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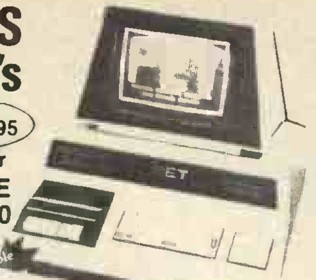

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The Sorcerer Computer is a completely assembled and tested computer system. Standard configuration includes 63-key typewriter-style keyboard and 16-key numeric pad, Z80 processor, dual cassette I/O with remote computer control at 300 and 1200 baud data rates, RS232 serial I/O for communications, parallel port for direct Centronics printer attachment, 4K ROM operating system, 8K ROM Microsoft BASIC in Rom Pac™ cartridge, composite video of 64 char/line 30 line/screen, 128 upper/lower case ASCII set and 128 user-defined graphic symbols, operation manual, BASIC programming manual and cassette/video cables, connection for S-100 bus expansion.

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- *RS232 interface *8K BASIC ROM
- *CUTS interface *4K MONITOR
- *KANSAS CITY interface *S100 BUS
- *User defined graphic symbols *Z80 cpu

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Atari's Video Computer System now offers more than 1300 different game variations and options in twenty great Game Program™ cartridges!

Have fun while you sharpen your mental and physical coordination. You can play rousing, challenging, sophisticated video games, the games that made Atari famous.

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SHORT C12 CASSETTES

FOR COMPUTER PROGRAMMES

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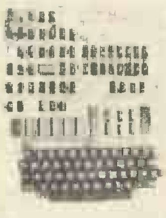
OHIO SUPERBOARD II *NEW*

For electronic buffs. Fully assembled and tested. Requires +5V at 3 Amps and a video monitor or TV with RF converter to be up and running.



STANDARD FEATURES

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
  - Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-keyboard with upper/lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM

Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters; without overscan up to 30 x 30 characters.

EXTRAS

Available expander board features 24K static RAM (additional), dual mini-floppy interface, port adapter for printer and modem and an OSI 48 line expansion Interface.

Assembler/editor and extended machine code monitor available.

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TELEPLAY have produced a product of cartridge games for you and all your family that will not go out of date. Just ADD each new cartridge as it becomes available, and your colour video centre will be up to date the Teleplay way. You will save pounds in the long run. Works OK on Black and White TV

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PRACTICAL
ELECTRONICS

VOLUME 15 No. 5 MAY 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR JUNE ISSUE WILL BE ON SALE FRIDAY, 11 MAY 1979
(for details of contents see page 67)

WATFORD ELECTRONICS

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MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

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POLYESTER CAPACITORS: Axial lead type. (Values are in µF) 400V: 0.001, 0.0015, 0.0022, 0.0033 **9p**; 0.0047, 0.0068, 0.01, 0.015, 0.018 **10p**; 0.022, 0.033, **10p**; 0.047, 0.068 **14p**; 0.10 **15p**; 0.15, 0.22 **22p**; 0.33, 0.47 **39p**; 0.68 **45p**. **160V:** 0.039, 0.15, 0.22 **11p**; 0.33, 0.47 **19p**; 0.68, 1.0 **22p**; 1.5 **29p**; 2.2 **32p**.
DUBILIER: 1000V: 0.01, 0.015 **20p**; 0.022 **22p**; 0.047 **26p**; 0.1 **38p**; 0.47 **48p**.

POLYESTER RADIAL LEAD (Values are in µF) 250V: 0.01, 0.015, 0.022, 0.027 **6p**; 0.033, 0.047, 0.068, 0.1 **7p**; 0.15 **11p**; 0.22, 0.33 **13p**; 0.47 **15p**; 0.68 **18p**; 1.0 **24p**; 1.5 **27p**; 2.2 **31p**.

FEED THROUGH CAPACITORS 100µF 350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF) 500V: 10 **40p**; 47 **68p**; **250V:** 100 **65p**; **63V:** 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8, 8, 10, 15, 22 **8p**; 47, 32, 50 **11p**; 63, 100 **27p**; **50V:** 50 **11p**; 100, 220 **25p**; 470 **32p**; 1000 **50p**; **40V:** 22, 33 **8p**; 100 **12p**; 2200, 3300 **62p**; 4700 **85p**; **35V:** 10, 33 **9p**; 330, 470 **32p**; 1000 **49p**; **25V:** 10, 22, 47 **6p**; 80, 100, 160 **8p**; 220, 250 **13p**; 470, 640 **25p**; 1000 **27p**; 1500 **30p**; 2200 **45p**; 3300 **62p**; 4700 **68p**; **16V:** 10, 40, 47, 68 **7p**; 100, 125 **8p**; 330 **14p**; 470 **16p**; 1000, 1500 **20p**; 2200 **34p**; **10V:** 4, 100 **6p**; 640 **10p**; 1000 **14p**.
Tag-End **70V:** 2000 **89p**; 4700 **135p**; **50V:** 10,000 **255p**; **40V:** 2500 65p; 3300, 4700 **70p**; 15,000 **450p**; **25V:** 4700 **68p**; 2200 **48p**; **325V:** 200 + 100 + 50 + 100 **190p**; 32 + 32 **175p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2µF, 3.3, 4.7, 6.8; 25V: 1.5, 10; 20V: 1.5; 16V: 10µF **13p** each, 47, 100 **40p**; 10V: 22µF, 33; 6V: 47, 68, 100; 3V: 68, 100µF **20p** each.

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF **6p**
0.015, 0.02, 0.04, 0.05, 0.056µF **7p**
0.01µF, 0.2 **9p** 50V: 0.47µF **11p**

CERAMIC CAPACITORS: 50V
0.5pF to 10nF **3p each**
15nF, 22nF, 33nF, 47nF **4p each**
0.1µF **6p**; 0.2µF **7p**

POLYSTYRENE CAPACITORS
10pF to 1nF **8p**; 1.5nF to 47nF **10p**.

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220, 250 **9p ea**
300, 330, 360, 390, 600, 820 **16p ea**
1000, 1200, 1800, 2000, 2200 **20p ea**

MINIATURE TYPE TRIMMERS
2 5 6pF 3-10pF 10 40pF **22p**
5 25pF 5 45pF 60pF 88pF **30p**

COMPRESSION TRIMMERS
3-40pF, 10-80pF, 25-190pF **30p**
100-500pF **45p**; 1250pF **60p**

SOLDERCON PINS*
100 pins **50p**; 1000 pins **400p**

POTENTIOMETERS (AB or EGEN)
Carbon Track. ¼W Log & ½W Linear values

500Ω, 1K & 2K (lin only). Single	27p
5KΩ-2MΩ single gang	27p
5KΩ-2MΩ single gang D/P switch	65p
5KΩ-2MΩ dual gang stereo	78p

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm

5KΩ-500KΩ single gang	70p
10KΩ-500KΩ dual gang	80p
Self Stick Graduated Bezels	22p

PRESET POTENTIOMETERS
Vertical & Horizontal

0-1W 50Ω- 5MΩ Miniature	8p
0 25W 100Ω—3-3MΩ Horiz	10p
0 25W 200Ω—4-7MΩ Vert	10p

RESISTORS - Erie make 5% Carbon Miniature High Stability. Low noise

RANGE	VAL	1 99	100 -
¼W 2-2Ω-4 7M	E24	1.5p	1p
½W 2 2Ω-4 7M	E12	2p	1.5p
1W 2-2Ω-10M	E12	5p	4p
2% Metal Film 10Ω-1MΩ		6p	4p
1% Metal Film 51Ω-1M		10p	8p

100 - price applies to Resistors of each type not mixed values.

RADIO 4 on MW
LW-MW Converter. Complete kit of parts incl. assembly instructions **£4.50** only.

OPTO ELECTRONICS★

LEDs plus clip	
TIL209 Red	13
TIL211 Grn	17
TIL2 12 Yellow	18
·2" Red	15
2" Yellow Green	18
Spare Clips	2
ORP12	63
2N5777	45
7 Seg Displays	
LS400	255
TIL307	675
TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DI704 C Cth ·3"	99
DL707 C.A. ·3"	99
DL747 C.A. .6"	180
FND357	120
MAN3640	175
LCD 3½ digit	875

SWITCHES★

TOGGLE 2A 250V	
SPST	28p
DPDT	38p
4 pole on/off	54p
SUB-MIN TOGGLE	
SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT Centre off	79p
DPDT Biased	115p
SLIDE 250V:	
1A DPDT	14p
1A DP C/off	15p
½A DPDT	13p
4 pole c/over	24p
PUSH BUTTON	
Spring loaded	
SPST on/off	65p
SPDT c/over	70p
DPDT 6 Tag	85p

	JACK PLUGS		SOCKETS		
	Screened chrome	Plastic body	open metal	moulded with break contacts	in line couplers
2·5mm	13p	10p	8p		11p
3·5mm	15p	10p	8p		12p
MONO	25p	14p	13p	20p	18p
STEREO	32p	18p	15p	24p	22p

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker	10p	8p	20p
3 4, 5 Pin Audio	13p	10p	20p
Co-axial (plastic)	10p	12p	12p
(metal)	18p	18p	22p
PHONO assorted colours	10p	6p single, 8p double	15p
Metal Screened	15p	18p 4-way	20p
BANANA 4mm	11p	12p	—
2mm	12p	12p	—
1mm	6p	6p	—
WANDER 3mm	7p	7p	

SWITCHES ★ Miniature Non-Locking

Push to Make **15p** Push to Break	25p
ROCKER (white) 10A 25u / SP changeover centre off	30p
ROCKER: (black) on/off 10A 250V	23p
ROCKER: Illuminated (white) Lights when on: 3A 240V	52p
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2-6W 3p/2-4W 4p/2-3W	41p
ROTARY: Mains 250V AC, 4 Amp	45p

ROTARY: "Make a switch". Make your own multiway switch. Adjustable stop shafting assembly. Takes 6 wafers. **69p**
1p/12W, 2p/6W, 3p/4W, 4p/3W, 6p/2W **47p**

TTL 74LS★ (TEXAS)

LS00	13	LS63	150	LS153	76	LS240	236	LS346	185
LS01	13	LS73	46	LS155	96	LS241	231	LS347	48
LS02	14	LS74	41	LS156	96	LS242	232	LS348	186
LS03	14	LS75	48	LS157	76	LS243	232	LS352	228
LS04	14	LS76	40	LS158	96	LS244	155	LS353	228
LS05	23	LS78	40	LS160	128	LS245	270	LS365	65
LS08	22	LS83	115	LS161	98	LS247	190	LS366	65
LS09	22	LS85	118	LS162	138	LS248	190	LS367	65
LS10	20	LS86	43	LS163	102	LS249	190	LS368	66
LS11	22	LS90	38	LS164	114	LS251	134	LS373	180
LS12	23	LS91	104	LS165	75	LS253	142	LS375	160
LS13	38	LS92	89	LS166	226	LS257	110	LS374	
LS14	75	LS93	89	LS168	155	LS258	110	LS377	212
LS15	30	LS95	116	LS169	150	LS259	160	LS378	184
LS20	20	LS96	116	LS170	288	LS261	450	LS379	215
LS21	22	LS107	44	LS173	105	LS266	52	LS384	86
LS22	22	LS109	55	LS174	106	LS273	244	LS385	155
LS26	48	LS112	55	LS175	110	LS275	250	LS386	86
LS27	28	LS113	50	LS181	398	LS279	66	LS390	230
LS28	48	LS114	50	LS183	298	LS280	250	LS393	230
LS30	22	LS122	70	LS189		LS283	192	LS395	218
LS32	27	LS123	70	LS190	140	LS290	128	LS396	215
LS33	39	LS124	180	LS191	140	LS293	128	LS398	276
LS37	39	LS125	60	LS192	132	LS295	185	LS399	230
LS38	39	LS126	60	LS193	130	LS298	68	LS445	150
LS40	28	LS132	95	LS194	166	LS299	468	LS447	144
LS42	98	LS136	55	LS195	136	LS300	175	LS490	180
LS47	63	LS138	85	LS196	100	LS302	175	LS668	182
LS48	120	LS139	85	LS197	140	LS323	468	LS669	182
LS49	120	LS145	108	LS199		LS324	240	LS670	248
LS51	24	LS147	170	LS200	348	LS325	290	LS673	1050
LS54	28	LS148	173	LS202	345	LS326	294	LS674	1450
LS55	30	LS151	96	LS221	96	LS327	286	LS677	1050

DIL SOCKETS★ (TEXAS)

	Low Profile	Wire Wrap
8pin	10p	25p
14pin	12p	35p
16pin	13p	46p
18pin	20p	52p
20pin	27p	65p
22pin	30p	70p
24pin	30p	78p
28pin	42p	85p
36pin	—	105p
40pin	55p	109p

SCRs Triacs Diacs Diodes Cases Proto Decs Vero etc. available.

COMPUTER/VDU HARDWARE★

2101	100	75450	120
2102-2	170	81LS95	95
2111	220	81LS96	95
2112	105	81LS97	120
2112-2	210	AY-3-1015	560
2114	750	AY-5-1013	450
2513	595	MC1488	85
2516	1800	MC1489	90
2708	750	MC14411	958
4027	190	SFC71301	820
4047	750	SFF96364E	1175
71301	820	SFS80102	205
74S188	165	Z80	1150
74S262	875	UHF Modulator	250
74S287	325		
74S470	325		
74S475	825		

TTL 74★

7400	13	7494	78
7401	13	7495	65
7402	14	7496	57
7403	14	7497	189
7404	14	74100	119
7405	18	74105	62
7406	38	74107	29
7407	38	74109	54
7408	17	74110	54
7409	17	74111	68
7410	15	74112	125
7411	20	74116	198
7412	17	74118	83
7413	30	74119	149
7414	51	74120	115
7416	30	74121	25
7417	30	74122	46
7420	16	74123	48
7421	29	74125	38
7422	24	74126	57
7423	27	74128	74
7425	27	74132	73
7426	36	74136	65
7427	27	74141	56
7428	35	74142	209
7430	17	74143	314
7432	25	74144	314
7433	40	74145	65
7437	30	74147	175
7438	33	74148	109
7440	17	74150	99
7441	74	74151	64
7442	68	74153	64
7443	115	74154	96
7444	112	74155	53
7445	94	74156	80
7446	94	74157	67
7447	82	74159	185
7448	51	74160	82
7450	17	74161	92
7451	17	74162	92
7453	17	74163	92
7454	17	74164	105
7460	17	74165	105
7470	28	74166	140
7472	25	74167	200
7473	32	74170	185
7474	27	74172	625
7475	38	74173	120
7476	36	74174	87
7480	48	74175	87
7481	86	74176	75
7482	69	74177	78
7483	72	74178	153
7484	95	74180	85
7485	106	74181	165
7486	31	74182	88
7489	210	74184	135
7490	33	74185	135
7491	75	74188	275
7492	38	74190	95
7493	32	74191	95
		74192	98
		74193	98
		74194	98
		74195	98
		74196	93
		74197	80
		74198	150
		75150	175
		75491	92
		75492	92

CMOS★

4000	15	4056	134
4001	17	4057	1999
4002	16	4059	480
4006	92	4060	115
4007	18	4061	1425
4008	82	4062	999
4009	38	4063	110
4010	38	4066	58
4011	18	4067	380
4012	18	4068	22
4013	45	4069BE	20
4014	80	4070	32
4015	82	4071	21
4016	45	4072	21
4017	82	4073	21
4018	87	4075	23
4019	48	4076	85
4020	99	4077	40
4021	95	4078	21
4022	85	4081	20
4023	22	4082	21
4024	66	4085	74
4025	19	4086	73
4026	180	4089	150
4027	45	4093	85
4028	81	4094	190
4029	99	4095	105
4030	58	4096	105
4031	205	4097	372
4032	100	4098	110
4033	145	4099	145
4034	116	4160	109
4035	111	4161	109
4036	325	4162	109
4037	100	4163	109
4038	108	4174	110
4039	320	4175	99
4040	105	4194	108
4041	80	4408	720
4042	75	4409	720
4043	94	4410	720
4044	95	4411	958
4045	145	4412F	1650
4046	128	4412V	1380
4047	87	4415F	795
4048	58	4415V	795
4049	48	4419	280
4050	48	4422	545
4051	72	4433	995
4052	72	4435	825
4053	72	4440	1275
4054	110	4450	295
4055	128	4451	295
		4490F	695
		4490V	525
		4501	19
		4502	120
		4503	69
		4506	51
		4507	55
		4508	298
		4510	99
		4511	150
		4512	98

LINEAR IC'S

702★	75	M253AA★	795
709C 14 pin	35	MC1303	88
710★	67	MC1304P	260
723★	45	MC1310	149
733★	125	MC1312P	195
741C★ 8 pin	22	MC1495★	390
747C★	78	MC1496★	92
748C★	36	MC1710★	79
753★	150	MC3401	52
810★	159	MC3403★	135
AY-1-0212	580	MC3340P★	120
AY-1-1313★	660	MC3360P	120
AY-1-1320	315	MFC6040★	97
AY-1-5050	180	MK50398★	635
AY-1-5051	145	MK50362★	650
AY-1-6721/6	195	MM5303★	635
AY-3-8500★	385	MM57160★	620
AY-5-1224A★	260	NE518A★	210
AY-5-1230★	450	NE555★	22
AY-5-1315	560	NE556DB★	60
AY-5-1317A	630	NE560★	325
CA3011★	82	NE561★	395
CA3020	170	NE562★	410
CA3023	170	NE565A★	120
CA3028A★	80	NE566★	160
CA3035	240	NE567★	170
CA3036★	110	NE570★	420
CA3043	190	NE571★	450
CA3046★	71	RC4136D★	120
CA3048	200	SAD1024A★	1350
CA3075	175	SG3402	295
CA3080E★	80	SN76003N	170
CA3081	190	SN76013N	140
CA3089E	210	SN76023N	140
CA3090AQ	398	SN76033N	175
CA3123E	200	SN76115N	215
CA3130★	85	SN76477★	225
CA3140★	80	SN76227	115
ICL7107★	975	TAA621AX1	250
ICL7106E★	795	TAA960	320
ICL7555★	95	TBA120S	70
ICL8038★	340	TBA5400	220
ICM7205★	1150	TBA641BX11	250
ICM7215★	1025	TBA651	180
ICM7217★	790	TBA800	90
LD130★	452	TBA810S	95
LF356★	98	TBA820	70
LM301A	30	TDA1004★	290
LM304	240	TDA1008★	290
LM308★	95	TDA1022★	575
LM318	195	TDA2020	320
LM324★	68	TL061CP★	48
LM339★	70	TL062CP★	125
LM348★	90	TL064CN★	199
LM379★	375	TL071CP★	76
LM380	90	TL081CP★	52
LM381N	145	TL082CP★	96
LM382	122	TL084CP★	130
LM1458★	50	UAA170	198
LM3900★	60	ZN414	90
LM3909N★	70	ZN424	135
LM3911★	125	ZN425E★	415
M252AA★	750	ZN1034E★	200

TRANSISTORS

AC117★	35	BC169C	12	BF184★	38
AC125★	20	BC170	18	BF194	12
AC126★	20	BC171	11	BF195	12
AC127★	20	BC172	11	BF196	12
AC128★	20	BC177★	18	BF197	14
AC141★	24	BC178★	16	BF198	18
AC141K★	38	BC179★	18	BF200★	30
AC142★	24	BC182	9	BF224A	18
AC142K★	38	BC182L	11	BF244	30
AC176★	22	BC183	9	BF256★	60
AC178	22	BC183L	11	BF257★	30
AC187★	20	BC184	9	BF258★	30
AC188★	22	BC184L	11	BF259★	30
ACY17★	35	BC186	21	BF394	27
ACY18★	40	BC187★	28	BF594	40
ACY19★	40	BC212	10	BF595	38
ACY20★	40	BC212L	11	BFR39	25
ACY21★	35	BC213	11	BFR40	28
ACY22★	40	BC213L	12	BFR41	28
ACY28★	40	BC214	12	BFR79	28
ACY39★	78	BC214L	13	BFR80	28
ACY40★	48	BC307B	20	BFR81	28
ACY44★	39	BC308	20	BFX29★	28
AD140★	68	BC328	15	BFX81★	45
AD149★	70	BC338	18	BFX84★	26
AD161★	42	BC441★	36	BFX85★	28
AD162★	42	BC461★	36	BFX86★	28
AF114★	40	BC477★	25	BFX87★	28
AF115★	40	BC547	12	BFX88★	28
AF116★	40	BC548	12	BFY18★	50
AF117★	40	BC549C	13	BFY50★	20
AF118★	55	BC557	15	BFY51★	20
AF121★	48	BC559C	20	BFY52★	20
AF124★	55	BCY30★	57	BFY71★	20
AF125★	35	BCY34★	75	BSX20★	18
AF127★	35	BCY39★	80	BSY65★	30
AF139★	35	BCY40★	78	BSY95A★	18
AF178★	70	BCY43	85	BU105	140
AF180★	70	BCY58★	90	BU205★	190
AF186★	50	BCY59★	90	BU208★	225
AF239★	42	BCY70★	18	E113	75
ASY26★	40	BCY71★	20	E176	115
ASY27★	45	BCY72★	20	E421	96
BC107★	9	BCY78★	25	MD8001★	158
BC107B★	10	BD115★	65	ME4102	10
BC108★	9	BD121★	78	ME6002	10
BC108B★	10	BD123★	98	MJ400★	90
BC108C★	12	BD124★	115	MJ491★	160
BC109★	9	BD131★	45	MJ2955★	120
BC109B★	12	BD132★	45	MJE340★	54
BC109C★	12	BD133★	43	MJE370★	58
BC113	20	BD135★	38	MJE371★	60
BC114	20	BD136★	37	MJE520★	65
BC115	20	BD137★	36	MJE521★	74
BC116	20	BD138★	50	MJE2955★	99
BC117	20	BD139★	40	MJE3055★	70
BC118	20	BD140★	36	MPF102	66
BC119★	28	BD142★	59	MPF103	36
BC134	20	BD145★	198	MPF104	36
BC135	20	BD222★	75	MPF105	36
BC136	18	BD695A★	65	MPF106	50
BC137	20	BD696A★	65	MPF107	50
BC140★	35	BDY17★	195	MPSA05★	25
BC142★	30	BDY60★	110	MPSA06★	25
BC143★	30	BDY61★	165	MPSA12	42
BC147	8	BF115★	34	MPSA55	25
BC148	8	BF154★	25	MPSA56	25
BC149	8	BF167	30	MPSA70	34
BC153	27	BF173★	25	MPSU02★	58
BC154	27	BF177★	24	MPSU05★	50
BC157	10	BF178★	25	MPSU06★	56
BC158	11	BF179★	30	MPSU52★	65
BC159	11	BF180★	35	MPSU55★	55
BC160	42	BF181★	35	MPSU56★	60
BC167A	11	BF182★	35	MPU131★	39
BC168C	12	BF183★	35	OC25★	170
				OC26★	170
				OC28★	150

OC29★	160	ZTX311	17	2N3663	26
OC35★	130	ZTX314	24	2N3702	11
OC36★	130	ZTX326	30	2N3703	11
OC41★	148	ZTX341	20	2N3704	11
OC42★	32	ZTX500	15	2N3705	11
OC43★	55	ZTX501	15	2N3706	11
OC44★	31	ZTX502	19	2N3707	11
OC45★	28	ZTX503	15	2N3708	11
OC46★	28	ZTX504	25	2N3709	11
OC70★	28	ZTX531	25	2N3710	16
OC71★	28	ZTX550	25	2N3711	12
OC72★	30	2N526★	58	2N3715★	250
OC74★	40	2N696★	35	2N3771★	233
OC76★	36	2N697★	25	2N3772★	195
OC77★	66	2N698★	44	2N3773★	288
OC79★	76	2N699★	54	2N3819	22
OC81★	28	2N706A★	19	2N3820	45
OC82★	40	2N707★	39	2N3823★	95
OC83★	48	2N708★	19	2N3824★	70
OC84★	44	2N914★	32	2N3866★	90
OC122★	48	2N916★	27	2N3903	20
OC123★	48	2N918★	40	2N3904	18
OC139★	110	2N920★	51	2N3905	18
OC140★	110	2N930★	18	2N3906	17
OC141★	110	2N961★	61	2N4037★	52
OC170★	40	2N1131★	22	2N4058	17
OC171★	40	2N1132★	22	2N4061	17
OC201★	75	2N1302★	35	2N4064★	120
OC202★	95	2N1303★	50	2N4236★	145
OC203★	85	2N1304★	50	2N4289	20
OC204★	85	2N1305★	28	2N4859	65
TIP29A	44	2N1306★	35	2N5135	42
TIP29C	60	2N1307★	50	2N5136	42
TIP30A	50	2N1308★	46	2N5138	20
TIP30B	64	2N1613★	23	2N5179★	60
TIP30C	65	2N1670★	150	2N5180★	38
TIP31A★	50	2N1671B★	215	2N5191★	70
TIP31B★	58	2N1893★	28	2N5305★	40
TIP31C★	66	2N1986★	60	2N5457	32
TIP32A★	55	2N2160★	350	2N5458	32
TIP32B★	70	2N2217★	43	2N5459	32
TIP32C★	75	2N2218A★	34	2N5485	35
TIP33A★	80	2N2219A★	20	2N5777★	45
TIP33B★	100	2N2220A★	23	2N6027	40
TIP33C★	110	2N2221★	23	2N6109★	50
TIP34A★	85	2N2222★	20	3N128★	112
TIP34B★	110	2N2297★	45	3N140★	112
TIP34C★	110	2N2303★	45	40311★	60
TIP35A★	195	2N2368★	21	40313★	125
TIP35C★	245	2N2369★	15	40316★	85
TIP36A★	220	2N2476★	125	40317★	52
TIP36C★	295	2N2483★	28	40324★	85
TIP41A★	66	2N2484★	25	40326★	52
TIP41B★	73	2N2646★	48	40327★	62
TIP42A★	72	2N2784★	55	40347★	80
TIP42B★	82	2N2846★	140	40348★	105
TIP2955★	65	2N2894★	30	40360★	43
TIP3055★	52	2N2904A★	22	40361★	45
TIS43	34	2N2905A★	22	40362★	45
TIS44	45	2N2906★	22	40407★	52
TIS45	45	2N2907★	22	40411★	295
TIS46	45	2N2907A★	22	40412★	65
TIS47	50	2N2926G	10	40467★	95
TIS48	50	2N3011★	24	40594★	90
TIS50	47	2N3053★	20	40595★	98
TIS60	52	2N3054★	55	40603★	65
TIS62	52	2N3055★	55	40636★	125
TIS74	47	2N3108★	32	40673★	68
TIS90	20	2N3121★	40		
TIS91	24	2N3133★	43		
ZTX107	12	2N3135★	33		
ZTX108	12	2N3250★	30		
ZTX109	14	2N3252★	36		
ZTX300	15	2N3302★	30		
ZTX301	15	2N3442★	146		
ZTX302	20	2N3563	20		
ZTX303	25	2N3614★	269		
ZTX304	24	2N3615★	269		

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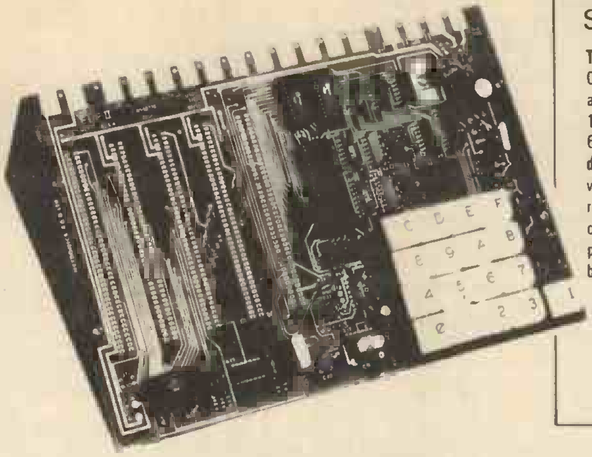
IN914	4
IN4148	4
CRO33★	148
Zeners 2.7V-33V	
400mW	9
1.3W	17

ELF II FEATURING THE AMAZING RCA COSMAC 1802 MICROPROCESSOR

£99⁹⁵

PLUS £7.99 V.A.T.



SPECIFICATIONS

The £99.95 ELF II computer features an RCA COSMAC COS/MOS 1802 8-bit microprocessor addressable to 64K bytes with OMA, interrupt, 16 registers, ALU, 256 byte RAM expandable to 64K bytes, professional hex keyboard fully decoded so there's no need to waste memory with keyboard scanning circuits, built-in power regulator, 5 slot plug-in expansion bus (less connectors), stable crystal clock for timing purposes and a double-sided, plated-through pc board plus RCA 1861 video IC to display any segment of memory on a video monitor or TV screen along with all the logic and support circuitry you need to learn every one of the RCA 1802's capabilities.

YOU can own an ELF II personal computer for just £99·95.
STOP reading about computers and get your "hands on" an ELF II and Tom Pittman's Short Course. ELF II demonstrates all the 91 commands which an RCA 1802 can execute, and the Short Course speedily instructs you how to use them.
ELF II's VIDEO OUTPUT makes it unique among computers selling at such a modest price. Attached to your Video/Monitor ELF II allows you to display alphanumeric readout, graphics or video games.

ELF II EXPLODES INTO A GIANT

ELF II's 5-Card expansion buses allows you to expand as your need for POWER grows. Plug in the **GIANT MONITOR BOARD** for I/O with cassette, ASC II Keyboard, TTY, RS232-C etc. ADD up to **16K RAM** onboard or more. Build your own circuits with a **KLUGE** prototype board.

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ELF-BUG MONITOR cassette lets you debug programmes at lightning speed, It displays contents of all registers on your TV at any point in your programme. Also displays 24 bytes with full addresses, blinking cursor and auto-scrolling. **A must** for the serious programmer.

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- ☐ **GIANT BOARD Kit** for cassette I/O: TTY, RS232-C I/O, 8 bit P I/O, decoders for 14 separate I/O instructions and systems monitor ..... £39·96
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QUARTZ LCD 5 Function

Hours, mins., secs., month, date, auto calendar, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.

Very slim, only 6mm thick.

M1

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Very slim, only 6mm thick.

M2

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6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
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Split and lap modes.
Back-light, auto calendar. Only 8mm thick.
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Adjustable bracelet.

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M3

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M4

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Hours, mins., secs., day, date, alpha day, back-light, auto calendar.
Adjustable stainless steel bracelet.
Only 9mm thick.

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M5

QUARTZ LCD Alarm Chronograph with Dual Time Zone Facility

Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication.
Perpetual calendar, day, date, month and year.
24 hour alarm with on/off indication.
1/10 second chronograph measuring net, lap and first and second place times.
Dual time zone facility night light.
Only 9mm thick.

£27.65

M6

QUARTZ LCD Alarm Chrono with front alarm

Dual time.
Ten function, 6 digit.
Hours, mins., secs., date, day of week, stopwatch, split time, alarm, second watch (dual time), back-light.

£29.65

M7

QUARTZ LCD Alarm Chrono

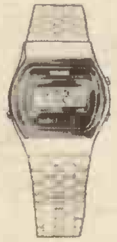
Ten function, 6 digit.
Hours, mins., secs., date, day of week, stopwatch, split time, alarm, second watch (dual time), back-light.
FRONT BUTTON OPERATION.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

6 digit, 11 function.
Hours, mins., secs. 1/100, 1/10 secs., mins.
Split and lap modules.
Auto calendar and back light.
Powered from solar panel with battery back-up.



£15.95

M9

SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass.

List Price £130.00

METAC PRICE

£105.00

M10

SEIKO Chronograph

LCD, hours, mins., secs., day of week, month, day, date, 12 hour chronograph, 1/10th secs. and lap-time. Back light, stainless steel water resistant, HARDLEX glass.

List Price £85.00

METAC PRICE

£68.00

M11

SOLAR QUARTZ LCD 5 Function

Genuine Solar

Solar panel with battery back-up.
Back light and auto calendar.
Hours, mins., secs., day, date.
Quality metal bracelet.

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Guaranteed same day despatch.

M12

HANIMEX Electronic LED Alarm Clock

Features and Specification:
Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright/dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm).
Weight: 1.43 lbs (0.65 kg).

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M13

QUARTZ LCD Ladies Slim Bracelet

5 function.

Hours, mins., secs., day, date and back light and auto calendar.
Elegant metal bracelet in silver or gold.
State preference.

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M14

QUARTZ LCD Ladies 5 Function

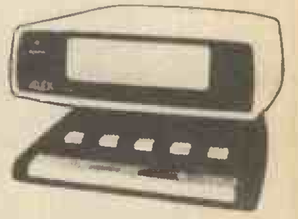
Only 25 x 20mm and 6mm thick.
5 function. Hours, mins., secs., day, date and back light and auto calendar.
Elegant metal bracelet in silver or gold.
State preference.

£9.95

Guaranteed same day despatch.

M15

DIGITAL LED CLOCK



Automatic brightness control. Weekend alarm cancel.

Features and Specification:
Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on-off control. Display flashing for power loss indicator. Repeatable 9-minute snooze. Automatic brightness control. Weekend alarm cancel.

£10.95

M16

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and the order details clearly, enclose 30p for post and packing or the amount stated. We do not wait to clear your cheque before sending the goods so this will not delay delivery. All products carry 1 year guaranteee and full money back 10 day reassurance. Battery fitting service is available at our shops. All prices include VAT.

Trade enquiries: Send for a complete list of trade prices — minimum order value £100.
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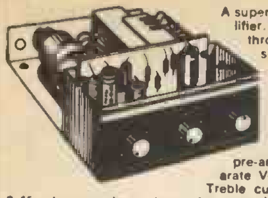
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8–15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high × 6in wide × 7½in deep. AC 200/250V.

PRICE £16·00 P. & P. £1·20.

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An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp.). Input 1, 15mV into 47k. Input 2, 15mV into 47k (suitable for use with mic. or guitar etc.). Input 3, 200mV into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240 volts. Size approx 12½in. wide × 5in high × 7½in deep

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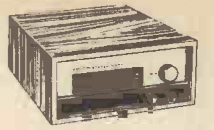
MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State F.M. A.M. Stereo Tuner. Covering M.W. A.M. 540–1605KHz V.H.F. F.M. 88–108MHz.

Built-In Ferrite rod aerial for M.W. Full AFC and AGC on A.M. and F.M. Stereo Beacon Lamp Indicator. Built in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600mV R.M.S. into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8½in wide × 4in high × 9½in deep approx.

Limited number only at £28·00 + £1·50 P. & P.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up. 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p + S.A.E. (Free with parts). All parts sold separately. ONLY **£15·50** P. & P. **£1·40**. Also available ready built and tested **£20·00** P. & P. £1·40.

STEREO MAGNETIC PRE-AMP Sens. 3mV in for 100mV out. 15 to 35V neg. earth. Equ. ±1dB from 20Hz to 20KHz. Input impedance 47K. Size 1⅜in × 2⅜in × 5⅜in H. **£2·60** + 20p. P & P.

Mullard LP1159 RF-IF module 470 kHz £2·25 + P. & P. 20p. Full specification and connection details supplied.
Pye VHF FM Tuner Head covering 88-108 MHz 10·7 MHz I.F. output. 7-8V + earth. Supplied pre-aligned, with full circuit diagram with precision-geared F.M. gang and 323PF + 323PF A.M. Tuning gang only £3·15 + P. & P. 35p.

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Slightly shop soiled radios by well-known manufacturer for AC Mains or battery use. MW and FM bands. Dynamic M/coil speakers, telescopic aerial and internal ferrite aerial. Earpiece socket for personal listening. Finished in attractive simulated leatherette.
Size 7"H × 9½"W × 4"D approx. Fully guaranteed.
Bargain price of only £10·00 + £1·30 p&p.

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GOODMANS speakers, 6½"-8 ohm, long throw, ceramic magnet, full range rated 10 watts R.M.S. (when fitted in enclosure). **£4·00 each + 80p. P. & P. (P. & P. on two £1·20)**

HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integral pre-amp with Bass. Treble and two Volume controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metalwork, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification, Power output: 14 watts R.M.S. per channel into 5 ohms. Frequency response ±3dB 12–30,000Hz. Sensitivity better than 80mV into 1 MΩ. Full power bandwidth ±3dB 12–15,000Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1A.

Overall size 12in wide × 8in deep × 2½in high.

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT . . . £14·50 P. & P. 80p
(Magnetic input components 33p extra)
POWER PACK KIT . . . £6·00 P. & P. 95p
CABINET . . . £6·00 P. & P. 95p

SPECIAL OFFER—only £25·00 if all 3 items ordered at one time plus £1·25 P. & P.

Full after sales service

Also available ready built and tested £31·25 P. & P. £1·50

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A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets and 5 pin din tape rec./play socket are mounted on the printed circuit panel. Size approx. 9½in × 2½in × 1in max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically) at only £10·00 + 50p P & P. Mains transformer with an output of 17V a.c. at 500mA can be supplied at £2·00 + 40p P. & P. If required. Full connection details supplied.

STEREO DECODER
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Type	Voltage	Current	£	p/p
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12FE06	6+6	1A EACH	2.10	60p
20FE06	6+6	1.6A EACH	2.74	70p
50FE06	6+6	3A EACH	3.25	70p
60FE06	6+6	4A EACH	3.98	85p
06FE09	9+9	0.3A EACH	1.58	50p
08FE09	9+9	0.5A EACH	1.90	50p
12FE09	9+9	0.75A EACH	2.10	60p
20FE09	9+9	1A EACH	2.74	70p
50FE09	9+9	2.5A EACH	3.25	70p
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20FE12	12+12	0.8A EACH	2.74	70p
50FE12	12+12	2A EACH	3.25	70p
60FE12	12+12	2.5A EACH	3.98	70p
80FE12	12+12	3A EACH	4.72	100p
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08FE15	15+15	0.25A EACH	1.90	50p
12FE15	15+15	0.4A EACH	2.10	60p
20FE15	15+15	0.6A EACH	2.74	70p
50FE15	15+15	1.6A EACH	3.25	70p
60FE15	15+15	2A EACH	3.98	85p
80FE15	15+15	3A EACH	4.72	100p
06FE20	20+20	0.15A EACH	1.58	50p
08FE20	20+20	0.2A EACH	1.90	50p
12FE20	20+20	0.25A EACH	2.10	60p
20FE20	20+20	0.5A EACH	2.74	70p
50FE20	20+20	1.2A EACH	3.25	70p
60FE20	20+20	1.5A EACH	3.98	85p
80FE20	20+20	2A EACH	4.72	100p

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Type	Voltage	Current	£	p/p
48FE12	0-6-12	4A	3.25	70p
66FE12	0-6-12	5A	4.00	85p
70FE12	0-6-12	6A	5.10	100p
08FE24	24+24	0.15A EACH	1.58	50p
12FE24	24+24	0.2A EACH	2.10	60p

Type	Voltage	Current	£	p/p
20FE24	24+24	0.4A EACH	2.74	70p
50FE24	24+24	0.8A EACH	3.25	70p
60FE24	24+24	1.2A EACH	3.98	85p
80FE24	24+24	1.5A EACH	4.72	100p
50FE28	28+28	0.75A EACH	3.25	70p
60FE28	28+28	1.1A EACH	3.98	85p
80FE28	28+28	1.4A EACH	4.72	100p
20FE30	30+30	0.35A EACH	2.74	70p
50FE30	30+30	0.75A EACH	3.25	70p
60FE30	30+30	1A EACH	3.98	85p
80FE30	30+30	1.2A EACH	4.72	100p

MULTI-TAP RANGE, VOLTAGE AVAILABLE 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 12-0-12 OR 15-0-15

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60FE36	0-12-15 24-30	2A	4.78	85p
80FE36	0-12-15 24-30	3A	5.95	100p
100FE40	0-12-15 24-30	4A	7.10	115p

CENTRE TAP SECONDARY

Type	Voltage	Current	£	p/p
FE06	6-0-6	1A EACH	2.10	60p
FE09	9-0-9	1A EACH	2.74	70p
FE12	12-0-12	1A EACH	2.80	70p
FE15	15-0-15	1A EACH	3.25	70p
FE20	20-0-20	1A EACH	3.25	70p
60FE52	26-0-26	1A EACH	3.98	100p
60FE28	28-0-28	1A EACH	3.98	100p
60FE60	30-0-30	1A EACH	3.98	100p
100FE26	26-0-26	2A EACH	5.15	115p
100FE30	30-0-30	2A EACH	5.15	115p
100FE36	36-0-36	2A EACH	5.15	115p

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FE03	0.3mH	0.26	20p
FE05	0.5mH	0.30	20p
FE10	1.0mH	0.60	25p
FE26	2.0mH	0.75	30p

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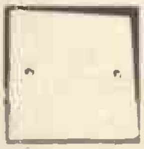
A Lightdimmer with NO knob. Dimming and on/off functions are controlled by touch. Features include:



- ★ No mains rewiring.
- ★ Easy to build – uses one MOS 1C.
- ★ Switches on to preset brightness.
- ★ Can be switched and dimmed from many locations using TDE/K kit making 2-way switching easy.

★★ PRICE TD300K £9.67
TDE/K £1.62

TSD300K TOUCH-SWITCH & DIMMER combined. One touchplate for on/off. Small knob controls brightness. £5.62
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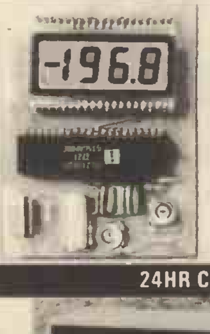
TSA300K AUTOMATIC. One touchplate. Preset time delay off variable 2 secs to 3½ mins. £4.64
LD300K LIGHTDIMMER. £3.24

DIGITAL VOLTMETER/THERMOMETER KIT



Based on the 7106 single IC 3½ digit D.V.M. the Kit contains a PCB, resistors, capacitors, presets, I.C. and 0.5" liquid crystal display. Components are also included to enable the basic D.V.M. kit to be modified to a Digital Thermometer using a single transistor as the sensor. Requires a 2mA 9V supply (PP3 battery).

ONLY £23.75

TRIAC BARGAINS

400V Plastic Case

3A	64p
6.5A with trigger	36p
8A	30p
12A	90p
16A	113p
20A	178p
25A	205p
SCR (C106D) 5A/400V	54p
Diac	23p

COMPONENTS

0.2" L.E.D.s
Red 13p (10 for £1.08)
Green 23p Yellow 27p

DL727 .5" display	£1.62
LCD .5" 4 digit	£8.75
LDR .5" dia.	64p
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ICL7 106 DVM IC	£8.10
IN4001	7p
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2N3819	25p

MINI MAINS TRANSFORMERS

Standard 240V mains primary
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6–0–6V	92p
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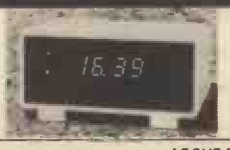

Switches any appliance of up to 1KW on and off at preset times once a day. KIT contains: AY–5–1230 Clock/Appliance Timer IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full Instructions. £16.09
White box (56 x 131 x 71mm) – drilled £2.70
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With Twin **200** Watt Cabinets

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WITH FOUR PDF 100A BINS

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C/W LIGHT SHOW & DISPLAY
TWIN LOUDSPEAKERS & LEADS
100W-600W

20% DEPOSIT CREDIT TERMS

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- ★ 2 Year warranty
- ★ Full Mixing+Crossfade+Mic/Tape Inputs
- ★ Headphone & Cue Light Monitoring
- ★ Full Range Bass/Treble Controls+Mic Tone
- ★ 4 Channel Soundlight + Display

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MONO SYSTEM WITH LOUDSPEAKERS

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100 WATT +Carr £15 & VAT **£159.90**
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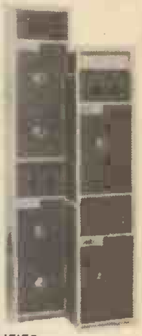
- ★ Four Mixing Inputs
- ★ Bass & Treble Controls
- ★ Twin Piezo Horn Columns

200 WATT +Carr £15 & VAT **£249.00**
12 months @ **£22.23** or 24 months @ **£12.73** Deposit **£57.12**



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AP100 AMPLIFIER
£49.50 +Carr £1.50
- ★ 4 Mixed Inputs
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- ★ 100 Watts Output

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£89.50 +Carr £1.50
- ★ Six Mixed Inputs
- ★ Three Sets Bass/Treble
- ★ 200 Watts Output
- ★ Slave Socket

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SAXON KLAXON

UK Police Hawaii 50
US Police Destroyer

Four Sirens in one package **£17.50**
Individual Sirens **£7.50**

NEW

SAXON SMASH

ALIEN VOICE SIMULATOR

Add a new dimension to your disco with this press button effect unit
Insert between mic & amp **£7.50**

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P140 **£38.50**
150 WATT
INC WHEEL

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250 watt Q.I. inc Cassette/Wheel
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ELECTRECT MIC DI501 **£18.50***
TOP QUALITY UNIT

ECM105 LOW COST ELECTRET **£5.00***
CONDENSER MIC

MELOS CASSETTE ECHO-REVERB UNIT – Twin input **£65.00**
VARIABLE SPEED & DEPTH

AMPLIFIER MODULES

- ☐ 30Hz-20kHz
- ☐ Short/open circuit proof
- ☐ Top grade components
- ☐ Suit most mixers

SA308 8 ohms 30W 45V **£10.75***
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Supply for 1 or 2 modules **£14.95**
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SA1208 8 ohms 120W 95V **£21.00**
Supply for 2 modules **£24.75**

DISCO MIXERS

– COMPLETE OR MODULAR

MONO OR STEREO WITH AUTOFADE

Available complete and ready to plug in or as an easy to connect module with all controls except monitor switch already fitted – full instructions supplied.

FEATURES INCLUDE:
Twin Deck – Mic & Tape Inputs – Wide range bass & treble controls – Full headphone monitoring – Crossfade – Professional standard performance.

COMPLETE MIXERS (with case)
Mono mains **£45.75**
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Mono module **£27.50**
Stereo module **£37.50**
Panel **£3.95**
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D.I.Y. MODULES FOR P.A. SYSTEMS

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Input Modules
Mono PCB only **£6.50**
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Stereo C/W Front panel **£13.75**

Mixer/Monitor Modules
Mono PCB only **£6.50**
Stereo PCB only **£10.50**
Mono C/W Front panel **£9.50**
Stereo C/W Front panel **£13.75**

Power supply to suit £9.50 – send for full details.

