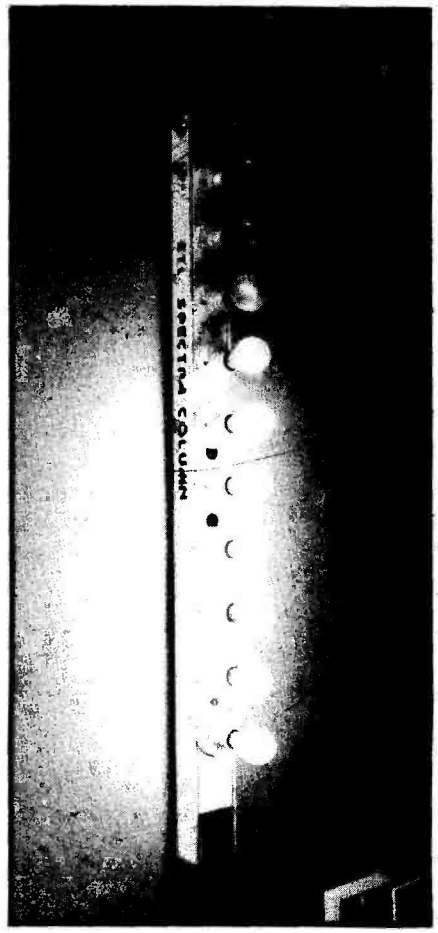
With this project we throw some light on the problem of how to jazz up your disco or party. This cost-effective, crammed-with-everything light column can be used singly or in groups to dazzle the dancefloor. Design by Rory Holmes.

The ETI Spectracolumn is an up-market sound-to-light system; by this we mean its lighting effect is a cut above the average 'three bulb' systems, although its cost is not. Ten mains bulbs, arranged in a column, respond to the intensity of music (or any sound signal) within a pre-selected frequency range. It works like a giant bargraph voltmeter; the more energy in the chosen frequency band the more bulbs will illuminate, forming a column of light that rises up from the floor and follows the rhythm of the music. The display system is very versatile; it can be built with any type of bulb in any configuration, and may be expanded for large parties or discos. Multiple columns can be set to adjacent frequency bands to build into a giant spectrum analyser and display system. Imagine — a kilowatt light column devoted to each octave across the whole audio spectrum!

In designing the band-pass filter system we have made use of the latest switched capacitor filter IC, the MF10. This device contains two second order filters whose cut-off frequencies are directly controlled by a square-wave clock input. Clock frequency control removes the constraint of having to use high tolerance filter network components and the associated difficulty of altering the filter frequency. The clock, and thus the filter frequency, can be set from a logic divider chain to provide any frequency in octave increments. We have configured the MF10 as a low-pass filter in cascade with a high-pass filter to allow complete control of the filter band. The upper and lower frequency limits may be set independently under logic control using rotary switches. There is no setting up or filter tuning required and the entire range of octaves is implemented with very few components.

On The Circuit

With the price of modern triacs and some economical design work from ETI, what seems to be a complex system in fact turns out to have only about £18-worth of parts (less the PCB and lightbulbs). Since the triacs don't need heatsinking, we adopted the 'let's get it all on one board' philosophy, and did exactly that. Even the small crystal mike that picks up the audio signal is mounted on the PCB to provide complete isolation between the sound equipment and the mains. Mounting a single board directly with all the bulbs in the column housing also removes the inconvenient cables that often make



Ten white light-bulbs, hanging on a wall . . .

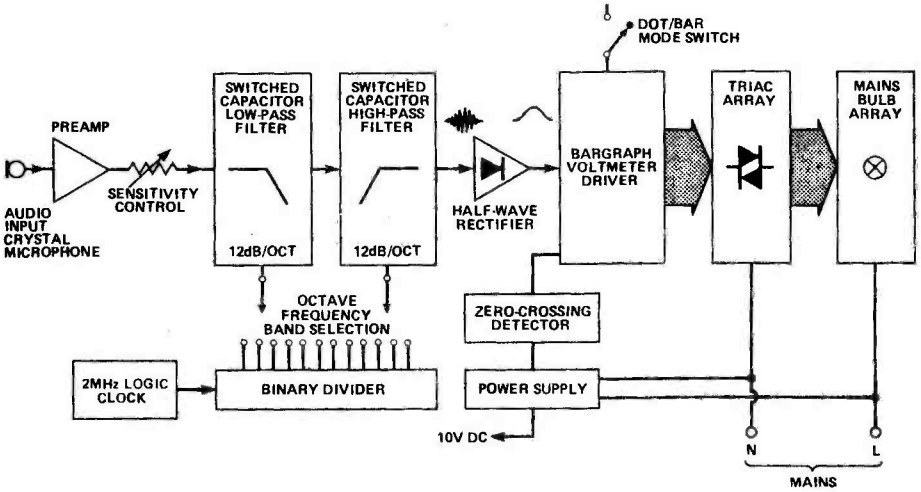


Fig. 1 Block diagram of the Spectracolumn.

FEATURES

- Drives 10 100W bulbs in bargraph or dot display
- Zero-crossing switching gives RFI elimination
- Logarithmically proportional display to correspond with music volume
- Independent high-pass and low-pass filters, 12 dB per octave
- Digitally-controlled switched capacitor filters eliminate setting up
- Pass band switchable in octave increments over 10 octaves anywhere in the audio spectrum
- Internal crystal mike gives complete isolation from sound equipment
- All parts on one PCB powered directly from the mains.

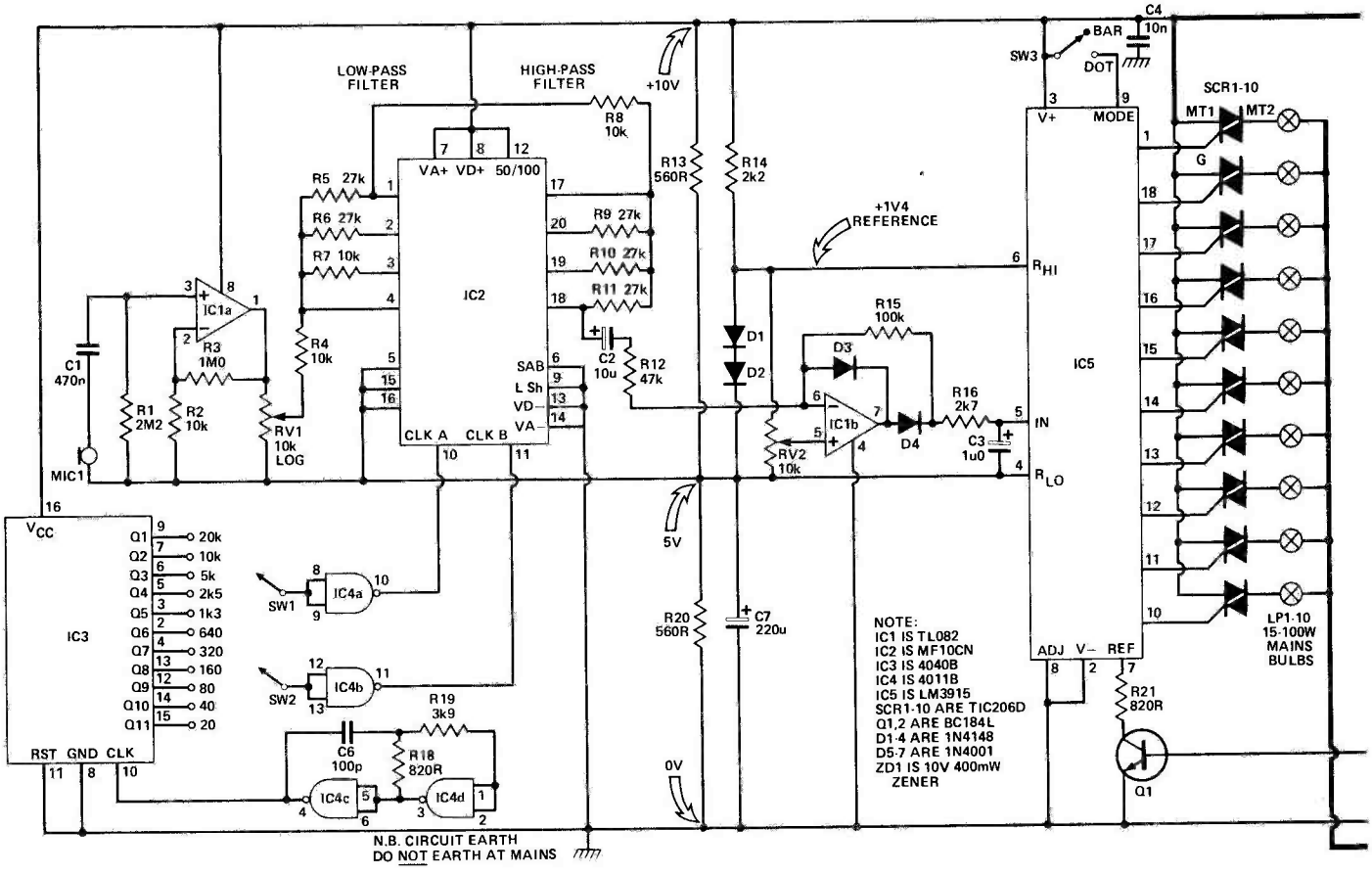


Fig. 2 Circuit diagram for the complete Spectracolumn.

TABLE 1

DIVIDER OUTPUTS	FREQUENCY (Hz) DIVIDED CLOCK	RESULTING FILTER F_C	STANDARD CENTRE
Q_1 (÷2)	1M	20k	
Q_2 (÷4)	500k	10k	16k
Q_3 (÷8)	250k	5k	8k
Q_4 (÷16)	125k	2k5	4k
Q_5 (÷32)	62k5	1k25	2k
Q_6 (÷64)	31k2	625	1k
Q_7 (÷128)	15k6	312	500
Q_8 (÷256)	7k8	156	250
Q_9 (÷512)	3k9	78	128
Q_{10} (÷1024)	1k9	39	64
Q_{11} (÷2048)	980	20	32

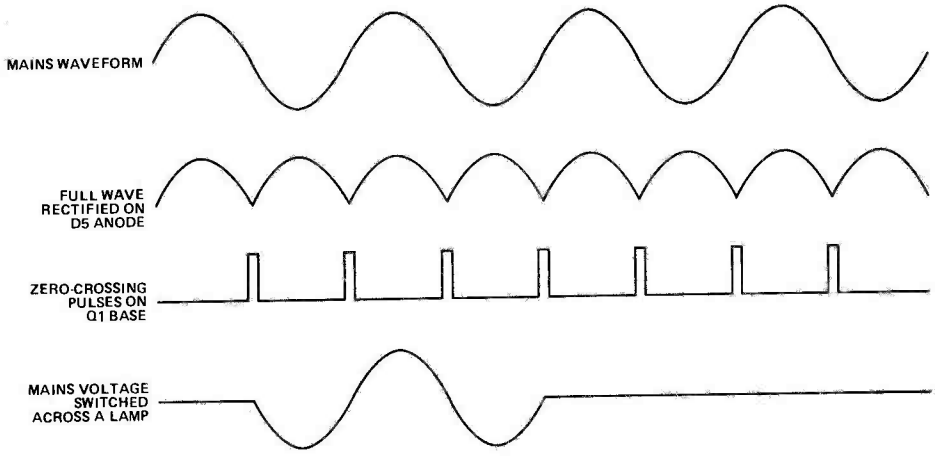


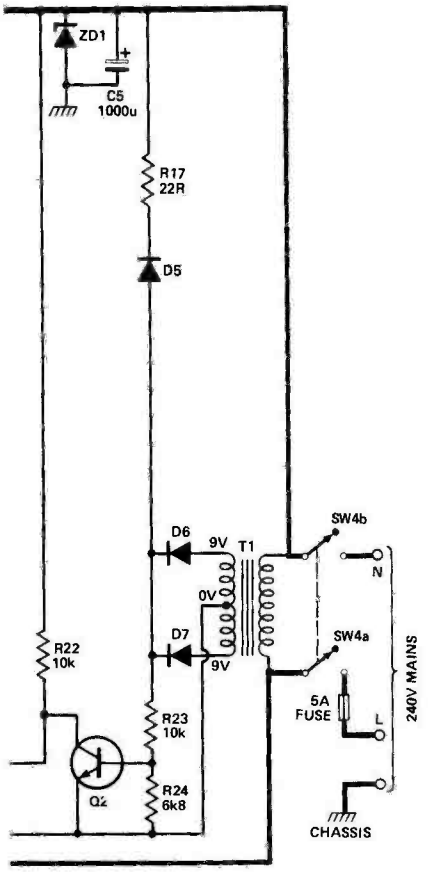
Fig. 3 Triac zero-crossing switching waveforms.

the dancefloor a dangerous place to negotiate. Finally, the design features zero-crossing triac control, so your sound equipment won't be plagued with RFI.

Using the system couldn't be easier; just plug it into the mains and switch on! No other connections are needed, because the internal mike picks up the music signal. The sensitivity control is turned up as required for the sound level, and a 'background' control is available which moves the illumination 'baseline' up or down the column, so increasing or decreasing the amount of light. With no sound it acts as a giant dimmer control.

The display could be hung on the wall, as we did for our photograph, or stood vertically on the floor. Large sheets of 'cinemoid' acetate (available from most good art shops) may be wrapped around the entire column to provide a coloured tube, which also tones down the display. But keep the plastic well away from the light bulbs!

The alternative is to use coloured bulbs. A three column system, using red, green, and blue for the bass, middle, and treble ranges would be an ideal starting system for most disco light shows. The filters could, for example, be



set at 20 Hz to 312 Hz, 312 Hz to 2.5 kHz, and 2.5 kHz to 20 kHz. As more Spectracolumns are added into the system the filter ranges can be instantly amended according to taste; but watch out for the current rating of your mains sockets!

Construction

All the components except the controls are mounted on our PCB. The triacs, the transformer, and even the microphone are mounted on board, as the overlay diagram of Fig. 4 illustrates. Assembly should begin first with the links, then resistors, followed by ICs and so on. IC sockets should be used as a good precaution, but note that IC5 is an 18-pin device and IC2 is a 20-pin DIL! Follow the overlay diagram for the orientation of all the components and solder in everything except the PCB-mounting transformer, the triacs, and the crystal mike.

The metal heatsink tab of the triacs has been used to form a screw terminal for the lamp connections (it's connected internally to the central leadout wire MT2). Hence the middle terminal lead of all the triacs must be completely cut off, which immensely simplifies board design too. The remaining two leads are inserted into the board and a 6BA

HOW IT WORKS

The block diagram of Fig. 1 illustrates the different parts of the system. Sound from a microphone is amplified and fed through both low-pass and high-pass filters (digitally controlled); the resulting audio signal is then rectified to produce a voltage envelope proportional to the sound intensity within the pre-defined frequency band. This envelope is displayed using a bargraph voltmeter IC to drive triac-switched mains bulbs which light up in a column according to the instantaneous sound level. A simple power supply provides both the 10 V DC rail and the 100 Hz signal for zero-crossing triac control.

Figure 2 shows the complete circuit diagram for the Spectracolumn. The audio signal provided by the music or other sound is picked up by the microphone insert MIC1 and amplified by IC1a, which is configured as a straightforward non-inverting amplifier with a gain of 100. The high input impedance required by the crystal mike is set by R1 to be about 2M0.

The audio input from this gain stage is taken via the sensitivity control RV1 (acting as a potential divider) to the input of the filter system at R4. The audio filter system is built out of an MF10 monolithic switched capacitor filter. This IC (featured in last month's Designer's Notebook) contains two identical second order (12 dB per octave) filter systems which can be configured in a number of different modes, with the filter corner frequency being determined by a single square wave clock input.

We have used the MF10 to construct both a low-pass and a high-pass filter, which are wired in cascade. The resistor values shown have been chosen to give a pass band gain of 3 and a Q of 1. The cut-off frequencies are set to be 1/50th of the applied clock signals, which can be independently varied for each filter. Using high and low-pass filters in cascade results in a band-pass type of response, where the bandwidth can be very effectively controlled using the two input clocks, and positioned in any part of the spectrum. The clock on pin 10 of the MF10 controls the low-pass filter determining the upper frequency limit, and the clock input on pin 11 determines the high-pass filter's corner frequency, thus setting the lowest frequency that will be passed.