Make your own mixer Mono/Stereo up to 20 channels accept all inputs available as PCB only or complete on front panels

SOUND-TO-LIGHT UNITS

3 CHANNEL – 3kW
- ☐ Operates from 1W upwords
- ☐ Bass/middle/treble/moster controls

£29.50 + £1 carr complete

Module only **£19.75** Panel **£2.95**

4 CHANNEL – 4 kW SOUNDLITE SEQUENCER *(illus)*
£39.50 Carr £1

- ☐ Dimmer on each channel
- ☐ Automatic sound light level
- ☐ Logic circuitry throughout

Module only **£26.75** Panel **£2.95**

MOTOROLA PIEZO HORNS £4.50. YES!!

FUZZ LIGHTS Red, Blue, Yellow, Green **£22.80**

HEAVY DUTY SPOT BANKS – MATCHES LOUDSPEAKERS
3 way 600W **£35.50** 4 way 800W **£39.50** Carr £2

100W SPOTS
Red – Blue – Amber – Green **£1.50 ea.**

CABINET FITTINGS
ICI Vynide 50" wide **£3.50m**
Kick-res grille 50" wide wide **£3.50m**
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Corners/feet/recess plates **15p** ea. Recess handle **45p**
Bar handles **£2.50** Jack plugs/sockets **25p**

LOUDSPEAKER CABINETS –

COMPLETE WITH LEADS

- ☐ Fitted with 100W 17,000 Gauss drivers
- ☐ Rugged cabinets with aluminium trim – black vynide etc
- ☐ Lifetime guarantee on main drive unit

Standard 100W 1 x 12 (48 x 41 x 24) **£39.00** Carr £3 Deposit £9.36
Large 100W 1 x 12 (65 x 48 x 24) **£49.50** Carr £3 Deposit £12.70
P.A. 1 x 12 (+ 2 Piezos) (80 x 38 x 24) **£66.50** Carr £3 Deposit £15.82
P.A. 2 x 12 200W (100 x 38 x 24) **£99.00** Carr £3 Deposit £20.92
Disco 2 x 12 200W (80 x 63 x 24) **£85.00** Carr £3 Deposit £19.80
PDF reflex bin (80 x 40 x 41) **£95.00** Carr £3 Deposit £20.60

PDF100 Reflex Bin – Twin Horns – Integrated Slave Amplifier – Accepts mono or stereo signals
- ☐ Use with all types of mixer
- ☐ Pan and volume controls
- ☐ Send for details **£130** Carr £3 Deposit £28.40

All prices subject to 8% VAT except where asterisked (12½%) Shop premises open Tues to Sat 9 am – 5 pm Lunch 12.30 – 1.30 pm Mail order dept open Mon to Fri 10 am – 4 pm Ring 01-684 6385

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Quality audio modules and accessories for

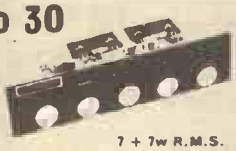
S450
STEREO FM TUNER Fitted with phase lock-loop

£23·24
+ 40p p&p
+ 12½% VAT

FREQUENCY RANGE	88–108 Mhz
SENSITIVITY	3 0 µV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo Indicator.

Stereo 30
COMPLETE AUDIO CHASSIS



£19·18
+ 66p p&p
+ 12½% VAT

7 + 7w R.M.S.

OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than 5% (Typically 3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm × 130mm × 33mm

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60
AUDIO AMPLIFIER MODULE 25 Watts RMS

25w R.M.S.

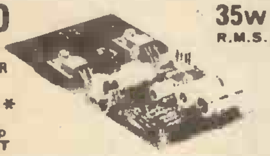
£4·69 + 35p p&p
+ 12½% VAT

OUTPUT POWER	25 Watts RMS
SUPPLY	30–50 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0 1%.

AL80
AUDIO AMPLIFIER MODULE

35w R.M.S.



£7·34*
+ 35p p&p
+ 8% VAT

OUTPUT POWER	35 Watts RMS
SUPPLY	40–60 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0 1%.

AL250
POWER AMPLIFIER

125w R.M.S.

£17·82* + 66p p&p + 8% VAT

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50–80 V
LOADS	4–16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION 50 WATTS into 4 ohms / 50 WATTS into 8 ohms	0·1% / 0 06%

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A
AUDIO AMPLIFIER MODULES

10w R.M.S.

£3·79 + 35p p&p
+ 12½% VAT

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than 25%
LOAD IMPEDANCE	8–16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz–25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm × 63mm × 28mm

These low cost 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80
STABILISED POWER SUPPLY

£4·40 + 35p p&p
+ 12½% VAT

INPUT A.C. VOLTAGE	33–40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA–1·5 amps
OVERLOAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100
STEREO PRE-AMPLIFIER

£16·05
+ 40p p&p
+ 12½% VAT

FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically ·07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms } For an output 250 mV
2. RADIO TUNER	100 mV/100 K ohms
3. MAGNETIC P.U.	3·5 mV/50 K ohms
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10–20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 × 90 × 33mm (less controls)

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

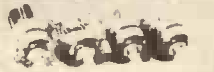
MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

£2·98
+35p p&p
+ 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3 5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—re earth
DIMENSIONS	110 × 50 × 25mm (inc DIN socket)

PA12
STEREO PRE-AMPLIFIER



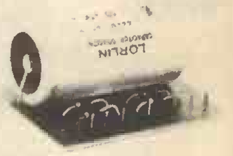
£7·78
+ 35p p&p
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz–20 kHz (—3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	—60 dB
SIGNAL/NOISE RATIO	—65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450 etc.
Transformer T538.
Input A.C. Voltage 15-20V.
Output D.C. Voltage 22-30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60 x 43 x 26mm.



£1·90
+ 12½% VAT + 35p p&p.

BP124 SIREN ALARM MODULE
5 WATTs —

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £3·50
+ 8% VAT + 35p p&p.

MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-kits modules, 2 × AL60 amps, 1 × PA100 pre-amp, 1 × SPM80 stab. power supply, 1 × BMT80 transf. giving 15 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.
Price £32 00 + 12½% VAT + 62p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm × 290mm × 95mm.
Price £19·95 + 12½% VAT + 86p p&p

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3·20 + 55p p&p + 12½% VAT
T2050 For use with Stereo 30
Order No. 2050 Price: £3·25 + 55p p&p + 12½% VAT
BMT80 For use with AL60 SPM80
Order No. 2034 Price: £5·40 + 86p p&p + 12½% VAT
BMT250 For use with AL250
Order No. 2035 Price: £6·35 + £1·10 p&p + 12½% VAT
2040. For use with AL60
Order No. 2040 Price £5·20 + 80p p&p + 12½% V.A.T.
2041. For use with AL80, AL120 and AL250
Order No. 2041. Price £6·80 + 86p p&p + 12½% V.A.T

CASES

TEAK 30. 32 x 23 x 8cm, designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. £5·95. + 12½% V.A.T. p&p 70p.

TEAK 60. 42 x 29 x 9cm, for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve – has no front or back panel. o/n 140. £7.00. + 12½% V.A.T. p&p 85p.

Professionals and Enthusiasts from BI-PAK

AL120 — 50W R.M.S.

AUDIO AMPLIFIER
(With integral heat sink and short-circuit protection).

£11.95
+ 8% V.A.T. P. & P. 35p

OUTPUT POWER	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	05% Max. (Typically 02%)
FREQUENCY RESPONSE ± 1dB	25Hz-20kHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP.	45 deg. C
DIMENSIONS	192 x 89 x 49 mm

Introduced to fulfill the demand for a fully protected power amp., capable of driving high quality speaker systems at up to 50w., with distortion levels below 05%. Ideal for domestic use. Discos, P.A. systems, electronic organs etc. The generously rated components ensure continuous operation at high output levels.

SPM120 — STABILISED POWER SUPPLIES

SPM120/45
SMP120/55
SMP120/65

£5·80
+ 12½% V.A.T.
P. & P. 35p

AC INPUTS	
SPM120/45	40-48v
SPM120/55	50-55v
SPM120/65	60-65v
OUTPUT CURRENT	2.5A
RIPPLE	1A 100mV 2A 150mV

SPM120 is a fixed voltage stabiliser available with an output voltage of either 45v, 55v, or 65v. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A., operates direct from a mains transformer requiring only the addition of 2 Electrolytic capacitors to complete the s/c protection.

GE100 Mk2.

10 CHANNEL MONOGRAPHIC EQUALISER

£20·00
+12½% V.A.T.
P. & P. 35p

Control Range	±12dB
Dynamic Range	110dB
Maximum Output	+15dB
Frequency Response	30Hz-20KHz (±1dB)
Power Supply	15–0–15v.
Voltage Handling Input	3v R.M.S.
T.H.D.	005%

Only 155mm x 65mm x 50mm including the 10 x 10K 1in slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20KHz you can cut and boost ±12dB with the 10 sliders, each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, P.A. systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power Supply for GE100. o/d SG30 £3.80.

VPS30

REGULATED VARIABLE STABILISED POWER SUPPLY

£7.60 +8% V.A.T.
P. & P. 35p

AC Input Maximum	25v
Voltage Regulation	2-30v
Regulated Current	0-2A
Incorporating short circuit protection	

This NEW versatile Regulated Variable Stabilised Power Supply with short circuit protection and current limiting, is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2v 30v, with a current limiting range of 0–2A With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 2033), 0–1ma (o/d 1310 or 1305), plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899), it can be used again and again as a self-contained bench, power supply, eliminating the use of batteries and thus saving ££'s!

PA200

STEREO PRE-AMPLIFIER

£16.55
+12½% V.A.T.
P. & P. 40p

FREQUENCY RESPONSE		20Hz to 20kHz ± 1dB	
TOTAL HARMONIC DISTORTION		Less than 1% (Typically ·70%)	
SENSITIVITY INPUTS	1. TAPE	100mV/100 K ohms	For an
	2. RADIO TUNER	100mV/100 K ohms	output
	3. MAGNETIC P.U.	3·5mV/50 K ohms	500mV
EQUALISATION		Within ± 1dB from 20Hz to 20kHz	
BASS CONTROL RANGE		± 15dBs at 75Hz	
TREBLE CONTROL RANGE		+ 10-20dBs at 15kHz	
SIGNAL/NOISE RATIO		Better than 65dBs (All inputs)	
INPUT OVERLOAD		Better than 2dBs (All inputs)	
SUPPLY		35 to 706v	
DIMENSIONS		300 x 90 x 33mm (less controls)	

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

ADAPTORS

AC-DC enables a large range of battery powered radios, recorders, calculators to be run off the mains. (220-240v AC) Switchable for 6 7.5 or 9 volts. Current rating 2,500mA. Polarity reversing switch. Universal plug incorporated. **o/n 137 £3·60.** + 12½% V.A.T. p&p 35p.

DC-DC for use in all cars, boats etc., with pos. or neg. earth for a regulated output of 6, 2.5 or 9 volts DC at 1A max. For radios, recorders etc. **o/n 138. £2.80.** + 12½% V.A.T. **p&p 35p.**

CROSSOVER NETWORKS

2-WAY channels for high and low frequencies to correct speakers – high to tweeters, low to woofers. Complete with instructions. Frequency: 3,000Hz. **o/n 1904. £1.10.** + 12½% V.A.T. p&p 35p.

2-WAY for 8 ohm speakers up to 30 watts. Frequency: .3KHz. o/n 1905. £1.65, + 12½% V.A.T. p&p 35p.

3-WAY for 8 ohms speakers up to 30 watts. Frequency: 800Hz and 4.5KHz. **o/n 1906. £2.95.** + 12½% V.A.T. p&p 35p.

MICROPHONES

DYNAMIC CASSETTE
For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick-up pattern is omnidirectional. On/Off switch, 1 metre of tough lead with floating 2 5 and 3.5mm plugs. Matching moulded strut. Impedance: 200 ohms. Sensitivity. 90dB. Frequency: 90-10,000Hz Size: 20mm dia x 120mm. **o/n 1326. £1·60** + 12½% V.A.T. p&p 35p.

DYNAMIC MICROPHONE
Superior quality portable cassette recorder mike with built-in remote control switch and lead fitted with 5-pin 240° DIN plug (remote switch) and 3-pin DIN plug (microphone). Provides a direct replacement for those supplied with recorders. With detachable stand. Omnidirectional. Impedance: 200 ohms. Freq. response: 100 to 10,000Hz. Sensitivity: 79dB at 1,000Hz. **o/n 1327. £2.65.** + 12½% V.A.T. p&p 35p.

RE – 317: DYNAMIC MICROPHONE
Highly sensitive, high-grade desk or hand mike suitable for use with many popular cassette decks. Incorporates On/Off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance: 5,000 ohms. Freq response: 100 at 12,000Hz. Sensitivity: (-7dB at 1,000Hz). **o/n 1336. £4·00.** + 12½% V.A.T. p&p 35p.

OMNIDIRECTIONAL CARDIOID
Powered by a 1½v battery located within the aluminium body. Satin silver finish with front disk protection to the diaphragm housing. On/Off switch. Also with 'Busby' type windshield. "U" bracket and stem and extremely supple cable. Consumption: 0.2mA from 1½v battery providing approx., 8-10,000 hours continuous life. Impedance: 600 ohms Sensitivity: 70dB. Frequency: 30-16,000Hz. Size: 23mm dia + 267mm. **o/n 1329. £12.80.** 12½% V.A.T. p&p 35p.

UNIDIRECTIONAL CARDIOID
Dual imp 600 and 50,000 ohms. Response 50 to 14,000Hz. Sensitivity 54dB at 50K/ohms. Size: 1½" dia x 6½" long. Weight approx., 190gm. **o/n 1328. £10.95.** + 12½% V.A.T. p&p 35p.

STANDS

GOOSENECK CHROME FLEXIBLE HOLDERS
Length 320mm. **o/n 1333. £2.40.** + 12½% V.A.T. p&p 35p.
Length 515mm. **o/n 1334. £3.40.** + 12½% V.A.T. p&p 35p.

FLOOR STAND Heavy chrome. Stow-away feet with rubber ends for maximum stability. Draws to a height of 5' maximum. o/n 1335. + £9·50. 12½% V.A.T. p&p 85p.

BOOM ARM for use with the above stand. Heavy chromed metal, it gives 30" reach from the stand. **o/n 1337 £9·20.** + 12½% V.A.T. p&p 70p.

WINDSHIELD COVERS
o/n 1331 Medium per pair **£1.20.** + 12½% V.A.T. p&p 35p. **o/n 1332** Large per pair **£1.80.** + 12½% V.A.T. p&p 35p.

AUDIO LEADS

107	FM Indoor Ribbon Aerial	£0.60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0.75*
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0.85*
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0.85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1.10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0.68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1.05*
119	2 + 2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0.90*
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0.60*
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1.50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0.75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0.75*
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1.30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0.80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1.05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0.68*
131	5 pin DIN plug to 3 pin DIN plug 1&4 and 3&5. Length 1.5m	£0.83*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£0.98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0.75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0.68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0.68*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1.75*
178	AC mains lead for calculators etc.	£0.45*

Please add 12½% V.A.T. to all the above leads.

HEADPHONES

A top quality headphone with cushioned earpads and headband Separate balance/volume controls. Stereo or Mono switch. Impedance: 8 ohms. Frequency: 30-18,000Hz. **o/n 884. £8.70.** + 12½% V.A.T. p&p 70p.

A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi-Fi. Impedance 8 ohms. Frequency: 30-15,000Hz. o/n 885. £4.40. + 12½% V.A.T. p&p 50p.

BIB HI-FI ACCESSORIES

Parallel Tracking GROOV KLEEN
The very latest in automatic record cleaning. Designed to suit all modern single play decks. Simple to fit, it is extremely efficient. Complete with two types of base and three height extensions. **o/n 8101. £3.68.** + 8% V.A.T. p&p 35p.

Cassette Tape Editing Kit
Enables cassette tapes to be edited and joined easily, quickly and accurately. Kit comprises: Tape Splicer ⅛" (3.2mm). 2 Precision Tape Cutters. Tape Piercer. 9 Self-adhesive Labels. Reel of Splicing Tape. 3 Winders and removers and instructions, all in a handy wallet. **o/n 811. £2.40.** + V.A.T. p&p 35p.

GROOV-STAT
The BIB Groov-Stat static reducer neutralises the static charge on records and other plastic surfaces. **o/n 8103. £5.45.** + 8% V.A.T. p&p 35p.

Cassette Head Cleaner
Essential for cleaning of tape heads, capstans and rollers. Pack contains Tape Head Applicator and tape head polisher tools. Plus bottle of special formula cleaning fluid and full instructions. **o/n 832. £0·64.** + 12½% V.A.T. p&p 35p.

METERS

Miniature Balance & Tuning Meter
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity: 100-0-100MA. Dimensions: 23 x 22 x 26mm. **o/n 1318. £1.95** +8% V.A.T. p&p 35p.

Balance and Tuning Meter
Clear view edgewise meter. Centre zero application. Sensitivity: 100 0–100UA. Dimensions: 45 x 22 x 34mm. o/n **1319. £2.00.** +8% V.A.T. p&p 35p.

Miniature Level Meter
Moving coil, for accurate level indication for tape recorders, amplifiers etc. Neat design, rugged construction will withstand five times rated value. Sensitivity: FSD: 200UA. 0dB. 130UA. Dimensions: 23 x 22 x 26mm. o/n 1320. £2.80. +8% V.A.T. p&p 35p.

Vu Meter
Calibrated -20 to +3 and 0-100%, making it suitable for use as a recording level meter or as a power output indicator. Sensitivity: 130uA. Dimensions: 40 x 29mm. **o/n 1321. £2.00.** +8% V.A.T. p&p 35p.

BI-PAK
DEPT. PE5, P.O. Box 6, Ware, Herts.
Components Shop: 18 Baldock Street, Ware, Herts.

KITS FOR SYNTHESISERS, SOUND EFFECTS

COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHOTOCOPIES of P.E. texts for most of the kits are available—prices in our lists.

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET.

P.E. MINISONIC Mk. 2 SYNTHESISER
A portable mains-operated Miniature Sound Synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, mixer, power supply.

Set of basic component kits (excl. KBD R's and tuning pots – see list for options available).	from £61·00
Set of printed circuit boards	£8·99

P.E. SYNTHESISER (P.E. Feb. 73 to Feb. 74)
The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage. Details in our lists.

FORMANT SYNTHESISER (Elektor 1977/78)
Very sophisticated music synthesiser for the advanced constructor who puts performance before price. Details in our lists.

128-NOTE TUNE-PROGRAMMABLE SEQUENCER (P.E. Nov/Dec 77)
Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable. (Please use order codes quoted in brackets.)

Main Circuit (Nov) excl. sw's (KIT 76-1)	£18·03
Power Supply (KIT 76-3)	£4·72
Trigger Inverter and Alt. Output (KIT 76-2)	£1·15
LED Counter (KIT 76-4)	£2·10
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2·61
PCB for KITS 76-2 & 4 (PCB 76B)	£2·54

P.E. STRING ENSEMBLE (PE Mar-July 78)
The new keyboard string-instrument synthesiser.
Basic component sets:

Power Supply (KIT 77-1)	£8·77
Tone Generator (KIT 77-2)	£14·66
Diode Gates (KIT 77-3)	£18·81
Chorus Generator (KIT 77-4)	£19·08
Voicing System (KIT 77-5)	£7·38

Printed Circuit Boards:

Double-sided PCB for Power Supply, Tone Generator & Diode Gates with most of the Matrix wiring as printed tracking (PCB 77L/R)	£18.40
PCB for Chorus Generator (PCB 77C)	£2.65
PCB for Voicing System (PCB 77D)	£2.62

Fuller details of kits & PCBs are in our lists.

P.E. JOANNA PLUS ORGAN VOICING
The basic five octave electronic piano (P.E. May/Sept 75 and Sound Design) has switchable alternative voicings for Honky-Tonk, ordinary piano, and Harpsichord or a mixture of any of these three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The modification retains all the circuitry associated with the piano but in addition provides an organ-voice envelope facility with 5 switchable pitches, variable attack and sustain, phasing and vibrato.

Set of components (excl switches) for PSU, Frequency generator, Pitch and Note Divider, Envelope Shapers, Voicings, and Control circuitries. (Order as KIT 71-5)	£99·25
Set of PCBs (Order as PCB SET 71-6)	£29·18

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

Component set with special foot operated switches	£7·69
Alternative component set with panel switches	£5·05
Printed circuit board	£1·43

ELEKTOR ELECTRONIC PIANO (Elektor Sept 78)
A touch-sensitive, multiple-voicing 5 octave piano using the latest integrated-circuit techniques for the keying and envelope shaping and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos. Details in our lists.

DIGITAL REVERBERATION UNIT (Elektor May 78)
A very advanced unit using sophisticated i.c. techniques instead of mechanical spring-lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main component set (KIT 78-1)	£45·45
Extension component set (KIT 78-2)	£43·36
PCB for Kit 78-1 (PCB 78A)	£2·86
PCB for Kit 78-2 (PCB 78B)	£1·06

ANALOGUE REVERBERATION UNIT (Elektor Oct 78)
Using i.c.s instead of spring-lines, the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main component set (KIT 83-1)	£26·18
Additional Delay Set (KIT 83-2)	£18·25
PCB (as published) to hold both above kits (PCB 9973)	£4·31

RESONANCE FILTER (Elektor Oct 78)
This filter module has been designed to allow a synthesiser to produce a more realistic simulation of natural musical instruments.

Basic component set (KIT 82-1)	£15·10
PCB (as published) (PCB 9951)	£3·29

SYNTHESISER EXTERNAL INPUT INTERFACE (P.E. Oct 78)
This unit allows external inputs, such as guitars, microphones etc. to be processed by the circuits within a synthesiser.

Basic component set (incl PCB) (KIT 81-1)	£2·94

GUITAR MULTIPROCESSOR (P.E. Dec/Feb 78)
An extremely versatile sound processing unit capable of producing, for example, Flanging, Vibrato, Reverb, Fuzz and Tremolo as well as other fascinating sounds. May be used with most electronic instruments. Details in our lists.

RHYTHM GENERATOR KITS
Several available – details in our lists.

GUITAR FREQUENCY DOUBLER (P.E. Aug. 77)
A modified and extended version of the circuit published.

Component set and PCB	£4·52

GUITAR SUSTAIN (P.E. Oct 77)
Maintains the natural attack whilst extending note duration.

Component set, PCB and foot switches	£5·13
Component set, PCB and panel switches	£3·71

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds.

Component set (incl. PCB)	£4·26

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

Component set using dual slider pot	£7·58
Component set using dual rotary pot	£6·89
Printed circuit board	£1·62

FUZZ UNIT
Simple Fuzz unit based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·05

TREMOLO UNIT
Based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·94

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component set (incl. PCB)	£2·51

WAVEFORM CONVERTER
Slightly modified from a circuit published in "Elektor". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and squarewave with an externally variable mark-space ratio.

Component set (incl. PCB but excl. sw/s)	£8·40

VOLTAGE CONTROLLED FILTER (P.E. Dec. 74)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 65-1)	£7·17

RING MODULATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 59-1)	£5·50

NOISE GENERATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 60-1)	£3·64

ENVELOPE SHAPER WITHOUT VCA (P.E. Oct. 75)
Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier.

Component set (incl. PCB)	£4·77

ENVELOPE SHAPER WITH VCA (P.E. Apr. 76)
This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.

Component set (incl. PCB)	£6·68

TRANSIENT GENERATOR (P.E. Apr. 77)
An envelope shaper, without VCA, having the usual attack, decay, sustain and release functions, and in addition it also provides a "Repeat Effect" enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo.

Component set	£4·87
Printed circuit board	£1·82

SOPHISTICATED PHASING AND VIBRATO UNIT
A slightly modified version of the circuit published in "Elektor", December 1976, and includes manual and automatic control over the rate of phasing and vibrato.

Component set	£17·38
Printed circuit board	£2·33

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£3·20

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB)	£4·74

WAH-WAH UNIT (P.E. Apr. 76)
The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component set (incl. PCB)	£3·63

AUTOWAH UNIT (P.E. Mar. 77)
Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.

Component set, PCB, special foot switches	£7·67
Component set and PCB, with panel switches	£4·83

VOICE OPERATED FADER (P.E. Dec. 73)
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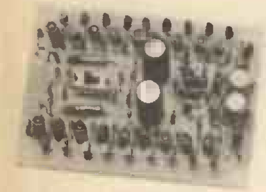

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XO2: XO3 – ACTIVE CROSSOVERS

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The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

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POWER SUPPLIES

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POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.

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XO3	**£23·06**
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CE 1004 100W/4 ohms 35-0-35v	**£19·22**
CE 1008 100W/8 ohms 45-0-45v	**£23·22**
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THERMAL CUT-OUT, 70°C	**£1·38**

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POWER SUPPLY:

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W01	1A 100V	0.30	PW02	6A 200V	0.97	S02	2A 200V	0.48
W02	1A 200V	0.32	PW04	6A 400V	1.08	S04	2A 400V	0.60
W04	1A 400V	0.40	PW06	6A 600V	1.18	S06	2A 600V	0.70
W06	1A 600V	0.50	PW08	6A 800V	1.28	S08	2A 800V	0.84
W08	1A 800V	0.60	PW10	6A 1000V	1.60	S10	2A 1000V	1.35
VM18	1A 100V	0.44	K005	25A 50V	2.20	B40C1500	1.5A 100V	0.53
VM28	1A 200V	0.48	K01	25A 100V	2.37	B40C3200	3.2A 100V	1.20
VM48	1A 400V	0.50	K02	25A 200V	2.75	B80C1500	1.5A 200V	0.82
BY164	1.4A 120V	0.75	K04	25A 400V	3.40	B80C3200	3.2A 200V	1.25
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74C08N	0.24	74C86N	0.64	74C163N	1.11	74C901N	0.54	74C915N	1.11
74C10N	0.24	74C89N	4.39	74C164N	1.04	74C902N	0.54	74C918N	1.15
74C14N	0.95	74C90N	0.85	74C165N	1.04	74C903N	0.54	74C922N	3.90
74C20N	0.24	74C93N	0.85	74C173N	0.90	74C904N	0.54	74C923N	3.74
74C30N	0.24	74C95N	1.04	74C174N	0.90	74C905N	7.28	74C925N	5.22
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74C42N	0.92	74C150N	4.14	74C192N	1.11	74C907N	0.54	74C927N	5.22
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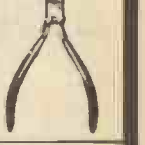

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74LS04N	0.29	74LS138N	0.65	74LS280N	1.65	SN74S387N	3.05
74LS05N	0.29	74LS139N	0.65	74LS283N	1.20	SN74S470N	5.06
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74LS11N	0.26	74LS151N	0.58	74LS295N	1.35	SN74S474N	13.48
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74LS20N	0.26	74LS157N	0.60	74LS325N	2.40	SN7493N	0.36
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74LS26N	0.32	74LS161N	0.85	74LS348N	1.10	SN7496N	0.54
74LS27N	0.26	74LS162N	0.80	74LS352N	1.07	SN7497N	1.95
74LS28N	0.29	74LS163N	0.85	74LS353N	1.07	SN74100N	1.40
74LS30N	0.26	74LS164N	1.10	74LS365N	0.55	SN74107N	0.24
74LS32N	0.27	74LS165N	1.15	74LS366N	0.55	SN74118N	0.95
74LS33N	0.29	74LS166N	1.65	74LS367N	0.55	SN74119N	1.40
74LS37N	0.32	74LS168N	1.45	74LS368N	0.55	SN74121N	0.28
74LS38N	0.32	74LS169N	1.45	74LS373N	0.85	SN74122N	0.55
74LS40N	0.26	74LS170N	1.90	74LS374N	0.85	SN74123N	0.55
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74LS47N	1.09	74LS174N	0.75	74LS377N	1.30	SN74125N	0.45
74LS48N	1.00	74LS175N	0.75	74LS378N	1.00	SN74141N	0.56
74LS49N	1.09	74LS181N	2.75	74LS379N	1.25	SN74145N	0.85
74LS51N	0.26	74LS183N	2.70	74LS386N	0.44	SN74148N	1.35
74LS54N	0.26	74LS189N	3.74	74LS390N	0.90	SN74150N	0.90
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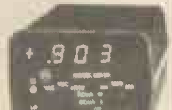

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2N388	0.80	2N718	0.30	2N1483	1.85	2N2219A	0.39	40232	0.60	AC188K	0.65	BC119	0.33	BCY34A	1.10	BD142	0.70	BF159	0.37
2N388A	0.77	2N718A	0.54	2N1485	2.20	2N2220	0.39	40233	0.70	AD136	2.75	BC122	0.61	BCY38	2.20	BDX14	1.32	BF160	0.33
2N398	0.80	2N720A	0.85	2N1507	0.35	2N2221	0.25	40235	0.65	AD142	1.45	BC123	0.65	BCY40	1.05	BDX18	1.90	BF161	0.65
2N456	2.20	2N721	1.05	2N1524	0.60	2N2221A	0.25	40237	0.45	AD143	1.45	BC125	0.22	BCY42	0.65	BDX32	2.67	BF166	0.44
2N489	4.90	2N722	0.45	2N1553	1.50	2N2222	0.26	40242	0.66	AD149	2.85	BC132	0.33	BCY43	0.76	BDY11	3.30	BF167	0.37
2N489A	5.40	2N727	0.50	2N1613	0.30	2N2222A	0.25	40251	1.16	AD150	3.10	BC134	0.22	BCY54	2.40	BDY17	3.30	BF170	0.76
2N489B	5.90	2N744	0.35	2N1637	0.72	2N2223	5.78	40254	0.66	AD161	1.00	BC135	0.22	BCY58	0.27	BDY18	3.80	BF173	0.37
2N490	4.99	2N753	0.35	2N1638	0.70	2N2223A	6.99	40264	0.95	AD162	1.00	BC136	0.21	BCY59	0.27	BDY20	1.10	TIP29C	0.65
2N490B	6.50	2N760	0.35	2N1711	0.30	2N2270	0.49	40280	3.70	AF106	0.60	BC137	0.22	BCY66	2.20	BDY23	2.45	TIP30A	0.54
2N490C	6.90	2N869	0.35	2N1889	0.30	2N2303	1.54	40309	0.60	AF109	0.82	BC138	0.44	BCY67	2.70	BDY24	2.65	TIP30C	0.70
2N491A	5.75	2N914	0.38	2N1890	0.30	2N2368	0.27	40310	0.85	AF114	0.70	BC140	0.30	BCY70	0.21	BDY25	2.85	TIP31A	0.54
2N491B	6.25	2N916	0.33	2N1893	0.30	2N2369	0.27	40311	0.55	AF115	0.70	BC141	0.32	BCY71	0.26	BDY38	1.10	TIP31C	0.72
2N491	7.50	2N917	0.38	2N1907	5.95	2N2369A	0.27	40312	0.99	AF116	0.70	BC142	0.32	BCY72	0.18	BDY54	1.55	TIP32A	0.59
2N492	6.25	2N918	0.45	2N1974	0.98	2N2405	0.66	40313	1.38	AF117	0.70	BC143	0.32	BCY77	0.70	BDY55	1.90	TIP32C	0.82
2N492A	6.75	2N929	0.37	2N1990	0.45	3N81	3.50	40315	0.60	AF118	0.70	BC152	0.38	BCY78	0.43	BDY56	2.10	TIP33A	0.86
2N492B	7.75	2N929A	0.37	2N1991	1.10	3N83	2.25	40316	0.95	AF124	0.70	BC153	0.30	BCY79	0.41	BDY57	5.90	TIP33C	1.18
2N492C	10.00	2N930	0.37	2N2060	7.00	3N128	1.35	40317	0.60	AF125	0.70	BC154	0.30	BCY87	5.35	BDY58	6.50	TIP34A	0.97
2N493A	7.99	2N930A	0.95	2N2102	0.50	3N139	1.60	40324	0.95	AF126	0.70	BC160	0.38	BCY88	3.99	BDY60	1.65	TIP34C	1.31
2N493B	8.75	2N1131	0.32	2N2147	1.55	3N140	1.10	40325	1.35	AF139	0.75	BC161	0.38	BCY89	3.80	BDY61	2.75	TIP35A	2.20
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2N494A	7.65	2N1204	1.65	2N2192	0.58	3N142	0.70	AC127	0.48	AF178	1.30	BC204	0.12	BD116	1.35	BDY92	2.75	TIP41A	0.76
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2N697	0.31	2N1306	1.00	2N2195	0.49	3N159	1.35	AC153K	0.59	BC114	0.22	BC209	0.17	BD135	0.40	BF134	0.60	TIP54	1.83
2N698	0.49	2N1307	1.00	2N2195A	0.49	3N187	1.80	AC176K	0.70	BC115	0.22	BCY10	1.10	BD136	0.40	BF137	0.60	TIP110	0.77
2N699	0.58	2N1308	1.10	2N2217	0.55	3N200	2.85	AC176	0.54	BC116	0.21	BCY30A	1.10	BD137	0.41	BF152	0.27	TIP112	0.93
2N706	0.30	2N1309	1.10	2N2218	0.35	3N201	1.35	AC187	0.59	BC116A	0.22	BCY31A	1.10	BD138	0.41	BF153	0.27	TIP115	0.83
2N706A	0.30	2N1370	0.55	2N2218A	0.38	40050	1.70	AC187K	0.65	BC117	0.22	BCY32A	1.10	BD139	0.43	BF154	0.27	TIP117	0.99

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PE VOLUME 15 No. 5 MAY 1979

LUCRATIVE MARKET

FROM time to time we see large industrial distributors or manufacturers breaking into the component retail market; this has happened again just recently. They obviously feel the market is a lucrative one; they certainly enter it with both eyes open and usually after considerable research—sometimes with quite a fanfare too! Unfortunately, nearly all these companies have in the past come to grief, having struggled along for a few years making little or no profit and finally giving up and closing down.

We were fortunate enough to be invited to the press launch for Doram—it was an impressive affair in a wine cellar in the city of London. The link between the fledgling company and Radiospares—as RS Components were then known—was emphasised. There was a display of kits and components that Doram would market and directors and technical staff were on hand to answer the many questions from the hobbyist and general electronic press. Those who doubted the viability of the project, in the light of the failure of other companies, were soon quietened by the enthusiasm and professionalism of the Doram people.

Alas it was not to be, and having struggled along for a few years, a recent change in policy to get out of components and just sell kits was eventually squashed by the decision to shut up shop completely. How then can so many "private" firms continue.

Perhaps it is simply that "industrial" companies need a bigger profit margin? Maybe they use over complex systems, designed for industry and not mail order? Or could it simply be that their marketing is all wrong for the hobbyist? It's probably a combination of all these factors. One thing is clear, our market is not an easy one to judge, or to be profitable in. Of course, we wish all "new" companies well and we hope the latest venture by a distributor will be successful—only time will tell.

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Many successful component suppliers advertising in this magazine have started with one or two people, often from someone's front room or a small back street office. They have built up a business from a spare time occupation and now many of them employ upwards of a dozen people. Perhaps because they started with very little capital they have learnt how to keep the overheads down, how to market to you the hobbyist consumer, and above all how to work and make a profit on a low margin.

We do, of course, get some complaints about suppliers, long delivery times, etc. but they are often faced with no delivery from manufacturers and the breaking of promised delivery dates from the world's suppliers. There is the odd bad company, but rest assured they are quickly weeded out of our pages and our mail order protection scheme is used to help those who's money has gone to a bankrupt company.

By and large we have nothing but praise and admiration for the component suppliers; most of them operate a fast, efficient service at an excellent price. They carry many thousands of different items with a large proportion available for pence rather than £s. It is necessary for them to buy stock directly from many countries, to rely on the post for most of their sales and to operate in a highly competitive field. Industry has shown many times that it is willing, but often unable to operate successfully in this area, so without the private retail component suppliers our hobby would probably cease, certainly be more expensive.

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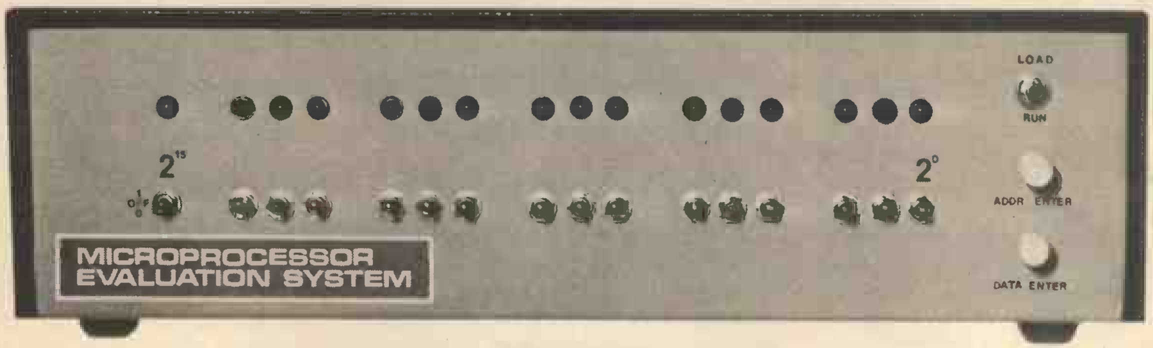
Microprocessor Evaluation System

D.S.COUTTS (General Instrument Microelectronics)



Part 1

WITH microprocessors steadily spreading through the electronics hobby scene, the author felt that it was time to learn a little about them and how they can be programmed to perform simple tasks. The question was, where to start? The requirement was for a very simple machine using a powerful processor so that the lessons learned could be applied later to build a more sophisticated machine. The simplest approach seemed to be to use switches to read in the address and data information (eliminating the need for a PROM programmer) and to use single l.e.d.s as the output display. The microprocessor chosen was the GENERAL INSTRUMENT CP1610, a 16 bit machine with a very powerful instruction set. A large memory wasn't considered necessary to learn the rudiments of programming so four 2112 RAMs were used, giving a total of 256 sixteen bit words (1,024 bits).

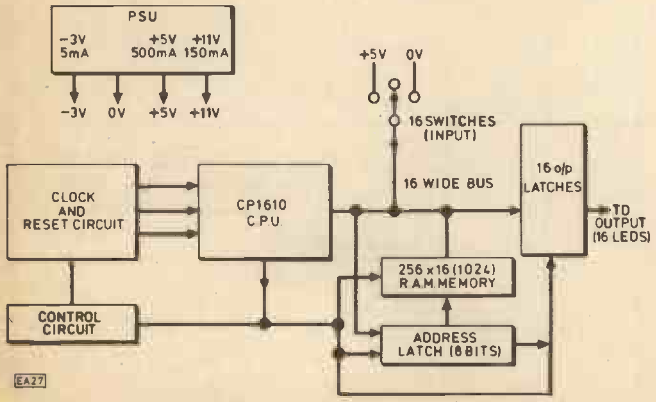


Fig. 1.1. Block diagram of the Evaluation System

The basic system block diagram is shown in Fig. 1.1. It consists of a power supply, the CP1610 CPU, TTL clock, reset and control circuits, four 2112 RAMs and TTL address and output latches. Data and addresses are set up by 16 s.p.d.t. toggle switches each with a centre off position. There is also a LOAD/RUN toggle switch and two push buttons for ADDRESS ENTRY and DATA ENTRY. 16 single l.e.d.s are used for the output. The memory occupies address space Ø–377 OCTAL (Ø–255 BINARY) and the output latches are at address 377 OCTAL (255 BINARY).

INTRODUCTION TO CP1610

The CP1610 internal block diagram is shown in Fig. 1.2. There is an array of 8 sixteen bit registers. Register 6 serves as the stack pointer (SP) while register 7 serves as the program counter (PC). The other registers are general purpose and may be used for arithmetic or other operations.

Communication to the outside world is via a 16 bit bi-directional bus, but internally the data is processed in two 8-bit bytes. There are four status flags SIGN (S), ZERO (Z), OVERFLOW (OV) and CARRY (C), and there is a 10 bit instruction register. Table 1 shows the CPU pin connections and functions.

All the pins are not used in our basic processor, pins 27, 28, 31, 32, 33 are linked to +5V and pin 40 also goes via a resistor to +5V. Pins 1, 22, 23, 24, 25 are not used at first. This leaves us with four power input pins, two clock input pins, a reset input, sixteen I/O lines for data and address and three output pins to decode for bus control purposes. Not too frightening!

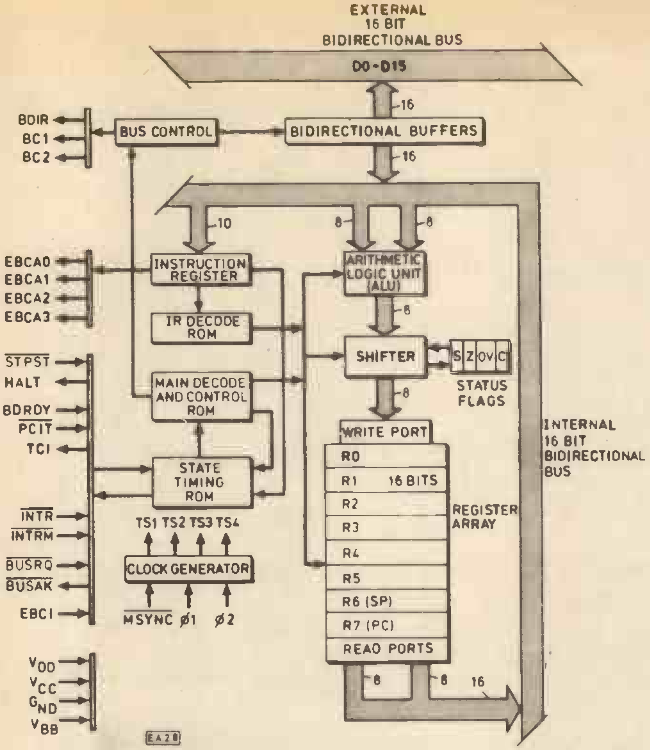


Fig. 1.2. Internal block diagram of the CP1610

The processor instruction set is shown in Table 2. It may seem a bit overpowering at first but there is a glossary of terms at the end of the table and it is intended to give programming examples when the processor has been completed.

CIRCUIT DESCRIPTION

The complete circuit diagram of the system is shown in Fig. 1.3. The circuit is relatively straightforward and will be described in blocks.

CLOCK CIRCUIT

IC1 a, b and c are used for the master oscillator and this feeds the shift register 2a, b and 3a, b. This shift register is used to produce four time slots, TS1 to TS4. IC5a and b are used to produce two non-overlapping clocks Ø1 and Ø2. These clocks are buffered by the open collector TTL IC6a and b, and drive the CPU via emitter followers TR1 and TR2.

LOAD/RUN AND RESET CIRCUIT

When S1a is in the load position IC4 pin 8 is low, preventing the shift register from running and stopping the clocks to the processor. The low on IC4 pin 8 is fed to IC4 pin 5, holding pins 6 and 2 high. As pin 1 is also high, pin 3 is held low, holding the CPU in the reset state. In this state the sixteen processor I/O lines are in their high impedance state and the switches (S4 to S19) may be used to load the program into RAM. When S1a is changed to the run position the CPU clocks are enabled and the CPU reset line goes high when IC3a pin 9 goes low, and the program is executed.

BUS CONTROL

IC8, a B.C.D. (decimal decoder) is used to decode the BC1, BC2 and BDIR lines from the processor to produce the necessary bus control signals. BC1 is on pin 3, BC2 on 4 and BDIR on 5. Pin 12 is fed from IC5c and goes high during reset and also during time slot TS1. This prevents IC8 from outputting unwanted signals during reset and also during

VCC	+5V
VBB	−3V
VDD	+11V
D0-D15	DATA AND ADDRESS LINES
MSYNC	RESET LINE
EBCAØ **EBCA1** **EBCA2** **EBCA3**	EXTERNAL BRANCH CONDITION ADDRESS. Outputs of 4 least significant bits of instruction register, used externally to select 1 of 16 digital states to be sampled by the CPU during BRANCH EXT. instruction.
EBCI	EXTERNAL BRANCH CONDITION INPUT
BDRDY	Input, used to make CPU wait for slow memories.
INTR **INTRM**	Interrupt inputs, one maskable
TCI	Output, terminates current interrupt.
BUSRQ	Used to cause CPU to relinquish control of bus.
BUSAK	Output to signal that CPU has released bus.
STPST	Alternately stops and starts CPU.
HALT	Output, indicating CPU halted.
PCIT	1. As an input prevents the program counter incrementing during fetch phase of instructions. 2. As output, outputs negative pulse during SIN (software interrupt) instructions.
BC1 **BC2** **BDIR**	Bus Control 1 Bus Control 2 Bus DIRection } see bus control signals below

BDIR	**BC1**	**BC2**		**DECODE FUNCTION**	
0	0	0	**NACT**	No ACTion, D0–D15=high impedance	
0	0	1	**IAB**	Interrupt Address to Bus, D0–D15=input	
0	1	0	**ADAR**	Addressed Data to Address Register, D0–D15=high impedance	
0	1	1	**DTB**	Data To Bus, D0–D15 =Input	
1	0	0	**BAR**	Bus to Address Register	D0–D15 =Output
1	0	1	**DWS**	Data Write Strobe	D0–D15 =Output
1	1	0	**DW**	Data Write	D0–D15 =Output
1	1	1	**INTAK**	INTerrupt AcKnowledge	D0–D15 =Output

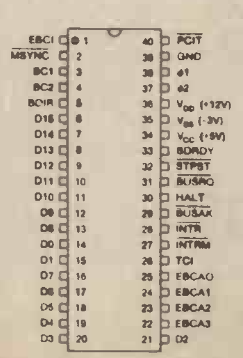


TABLE 1. Complete list of functions for the 1610 microprocessor together with its bus control signals and pin connection diagram

REGISTER—REGISTER

MNEMONIC	OPERAND	CYCLES	INSTRUCTION			DESCRIPTION	STATUS CHANGE
MOVR	SSS, DDD	6*	0010	SSS	DDD	MOVe contents of Register SSS to register DDD. *If DDD is 6 or 7 add 1 to Cycles.	S, Z
TSTR	SSS	6*	0010	SSS	SSS	TeST contents of Register SSS. *If SSS is 6 or 7 add 1 to Cycles	S, Z
JR	SSS	7	0010	SSS	111	Jump to address in Register SSS. (Move address to Register 7).	S, Z
ADDR	SSS, DDD	6	0011	SSS	DDD	ADD contents of Register SSS to contents of register DDD. Results to DDD	S, Z, C, OV
SUBR	SSS, DDD	6	0100	SSS	DDD	SUBtract of Register SSS from contents of register DDD. Results to DDD.	S, Z, C, OV
CMPR	SSS, DDD	6	0101	SSS	DDD	CoMPare Register SSS with register DDD by subtraction. Results not stored.	S, Z, C, OV
ANDR	SSS, DDD	6	0110	SSS	DDD	logical AND contents of Register SSS with contents of register DDD. Results to DDD.	S, Z
XORR	SSS, DDD	6	0111	SSS	DDD	eXclusive OR contents of Register SSS with contents of register DDD. Results to DDD.	S, Z
CLRR	DDD	6	0111	DDD	DDD	CLeaR Register to zero.	S, Z
INCR	DDD	6	0000	001	DDD	INCrement contents of Register DDD. Results to DDD.	S, Z
DECR	DDD	6	0000	010	DDD	DECrement contents of Register DDD. Results to DDD.	S, Z
COMR	DDD	6	0000	011	DDD	one's COMplement contents of Register DDD. Results to DDD.	S, Z
NEGR	DDD	6	0000	100	DDD	Two's complement contents of Register DDD. Results to DDD.	S, Z, C, OV
ADCR	DDD	6	0000	101	DDD	ADd Carry bit to contents of Register DDD. Results to DDD.	S, Z, C, OV

REGISTER SHIFT

Executable only with Register 0, 1, 2, 3. n=1 or 2 (places)
Shift Right instructions set the S flip-flop with Bit 7 of the result after the Instruction.
Add 2 cycles if shift is 2 bits or two bytes.
Shifts are not interruptable.

MNEMONIC	OPERAND	CYCLES	INSTRUCTION			DESCRIPTION	STATUS CHANGE
SWAP	RR<,n>	6	0001	000	NRR	N=0, SWAP bytes of register RR. S equals Bit 7 of results of SWAP.	S, Z
		8				N=1, SWAP bytes of register RR, then swap them back to original form	S, Z
SLL	RR<,n>	6	0001	001	NRR	N=0, Shift Logical Left one bit, zero to low bit.	S, Z
		8				N=1, Shift Logical Left two bits, zero to low 2 bits.	S, Z
RLC	RR<,n>	6	0001	010	NRR	N=0, Rotate Left one bit using Carry bit as bit 16.	S, Z, C
		8				N=1, Rotate Left two bits using C as bit 17 and OV as bit 16	S, Z, C, OV
SLLC	RR<,n>	6	0001	011	NRR	N=0, Shift Logical Left one bit using C as bit 16, zero to low bit.	S, Z, C
		8				N=1, Shift Logical Left two bits using C as bit 17, OV as bit 16, zero to low 2 bits	S, Z, C, OV
SLR	RR<,n>	6	0001	100	NRR	N=0, Shift Logical Right one bit, zero to high bit	S, Z
		8				N=1, Shift Logical Right two bits, zero to high two bits.	S, Z
SAR	RR<,n>	6	0001	101	NRR	N=0, Shift Arithmetic Right one bit, sign bit copied to high bit.	S, Z
		8				N=1, Shift Arithmetic Right two bits, sign bit copied to high bits.	S, Z
RRC	RR<,n>	6	0001	110	NRR	N=0, Rotate Right one bit using Carry as bit 16.	S, Z, C
		8				N=1, Rotate Right two bits using C as bit 16, OV as bit 17.	S, Z, C, OV
SARC	RR<,n>	6	0001	111	NRR	N=0, Shift Arithmetic Right one bit, thru Carry, sign bit copied to high bit.	S, Z, C
		8				N=1, Shift Arithmetic Right two bits, thru Carry and OV, sign bit copied to high 2 bits	S, Z, C, OV

CONTROL

MNEMONIC	OPERAND	CYCLES	INSTRUCTION			DESCRIPTION	STATUS CHANGE
GSWD	DD	6	0000	110	0DD	Get Status WorD in register DD. Bits 0–3, 8–11 set to 0 Bits 4, 12=C; 5, 13=OV; 6, 14=Z; 7, 15=S.	
NOP		6	0000	110	10N	No operation	
SIN	<n>	6	0000	110	11N	Software Interrupt; pulse to PCIT * pin, n=0 or 1	
RSWD	SSS	6	0000	111	SSS	Restore Status Word from register SSS; Bit 4 to C. Bit 5 to OV, Bit 6 to Z, Bit 7 to S.	S, Z, C, OV
HLT		4	0000	000	000	HaLT after next instruction is executed. Resume on control start.	
EIS		4	0000	000	010	Enable Interrupt System. Not Interruptable.	
DIS		4	0000	000	011	Disable Interrupt System. Not Interruptable	
TCI		4	0000	000	101	Terminate Current Interrupt. Not Interruptable.	
CLRC		4	0000	000	110	CLeaR Carry to zero. Not Interruptable.	C
SETC		4	0000	000	111	SET Carry to one. Not Interruptable.	C

BRANCHES

The Branch instructions are Program Counter Relative, i.e., the Effective Address=PC±Displacement. PPPPPPPPP is the Displacement and S is 0 for +, 1 for −. If Memory is greater than 10 bits then the appropriate number of lead bits pppppp will be a part of the Displacement. For a forward branch and addition is performed; for a backward branch a ones complement subtraction is performed. Computation performed on PC+2.

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
B	DA	7/9	1000 S0 0000 pppppp PPPP PP PPPP	Branch unconditional, Program Counter Relative (+1025 to −1024)	
NOPP		7	1000 S0 1000 pppppp PPPP PP PPPP	No OPeration, two words	
BC	DA	7/9	1000 S0 0001	Branch on Carry, C=1	
BLGE	DA		pppppp PPPP PP PPPP	Branch if Logical Greater Than, or Equal, C=1	
BNC	DA	7/9	1000 S0 1001	Branch on No Carry, C=0	
BLLT	DA		pppppp PPPP PP PPPP	Branch if Logical Less Than, C=0	
BOV	DA	7/9	1000 S0 0010 pppppp PPPP PP PPPP	Branch on OVerflow, OV=1	
BNOV	DA	7/9	1000 S0 1010 pppppp PPPP PP PPPP	Branch on No OVerflow, OV=0	
BPL	DA	7/9	1000 S0 0011 pppppp PPPP PP PPPP	Branch on PLus S=0	
BMI	DA	7/9	1000 S0 1011 pppppp PPPP PP PPPP	Branch on MInus S=1	
BZE	DA	7/9	1000 S0 0100	Branch on ZEro, Z=1	
BEQ	DA		pppppp PPPP PP PPPP	Branch if EQual, Z=1	
BNZE	DA	7/9	1000 S0 1100	Branch on No ZEro, Z=0	
BNEQ	DA		pppppp PPPP PP PPPP	Branch if Not EQual, Z=0	
BLT	DA	7/9	1000 S0 0101 pppppp PPPP PP PPPP	Branch if Less Than, S ⊻ OV=1	
BGE	DA	7/9	1000 S0 1101 pppppp PPPP PP PPPP	Branch if Greater than or Equal, S ⊻ OV=0	
BLE	DA	7/9	1000 S0 0110 pppppp PPPP PP PPPP	Branch if Less than or Equal, ZV (S ⊻ OV)=1	
BGT	DA	7/9	1000 S0 1110 pppppp PPPP PP PPPP	Branch if Greater Than, ZV (S ⊻ OV)=0	
BUSC	DA	7/9	1000 S0 01111 pppppp PPPP PP PPPP	Branch if Unequal Sign and Carry C ⊻ S=1	
BESC	DA	7/9	1000 S0 1111 pppppp PPPP PP PPPP	Branch if Equal Sign and Carry C ⊻ S=0	
BEXT	DA, E	7/9	1000 S1 EEEE pppppp PPPP PP PPPP	Branch if EXternal condition is True. Field E is externally decoded to select 1 of 16 conditions. Response is tested for true condition.	

JUMP

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
J	DA	12	0000 000 100 11AA AAA A00 AAAA AAA AAA	Jump to address. Program counter is set to 16 bits of A's	
JE	DA	12	0000 000 100 11AA AAA A01 AAAA AAA AAA	Jump to address. Enable interrupt system. Program counter is set to 16 bits of A's.	
JD	DA	12	0000 000 100 11AA AAA A10 AAAA AAA AAA	Jump to address. Disable interrupt system. Program counter is set to 16 bits of A's.	
JSR	BB, DA	12	0000 000 100 BBAA AAA A00 AAAA AAA AAA	Jump and Save Return address (PC+3) in register designated by 1BB. Program counter is set to 16 bits of A's. BB≠11	
JSRE	BB, DA	12	0000 000 100 BBAA AAA A01 AAAA AAA AAA	Jump and Save Return and Enable interrupt system. Return (PC+3) is saved in register 1BB. Program counter is set to 16 bits of A's. BB≠11	
JSRD	BB, DA	12	0000 000 100 BBAA AAA A10 AAAA AAA AAA	Jump and Save Return and Disable interrupt system. Return (PC+3) is saved in register 1BB. Program counter is set to 16 bits of A's. BB≠11	

DIRECT ADDRESSED DATA—MEMORY

Field aaa aaa is dependent on the width of memory. 16 bits is maximum for aaa aaa AAAAAAAAAA.

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
MVO	SSS, A	11	1001 000 SSS aaa aaa AAAA AAA AAA	MoV Out data from register SSS to address A–A.	
MVI	A, DDD	10	1010 000 DDD aaa aaa AAAA AAA AAA	MoVe In data from address A–A to register DDD.	
ADD	A, DDD	10	1011 000 DDD aaa aaa AAAA AAA AAA	ADD data from address A–A to register DDD. Results to DDD.	S, Z, C, OV
SUB	A, DDD	10	1100 000 DDD aaa aaa AAAA AAA AAA	SUBtract data from address A–A from register DDD. Results to DDD.	S, Z, C, OV
CMP	A, SSS	10	1101 000 SSS aaa aaa AAAA AAA AAA	CoMPare data from address A–A with register SSS by subtraction. Results not stored.	S, Z, C, OV
AND	A, DDD	10	1110 000 DDD aaa aaa AAAA AAA AAA	logical AND data from address A–A with register DDD. Results to DDD.	S, Z
XOR	A, DDD	10	1111 000 DDD aaa aaa AAAA AAA AAA	eXclusive OR data from address A–A with register DDD. Results to DDD.	S, Z

INDIRECT ADDRESSED DATA—REGISTER

MMM Source data is located at the address contained in Register. R1–R6.
MMM = 4, 5 post increment R4 or R5.
MMM = 6—MVO Instruction—post increment R6 PUSH data from Register SSS to the Stack.
Other instructions—pre-decrement R6. PULL data from the Stack to be used as the first operand.

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
MVO@	SSS, MMM	9	1001 MMM SSS	MoVe Out data from register SSS to the address in register MMM. Note: SSS=MMM=4, 5, 6 or 7 not supported.	
PSHR	SSS	9	1001 110 SSS	PuSH data from Register SSS to the stack.	
MVI@	MMM, DDD	8*	1010 MMM DDD	MoVe In data to register DDD from address in register MMM.	
PULR	DDD	11	1010 110 DDD	PULl data from the stack to Register DDD.	
ADD@	MMM, DDD	8*	1011 MMM DDD	ADD data located at address in register MMM to the contents of register DDD. Results to DDD.	S, Z, C, OV
SUB@	MMM, DDD	8*	1100 MMM DDD	SUBtract data located at address in Register MMM from contents of register DDD. Results to DDD.	S, Z, C, OV
CMP@	MMM, DDD	8*	1101 MMM SSS	CoMPare data located at address in Register MMM with contents of register SSS, by subtraction. Results not stored	S, Z, C, OV
AND@	MMM, DDD	8*	1110 MMM DDD	logical AND contents of register DDD with data located at address in register MMM. Results to DDD.	S, Z
XOR@	MMM, DDD	8*	1111 MMM DDD	eXclusive OR contents of register DDD with data located at address in register MMM. Results to DDD.	S, Z

* Add 3 to number of cycles if MMM = 6.

IMMEDIATE DATA—REGISTER

The number of iiiiii bits depends on the memory width, 16 bits is maximum.

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
MVOI	SSS, I	9	1001 111 SSS iiiiii IIII III III	MoVe Out Immediate data from register SSS to PC+1 (field).	
MVII	I, DDD	8	1010 111 DDD iiiiii IIII III III	MoVe In Immediate data to register DDD from PC+1 (field).	
ADDI	I, DDD	8	1011 111 DDD iiiiii IIII III III	ADD Immediate data to contents of register DDD. Results to DDD.	S, Z, C, OV
SUBI	I, DDD	8	1100 111 DDD iiiiii IIII III III	SUBtract Immediate data from contents of register DDD. Results to DDD.	S, Z, C, OV
CMPI	I, SSS	8	1101 111 SSS iiiiii IIII III III	CoMPare Immediate data from contents of register SSS by subtraction. Results not stored	S, Z, C, OV
ANDI	I, DDD	8	1110 111 DDD iiiiii IIII III III	logical AND Immediate data with contents of register DDD. Results to DDD.	S, Z
XORI	I, DDD	8	1111 111 DDD iiiiii IIII III III	eXclusive OR Immediate data with contents of register DDD. Results to DDD.	S, Z
SDBD		4	0000 000 001 This instruction is normally supplied by the assembler as required to properly generate machine code.	Set Double Byte Data for the next instruction which must be an external reference instruction. The effective address of the external reference instruction will address the low order data byte; the address of the high order data byte will be EA+1 if register 4, 5 or 7 is used. If register 1–3 is used the EA will access the same byte twice resulting in both bytes of data being the same. Use of modes 0 and 6 are not supported by this instruction.	

INDIRECT ADDRESSED DOUBLE BYTE DATA—REGISTER

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
SDBD MVI@	MMM, DDD	4 10	0000 000 001 1010 MMM DDD	MoVe In double byte data from the address in register MMM to register DDD.	
SDBD ADD@	MMM, DDD	4 10	000 000 001 1011 MMM DDD	ADD double byte data from the address in register MMM to the content of register DDD. Results to DDD.	S, Z, C, OV
SDBD SUB@	MMM, DDD	4 10	0000 000 001 1100 MMM DDD	SUBtract double byte data located at address MMM from the content of register DDD. Results to DDD.	S, Z, C, OV
SDBD CMP@	MMM, DDD	4 10	0000 000 001 1101 MMM SSS	CoMPare double byte data located at address in register MMM with the content of register SSS by subtraction. Results not stored	S, Z, C, OV
SDBD AND@	MMM, DDD	4 10	0000 000 001 1110 MMM DDD	logical AND double byte data located at address in register MMM with the content of register DDD. Results to DDD.	S, Z
SDBD XOR@	MMM, DDD	4 10	0000 000 001 111 MMM DDD	eXclusive OR double byte data located at address in register MMM with the content of register DDD. Results to DDD.	S, Z

IMMEDIATE DOUBLE BYTE DATA—REGISTER

Note: The SDBD command is provided by the assembler when the immediate data is greater than the memory width and requires two bytes.

MNEMONIC	OPERAND	CYCLES	INSTRUCTION	DESCRIPTION	STATUS CHANGE
MVII	I, DDD	14	0000 000 001 1010 111 DDD XXLL LLL LLL XXUU UUU UUU	MoVe In Immediate double byte data to register DDD. L's will be low byte and U's upper byte. XX = don't care	
ADD1	I, DDD	14	0000 000 001 1011 111 DDD XXLL LLL LLL XXUU UUU UUU	ADD Immediate double byte data to contents of register DDD. Results to DDD. L's indicate low byte of literal, U's upper byte	S, Z, C, OV
SUBI	I, DDD	14	0000 000 001 1100 111 DDD XXLL LLL LLL XXUU UUU UUU	SUBtract Immediate double byte data from contents of register DDD. Results to DDD. L's indicate low byte of literal, U's upper byte	S, Z, C, OV
CMPI	I, SSS	14	0000 000 001 1101 111 SSS XXLL LLL LLL XXUU UUU UUU	CoMPare Immediate double byte data with contents of register SSS by subtraction. Results not stored. L's indicate low byte of literal, U's upper byte.	S, Z, C, OV
ANDI	I, DDD	14	0000 000 001 1110 111 DDD XXLL LLL LLL XXUU UUU UUU	logical AND Immediate double byte data with the contents of Register DDD. Results to register DDD. L's indicate low byte of literal, U's upper byte.	S, Z
XORI	I, DDD	14	0000 000 001 1111 111 DDD XXLL LLL LLL XXUU UUU UUU	eXclusive OR Immediate double byte data with the contents of register DDD. Results to Register DDD. L's indicate low byte of literal, U's upper byte.	S, Z

GLOSSARY OF TERMS

SSS—Source Register
DDD—Destination Register
n —Number of Shifts
RR —Register to Shift (only 0–3 allowed)
AAAAAA Memory address for Jump.
AAAAAAAAAA (new Program Counter)
BB—Register to save old PC in for Jump. (Reg = 1BB. 4, 5 or 6)
S —Sign of address displacement for Branch (PC relative).
pppppp PPPPPPPPPP—Address displacement for Branch
pppppp is dependent on the memory word size.
aaaaaa AAAAAAAAAA—Direct address of data word.
aaaaaa is dependent on the memory word size.
iiiiii IIIIIIIIII—Immediate data word. iiiiii is dependent on memory word size.
LLLLLLLL Lower 8 bits of double byte data.
UUUUUUUU Upper 8 bits of double byte data.

MMM—Address Mode
000—direct address in location following instruction.
001—indirect address for Register 1
010—indirect address for Register 2
011—indirect address for Register 3
100—indirect address for Register 4, post increment
101—indirect address for Register 5, post increment
110—indirect address for Register 6, post increment for MVO only
indirect address for Register 6, pre decrement for all instructions except MVO.
111—Indirect address for Register 7, post increment.
(Immediate data in location following instruction.)

TABLE 2. Complete Instruction Set for the CP1610

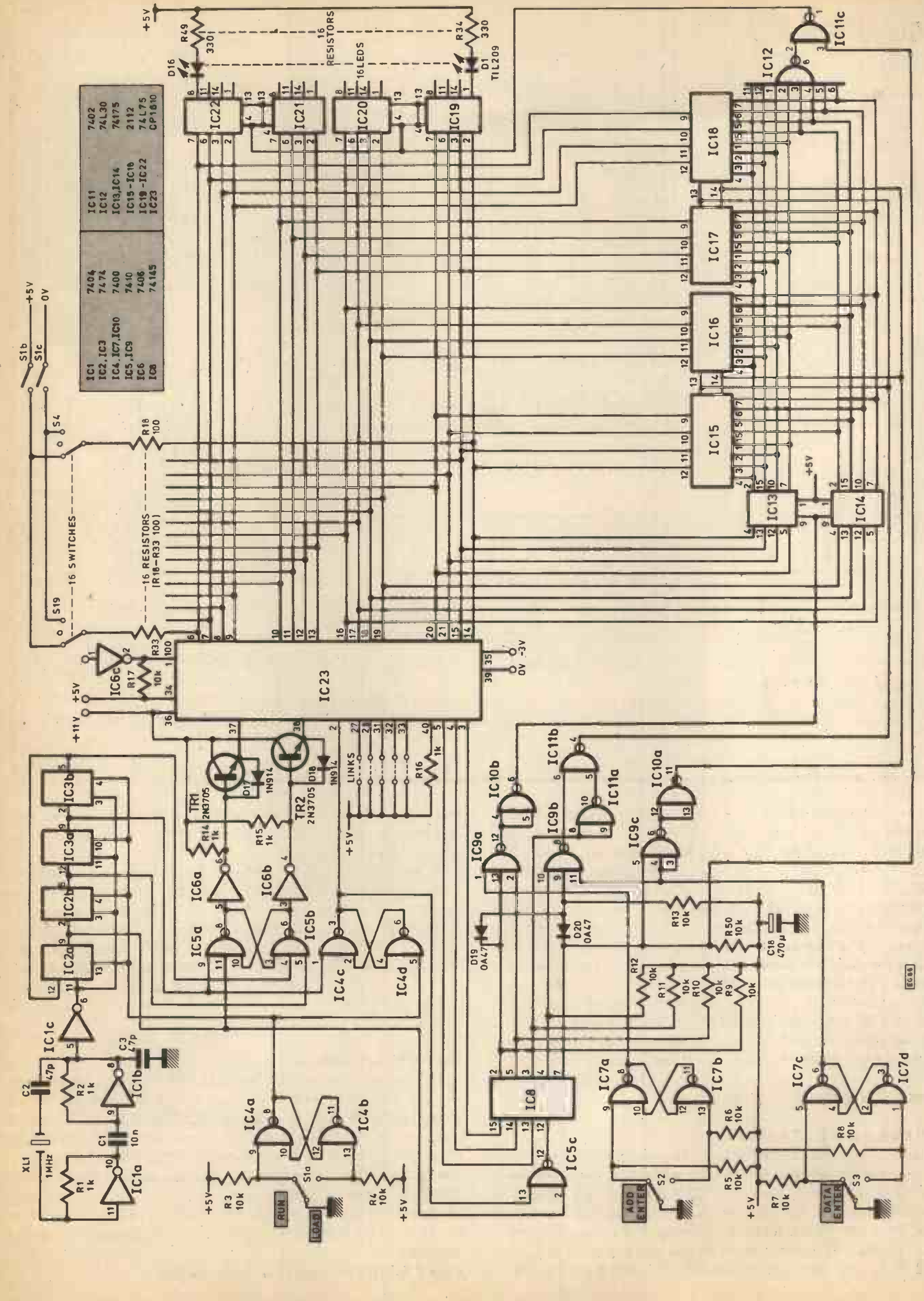


Fig. 1.3. Main circuit diagram of the Evaluation System (Note that the decoupling capacitors C4–C17 are not shown)

COMPONENTS . . .

Resistors

R1, R2, R14, R15, R16	1k (5 off)
R3–R13, R17, R50	10k (13 off)
R18–R33	100 (16 off)
R34–R49	330 (16 off)
R51–R54	390 (4 off)
R55	3k9
R56	1k8

Capacitors

C1	10n ceramic
C2, C3	47p ceramic (2 off)
C4–C17	10µ 16V tant. (14 off)
C18	470µ 10V elect.
C19, C20	220n (2 off)
C21	4700µ 10V elect.
C22	1000µ 10V elect.
C23	2200µ 25V elect.
C24	100µ 10V elect.

Diodes

D1–D16	TIL 209 (16 off)
D17, D18	IN914 (2 off)
D19, D20	OA47 (2 off)
D21, D22, D23	IN4001 (3 off)
D24	3V3 Zener BZY88
D25	6V2 Zener

Transistors

TR1, TR2	2N3705 (2 off)
TR3	2N3904

Integrated Circuits

IC1, IC27	7404 (2 off)
IC2, IC3	7474 (2 off)
IC4, IC7, IC10	7400 (3 off)
IC5, IC9	7410 (2 off)
IC6	7406
IC8	74145
IC11	7402
IC12	74L30
IC13, IC14	74175 (2 off)
IC19, IC20, IC21, IC22	74L75 (4 off)
IC15, IC16, IC17, IC18	2112 (4 off)
IC23	CP1610
IC24, IC25	7805 (2 off)
IC26	7403

Switches

S1	3 pole change over (toggle)
S2, S3	S.p.c.o. push button (2 off)
S4, S19	S.p.c.o. centre off (16 off)
S20	S.p.s.t. 1A
S21–S24	Push button (4 off)
S25	S.p.d.t.

Miscellaneous

FS1	1A slow blow fuse 20mm
T1	240V, 6V 1A, 6V 1A
XL1	1MHz crystal
Case	(380 x 200 x 100mm)
Case	(150 x 80 x 40mm)

Fuse Holder
Holders for i.c.s. (if req.)
Printed circuit board (main board)
Printed circuit board (power supply)
LS1 8ohm 0·2W speaker
7 way DIN socket (2 off)
7 way DIN plug (2 off)
Veroboard

CONSTRUCTORS NOTE

All the components including the CP1610 microprocessor are available together with a data sheet from **Technomatic** and **Watford Electronics** who both advertise in the magazine.

TS1 when data is not valid. IC8 pin 2 outputs ADAR which causes the addressed contents of memory to be gated on to the bus and strobed into the ADDRESS REGISTER. Pin 5 outputs BAR which strobes the CPU output into the ADDRESS REGISTER. These two low going signals are orred together by IC9a, and used to strobe the address into IC13 and 14, the address latches. IC8 pin 3 outputs IAB which, via gates 11a and b, enables the RAMs IC15 to 18, to output the program starting address on to the bus. IC8 pin 4 outputs DTB. This signal is fed via gates 9b and 11b to the RAMs chip enable to read data out on to the bus. The final output of IC8, pin 7, is DWS. This signal also enables the RAMs via gates 9b and 11b, but it also strobes the RAMs write inputs via gates 9c and 10a. It is also used to strobe data into the output latches IC19 to 22 when gated with address 255 in gate 11c.

ADDRESS AND DATA ENTRY

When S1 is in the load position S1b provides +5V to one bus feeding the switches S4 to S19 while S1c provides 0V to the other bus. Switches S4 to S19 are normally at their centre off position. To load an address into the address latches, first set the switches to the required binary pattern (+5V="1", 0V="0") and then push the address enter button S2. S2 feeds the anti bounce circuit IC7a and b. IC7 pin 8 goes low; this puts a low on IC9 pin 1. IC10 pin 6 goes low, reading the data from the switches into the address latches when it goes high again.

The word that has been loaded into the address latches is now addressing the RAMs although they are not yet enabled. By setting the sixteen switches to the required DATA pattern and pushing the ENTER DATA switch S3, the data is entered into the addressed RAM location. When S3 is pushed IC7 pin 6 goes low and this enables the RAMs via gates 9b and 11b. At the same time it strobes the RAMs write enable via gates 9c and 10a, writing the data from the sixteen switches into the RAMs.

OUTPUT LATCHES

The output latches (IC19–IC22) are 74L75 quad latches. The 16 bus lines feed the D outputs of the latches. When binary address 255 is selected (OCTAL 377) IC12 pin 8 goes low and if DWS goes low at the same time the output of gate 11c goes high, strobing the data from the bus into the latches. The output latches provide both Q (high going) and $\bar{Q}$ (low going) outputs. The $\bar{Q}$ outputs are used to drive single l.e.d.s via current limiting resistors. The Q outputs of the latches could be brought out to drive external circuitry if required.

NEXT MONTH: Construction details

VEHICLE INSTRUMENT DISPLAYS

B. Shepherd C.Eng FIEE*

The car market is acknowledged to be one of the most difficult for electronic systems to penetrate. The combined environment of temperature, humidity, vibration, electrical transients, etc. coupled with the required visual appeal and cost targets, are very demanding. Nevertheless, the present state of the available technologies indicate that displays will be available for vehicles in the early 1980s.

THE modern motor vehicle contains instruments that have been optimised to provide good performance at reasonable cost levels. They are usually attractively mounted in plastics mouldings and form an integral part of the vehicle fascia. The content of the instrument package is defined by the vehicle specification, written around the marketing requirements, on the generalised assumption that the cost is directly related to the complexity.

Electronic instruments in the form of tachometers and speedometers, etc. have been introduced in the past few years which utilise medium-scale integrated circuits, but again the display system used is a moving-coil instrument that is essentially of mechanical construction. The manufacturing cost of an individual instrument is fairly low, and to consider utilising electro-optic methods of display on an individual basis would generally be too expensive.

BASIC REQUIREMENTS

Examination of available display technologies indicates that separate instruments, complete with drive electronics, would be more expensive than their conventional electromechanical equivalent. If, however, all the individual elements of a dashboard are combined on one large display, and the electronics are also integrated to form one complete panel, then a cost-effective solution can be realised. The phrase "solid-state displays" has been coined to cover this type of panel, though it can be a misnomer in certain cases.

The most important parameters to be considered when choosing a particular technology are those of overall system cost, visual appeal, reliability, life and legibility, which covers the brightness and contrast aspects. The display must be capable of being manufactured on a large scale with a reasonable level of tooling and a minimum of assembly labour. Furthermore, the display technology chosen must be compatible with available integrated circuits and operate within reasonable voltage and power limitations. The ability to multiplex becomes a very critical factor.

The main parameters of importance for choosing a display technology suitable for a motor vehicle are those of total system cost, visual appeal, reliability, including operation over a wide temperature, vibration, and humidity range, together with a life requirement equal to that of the vehicle.

DISPLAY TECHNOLOGIES

Generally, the available technologies break down into those suitable for small-area display and those suitable for large areas; they also have different suitability as regards the optimum number of bits. A "bit" of information is defined as a single separate display area that has to be controlled independently (Table 1).

DISPLAY COST COMPARISON

The graphs in Fig. 1 show how the cost of these displays differs depending on their manufacture. A display consisting of only a few bits, e.g. warning lights, will have the lowest cost using individual elements like l.e.d.s. A display with an extremely large number of bits will have the lowest cost using a cathode-ray tube.

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TABLE 1. OPTIMUM NUMBER OF BITS FOR A GIVEN DISPLAY TECHNOLOGY

Technology	optimum number of bits
Tungsten filaments	1–20
Light-emitting diodes	1–30
Cathode-ray tubes	10k–250k
Gas discharge (plasma panels)	30–5k
A.C. or d.c. electroluminescence	30–3k
Liquid-crystal display	5–200
Electrochromic (liquid or solid)	5–200
Electrophoretic	5–200
Vacuum fluorescent	10–100

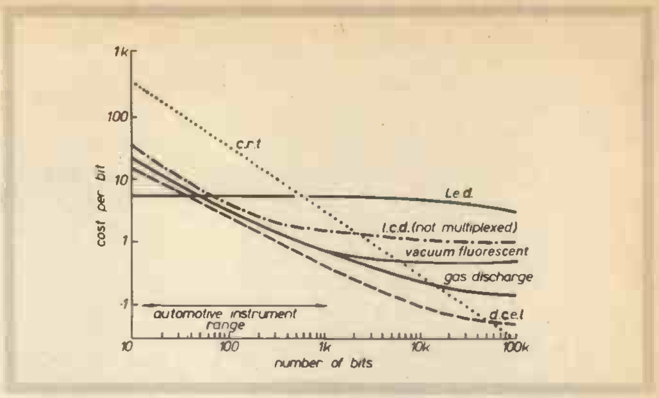


Fig. 1. Comparison of cost per bit against number of bits

A typical full instrument panel for a vehicle will have between 150 bits for a low-line vehicle to 300 bits for a high-line vehicle. It is evident that d.c. electroluminescence (d.c.e.l.) is most cost effective within this range, and that other technologies, e.g. liquid-crystal display (l.c.d.) and vacuum fluorescence, could also prove viable. The system of course also includes the drive electronics, and thus the system cost will involve other technical considerations as described later.

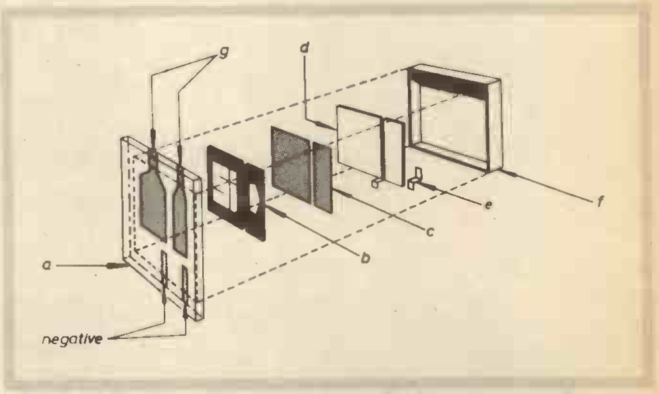


Fig. 2. Assembly for a d.c. electroluminescent display

(a) Front glass. **(b)** Insulating mask. **(c)** Phosphor, which is in contact with g through apertures in b. **(d)** Aluminium rear electrode. **(e)** Conductive strip. **(f)** Hermetically sealed cover. **(g)** Transparent conductive pattern (positive).

D.C. ELECTROLUMINESCENCE

The particular advantage of d.c.e.l. for vehicle-display applications is that, under normal and low ambient lighting, the display has considerable visible appeal with a reasonably wide range of colours. The disadvantages at present are associated with the available brightness and contrast ratio under extreme sunlight conditions. Work is continuing to overcome these problems.

The technology emits light and hence requires no other means of illumination. The construction is outlined in Fig. 2. The overall visual appeal, together with package cost advantages, have made it the favourite technology at present.

D.C. electroluminescent displays are based on polycrystalline copper and manganese-doped zinc-sulphide power phosphors. The devices are fabricated on transparent conductively coated glass substrates, which are photolithographically etched to provide delineation of the required light emission pattern and electrical input. All displays are hermetically sealed in a robust flat-pack configuration.

As a display technology, d.c.e.l. possesses many unique and advantageous features. The devices operate with high visual efficiency giving excellent legibility and an arresting appearance. The emission spectrum is broad band with its peak close to that of the human eye sensitivity curve. The basic bright yellow colour may be externally filtered to provide readily discriminated green and red displays. The emission is physiologically restful for continuous observation and contrasts sharply with unselected areas of the display and the surround.

Light emission takes place at the junction of the transport conducting film and the phosphor layer. It occurs uniformly over the whole positive electrode area, and individual phosphor particles cannot be resolved with the naked eye.

The display brightness is continuously variable and the voltage range is small because of the superlinear brightness voltage characteristic. There is no threshold or striking voltage. A vast range of display formats is possible. High resolution is provided by photoetching of the substrate conductor pattern. Combinations of complex shapes both small and large may be provided on the same substrate, as may analogue and digital information together with fixed legends.

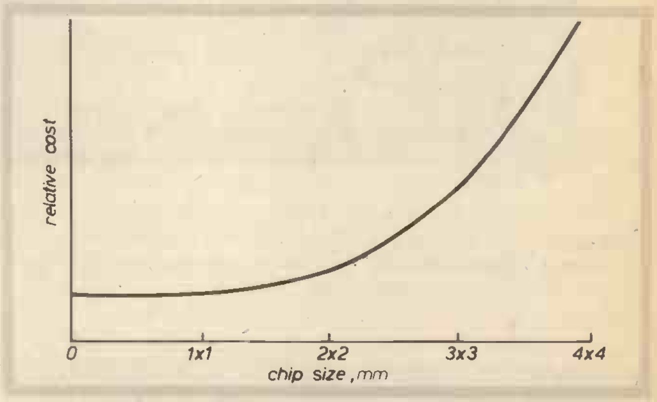
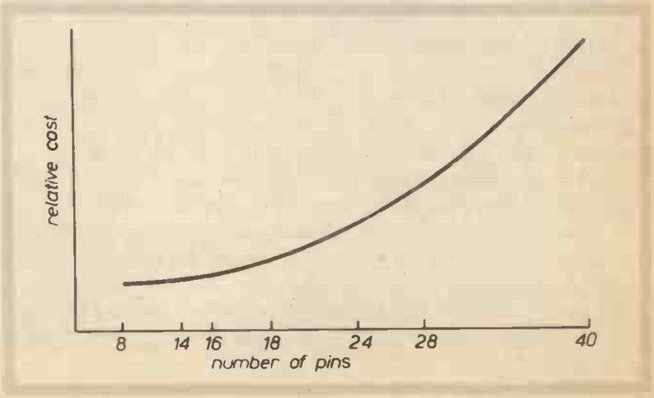
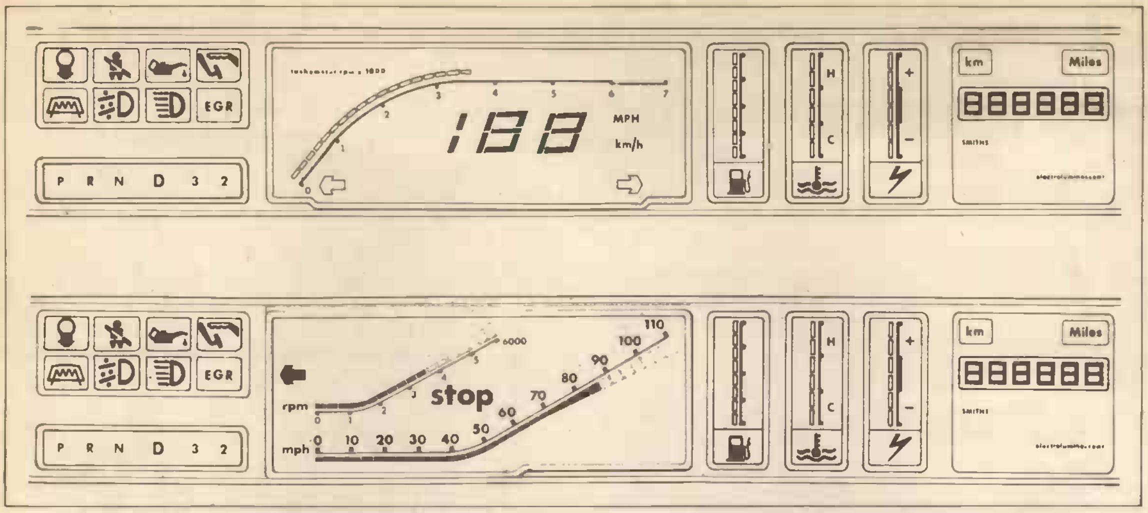


Fig. 3. Integrated circuit cost variation with size

Fig. 4. Integrated circuit cost variation with number of pins





Complete panel styles (a) with digital speedometer; (b) with analogue speedometer

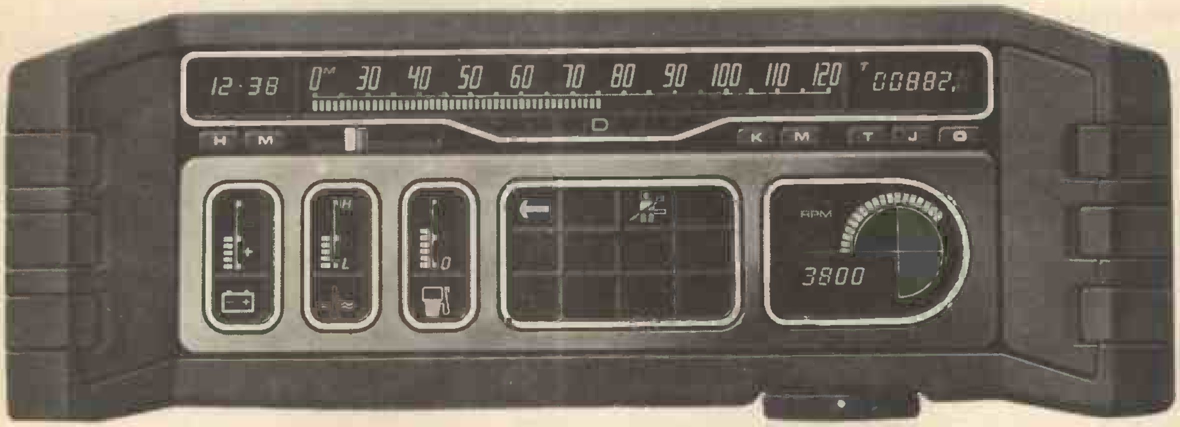
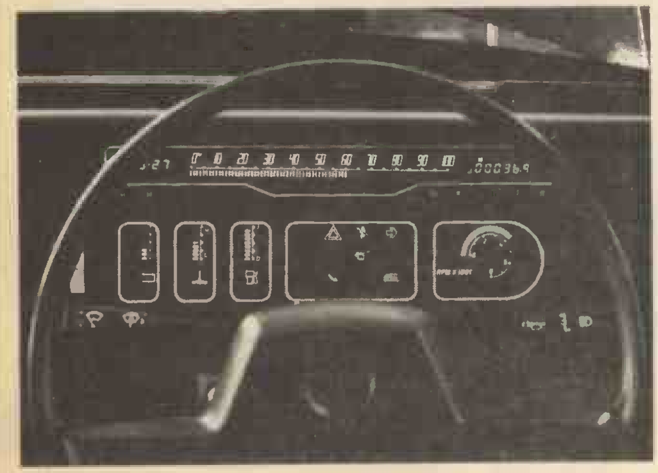


Illustration of a display designed for the Austin Princess, showing (above) all controls and (below) the presentation in the car (see also front cover).



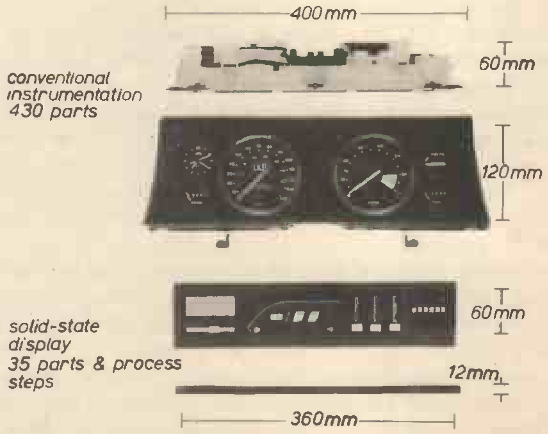


Fig. 5. Size comparison of conventional and solid-state displays

CONSTRUCTION

The simplicity of construction and processing are well suited to large-scale production, and flexibility in design allows economic manufacture of small quantities for prototype assessment. Custom displays are more readily realised than with any other solid-state light-emitting-display technique. D.C. electroluminescent displays are truly solid state. There is no sudden catastrophic failure mode. The slow increase in electrical resistance of the phosphor layer, which is characteristic, may be compensated for by simple constant-power-drive conditions. Neither luminous nor electrical power conversion efficiency show any appreciable decrease during operation.

The target life for this type of vehicle instrumentation is 5,000 hours. Life is measured as the time betweeen the initial brightness level down to one half of this value. Results obtained on small panels are giving encouraging results and continuous life-test data are being collected.

It is expected that such displays will first appear on vehicles with panels of approximately 100cm², containing digital clock, tachometer, fuel and temperature gauges and warning lights. This will be followed by complete dashboards containing speedometers and odometers also.

Simpler instrumentation, such as a digital clock alone, can be more suited to a digital l.e.d., or vacuum fluorescent or gas display panel. These types of displays are now available from many sources, using a standard 7-segment digital format, and could be combined with a conventional instrument to form a clock/tachometer display for instance.

INTEGRATED-CIRCUIT TECHNOLOGY

An instrument control system requires a combination of fairly dense logic for quartz-controlled digital clock, and odometers, linear analogue circuitry for bar-graph displays, e.g. small gauges, tachometers, etc. and display drive circuitry dependent on the type of display required. The complexity of the logic plus the fact that part of the circuit must still operate when the ignition is off will require low power. Electrical interference will require high noise immunity. Many displays require high-voltage switching.

The integrated circuits currently being designed are using integrated injection technology for the logic and high-voltage bipolar circuits for display drive. Custom-designed integrated circuits are considered best for this market because of the optimum product costing relative to the large volume requirement for the complete market.

Partitioning of these circuits has been made both to give the most flexible "kit" from which to build various panels and the lowest cost relative to Figs. 3 and 4.

As the display content grows, it becomes increasingly evident that "multiplexing" is essential to produce the lowest cost and highest reliability. Multiplexing is the term given to controlling the display element by its two connections, in parallel with other elements, so that the minimum number of interconnections are required. A non-multiplexed panel with 256 elements will require 257 connections. Multiplexed in a 16 × 16 manner only 32 connections are required.

Each connection requires a signal from an integrated circuit and a pin connection to that circuit. Typical low-cost circuits have 14 pins with a cost increase for the other standards of 16, 18, 24, 28 and 40. Also, the cost of an integrated circuit is dictated by the area of silicon used, with a cost curve generally proportional to area up to the point where low yield increases the cost still further. Figs. 3 and 4 indicate typical variations in cost.

The set of integrated circuits that will be used is being designed jointly with Plessey microelectronics, and samples are now becoming available for complete system evaluation by various European car manufacturers.

STYLES

The flexibility of a solid-state display to produce an attractive instrument panel is very important. The dashboard is immediately in front of the driver and the display aesthetics can be an important factor not only in the sale of the vehicle, but also in the subsequent safety aspects, and the manner in which information is transmitted from the vehicle to the driver. Early styles are shown on the cover and opposite.

As can be seen from the size information in Fig. 5, there is considerable potential space saving advantage when using solid-state displays.

FUTURE

Further examination of trends indicates that integrated circuits are becoming more complex and larger for a given cost level, and the display technologies are also improving. The cost per bit is therefore falling for large displays, but remaining the same for small displays. From this we can deduce that it will be most economic to offer more and more facilities at the same cost level.

Microprocessors are becoming available that can compute the relationships between several input parameters and give the driver better information. The instrument panel can become the control centre for the vehicle, optimising the vehicle performance for fuel economy, braking, entertainment, etc.

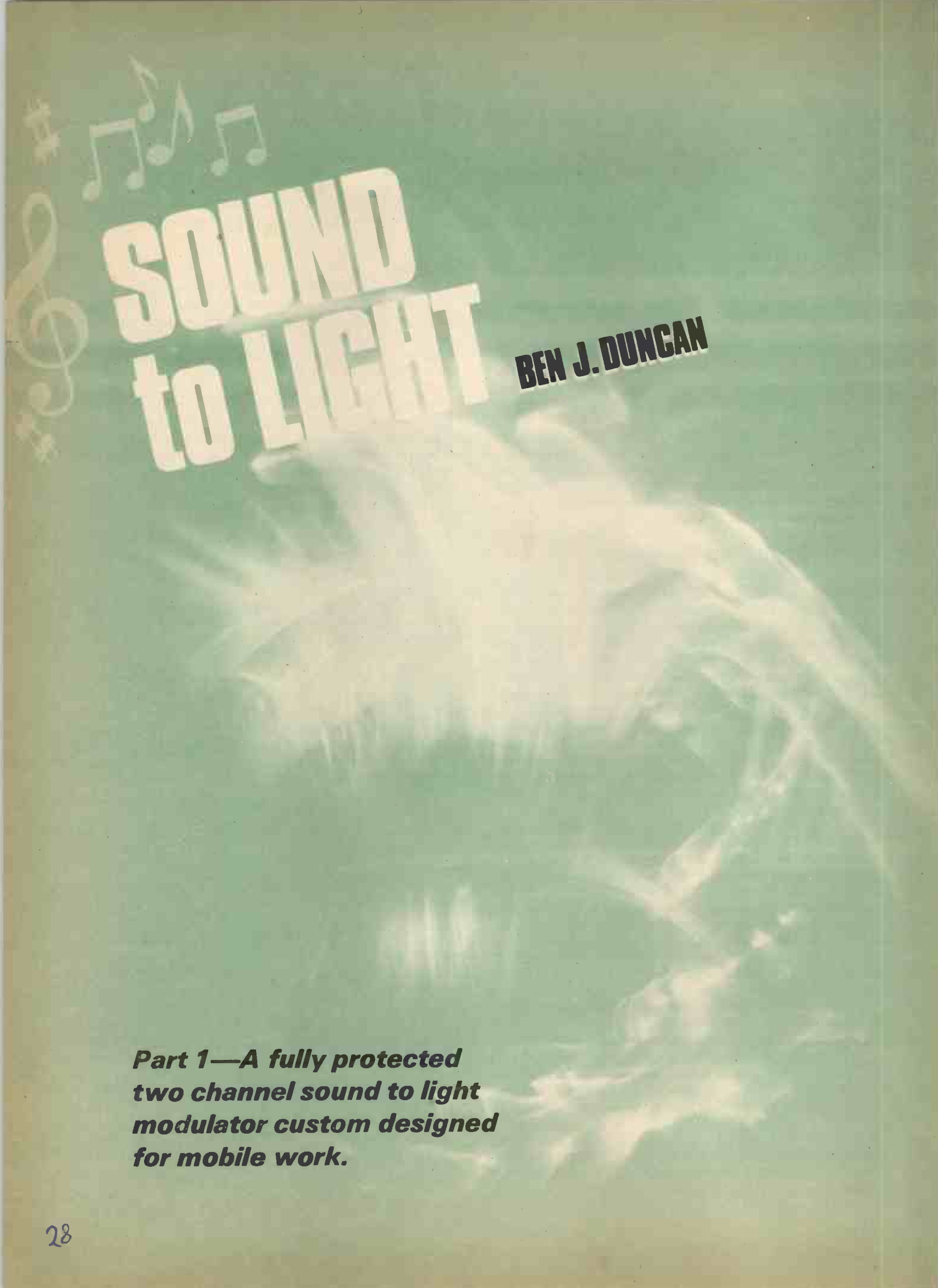
Coupled with information systems, e.g. route guidance, diagnostic sensing of engine and vehicle performance, this control centre will make the driving task much easier, only giving the driver information when he requires it or in an emergency. A keyboard will probably appear, integrating calculator, and a message display panel as an *aide memoire* for things like shopping lists.