The clock signals are generated and selected using a separate block of CMOS logic circuitry. IC4c and d are configured as a standard CMOS astable to provide the master clock of 2 MHz. This clock is fed directly to the counter divider chip IC3 (a 4040). The Q outputs progressively divide the clock frequency by two to give those frequencies shown in Table 1. As music lovers will know, dividing the frequency thus will give us equal octave increments; the entire audio bandwidth is thus catered for using the 11 outputs of the 4040. The two remaining gates of IC4 take their inputs from the common pole of each 10-way rotary switch, SW1 and SW2, buffering the outputs from the divider chip and providing selectable clock frequencies to program the high and low-pass filters.

The band-pass filtered audio signal is coupled via C2 to a precision half-wave rectifier, built around IC1b. A positive-going audio envelope thus appears across C3. R16 determines the attack time constant and R15 the decay time-constant. Potential divider RV2 supplies an offset voltage derived from the 1V4 reference to the non-inverting input terminal of the op-amp IC1b. This allows a 'background' voltage level to be superimposed on the envelope voltage, giving an independent control of the light column's illumination. The 1V4 reference is created by the forward voltage drop across D1 and D2 which are biased by resistor R14; this reference is also used to feed the internal resistor chain of the LM3915 at pin 6 of IC5. The LM3915 converts the envelope voltage applied at the pin 5 signal input to an array of 10 switched outputs. Pin 4 is the earth reference for the signal and resistor chain voltages; it is tied to the 5 V 'pseudo earth' rail. This half supply-volts rail is derived from the low-impedance potential divider R13, 20.

Direct drive from IC5 to the triacs is achieved by tying the mains neutral to the positive rail on IC5 and the common MT1 terminals of all the triacs. The switched outputs of IC5, which provide constant current, are taken directly to the gates of the triacs and the bulbs are placed in series with the triacs in the returning mains live lead. Now, resistor R21 is normally used for setting the output drive current of the LM3915, going from the pin 7 reference to ground.

In our arrangement, however, it is switched to ground using Q1. Thus when Q1 is off, the constant current sources that drive the gates of triacs SCR1 to 10 will all be disabled, and the triacs cannot turn on. Q1 is driven by brief pulses derived from the zero-crossings of the mains cycle; in other words when the AC mains cycle reaches 0 V (which occurs 100 times per second), transistor Q1 turns on and allows the triacs to be triggered on only at this moment. The triacs automatically turn off again as the mains current falls away to zero, assuming there is no further drive signal. For the triac to turn on, then, the corresponding output from IC5 must be 'active' due to the sound level, and at the same time as a zero-crossing pulse occurs. By turning on the triacs and thus the lamp current flow only when the mains voltage is close to zero, the problems of radio frequency interference are effectively avoided.

The circuitry is powered from a 10 V supply rail, regulated by the 10 V zener diode ZD1, and decoupled by C5. The centre-tapped 9-0-9 V transformer is full-wave rectified by D6 and D7; Q2 is driven by the 100 Hz signal at the junction of D6 and 7 to detect the zero crossing points. As the voltage cycle falls down to zero the voltage on the base of Q2 also falls. When it goes below 0V6 Q2 will turn off (the zero crossing point), thus allowing Q1 to turn on. D5 and R17 isolate the full wave rectified DC from the 10 V power rail.

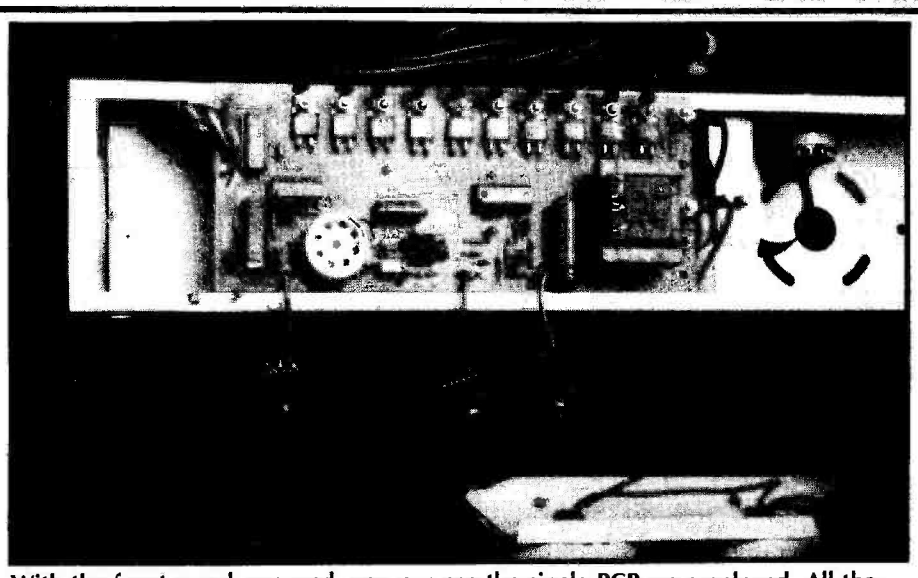
nut and bolt are used to clamp the metal tab to the PCB. The bolt protrudes above the component side and a further washer and nut can be added to create a screw terminal. When all the triacs are bolted in place their leadout wires should be soldered and cropped as normal. The lamp wires will be retained on the screw terminals using solder tags.

The PCB-mounting transformer has been used simply for convenience and should be soldered in as a normal component. Other types could also be used provided they are connected to the PCB pads as per the circuit diagram. Bolts should also be fitted, in the same manner as the triacs, to make screw terminals on the pads marked for the mains connections. The photographs of our completed PCB show these terminal connections.

Our crystal microphone insert was 23 mm in diameter; it should be mounted last. The metal screening case of the insert is connected internally to one of its terminals. This screen terminal should be identified (use an ohm-meter) and wired to the mid-rail reference as shown on the overlay; ensure that the wire used is very thin and flexible. A piece of sponge foam about the size of the mike should be stuck to the PCB and the mike may then be glued on top of this to provide a resilient mounting, free from direct vibration pickup.

An electret condensor type of mike insert could also be used and would probably give better quality sound pickup. They usually come with their own internal FET preamplifier, which requires a 1V5 power supply. Luckily, the 1V4 reference terminal indicated on the overlay is ideal for this job, and may be wired directly to the insert.

When the board is completely assembled the two control pots and the mode switch can then be wired up as indicated. Veropins should be inserted as terminals at the appropriate points. The two rotary switches for the frequency selection should also be wired up using ribbon cable as shown in the diagram. Note that the rotary switches are both set to select one out of 10 corner frequency outputs from the PCB and the rotary switches are offset by one frequency band relative to each other: ie the upper limit switch ranges from 40 Hz to 20 kHz while the lower limit ranges from 20 Hz to 10 kHz.



With the front panel removed, you can see the single PCB we employed. All the pots and switches are mounted on the sides.

Testing And Setting Up

After wiring up the controls some initial tests can be made before completing the assembly. Initially, do not connect any light bulbs and do not plug in any ICs; but do remember that all parts of the circuit are effectively live. Connect the mains as shown via a double pole toggle switch and a 5 amp fuse, and then switch on. Using a voltmeter check that there is about 10 V across C5 and 5 V across C7. 10 V should also appear across pins 8 and 4 of IC1, pins 8 and 13 of IC2, pins 16 and 8 of IC3, pins 14 and 7 of IC4 and pins 3 and 2 of IC5. If all is well, unplug from the mains and insert all the ICs. One light bulb can now be wired onto the SCR5 terminal, its other lead returning to mains live. Set the upper limit switch to 5 kHz, and the lower limit to 640 Hz; this gives a fairly broad frequency band for vocal testing. The unit should be turned on again with SW3 set in bar mode. Altering the background control RV2 should cause the bulb to switch on and off at some point. As the bulb switches off continue to turn RV2 in the same direction to the end of its travel. The background illumination control is then at its zero setting. Now, depending on the sensitivity setting, a loud noise should re-illuminate the bulb. Increasing the sensitivity control should eventually allow the bulb to come on with normal speech volume. If this test works

BUYLINES

All of the electronic components, including the hard-to-find MF10, are available from Rapid Electronics, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. The fluorescent fitting, bulbs and holders will be available from any electrical store, while the order form for the PCB Service can be found on page 99.

PARTS LIST

Resistors (all ¼W, 5%)	
R1	2M2
R2, 4, 8, 22, 23	10k
R3	1M0
R5-7, 9-11	27k
R12	47k
R13, 20	560R
R14	2k2
R15	100k
R16	2k7
R17	22R
R18, 21	820R
R19	3k9
R24	6k8
Potentiometers	
RV1, 2	10k logarithmic
Capacitors	
C1	470n polycarbonate
C2	10u 16 V tantalum
C3	1u0 35 V tantalum
C4	10n ceramic
C5	1000u 25 V axial electrolytic
C6	100p polystyrene
C7	220u 16 V axial electrolytic
Semiconductors	
IC1	TL082
IC2	MF10CN
IC3	4040B
IC4	4011B
IC5	LM3915
Q1, 2	BC184L
SCR1-10	TIC206D
D1-4	1N4148
D5-7	1N4001
ZD1	10 V 400 mW zener
Miscellaneous	
SW1, 2	1-pole 12-way rotary switch
SW3	SPST toggle switch
SW4	DPST mains-rated toggle switch (250 V, 5 A)
MIC1	crystal mike insert
T1	9-0-9 3 VA mains transformer (PCB-mounting; see Buylines)
FS1	5 A fuse and fuseholder

PCB (see Buylines); 10 mains bulbs, 15-100 W, and holders; fluorescent lamp fitting (no tube required).

satisfactorily then all the bulbs can be wired up to their corresponding terminal posts and the entire display can be tested.

Turning the background control up should result in the successive illumination of bulbs; now turn it down to zero, when all the bulbs should be off. Increasing the sensitivity control will now allow sound to illuminate all the bulbs. Having established a good sensitivity setting, different types of music from a record deck or radio can be used to check the different frequency bands available on the rotary switches. The display can be switched to dot mode at any time, which provides an interesting effect with constant light level.

A Case In Point

The actual hardware construction of the light bulb arrangement is very much a matter of personal choice. We used large white plastic bulb holders, and mounted the entire column and PCB in a fluorescent light case that was to hand. The case was earthed and provided a nice self-contained unit. Batten-mounting bulb holders could equally well be screwed down to a long strip of wood and the electronics mounted in a separate diecast box. The photographs illustrate the construction method we used.

A number of important points should be noted with the final assembly. Owing to the circuitry used, the positive rail is directly connected to the mains neutral; therefore all parts of the circuit should be treated as being effectively **live** since somebody could easily swap the mains and neutral leads by accident at the mains plug end. Consequently we suggest:

- The PCB should be mounted in a metal case on insulating pillars or blocks.
- The case should be earthed to the mains but there should be no other connection between the PCB and the case. Circuit ground **must not** connect to mains earth.
- The mode switch and on-off switch should both be 250 V mains rated and have a current rating sufficient for the total power of the bulbs used.
- The pots and rotary switches should all have plastic spindles and plastic knobs. Ideally the metal pot cases should be insulated from the chassis, or they could be soldered directly to the PCB terminals such that only the plastic spindles pass through the chassis.
- For the reasons of mains isolation the microphone must stay inside the

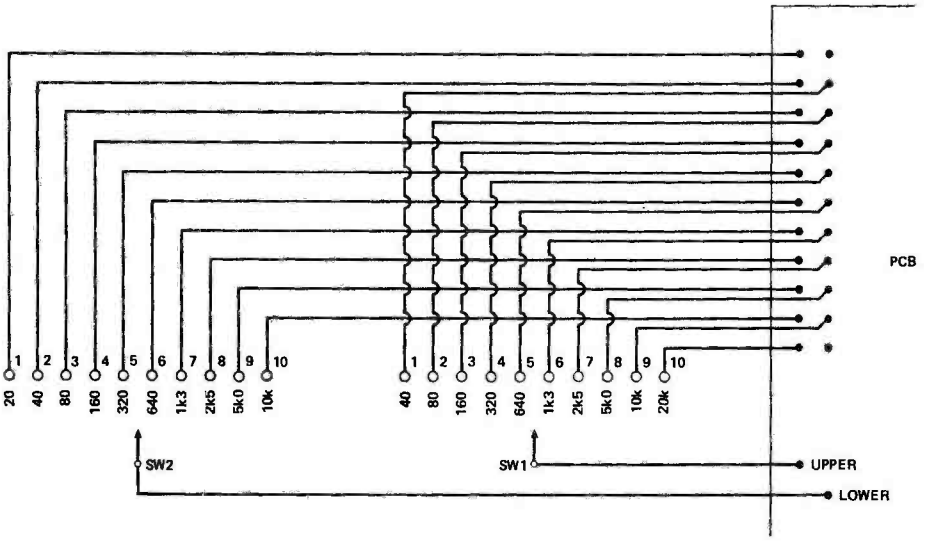


Fig. 4 This diagram shows how to wire up SW1 and SW2.

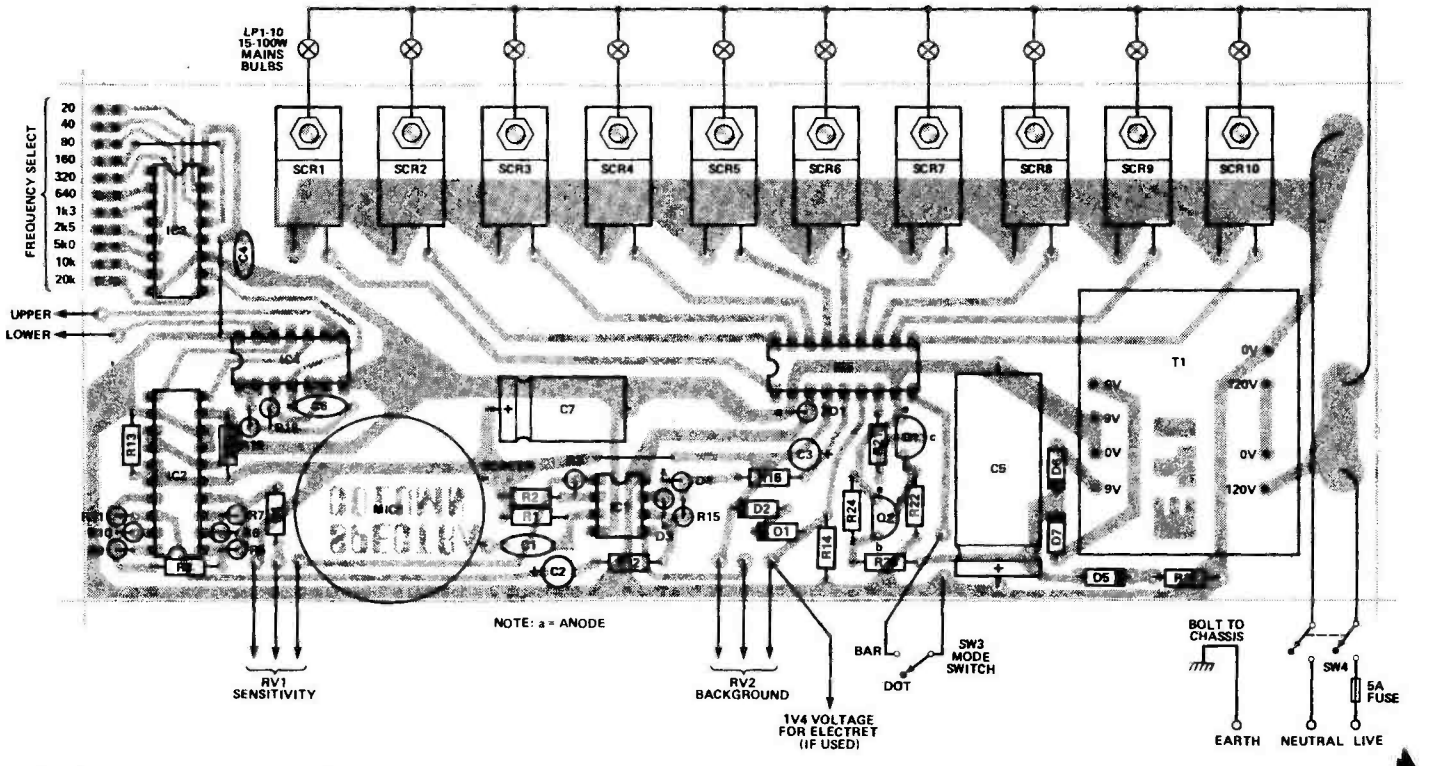
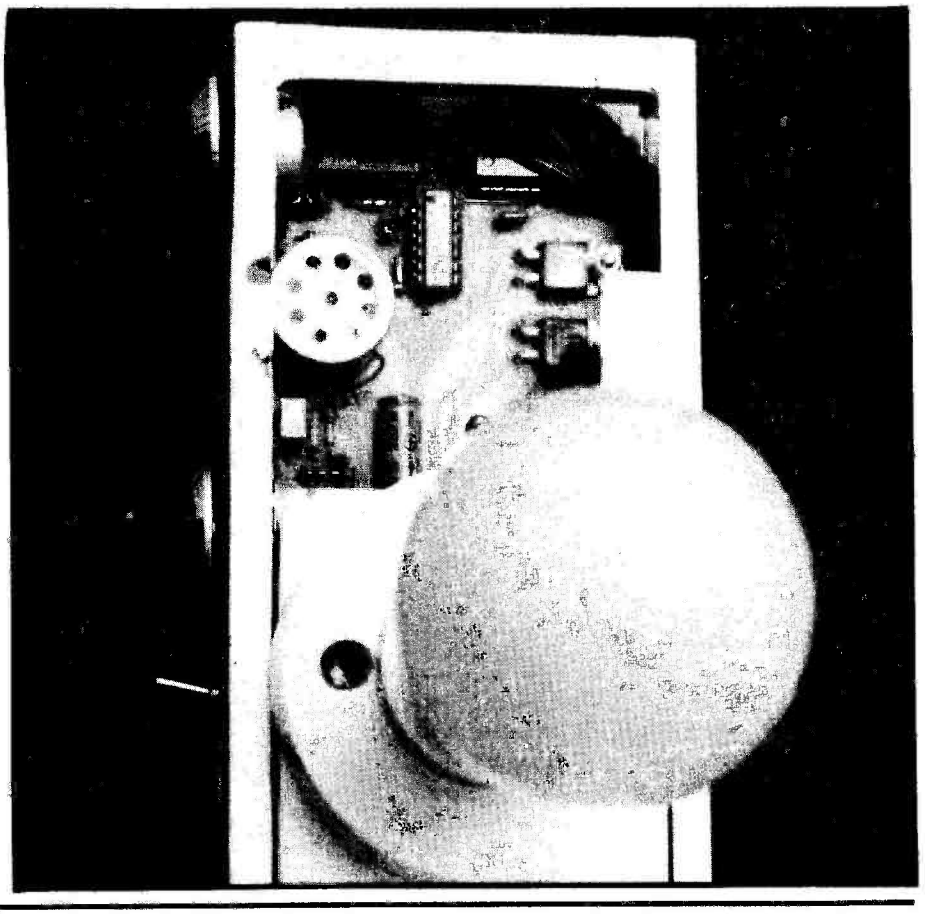