The boredom of a traffic jam may eventually be overcome by electronic games and in-car entertainment could take on a new meaning. ★

For assistance in all the above display work, acknowledgement is gratefully given to the Royal Signals Research Establishment, Phosphor Products Co., and Plessey Ltd.

SOUND to LIGHT

BEN J. DUNCAN



Part 1—A fully protected two channel sound to light modulator custom designed for mobile work.

THIS article describes a sound to light modulator which was developed to overcome the problems found in many units. The design is intended primarily for discotheque applications, therefore emphasis is placed on reliability.

In essence a sound to light modulator converts analogue signals into a quasi-digital format which conveys the overall pattern of the music into modulation of the display lamps. An SLM can give considerable enhancement to the mainly physical class of music danced to in discotheques.

The development of SLMs, it would seem, has been overshadowed by gimmicky effects as found in random lighting displays which add little to the music, as a result they have remained relatively primitive since their inception some ten years ago.

Many discotheque operators will have experienced problems resultant of this poor state-of-the-art. These are summarised below:

(1) Continual adjustment is needed at every change in programme level in order to maintain the required degree of lamp saturation.
(2) Poor channel separation, resulting in a confused display.
(3) Unreliability, for no apparent reason.
(4) R.f.i. appearing in audio circuitry.

The circuit to be described has been designed according to the premise that simplicity is the first step towards reliability; this being an essential requirement for discotheque equipment. For this reason, the design is not totally devoid of the aforementioned shortcomings, notably the first, but is certainly a step in the right direction.

SPECIFICATION

Bass −3dB Turnover Frequency	320Hz −18dB/ Octave
Treble −3dB Turnover Frequency	3·5kHz −18dB/ Octave
Input Sensitivity	2V r.m.s.
Input Impedance	>100 kilohms
Input Protection	AC to >60 volts (equivalent to 450 watts into 8 ohms) DC to >90 volts
Channel Power Capacity	1·4kW (220–250 volts)
RFI Suppression	Zero voltage switched, choke-capacitor filtering
Overcurrent Protection	Glass fuses for small overloads to 80 amps. High speed fuses for short circuits to 850 amps
Overvoltage Protection	VDRs and snubbers against fuse arc and mains transient suppressors

THE FAULTS DISCUSSED

Before considering the circuit, it is useful to discuss the faults and their solutions. First (1).

A triac has a certain set voltage at which it will trigger. If the device is turned on continuously, the associated lamps will light continuously, resulting in a boring display; this situation is termed "oversaturation". When the signal level is suitably set, the triac will only switch on when most prominent parts of the music (usually the bass line and vocals) are prevalent. In this situation, the overall rhythm of the music is imitated. The associated lamps are then said to be correctly saturated. In common terms, "They flash to the music."

If the signal level is too low, the lamps will be switched on very briefly or not at all. The signal level for perfect saturation is critical, but some ±3dB variation in "mean" voltage will not seriously degrade the display.

There are two ways around the problem. Firstly, the SLM could be provided with a compressor, which will ensure a constant triggering voltage. However, a simple compressor cannot discriminate between long term changes in audio level and short term changes in the dominant sounds. It will tend to bring parts of the mix which were intended to remain in the background to the forefront, and reduce the dominant rhythms to a common level, thereby giving a false display.

A careful choice of time constant can alleviate this to an extent, but complex circuitry is almost certainly involved if a complete solution is sought. Futher, setting up the SLM so that the lighting level remains constant over the anticipated range of sound pressure level requires a precise knowledge of signal levels, again requiring complex circuitry if rapid setting up is necessary. The use of a compressor was not explored because a far simpler solution exists.

If the signal for the SLM is derived prior to any variable level or tone controls, then changes in signal level resulting from the operation of these is no longer a problem. There remains the changes in level resulting from the dynamic range of the source signal (typically 50dB for albums) and from differing modulation levels (a 12in single having the highest, then 7in singles, and 12in albums with the lowest). However, since we require in any case to capture only the overall pattern of the music, herein defined as the recurrent peaks, the former point can be neglected. Regarding the latter, the 6dB leeway, previously noted, that will permit a satisfactory display is the solution to the problem of differing disc modulation levels.

Careful setting up is required nevertheless; this is speedily effected by testing the display using a noisy 12in single and a relatively quiet album track.

It must be emphasised, however, that the direct connection of sensitive audio equipment to circuitry employing triacs provides an excellent opportunity for r.f.i. to creep into the audio chain, hence r.f.i. must be reduced to negligible levels.

POOR CHANNEL SEPARATION

Many designs feature 6 or 12dB/octave filters. Further, three channels are often used. Disco music can be adequately presented with two channels, simply bass and treble, and indeed, more channels serve only to confuse.

For two channels to act discretely, yet cover a reasonable range of frequencies, a high order of filter is required; 18dB/octave (3rd order) filters are the compromise between filters of a higher order requiring high tolerance components and lower order filters which would make even a two channel display ambiguous.

UNRELIABILITY

The most likely reason for unreliability is ignorance of the need for transient overload protection when triacs are used in mains circuits. For all its inherent reliability, the triac is easily destroyed, particularly when operated from the mains supply, where extremely high transient voltages and fault currents can be encountered. The incandescent lamp has two positively unwelcome characteristics:

(a) When power is initially applied to a lamp, a surge current an order of magnitude higher than the nominal current flows, reaching a peak after some 400µS, which lasts for up to 20mS and then dies away exponentially, reaching the nominal current level in 70mS. In an SLM, power is constantly reapplied to the lamps, hence the surge conditions are repetitive.

(b) When a lamp filament ages, it grows brittle and will eventually fracture or "blow". The sudden change of current causes arcing across the fracture, and the heat of the arc may be sufficient to ionise the nitrogen-argon mixture around the filament. The ionised gas will conduct heavily, resulting in a short circuit which lasts until the arc is extinguished. Filament failure in infrequent, but should it occur, an unprotected triac will almost certainly be destroyed. Fuses are the most practical means of protecting triacs from short circuit conditions in mains circuitry. Prior to considering fusing in detail, the most likely overload conditions will be identified; these are:

Small overload. Human error will make it inevitable in the long run that an SLM unit is overloaded. Given that the overload is highly unlikely to exceed 100 per cent, ordinary glass fuses will protect a triac.

Lamp surge. Fourteen 100W lamps at 225V will cause a 77A surge current to flow repetitively in an SLM. Any fuses used, and the triac, must be capable of withstanding this surge on a continuous basis.

Short circuit. The failure of a lamp filament can result in a short circuit and the prospective fault current is limited only by the supply impedance. Assuming worst case conditions, a current of 1,000A peak can be expected on a 30A ring circuit. Since short circuits can also occur if cables are damaged, the relative unlikelihood of filament failure causing a short circuit should not be cited as a reason for disregarding the necessity for short circuit protection.

Because semiconductor junctions can be destroyed extremely rapidly under short circuit conditions, the common glass fuses are inadequate; high speed fuses must be utilised. These have precisely defined characteristics and are capable of clearing high current faults in a matter of milliseconds.

The rapid current cut-off causes arcing and the fuse will not clear the fault until the arc is extinguished, which happens rapidly; the important point to note is that the arc voltage may be considerably greater than the mains voltage.

The fault protection arrangements in many SLMs is non-existent or pitifully inadequate. This design is protected against the aforementioned overloads.

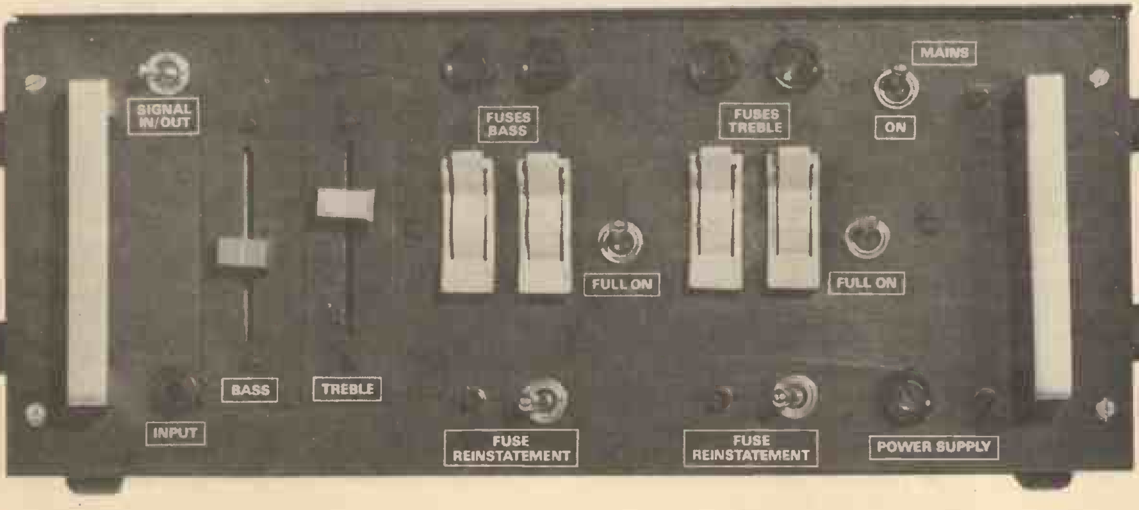
FUSE SELECTION

For adequate discotheque lighting, maximum use of a 13A outlet should be aimed at. Assuming that the minimum mains voltage is 225V, fourteen 100W lamps per channel are permissible with enough capacity to power an amplifier and discotheque console. The lamp surge current using 100W lamps will be 12·4 times the nominal, hence 77A at 225V per channel.

The fuses and triacs must withstand this surge for at least 20mS on a repetitive basis. A special anti-surge type of high speed fuse will be required. A Ferraz 600 CP-AS 10.38/12 fuse will withstand a 78A surge for 110mS. The same fuse has an I^2t of $160A^2S$ at 250V and will clear 850A r.m.s. in 2·0mS. A BTX-94 triac has a $190A^2S$ I^2t rating for this duration, and can withstand a repetitive 100A surge; hence it is suitable for the application.

Whilst the use of a 25A triac to control a 6A load smacks of gross overdesigning, it can be seen that the choice of triac is determined primarily by the available fuses, the prospective fault current and the lamp surge current.

A slow blow fuse must now be selected to protect from small overloads and to prevent catastrophic destruction of the high speed fuse which can occur when it is subjected to a steady current in excess of its nominal rating (12A in this case). Glass fuses are produced to wide tolerances, thus selection is based upon worst case samples of the fuse, and good samples may be blown. Specifically, the 5A $1\frac{1}{4}$in fuse detailed in the design will handle the 6·2A nominal load current provided it is not a fast blowing specimen. In fact, the specified fuse will comfortably protect the triac up to 80A.



TRANSIENT VOLTAGE PROTECTION

The triac must also be protected from transient voltages in excess of its rating. A compromise between an ideal yet complex transient suppression circuit (allowing low cost 400V triacs to be used) and a very high voltage triac (needing little suppression but a lot of money) is required.

To protect the triac from the majority of transients, zinc oxide voltage dependent resistors are connected across the devices. These present a high impedance to the usual mains voltage, but present a low impedance to a transient significantly in excess of the normal voltage, thereby absorbing the energy. Fortunately, transient voltages tend to have an inverse amplitude/duration characteristic, which avoids excessive VDR dissipation. Unfortunately, the highest voltage which the VDR will reduce to a safe level is dependent upon the source impedance of the transient, but in this design, transients up to several kilovolts will be clipped to below 600V by the VDR.

Two voltage transients of known amplitude can be identified. The clearing of the high speed fuses creates a 710V arc and the voltage rating of the chosen triac is selected to be in excess of this. The series inductor, used to mop up residual r.f.i., generates back e.m.f.s of the order of 400V. A capacitor in parallel with the inductor acts to define this voltage.

Finally, a CR network (snubber) is placed across the triacs to assist the operation of the VDR by limiting the rate of change of voltage at the leading edge of a transient (particularly that generated by the high speed fuse) giving the VDR time to operate.

COMPONENTS . . .

Resistors

R1	22k
R2	1M
R3	10k
R4	1k8
R5-R7	10k
R8	22k
R9	470k
R10	22k
R11	1k
R12	10k
R13	3k9
R14	150k
R15	22k
R16	22k
R17	470k
R18	1k
R19	10k
R20	1k
R21	10k
R22	10k
R23	47 10W
R24	47 10W
R25	Voltage dependent resistor (R.S. 238-457)
R26	100
R27	Voltage dependent resistor (R.S. 238-457)
R28	68
29	Voltage dependent resistor (R.S. 238-457)
R30	68

All ¼W carbon film 5% except where otherwise stated

Capacitors

C1	470n polycarbonate
C2	3n3
C3	68n
C4	180n
C5	10n
C6	10μ
C7	3n3
C8	3n3
C9	100n
C10	220n
C11	100n 1,000V
C12	100n 1,000V
C13	220n 1,000V
C14	100n 250V
C15-C16	2,200μ 40V elect
C17-C18	100n
C19-C20	470n
C21	220n 1,000V
C22	100n 1,000V
C23-C24	100n
C25-C26	250μ 25V elect

Potentiometers

VR1-VR2	10k log

Semiconductors

IC1-IC5	741C
TR1	BC184
TR2-TR3	BC337
CSR1-CSR2	C106D
CSR3-CSR4	BTX94—600U
D1-D2	BZY88C—12V
D3-D4	1N914
D5	OA91
D6	BZY88C—6V2
D7	OA91
D8	BZY88C—6V2
D9-D13	1N5401
D14	BY206
IC6	+15V, 1A regulator, 7815
IC7	−15V, 1A regulator, 7915

Inductors

L1, L2	500 turns of 19 s.w.g. enamelled copper wire layer wound on 200 × 10mm ferrite rod
T1, T2	1:1pulse transformer (R.S. 196-369) (Maplin)
T3	Mains primary: 17-0-17V 1A secondary

Miscellaneous

LP1-LP4	Mains neons
FS1, 3, 5, 7	Slow fuses 5A 1¼in
FS2, 4, 6, 8	Fast fuses Ferraz type 600-CP-AS 10.38—12A
FS9	500mA 1¼in
	1¼in panel fuseholders
	Ferraz fuseholders type SGR10
S1, S4, S6	S.p.s.t. 15A toggle
S2	D.p.s.t. 15A toggle
S3, S5	D.p.d.t. 15A toggle
	19°C/watt heatsinks (2 off)
	2·1°C/watt heatsinks (3 off)

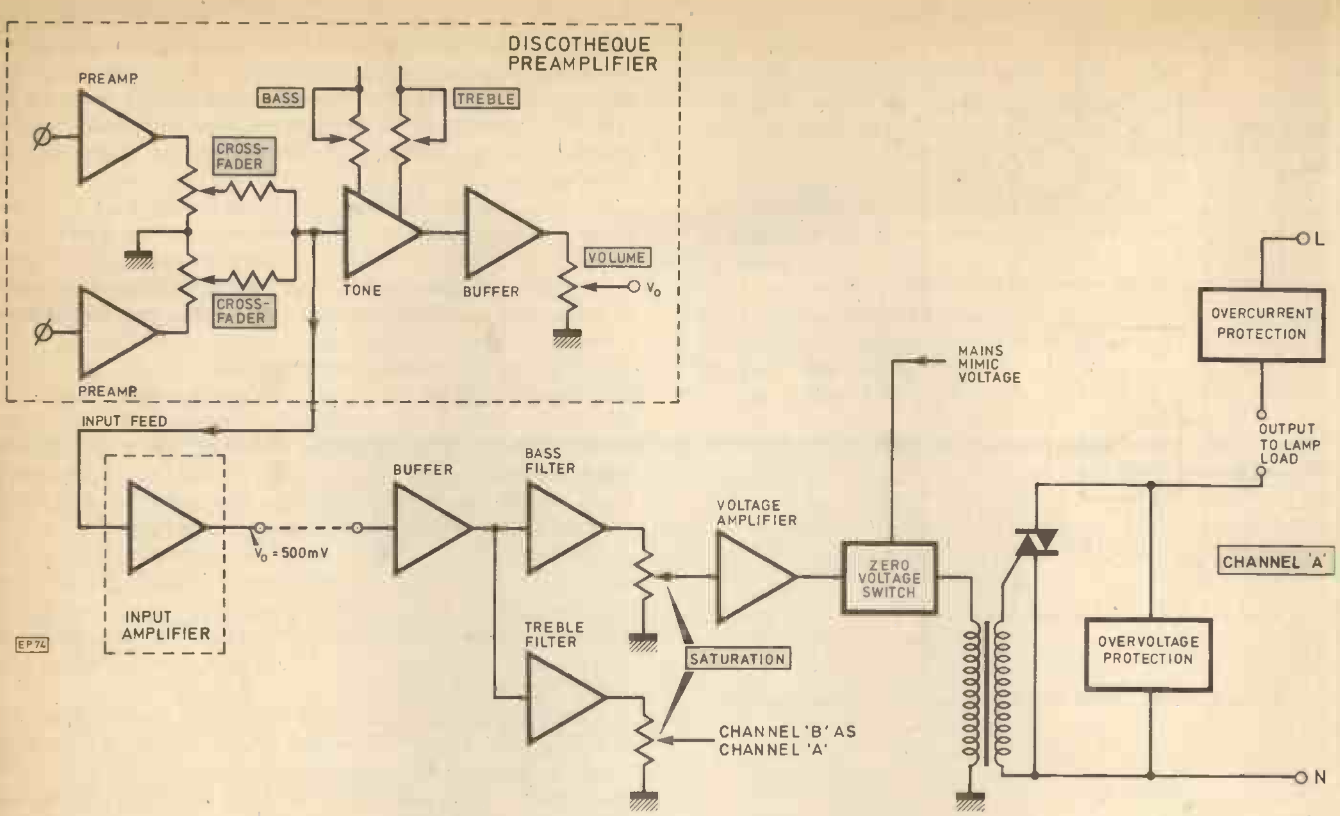


Fig. 1. Block diagram of unit and signal derivation points from typical disco console

R.F.I. APPEARING IN THE AUDIO CIRCUITRY

The use of zero voltage switching is a foregone conclusion when sensitive audio circuitry is directly connected to and in close proximity to a potential source of r.f.i. This is totally eliminated when the triacs are triggered at the zero point of the mains cycle. This is an ideal that is difficult to achieve for two reasons—first the mains voltage is at zero for a very small period of time. Electronic circuitry has a finite operating time. And second, triacs have a minimum holding current below which they will not remain in their on state after removal of the gate trigger signal. For a typical I_H value of 60mA, this implies that the mains voltage for a 1,000W load on a 250V supply must be above 3·7V for reliable triggering to occur. Even at this voltage, not insignificant r.f.i. will be generated. Additional filtering is therefore required.

A series inductor of several hundred microhenries will limit dI/dt to around 1V/µS (with the nominal load) which is considered satisfactory for reducing r.f.i. on nearby AM broadcast receivers to negligible levels. The addition of a parallel capacitor creates a −12dB/octave low pass filter with a −3dB breakpoint of around 35kHz.

If the unit is housed in a steel, or better still aluminium case, connected to a low impedance earth, and normal precautions are taken with respect to avoiding interaction between conductors carrying small signals and load currents, then to all intents and purposes, r.f.i., whilst undoubtedly occurring, can be disregarded.

INPUT AMPLIFIERS

In order to minimise r.f.i. pickup, the input sensitivity of the SLM is set at around 2V. For reasonably constant lamp saturation, the input signal must be derived prior to volume, tone or other equalisation controls on the discotheque console, mixer, etc. (Fig. 1). Here an input amplifier will normally be required, Figs. 2a, 2b and 2c. If tone or level controls precede equalisation stages, then the input amplifier must be provided with its own equalisation.

In discotheque applications, the microphone may also be required to feed the SLM, and in the case of a stereo desk, left and right channels must be mixed, Fig. 2c.

Power for the op-amps may be derived from power rails in the desk, a separate p.s.u. based on that illustrated in Fig. 4 may be provided, or the input amplifier may be powered from the SLM ±15V rails.

As a last resort, the input amplifier may be mounted inside the SLM, but particular attention must be paid to screening, which should be copper based for maximum effect at high frequencies. The source impedance of stages driving the input amplifier should be less than 20 kilohms.

If the aforementioned signal derivation is too troublesome, a 10 kilohm log pot can be wired across Fig. 3 input and 0V, the wiper connected to C1. The unit will then operate directly from speaker lines at powers of 10 to 450W into 8 ohms and half and double these powers for 16 and 4 ohm systems respectively. The SLM input is ground referenced, so care must be taken to ensure that speaker lines are correctly polarised.

The input is protected up to 60V; below this signal level excessive attenuator settings are not harmful. With this method of signal derivation the lamp saturation is now subject to changes in volume and tone control settings, but its simplicity is expedient and it makes the SLM more versatile.

SIGNAL PROCESSING CIRCUITRY

Referring to Fig. 3, C1 provides d.c. isolation. Zeners D1, D2 and diodes D3, D4 protect the unit from excessive signal input voltages, up to some 60V, in conjunction with C1 and R1.

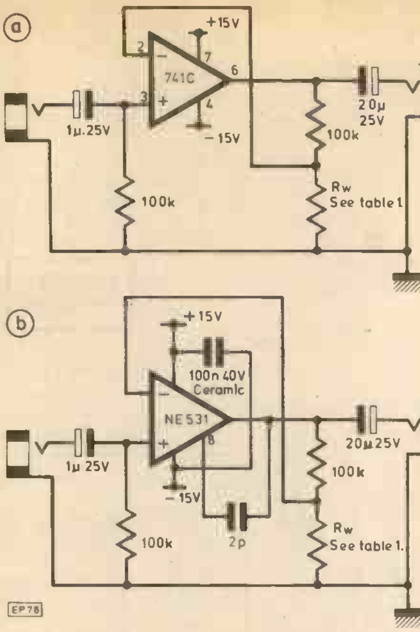


TABLE 1 MONO SOURCE		
Vin	Rw	CCT
20mV	1k	(b)
50mV	2k7	(b)
100mV	4k7	(a)
250mV	12k	(a)
500mV	22k	(a)
1V	47k	(a)

Figs. 2(a)–(b). Input amplifiers for mono music source

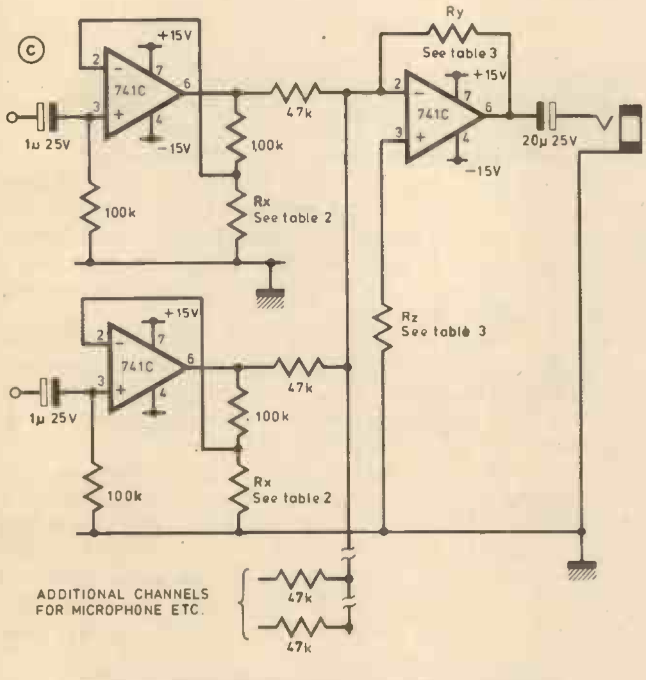


TABLE 2 MULTISOURCE		
Vin	Rx	NOTES
2mV	1k8	
10mV	10k	
20mV	22k	
50mV	47k	
100mV	OMIT	OPEN CIRCUIT
250mV	OMIT	DIVIDE Ry BY 2·5
500mV	OMIT	DIVIDE Ry BY 5

EP79

TABLE 3 MULTISOURCE		
No OF INPUTS	Ry	Rz
2	470k	22k
3	330k	15k
4	220k	12k
5	180	9k1

Fig. 2(c). Input amplifiers for multisource inputs

Switch S1 is provided to control earthing arrangements. In certain circumstances r.f.i. may be injected into sensitive audio stages, and in most cases the switch will be open to prevent earth loops. If the unit is ever operated from a floating source, however, earthing can be conveniently restored.

IC1 is a buffer-amplifier, providing a low source impedance for the filters and some voltage gain. The filters, built around IC2 and IC4 are bass and treble respectively. These are third order Butterworth types with unity gain in their passband. Their −3dB turnover frequencies are 320Hz and 3·5kHz.

VR1 and VR2 control lamp saturation.

If saturation is seriously upset when changing from 12in singles to albums, or synthesised music with excessive treble content is played, then a switched attenuator at this point can be a useful asset, since it allows rapid correction. The operator must then develop the habit of switching the attenuator when turntable speed is changed.

IC3 and IC5 are voltage amplifiers providing low impedance drive to the zero voltage switch. Zeners D6 and D8 provide a pulsating "strobelike" display, but experimentation with different Zeners or even their omission is suggested, as a lot depends upon the type of display, thermal lag of the lamps and the application.

If one channel is found to be insensitive, then resistor R8 or R15 may be increased. A doubling of value to 47 kilohms is recommended; the corresponding resistor R10 or R16 must then be changed to 10 kilohms in order to minimise offset voltages.

ZERO VOLTAGE SWITCH

A single polarity mimic of the mains voltage is derived from the unsmoothed but rectified output of the power supply. This voltage is applied to the base of TR1 (Fig. 5). When this is above 0·7V, TR1 is saturated and TR2, TR3 remain off. When the base voltage drops below 0·7V (corresponding to a mains voltage of around 11 volts), TR1 turns off and base drive is then applied to TR2 and TR3. The pulse width is around 200µS symmetrical about the zero point.

The zero crossing pulse is applied at 100Hz to the C106D anode. Two conditions must be met simultaneously for current to flow through the pulse transformer: (a) a triggering signal must be present at the gate of the thyristor, and (b), the mains voltage must be about the zero point.

The C106D thyristor has high gate sensitivity, allowing it to be triggered directly from an op-amp. Whilst pulse transformers may be easily hand wound, the use of a commercially manufactured component which can be relied upon implicitly for reliable isolation is an important safety factor.

MAINS CONTROL CIRCUITRY

Since fuses usually blow at an inconvenient time, a changeover switch is provided in Fig. 4 to allow rapid reinstatement. The blown fuses are isolated by throwing the switch, allowing safe renewal. Neons LP3, LP4 will light when a fuse blows, provided a load is connected. The high speed fuses have a ceramic body, so inspection will not reveal whether they or the glass fuses only have blown. If the glass fuses are intact, then the high speed fuses are "dead" but the reverse is not necessarily so.

The snubber networks C13, R28 and C21, R30 protects the triacs from voltage transients generated by the arcing of the high speed fuses when they clear, together with the voltage dependent resistors in parallel. Protection against mains borne transients is also ensured. C12, L1 and C22, L2

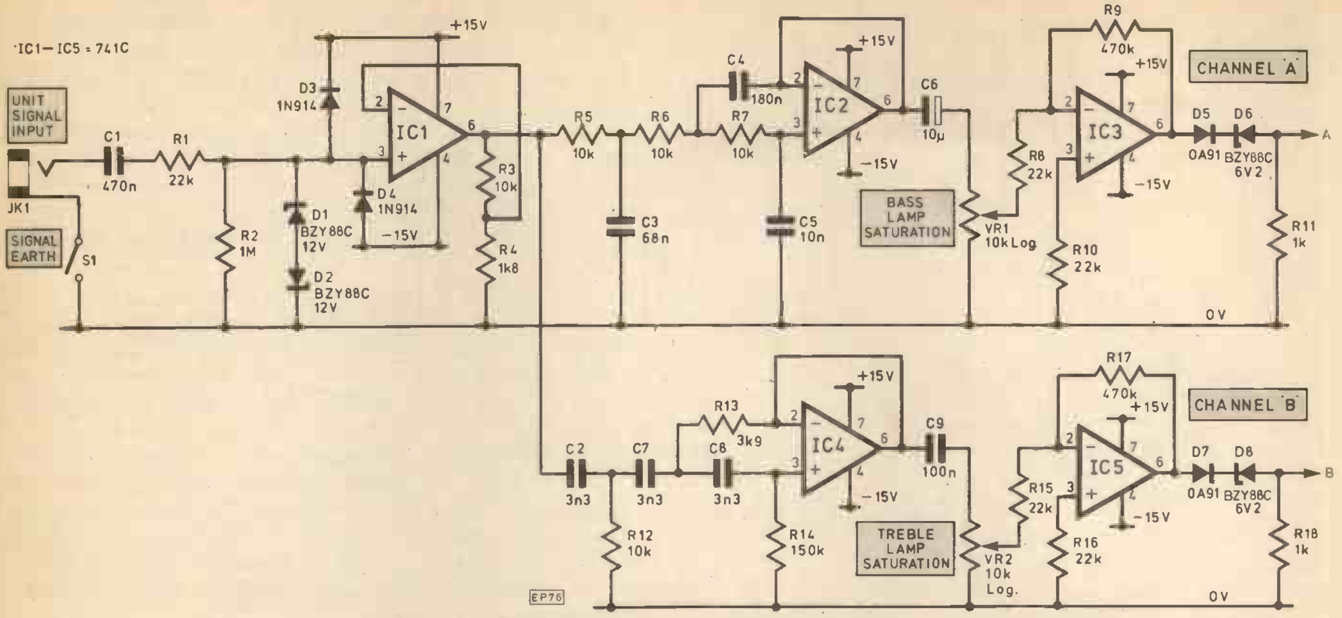


Fig. 3. Signal processing circuitry

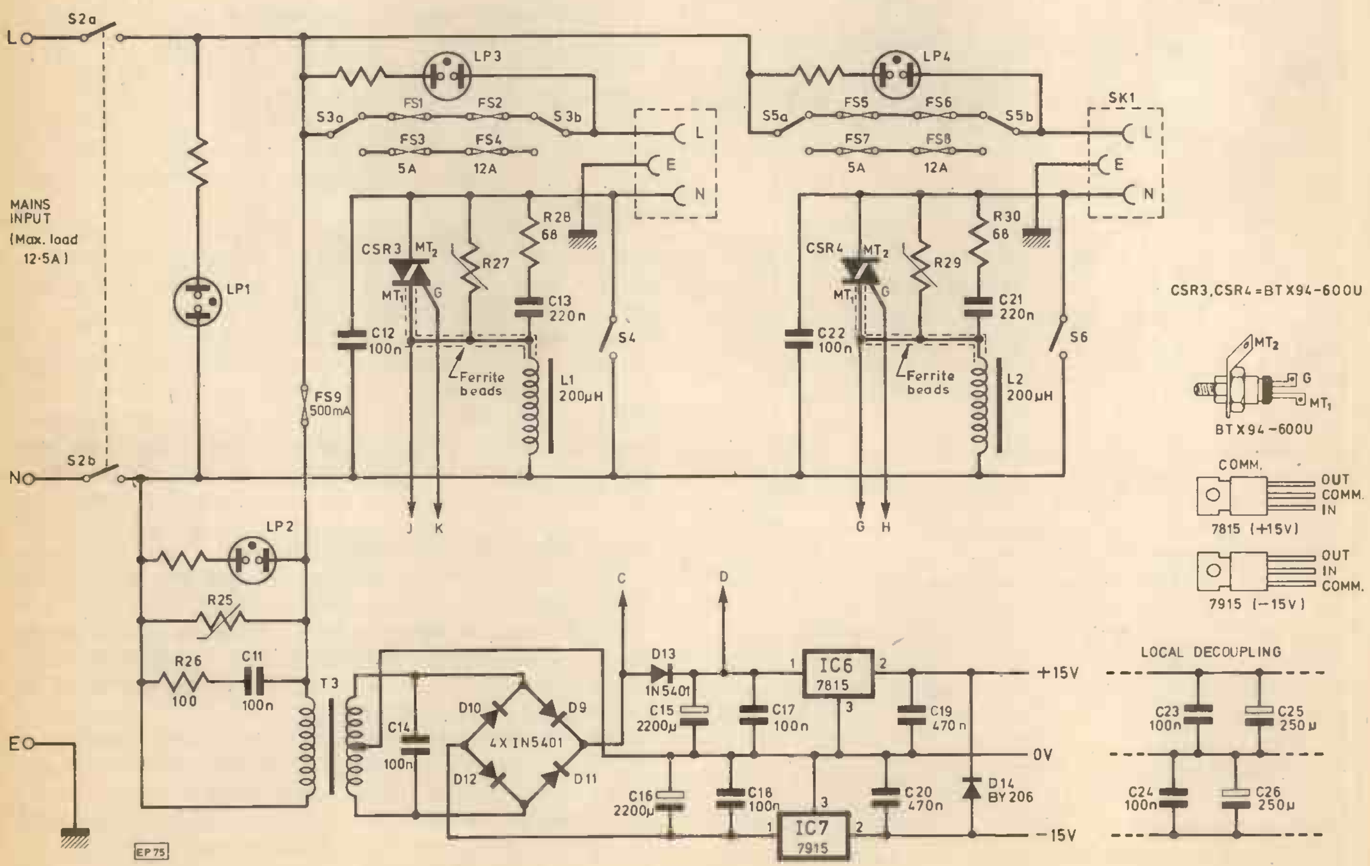


Fig. 4. Control circuitry and power supply

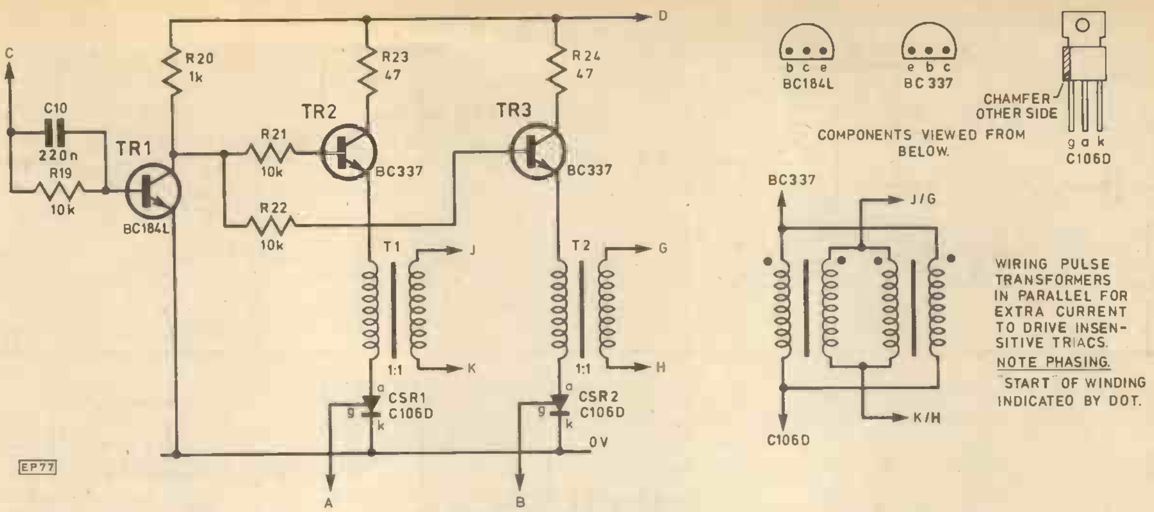
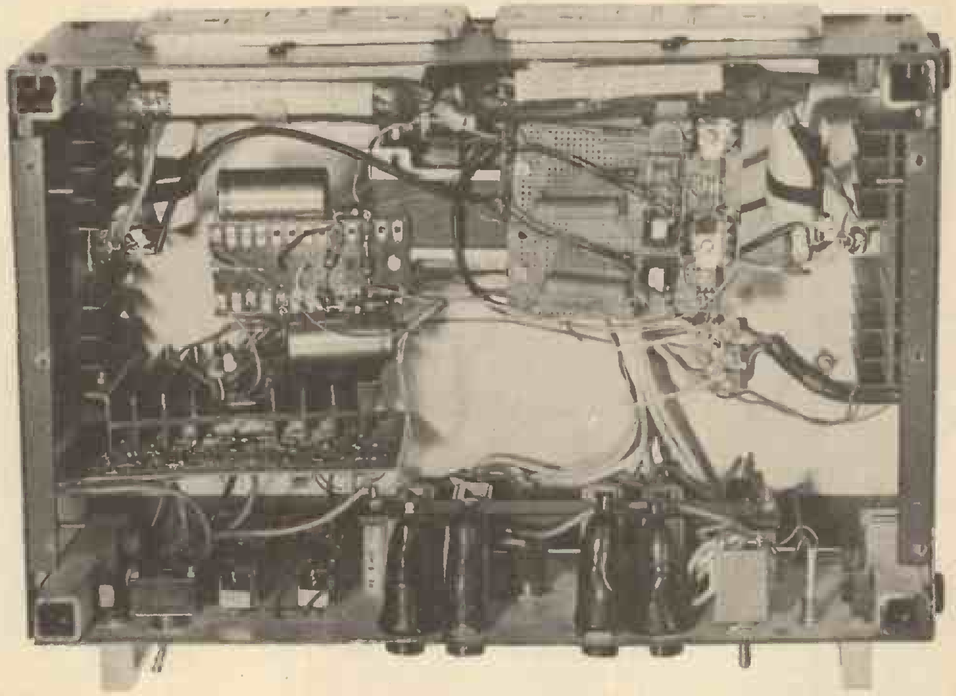


Fig. 5. Zero voltage switch



are placed so that stray capacitances do not hinder the effectiveness of the filtering.

The chokes must be wired as close as practical to the triacs, and the intermediate wire should be covered with ferrite beads (shown as dashed lines).

Mains cables, particularly those carrying the lamp current, should be kept well away from the signal circuitry. The trigger wires to the pulse transformer must be kept short, and should be tightly twisted or in a common sheath. The use of 25A triacs to control a 6A lamp load is undeniably expensive, and if reliability is to be sacrificed for the sake of cost, then 15A plastic triacs (BT 139-600) may be directly substituted. The high speed fuses may then be disregarded.

POWER SUPPLY

R25, R26 and C11 protect the regulators and signal processing circuitry from mains borne and control circuitry generated transients. Neon LP2 monitors the fuse FS9. The use of a regulated supply is essential as poor mains or transformer regulation may cause interactive effects if the op-amp's supply rails are upset. If both channels switch on simultaneously, a significant drop in mains voltage may be experienced. Also, the protection diodes D3, D4 (Fig. 3) inject supply ripple into the signal line.

Supply ripple is minimised by the use of cheap plastic regulators in place of large capacitors. The BY206 diode further suppresses this effect and allows the regulators to start under a common load.

Local decoupling is provided by 100n capacitors, preferably ceramic types, on account of their low inductance. 250µF capacitors are added to cure possible low frequency instability. Their use is particularly recommended if the supply leads are more than a few inches in length.

Next Month: Construction and setting up.

Strictly Instrumental

by K. Lenton-Smith

Transcriptions of a well-known organist's numbers are always interesting. In Harry Stoneham's case they present a definite challenge to brain and fingers as the score is spattered with fast semiquaver and triplet runs. Browsing in my local music store recently, I came across "Play Jazz Organ" containing twelve numbers arranged exactly as Harry Stoneham plays them. These include "Michael's Theme"—his composition used to play in the Parkinson show.

Certain of the numbers in this album have been recorded on l.p. discs in the past and for those that have an organ record collection these are "Hammond My Way" (Contour 2870112) and "Two Fellas to Follow" (Tepee TPRS 100). The transcriptions tally even to the key, which at least simplifies the task of learning to play the score. The album is distributed exclusively by Music Sales Ltd., 78 Newman Street, London W1P 3LA and costs £2·50.

There is a tendency to think that all organs sound the same when fast Leslie is applied but there is a decided difference between the two records mentioned, the first being on Hammond and the second on Lowrey with Automatic Orchestra Control. Harry's fingers are nimble enough but A.O.C. gives an added interest to his brilliant runs.

B-3000

New models constantly appear but the Hammond B-3000 first shown at the NAMM Exhibition in Chicago late last year deserves a special mention. Readers with greying temples will look at our illustration

and think they recognise the Hammond B-3, which was in its heyday some two or three decades ago but is now out of production though still in demand. The fabulous Ethel Smith, some may remember, featured the B-3 in playing "Tico Tico" in a film years ago: she was present at the NAMM show and no doubt the sight of Hammond's latest model brought back memories for her.

In fact, the B-3000 is the electronic equivalent of the B-3 tonewheel organ. Even the consoles are identical at first glance, but there are important differences other than the method of tone generation. Drawbars, second and third harmonic percussion and reverse-colour preset keys are as before but Grand Piano, Electric Piano and Drawbar Sustain have been added. The new organ also has a Transposer which can shift the compass up two semitones or down four.

The purist may say that this device is not necessary, but there is no doubt that playing in D_b sounds brighter than the key of C: the Transposer saves the mental problems of sorting out accidentals in a different key. "Bright Wave" drawbars are available on the lower manual "B" preset, allowing the player to select five flute pitches and/or four bright voices.

IT CLICKED

Certain new rocker tabs have been added, the most interesting being one marked "Key Clicks". This ought to bring a wry smile to the faces of constructors who have burnt gallons of midnight oil trying to eliminate key clicks—but such is the state of the art!

The Hammond's original popularity was partly due to the fact that rhythmic performers found key clicks to their liking (though erstwhile tone cabinets were designed to suppress clicks as far as possible). As the particular tab was fitted during the later stages of design, this special Hammond feature appears to be as popular as ever.

Donald Leslie heard the organ when it was on the stocks and decided that a special tone cabinet was required. The Leslie 822 was thus designed to mate with the B-3000 and provides 215W output power—sufficient for a large audience and making the installation ideal for the professional performer.

One disadvantage of the original B-3 (and indeed the C-3, A-100 and RT-3 organs) was that the preset keys required only a light touch. It was only too easy to take off the "B" preset when "smearing" the manual, so being left with no drawbars in operation—an embarrassing episode in public performance!

The new organ has a more definite preset action and it is now possible to combine several keys simultaneously for multiple combinations.

Priced at around £5000, the B-3000 does not have a rhythm unit, automatic chords or arpeggiator, but two full 61-note manuals and a 25-note pedal clavier make it suitable for playing classical *and* light music. It makes a pleasant change to be able to report that this is a real organ with the minimum of frills, ideally suited to the professional musician.

TAPE—FOR GOOD MEASURE

Many constructors never manage to learn to play the instruments they make and conversely others that can play go aground with electronic problems. Even so, there are those who are fortunately accomplished in both fields.

Whatever the level of musical ability, the best critic is oneself—heard on a tape playback. This method of self-discipline is excellent for—as the reader has probably found—the simple act of pressing the "Record" button will be followed by a number of disasters! The player is under pressure, as he would be if suddenly confronted with a public performance, but at least the tape can be scrapped: better still, the tape is used to spur the player to eradicate the problems.

These points came to the fore recently when talking to a keen young musician who agreed, but pointed out that purchasing his instrument had not left much spare cash for luxuries such as good stereo recording equipment. Having ascertained that he had a stereo amplifier and might be prepared to spend some £30, I decided to work on the project. The following notes may be of interest to anyone in a similar position.

INSERTS

The problems with home recording are not only associated with musical ability: there is also the question of clear, undistorted recording.

Our young friend lives close to both TV transmitters in London, so r.f. breakthrough had to be considered. Consquently, a pair of Grundig Electret microphone inserts were purchased for some £3. They were found to give good frequency response and did not invite a background of TV sound while in operation.

The Electret inserts have an integral FET preamplifier which requires a positive supply of between 3V and 6V, easily found from mercury cells as the current drain is small. The insert, slide switch and cells were mounted in a 6in. length of metal tube, the completed microphones being fitted with a two yard coaxial cable and miniature jackplug. Results from these microphones were far superior to the usual "dynamic" cassette types.

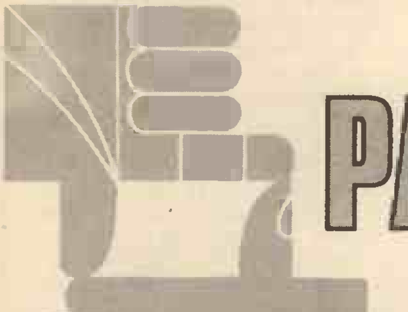
CASSETTE

Both inserts and cassette mechanisms appear in the advertisements in this magazine. Having studied the specifications, a mechanism with mated electronics, twin VU meters, high frequency erase, auto stop and CRO_2 switch was purchased.

Having too many pending jobs already, I was pleased that the work entailed (other than a cabinet) took very little time. This involved fitting a mains transformer and two other components and arranging input and output connectors for the stereo amplifier. Suitable series resistors for the high level input were found to be 100k.

The overlay panel supplied was somewhat larger than necessary and was sawn down slightly and fitted with a mains switch and pilot before it was attached to the mechanism and boxed. There was one problem with some brass studs moulded in to the underside of the top panel which were 3BA, so that 4BA nuts had to be tapped accordingly.

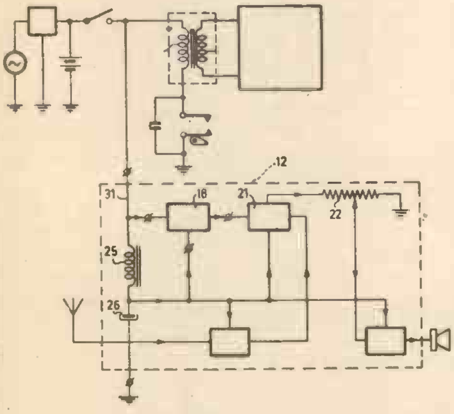
The result was a spendid little machine, fully equal to expensive counterparts. After experimenting with various microphone positions, we obtained extremely clean and accurate recordings. Given good tape—Superferric or CRO_2—there was no noticeable hiss from the i.c. circuitry, which is non-Dolby, of course. The combination of high-quality Japanese mechanism and Electret inserts should satisfy the limited budget reader. Does anyone want a quarter-track reel to reel recorder cheap?



PATENTS REVIEW...

Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

CAR RADIO A.G.C.



Philips in BP 1 522 421 patent an interesting new approach to automatic volume control for a car radio. The patent was applied for in 1975 and is granted under the old laws. As any driver knows, when vehicle speed increases, so ambient noise also increases. It thus becomes necessary to increase the radio volume to maintain audibility and programme enjoyment.

Many types of automatic speed-compensated volume controls have been proposed in which a gain control signal is derived from a sensor which monitors the engine speed. Such systems require modification and sophistication of the car electric system.

Philips aim to simplify installation by making the audio amplifier gain dependent on the output of an electronic detector which senses ignition pulse frequency.

In car radio 12 a frequency detector 18 is coupled to the car d.c. power supply and to an audio control amplifier 21. The supply line carries d.c. and ignition interference pulses; capacitor 26 prevents the d.c. reaching chassis and inductance coil 25 presents a large impedance to the pulses so that they pass to the frequency detector 18.

The detector has a threshold which is continuously readjusted to the value of the last pulse having the largest amplitude and produces a d.c. voltage of which the magnitude represents the frequency of the pulses. This d.c. voltage is fed to the control input of amplifier 21.

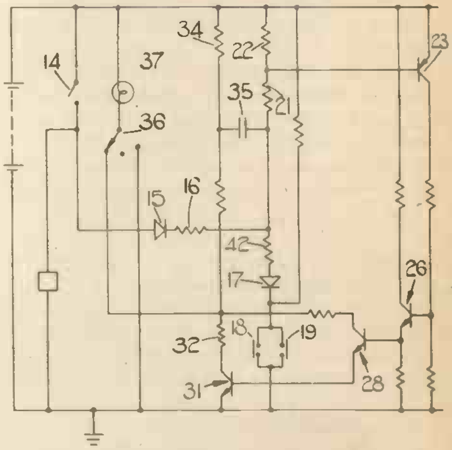
The car driver manually sets the car radio volume to a preferred level by means of a conventional control pot 22. Thereafter the signal derived at 18 from the ignition pulse rate, and thus from the engine r.p.m., controls the amplification factor at 21 to vary the audio signal level above and below the mean value set at pot 22.

In this way an increase in engine speed and ambient noise produces a compensatory increase in audio level and a drop in speed produces an audio reduction. This produces the subjective effect of constant audio level. The patent gives details of the frequency detector circuit, complete with suggested values for all components.

DELAYED COURTESY LIGHT

Lucas Electrical in BP 1 513 127 (granted on a 1974 application under the old laws) patent a simple modification of a car electrical system which keeps the courtesy light illuminated for a predetermined period after the door is closed—but only until the engine is started. Normally, of course, the lamp is switched directly on and off by opening and closing of the door.

When a door is opened, one of two switches 18, 19 closes and capacitor 35 charges through resistors 34, 42, diode 17 and the closed switch. Transistor 23 is turned on by current flow through resistors 22, 21, 42 and diode 17. Transistors 26, 28 and 31 also turn on and the courtesy lamp 37 is illuminated via a manual switch 36, resistor 32 and transistor 31.



When the car doors are closed, so that switches 18 and 19 are open, capacitor 35 discharges through resistor 21 and the base-emitter of transistor 23 to hold the transistor 23 on for a limited period of time, e.g. eight seconds. During this period transistors 26, 28, 31 are held on and the courtesy lamp remains lit.

If, after the doors have been closed and the switches 18, 19 opened, the car ignition switch 14 is closed (to start the car) the capacitor 35 discharges rapidly through diode 15 and resistor 16. The courtesy lamp 37 thus goes out almost immediately.

In this way there is no risk of the courtesy lamp remaining lit while the car is driven off.

Semiconductor UPDATE...

FEATURING : TDA 1028, TDA 1029 MC 3423

R. W. Coles

A.F. SWITCH

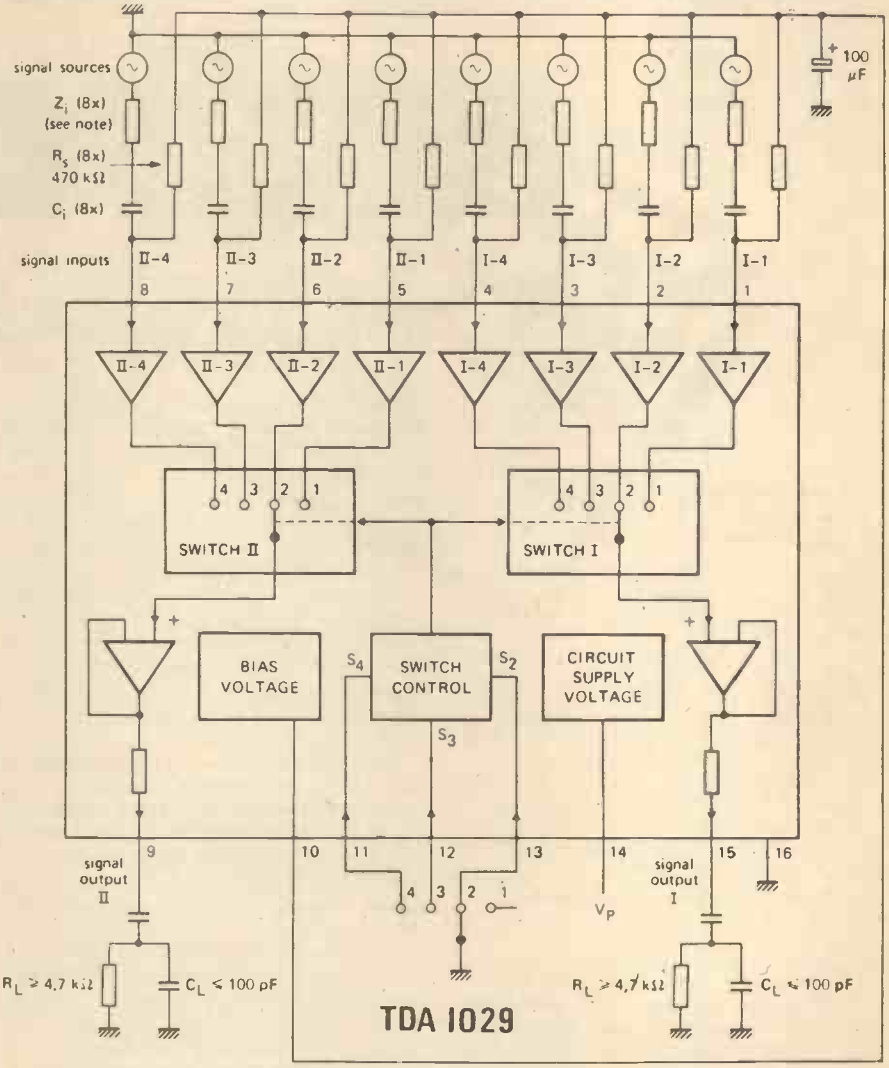
Ever had the problem of switching one of several audio signals to a common output? Traditionally, you would use a few feet of screened cable and a panel mounted switch to do the job. Of course, you would have to use a high quality switch and be very careful with your cable routing, but if the extended signal paths didn't increase cross-talk and mains hum pick-up too much, the mechanical switch solution might be quite acceptable.

More recently electronic switching has become possible. Using this method a mechanical switch is still needed, but now it carries not the signal, but what are in effect logic levels to control the electronic "business end". You could throw one of these together with a handful of op amps and an analogue multiplexer, or you may be able to lay your hands on some op amps whose outputs can be gated into a high impedance state so that the multiplexer is not needed. In either case the solution may be rather expensive and will involve several packages.

To solve the problems of both mechanical switches and the multi-package electronic switch, Mullard have introduced a couple of devices which they call "Signal Sources Switches". The **TDA 1028** and the **TDA 1029** as they have been coded, look ideal for use in audio, even hi-fidelity audio, systems. They contain, in single 16 pin d.i.l. packages, complete electronic switching systems which run from single 6–23V supplies and feature input protection by clamp diodes together with full output short circuit protection. The TDA 1028 consists of two, two-pole, two-way switches, which means that it has eight input lines and four output lines which are controlled in pairs by two "Switch Control" inputs. The TDA 1029 consists of one, two pole, four-way switch, so it has eight inputs and two outputs controlled by three "Switch Control" input lines. (A fourth control line is not needed because with the three control lines floating, channel one is automatically selected.)

The typical specifications for these devices look good. Over the 20Hz to 20kHz band, the r.m.s. output noise voltage is only 5μV, and a 5V input signal in the same band suffers only 0·04 per cent total distortion. Amplitude response across the band is within 0·1dB, and at 1kHz crosstalk between inputs is 75dB down.

Apart from use as stereo quad switches, these devices would seem ideal for use in disco systems and synthesisers etc.



CROWBAR

Ever had the experience of a voltage spike on the supply rail which ruins your delicate i.c.s? What you need is a *crowbar*. (No, not to smash up the errant power supply you idiot!)

A crowbar is usually formed by using an SCR connected between the raw d.c. supply and ground. When an overvoltage condition is sensed, the crowbar SCR is triggered and the resulting short circuit causes an immediate drop in the voltage supply, followed by a blown fuse within a few tens of milliseconds for a more permanent solution!

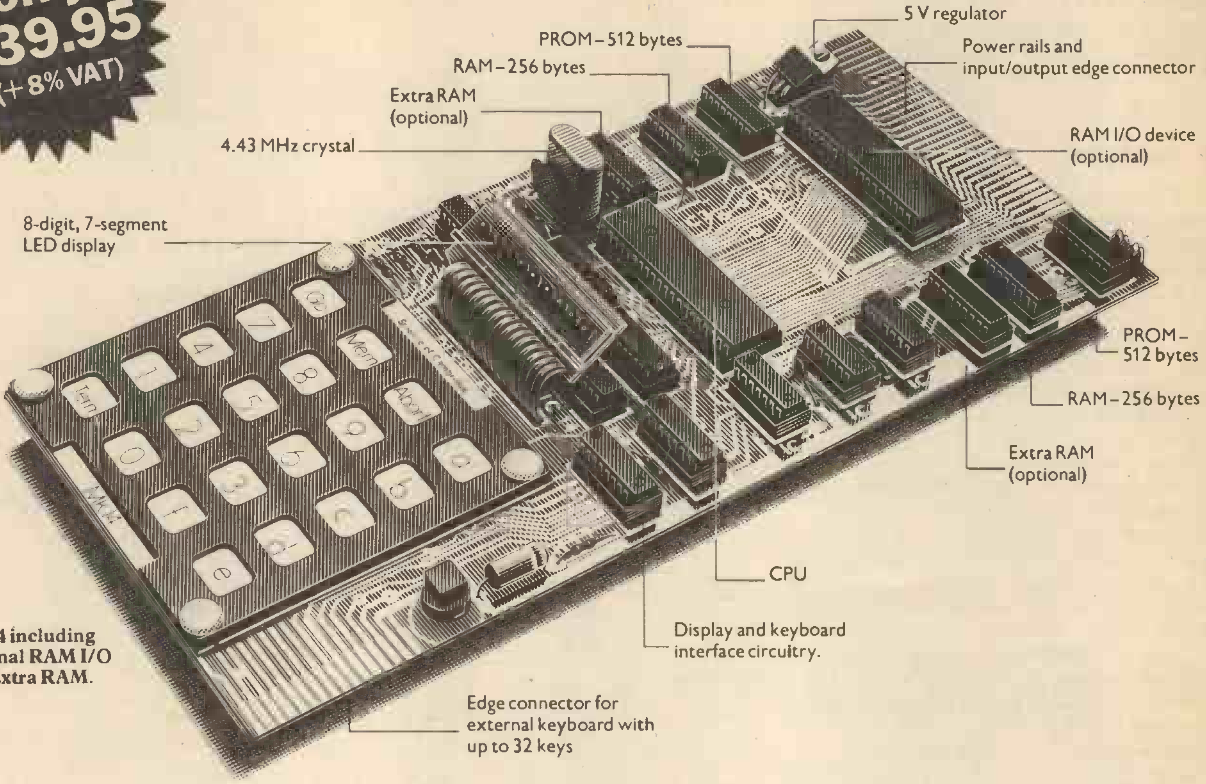
The SCR part of a crowbar is simple. The difficult bit is sensing an overvoltage and generating the necessary trigger pulse, two jobs done very well by a new device from Texas Instruments, coded **MC 3423.**

The MC 3423 lives in an 8 pin mini-chip package and contains a voltage reference and a comparator, together with output drive transistors for (a) the SCR gate and (b) an indicator lamp or l.e.d. which must be fed from a separate supply.

The indicator is necessary because it shows the unlucky user just *what* has gone wrong. Without it, he would just have to suck his thumb while the wisp of smoke from the fuse drifted skywards!

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only £39.95 (+8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

More memory – and peripherals!

Optional extras include:

1. Extra RAM – 256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB) giving further 128 bytes of RAM.
3. Low-cost cassette interface module – which means you can use ordinary tape cassettes/ recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

• Hexadecimal keyboard • 8-digit, 7-segment LED display • 8 x 512 PROM, containing monitor program and interface instructions • 256 bytes of RAM • 4 MHz crystal • 5 V regulator • Single 8 V power supply • Space available for extra 256-byte RAM and 16 port I/O • Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

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Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

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Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Please send me the following, plus details of other peripherals:

☐ MK 14 Standard Microcomputer Kit @ £43.55 (inc 40p p&p.)
☐ Extra RAM @ £3.88 (inc p&p.)
☐ RAM I/O device @ £8.42 (inc p&p.)

I enclose cheque/money order/PO for £__________(indicate total amount.)

Name____________________

Address (please print)____________________

PE 5 Allow 21 days for delivery.

Science of Cambridge

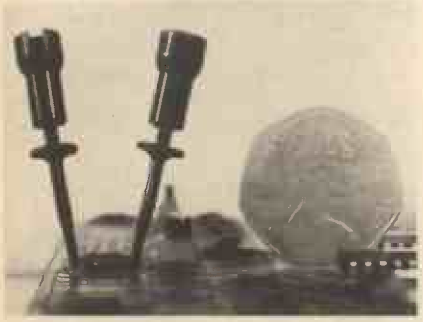
Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by Alan Turpin and David Shortland

GETTING HOOKED

This micro hook is ideal for test hook ups to i.c.s. Weighing less than one gram it will not damage an i.c. leg while remaining tenaciously attached.



Overall length of the hook is 1·75in and it operates with a "hypodermic" action.

Available ex-stock in ten colours the price is 62p plus VAT and p&p. Cash with order, otherwise minimum order charge £10. Trade enquiries invited.

Special Products Division, British Central Electrical Co. Ltd., Briticent House, New Street, Ringwood, Hants. (04254 4611).

FOR MAINLINE READ ARROW

Arrow Electronics, makers of the "Leader" range of kits, have acquired the entire stock of Mainline Electronics, previously suppliers of amplifiers, audio equipment spares, semiconductors and components.

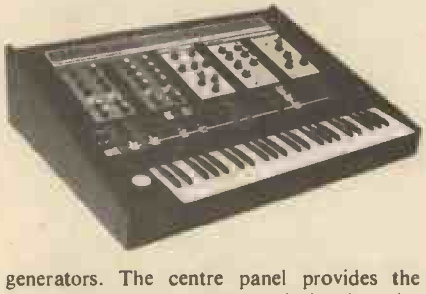
It is thought that production of the Mainline amplifiers will be continued and merged with Arrow's existing range of "Leader" kits.

Arrow Electronics Ltd., Leader House, Coptfold Road, Brentwood, Essex CM14 4BN (0277 219435).

PRETTY POLY

A new live performance synthesiser employing patch switching has just been introduced by EMS. Named the Polysynthi this colourful instrument has a four octave keyboard but can cover nine octaves in six overlapping ranges. Tuning is claimed as completely stable.

Outputs from the instrument are polyphonic, pressure dependent control and position dependent control. The first control relates to pressure applied to the keyboard and the second to the highest note played. Their voltages can be routed to external devices. In the photograph the left two panels control the envelope follower, two voltage controlled l.f. oscillators and two ADSR envelope



generators. The centre panel provides the sound source; pulse, square and triangle; noise generator and external input. These can be mixed in any proportion. The two right-hand sections contain the treatment with two and four pole filters and a v.c.a. Included is an analogue delay line with voltage control of delay and with variable feedback and mix. The analogue delay line can be used for echo, reverberation, chorus and flanging. The instrument is expected to retail for around £1,000.

Electronic Music Studios (London) Ltd., The Priory, Great Milton, Oxford.

DIGITAL BREADBOARD

The Powerace 102 is a complete circuit building system that allows prototyping and experimentation without the use of a soldering iron. With a regulated 5V power supply built in, the unit has been designed specifically for digital work. Two breadboard strips allow i.c.s and/or discrete components to be plugged in directly. Both strips have a matrix of 256 terminals each with five interconnected contacts.

The distribution system comprises 16 buses each consisting of 25 electrically connected contacts. These buses may be patched around

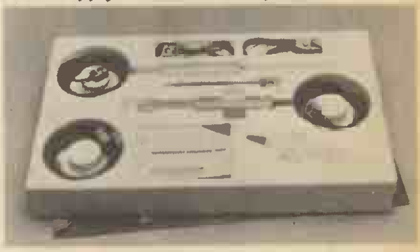
or jumpered together in any combination to provide unique or common functions, such as voltage and ground lines, reset lines, clock lines and shift command.

Other built-in features include pulse detection (100ns high or low selection); two logic switches with debounce circuitry; four data switches (logic 1 or 0); logic indicators (3 buffered l.e.d.s); clock generator offering 1Hz, 10Hz, 100Hz, 1kHz, 10kHz and 100kHz O/Ps; and/or one-shot (7ms, Q or $\bar{Q}$)—both Q and $\bar{Q}$ can source 400μA and sink 15mA.

The price of the Powerace 102 is £105 inc. VAT and p&p. For further details contact **Lektrokit Limited, Sutton Industrial Park, London Road, Earley, Reading, Berks RG6 1AZ (0734 669116).**

THERMOCOUPLE PROBE KIT

This kit by Comark comprises—a surface probe for medium to large surfaces, with a spring loaded tip enclosed in a ceramic sheath to minimise air current errors, measuring with good repeatability to +750°C; two fast response bead thermocouples with an operating range from −100°C to +250°C; a needle probe handling from −100°C to +600°C; a thermocouple adaptor lead; a two metre extension lead; a quantity of thermally conductive compound packed in a syringe; and a supply of self-adhesive pads.



Price inc. of VAT and carriage is £53·46.

Comark Electronics Ltd., Brookside Avenue, Rustington, Sussex BN16 3LF (09062 71911).

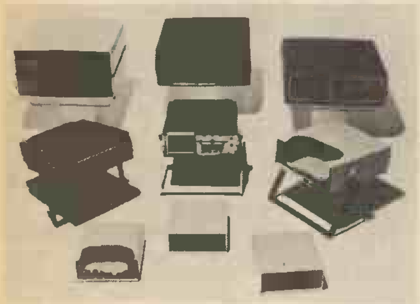
Market Place

AT THE ALL-ELECTRONICS SHOW

Two hundred and six stands, a warm dry atmosphere, and beer at 90p a pint, that was the prospect on entering the Grosvenor House Hotel, Park Lane, on the 27th of February. The exhibition was sponsored by New Electronics and well organised by the Evan Steadman Communications Group.

SMART CASES RULE—OK

Proven in use in the U.S. of A. these project cases by OK Machine and Tool are what any self respecting project builder should be treating himself (herself) to as soon as a circuit idea has been breadboarded and a layout size



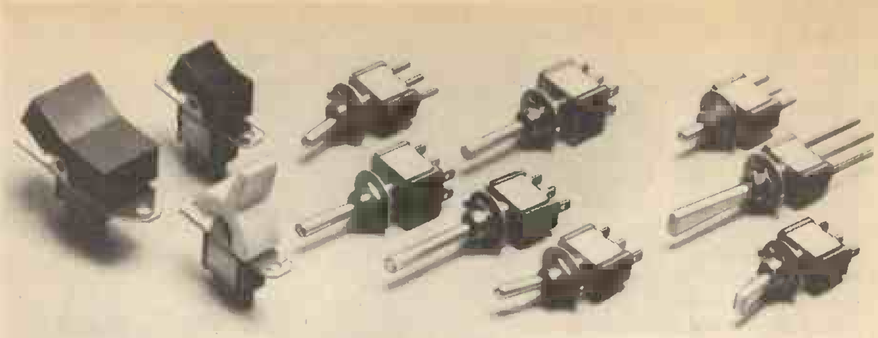
is known. They are available in several widths, heights, and depths in beige, blue or black. The 3mm ABS mouldings incorporate vertical circuit board guides in 11 places, and handles and tilt leg stands are options.

Pac Tec "C" series, from £5·33 by OK Machine & Tool (UK) Ltd., 48a The Avenue, Southampton, Hants SO1 2SY (0703 38966). Trade enquiries invited.

NO SHORTS

With a smart case to house your project what better next than to lash out on a completely new pair of pliers with an off-cut retaining device specially designed to prevent the inevitable short in the hidden areas beneath i.c.s.

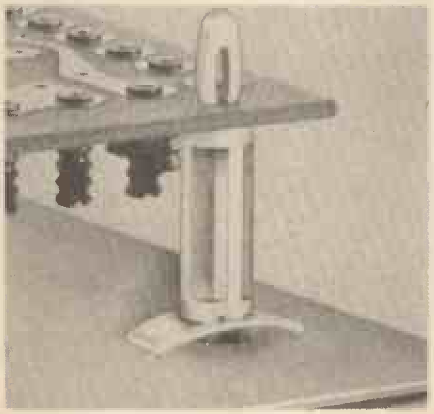
The Swedish company Bahco make a useful range of high quality cutters and pliers, and the 2131 electronics pliers shown are the result of a detailed international survey of industrial users requirements. They have a new design of return spring and the handles are nice and wide. The jaws are available single or double bevelled. These cutters retail at £6·38 plus VAT and Bahco tools are widely available.



TOGGLES, ROCKERS 'N' LEVERS

Pye Electro-Devices have introduced a range of miniature switches; toggle, rocker and lever switches with conventional terminals, wire-wrap or p.c.b. mountable terminals; p.c.b. mountable toggle switches with terminals bent at 90°; p.c.b. mountable toggle, rocker and lever switches with support brackets. Pye are also making an offer you cannot refuse—a sample pack of five different switches at a special introductory price of £2 post free. With a number of types giving thousands of combinations they are obviously not able to select five switches of your choice but the pack has been made up of the most commonly used types and includes one rocker, one lever, and one p.c.b. mountable with edge actuation. This is a limited offer so check availability by phone first. No order required.

Pye Electro-Devices Ltd., Exning Road, Newmarket, Suffolk CB8 0AX (0638 5161).



SUPPORT YOUR P.C.B.s

Are you still fiddling about with nuts, bolts and spacers to support your p.c.b.s and running into the snag of having to avoid any track being close to mounting metal? Nylon circuit board supports are the answer—quick to fix, boards easily lifted off for fault finding, no chance of shorts.

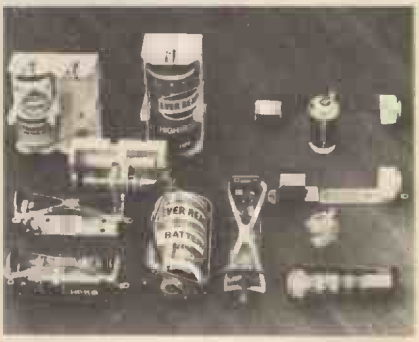
From Chicago, the Richco Plastic Company manufactures fasteners for industry and their stock includes a range of p.c.b. supports; spacers; circuit board guides; wire saddles; cable and wiring accessories; round and flat cable clamps; clips; bushings; extrusions; nylon rivets; circuit board ejectors and pullers.

Mainly a supplier to industry, with a £10 min. order, you may be able to get samples. Stand off distances are from 5 to 22mm. Or persuade your component supplier to stock.

Richco, Universal House, 10a Gilbert Road, Belvedere, Kent DA17 5DA (032 24 47227). Trade enquiries invited.

HOLD 'EM DOWN

One of the most common poorly secured parts inside project boxes which arrive at the P.E. offices is the battery, often wedged in one corner with a piece of cardboard, taped to the side of the box, or even just left to rattle around. The difficulty is to hold the thing firm while still allowing it to be replaced easily. Double sided sticky pads are an ingenious quick fix solution but for bother free replacement times a properly designed mechanical device gives a professional finish.



The holders shown secure those most difficult of d.c. sources, the single cylindrical cell. If more than one cell is needed the nylon holders are easily interlocked to form an array.

Cambion Electronic Products Ltd., Castleton, Sheffield S30 2WR (0433 20831). Trade enquiries invited.

WHEN TWINS ARE WELCOME

The Weir range of Twinpack power supplies contains three models: 0–30V @ 1A, 0–30V @ 2A and 0–60V @ 1A. A current limiting circuit enables the user to set the

current limit to any value from the rated minimum down to zero. Prices, £150–£180.

Weir Instrumentation Ltd., Durban Road, Bognor Regis, Sussex PO22 9RW (02433 26611).

Having built your project go to the next page to find a suitable DMM for testing and fault finding, if you're not already constructing our Autoranging DMM.

The All Electronics Show had a wide range of digital multimeters on display with Gould Electronics launching their Advance Alpha IV, a 3½ digit unit using liquid crystal display. This is their first Alpha type multimeter to feature a l.c.d. and it is claimed that the battery life is increased from 8 hrs. (using the l.e.d. display) up to 400 hrs. The Alpha IV has a basic accuracy of 0·2 per cent. The large liquid crystal display gives automatic indication of decimal point position, polarity and over-range. The instrument normally operates from four "C" cells, but a mains/battery eliminator option is also available.

A total of 25 measurement ranges are provided, covering d.c. voltage measurements from 200mV to 1kV, a.c. voltages from 200mV to 750V r.m.s., d.c. and a.c. currents from 200µA to 2A, and resistances from 200Ω to 2MΩ. Maximum resolution is 100µV, 100nA and 100mΩ. The unit is supplied complete with test leads, a handbook and a set of batteries. Optional accessories include the battery eliminator unit, a high-voltage probe and a carrying case. The price of the Alpha IV is £105 plus VAT, from **Gould Instruments Division, Roebuck Road, Hainault, Essex 1G6 3UE (01-500 1000).**

BACH-SIMPSON

The Bach-Simpson 463 has a 3½ digit 0·5in. l.c.d. display with push button selection of all ranges and functions.

The instrument has 26 ranges, 5 d.c. up to 1kV, 5 a.c. up to 600V, 6 resistance up to 20MΩ, 5 a.c. and d.c. current ranges up to 2A, with an accuracy of 0·2 per cent on d.c. voltage ranges.

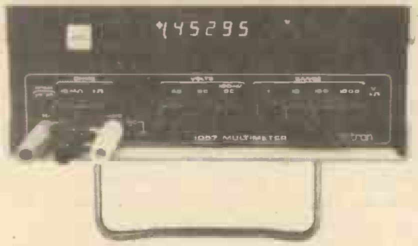
The 463 is supplied with alkaline batteries which enable 200hrs of continuous operation. An automatic indicator gives a warning of low battery condition. The cost of the 463 is £125 plus VAT and carriage.

Bach-Simpson (UK) Limited, Trenant Industrial Estate, Wadebridge, Cornwall PL27 6HD (020881 2031).

5½ DIGIT

The Datron 1057 is a high quality multimeter with a 5½ digit display offering a scale length of 199,999. This enables d.c. measurements to be made to an accuracy of 0·01 per cent.

The instrument has 5 d.c. voltage ranges (0–1,000V), 4 a.c. voltage ranges (0–700V) and 5 resistance ranges (0–20MΩ). A 1kV peak can be applied continuously to any a.c. or d.c. voltage range and up to 250V r.m.s. on



any resistance range without damage.

The price of the 1057 is £650 plus VAT and a current shunt set is available as an optional extra for £150.

Datron Electronics Limited, Hurricane Way, Norwich Airport, Norwich NR6 6JB (0603 404824).

LAWTRONICS

The Lawtronics range of LM Multimeters feature four l.e.d. models (3, 3½ and two 4 digit) and two l.c.d. (3 and 3½ digit) models. All six models have 21 ranges and are housed in the same size case (48 × 68 × 100mm) making them ideal for field work.

The l.e.d. models are supplied with rechargeable cells and a mains adaptor whereas with the l.c.d. models they are an optional extra. Other extras include a high voltage probe (45kV), leather carrying case and a panel mounted flange case to replace the tilt stand. The prices of the LM range vary from £81 to £195 plus VAT and p&p.

Lawtronics Limited, 139 High Street, Edenbridge, Kent TN8 5AX (0732 865191).

ANALOGUE/DIGITAL?

If you have ever unsuccessfully tried to decide between an analogue or digital system then the Normameter D could be your ideal choice of multimeter. This instrument combines the advantages of both the digital and analogue display in one unit.

The 3½ digit display allows exact readings to be taken whilst the analogue display shows the changing state of quantities being measured. The digital unit has a maximum settling time for d.c. quantities of 2 secs. A storage circuit is used for smoothness of operation with digits changing only after an integration period. The display can be fixed

and released at anytime by operation of a storage key without affecting the analogue display.

At the back of the instrument there is a 24 pole socket for connection to a printer. The cost of this schizoid multimeter (£462 plus VAT) might well help you make up your mind.

Cropico Ltd., Hampton Road, Croydon, Surrey CR9 2RU (01-684 4025).

FARNELL

Although not at the Show, the Data Precision 935 DMM which is being distributed by Farnell is well worth including in this review. The 935 is a high performance low cost meter designed for field use with all the range and function switches mounted to one side to allow single handed operation leaving the other hand free to use the probe.

With a 3½ digit 0·5in. liquid crystal display, the 935 has 29 ranges for d.c. or a.c. voltage/current and a high (2·8V) and low (250mV) resistance range.

Calibration is guaranteed for one year and full protection for over voltage, overcurrent and high voltage transients is provided. All resistance ranges will tolerate 500V r.m.s. or d.c. without damage or loss of accuracy. A standard PP3 battery will power the 935 for over 200 hrs or an a.c. adaptor is available as an optional extra.

The £99 plus VAT price includes test leads, battery, instruction manual and a one year guarantee.

Farnell International Instruments Ltd., Sandbeck Way, Wetherby, West Yorkshire LS22 4DH (0937 63541).

FRANK W. HYDE

CANADA

New frontiers are available to the Anik-B, the communications satellite put into orbit by the National Aeronautics Space Administration of America on behalf of neighbour Canada. The launch in December by a Delta 3914 was a first for the new self-correcting guidance system. The satellite weighs about a ton and is in a geostationary orbit. The altitude is 22,300 miles at a longitude of 109°W. The satellite can reach the whole of Canada from coast to coast and from the United States border to 75°N latitude. Beyond this the curvature of the Earth limits the usefulness of the vehicle. It brings Resolute on Cornwallis Island within the area covered. Resolute is about 210 miles East of the north magnetic pole.

The satellite was built for Canada by RCA-Astro-Electronics and is reported to be the most powerful satellite for domestic use of telecommunications. Anik-B has 12 channels in the 6-4GHz band and six in the more powerful band of 14-12GHz. Telesat, which is the corporation that operates the Canadian communication satellite system, paid 20M dollars for the satellite itself and another 20M dollars for the launch facilities.

The name Anik has been used for the whole series of satellites, Anik-A in 1972 and another in 1973 have been extremely successful. The word Anik is Eskimo for brother and is aptly applied, for the system has brought together all the scattered places of the second largest country in the world. With the advent of Anik-B, specific targets can be reached, even urban areas can be included without danger of interference. The terminal receivers can use smaller aerials (which means also cheaper) than those that were required for the first two satellites.

The channels are divided between the Canadian Department of Communications and the Canadian Broadcasting Company. The Department of Communications has leased four high frequency channels in order to test a number of educational and social service schemes. These will be beamed towards professional organisations in the cities as well as to remote areas. It seems that Canada is to implement the most ambitious and advanced programme ever attempted by the use of satellites. Health and Education, which includes the extension of such services to the Eskimo settlements in the far north, will include also the teaching of English as a second language.

The launch of Anik-B was witnessed by a contingent from the People's Republic of China. The contingent, including 35 trainee astronauts, came to inspect the launch facilities. They have already begun negotiations for a satellite communications system which would be put into orbit by shuttle in 1980. The Canadian Minister for Communications, Jeanne Suave, examined the launch facilities but admitted that she was also considering the European Space Agency's "Ariane" rocket launcher for future payloads as well as the shuttle facilities. This will probably depend largely on price requirements.

MORE ABOUT VENUS

The unique Venus expedition with its multiple vehicles is now answering some questions, but posing others. Some of the questions were answered before the probes entered the Venusian atmosphere. A number of questions were to the point before the mission, and these were based on previous missions, both American and Russian. The amount of scientific covering was extensive when the two Nations entered the vicinity of the planet with almost simultaneous missions. Much data had been received from the previous Russian landers and those from the USA. Some of those questions are answered and more will be in the months to come.

One important result of this mission was that the probes offered detailed information about the atmosphere supplementing that already available from the earlier Russian missions. Venus has no magnetic field in the sense that the Earth has; what does exist is very small, if any at all. Yet the effect of the solar wind is similar to that on the Earth. The bow shock wave which is set up in the Earth's atmosphere when the solar wind presses on the magnetosphere, appeared also in the atmosphere on Venus. This occurred at some 750 miles above the surface of the planet. It is clear that the solar wind induces a magnetic field in the ionosphere. The shock area is the barrier to the electrons and protons of the solar wind. The strong magnetic field was apparent at the height of 750 miles. The energy involved by the leakage of some of the particles beyond the shock wave would be sufficient to heat up the atmosphere. The temperatures involved could reach 5,000°K.

The Orbiter spacecraft verified previous suggestions that the level of the ionopause varies in height according to the speed of the solar wind. The first week of observations by the Orbiter indicated a falling speed of the solar wind from 300 miles/second to 155 miles/second. The consequence of this was that the ionopause rose from 155 miles to 930 miles. This sort of change means that the level of the ionopause is very sensitive, so much so that if there is an eruption such as a flare on the Sun then the conditions in the atmosphere would very rapidly change.

It so happened that during the first week of the orbiter monitoring there was a flare. This resulted in an increase of the solar wind speed to nearly 400 miles/second. The ionopause was flattened and was only 155 miles above the surface of the planet. The temperature of the atmosphere has an interesting gradient. It was measured to be 27°C at 155 miles down to −90°C at 60 miles then increasing to 450°C at the surface.

In spite of the high temperature the presence of swamps and vegetation beloved of science fiction is not possible, for it would seem that most of any water that may have existed at an earlier date has now gone. This is deduced from the fact that very little hydrogen is now escaping, which would indicate that the loss of water has been completed. However, there is evidence that there was water in abundance but that it circulated in the atmosphere and was, by the action of ultraviolet radiation, disassociated and lost from the planet.

It is a peculiar world from the human point of view. It is not possible to see the Sun or even be sure where it is in the sky (sic). Visibility on the surface is about 1·8 miles but everything is red in colour. For the most part it would appear to be almost flat everywhere but at one place there was revealed a strip about 75 miles wide which showed an elevation of 10,000 feet. There is a tremendous amount of dust. This was revealed by the toppling of one of the probes which sent up a cloud of dust which took some minutes to settle. On the whole the terrain so far seems to be like Earth and not at all like the Moon, Mercury or Mars.

SKYLAB

The problem of the demise of Skylab has occupied space engineers for some time now. The dangers were headlined far and wide in spite of the factual reports from NASA. The space experts have been very conscious of the hazards. The space station weighs some 85 tons and in burning up during the final descent there could be about 400 or 500 pieces. Most of them would provide no more than a very magnificent firework display. There is then left the major hazard of two possibly large pieces that would survive. These could weigh around two tons.

To reduce this hazard mission controllers have adjusted the station's orbit so that there is more control over the path of re-entry when the atmospheric drag takes effect. To this end a signal was sent to Skylab to command a change in attitude. This attitude will ensure that the solar panels will continue to absorb power from the Sun. An official stated that there will be enough electrical power to make some control possible down to the last moment. This control could be in action for perhaps two orbits. By firing the small thrusters it may be possible to ensure that it is a "splash down" and thus avoid damage to property. The major part of the debris will be harmless, it is the large pieces that are cause for concern. Since they are potentially dangerous should they fall on land that is inhabited, every effort will be made to avoid this.

GROWTH OF SATELLITE COMMUNICATIONS

At the end of 1968 revenues from satellite communication services had reached some 420M dollars. The growth rate is such that the US market research organisation, Creative Strategies International, has forecast that the revenue by 1983 will reach one billion dollars. This is only part of a number of forecasts in the journal *Satellite Communications*.

News Briefs

COUNTDOWN

Third International Symposium and Technical Exhibition of Electromagnetic Compatibility—May 1–3. Rotterdam. Details: Mr. R. E. Gerritson (070) 906 800.

Compec Europe—May 10. Centre International Rogier, Brussels. Details: 01-261-8437/8.

Welsh Amateur Radio, TV, Electronics and Computer Exhibition.—Sunday, May 20. Barry Memorial Hall. There will be trade, and bring-and-buy stands. Further details: Reg Rowles on 0222-565656.

Midlands Breadboard—May 23–26. Bingley Hall, Birmingham. Details: Trident.

Intel Fair—June 11, 1979. Wembley Conference Centre. Details to be announced.

Transducer 79 + Testmex 79—June 19–21. Wembley Conference Centre. Details: Trident.

Great British Electronics Bazaar—June 28–29, 1979. Alexandra Palace, London. Details: 0799 22612.

1979 Microcomputer Show (incorporating the DIY Computer Fair) — July 5–7. Bloomsbury Centre Hotel. London. Will include seminars. Further details: Online Conferences Ltd. Tel: Uxbridge (0895) 39262.

Harrogate International Festival of Sound—August 18–19 (public), August 20–21 (trade) 1979. The Exhibition Centre + hotels. Details: Exhibition and Conference Services Ltd., Tel. 0423 62677.

Telecom '79—Sept. 20–26. Palais des Expositions, Geneve. Details: Secretariat Telecom '79, Orgexpo, 18 Quai Ernest-Ansermet, Case Postale 65, CH-1211, Geneve 4 (Suisse).

Eltro Hobby '79—October 3-7. Killesberg Exhibition Grounds, Stuttgart. Details: 01-236-0911.

Compec—November 6-8, 1979. Grand Hall Olympia, London. Details: Iliffe Promotions Ltd. Tel: 01-261-8437/8

Electronics 79—November 20–23. Olympia, London. Details: 021 705 6707.

Breadboard 79—December 4–8. Royal Horticultural Halls, Westminster. Details: Trident International Exhibitions. Tel. 0822 4671.

The next **All-Electronics show** will take place over the period April 29–May 1, 1980. Grosvenor House will again be the venue. Organisers are The Evan Steadman Communication Group. Details: 0799-22612.

HIGHER SPEED, LOWER POWER TTL

TWO new third generation series of computer logic i.c.s have been announced by Texas Instruments Incorporated. They are advanced Schottley series SN74AS and advanced low power Schottley series SN74ALS. The high speed advanced series are designed for computer applications and systems that achieve efficiency through high speed switching capability. The SN74ALS series are intended for minicomputers, terminals and other electronic office equipment in which lower power consumption rather than high speeds improves efficiency.

Series SN74AS gates will be offered in 20 and 24 pin d.i.p. packages the latter with MSI functions. Series SN74ALS gates will appear in 14, 16, 20 and 24 pin d.i.p.

Initially, the high speed circuits will combine high performance gate and MSI arithmetic function. Twenty five device types will spearhead the low speed series. Included are gates and dual D and J-K flip-flops as well as MSI circuits.

HAMS RALLY

THE North Midlands Mobile Rally organised by The Midland Amateur Radio Society and Stoke On Trent Amateur Radio Society will take place on Sunday April 29th 1979 at Drayton Manor Park near Tamworth, Staffs. The Park is located on the A4091, which is within easy reach of the M1, M5 and M6 motorways, and is well signposted.

Visitors will be made very welcome. The rally opens at 11.30 a.m. Radio talk in stations on 2 metres and 70 centimetres.

Further details, car stickers etc. are available free on request from: Norman Gutteridge G8BHE, 68 Max Road, Quinton, Birmingham B32 1LB.

POINTS ARISING

MICROPRINTER *(February 1979)*

The stripboard layout shows the correct pinouts for the BC212 transistors. The inset is wrong. Some links are missing from the stripboard, and these are: IC3 pin 4 to pin 9. IC7 pin 10 to +5V. IC3 pin 13 to IC5 pin 5. Junction at emitter of TR15 to +5V. The first link out from pin 13 on IC4 (the "bendy" one) should be removed, to prevent IC4 pin 13 from connecting to IC1 pin 13.
The value of "R" should be 10Ω/$\frac{1}{2}$W.

SEQUENCER *(April 1979)*

For continuity between both sides of the main p.c.b. it is necessary to solder the component leads on each side and to use Soldercon pins for the i.c.s.

SOUND OPERATED SWITCH

Michael Tooley B.A. **David Whitfield** B.A.

THE sound operated switch described in this article can be used for any application where the presence of an audio frequency signal is required to provide control of an external circuit. A typical use is that of providing for automatic operation of transmitter receivers, or the start/stop control of tape recorders. In the former application the sound operated switch is inserted between the microphone and "press-to-talk" rail, so that the operator's voice actuates the change-over relays. In the latter, the sound operated switch is used to provide automatic start of the tape recorder when the required input signal, such as speech, music, or even bird song, is present!

The block diagram of this system is shown in Fig. 2.

CIRCUIT DESCRIPTION

The complete circuit of the sound operated switch is shown in Fig. 1. The incoming audio frequency signal is applied to a conventional voltage amplifier stage, IC1d, which has variable gain between 1 and approximately 50 by means of VR1. The output of this first stage is nominally several hundred millivolts peak to peak, and this is then fed to a precision unity gain active fullwave rectifier formed by D1, D2, IC1a, and IC1c. The positive output excursion of this rectifier is applied to a comparator, IC1b, the threshold of which is made variable by means of VR2. The negative output excursion of the comparator is used to enable a conventional timer circuit which uses a 555. The time constant of the timer monostable is controlled by means of VR3, and the positive going output of the timer is made available for control of external circuitry. A light emitting diode, D4, is incorporated in order to provide a visual indication of the output stage.

It is important to note that, once the input level has risen sufficiently to trigger the circuit and enable the timer, the output of the monostable will remain "high" (for a period of time dependent on VR3, R12, and C6) regardless of any subsequent reduction of input level.

In practice this means that there is a pre-determined delay in the output reverting to its original state and hence the circuit does not "drop out" at regular intervals when the input level falls during momentary pauses in speech or music. Those familiar with voice operated equipment will know that there is nothing worse than a voice operated switch that drops out at the end of each syllable!

CONSTRUCTION

With the exception of the sockets, l.e.d.s, and VR3, all the components are mounted on a small single sided printed circuit board. The layout of the p.c.b., viewed from the copper foil side, is shown in Fig. 3. The corresponding component layout, on the top side of the board, is shown in Fig. 4. Care should be taken to ensure that all components are located correctly on the p.c.b. and the use of sockets for the two integrated circuits is recommended. The p.c.b. is mounted using four short 6BA pillars and, by virtue of its relatively small size, it may be easily fitted into almost any vacant space inside an existing piece of equipment. Alternatively, where the circuit is to be used externally, the use of a standard die-cast aluminium or plastic box is recommended. In this case, the box should be sufficiently large to accommodate an internal battery.

TESTING AND INITIAL ADJUSTMENT

Carefully check the p.c.b. and external wiring before connecting the supply. Connect a 9V battery (PP3, PP6 or similar), or alternatively a stabilised d.c. supply of 8V to 12V, perhaps from the equipment to which the circuit is fitted. Insert a milliammeter on the 100mA range in the positive

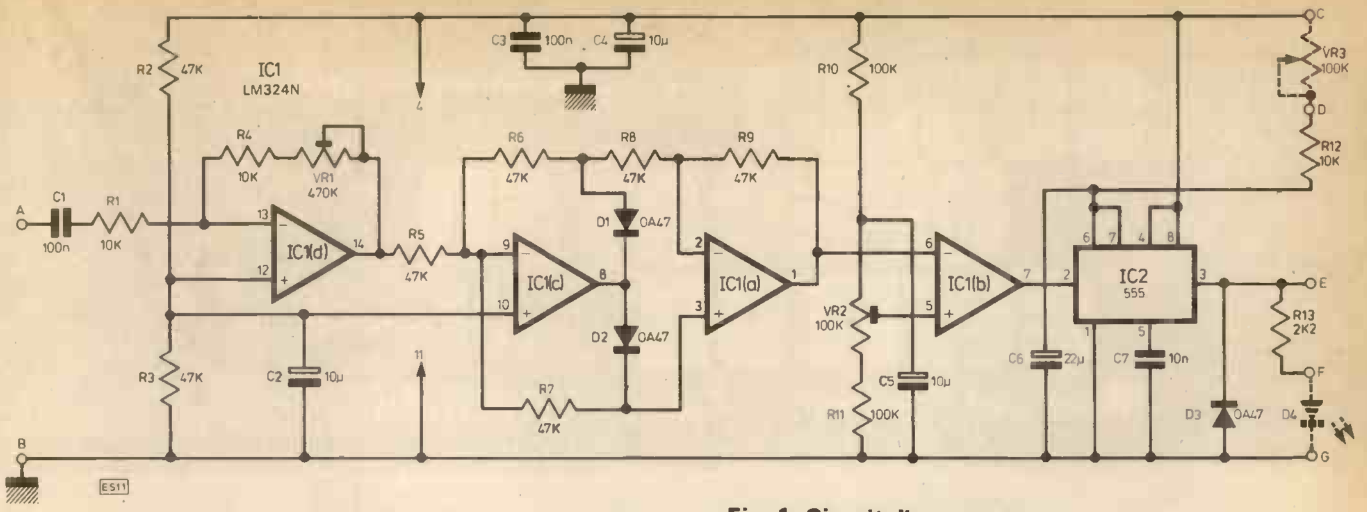


Fig. 1. Circuit diagram

SPECIFICATION

Maximum input sensitivity: 2mV pp sine wave at 1kHz into 10kΩ

Frequency response: 60Hz to 15kHz at −6dB (see Fig. 5)

Output control voltage: standby = 0V
triggered = 7·5V

Time delay (on reverting from triggered to standby): continuously variable from 200ms to 2·8s*

Attack time (on changing from standby to triggered): typically less than 500µs

Supply: 9V d.c. at 7·5mA standby, and 11mA triggered. Alternatively an external regulated supply of between 8V and 12V may be used.