Fig. 5 Component overlay for the Spectracolumn. Use spade connectors for the triac and mains connections.

case; and on no account try to connect up the mike input to a direct audio signal from your sound equipment (this could be done **only** with an audio isolating transformer).

Notes On Modifications

For those with the urge to experiment here are some notes on modifying circuit values: R3 decreases the mike preamplifier gain; decreasing R4 and R8 increases the filter gain; increasing R6 and R10 will increase the Q of the filters; R18 alters the frequency of the master clock, currently set at 2 MHz; R21 determines the drive current to the triacs; increase C3 or R16 to increase the attack/decay display time constant; R16 could be a 22k variable pot.



This close-up of the business end of the Spectracolumn shows how we cut away part of the front panel of the fluorescent fitting to allow sounds to reach the crystal mike insert. A cover can be built using speaker cloth and a stiff card frame, as shown in the photograph on the first page of this article.

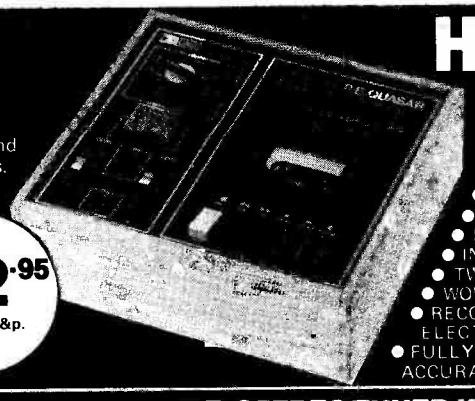
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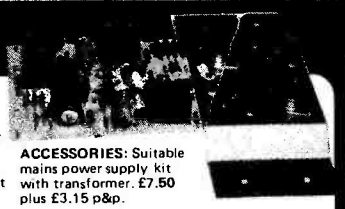
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P.E. STEREO TUNER KIT



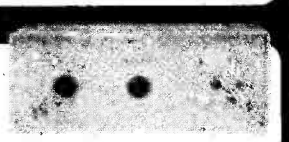
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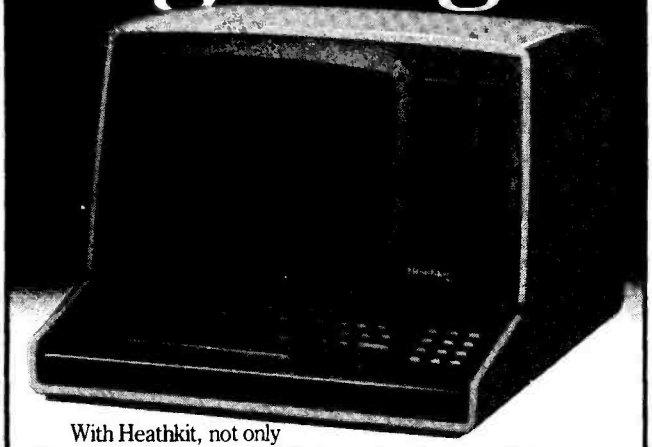
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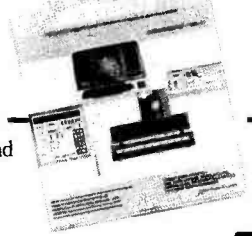
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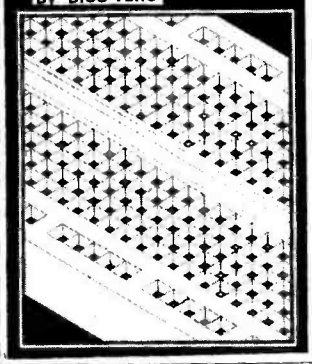
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C2 3.579545MHz Xtal HC6U case 50p
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C6 12V reed relay, SP break 40p
C8 68A00 CPU £1.50
C9 UDN6116A display driver 50p
C10 Speedblock ribbon cable: 10 way 30p/m; 20 way 60p/m; 40 way £1.20/m

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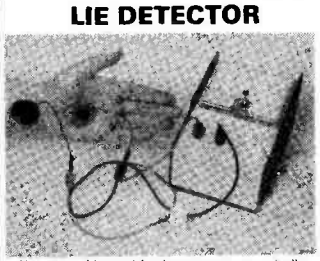
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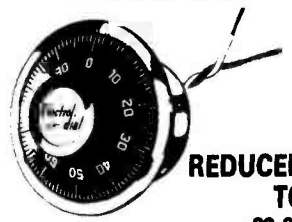
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The timebase is a circuit which generates a sawtooth waveform, one whose voltage changes linearly with time: a graph of voltage plotted against time will be as shown in Fig. 1 (though it may be either positive-going or negative-going). The best-known application is in oscillosope timebases, but the circuit can also find use in digital-analogue converters and in timing circuits.

The most simple timing circuit is, of course, a capacitor charging through a resistor (Fig. 2). The time constant CR determines the total charging time which, though theoretically infinite, is in practice about four or five times the length of the time constant. The graph shape of voltage plotted against time is, however, exponential rather than linear because the charging current drops as the capacitor charges. All timebases of the capacitor-charging type therefore need some method of keeping the charging current constant as the voltage across the capacitor rises.

Transistor Control

In the days of valves, many elaborate circuits were devised to overcome the problem of constant current control, but it took the development of the transistor to come up with a really simple system with good performance. A transistor whose base-emitter junction passes a constant current will also pass a (larger) constant current between its collector and its emitter, and this current can be maintained up to the level where the collector voltage is less than half a volt different from the emitter voltage.

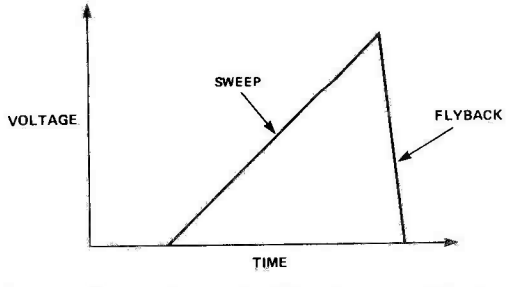


Fig. 1 The waveform of a perfect timebase — this should be a straight line.

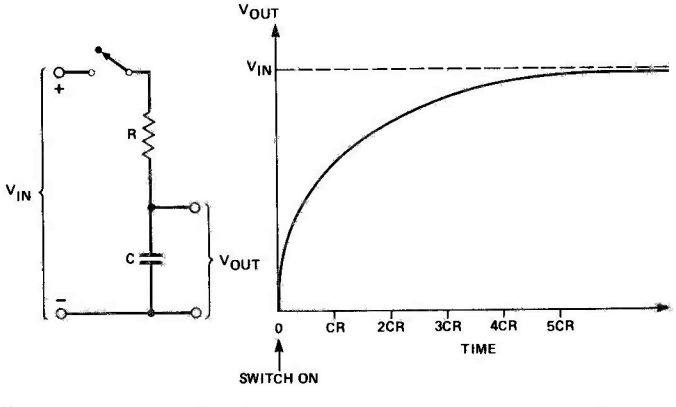


Fig. 2 Capacitor charging. When a capacitor is charged through a resistor the waveform is an exponential rather than a straight line.

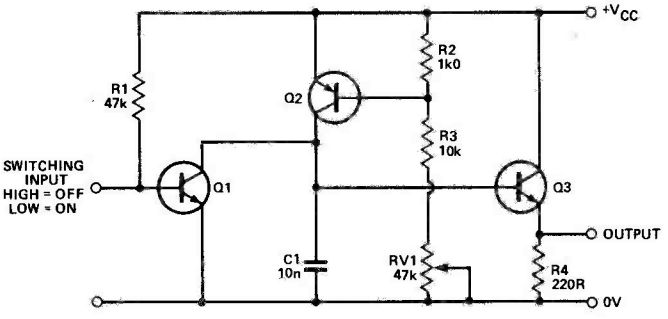


Fig. 3 Using a transistor in place of a resistor for capacitor charging. Since the current through the transistor remains constant, the sweep waveform is straight rather than exponential.

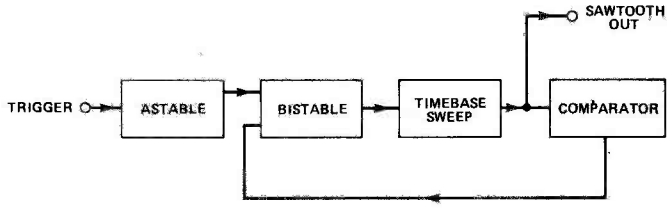


Fig. 4 Block diagram of an oscilloscope timebase.

Figure 3 shows a simple timebase circuit using this principle. Q1 is a switching transistor which is normally conducting, keeping the voltage across the capacitor low. Q2 is a PNP transistor whose base current is set by the resistor chain R2, R3, RV1, and which can be varied by altering the value of RV1. Since the base current is constant, the collector current will also be constant. Q3 is simply an emitter-follower to avoid non-linear effects which would be caused by a resistive load connected across the charging capacitor (since a resistance takes more current as the voltage across it is increased). For best results, Q3 should be a transistor with a high h_{fe} value, and a double emitter-follower is often preferable to ensure the highest possible input resistance.

The action is as follows. When Q1 is cut off by a negative pulse at its base, capacitor C1 can be charged by current flowing through Q2. This current will not change until the collector voltage of Q2 has reached a value close to the positive supply voltage, so that the wave form is linear up to this region. If Q1 remains cut off, the waveform will then flatten off, but if Q1 is switched on again before this point is reached, then a good sawtooth shape is preserved.

Timing The Timebase

The action depends to a large extent on switching the transistor Q1 at the correct times, and all timebases consist

basically of two sections — a square wave generator which handles the switching and a sawtooth generator which provides the desired waveform. An oscilloscope timebase would use a level-detecting circuit at the output to ensure that the switching transistor Q1 was switched off before the voltage level at the output reached the non-linear region — a block diagram with waveforms is shown in Fig. 4. In this arrangement, the repetition rate of the timebase is determined by an astable which provides a trigger pulse. The trigger pulse sets the bistable, which in turn cuts off the switching transistor of the timebase generator and so starts the charging of the capacitor. When the charging has reached some preset voltage level, the level detector (comparator) circuit switches the bistable back, so discharging the capacitor ready for another sweep. For many oscilloscope purposes, the astable is set to run freely at a low speed, and is synchronised to whatever waveform is to be displayed — this is the auto timebase system found on most modern oscilloscopes. The sweep speed is then determined by the time constant of the charging capacitor.

The use of a transistor as a constant current device for a timebase is good enough for many purposes, but two other methods of creating linear sweep waveforms from the basic capacitor charging circuit have been well established for many decades in oscilloscope circuitry. One of these is the bootstrap circuit. Bootstrapping is positive feedback applied over a circuit in which the gain is less than unity, so that it does not cause oscillation.

By His Bootstraps

The principle of the bootstrap is shown in Fig. 5. A capacitor is charged through two series resistors, and a unity-gain amplifier is connected so that the voltage across the capacitor can be applied, in phase but with its DC level shifted, to the point where the resistors join. When the capacitor starts to charge, the increase of voltage across the capacitor causes a matching increase of voltage across R2, so that the voltage across R2 has not changed in this time. Since the voltage across R2 is constant, the current through R2 is also constant, which is the condition for a linear sweep.

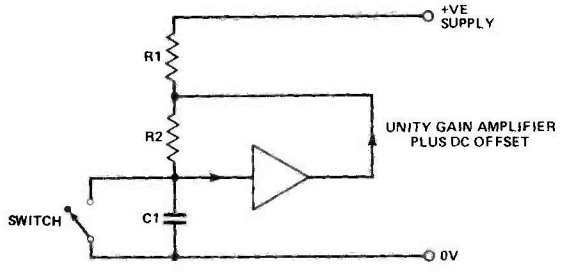


Fig. 5 The principle of the bootstrap timebase circuit.

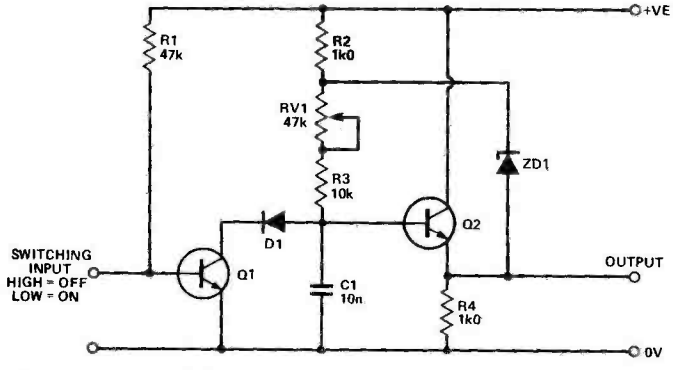


Fig. 6 A practical form of the bootstrap circuit, using an emitter-follower as the unity-gain amplifier.

The bootstrap depends on being able to keep the voltage at the junction of the resistors at a constant amount greater than the voltage across the capacitor. The whole idea seemed so absurd when it was first proposed that the (US) inventor remarked that it seemed "rather like lifting yourself by your own bootstraps". As so often happens, the name stuck.

A practical form of the timebase is shown in Fig. 6. Q1 is, as before, the switching transistor which starts and stops the sweep. The charging resistor chain consists of R2, R3 and RV1, of which R3 is a limiting resistor whose value is set so that excessive current does not flow through Q1 when the variable is set at its minimum value. D1 is used to prevent C1 from discharging below about 0V7, so ensuring that Q2 will not switch off, causing non-linearity. If Q2 is allowed to switch off, then the timebase output will have a decided 'kink' at the voltage at which Q2 switches on.

Q2 is an emitter-follower, whose emitter is connected through a zener diode ZD1 to the junction of R2 and R3. The zener diode, along with the base-emitter voltage drop of Q2 determines the voltage across R3 and RV1, so that the charging rate can be calculated. For example, suppose the voltage is 6 V, the values of RV1 and R3 add to 56k and C1 is 22nF. The charging current I is 6/56 mA, which is 0.107 mA, and the rate of change of voltage across C1 is I/C1. Using units of milliamps and nanofarads, the rate of rise of voltage will be in volts/microsecond, and the example gives 0.00486, equivalent to 4.86 volts per millisecond. If you know the sensitivity figure for the cathode ray tube for which the timebase is to be used (in terms of centimetres of deflection per volt), then you can calculate what amount of amplification will be needed to obtain full screen coverage, and what time constants will be needed for the various scan speeds.

There are limitations on the voltage gain of the emitter follower and the frequency range over which the zener diode remains effective, but with suitable choice of components, good timebase circuits can be designed around this core configuration. Commercial circuits of this type often look remarkably complicated, but once the bootstrap section is separated from the other parts of the complete timebase (the triggering and the comparator sections), the essential simplicity of the circuit can be seen.

The Miller Alternative

The other basic capacitor charging circuit is the Miller integrator. These two circuits, the bootstrap and the Miller, were curiously polarised for many years, with the bootstrap used on US equipment and the Miller on UK equipment almost exclusively. This is no longer completely true, but though you will see bootstrap timebases appearing on equipment designed in this country, you will even now seldom see a Miller timebase used on the other side of the pond.

The Miller timebase is named after (yes, got it!) Miller, who discovered the result of negative feedback across the anode-grid capacitance of triode valves. The name became attached to the timebase (which was not designed by Miller) because the Miller timebase makes deliberate use of such feedback to achieve linearity. The basic circuit is shown in Fig. 7, and the most startling thing about it is its simplicity, because the switching transistor is also the current regulator! If we imagine the transistor starting cut-off, then a square wave applied to the input will raise the base voltage until the transistor starts to conduct. When conduction starts, however, the collector voltage will drop, and the negative feedback through C1 will prevent the base voltage from rising to the level of the input voltage. Once this has happened, the base voltage can rise

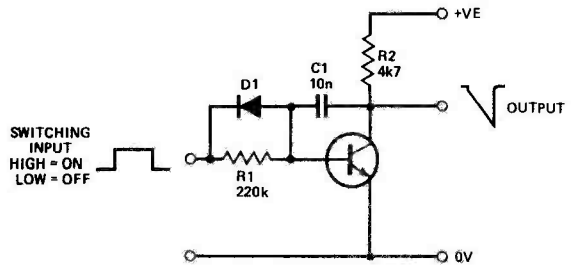


Fig. 7 The basic Miller timebase circuit.

only as fast as the capacitor C1 can be discharged, and the discharge is at a steady rate because of the negative feedback.

The time constant for the Miller integrator is given by the value of R1 and C1 rather than R2 and C1 as you might expect, and the conventional use of the circuit as shown here produces a timebase waveform which is negative-going, with a small 'step', as shown in Fig. 8, just at the point where the transistor switches on.

The circuit will operate in the opposite direction, when the 'free' end of R1 is at ground potential. In this case, the voltage at the transistor's collector rises just quickly enough to keep sufficient current flowing into its base (and also R1) to keep it on. In both cases, the simplest way to achieve the fly-back is to connect a diode, D1, in parallel with R1. For operation in the opposite direction from that first described, the direction of the diode must be reversed.

More elaborate versions of the Miller use two stages of amplification with the output in phase, and a low-impedance stage driving the capacitor. Very good results can be obtained, and with a wide-band op-amp used in place of a transistor, excellent timebase linearity is possible.

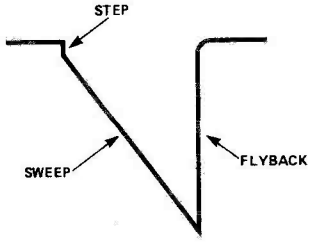


Fig. 8 The waveform from the simple Miller circuit.

Before we leave the subject, timebases can also make use of the growth of current through an inductor. The effect that is used here is the inductive equivalent of capacitor charging, and it is useful because if the inductor is also a deflection coil for a cathode-ray tube, then the timebase and deflection system can be combined. Linearity is much less easy to achieve, however, and one method is the use of a saturable reactor in series with the inductor which carries out the timebase action. The inductance of a saturable reactor will vary with the amount of voltage across it in order to keep the current constant. Using this and other components, it is possible to balance out the worst of the non-linearity of the charging process. For truly linear timebases, however, the capacitor charging circuits which we have described in this article are considerably superior to inductive time-bases. No-one watching TV seems to care too much if the characters are very slightly fatter on the right hand side of the screen than on the left, but we need to know the truth from our oscilloscopes! **ETI**



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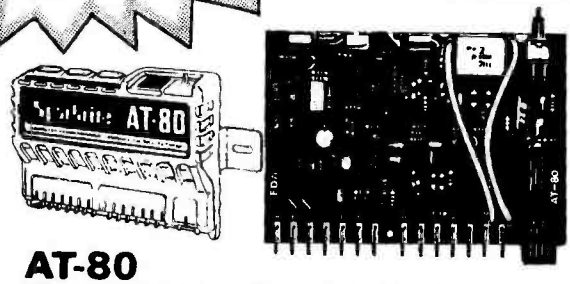
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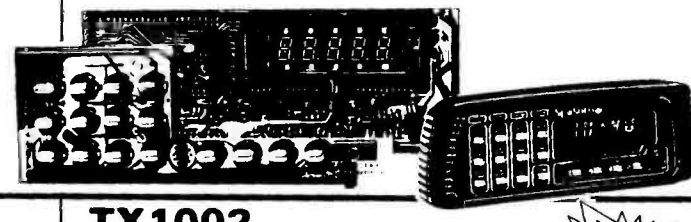


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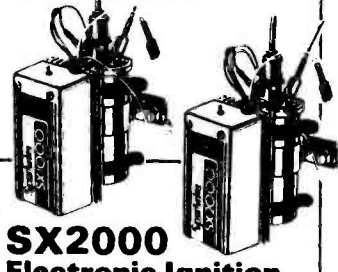
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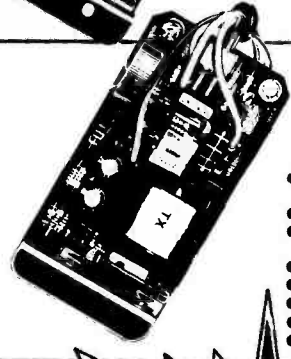




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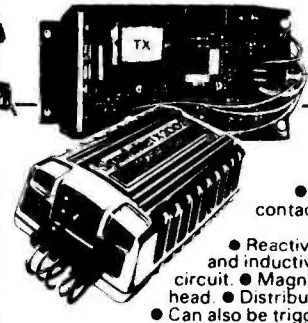
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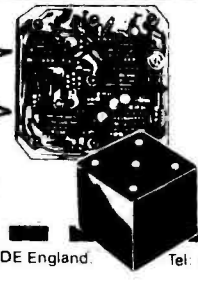
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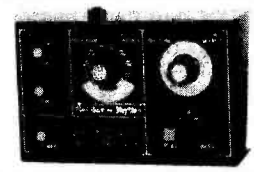
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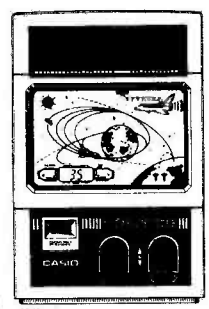
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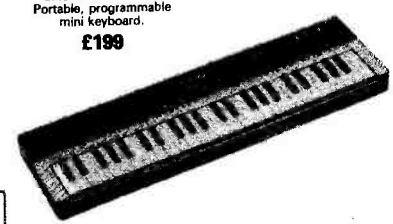


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SERVO INTERFACE

PART 2



Are you being servoed? This month we get to grips with the construction of our arm interface board, which can also be used to control up to four servos for any other application you can think of. Design by Rory Holmes.

The servo interface is built on a single-sided PCB. An additional double-sided PCB is used to make a lead-through type of edge connector plug, similar to that used on the ZX printer. The interface electronics are too bulky to be mounted directly on the Sinclair edge-connector, but our small Verobox-enclosed plug, wired to the main board via ribbon cable, puts less strain on the expansion connector.

Start construction with the main PCB, soldering in the links and resistors first (there should be eight links altogether), followed by the IC sockets and other components. Insert Veropin terminals at all the computer bus connections, since this makes wiring up to the ribbon cable easier. Veropins, or a five-way Molex connector socket should also be used at the servo output terminals as illustrated on the PCB overlay diagram of Fig. 1.

Adjust Your Address

The three DIL switches can be replaced by appropriate wire links if the address combination that you wish to use is going to be a permanent fixture. The address selection details given below should be studied to appreciate the possible configurations of the address decoder. Observe that the two switches corresponding to the Z80 control lines (those nearest C4) should always be set to logic low, ie closed. Also note that IC3 is positioned the other way round to the other ICs.

We used the Pactec type HP case to house the main PCB which was mounted by four bolts at the corners. Four ordinary grommets were used as spacers over the bolts to allow room under the PCB for the ribbon cables. These ribbon cables are wired up to the two PCBs as shown in the main overlay and edge-connector wiring layout — an 11-way ribbon is used for the topside and a 14-way for the bottom side.

Pot Luck

The edge connector PCB is cut to exactly fit into the smallest Vero potting box. By a lucky coincidence the 23-way Sinclair expansion bus will exactly fit the inside of this box. The solder tags on the edge socket are spaced wider apart than the PCB thickness and must be adjusted slightly — don't forget the keyway orientation shown in the wiring layout. One row of tags should first be soldered as they are to the 'underside' PCB terminals and then the other row can be bent down to reach the topside terminals, allowing the assembly to fit in the Verobox.

Figure 3 shows how slots should be cut in the box to house the edge connector plug and socket. Two large size stick-on rubber feet should be positioned on the inside of the lid to hold the board firmly in place as the lid is screwed down. If one of the feet is stuck above the ribbon cable entry point, it will act as a cable clamp. A very neat and solid connector system will result from this construction method.

Address Selection

If the Spectrum computer is to be used then IC7 and IC8 should not be plugged in (the address lines that would normally reach these ICs from the ZX81 do not go to the same pins on the Spectrum bus), but IC9 must be used. Under these circumstances the switches SW1 and SW2 and the associated pull-up resistors are not actually required on the board though they can be left in place (open circuit) if future ZX81 use is anticipated. Jumper JA must be fitted while JB and JC are left open. The switches on SW3 should all be set to logic low, ie closed, and then the four servo addresses will be

Servo 1 OUT 65340, X
Servo 2 OUT 65341, X
Servo 3 OUT 65342, X
Servo 4 OUT 65343, X

For use with the ZX81, IC8 and 9 must be fitted while IC7 is optional depending on the degree of address decoding required. Jumper links JB and JC should be fitted but not link JA. The memory map given in part 1 showed the address line logic levels needed to decode different address ranges.

PARTS LIST

Resistors (all ¼W, 5%)

R1–8, 25, 26	10k
R9–23, 27	3k3
R24	470R

Potentiometers

PR1	47k miniature horizontal preset
PR2	470k miniature horizontal preset

Capacitors

C1	470p ceramic
C2,3,6	10n ceramic
C4	47u 16 V tantalum
C5	100n ceramic

Semiconductors

IC1,2	74LS170
IC3	40103B
IC4	4555B
IC5	4093B
IC6	4520B
IC7–9	74LS85
Q1	BC184L
D1–3	1N4148

Miscellaneous

SW1–3	4-way single-pole DIL switches (wire links can be used)

PCBs (see Buylines); 0.1″ 23-way double-sided edge connector (see Buylines); 5-way Molex connector socket; Veropins; case for interface — Pactec type HP, size 146 × 91 × 23 mm (see Buylines); case for plug — general purpose Vero potting box; 14-way ribbon cable.

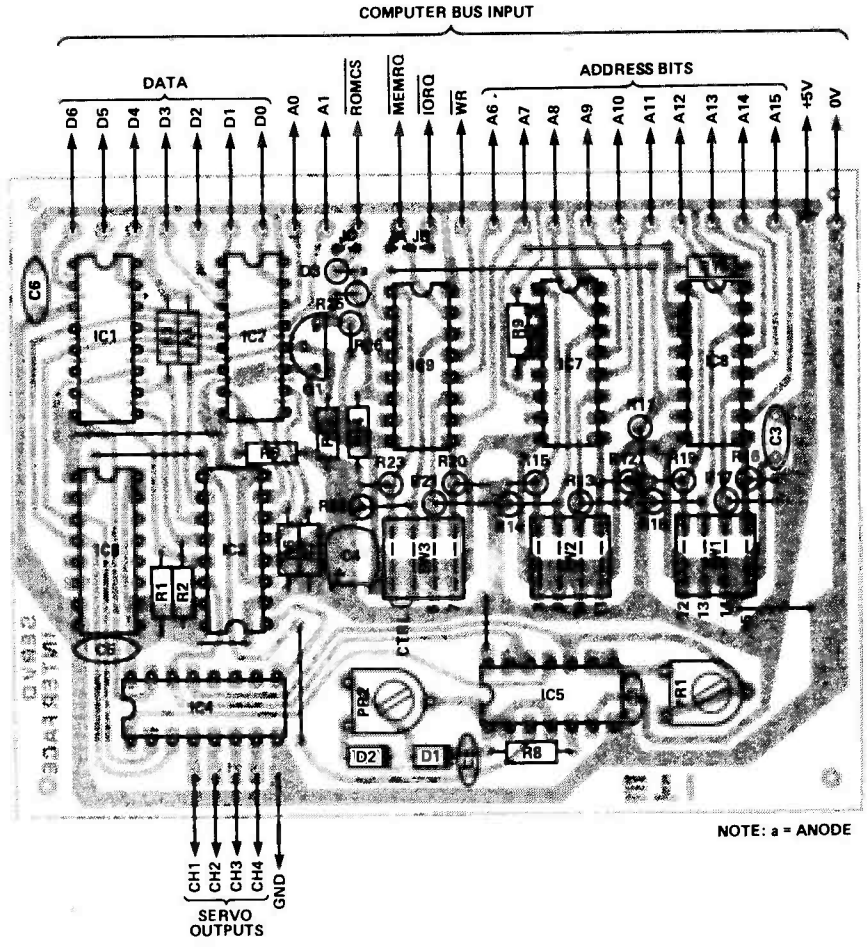
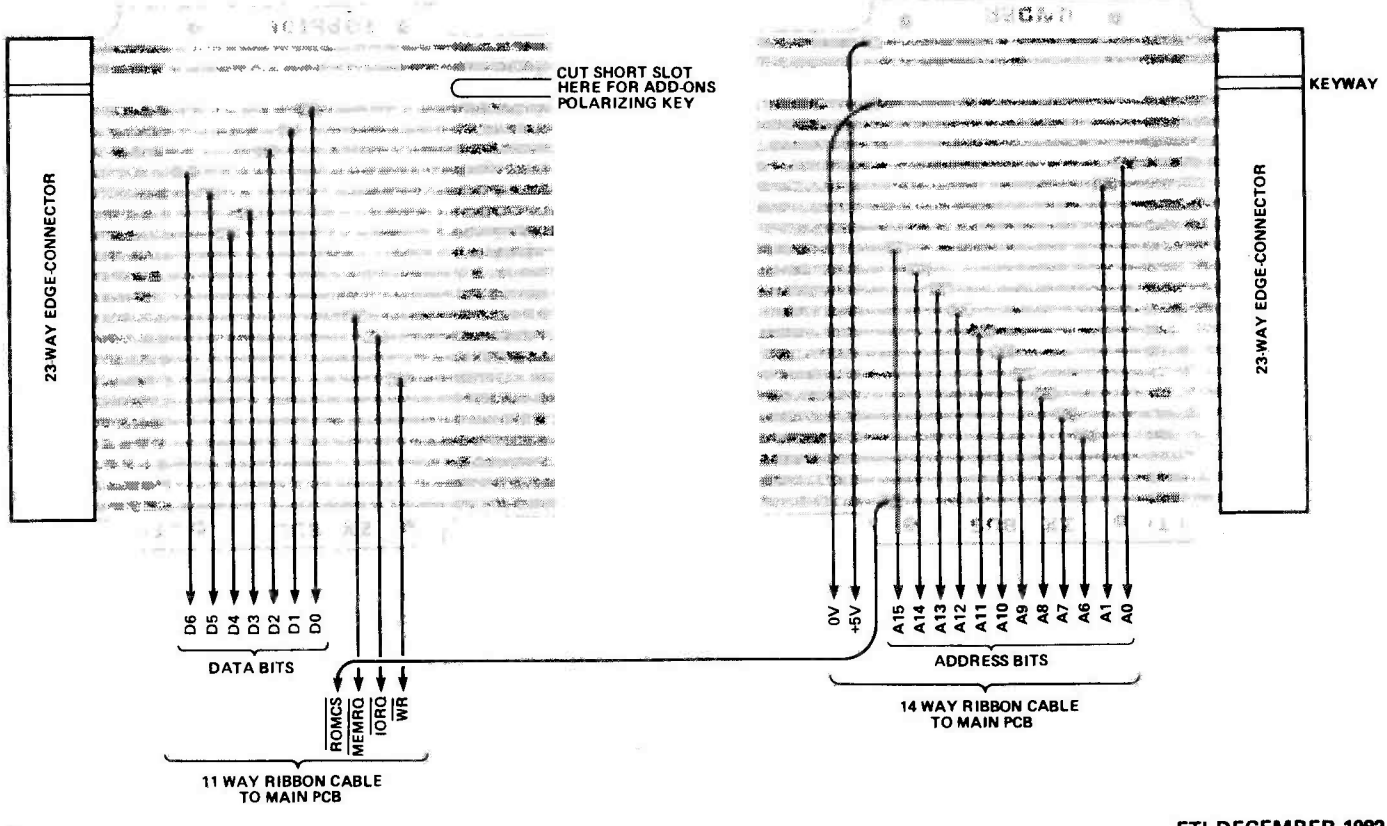


Fig. 1 (Right) Overlay for the servo arm interface board.