* Longer time delays may be obtained by increasing the value of VR3. A 1MΩ variable will, for example, give a time delay of approximately 30s.

Fig. 2. Block diagram of Sound Operated Switch

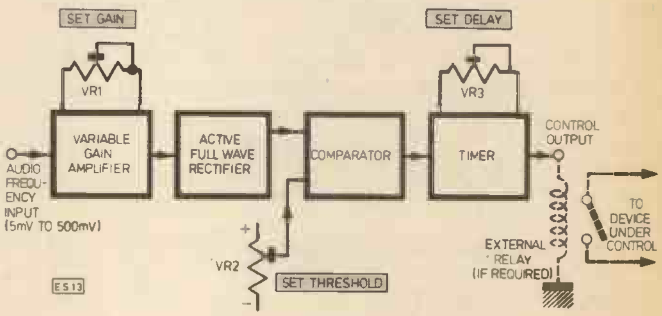


Fig. 3. Printed circuit board track layout (actual size)

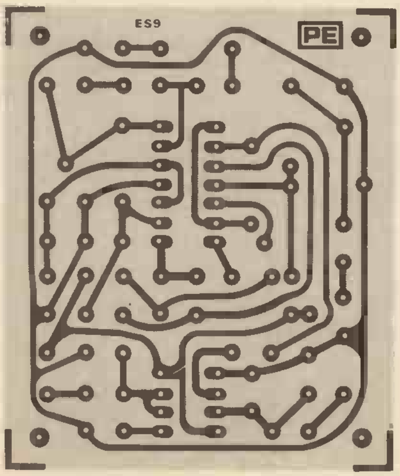
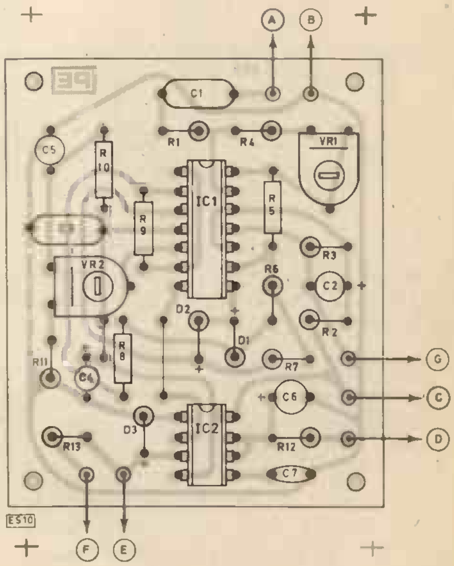


Fig. 4. Component layout



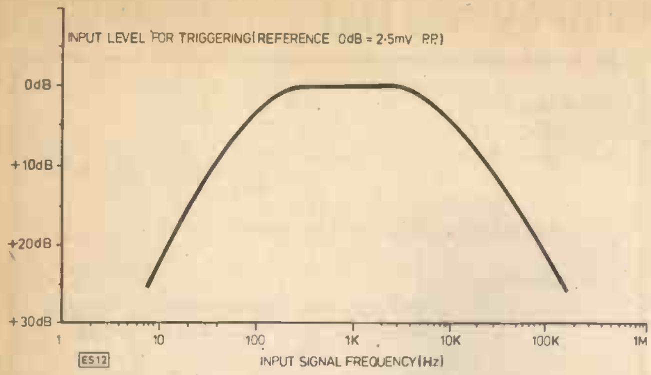


Fig. 5. Frequency response of the sound operated switch

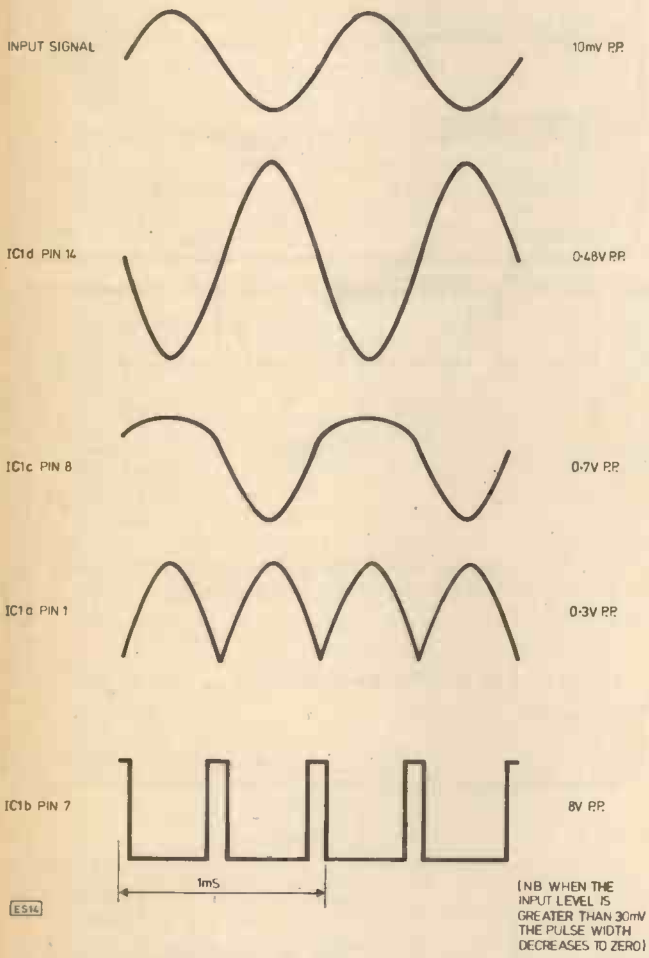


Fig. 6. Waveforms (input =10mV pp at 1kHz). When the input level exceeds 30mV, the pulse width on pin 7 decreases to zero

lead and check that the supply current is in the range 10mA to 20mA. Where an l.e.d. is incorporated to indicate that the supply is turned on, check also that this is illuminated. At one extreme setting of VR2, D4 should not be illuminated and at the other it should be illuminated. Carefully adjust VR2 until D4 is just extinguished. This should occur at about mid-position of VR2.

Set VR1 to maximum position (this corresponds to maximum gain) and connect a microphone or signal generator to the input. It should now be possible to trigger the circuit with an audio frequency signal of a few millivolts peak to peak.

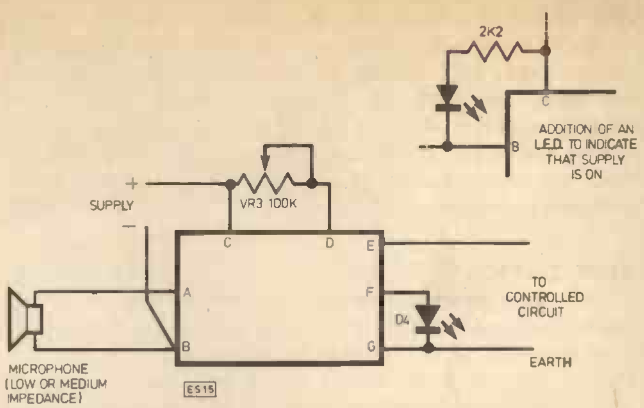
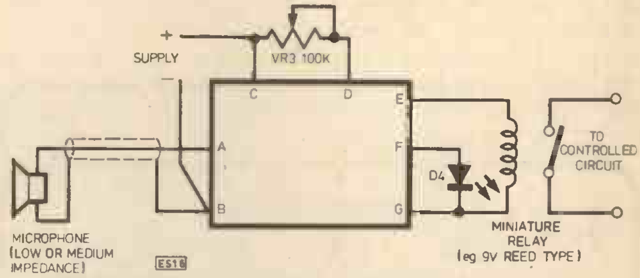
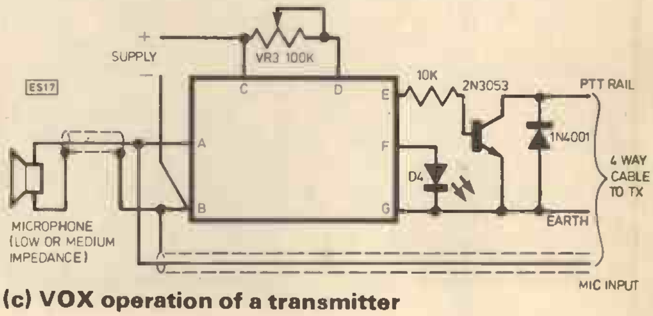


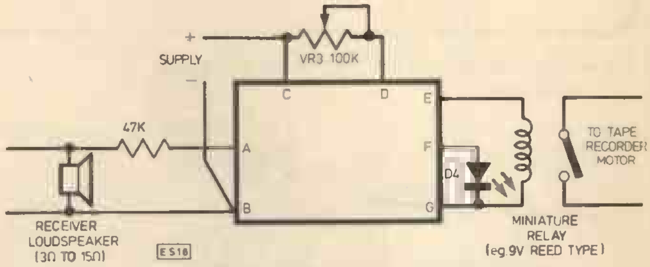
Fig. 7. (a) Basic arrangement of external circuitry



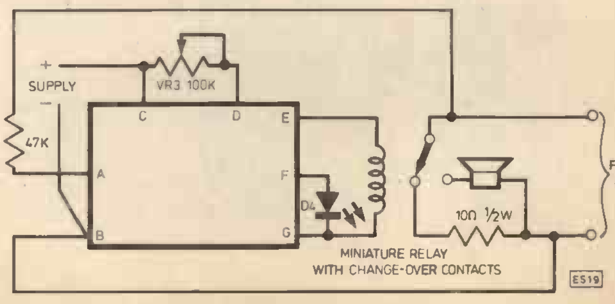
(b) Use of a relay to control an external circuit



(c) VOX operation of a transmitter



(d) Automatic recording system (audio connection to tape recorder not shown)



(e) Audio derived squelch for a receiver

VR2 can, if necessary, be re-adjusted for an increase in threshold sensitivity. Adjustment of VR3 should provide a variable delay in re-setting the output once the input signal has been removed. At minimum setting, VR3 should produce a delay which is hardly noticeable. At maximum setting the delay should be approximately three seconds. The state of the output of the switch is, of course, readily indicated by means of D4.

APPLICATIONS

The basic arrangement of the external circuitry of the sound operated switch is shown in Fig. 7(a). The microphone used should be a low or medium impedance type (300Ω to 50kΩ). An l.e.d. may also be added, as shown, in order to give an indication that the supply is on. For many applications the use of a miniature relay is recommended, as shown in Fig. 7(b). A 9V reed type should prove suitable. When long microphone cables are necessary, the use of screened cable is recommended. This helps prevent spurious triggering of the switch due to hum and stray transients, especially when the circuit is used with maximum gain.

COMPONENTS LIST . . .

Resistors

R1, R4, R12	10k (3 off)
R2, R3, R5–R9	47k (7 off)
R10, R11	100k (2 off)
R13	2k2

All fixed resistors $\frac{1}{4}$W 5% carbon types

Potentiometers

VR1	470kΩ subminiature horizontal skeleton preset
VR2	100kΩ subminiature horizontal skeleton preset
VR3	100kΩ linear carbon potentiometer

Capacitors

C1, C3	100n polyester (2 off)
C2, C5	10µ miniature 6V electrolytic (2 off)
C4	10µ miniature 12V electrolytic
C6	22µ miniature 12V electrolytic
C7	10n ceramic

Semiconductors

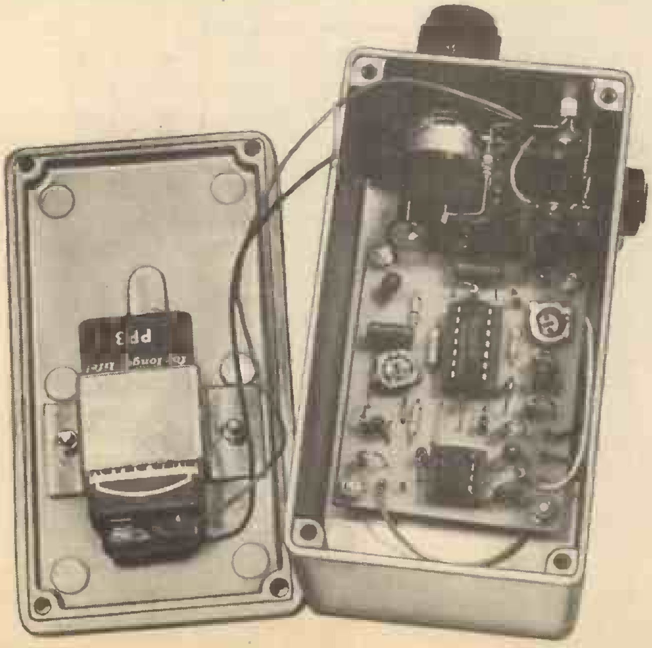
IC1	LM324N quad operational amplifier
IC2	555 timer (8-pin pack)
D1–D3	OA47 general purpose diode (3 off)
D4	l.e.d. light emitting diode

Voltage Table

		"standby"	"triggered"
IC1	pin 1	4·5	6·8
	pin 2	4·5	5·1
	pin 3	4·5	5·3
	pin 4	9·0	9·0
	pin 5	4·5	4·5
	pin 6	4·5	6·8
	pin 7	7·4	0
	pin 8	4·5	4·0
	pin 9	4·5	4·5
	pin 10	4·5	4·5
	pin 11	0	0
	pin 12	4·5	4·5
	pin 13	4·5	4·5
	pin 14	4·5	4·5
IC2	pin 1	0	0
	pin 2	7·4	0
	pin 3	0	7·2
	pin 4	9·0	9·0
	pin 5	5·8	5·8
	pin 6	0	rising to 5·8
	pin 7	0	rising to 5·8
	pin 8	9·0	9·0

The above voltages were measured using a 10MΩ input resistance voltmeter. The supply voltage was 9V.

If debugging is necessary, use these test point voltages

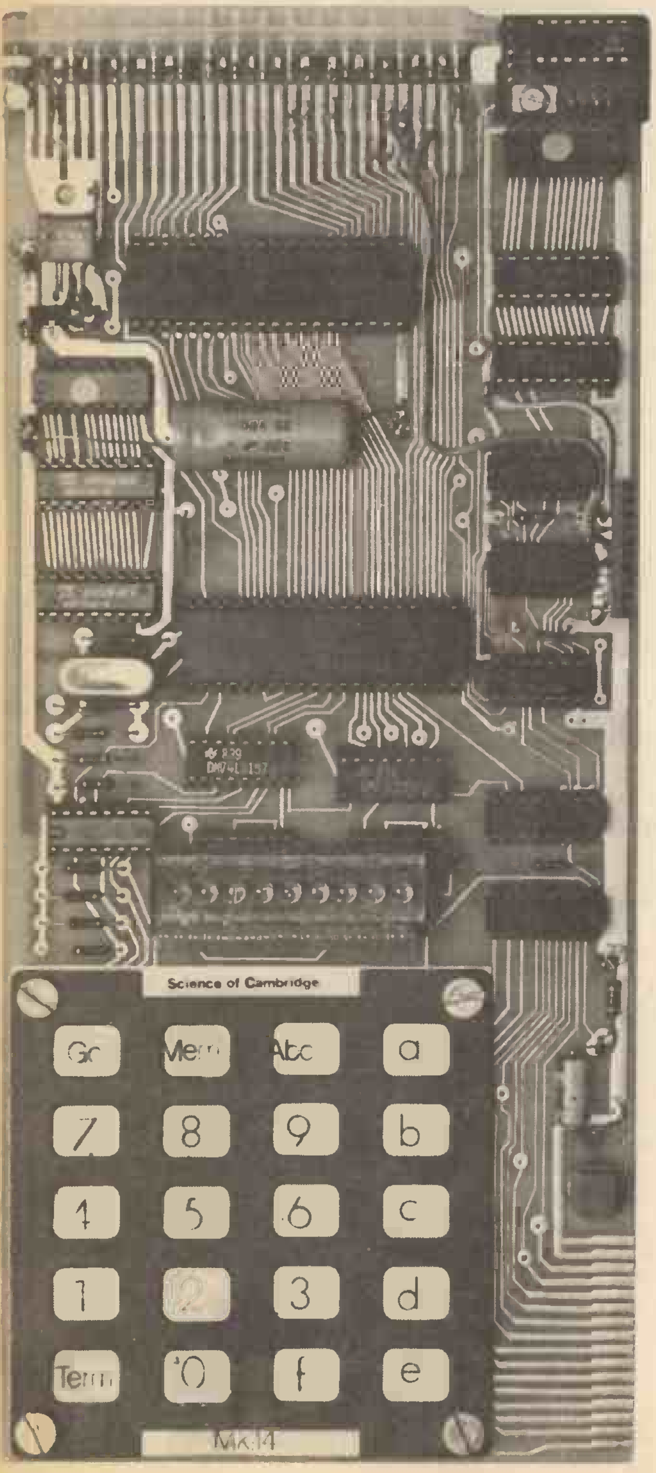


An arrangement for the VOX operation of a transmitter is shown in Fig. 7(c). The transistor is saturated whenever the switch is triggered. Thus the "press-to-talk" rail is effectively earthed whenever the operator speaks and this actuates the change-over relays in the transmitter or transceiver. An automatic recording system is shown in Fig. 7(d). In this application the presence of a signal at the loudspeaker causes the tape recorder motor to be energised. The recorder will run as long as signals are present. The 47kΩ resistor connected in series with the input provides attenuation since, in this application, the sensitivity of the switch is too high and it is thus liable to become triggered by noise.

An audio derived "squelch" arrangement is shown in Fig. 7(e). When there is no signal from the receiver the loudspeaker output is terminated in a 10Ω resistor. The receiver is thus muted and background noise is eliminated. When a signal is present the loudspeaker is brought into circuit. The threshold of switching may be set by adjustment of VR1 and VR2. ★

MK14 REVIEW

A. A. BERK B.Sc. Ph.D.



The MK14 must surely represent one of the most remarkable revolutions in computer technology to date. Much has been said about this little kit, both in magazine articles by reviewers (see *Microbus* in Feb. issue) and word of mouth by constructors—whatever I or anyone else may say, the complete computer for around £40 is a landmark of, at present, unassailable proportions. The following, not uncritical, article pieces together my experience of the above device along with the description of the cassette interface by Science of Cambridge, and an interface to the *P.E. VDU* giving, all in all, a very cheap and powerful system.

THE kit comes pleasantly and well packaged as a set of resistors, capacitors, integrated circuits (without sockets), l.e.d. display, keyboard, reset switch, crystal, p.c.b. and even contains a 5 volt, 1 amp regulator. A "Micro Computer Training Manual" for the MK14 is also included.

The manual has clearly been designed with the absolute beginner in mind including, for instance, a good section on how to solder. However, it is generally agreed that absolute beginners and even beginners in either software or hardware alone, find it difficult to decipher some of the more fundamental concepts introduced in the manual.

The kit uses the National Semiconductors SC/MP II m.p.u. as its basis and the architecture and instruction set is described in the manual in just nine pages. Everything is there, but the beginner would do better to buy a full software introduction to SC/MP programming—I would recommend, for instance, Drury and Smart's "A Guide To SC/MP Programming".

MEMORY MAP

The hardware of the MK14 is also described in a cursory manner—even a complete memory map with addresses is lacking and for those who are contemplating using the MK14 the memory map shown opposite may be useful.

In addition to this omission, until recently, no pin numbers were included on the circuit diagram which made it very difficult to expand in any way—I am very pleased to see this rectified on the latest versions.

The upper four address lines of the system are left encoded (they have to be demultiplexed from the Data Bus anyway) and hence 12 BITs of address are available giving 4K of memory capability. This is the reason for the character "X" appearing in the memory map. The most significant hexadecimal character of the address must be used but may be anything—i.e. the addresses 0123 and F123, for instance, are indistinguishable.

The map indicates the hardware available in the kit. Included in the basic price of £39·95 + £3·20 VAT and postage etc., are 256 bytes of random access memory (using two 2111 chips). The display is a calculator type 9-digit, 7-segment multiplexed l.e.d. display giving an adequate read-out for simple programming. Space is provided on the p.c.b. for a further 256 bytes of RAM (two more 2111s) and an I/O device which itself contains 128 bytes of RAM.

If the above additions are made, the final system contains 640 bytes of RAM and 16 ports each of which may be separately configured as an input or an output line. "Handshaking" is also

XFFF	
	STANDARD RAM
XF00	
	RAM I/O
XE00	
	DISPLAY
XD00	
	RAM I/O
XC00	
	OPTIONAL RAM
XB00	
	RAM I/O
XA00	
	DISPLAY
X900	
	RAM I/O
X800	
	MONITOR
X600	
	MONITOR
X400	
	MONITOR
X200	
	MONITOR
X000	

Memory Map Table

possible via 8 of these lines for communication with an independent system of some kind—such as another MK14, as the manual informs us.

The memory map also shows how much of the 4K of immediate memory is lost by repeats. The 512 bytes of monitor, for instance, appears four times. This is due to incomplete memory decoding adopted to keep the cost to a minimum. However, it turns out that a small change is sufficient to free the extra monitor space and advice on this is given in the Issue IV kit.

The issue number, by the way, is found on the underneath of the p.c.b. This version explains how memory expansion can be effected to make a further $1\frac{1}{2}$K of RAM available in the address locations X200 to X7FF (and not X2000 to X7FFF as incorrectly stated in the note). This would give a total of 2,176 bytes or RAM—quite respectable for the machine's size and basic cost, and excellent for the field of hardware control.

POOR FEATURES

There are two features which let the kit down, however. They are, firstly, the keyboard—which relies on bridging p.c.b. tracks with "conductive rubber"—and secondly, the extremely long lead times on delivery of the kit. I received one in January which was ordered in the previous Summer! Others have experienced waits from 2 to 4 months. The first of these criticisms is easy enough to overcome and the second is sure to ease in time—you might even try turning up at their doorstep or buying from a distributor to speed matters. The delay does not seem to extend to servicing, I only waited about fourteen days for them to check the monitor ROMs which I thought were faulty.

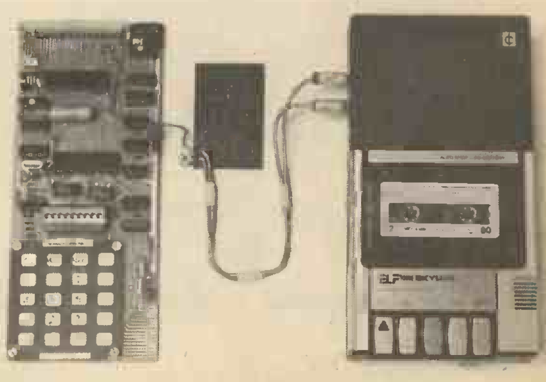
The issue IV board comes with a note to the effect that a kit of metal-domed switches may be purchased from Science of Cambridge for £2. The p.c.b. does, in fact, have an expansion edge connector next to the keyboard to add an external keypad, and though the manual gives no pin-out diagram for the connector, the tracks are easy to follow.

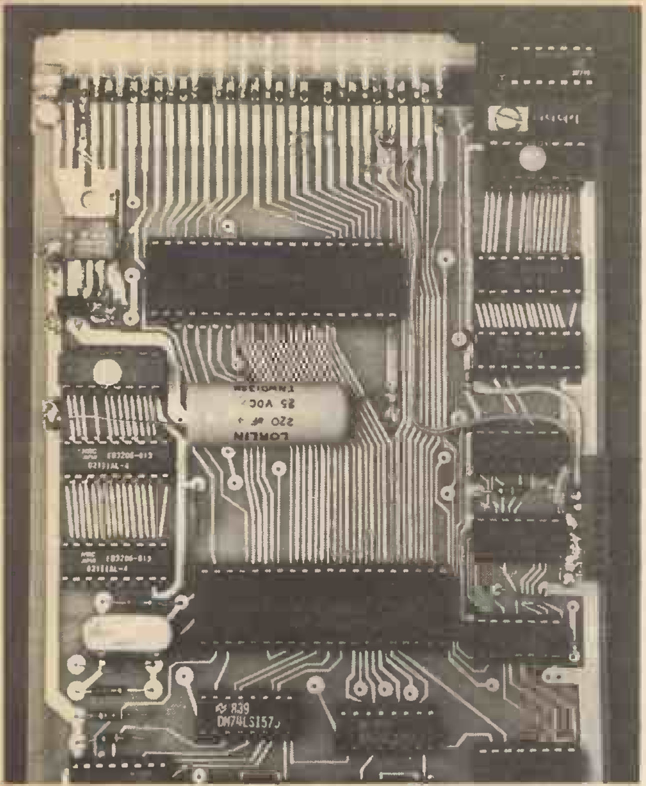
The kit is continually being updated. A few small mistakes in the earlier boards have been ironed out and the current p.c.b. is excellent—the only problem is in the extreme thinness of some of the tracks, and great care must be exercised not to break one of them.

One of the most important updates is the revised monitor program, available on fusible link PROM and pin compatible with the old one. This includes, among other things, an offset calculation for easier programming, single step facility (with some extra logic), and cassette tape interface control. The monitor occupies the same space as before by making some of the original routines more efficient.

CASSETTE INTERFACE

The photograph shows the cassette interface being used; and though slow (about four characters per second) it is very cheap, easy to use and of straightforward construction. The use of cassette files makes a tremendous difference to any machine, saving considerable amounts of time and energy. The interface uses two integrated circuits and some discrete components on a





The positioning of the connector and extra components to link with the *P.E. VDU*

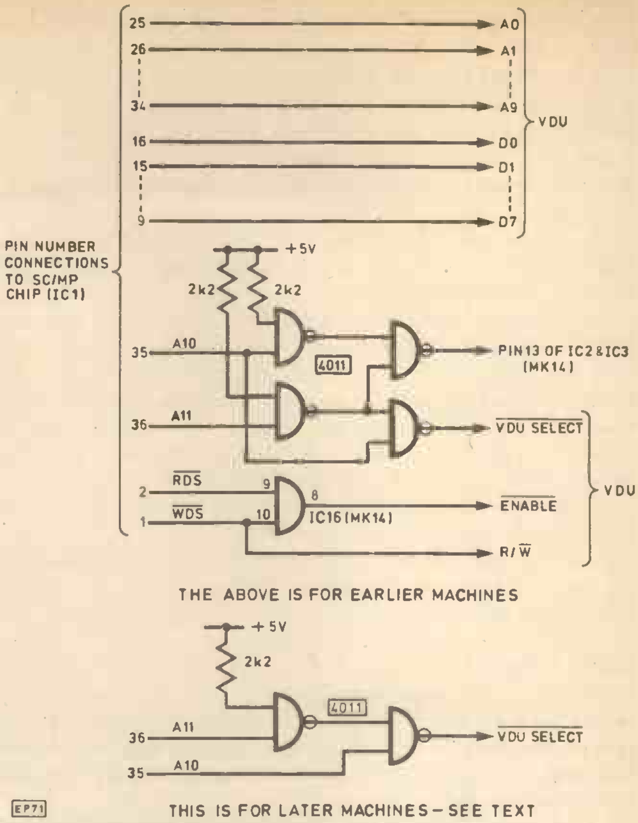


Fig. 1. Interface arrangements to the *P.E. VDU*

small single sided p.c.b. The only fault I found was the marking of the positive end of the diode—wrong on the p.c.b. but correct on the circuit diagram. To store on cassette, the length and starting address must be set up in three memory locations. The length takes up a single byte and hence a maximum of 256 bytes may be stored at a time. The starting location of the cassette routine is then set up on the MK14's display and the recorder switched on. Pressing "GO" causes the block to be recorded—a l.e.d. on the cassette board flashes until the recording is complete. Taking information from the tape is a similar exercise. As the instructions implied, I found the volume control, on playback, to be very critical. The machine does work however, and several others I have talked to agree.

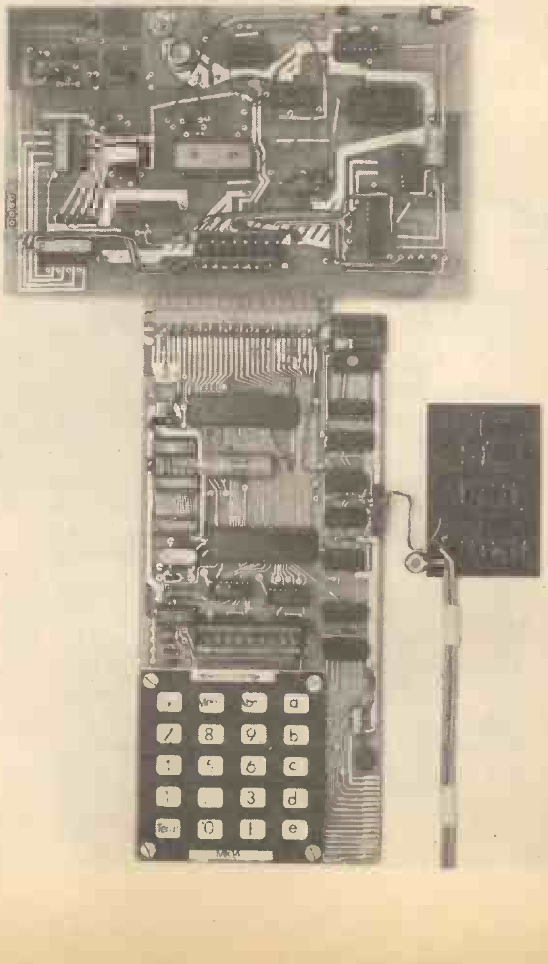
One of the most spectacular uses of the tape is in the direct loading of a block of information straight to a VDU screen. A set of notes can be kept on cassette and simply read back at leisure—especially if the tape has a tape counter for easy indexing. Another use would be for special screen formats stored on tape and used for particular programs to fill areas of the screen specially set aside for different functions. The programs involved would be very much simpler than normally necessary as the various lines and patterns used would not have to be generated in software—could be useful in the sort of minimal system for which the MK14 is ideally suited.

P.E. VDU INTERFACE

Of course a VDU or some sophisticated means of output, is essential for anything but the most basic uses of any machine, and below is described an interface to the *P.E. VDU* (published in October, November and December 1978).

The photograph shows that a 31-way Vero connector socket has been mounted on the top edge of the MK14 p.c.b. This is not connected to the expansion edge connector in that region but is bussed, via wire links beneath the p.c.b. to the data, address and

MK14 and *P.E. VDU* connected up



control lines of the SC/MP chip. In addition, a 4011 CMOS chip is mounted at top right of the p.c.b. and connected as shown in Fig. 1.

A spare gate in IC16 is used to enable the VDU only when RDS or WDS is high—this prevents the address and status information on the data bus from interfering with the VDU RAM. The circuit shown enables the VDU as a 1K block of memory replacing the top two copies of the monitor (each of 512 bytes).

To connect the interface to the MK14, "A11" must be disconnected from the enable inputs of IC2 and 3 (pin 13) and fed, along with "A10", to the 4011 as shown. Pin 13 of IC2 and 3 is then connected to an output of the 4011, again as in the diagram. The VDU "screen" then occupies the addresses X400 to X7FF. Later machines may have the monitor correctly decoded to lie only in the lowest 512 bytes—I have an issue V board which apparently has this modification. You can check by viewing a few addresses between X200 and X7FF to see if the monitor is there. If it is not then a simpler interface may be used which does not involve IC2 and 3. This is also shown in Fig. 1, the rest of the interface is as before.

It should be noted that no buffering was found necessary on any of the busses to drive the VDU as it presents, almost entirely, low power loads.

CONCLUSIONS

The expansions described will produce not only a reasonably sophisticated personal computer, but also a control development system of some power. In my opinion it is this latter area which has been somewhat neglected by Science of Cambridge's marketing philosophy.

In conclusion, the MK14 is a well thought out product nicely packaged, and easy to use with the revised monitor. Indeed, my firm opinion is that no electronics enthusiast or engineer should be without one in today's technology.

A reasonably sophisticated personal computer resulting from the use of the *P.E. VDU* with the MK14 and cassette interface

News Briefs

FINAL PHASE

IN OUR January issue we gave a few details of the Lucas "How Far Can You Travel?" competition (see Electric Chariot Race). Well, the successful design stage entrants will now be battling it out on Sunday 2nd September 1979, at Donnington Park, Castle Donnington, Derby.

The competitor whose "home made" vehicle can transport him the furthest on two standard Lucas 12V batteries along the $\frac{1}{4}$ mile circuit, is the winner. Track marshalls will be on the lookout for barbed axles, and will "black flag" anyone seen *slipstreaming* behind another competitor.

FERRITE-CLAD AERIALS

A DISCOVERY by Professor J. R. James and Dr A. Henderson of the Electronics Department at the Royal Military College of Science, has resulted in the possibility of more compact whip aerials operating with HF and VHF band portable radios.

The discovery is that a thin cladding of ferrite material can be as effective as a thicker cladding of pure dielectric material in reducing the height of high frequency whip aerials, whilst offering the advantage of increased input impedance.

The ferrite may be of a coating formed *in situ*, or it can be achieved by sliding ferrite beads onto the conductor. The present lack of low-loss ferrites at high frequencies imposes an upper limit of about 100MHz generally, but the theoretical limit is considerably higher should new materials become available. Bulkiness limits the lower end to about 5MHz.

Manufacturing licensing arrangements for interested parties are being dealt with by Jim Strutt, Computers, Systems and Electronics Group, of the National Research Development Corporation, Victoria Street, London.

RAPID RECALL MOVE

LARGER premises at Wooburn Green now house Rapid Recall after a move from 9 Betterton Street, London.

The move was necessary because of the larger number of staff required to handle their franchise with the Digital Equipment Corporation, and cope with increasing sales of Intel and Intersil products.

The new headquarters are at: 6 Soho Mills, Wooburn Green, Bucks. Telephone, Bourne End (06285) 27072/5 and 24961. Telex 849439. Rapid Recall's northern office at Nantwich remains the same.

NASCOM CLUB

THE International Nascom Microcomputer Club is now officially launched with (at the time of writing) the publication of INMC News, issue one.

Further details about membership, which costs £5.00 per annum, are available from Tony Rundle at Nascom Microcomputers, 121 High Street, Berkhamsted, Herts.

LOW NOISE PRE-AMP

J. GERRARD

WHEN attempting to record or amplify low level sounds (such as wildlife) with low output, low impedance microphones, you are often faced with the prospect of trying to pick out the desired sounds from under a blanket of hiss. This hiss or noise usually comes from the pre-amplifier. A good low noise pre-amplifier, as described here, can make all the difference between a foggy, messy sound that is hard to listen to, and a clean professional sound that is a pleasure to hear.

Having had a lot of trouble with noisy recordings, the author decided to put eight low impedance pre-amps through their paces to find the one with the lowest noise output. Two of the pre-amps used i.c.'s; and it was one of these that came top. It uses the ZN459 i.c. which is truly a low noise i.c.—the noise output voltage being a third of that for its transistor counterparts.

THE ZN459

The ZN459 is a versatile, wide band, low noise amplifier, operating up to 15MHz, with a voltage gain of 60dB. It basically consists of two amplifiers with gains of 100 and 10; giving 1000 (60dB) in all. The i.c. operates from a single supply of 6V maximum; has an input impedance of 7k at 10kHz, and internal input biasing. The i.c. lends itself to high performance circuits with few external components.

CIRCUIT DESCRIPTION

The circuit diagram of the Pre-Amp is shown in Fig. 1 and IC1 is operated from about 5·5V supplied from a 9V battery, via dropper R1, and held steady by C1. C2 decouples the input, and determines the low frequency limit. Bypass capacitor C3 prevents extraneous signals from reaching the input circuitry through the supply lines and causing instability. The output is taken via R2, and decoupling capacitor C4. R2 is to prevent excessive loading on the output. In determining the high frequency limit, it was found that RC frequency selective feedback caused instability, so an alternative approach was used. C5 is connected straight across the input and effectively bypasses r.f. Fig. 2 shows the modifications necessary for a 600 ohm input. Pin 5 is a point halfway along the internal feedback path. By partially bypassing the a.c. feedback through C6 and R3 to 0V, the input impedance is raised to 600 ohms. C5 is changed to 15n to keep the same high frequency limit.

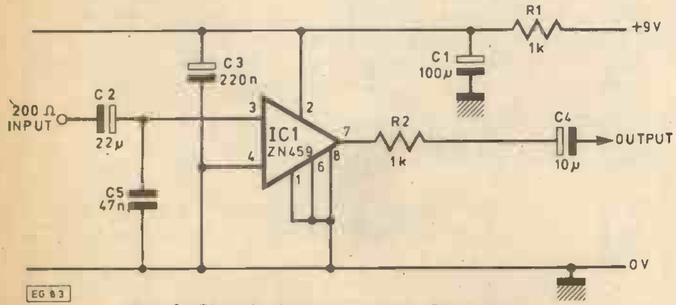


Fig. 1. Circuit diagram of the Pre-Amp

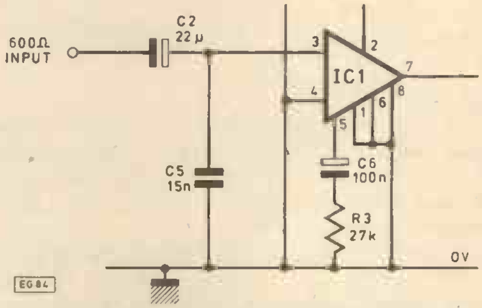


Fig. 2. Modification for a 600 ohm input

COMPONENTS . . .

Resistors

R1, R2	1k (2 off)
R3	27k

Capacitors

C1	100μ tant
C2	22μ tant
C3	220n tant
C4	10μ tant
C5	47n (200 ohm input) or 15n (600 ohm input) metallised polyester film
C6	100n tant

Semiconductors

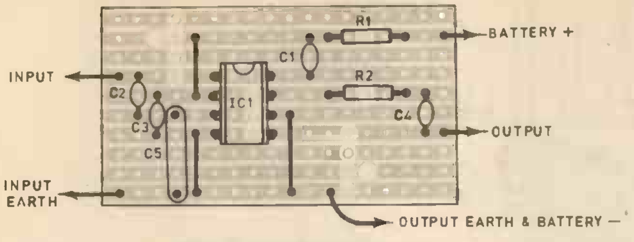
IC1 ZN459

Miscellaneous

Input and output sockets
On/off switch
Metal case (80 x 55 x 25mm)
9V battery
Battery connector
Holder for 8 pin i.c. (if req)
Veroboard 0·1in. matrix

CONSTRUCTION

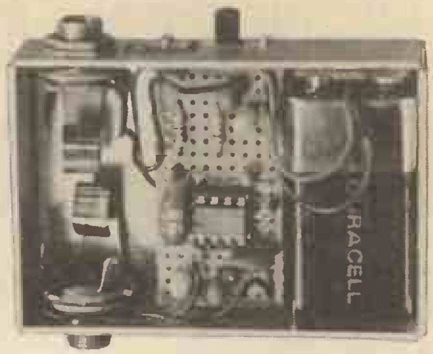
Construction is very straightforward and should present no problems. The Veroboard layout is shown in Fig. 3. Care should be taken to ensure correct polarity of capacitors, and



EG85

Fig. 3. Veroboard layout

that there are no accidental shorts between tracks. Put the i.c. in its socket last of all. The pre-amp should be housed in an all metal box for screening, with appropriate on/off switch, input and output sockets to suit individual requirements. The circuit board should be mounted on non metal supports to avoid short circuits. The pre-amp is now ready for testing.



SPECIFICATION

Input impedance	200 ohm or 600 ohm
Gain	60dB
Maximum Input Voltage	1mV
Frequency response	25Hz — 35kHz +0 −3dB
Distortion (THD)	0·15% typ. (1V p-p, 10kHz)
Output Noise (unweighted) (Referred to an output level of 1V)	
200 ohm	0·07mV (−83dB)
600 ohm	0·12mV (−76dB)

TESTING

Check there is about 5·5V across pin 2 and 0V. Current consumption should be about 3mA. Plug in a microphone and monitoring source (with medium to high input impedance) and listen. The result should be a clean, distortion free, noise free sound.

LIMITATIONS

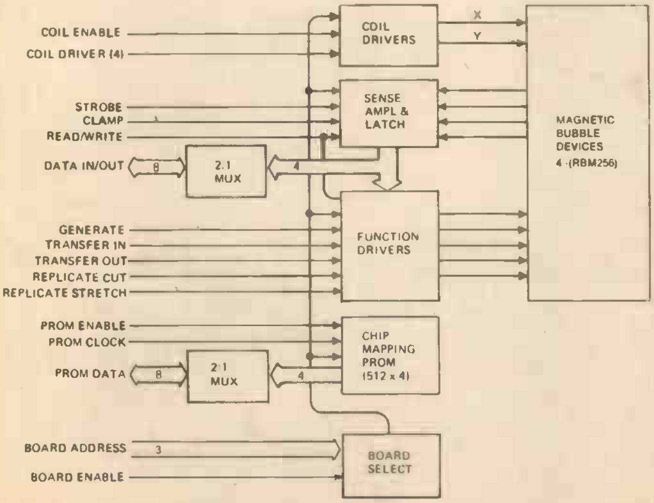
With a maximum input of only 1mV before clipping occurs (due to the i.c.'s input circuitry), the pre-amp would be unsuitable for use with a singer's hand-held microphone, for example. Also, the pre-amp could be powered from existing equipment, but the supply would have to be exceptionally ripple-free, if not battery operated, to give good, hum-free results. ★

News Briefs

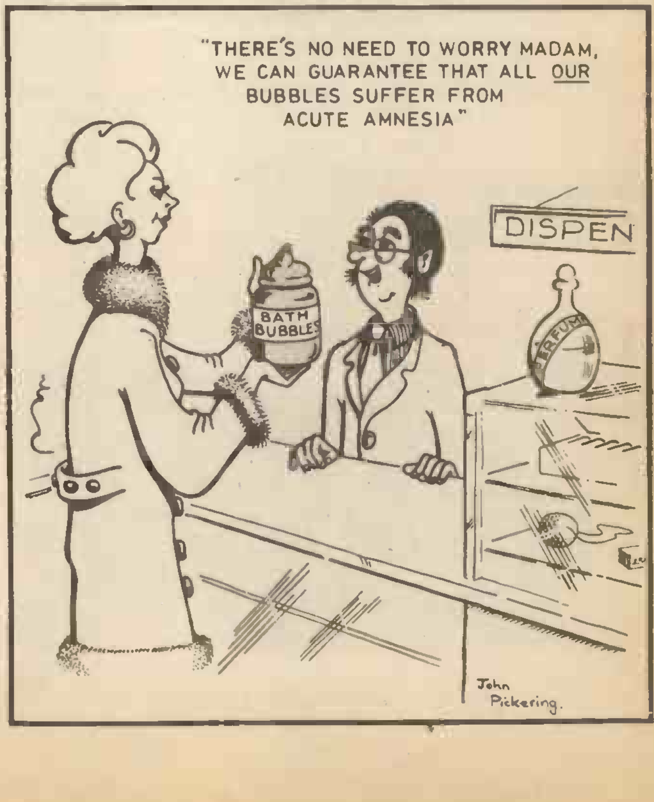
DEVELOPMENT SYSTEM

IT LOOKS as though bubbles are going to continue hitting the news for some time. Another contender in this memory race is Rockwell, with a 256K-bit block access device. But to help encourage initial development towards bubbles by OEMs, Rockwell have produced a ¼M-byte bubble development option for their System 65 microcomputer development system. It comprises one RCM650 controller with two RLM658 Linear Storage Modules.

The 6502 based development system can, with an auxiliary card cage, be expanded to the full 2M-byte bubble memory subsystem capability.



Linear bubble memory module (Rockwell). The chip mapping PROM holds redundancy information about faulty loops which may exist within the bubble memory.



AUTORANGING MULTIMETER PART 2

ALEX KOWALEWSKI Dr. MARK A. SAWICKI

This final part concludes with the remaining theory, and overall construction

DISPLAY BOARD

THE Autoranging Multimeter always requires that Over and Underrange must be detected. In our particular situation only digits 1 and 2 need to be sensed.

Overrange Digits 2, 3, 4 are all "off".

Underrange Digit 2 shows 0 or 1 and Digit 1 "off". Consequently segments 1b, 1c (connected in parallel) and 2a, b, f, d, must be interfaced so that the logic knows whether they are "on" or "off".

The complete Display Logic Interface employs five similar circuits as presented in Fig. 2.1 shaded portion.

INTERFACE CIRCUIT

If the segment is off, point A is at +5V, the transistor is off and B is −5V. If on, point A falls to approximately +3V due to the voltage drop across the l.e.d., the transistor turns on and point B rises to +5V. The capacitors on the interfaces for segments b and g are specially provided to stop false overrange indications during the 6 to 7 transition at digit 2. The complete circuit diagram of the display logic interface is shown in Fig. 2.1. The decimal point and the lowest range l.e.d. indicator wiring diagram is quite straightforward.

Details of the p.c.b. layout can be found in a combined form at Fig. 2.3(a) and Fig. 2.3(b).

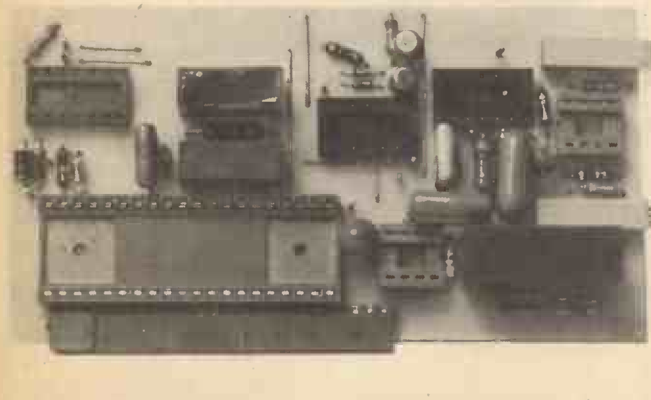
The display board and the Main Board are connected together using "edge inter-board connectors".