Fig. 2 (Below) Overlay for the edge connector PCB; this will allow the use of other peripherals, such as the ZX Printer in our lead photograph. Ribbon cable with 14 ways and 11 ways is used, although one of the wires from the 11-way piece is soldered to the other side of the PCB as shown.



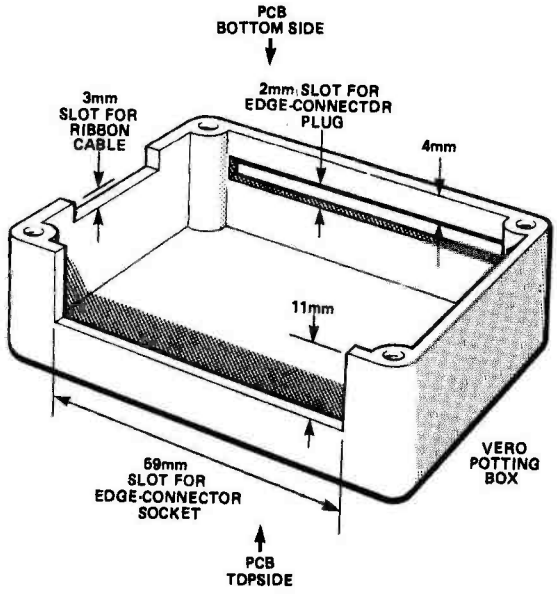
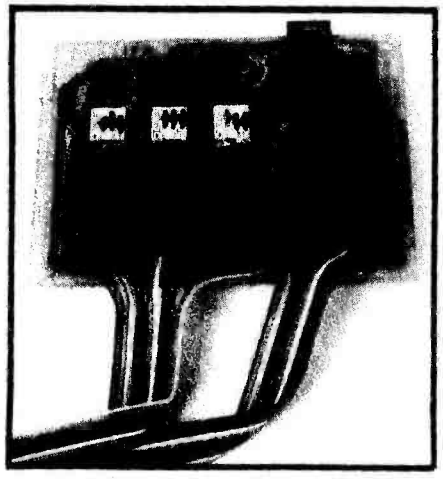


Fig. 3 Construction of the edge connector box.



A completed interface board; the ribbon cable colds under the PCB.

These logic levels are set on the switches to decode the required addresses for the servo locations.

As an example, the switches on the PCB could be set to the following logic levels (address bits 2, 3, 4, and 5 are uncommitted so the decoder will respond to a range of addresses):

switch	6	7	8	9	10	11	12	13	14	15
logic level	1	1	1	1	1	1	1	1	0	0

Thus servo 1 will respond to an address in binary of

0011 1111 1111 1100

or 3 F F C

in hexadecimal. In decimal this gives servo addresses of:

Servo 1 POKE 16380, X
Servo 2 POKE 16381, X
Servo 3 POKE 16382, X
Servo 4 POKE 16383, X

The servo 4 location is the highest byte of the second 8K block.

Testing

Once all the cables are wired up the interface can be tested by plugging in to the Sinclair expansion port, either on a Spectrum or a ZX81. Ensure that the jumper links and IC/address switch combinations are set up for the type you are using, and start with no ICs plugged in. If the computer resets correctly and still seems to work, then the first hurdle is over. Check that the 5 V power rail appears at all the IC sockets and then disconnect the interface to plug in all the ICs. With both presets at mid-travel turn PR1 45° anti-clockwise and PR2 45° clockwise; this will give a suitable pulse width to start with.

Plug in the interface again, reset the computer, and write zeros (using either the POKE or OUT command) to your chosen servo locations. On checking the servo outputs with a scope the 20 to 25 mS repetition (frame) rate should be observed, and the positive-going pulses should be at their smallest width of about 1 mS. PR2 may be used to adjust the 'minimum' pulse width. To decrease the pulse width, turn PR2 clockwise. All the servo output channels should be producing identical pulse sizes but with the appropriate phase lag according to the time slot where they occur.

Now, choosing a specific servo channel, observe the pulse output on a scope as the number 127 is written to this channel. The pulse width should shift to be about 2 mS, and this 'maximum' pulse width can be adjusted using PR1. If a servo is at hand it can be connected up as shown in the diagram of Fig. 4, whereupon it should immediately take up the position dictated by the pulse width. Different numbers can now be POKEd to the servo to test a number of pulse positions.

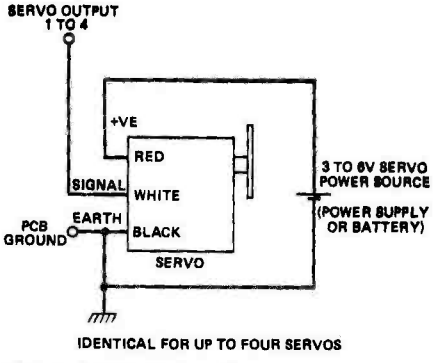
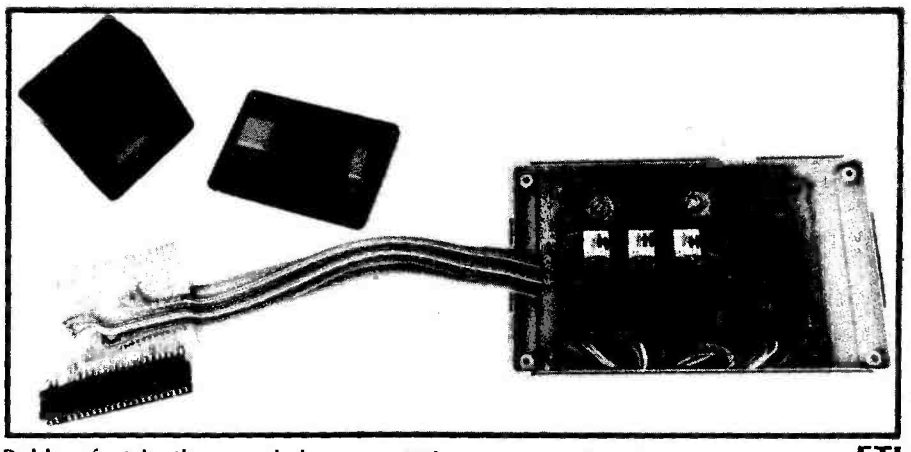


Fig. 4 Servo connections.



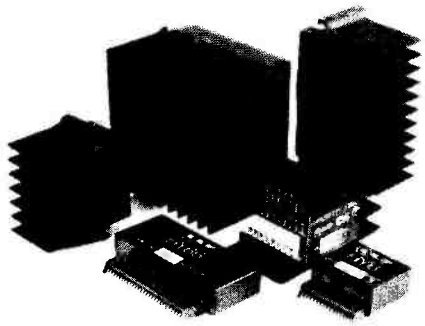
Rubber feet in the case help support the connector board.

BUYLINES

The 23-way edge-connector socket specified in the Parts List is available from Watford Electronics. Electroware stock the Pactec case used for housing the interface board; you can find them at Dutton Lane, Eastleigh, SO5 4SL (telephone 0703 610944). The two PCBs, one for the servo arm interface and the other for the connecting plug, can be purchased using the PCB Service order form on page 99.

ETI

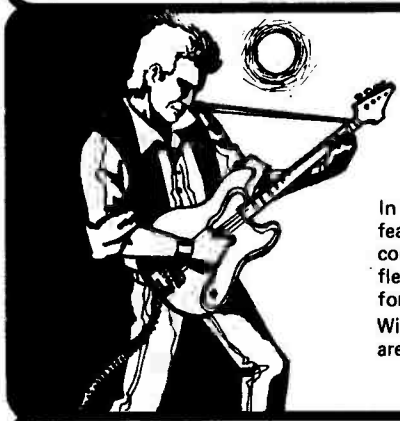
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HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
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MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

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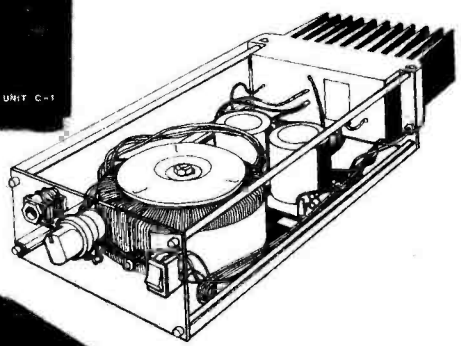
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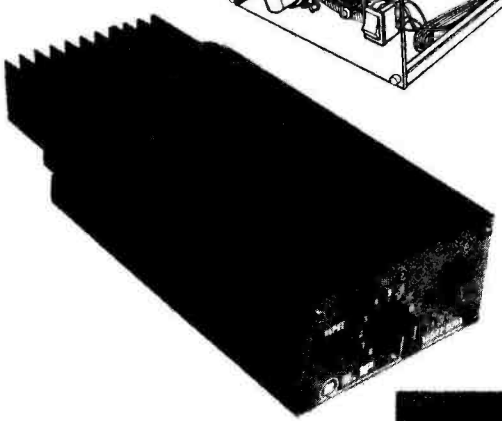
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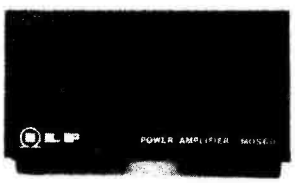
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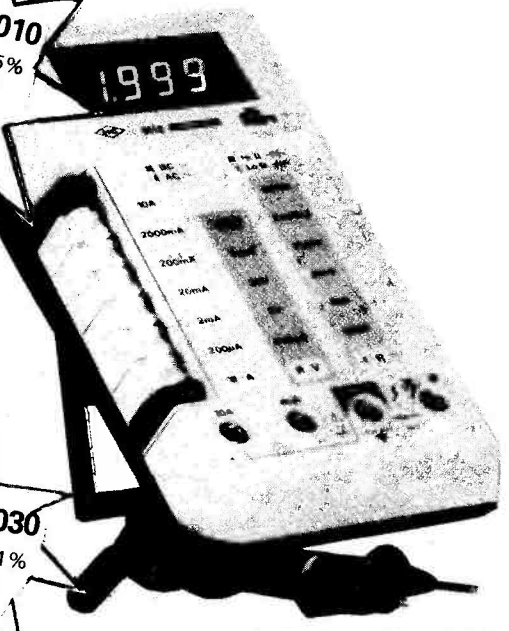
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READ/WRITE

Letters for this page should be addressed to Read/Write at our Charing Cross Road address.

Dear Sir,

I read with interest Tim Orr's series on electro-music techniques, and plan to use some of his circuits in a project. The problem is, as far as I can find out, your advertisers do not seem to stock the Curtis devices mentioned. Could you please give me some indication as to where these items may be obtained?

D. J. Stephenson,
Cheltenham

Digisound Ltd are the agents for the Curtis ICs used in Tim Orr's circuits. In particular, the CEM3310 costs £4.20, CEM3320 is £4.00, CEM3330 is £4.40, and the CEM3340 is £6.10, plus 30p postage and packing, and VAT must be added to the total order. Digisound are at 14/16 Queen Street, Blackpool, Lancs FY1 1PQ (Tel. 0253 28900).

Dear Sir,

I am presently constructing an audio amplifier which consists of the System A preamp and the Audiophile power amp split into two mono amps so that they may be sited next to the speakers.

Do you think it will be necessary to attenuate the output of the System A preamp down to 500 mV to match the Audiophile preamp output or is this unnecessary as the maximum voltage swing from each preamp is almost the same?

If the DC offset of my System A preamp is sufficiently low as to make the capacitor at the output unnecessary, can I also dispense with the electrolytic capacitor at the input to the Audiophile power amp?

Finally I am using toroidal transformers in the power amps which, although they function correctly, hum quite loudly. The manufacturers (ILP) suggest that the cause is a poor mains waveform. Is there any way of reducing this effect for a modest cost?

D. A. Davies,
W. Sussex

No, it shouldn't be necessary to attenuate the output of the preamp, because the mis-match in levels is fairly small, and the right way round in any case (775 mV output into a 500 mV input — the other way round would stop you from getting maximum output from the power amp). Ideally, you could leave out both the DC blocking capacitors, but in practice, we wouldn't recommend doing so because then any DC fault in the preamp would be amplified and fed through all the way to the loudspeaker's coils, which is one of the best ways we've discovered of destroying them. So for safety's sake, leave one of the caps in circuit, though keeping both is not necessary.

In our opinion, a well-designed transformer (toroidal or otherwise) should not be obtrusively noisy. However, you may have accentuated the relatively innocuous noise any mains transformer is bound to make by the way you have mounted it. We suggest experimenting with alternative techniques, for example, mounting the transformer on something soft and accoustically dead (foam rubber would be ideal but for its inflammability — so try whatever you have to hand until you find something that works).

Dear Sir,

First of all, congratulations on an interesting magazine. I am, at present, in the process of building the System A preamp and the 150 W MOSFET amplifier. I would appreciate it if you could let me know of the modification involved in matching these units. I note that the preamp's output is 775 mV and the amp's input is 1 V.

Also, could you tell me which configuration to use to match an Elite EEI 700 MM cartridge to the preamp's input?

Yours faithfully,
W. Suzor,
South Africa.

Hmm — the opposite problem to Mr Davies. Well, you can settle for leaving things as they are and possibly not getting quite the maximum volume out of the system (it all depends on the outputs of the signal sources): or you can tinker with the preamp. Referring back to the circuit diagram in the July 81 issue, R37 may be increased to 15k: on the other hand you could reduce RV2 to a 470R pot or solder a 1k0 resistor from either side of RV2 to ground. The first modification might affect the preamp stability, the second will alter the operating characteristics of the balance control. You'll just have to suck it and see . . .

As for the cartridge matching, we recommend the use of option H in this instance. Good listening.

Dear Sir,

It was intriguing to read in the September 82 issue of Which? (with Money Which?) of the possibility of an electronic solution to the ancient problem of ascertaining when it is possible to have sex without contraception and no danger of pregnancy. Your designers will enjoy working on a project which will interpret temperature changes in the breasts and indicate if sex without conception is possible. I do hope that you can come up with such a design — it is bound to be popular.