This is an economical and simple method of making right-angled connections between p.c.b.s by just inserting solder pins on the 0·1 inch p.c.b. pitch of the Display/Main Boards, i.e. plug (23-way) is soldered into the Display Board and the relevant socket is fixed to the Main Board. The DL 727 data is given in Table 2.1.

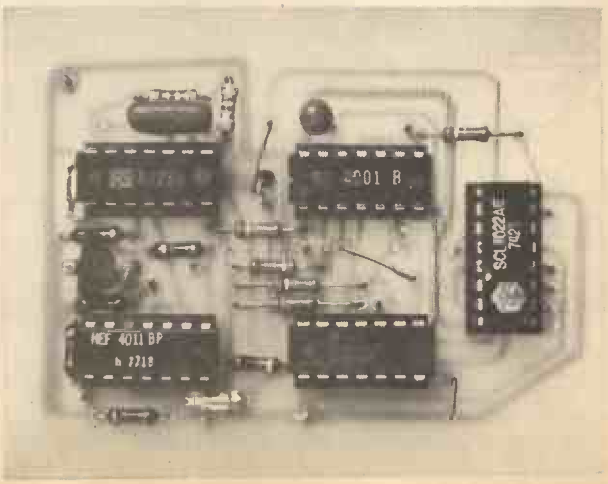
PSU

Approaching the final part of this project, we now give details of the power supply circuit. This is shown in Fig. 2.2, and the p.c.b. layout is shown in Fig. 2.4. The system uses a pair of popular LM309K regulators and all the other things are pretty standard. A protection fuse of 200mA on the

MAIN BOARD



LOGIC BOARD



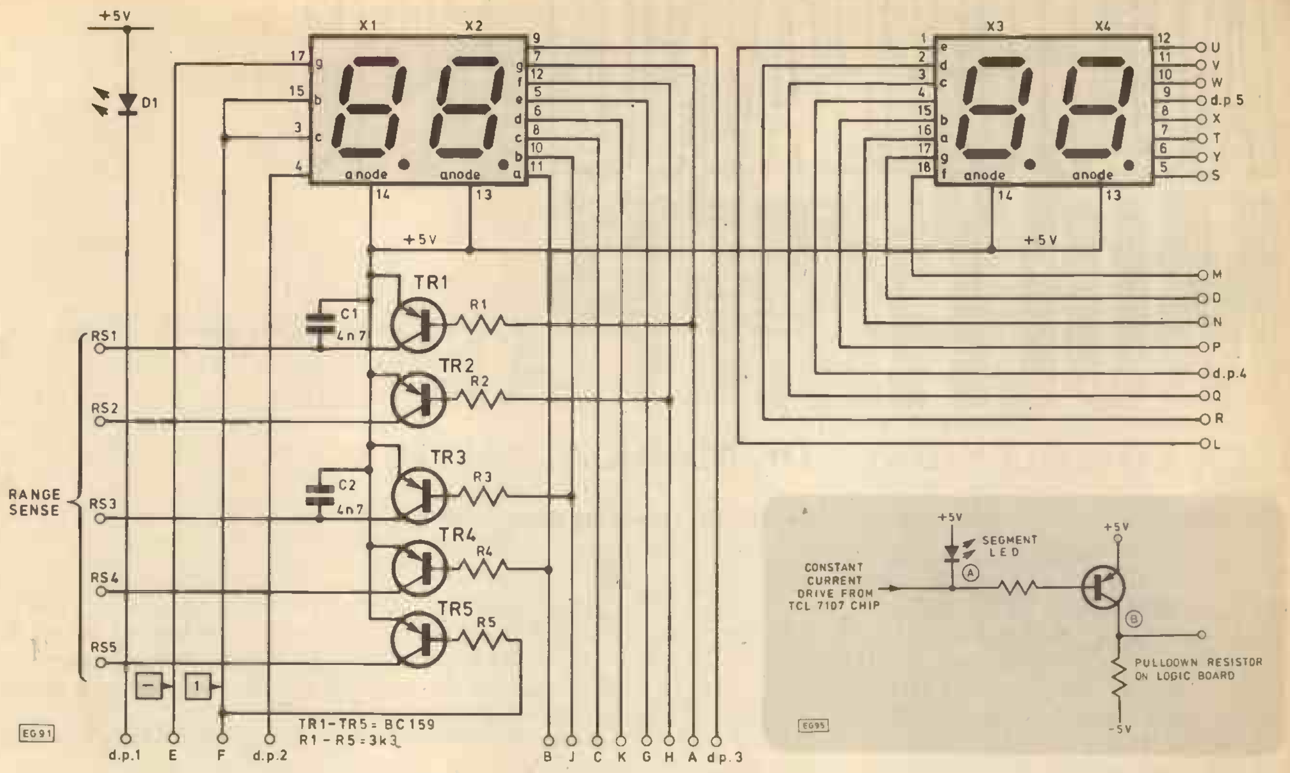
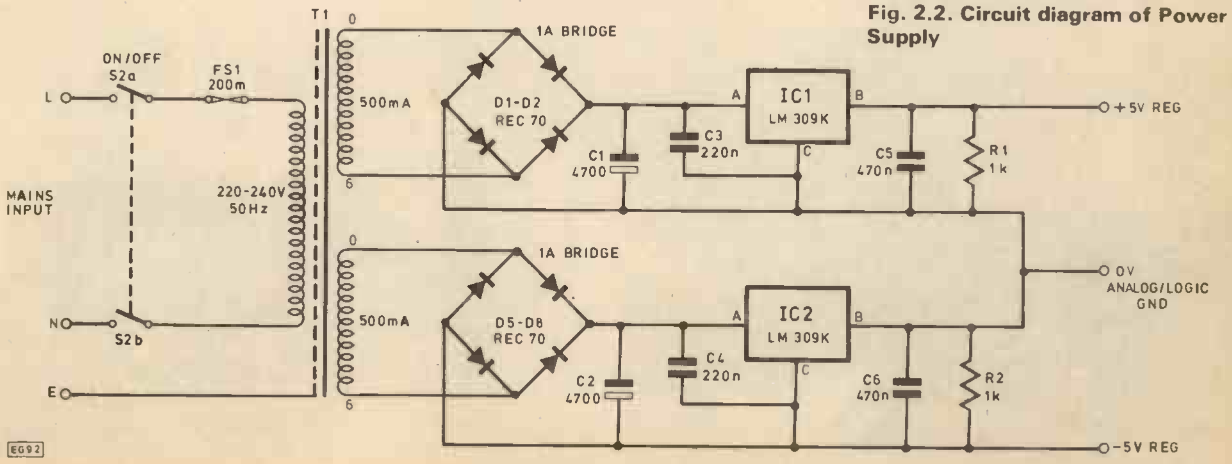


Fig. 2.1. Circuit diagram of Display Board

Table 2.1. DL727 dual numeric display. Viewed from display side: Digit 1 = left, Digit 2 = right.

Pin		Designation
1	—	Cath E (No. 1)
2	—	Cath D (No. 1)
3	—	Cath C (No. 1)
4	—	d.p. Cath (No. 1)
5	—	Cath E (No. 2)
6	—	Cath D (No. 2)
7	—	Cath G (No. 2)
8	—	Cath C (No. 2)
9	—	d.p. Cath (No. 2)
10	—	Cath B (No. 2)
11	—	Cath A (No. 2)
12	—	Cath F (No. 2)
13	—	Anode (No. 2)
14	—	Anode (No. 1)
15	—	Cath B (No. 1)
16	—	Cath A (No. 1)
17	—	Cath G (No. 1)
18	—	Cath F (No. 1)

Fig. 2.2. Circuit diagram of Power Supply



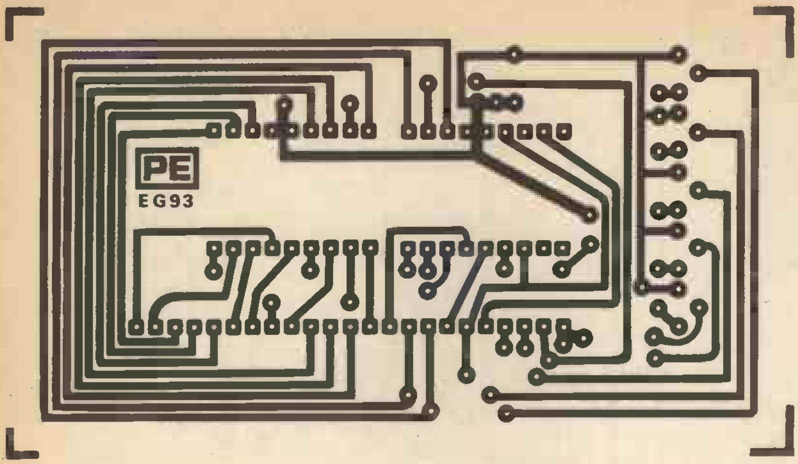


Fig. 2.3. (a) Display Board p.c.b.

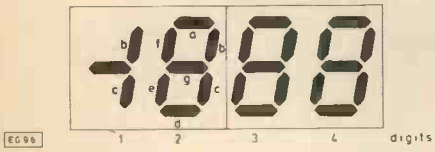
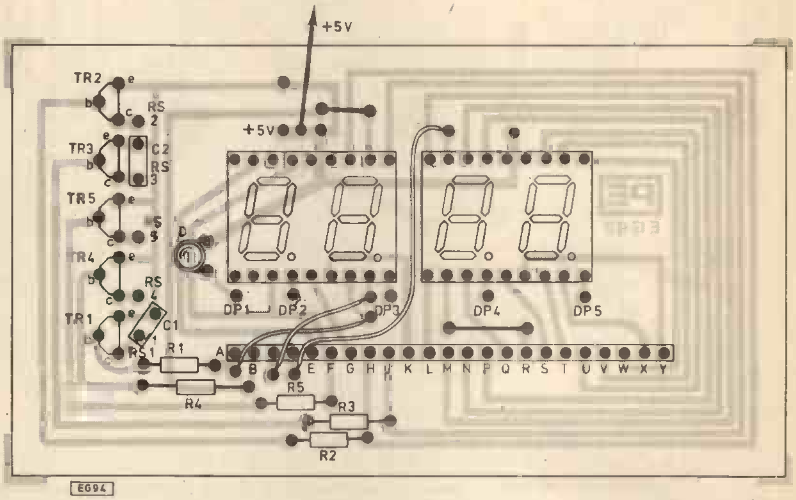


Fig. 2.3. (b) Display Board component layout



COMPONENTS . . .

Resistors
R1–R5 — 3k3 (5 off)

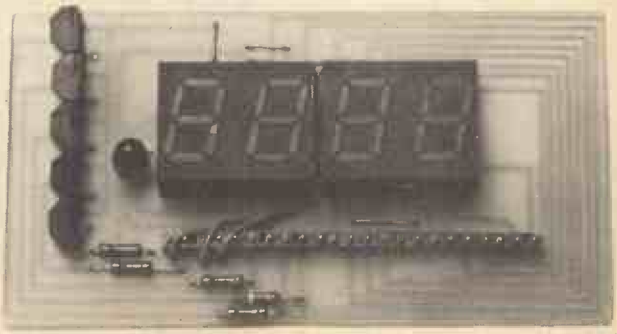
Capacitors
C1, C2 — 4n7 (2 off)

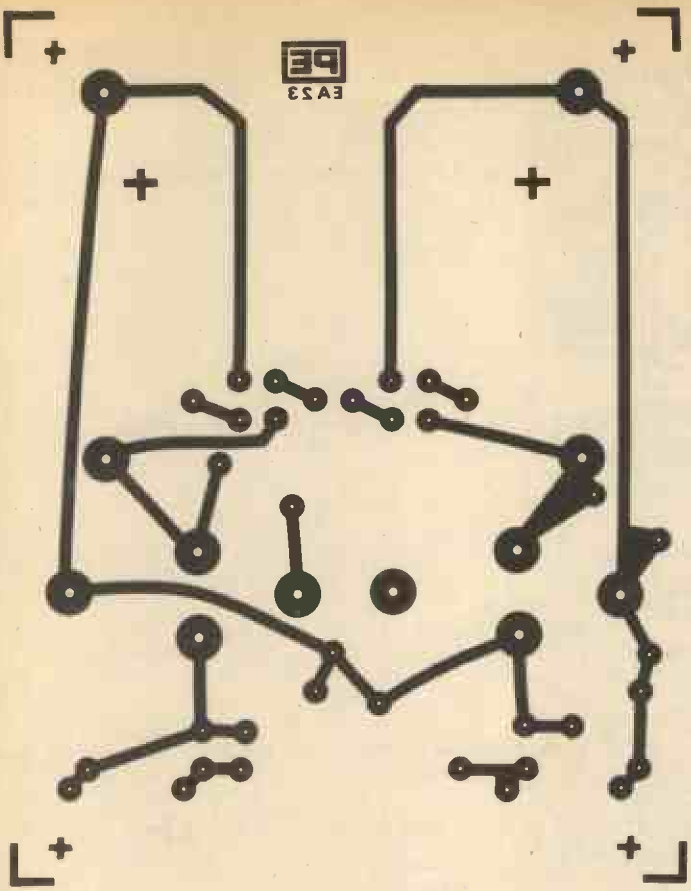
Transistors
TR1–TR5 — BC159 (5 off)

Displays
X1–X2, X3–X4 — Litronix DL727 Dual 7-segment (2 off)
D1 — 0·2 inch l.e.d.

RELAY BOARD

DISPLAY BOARD





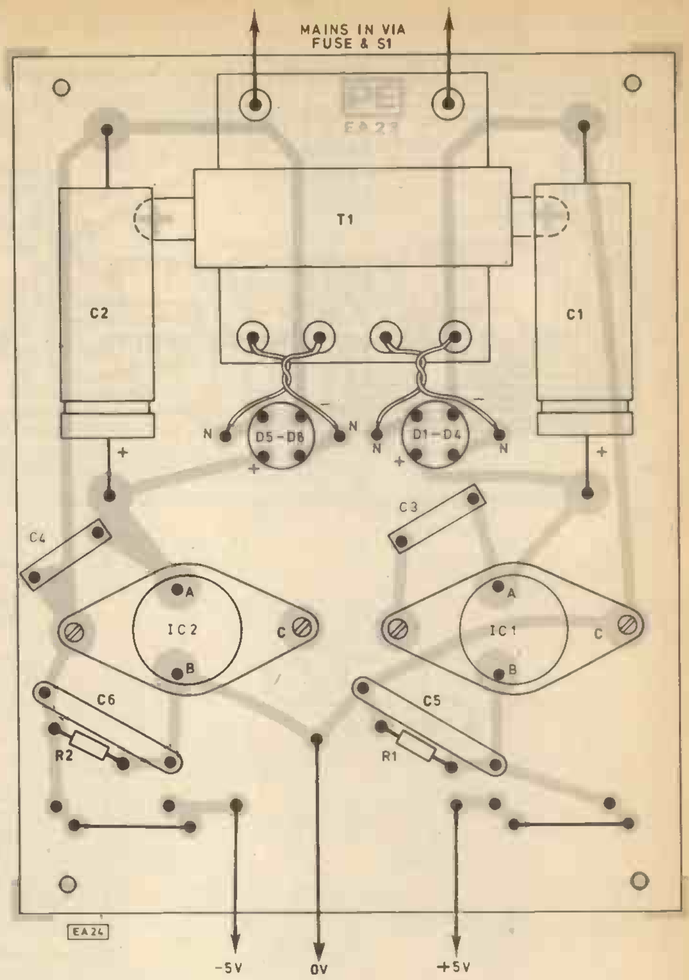


Fig. 2.4. (Above) Power Supply p.c.b. (Right) Component layout

COMPONENTS . . .

POWER SUPPLY

Resistors

R1, R2	1k ¼W 5% (2 off)

Capacitors

C1, C2	4700µ/25V (2 off)
C3, C4	220n (2 off)
C5, C6	470n (2 off)

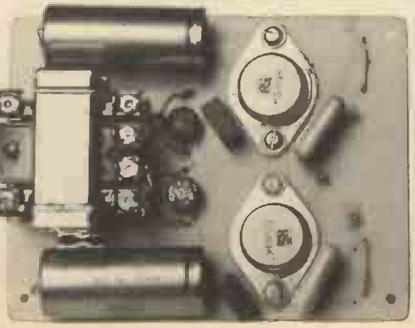
Semiconductors

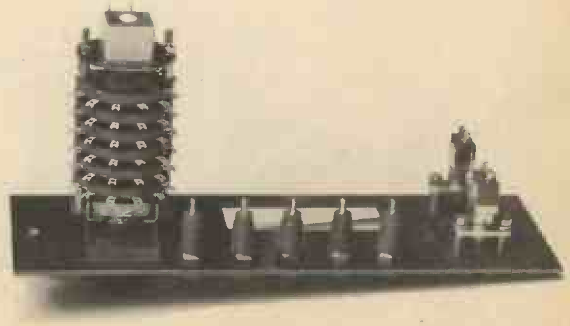
D1–D4, D5–D8	REC 70 (2 off)
IC1, IC2	LM309K (2 off)

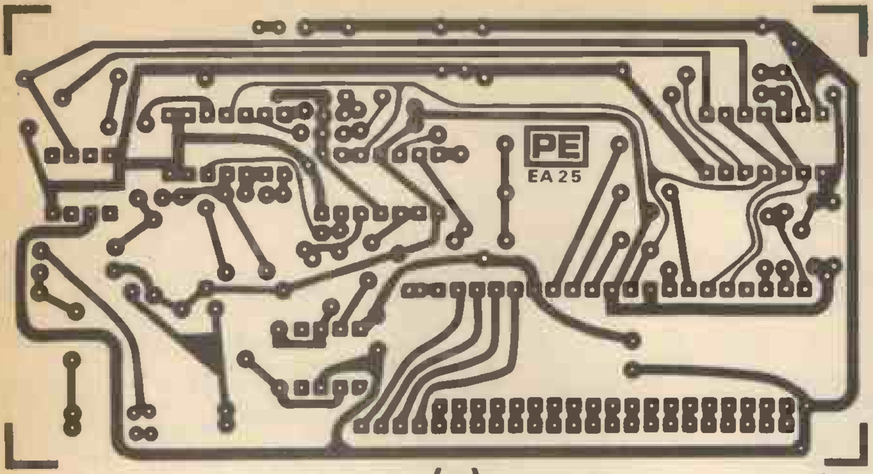
Transformer

T1 240V/2×6V, 0·5A sec's.
RS type 196–296 or equivalent
(via Ace Mailtronix)

PSU BOARD



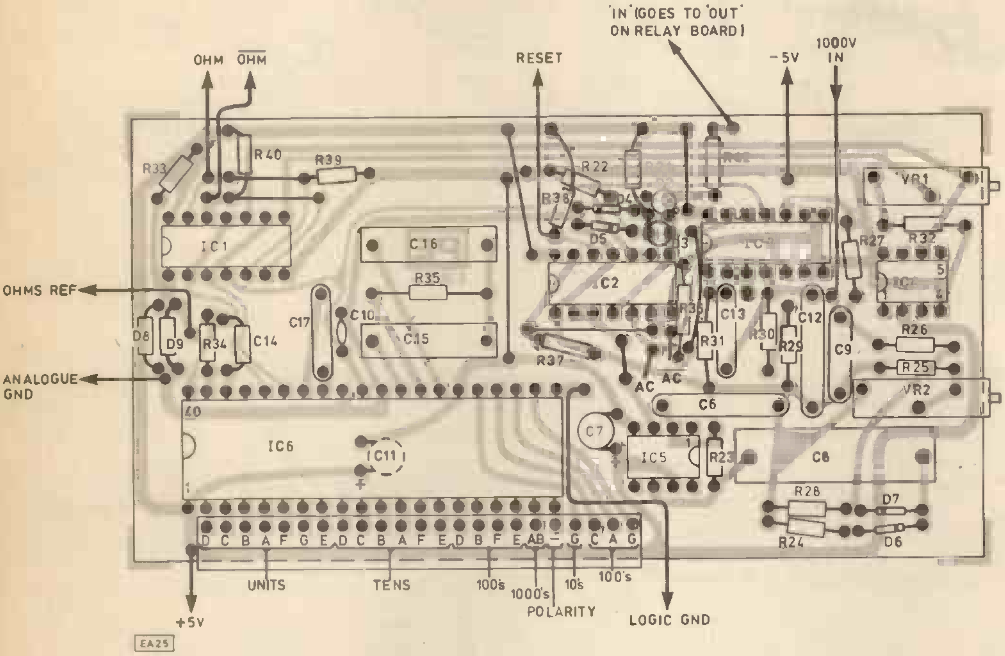




(a)

Table 2.2. Analogue Switch Allocation

I/O pins	Control pin	Switch	Function
		IC1	
3–4	5	S3(b)	OHM
1–2	13	S3(c)	OHM
10–11	12	S4(a)	$\overline{OHM}$
8–9	6	S4(b)	OHM
		IC2	
3–4	5	S1(a)	$\overline{AC}$
1–2	13	S2(a)	$\overline{AC}$
8–9	6	S2(b)	$\overline{AC}$
10–11	12	S3(a)	Reset
		IC3	
10–11	12	S1(b)	AC
1–2	13	S1(c)	AC
3–4	5	S2(c)	$\overline{AC}$



(b)

REF–02 Regulator

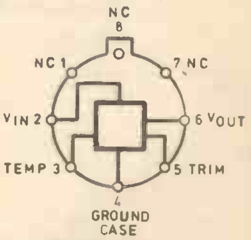
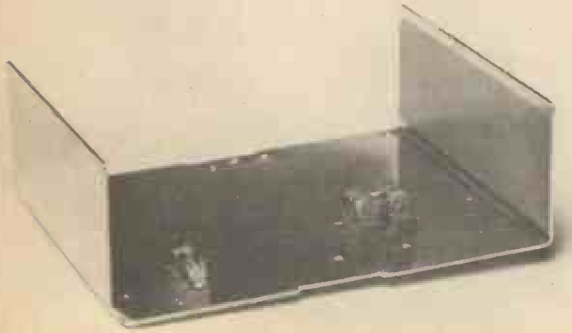
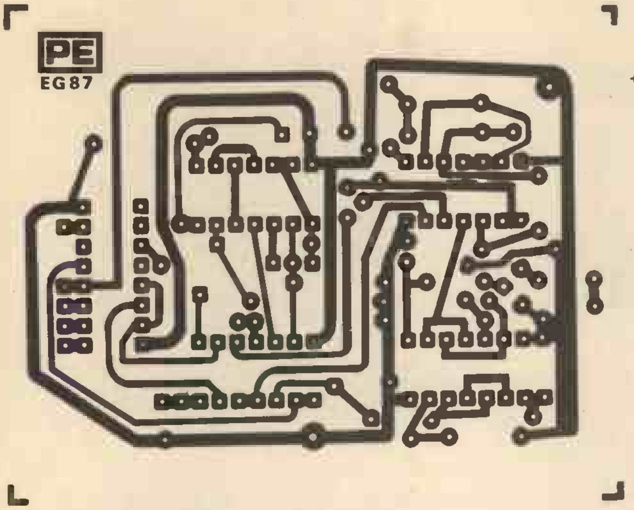


Fig. 2.5. (a) Main Board p.c.b.
(b) Component layout



AUTORANGING MULTIMETER

(a)



(b)

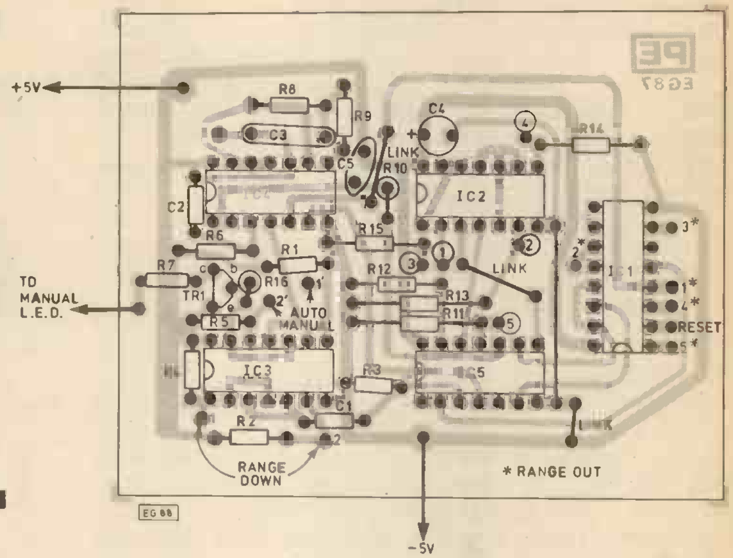


Fig. 2.6. (a) Logic Board p.c.b. (b) Component layout

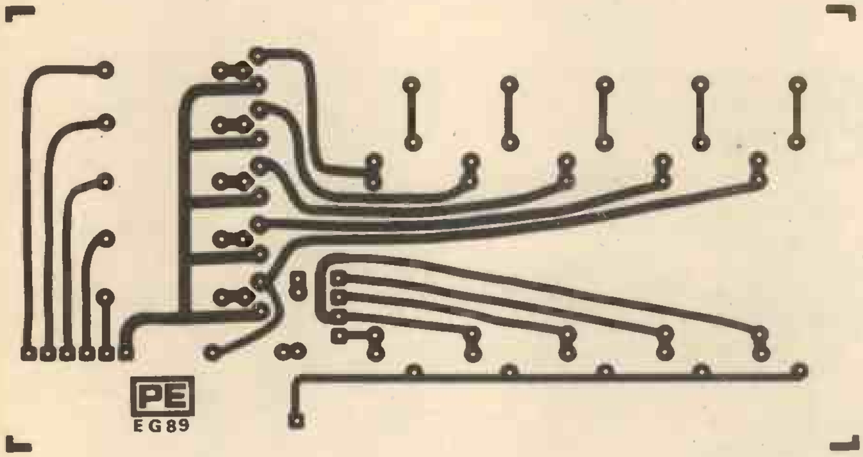
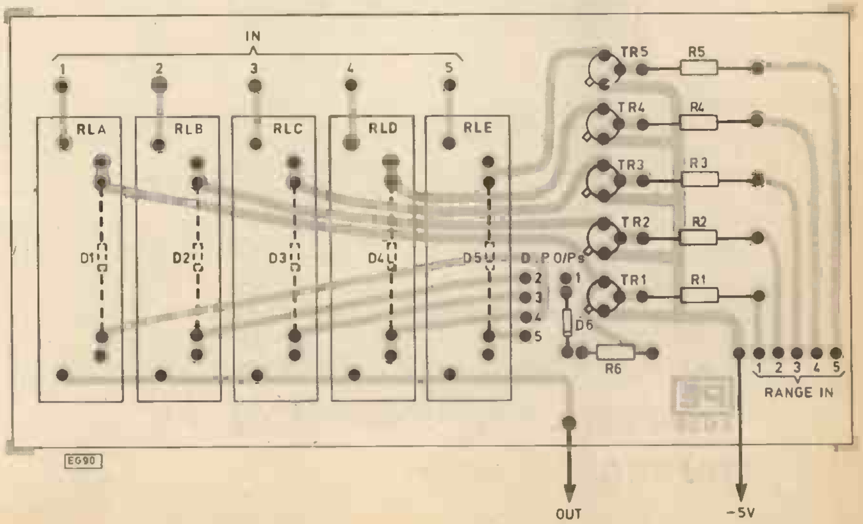


Fig. 2.7. (a) Relay Board p.c.b. (b) Component layout

(a)

(b)



All p.c.b.s are shown full size. Dotted components are mounted on the p.c.b. track side. Some photographs differ from their associated layout diagrams where components have been mounted on the track side initially. It must be emphasized that track layouts are critical for stability, *and must not be altered.*

mains Live side follows two sets of contacts of the mains switch mounted right at the bottom of the function switch. In order to help you with the function switch wiring, Fig. 2.8 and Fig. 2.9 show both the top and the bottom halves of this switch's wafers and associated wiring.

MAIN BOARD PCB DETAILS

The Main Board p.c.b. layout is shown in combined form in Figs. 2.5(a) and 2.5(b). The reason for insertion of a few components on the copper side was to keep the layout around the 7107 device as similar as possible to Intersil recommendations. However, this does not create, in the author's opinion, any serious constructional problems.

Some additional information about component layout can be found from the photographs.

LOGIC BOARD

The Logic Board p.c.b. is shown in Fig. 2.6.

RELAY BOARD

The Relay Board p.c.b. layout is presented in Fig. 2.7(a) and 2.7(b). The only components soldered into the copper side are the five 1N4148 diodes in parallel to the reed relay coils. The reed relays chosen are the popular and economic, yet still high quality, RS348-986 type. The use of this particular type of relay is not critical as long as its rating and size are similar.

INSTRUMENT ENCLOSURE

Since most of you will be electronically minded rather than mechanically minded, you may prefer to get hold of a ready-made attractively styled instrument case complete with stick on feet. We used the RS standard case No. 509-901.

A display window was then cut in the front panel, and the rotary function switch, Mode/Auto manual and Range Down pushbutton switches with corresponding yellow Manual l.e.d. were placed on the left side. All the input sockets (continental 4mm type) were set in at the bottom of the front panel. For ease of identification we used red, with the exception of the Ground socket, which was green.

All Autoranging Multimeter p.c.b.s and fuse holders (except the mains power supply fuse) are mounted into a specially provided aluminium chassis. Last but not least, the rotary function switch requires a little perspex plate (4mm thick) to lock the device and prevent overturning the switch.

CALIBRATION

After calibration of "Set Ref", described last month:

(1) If a known r.m.s. source is available or another accurate DMM, adjust AC Cal. until the reading agrees with the source *or* the other meter.

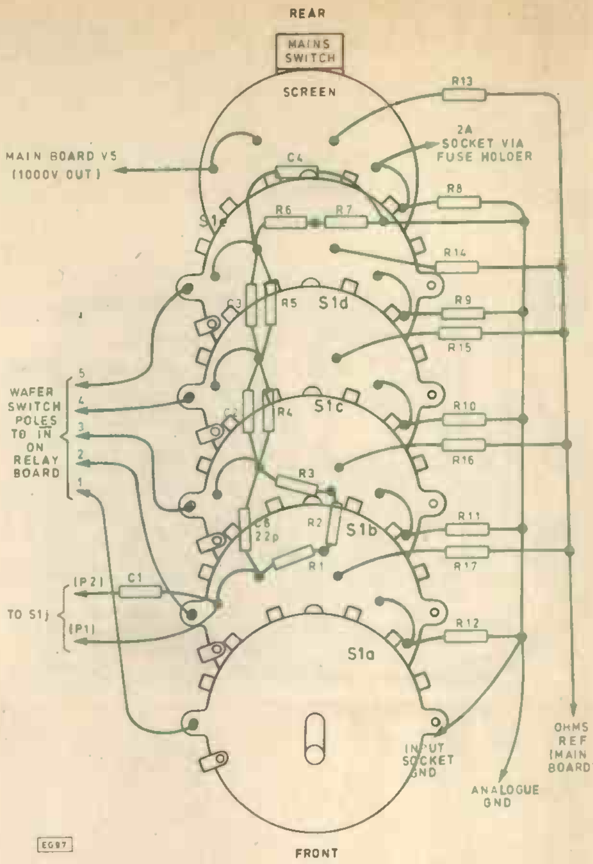
(2) Short the 10n capacitor on function switch and C1, C2.

Preferably keeping to same range: put meter in DC Volts mode, measure any d.c. voltage. Switch to AC Volts mode and adjust AC Cal until reading is 3·2214 times the previous one in DC Mode.

Remove shorts.

IMPORTANT NOTE

It is advisable to calibrate the instrument without removing it from its grounded case. ★



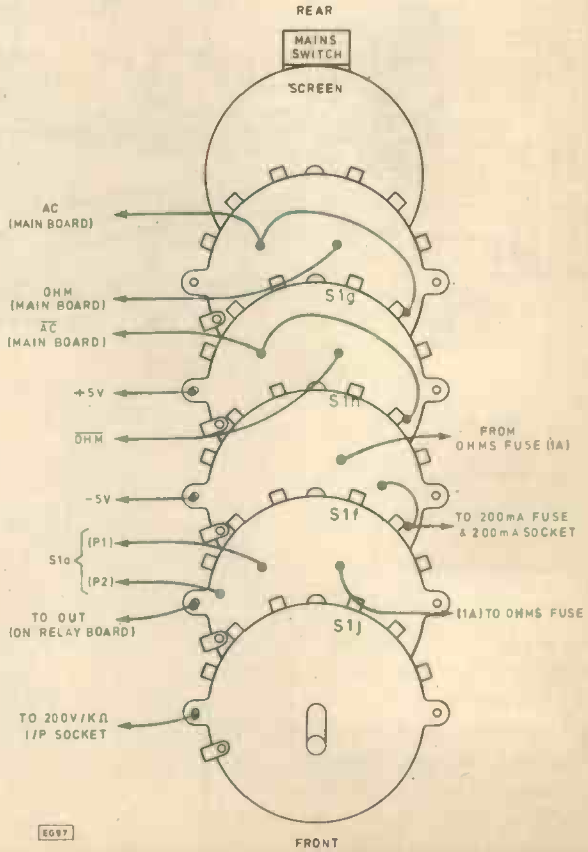


Fig. 2.8. (Top) Shows top half of S1
Fig. 2.9. (Above) Shows bottom half of S1

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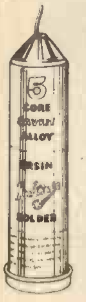

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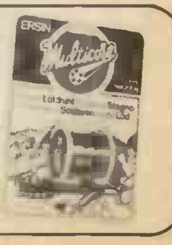

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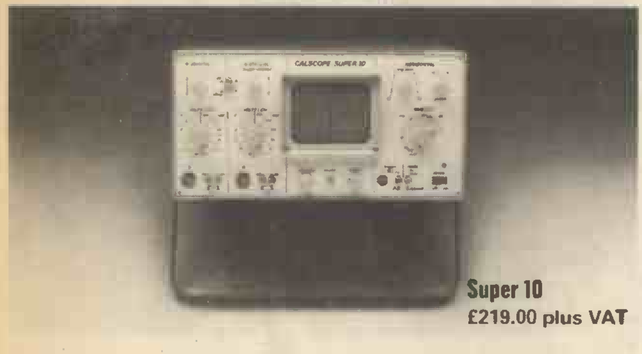

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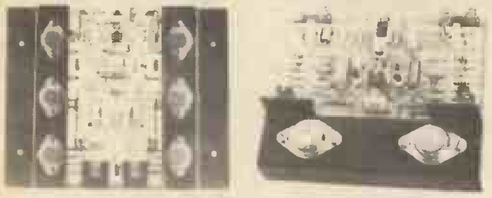

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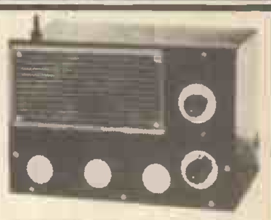

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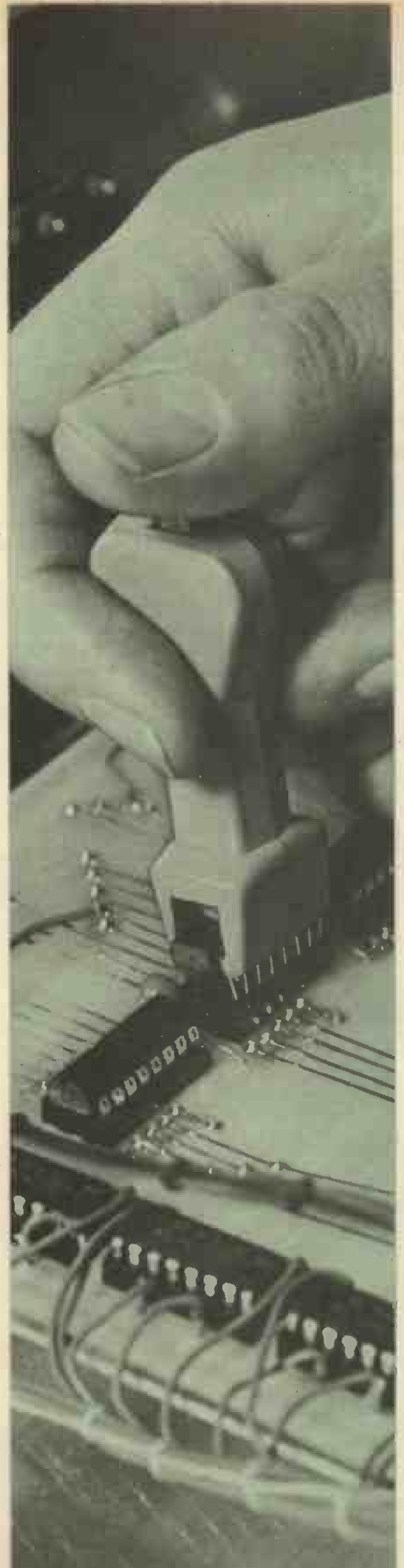

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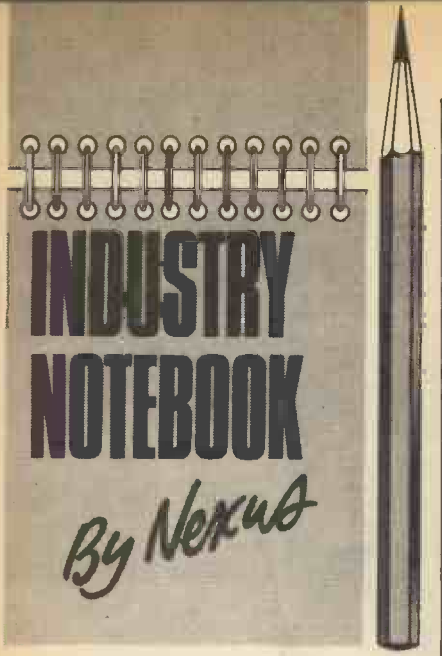
The above photograph shows the tool dismantled. This enables the elastic band, which forms the plunger return spring, to be replaced should it ever perish. The two halves of the body can be parted by carefully inserting a blade in the joint. It is then a simple operation to replace the band and reassemble the tool.

The two halves are held by four fixed pegs which are a tight press fit, no adhesive is used on the joint. It is of course possible to use the tool without the return spring, though it will lose its smooth "feel".



Telecomms

Nothing illustrates better the cruel dilemmas resulting from electronics than the telecommunications business. The old faithful electro-mechanical telephone exchanges are having to give way to modern electronic exchanges requiring less space and less day-to-day maintenance as well as being more efficient and flexible in use and cheaper into the bargain.

But what an upheaval! The Strowger exchange using step-by-step switching through uniselectors and relays is labour-intensive in manufacture. Fine when you could employ low-cost female labour, displaced from the old textile mills, on assembly lines. But times have changed and not only are labour rates much higher today but legislation on equal pay means that the girls cost just as much as the lads. But in any case the run-down of manufacture of the old equipment means redundancy and we already have enough unemployment.

Plessey is one of the unhappy firms faced with problems of the gradual phasing out of Strowger production for the Post Office. Just to change over to electronic exchange production solves nothing because only a quarter of the workforce would be required. Either way people must go, especially as the Plessey factory in Liverpool is said to be losing £7 million per year. The Post Office is reported to be negotiating a revised price for Strowger equipment which will ease the financial problem for Plessey but not cure it in this particular plant. It is a problem which will continue well into the 1980s as electronics products continue their penetration of markets traditionally based on electro-mechanical devices.

The Strowger exchange has a curious history. Its inventor was not, as might be imagined, a highly trained scientist working in a well-equipped laboratory. Almon B. Strowger was a Chicago undertaker whose rival appeared to be getting all the orders for laying out, embalming and subsequent burial. The story goes that he attributed this not to his own lack of skill or even pricing policy but to manual switchboard girls who directed all enquiries to the rival company. He thought an automatic switchboard not relying on people would ensure getting his share of undertaking work and so he set about inventing one. This was in 1889. By 1912 the Strowger system was in full use and, with only minor improvements, has continued to the present day and beyond.

For although the days of Strowger are clearly numbered the British Post Office will still be taking deliveries of the system until at least 1981 and assuming a service life of 20 years it seems that uniselectors will still be clicking away in the 21st Century. It just shows how a fundamentally sound system can last in the face of much more modern technology. The other example is the carbon granule microphone, virtually unchanged in a hundred years, still used in our telephones. Now the Post Office is searching for a modern electronics replacement, a unit which can be an exact replacement insert but with better and more consistent speech quality.

Time Scales

We are so frequently overwhelmed with a seemingly endless flow of new inventions and ideas that they seem almost instantaneous. Actually, time scales are often much longer than we imagine. The semiconductor effect was observed in lead sulphide and iron sulphide in 1874. It was 75 years later that the first crude point-contact transistor was made in a laboratory and another 13 years before the transistor found general acceptance in the electronics industry.

With all the present excitement about VLSI we tend to forget that the first MOS LSI circuits, albeit with a modest device count of only 2,500 elements per chip, were available ten years ago.

Some inventions have to wait for technology to catch up. Pulse code modulation (PCM) was proposed in the 1930s but had to wait for the invention of the transistor before becoming a practical proposition. The laser was a fine invention in 1960 but remained for years a scientific toy while waiting for suitable applications to be found.

On the other hand development can be quite rapid once the principles and the learning curve are established. In little more than a decade communications satellites have increased their capacity from 240 duplex voice channels (Intelsat II, 1967) to 12,000 channels (Intelsat V, 1979).

Speed

State-of-the-art in oscilloscopes was 500MHz bandwidth last year. Now Tektronix has made a huge leap forward in Model 7104 with a bandwidth of 1GHz, allowing direct observation of signals which on less sophisticated equipment are normally invisible. The writing speed of the trace is now an almost incredible 20cm/ns.

To get such performance Tektronix had to improve many aspects of oscilloscope design, not least the CRT itself. As it is virtually a microwave instrument, the p.c.b.s are based on microstrip techniques and even the interconnections are based on microwave technology to reduce internal mismatches and reflection losses. Costing about £15,000 with an appropriate range of plug-in accessories, it is hardly designed for the impecunious hobbyist. But it will clearly appeal to the professional who can now record the fastest transients on ordinary film rather than the elaborate and cumbersome camera techniques formerly necessary.

Control Data Corporation's Cyber 203 computer, just announced, is also another record-breaker. Six times as fast as its predecessor the 203, using a method named vector processing, performs a handy 100 million calculations per second. The 203 is available in a range of sizes, the largest of which has a memory of two million 64-bit words. Price range is a little under £3 million to almost £6 million. First customer is the United States Air Force for three systems.

Computer World

Clearly, the big mainframe computers like the Cyber 203 still command a market but today's pioneering area is still in micro-systems for the hobbyist, the small business and education. The United States, trend-setting as ever, now has hundreds of computer stores doing over-the-counter business. In the UK, Commodore is following suit with a dealer network for the Pet computer which is expected to expand to 100 retail outlets this year.

At the recent Microsystems '79 exhibition in London, some 60 firms showed systems costing as little as £100 up to £5,000 or so. Add-on sales are important. According to one market research report people are spending up to twice the initial processor cost on peripherals and other enhancements to their systems.

VLSI Stakes

GEC-Fairchild, having now appointed its full board of executives, settled on a site at Norton, Cheshire, and with appropriate finance lined up, look like meeting their target date for production next year of general purpose chips for the mass market, as much as two years ahead of Inmos, Britain's other new entrant. A strictly no-nonsense commercial venture, GEC-Fairchild while expecting to employ 1,100 people by mid-1981, will have all assembly work done in the Far East where labour costs are lower. It may seem a pity but necessary if the project is to be successful.

Incidentally, Fairchild has pulled out of the electronic watch business altogether and is cutting back on MPU-based video games. Market instability and low profit margins in the watch game are given as reasons. Fairchild made record sales in 1978, up to $533 million with profits doubling to $24·8 million.

Meanwhile, Inmos has been busy recruiting both in the UK and USA. The U.S. headquarters and technology centre are now to be at Colorado Springs. In the UK the Bristol site will be the technology centre but not necessarily the company HQ.

NEXT MONTH

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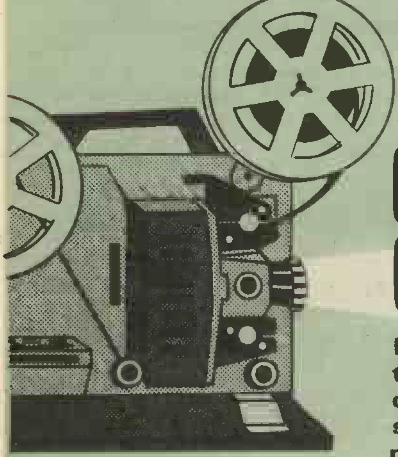
We have been extremely careful with choice of watch—an alarm chrono, with stopwatch and dual time zone facilities. Price, we hope it will fall in the next month so it will be shown on the offer page only, to enable us to fix it at the last possible moment.