Yours sincerely,
W. K. C. Townley,
Morecambe.

Not only does this suggestion win our Raincoat of the Month award, but if followed up would probably offend our female readership.

Dear Sirs,

With reference to ETI September, page 11; Digest News. 'Eric' is the Tangerine Users Group mascot; yes, a small IC is the mascot of that fairly large users group. Eric is more commonly known as a 24-pin 2708 EPROM.

Yours faithfully,
Master N. P. Leirs,
Swansea

PS How about a binder for my five years of back issues of ETI or a year's subscription (even better) for the above info.

Thanks for identifying Eric; as promised in the Digest item, you don't win a prize! (Sorry if we got your name wrong, but we couldn't make out your signature.)

OOPS

Two small errors crept into the Spectrum Analyst project last month. In Fig. 3, the circuit diagram of the filter-rectifier block, R37–52 should be 10k, as listed in the Parts List. In Fig. 5, the overlay for the main board, the +10 V and −10 V connections marked 'FROM PSU' (at the corner of the PCB nearest the caption) should be swapped over. In the Cortex article, the block diagram showed two TMS9995s; the VDP is, of course, a TMS9929.

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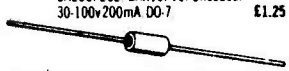
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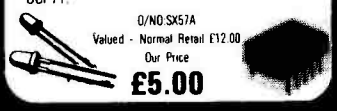
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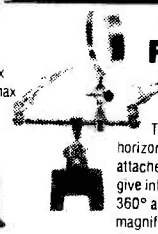
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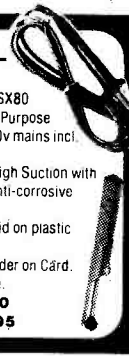
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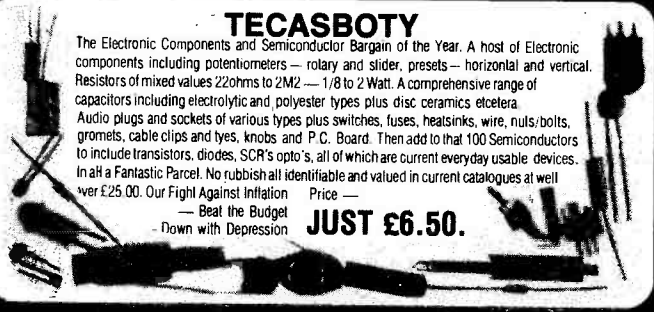
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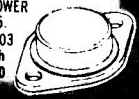


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AUDIOPHILE

Ron Harris has got lots of arms. This doesn't mean he can write articles faster than the rest of us, but it's useful for testing cartridges. Here he tells you how to give your hi-fi the (Gold)ring of confidence.

The G910IGC represents something of a rethink for Goldring. Some time ago, they launched their successful G900IGC with a compliance approaching 50 cu (x 10^{-6} cm/dyne); they subsequently issued the G910 with an identical generator system and stylus, but a much reduced compliance. Ostensibly this was to bring the G900 cartridge a potentially wider audience by allowing its use in higher mass arms. (The G900IGC itself is really only viable in an SME, since any higher arm mass is liable to bring the resonance into the range where it will affect the audible reproduction.)

The resonant frequency generated by the compliance of the cantilever and the combined arm and cartridge mass can be calculated from:

$$f_r = \frac{1}{2\pi\sqrt{(M + m)C_o}}$$

where f_r = resonant frequency (Hz)
M = arm effective mass (grams)
m = cartridge mass (grams)
C_o = Compliance (cu)

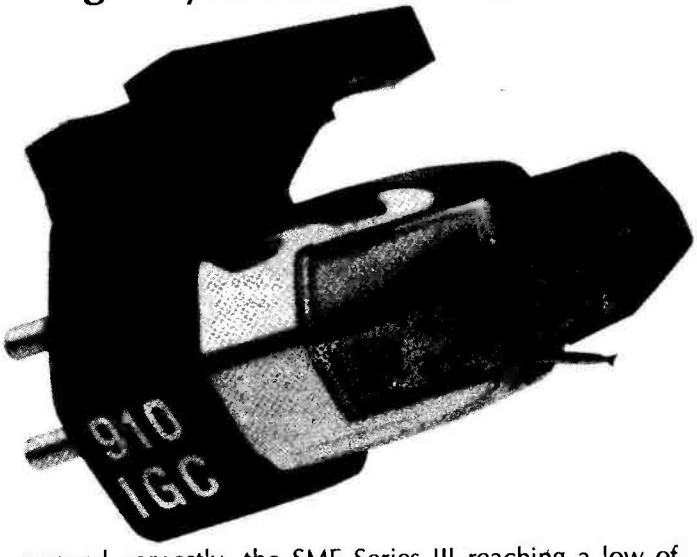
Ideally this figure should lie above the frequencies of warps on records (4–7 Hz), yet below the audio range of 15 Hz upwards: a suitable compromise has been established as being between 9–12 Hz. If you do the arithmetic, it becomes very clear that with a compliance figure up around 50 cu the G900IGC is going to have a hard time with any arm having an effective mass higher than about 6–7 g.

Thus the 910IGC, with its compliance of 25 cu, will be more suitable for a much wider range of arms and thus allows a more secure performance in more decks. (Goldring recommend arm masses between 3 g and 12 g.)

No Arm Done?

It is not just the frequency of the resonance that matters, but the strength of the resonance is important too. Damping is becoming an increasingly popular option on tonearms these days, as the importance of this subsonic resonance is recognised. The effect of energy entering the resonance is to excite the arm into motion (thus affecting the cartridge's hold upon the groove) and/or to degrade the reproduction of the lower registers by pouring energy into the system at a frequency sufficiently close to the bass register to 'modulate' the signal and colour the sound severely.

In the past, ultra-high compliance figures of around 60 cu have been present in cartridge designs, notably from Empire. Shure and Goldring too were following that path, and Shure's new V15V still has a cantilever with compliance of around 35–40 cu. It does, however, incorporate its own damping system. The thinking behind this idea is that the ideal pickup system consists of a massless arm and cartridge, tracking at zero grams. Such a unit would have no inertia and no overshoot. With no mass it could not wear out records and would track every groove perfectly. Ever lower arm mass figures were



pursued earnestly, the SME Series III reaching a low of around 6 g. The Ortofon Concorde and the Shure MV30HE are both attempts to reach as close as possible to the unobtainable ideal.

The closest thing, in practice, to the massless groove scanner is probably the laser-beam of the Philips Compact Disc player. It's impossible to wear out what you don't touch. Surface noise is also eliminated by this method and even scratches on the surface can be 'correlated' out by the following circuitry. Visions of silent background, massive dynamic range and practically invulnerable records are promises that lie temptingly just beyond the next technological revolution. One more miracle to await, headphones in hand and conductor's baton raised.

Speaking as a professional cynic, I've yet to hear a convincing demonstration of this 'new-wave' hi-fi. Good ol' analogue — warts and warps et al — can still beat the sleeves off anything else I've heard. Listen to a top flight analogue recording of a live performance — the Deutsche Gramophone 'Ring Cycle' for example — and I think you'll see what I mean.

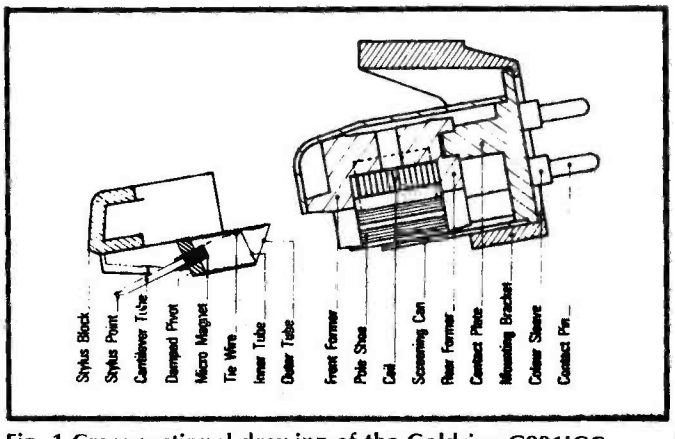


Fig. 1 Cross-sectional drawing of the Goldring G901IGC cartridge.

Lots of Life — But Not Live

A vital part of a live recording is the effect of the hall in which the recording was made. Any bounded space will affect sound generated within it. Resonances are (again) present and they reinforce certain sections of the sound spectrum, effectively adding peaks to the overall frequency response. These are directly related to the size of the hall or room and will in addition limit the bass response obtainable.

Reflections from the boundaries reach the recording mics later than the original signal and add 'reverberation' to the sound. With a different frequency spread for each reflection, depending upon the nature of the boundary doing the reflecting, a definite character will be added to the overall result.

This is because few materials reflect all audible frequencies equally, and most will absorb some quite readily. High frequencies are soaked up by brick, cloth, carpet, people — even plants! Bass frequencies are harder to absorb and travel quite effortlessly through walls into next door's living room, for example, adding little to a sense of neighbourly good-will in the process.

Thus overall, each concert hall — and living room — will have a distinct sonic character to impart to sound produced within it and it is this low-level information that digital recording is, at present anyway, lousy at replaying. Recordings of even the best orchestras and musicians are apt to sound decidedly lacking in life and character. No 'ambience' is a more up-market method of expressing the same sentiment. In plain terms they just sound dull and flat.

A Bit Short?

Perhaps as the sampling rates and number of bits used in each sample increase, this problem will be resolved. For the moment, though, we are left with the uneasy feeling that the circuitry is filtering out the life with the noise! Almost enough to justify a science fiction story or two, that — emotion classed as surface noise and filtered out at the reproduction stage! Worth a quiet shudder or two over a glass of wine, methinks.

If your tastes don't run to opera, try the new Ry Cooder LP, 'Into the Slide Area'. It was recorded live and the quality is absolutely magnificent. Frequency balance has been well maintained and the voices come across superbly. Match that one, Philips!

Back To The Plot

At least this all goes to show that there is quite a few years left in the record deck yet. It will be a considerable time until G910IGCs and Karat Diamonds become as hard to get as pine needles! It is interesting to note, though, that Quad mention in the release for their new preamp (see later in this article for more details) that the auxiliary input is now intended for 'compact disc players' . . . . . .

So now that we've established that the G910IGC possesses a future, let's take a closer look at it. As I said, it is identical to the G900IGC in all respects, save that lowered compliance.

This means it has the van den Hul stylus point, with its Improved Groove Contact geometry (IGC). This means a minor radius of a mere 3.5 um and a major (contact) dimension of 85 um lying perpendicular to the groove. Thus the stylus as a whole closely approximates to the shape of the head which cut the master disc in the first place.

Being of the same shape means that it is supposed to have less trouble following the groove — and staying in it — than other stylus profiles. Claimed benefits are improved definition of detail, better imaging through



The point of the exercise? The van den Hul in close-up. The advantages of the shape are claimed to be decreased wear, due to increased contact radius, and improved groove following abilities.

channel separation and stability, low record wear through increased contact area and lower intermodulation distortion. Not quite everything but the kitchen sink, though close. The elliptical tip may as well pack up and go home!

The *really* disquieting thing is that the IGC cartridges deliver on all the claims made for them! The surface noise really is very low, stereo image is excellent and you won't find better detail in a cartridge anywhere. Worrying that.

Stiffer Upper Lip

The older G900IGC works exceptionally well in an SME Series III, and I've encountered no problems playing the unit in this manner. Many are the tales I have heard, however, of horrendous bending cantilevers, sound breaking-up faster than the Labour Party, and unstable bass response which rocks speaker cones on their suspensions.

Most of these, I suspect, can be put down to poor matching between cartridge and arm. Still, it does a manufacturer no good to get lumbered with such tales, whether they are his fault or not. The 910IGC is thus a most sensible answer to the criticisms.

TEST RESULTS

G910IGC SERIAL NUMBER 1142

OUTPUT VOLTAGE (AT 5 cm/s):	6.6 mV (L) 6.7 mV (R)
CHANNEL SEPARATION:	1 kHz: 30 dB 10 kHz: 24 dB
FREQUENCY RESPONSE: (see graph)	20 Hz — 20 kHz ± 1.5 dB
STATIC COMPLIANCE:	25 cu
EQUIVALENT TIP MASS:	0.4 mg
CHANNEL BALANCE (AT 1 kHz):	within 1.5 dB
VERTICAL TRACKING ANGLE:	24°
OPTIMUM TRACKING WEIGHT:	1.7 g
OPTIMUM ELECTRICAL LOAD:	47k/200p
WEIGHT:	4.3 g
TYPICAL PRICE:	£59.00 including VAT

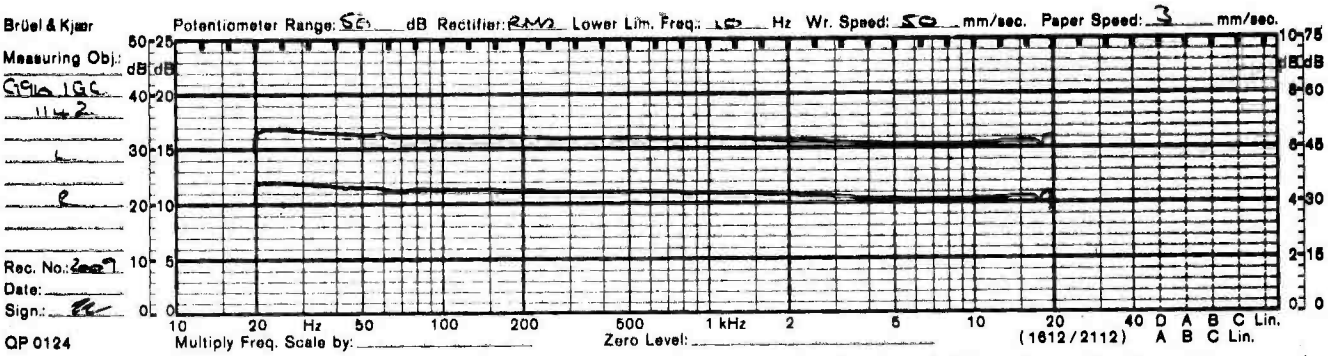


Fig. 2 (above) Frequency response plot of the G901IGC. Would that it contained a few deficiencies so that I could moan about them.

I tried the 910IGC in a wide variety of arms, from the SME itself to an Audio Technica of dubious parentage. It gave a good account of itself in all. Curiously it also appeared to offer a more refined performance than the 900IGC, even with the SME. Could it be there are more refinements lurking within the strangely shaped shell than Goldring are admitting?

The treble in particular seemed to have been cleaned-up somewhat with the 910 producing a clearer and sharper rendition of transients than its stable companion. The overall performance could simply be described as more confident and controlled, but can in no way be totally ascribed to the mere lowering of compliance.

Bench Testing

Putting both a 900 and 910 through a series of tests side-by-side failed to reveal any significant technical differences between them. The 910 measured out at 20 Hz – 20 kHz ± 1.5dB with a slightly falling upper-end response, which may in some way account for the tolerance of surface noise.

Output was very high at around 7 mV and overload problems may well arise on lesser preamps. Using the cartridge with lower grade systems is a waste anyway, but check nonetheless. You will need around 90–100 mV overload to be reasonably safe.

Separation was very high also, at around 30 dB at 1 kHz and 24 dB at 10 kHz. Optimum tracking was achieved at 1.7 g and no practical improvement is to be gained beyong this.

Under a microscope the finish on the diamond was very good and the alignment appeared to be spot-on. Goldring have obviously gone to a good deal of trouble with their van den Hul point and it shows in the product.

Competition Results

At around £60.00 the G910IGC is not cheap. By today's inflationary standards it is difficult to justify calling it expensive, however. Taking into account the very fine performance offered, the cartridge *can* justifiably be labelled as value for money. The sound quality is nicely open and well detailed. Bass is extended and free of 'boom', a characteristic which has, perhaps, been gained at the expense of a little 'weight'. Treble is clean and extended also, with no sign of the hardening on difficult material which can so easily beset lesser designs.

A good product, then, and one which has a great deal to offer a wide range of users. I personally preferred the G910IGC to its more specialised companion the 900. A worthy contender in the £50–£100 market.



Above: the new Quad 34 preamp — sorry, 'control unit' — lined up with the FM4. nother new Quad model is quite an event. That's more than one THIS YEAR . . . must be a rush of blood to the design department. The versatile filtering is retained from the existing 44 and the price is, well, interesting. Audiophile is trying to lay its hands on one, so more details when we hear from Huntingdon. Mind you, after that crack about design departments . . .

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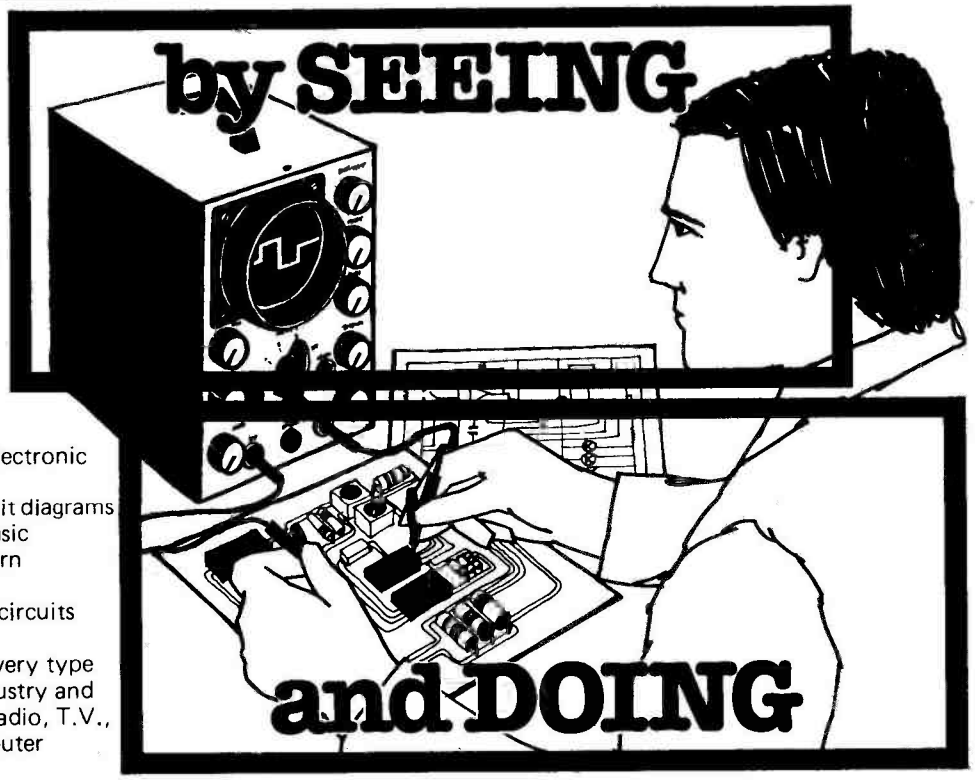
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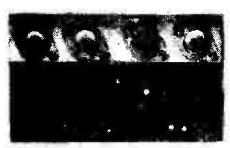
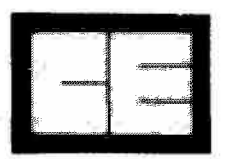
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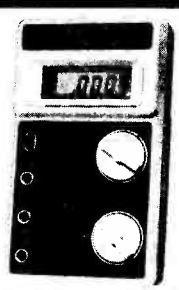
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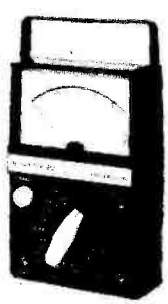


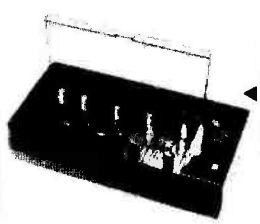
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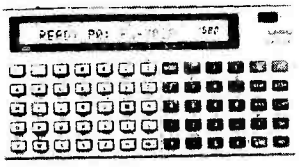
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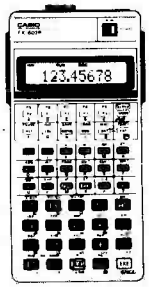
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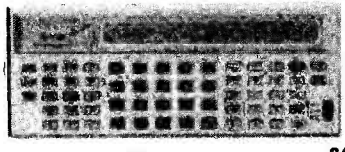
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TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
30 VA 70×30mm 0.45Kg Regulation 18%	1x010	6+6	2.50	**£5.12** +p/p £1.04 +VAT £0.92 TOTAL £7.08
	1x011	9+9	1.66	
	1x012	12+12	1.25	
	1x013	15+15	1.00	
	1x014	18+18	0.83	
	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
50 VA 80×35mm 0.9Kg Regulation 13%	2x010	6+6	4.16	**£5.70** +p/p £1.30 +VAT £1.05 TOTAL £8.05
	2x011	9+9	2.77	
	2x012	12+12	2.08	
	2x013	15+15	1.66	
	2x014	18+18	1.38	
	2x015	22+22	1.13	
	2x016	25+25	1.00	
	2x017	30+30	0.83	
	2x028	110	0.45	
	2x029	220	0.22	
	2x030	240	0.20	
80 VA 90×30mm 1Kg Regulation 12%	3x010	6+6	6.64	**£6.08** +p/p £1.67 +VAT £1.16 TOTAL £8.91
	3x011	9+9	4.44	
	3x012	12+12	3.33	
	3x013	15+15	2.66	
	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0.36	
	3x030	240	0.33	
120 VA 90×40mm 1.2Kg Regulation 11%	4x010	6+6	10.00	**£6.90** +p/p £1.67 +VAT £1.29 TOTAL £9.86
	4x011	9+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA 110×40mm 1.8Kg Regulation 8%	5x011	9+9	8.89	**£7.91** +p/p £1.67 +VAT £1.44 TOTAL £11.02
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0.72	
	5x030	240	0.66	

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	6x013	15+15	7.50	
	6x014	18+18	6.25	
	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA 110×50mm 2.6Kg Regulation 6%	7x013	15+15	10.00	**£10.17** +p/p £2.00 +VAT £1.83 TOTAL £14.00
	7x014	18+18	8.33	
	7x015	22+22	6.82	
	7x016	25+25	6.00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA 140×60mm 4Kg Regulation 4%	8x016	25+25	10.00	**£13.53** +p/p £2.35 +VAT £2.38 TOTAL £18.26
	8x017	30+30	8.33	
	8x018	35+35	7.14	
	8x026	40+40	6.25	
	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA 140×75mm 5Kg Regulation 4%	9x017	30+30	10.41	**£16.13** +p/p £2.50 +VAT £2.79 TOTAL £21.42
	9x018	35+35	8.92	
	9x026	40+40	7.81	
	9x025	45+45	6.94	
	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5.68	
	9x029	220	2.84	
	9x030	240	2.60	

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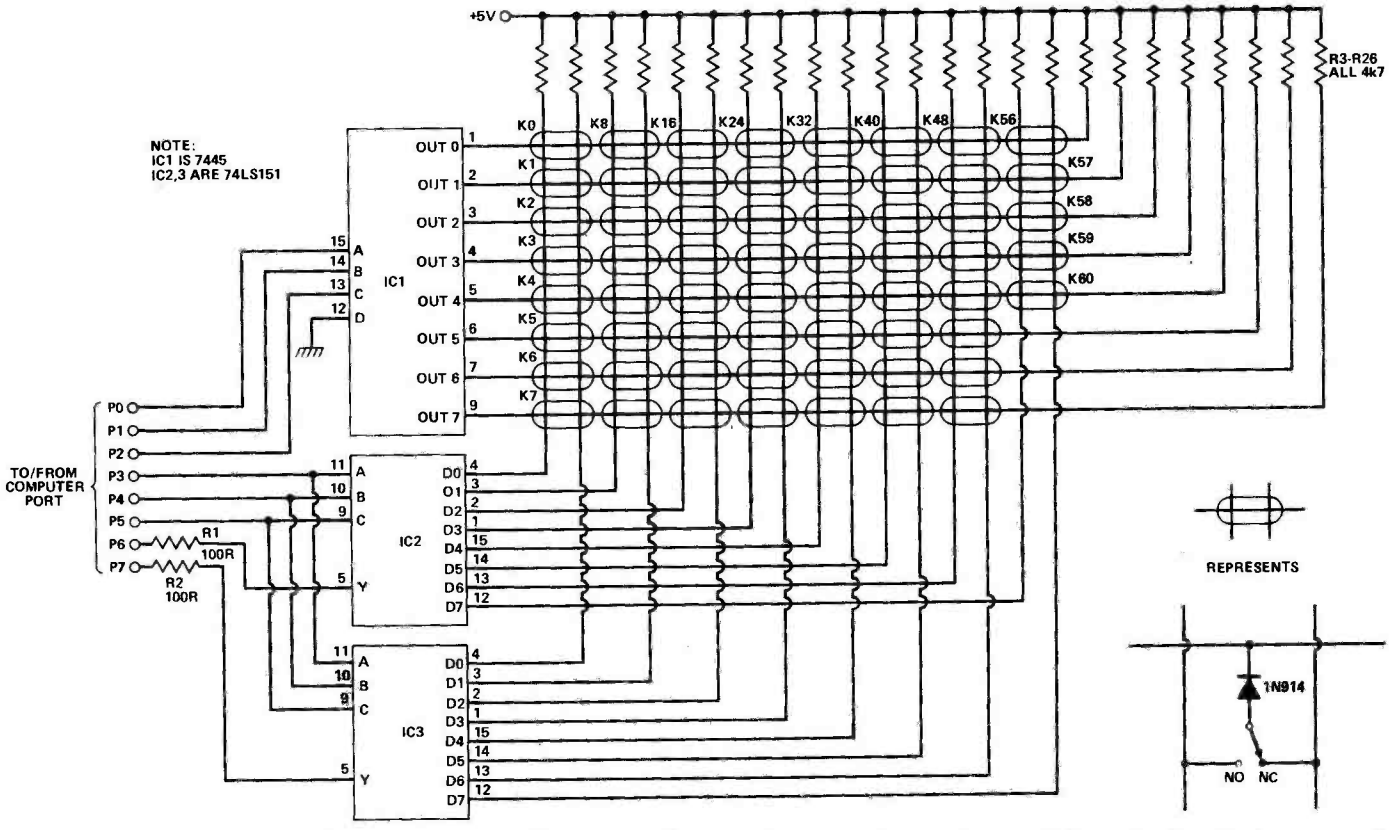
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TECH TIPS



Computer/synth Keyboard Interface

Philip Jones, Wirral

This circuit was produced to interface a 61-note music keyboard to a microcomputer for music synthesis applications. The facility for touch sensitivity is included by using changeover contacts for the keys and two multiplexer ICs (74LS151). Complete control from the computer is possible using one input/output port.

The computer sets the port so that the lower six bits are outputs and the two top bits are inputs. A six-bit code on the output bits will select one key out of the possible 64 (although only 61 are used). The top two port lines feed back the status of the selected key to the computer. This status can then be further processed by the software to give many different keyboard responses, for example monophonic, polyphonic, touch sensitive.

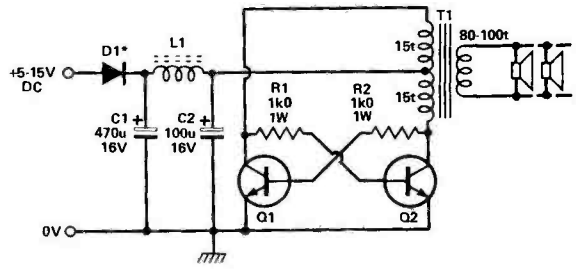
The resistors R1 and R2 protect against the danger of setting all the port lines to be outputs and thus shorting two outputs together.

High Efficiency Piezo Siren

Mrs L. Jawad, Warrington

The circuit shown is a self-starting inverter where Q1 and Q2 are connected as a multivibrator with the transformer primary forming the collector loads. The 1k0 resistors provide the base drive.

A square-wave of nearly 1 kHz is produced. This is stepped up by the transformer secondary winding which can drive one or more piezoelectric horn tweeters. The frequency of oscillation depends mainly on the number of primary turns and the type of ferrite core used. A slight adjustment to the frequency may be made by changing the value of the base drive resistors.



NOTE:
Q1,2 ARE TIP31, TIP41, BD201, MJ3055, ETC. WITH ADEQUATE HEATSINKS

T1 PRIMARY: 15t + 15t 25 SWG (BIFILAR)
SECONDARY: 80-100t 30 SWG
ON SIEMENS FERRITE CORE
B65831J0R26 OR MULLARD FX2243

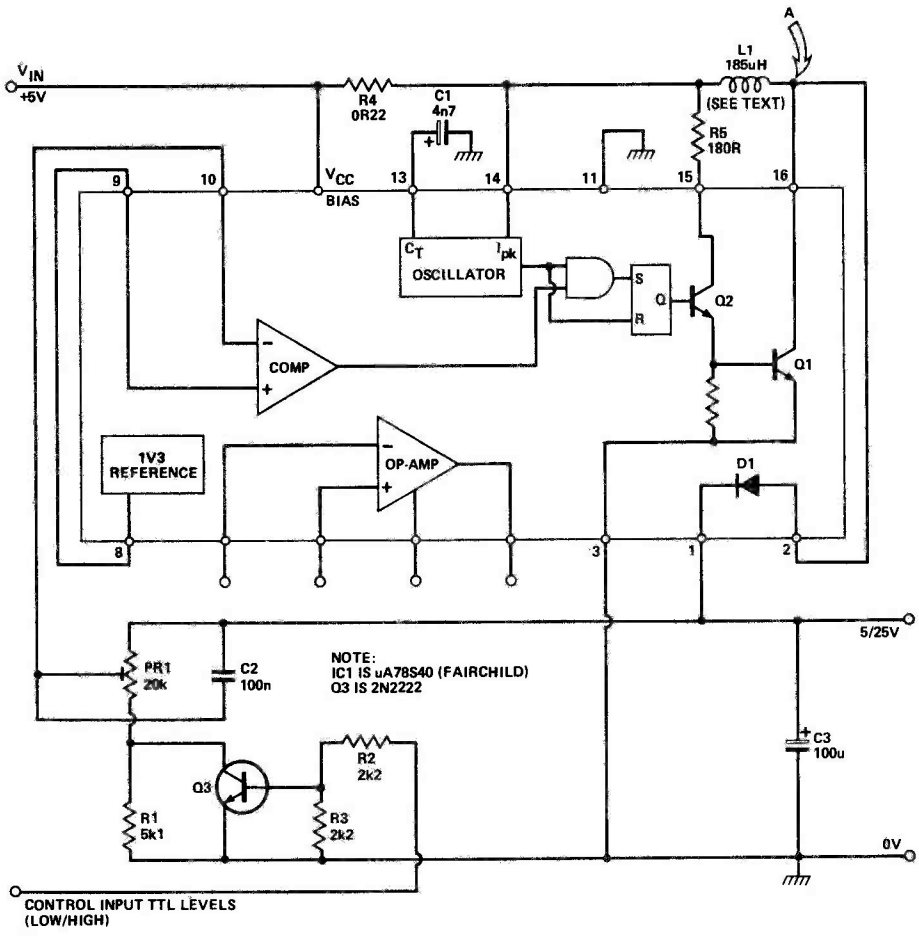
L1 10-15 turns 19 SWG
ON SIEMENS B64290J46X026
OR MULLARD FX3830 TOROIDAL CORE

*D1 IS 1N4001 (REQUIRED ONLY IF POLARITY REVERSAL IS NEEDED)

A very powerful sound is produced by the horn tweeter or tweeters due to the square-wave drive signal. This circuit was primarily designed to be used instead of the horn in a car alarm system, mainly to reduce the drain on the battery since the current consumption is less than 200 mA compared to more than an amp for the horn. However, this siren can also be used in place of any electromechanical warning devices such as bells, horns, motor-driven sirens, etc, especially those driven by a battery when it considerably reduces the current drain. Since piezo tweeters (such as the Motorola ones) are widely available and reasonably cheap, more than one tweeter can be used to distribute the sound over a larger area with the minimum of cost.

5 V to 25 V Switched Mode PSU For EPROM Blowing

C.J. Jay, Bristol



The circuit shows the application of a Fairchild 78S40 switched mode power supply chip used to generate a 25 V or 5 V (binary selectable) V_{pp} input to a 2716 type EPROM. The supply was designed to be quite small and compact so that it could fit onto a single card EPROM programmer. All the necessary power input requirements were satisfied by a single 5 V V_{cc} input; this circuit will therefore eliminate the need for a transformer derived 25 V supply and the additional supply distribution on an already overcrowded microcomputer backplane.

The 78S40 is designed into a 'step up' circuit configuration. The output is derived from pin 1 of the IC, the cathode of the internal charge pump diode D1, to a reservoir capacitor C3. When the internal transistor Q1 is turned on, current flows through inductor L1 causing energy to be stored in the magnetic flux around the windings; the charge pump diode is reversed biased when Q1 is conducting. When Q1 turns off the magnetic flux collapses, inducing a positive voltage at node A. If this node voltage exceeds the voltage on the positive plate of capacitor C3, D1 will conduct and the capacitor will charge to a more positive potential. To regulate the output voltage it is necessary to control the switching of Q1. This is achieved by tapping V_{OUT} through a potential divider of R1 and PR1 to pin 10 of the 78S40. This negative feedback controls the on/off times (mark/space), and the frequency at which Q1 switches. Q1 is driven from an internal voltage-controlled oscillator, which is in turn controlled by the negative feedback derived from V_{OUT}.

Q3 has been included in the potential divider to select the amount of feedback required to provide outputs of 25 or 5 V. When Q3 is turned on the feedback is reduced, so V_{OUT} will rise to +25 V. When off, feedback is increased and the output will fall to +5 V. To set the output voltage range it is necessary to adjust the multiturn cermet type trimpot, PR1. This should be done off load because high voltages can be generated if the feedback has been initially set up incorrectly. The CONTROL input may be CPU-programmed via a TTL, latch or PIA; the two resistors R2 and R3 are chosen to enable Q3 to be driven hard on or hard off by TTL high or low level inputs.

Other components used in the design are a timing capacitor C1 of 4n7, a peak current limiting resistor of 0R22 (R4) and a current limiting resistor R5, 180R. Capacitor C2 was included to aid smoothing of the switch ripple on the 25 V output. L1 is 34 turns of 24 swg wire on an RS RM6 ferrite core.

Regarding the performance, the circuit provides an excellent stabilised output of 25 V for loads requiring up to 75 mA. The +5 V supply does exhibit 500 mV of switching ripple, but superimposed on a mean 5 V DC level this will not violate the static input requirements of the 2716's V_{pp} input. The conversion efficiency of the entire supply was about 60%.



Tech Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for at a competitive rate.

Drawings should be as clear as possible and the text should be typed. Text and drawings must be on separate sheets. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

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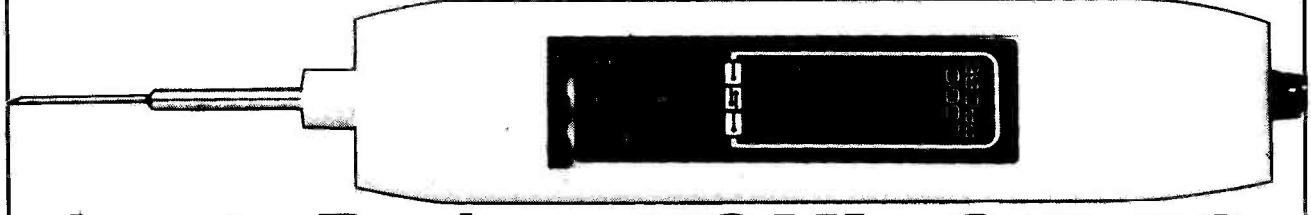
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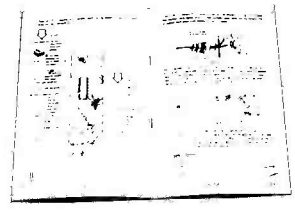
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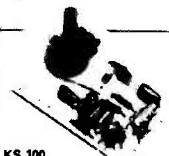
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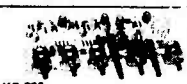
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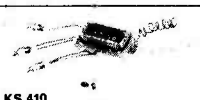
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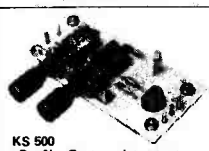
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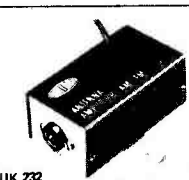
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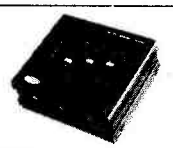
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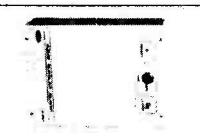
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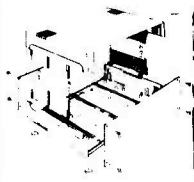


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SIGNAL LINE TESTER

If you're a PA person, here's an incredibly simple device to prevent embarrassment when all you can give them is the sound of silence. Design by Vivian Capel.

This project came about as a result of a very unfortunate incident. The author was in charge of a large public-address system that had been temporarily installed to cater for a public meeting with an audience of several thousand. There were spare microphones, spare inputs on the mixer, and to make quite sure, a spare mixer under the bench. Very little really could go disastrously wrong — but it did! Part way through the main speech everything went dead. Calm and reasoned diagnosis was employed (it wasn't really, but I couldn't admit to blind panic). Finally, after what seemed an age of silence from the speaker and murmerings from the audience, the fault was revealed as a dead short across the audio cable between mixer and amplifier rack.

Thus the fault-warning unit here described was conceived, embarrassment being the mother of invention! The idea was to constantly monitor the condition of a signal cable; if it should go either short-circuit or open-circuit, an appropriate LED would immediately light up to indicate what had happened.

The device could be used not only for public address applications, but any situation where a vulnerable signal cable needs protection by constant monitoring. A security intercom or telephone link, for example, could be monitored to reveal a fault or tampering as soon as it occurred, and avoid the need for frequent testing.

Requirements

To utilise the device successfully, the normal signal for which the cable is used must be AC. Furthermore there must be a DC path or load resistor at the far end of the cable to pass the small open-circuit mode sensing current. The input to the amplifiers or other equipment at the far end must be AC-coupled otherwise the input stages could be affected by the DC monitoring potentials. As a rule, these conditions are met in most slave amplifiers by the input gain control and following coupling capacitor. Should the capacitor come first, a load resistor must be added across the input socket.

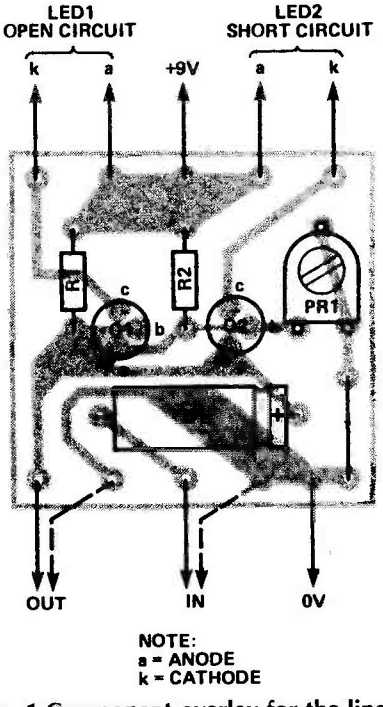


Fig. 1 Component overlay for the line checker. The line below PR1 may be replaced by a resistor — see text.

PARTS LIST

Resistors (all ¼W, 5%)	
R1	100k
R2	10k
Potentiometer	
PR1	10k miniature horizontal preset
Capacitor	
C1	10u 25 V axial electrolytic
Semiconductors	
Q1, 2	BC108
LED1, 2	3 mm red LED
Miscellaneous	
PCB (see Buylines); case and sockets (if built separate from audio equipment).	

BUYLINES

Nothing is used in this project that you can't find in your junk box. The PCB can be bought from our PCB Service as advertised on page 99.

In considering the design, several features were deemed desirable. First, the value of the load terminating the line should not be critical. While false indications can be obtained under extreme load conditions with the circuit eventually evolved, there is a wide latitude in load values and no false alarms wil be obtained within the specified limits. The nominal load for which the circuit was designed is 10k, but variations up to 20k and down to under 1k0 can be tolerated. This will accommodate most applications, but other values could be obtained by changing the values of the three resistors from those given.

Second, the circuit must take very little current as it is active for the whole time the mixer is switched on. A current of 1 mA was stipulated as the maximum allowable in the quiescent mode. This meant that few active components could be used, and that they had to be non-conducting until a fault condition occurred.

Third, the unit should be as simple as possible; far too many electronic circuits at present are needlessly complicated. In this case simplicity was pursued not merely for its own sake but as a fundamental necessity for fault monitoring equipment. It has to have a high degree of reliability if it is to be depended upon, and every extra component is one more that could itself break down.

Construction

The original circuit was built in to the mixer and powered from the mixer batteries, but construction and housing is by no means critical and almost any convenient form can be used. Input and output sockets can be standard jacks, Cannon XLR plugs or any suitable terminations appropriate for the equipment involved.

Before applying the battery voltage make sure that the variable preset PR1 is fully advanced so that maximum resistance is in circuit. If it should be fully the other way

HOW IT WORKS

The circuit diagram is shown in Fig. 1: we will consider the operation of the open-circuit indicator first. The emitter of Q1 is taken to the junction of R2 and PR1 which have values of 10k and 1k0 respectively, so the emitter is at a potential of one-tenth of the supply. The base of Q1 is connected to the junction of R1 (100k) and the load, which is nominally 10k; hence it too is at one-tenth of the supply voltage. Therefore there is no forward bias on Q1 as the base and emitter are at about the same potential, so no current passes through it and the LED in its collector circuit.

If the load now goes open circuit, the positive voltage on Q1 base rises since it is no longer tied down, so Q1 becomes forward biased, and current flows through LED1, illuminating it. Current limiting is provided by PR1 in the emitter circuit, which safeguards LED1.

The short circuit detector is built round Q2. The base of this transistor is taken to the R2-PR1 junction, and is at one-tenth of the supply; Q2 emitter is connected to the junction of R1 and the load, and so it too has base and emitter at the same potential and is cut off. Should the load become short circuited, the emitter voltage drops to zero which means there is a positive bias on the base. Therefore Q2 conducts and LED2 lights to indicate a short. Although there is no current-limiting resistor in series with LED2, the bias on the transistor can be adjusted by PR1 to give the correct current and desired illumination.

Note that neither fault condition affects the warning circuit of the other. If the load is short-circuited, Q1 base drops to 0 V while its emitter is still positive, so it is driven even further into cut-off. Similarly, if the load becomes open-circuit, the emitter voltage of Q2 rises above that of its base.

The capacitor C1 blocks DC from the sending equipment, should there be any, from upsetting the operation of the warning circuits and vice versa. It also prevents any DC path in the output of the sending device from shunting the load and rendering the open-circuit test ineffective.

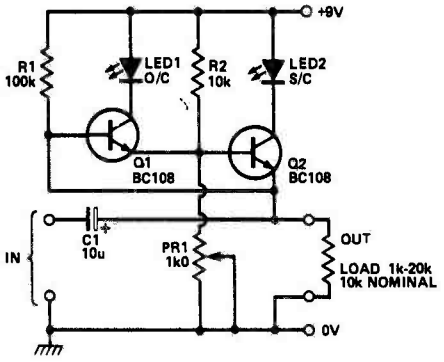


Fig. 2 Circuit diagram of the signal line tester.

there will be no limiting resistance for LED1 and it could be destroyed. If preferred, the value can be split between a 500R preset and 560R fixed resistor for the sake of safety. Once set, the preset should not require re-adjustment, and so can be sealed with a spot of paint.

Connect a 10k load resistor across the output socket. If one is already fitted across a switched jack socket, this will not be necessary. On applying the supply, both LEDs should remain off. Disconnect the load and LED1 should light up. Now short-circuit the output; LED1 should go out and LED2 illuminate. It will be found that one LED is brighter than the other due to differences in the h_{fe} of the transistors and tolerances of the resistors. Adjusting PR1 will produce equal brightness, so repeat the open-circuit and short-circuit tests and adjust PR1 each time until the desired illumination is achieved. Decreasing the value darkens LED2 and brightens LED1 and vice-versa.

Check that both LEDs are off with loads of 20k and 1k0. If LED1 glimmers at 20k increase the value of R1 to 120k or even more if required. This may be necessary if Q1 has an exceptionally high h_{fe}.

ETI

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POLYSTYRENE. SIEMENS 5% Tolerance. 160V 5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF 12p; 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF; 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7 13p, 5n6, 6n8, 8n2 10p
CERAMIC Very small. 1.8, 2.2, 2.7, etc. up to 1n 9p each. 1n5, 2n2, 3n3, 4n7, 6n8 9p; 10n, 22n 8p. 33n, 47n 7p; 100n 8p.
POLYESTER, SIEMENS LAYER-TYPE *7.5mm lead spacing 100V* 1n, 1n5, 2n2, 3n3, 6p; 4n7, 6n8, 8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 39n, 47n 7p. 82n, 100n 9p; 120n, 150n 11p; 180n, 220n 12p; 270n, 330n 15p; 390n, 470n 17p; 560n, 680n 24p; *10mm spacing* 1µF 28p; *15mm spacing* 2µ2 36p; *22.5mm spacing* 1µF 400V 47p; 3.3µF 100V 89p; In-depth stocks.
ELECTROLYTICS NON-polar (for LS X-overs) 50V peak 2µF 28p; 4µF 29p; 6, 8, 10, 16µF 32p; 25µF 37p; 40, 60µF 89p; 100µF 89p.
POLARISED, SIEMENS OR MULLARD (µF/V) 1/63, 2.2/63, 4.7/63, 6.8/40, 10/25, 22/10, 10p; 10/40, 22/25, 47/10 11p; 47/25 12p; 100/10 13p; 10/63, 22/40, 100/16 14p; 22/63, 47/40, 100/25, 100/40 15p; 220/10, 220/16 16p; 220/25 18p; 220/40 20p; 470/10, 470/16, 470/25, 100/10 18p; 470/40, 1000/16 27p; 1000/25 36p; 1000/40, 2200/16 44p; 1000/63 78p; 2200/40,4700/16 73p.
PLUGGABLE SIEMENS single ended 1/63, 2.2/63, 4.7/63 10p; 10/63, 22/63 8p; 22/40, 47/16 10p; 47/40 12p; 47/63 10p; 100/16, 100/25, 100/40 10p; 100/63 20p; 220/10 13p; 220/16, 220/25 13p; 470/6.3 15p; 470/10 18p; 470/16 18p; 470/25 22p; 470/40 26p; 1000/10 22p; 1000/16 23p; 1000/25 40p.
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TANTALUM 0.1/35, 0.22/35, 0.47/35, 1/35, 2.2/16 13p; 2.2/35, 2.2/16 13p; 2.2/35, 4.7/16 16p; 10/6.3 16p;4.7/35, 10/16, 22/6.3, 10/25 15p;22/16, 22/25, 33/10, 47/6.3, 100/3 30p
LOW LEAKAGE All single ended 0.1/50, 0.22/50, 0.47/50, 4.7/35 11p; 1/60, 2.2/50, 4.7/50 11p; 10/16, 22/6 11p; 10/35, 22/10, 22/16, 22/35, 47/6, 47/10 12p; 47/16, 100/6 12p

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ETI PCB SERVICE

Up until now PCBs were always the hardest component to obtain for a project. Of course you *could* make your own, but why bother anymore?

Now you can buy your boards straight from the designers — us! As of this issue all (non-copyright) PCBs will be available automatically from the ETI PCB Service. Each board is produced from the same master used to build our prototypes, so you can be sure it's accurate, and will be finished to the high standard you would expect from ETI.

In addition to the PCBs for this month's projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please note that NO OTHER BOARDS ARE AVAILABLE. If it's not listed, we don't have it!

APRIL 79
- ☐ Guitar Effects Unit £2.64
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JUNE 79
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FEBRUARY 80
- ☐ Tuning Fork £2.64

MARCH 80
- ☐ Signal Tracer £2.27

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- ☐ Bench Amplifier £2.53
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- ☐ Mains Audio Link (three boards) £7.35
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- ☐ Signal Line Tester £1.78

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