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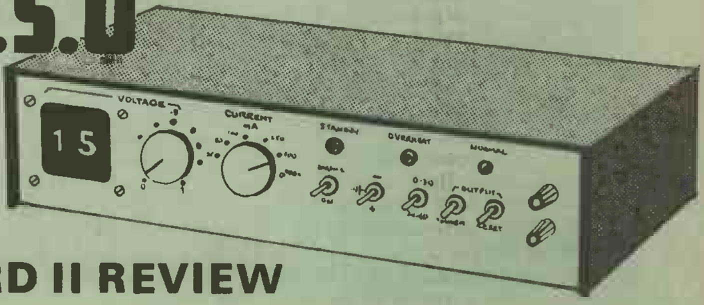

PLUS OHIO SUPERBOARD II REVIEW

PRACTICAL
ELECTRONICS

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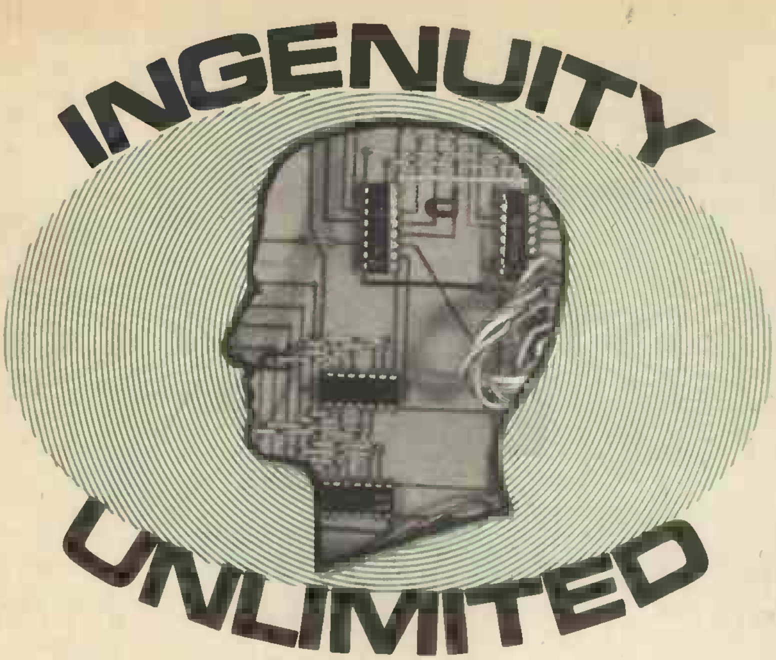


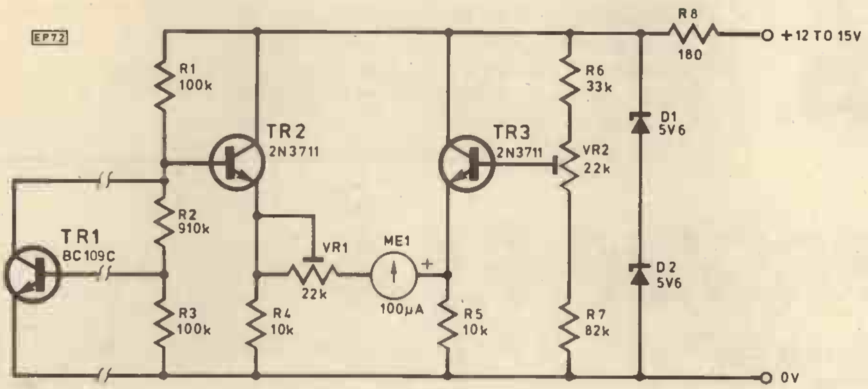
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

CHEAP THERMOMETER



This inexpensive thermometer gives suprisingly good stability and accuracy despite its simplicity.

The heart of the circuit is TR1, which forms the temperature sensitive probe with its own inbuilt amplification. This stage works in the V_{bf} multiplier mode, common in power amplifiers, which amplifies its temperature dependent base-emitter voltage to about −25mV/°C. This voltage is then buffered by TR2.

VR2 picks off an offset voltage to bias TR3 such that the voltage between the emitters of TR2 and TR3 is proportional to the temperature. ME1 and VR1 form a voltmeter to measure this voltage.

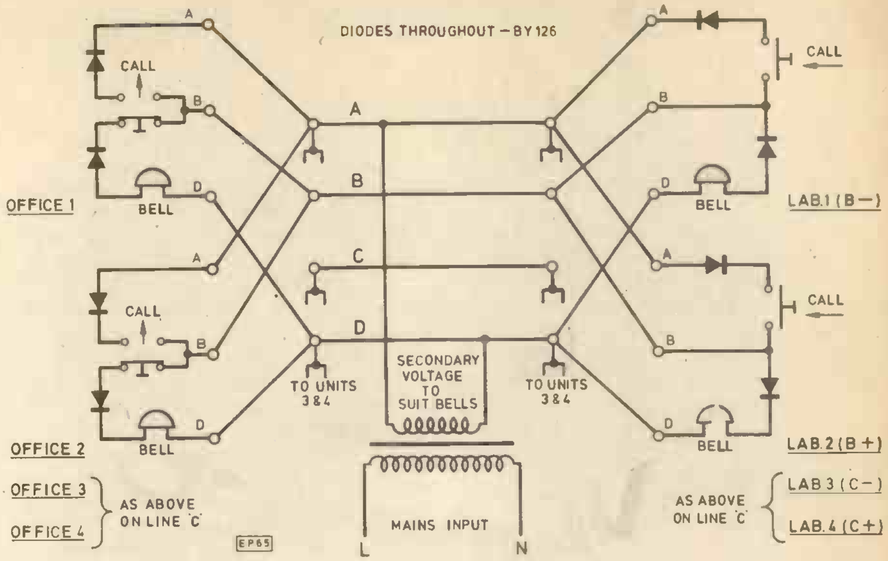
TR2 and TR3 should be glued together for thermal tracking. The supply voltage is regulated by R8, D1 and D2. The use of a high voltage Zener diode is avoided because of its inherent temperature sensitivity. The metering unit is thus fairly free from temperature dependance enabling the probe alone to determine the meter deflection.

The probe should be connected to the metering unit via a suitable heat resistant cable. The leads of TR1 should be encapsulated in a silicon adhesive.

VR2 is adjusted so that the meter reads 0 with the probe in melting ice. VR1 is then adjusted so that the meter reads full scale with the probe in boiling water. The meter scale will then be linear, reading 0 to 100°C.

P. R. Williams,
Stevenage,
Herts.

4 WIRE–8 WAY BELL SYSTEM



WE have four offices, each associated with one of four laboratories some distance away. Each lab and office has a pair of phones on the same extension number, and my bell system is used mainly to call the phones on the other end of the 'pair'. The bell system is, of course, not electrically connected to the phones.

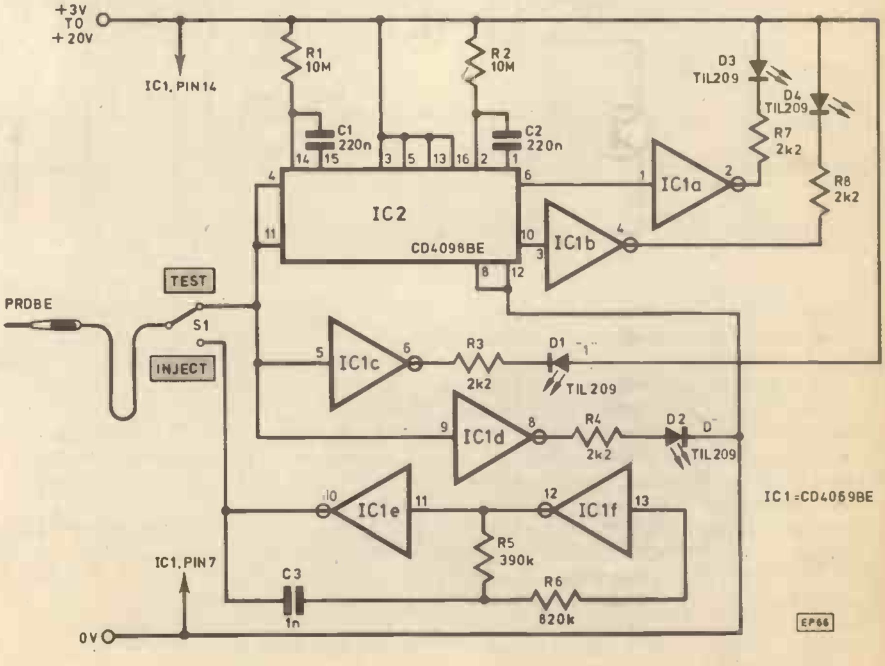
It can be seen that two of the four wires are the power lines and are fed (at any convenient point in the system—ours is fed in one of the labs) with an a.c. voltage to suit the chosen bells or buzzers. The other two calling lines are steered to the appropriate bells by diodes, thus each bell receives half wave rectified a.c. when its calling line is connected to the supply line via a diode of corresponding polarity.

Only two pairs of units are shown on the circuit diagram—the other two pairs are identical, but use calling line C. The office units are shown with change-over push buttons—wired this way, the local bell does not ring when the push button is pressed. The lab units are shown with simple s.p.s.t. buttons—wired this way, each push would ring the bell at both ends of the line at once.

If line D is made an earth return, then the circuit becomes a 'three wire eight way' bell system!

C. P. Finn,
Southwood Park,
Beverley.

CMOS LOGIC PROBE



THE probe employs two 'B' type CMOS integrated circuits to provide a comprehensive logic probe together with a square-wave signal injector. Four light-emitting diodes show the state of the circuit under test. D1 indicates a logic level '1', whilst D2 indicates a logic level '0'. These two are isolated from the external circuit via inverters.

Any logic pulses fire IC2, a dual monostable multivibrator. Positive pulses fire monostable 'a' which feeds D3, whilst negative pulses fire monostable 'b' which feeds D4. Thus a continuous wave-train will light all four. S1 switches between the logic test function and the signal inject function. The signal injector is formed from the two spare inverters in IC1, and oscillates at approximately 1kHz.

D. P. Akerman,
Coventry.

VARITONE STYLOPHONE

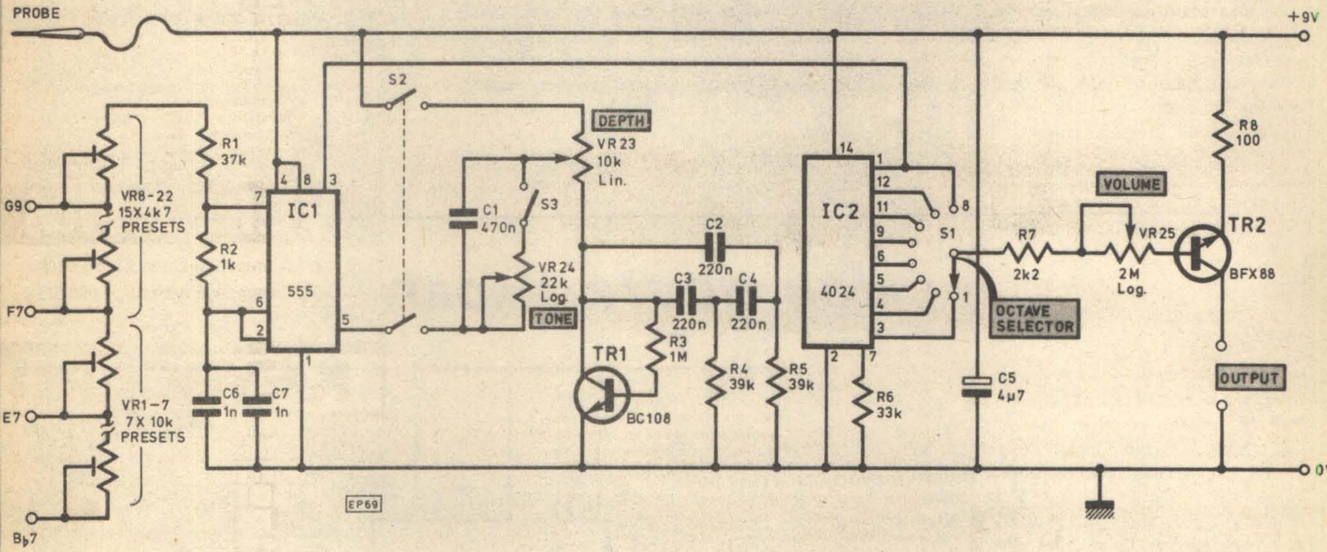
HERE IC1 is connected as an oscillator with a frequency determined by the presets. By touching the probe onto the printed circuit board's "keys" (shown in the etching detail), which are connected to their corresponding presets, IC1 is made to give a frequency of between B♭7 (3729Hz) and G9 (12,544Hz). This squarewave signal is fed into IC2, a CMOS binary divider with its outputs connected to rotary switch S1, which selects the octave required and feeds the signal through TR2, via a volume control potentiometer. The amplified note now passes through a loudspeaker, giving a musical sound. Any number of keys may be included, providing there is a preset to tune each note.

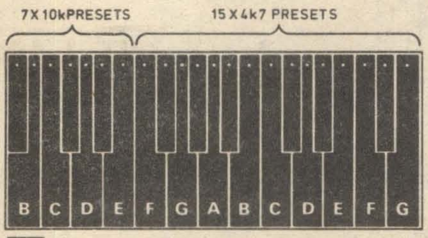
A tremolo effect is added using the circuit around TR1, which provides a 6Hz modulation of variable depth when fed into pin 5 of IC1. Some interesting effects may also be obtained using the "tone control" potentiometer. However, this does alter the pitch of the note produced, and so a switch is included to disconnect it in normal operation.

The squarewave tone output may be modified by passing it through an audio transformer T1 as shown, D1 being required to soak up any back e.m.f. from the windings. The modified output has a harsher quality than the plain squarewave sound.

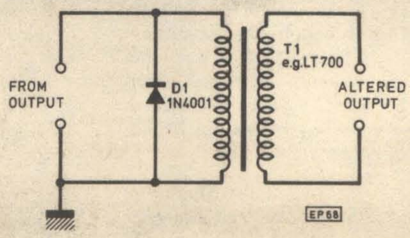
The instrument is tuned using the fifteen 4·7 kilohm and seven 10 kilohm presets connected in series. They should be adjusted to tune the notes starting at the highest and working down the scale.

T. J. Barker,
Reigate,
Surrey.





ETCHED KEYBOARD DETAIL



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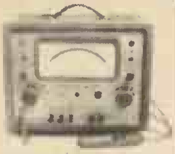

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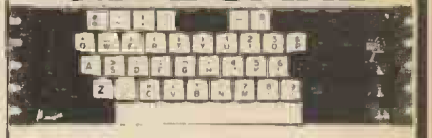
KEYBOARD



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Are your hot parts sweltering? Then keep them cool with our high efficiency radial snail type blowers. Made by Smiths, designed for continuous use in expensive electronic equipment very powerful and quiet, gives massive air flow to prolong component life and reliability. Easily mounted, air aperture 2¼" x 3". Ideal linears etc.
Please state 240v or 110v operation. 50hz only.
BRAND NEW **£4.25** P.P. £1-10

ONE INCH NUMERIC DISPLAYS

This fine example of modern miniature optical engineering consists of a 12 lamp and lens system constructed to project numerals between "0" and "9" and a "+" and "–" sign onto an opaque screen to give extremely legible, rounded characters of up to 1" in height. Features easily replaceable 6 volt bulbs, changeable negative for different character fonts. Dimensions 1½" x 1" x 3¼" supplied complete with bulbs and plug in carrier. Ex- equipment **£1.00**

DISPLAY ELECTRONICS

103 Tamworth Road Croydon CR9 1SG 01688 1833

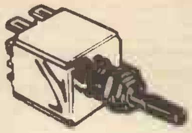
MAIL ORDER INFORMATION:
All prices inclusive of VAT. Cash with order. Minimum order value £1-00. Postage quoted for UK only. Bona Fide account orders minimum £10-00. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard welcome.

MINIATURE SNAIL BLOWER

This superb "little" blower, imagined as a cube measures only 3¼" x 3¼" x 3¼" with a 1¼" x 1¼" air output aperture. Almost silent running, ideal for miniature projectors, computers, P.S.U.'s etc. Brand new at only
Please state 110v or 240v operation.
£3.99 + p.p. 55p.

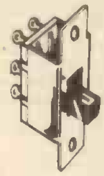
STEVENSON
Electronic Components

SWITCHES



Subminiature toggle. Rated at 3A 250V.
SPDT 65p SPDT centre off 70p
DPDT 75p DPDT centre off 90p

Standard toggle.
SPST 34p DPDT 48p



Wavechange switches.
1P12W, 2P6W, 3P4W or 4P3W all 37p each.

Miniature switches (non-locking)
Push to make 15p Push to break 20p

Slide Switches (DPDT)
Miniature 14p Standard 15p

REGULATORS

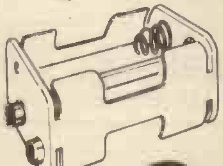
78L05	30p	7805	60p	79L05	70p	7912	80p
78L12	30p	7812	60p	79L12	70p	7915	80p
78L15	30p	7815	60p	7905	80p	LM723	35p

HARDWARE

HEATSINKS

TO18 and TO5 push on type . 9p
TO220 . . . . 20p
TO3 . . . . 22p

BATTERY HOLDERS



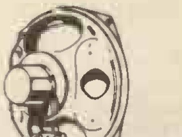
To hold 4 HP7 batteries, square and long types 20p
PP3 clip 6p

CONTROL KNOBS

Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black . 14p

TERMINALS

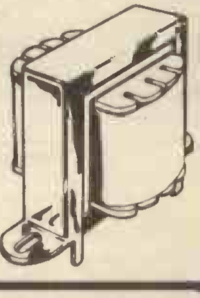
Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . 27p



LOUDSPEAKERS

56mm dia. 8 ohms 70p
64mm dia. 8 ohms 75p
64mm dia. 64 ohms 75p
70mm dia. 8 ohms 100p
70mm dia. 80 ohms 110p

MINIATURE TRANSFORMERS



240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of: 6-0-9, 9-0-9 and 12-0-12. 92p each

TRANSISTORS

AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC148	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214L	10p			2N5459	32p
BC477	19p			2N5777	50p
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

1N914	4p	1N4148	3p
1N4001	4p	1N5401	13p
1N4002	4p	1N5402	15p
1N4004	5p	1N5404	16p
1N4006	6p	1N5406	18p

BZY88 series 2V7 to 33V 8p ea.

74LS

LS00	16p	LS73	29p	LS156	80p
LS01	16p	LS74	29p	LS157	45p
LS02	16p	LS75	44p	LS164	90p
LS03	16p	LS76	35p	LS174	60p
LS04	16p	LS78	35p	LS175	60p
LS08	16p	LS83	60p	LS190	80p
LS10	16p	LS85	70p	LS192	70p
LS13	30p	LS86	33p	LS193	70p
LS14	70p	LS90	45p	LS196	80p
LS20	16p	LS93	45p	LS251	60p
LS30	16p	LS95	65p	LS257	55p
LS32	24p	LS123	56p	LS258	55p
LS37	26p	LS125	40p	LS266	40p
LS40	22p	LS126	40p	LS283	60p
LS42	53p	LS132	60p	LS290	55p
LS47	70p	LS136	36p	LS365	45p
LS48	48p	LS138	54p	LS366	45p
LS54	16p	LS139	50p	LS367	45p
		LS151	50p	LS368	45p
		LS153	50p	LS386	35p
		LS155	80p	LS670	180p

TTL

7400	12p	7454	14p	74132	50p
7401	12p	7473	25p	74141	56p
7402	12p	7474	25p	74148	90p
7404	12p	7475	32p	74150	70p
7408	14p	7476	28p	74151	50p
7410	12p	7485	70p	74156	52p
7413	25p	7489	145p	74157	52p
7414	48p	7490	32p	74164	70p
7420	12p	7492	35p	74165	70p
7427	24p	7493	34p	74170	125p
7430	12p	7494	52p	74174	68p
7442	43p	7495	52p	74177	58p
7447	55p	7496	50p	74190	72p
7448	58p	74121	25p	74191	72p
		74122	33p	74192	64p
		74123	40p	74193	64p
		74125	35p	74196	55p
		74126	35p	74197	55p

LINEAR

THIS IS ONLY A SELECTION!

709	25p	CA3140	70p	NE555	25p
741	22p	LM301AN	28p	NE556	60p
747	50p	LM318N	125p	NE565	120p
748	30p	LM324	50p	NE567	170p
CA3046	55p	LM339	50p	SN76003	200p
CA3080	70p	LM380	75p	SN76013	140p
CA3130	90p	LM382	120p	SN76023	140p
		LM1830	150p	SN76033	200p
		LM3900	50p	SN76477	220p
		LM3909	60p	TBA800	70p
		MC1496	60p	TDA1022	650p
		MC1458	35p	ZN414	75p

CMOS

4001	15p	4018	65p	4050	28p
4002	15p	4023	15p	4066	40p
4007	15p	4024	45p	4068	20p
4011	15p	4026	95p	4069	16p
4013	35p	4027	35p	4071	16p
4015	60p	4028	52p	4075	16p
4016	35p	4029	60p	4093	48p
4017	55p	4040	68p	4510	70p
		4042	54p	4511	70p
		4046	100p	4518	70p
		4049	28p	4520	65p

FULL DETAILS IN CATALOGUE!

CAPACITORS

TANTALUM BEAD

each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V 9p
4.7, 6.8, 10uF @ 25V 13p
22 @ 16V, 47 @ 6V, 100 @ 3V . . . 16p

MYLAR FILM

0.001, 0.01, 0.022, 0.033, 0.047 . . . 3p
0.068, 0.1 . . . 4p

POLYESTER

Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 5p
0.15, 0.22 . . . 7p
0.33, 0.47 . . . 10p
0.68 . . . 14p
1.0uF . . . 17p

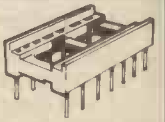
CERAMIC

Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF . . . 2p

RADIAL LEAD ELECTROLYTIC

63V	0.47 1.0 2.2 4.7 10	5p
	22 33 47	7p
	100	13p
	220	20p
25V	10 22 33 47	5p
	100	8p
	220	10p
	470	15p
	1000	23p

SKTS



Low profile by Texas

8 pin 10p 16 pin 13p 28 pin 28p
14 pin 12p 24 pin 24p 40 pin 40p

Soldercon pins: 100:50p. 1000:370p

OPTO

LEDs	0.125in.	0.2in	
Red	TIL209	TIL220	9p
Green	TIL211	TIL221	13p
Yellow	TIL213	TIL223	13p
Clips	3p	3p	

DISPLAYS
DL704 0.3 in CC 130p
DL707 0.3 in CA 130p
FND500 0.5 in CC 100p

CONNECTORS

JACK PLUGS AND SOCKETS

	screened	unscreened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

1mm PLUGS AND SOCKETS

Suitable for low voltage circuits. Red & black.
Plugs: 6p each Sockets: 7p each.

4mm PLUGS AND SOCKETS

Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each

PHONO PLUGS AND SOCKETS

Insulated plug in red or black 9p
Screened plug 13p
Single socket . 7p Double socket . 10p

RESISTORS

Carbon film resistors. High stability, low noise 5%.

E12 series. 4.7 ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

METAL FILM RESISTORS

Very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

	each	100+	1000+
0.25W	4p	3.5p	3.2p

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Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED
Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.
NOTE — Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £3.85 inc. VAT. post & packing UK only.

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Inc. V.A.T. and P.P.	QUANTITY REQ'D.
X4 KIT £16.65	
TACHOPULSE SLAVE UNIT £3.85	

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I enclose cheque/PO's for
£ ....
Cheque No.

Please state polarity pos or neg earth.
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DIGITALLY SYNTHESIZED DOOR CHIME

24 tunes including "Rule Britannia", "Col. Bogie" etc.
Adjustable speed and tone.
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Membrane actuated, very sensitive. ¼" shaft. 250V. 3.75A Contacts. Ideal for greenhouses, centrally heated homes, offices etc., Build your own humidifiers or alarms. Fraction of original cost 50p ea. 5 for £2.

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Self Regulating, will operate 6-12V. Ideal for modelers, mechanical switching etc. 2000 R.P.M. approx 90p ea.

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Transmitter and receiver. 40 kHz 14 mm.diam. £4.25 pair.

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100 MINIATURE REED SWITCHES
We are the cheapest! £3.30

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MAKE CHEAP BATTERY ELIMINATORS
Fully shrouded mini mains transformers. 240V in 6-0-6V at 100 MA out. Complete with mains lead and plug. ex new equip 90p

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Includes 150 sq. ins. copper clad F/G. board. 1 lb ferric chloride. 1 dalo etch resist pen. Abrasive cleaner. Etch tray plus instructions. Special Price £4.95
1 lb FE. C1. To mil. spec. £1.25
5 lb FE. C1. To mil. spec. £5.00
150 sq in. Single sided board £2.00
150 sq in. Double sided board £3.00

SMOKE AND GAS DETECTOR
Uses TGS 105 plug in sensor, housed in neat 3½" die cast box. led indicator. 24V. (12V by altering 3 component values). Will operate lamp or relay. with data and circuit £6.95
Relays for above £1 ea. state voltage

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These cost a fortune! Were made for various music centres. Includes independent and interdependent latching types multi pole c/o etc. Can be modified. Can't be repeated. 3 Banks for £1

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300 mixed ¼ & ½ watt resistors £1.50
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100K MINIATURE THUMBWHEEL SLIDER POTS
Very neat, can be banked side by side. Ideal for v. cap tuning, graphic equalisers etc. 10 for £1

100K STEREO SLIDER POTS
Good quality. 25p ea. 5 for £1

MINIATURE LEVEL/BATT. METERS 200μA
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TBA800 10 for £5·00. ORP61 Mullard boxed 30p. 741 8 Pin 6 for £1. LM3900 35p each. ZN414 75p each.
L.E.D.'s. TIL209 0·2" Red 10p each. Toshiba TLG113 0·2" Green 14p each. TLR120 0·2" Clear Infra Red 19p each. TLG107 Green 0·2" Flat Top 17p each. NE555 Timers 27p each.

TRANSFORMERS. 6-0-6v 100ma, 9-09 75ma, 12-012 50ma 75p each, 12-012 100ma 95p, 12v 500ma 95p, 1:1 triac/xenon pulse transformers 30p, CHOKES 6MH 3 amp 20p. U.H.F. TV Tuners, push button (not varicap) new and boxed £2·50p. Miniature toggle switches, SPST 8 x 5 x 7 45p, DPDT 8 x 7 x 7 50p, DPDT c/o 12 x 11 x 9 75p, Min. push to make or push to break 16 x 16mm 15p each type. Texas BY205 800v 6a Sil. Rects 18p each. Nat Sem. LM340T 6v 1a voltage regs 40p. AD161/162 matched pair 70p pair.

TOOLS Small side cutters 5" insulated handles £1·35p. Snub nosed pliers 5" insulated handles £1·35p. Board with 14 12 volt reed relays £1·95p. Large mains tester screwdrivers, fully insulated 8" 44p. Test lead jumper sets, 10 leads with insulated croc clips each end different colours 80p. Telephone pick up coil, suction type with 3.5 mm jack plug 50p. 9 volt battery eliminators, 240v ac input 9v dc out at 120 mA, stabilised replaced PP3, PP6, PP7, PP9 £2·45p, Edge connectors, 0·1 64 way 65p, 34 way 40p, 0·2 18 way 15p, Murata MA4Ur. 40KH2. Transducers Rec/Sender, £3·25p pair. Tape head demagnetisers, 240v ac with on/off switch, straight probe £2·00, curved probe (cassette) £2·35p.

TERMS: cash with order, (of official orders from colleges etc). Postage 30p unless otherwise shown, overseas post at cost. VAT inclusive prices S.A.E. for new illustrated lists.

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20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet. Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic. magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features two mains outlets DIN speaker and input sockets plus fuse 20x20 watts RMS 40x40 watts peak. For use with 8 to 15 ohm speakers.

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30x30 WATT AMPLIFIER IN KIT FORM

For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output. 60x60 watts peak. For use with 4-15 ohms speakers.

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30x30 WATT AMPLIFIER IN KIT WITH SPEAKERS

2 GOODMAN compact 12" bass woofers with cropped size 14,000 Gauss magnet. 30 watts RMS handling, plus 2, 3" approx. tweeters and cross overs to suit.

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Mullard

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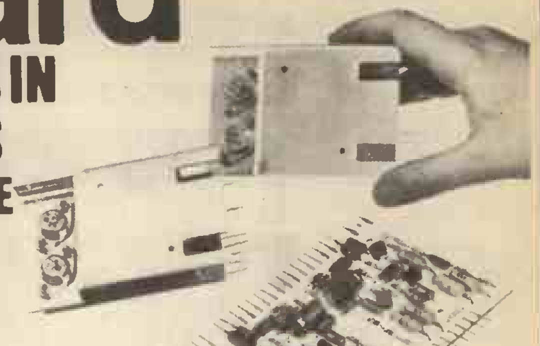

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OUR PRICE p+p £1.00 **£4.95**

2 PACK 2. 2 x LP1173 10w. RMS output power audio amp modules + 1 LP1184/2. Stereo pre amp for magnetic, ceramic and auxiliary inputs.
illus. OUR PRICE p+p £1.00 **£7.45**

ACCESSORIES

Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary stereo controls for treble, bass, volume and balance.

£2.90 plus £1.50 p & p

Two Way Speaker Kit

Comprising of two 8" x 5" approx. 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors.

£3.95 per stereo pair plus £1.50 p & p

Available also to purchasers of the 10 + 10 Amplifier Kit.

EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround; 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

£14.95 Per stereo pair + £3.40 p&p.

10 + 10 AMPLIFIER KIT

An opportunity to buy a 10 watts per channel stereo amplifier kit which is suitable for use with a ceramic cartridge. The amplifier utilises proven Mullard modules and is available at a very competitive price. The amplifier kit comes complete with instructions and includes: a Mullard LP1183 stereo preamplifier module, two LP1173 power amplifiers with integral heatsinks, a power supply, Zobel networks, front and back mounting panels, a finished fascia panel, all control potentiometers (bass, treble, volume and balance), switches, input, output and headphone sockets, wire, and an easily assembled wrap around cabinet to house the finished unit.

p&p £2.05 **£11.95**

BSR P200

Belt drive chassis turntable unit semi automatic, cueing device. **£24.95** p&p £2.55

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BSR

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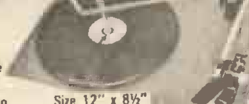

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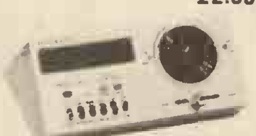

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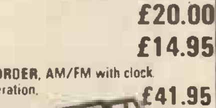

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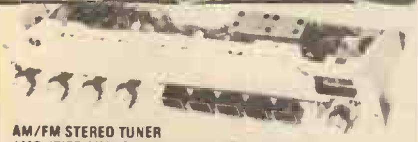

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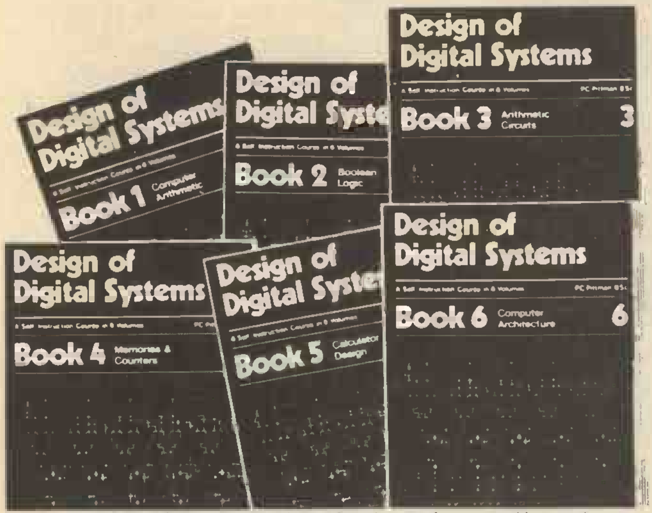

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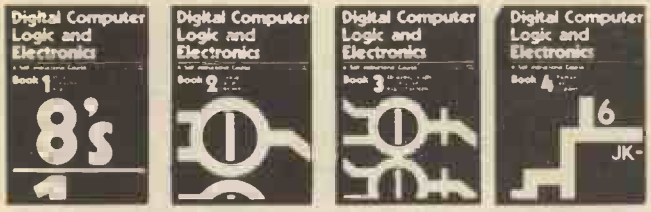

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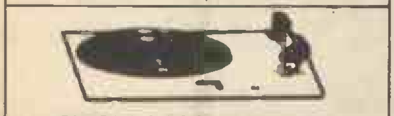

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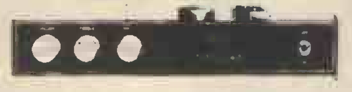

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IM 380N	95p
AD 161 & 162 PR	99p

Electrolytic Cap. 50 for 99p (P&P 30p)

3" 8Ω SPHR	99p (P&P 30p)
20 x 2N930	99p
4" 8Ω SPHUR	£1.44 (P&P 30p)

Transformers P&P 60p VAT 8%

6-0-6 100 ma	93p	9-0-9 1 amp	£2.44
6-0-6 1.5amps	£3.20	12-0-12 1 amp	£2.69
12-0-12 100mA	99p	15-0-15 1 amp	£2.69
30-0-30 2 amp	£5.50	30-0-30 1 amp	£3.10

TRANSISTORS

TYPE	PRICE
AC107	0.23
AC125	0.17
AC126	0.17
AC127	0.16
AC127K	0.23
AC128	0.14
AC128K	0.25
AC128/176	0.42
AC142	0.18
AC153	0.55
AC158	0.50
AC176	0.16
AC187	0.50
AC187K	0.55
AC188K	0.55
ACY20	1.02
ACY22	1.02
AD142	0.87
AD143	0.87
AD149	0.65
AD161	0.35
AD161/162	0.70
AD162	0.35
AD262	0.36
AD263	0.36
ADY26	4.74
ADZ11	4.05
AF106	0.45
AF109R	0.36
AF124	0.25
AF125	0.26
AF126	0.25
AF127	0.25
AF139	0.32
AF178	0.30
AF179	0.30
AF200	0.36
AF201	0.39
ASY73	0.30
ASZ15	0.60
ASZ16	0.60
ASZ17	0.60
AU103	0.90
AU107	1.00
AU110	0.90
AU210	0.90
BC107	0.06
BC107A	0.07
BC107B	0.07
BC108	0.06

BC108A	0.07
BC108	0.07
BC109	0.06
BC109B	0.07
BC109C	0.07
BC113	0.12
BC114	0.15
BC116	0.13
BC117	0.15
BC118	0.12
BC119	0.25
BC125	0.15
BC125B	0.16
BC126	0.15
BC136	0.15
BC137	0.15
BC138	0.30
BC140	0.27
BC141	0.29
BC142	0.20
BC147	0.06
BC147B	0.07
BC148	0.06
BC148A	0.07
BC148B	0.07
BC149	0.06
BC157	0.06
BC157A	0.07
BC158	0.07
BC158A	0.08
BC158V1	0.09
BC159	0.06
BC159A	0.07
BC159B	0.07
BC161	0.25
BC167	0.06
BC168	0.06
BC169	0.06
BC170B	0.07
BC170C	0.07
BC171	0.06
BC171A	0.07
BC171B	0.07
B172	0.06
BC172A	0.07
BC172B	0.07
BC172C	0.07
BC173	0.06
BC173B	0.07
BC174B	0.07
BC177A	0.12

BC177B	0.12
BC178B	0.12
BC179	0.12
BC182A	0.09
BC182B	0.09
BC183A	0.09
BC183LA	0.09
BC183LB	0.10
BC184	0.08
BC184L	0.09
BC184LB	0.10
BC186	0.19
BC187	0.19
BC204	0.08
BC204B	0.09
BC206	0.10
BC206B	0.11
BC207	0.10
BC209B	0.09
BC212A	0.10
BC213L	0.10
BC214L	0.10
BC237	0.15
BC237A	0.16
BC237C	0.21
BC238	0.15
BC238B	0.16
BC238C	0.18
BC251A	0.15
BC251B	0.17
BC252A	0.15
BC252B	0.17
BC252C	0.20
BC258	0.20
BC261A	0.10
BC262	0.20
BC267A	0.21
BC267B	0.22
BC268	0.21
BC304	0.25
BC307	0.15
BC307A	0.15
BC307B	0.15
BC308	0.15
BC309A	0.15
BC317B	0.15
BC322	0.10
BC327	0.16
BC328	0.16
BC337	0.16
BC338	0.16

BC348A	0.15
BC350A	0.17
BC441	0.20
BC461	0.24
BC546	0.10
BC547	0.11
BC547A	0.11
BC547B	0.11
BC547C	0.11
BC548A	0.11
BC548B	0.11
BC548C	0.11
BC549A	0.11
BC549B	0.11
BC550	0.11
BC557	0.11
BC557A	0.11
BC557B	0.11
BC557C	0.11
BC558	0.11
BC558A	0.11
BC558B	0.11
BC559B	0.11
BCY42	0.55
BCY58	0.20
BCY71	0.13
BCY72	0.13
BD115	0.30
BD116	0.30
BD123	0.60
BD128	1.02
BD131	0.35
BD133	0.40
BD135	0.30
BD136	0.30
BD137	0.30
BD138	0.30
BD139	0.30
BD140	0.30
BD144	0.30
BD168	0.50
BD178	0.72
BD181	1.32
BD183	1.50
BD232	0.60
BD233	0.60
BD234	0.60
BD235	0.40
BD236	0.40
BD237	0.40
BD238	0.40
BD434	0.40
BD507	0.50

BD508	0.50
BD518	0.50
BD537	1.02
BD587	1.40
BDX32	1.90
BDY16	0.50
BDY20	0.50
BF115	0.35
BF121	0.20
BF123	0.20
BF125	0.20
BF127	0.20
BF137	0.21
BF152	0.15
BF154	0.15
BF157	0.37
BF158	0.15
BF167	0.25
BF173	0.20
BF174	0.20
BF177	0.25
BF178	0.25
BF179	0.25
BF180	0.20
BF181	0.20
BF182	0.20
BF183	0.20
BF184	0.20
BF185	0.20
BF194	0.06
BF194A	0.07
BF195	0.06
BF195D	0.07
BF195G	0.07
BF196	0.06
BF197	0.06
BF198	0.06
BF224	0.18
BF253	0.18
BF254	0.18
BF255	0.18
BF257	0.16
BF258	0.28
BF259	0.28
BF324	0.20
BF335	0.20
BF338	0.45
BF457	0.60
BF523	0.22
BF594	0.10
BFR91	5.00
BFT43	0.54
BFX29	0.20

BFX43	0.70
BFX84	0.20
BFX85	0.20
BFX88	0.20
BFY18	0.50
BFY19	0.50
BFY33	0.50
BFY34	0.50
BFY46	0.50
BFY51	0.12
BFY52	0.12
BFY81	4.00
BRY39	0.35
BSX20	0.18
BSX52	0.33
BSY20	0.21
BSY25	0.30
BSY26	0.30
BSY27	0.30
BSY29	0.54
BSY39	0.15
BSY52	0.33
BSY54	0.39
BSY56	0.36
BSY60	0.36
BSY84	0.30
BU105	1.08
BU105-04	1.08
BU108	1.80
BU126	1.00
BU133	1.75
BU204	1.30
BU205	1.30
BU208	1.50
BU208-02	1.75
BU406	3.60
BUY69A	6.75
BUY69B	2.00
BUY69C	7.00
BUY70A	5.00
BUY71	4.50
MPS6517	0.48
MPS6523	0.27
MPSA06	0.90
MV5053	0.72
NKT214	0.25
NKT224	0.25
OC22	1.40
OC26	1.40
OC29	0.85
OC36	1.00
OC44	0.12
OC45	0.12

OC71	0.09
OC74	0.10
OC75	0.10
OC82	0.48
OC139	0.50
OC203	2.50
OC207	2.70
OC1072	2.50
OC1074	2.50
R2008B	2.10
TIP30	0.35
TIP31	0.45
TIP31A	0.45
TIP32	0.45
TIP33	0.60
TIP42	0.60
TIP2955	0.65
TIS90	0.18
2N344B	0.30
2N404	0.45
2N524	0.48
2N526	0.48
2N527	0.48
2N685	3.50
2N705	0.10
2N706	0.10
2N706A	0.11
2N708	0.12
2N1039	0.15
2N1059	0.15
2N1101	0.15
2N1102	0.15
2N1132	0.20
2N1304	0.50
2N1305	0.50
2N1307	0.50
2N1309	0.50
2N1613	0.18
2N1671	1.10
2N1671B	2.20
2N1711	0.20
2N1893	0.25
2N1905	0.25
2N1990	0.25
2N2060	1.00

2N2188	0.20
2N2218A	0.22
2N2222	0.18
2N2222A	0.20
2N2270	0.39
2N2368	0.10
2N2484	0.18
2N2904	0.18
2N2906	0.18
2N3053	0.15
2N3117	1.00
2N3440	0.70
2N3638	0.15
2N3638A	0.16
2N3643	0.24
2N3692	0.24
2N3705	0.06
2N3706	0.06
2N3707	0.06
2N3711	0.06
2N3819	0.20
2N3899	3.00
2N3904	0.06
2N3905	0.06
2N3906	0.06
2N4037	0.25
2N4058	0.10
2N4222A	0.65
2N4348	2.00
2N4448	1.50
2N4914	3.50
2N5172	0.25
2N5245	0.30
2N5296	0.40
2N5458	0.25
2N5496	0.60
2N5670	0.65
2N5926	0.55
2N6123	0.65
2S003	0.75
2S303	0.90
2S304	0.90
2S305	0.90
2S323	1.00
2S732	1.00

TTL / CMOS

TTL						CMOS			
7400	.12	7476	.13	74161	.80	4000	.15	4073	.20
7401	.12	7483	.75	74163	.80	4001	.15	4075	.20
7402	.12	7484	.90	74164	.90	4002	.20	4076	1.10
7403	.12	7485	.90	74165	.90	4006	.95	4078	.20
7404	.13	7486	.26	74166	1.00	4007	.20	4081	.20
7405	.13	7489	2.00	74167	2.70	4008	.94	4082	.20
7406	.29	7490	.35	74170	1.70	4009	.46	4502	.90
7407	.29	7491	.65	74172	4.00	4010	.50	4507	.52
7408	.14	7492	.45	74173	1.20	4011	.15	4508	2.30
7409	.14	7493	.36	74174	.90	4012	.15	4510	1.10
7410	.13	7494	.80	74175	.70	4013	.35	4511	.70
7411	.18	7495	.55	74176	.90	4014	.85	4512	.95
7412	.21	7496	.62	74177	.90	4015	.80	4516	.70
7413	.25	7497	2.40	74178	1.20	4016	.45	4518	.65
7414	.54	74100	.95	74179	1.10	4017	.55	4520	1.10
7416	.27	74105	.40	74180	.70	4018	.90		
7417	.27	74107	.28	74181	1.95	4019	.45		
7420	.13	74109	.45	74182	.75	4020	.60		
7421	.28	74110	.46	74184	1.20	4021	.85		
7423	.25	74111	.70	74185	1.20	4022	.85		
7425	.22	74116	1.60	74186	7.20	4023	.20		
7426	.25	74118	.82	74188	5.40	4024	.68		
7427	.25	74119	1.30	74190	1.10	4025	.20		
7428	.34	74120	.82	74191	1.00	4026	1.35		
7430	.13	74121	.26	74192	1.00	4027	.35		
7432	.24	74122	.40	74193	1.10	4028	.70		
7433	.32	74123	.55	74194	.92	4029	.90		
7437	.24	74125	.45	74195	.85	4030	.50		
7438	.24	74126	.46	74196	.92	4033	1.40		
7440	.13	74128	.62	74197	.92	4035	1.10		
7441	.52	74132	.70	74198	1.60	4040	.90		
7442	.55	74141	.58	74199	1.50	4041	.80		
7444	.90	74142	2.02			4042	.75		
7445	.70	74143	2.02			4043	.85		
7446	.70	74144	2.02			4044	.85		
7447	.66	74145	.65			4049	.28		
7448	.60	74147	1.35			4050	.45		
7450	.13	74148	1.20			4051	.88		
7451	.13	74150	1.00			4052	.88		
7452	.13	74151	.60			4053	.88		
7454	.13	74153	.60			4055	1.00		
7460	.13	74154	1.06			4060	1.00		
7470	.28	74155	.63			4066	.35		
7472	.22	74156	.63			4068	.20		
7473	.26	74157	.63			4069	.20		
7474	.20	74158	.70			4070	.20		
7475	.28	74160	.80			4072	.20		

RESISTORS

¼W Values available in E12 series from 10R to 1M Price 0.03 each.
½W Values available in E 12 series from 1R0 to 10M Price 0.03 each.
1W Values available in E12 series from 2R2 to 10M Price 0.06 each.
2W Values available in E12 series from 10R to 10M Price 0.11 each.
5W Values available in E6 series from 1R0 to 6K8.
Prices 1R0 to 1K0 0.19 each.
1K5 to 3K3 0.22 each.
4K7 to 6K8 0.24 each.
7W Values available in E12 series from R47 to 22K.
Prices R47 to R82 0.25 each.
1R0 to 1K0 0.26 each.
1K2 to 12K 0.27 each.
15K to 22K 0.28 each.
11W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 1K0 0.29 each.
1K5 to 12K 0.30 each.
15K to 22K 0.35 each.
17W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 4K7 0.39 each.
6K8 to 22K 0.41 each.

½W Single turn cermet potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K, 200K, 500K, 1M
Price 0.97 each.

½W Multiturn cermet potentiometer. Values available 20R, 50R, 100R 200R, 500R, 1K0 2K0, 5K0, 10K, 20K, 100K, 500K.
Price 1.40 each.

1W Potentiometer with 2" spindle. Values available 10R, 25R, 50R, 100R, 250R, 500R, 1K0, 2K5, 5K0, 10K, 20K.
Prices 10R to 5K0 1.61 each.
10K & 20K 1.62 each.

1.5W Convergence preset potentiometer. Values available 5R0, 7R0, 10R, 15R, 20R, 100R, 500R.
Price 0.50 each.

2W 10 Turn potentiometer. Values available 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K.
Price 7.34 each.

DIODES

AA119	0.17	BB105G	0.36	BY201 3	0.40	ITT210	1.36	OA202	0.07
AA121	0.11	BB110G	0.45	BY201-4	0.45	ITT827	2.36	ST2	0.14
AA129	0.08	BB142	1.25	BY201-5	0.56	ITT921	0.20	1N4001	0.04
AA143	0.15	BR100	0.20	BY201-6	0.56	ITT923	0.35	1N4002	0.05
AA144	0.09	BR101	0.30	BY203-12	0.60	ITT1075	0.25	1N4003	0.05
BA102	0.30	BY100	0.20	BY203-16	0.65	ITT2001	0.25	1N4004	0.06
BA111	0.08	BY103	0.36	BY203-20	1.00	ITT2002	0.20	1N4005	0.06
BA115	0.25	BY118	1.46	BY204-4	0.45	MR502	0.75	1N4006	0.07
BA145	0.15	BY126	0.16	BY204-8	0.66	MR813	0.90	1N4007	0.08
BA148	0.12	BY127	0.10	BY204-10	0.75	MR854	1.80	1N4148	0.04
BA154	0.10	BY130	0.16	BY206	0.30	MR856	2.10	1N4150	0.45
BA155	0.12	BY133	0.10	BY210-400	0.45	MR992A	1.55	1N4448	0.25
BA156	0.12	BY134	0.45	BY210-600	0.50	MV2203	1.60	1N5401	0.12
BA157	0.46	BY142	0.46	BY210-800	0.55	MV5460	0.86	1N5402	0.15
BA158	0.65	BY164	0.50	BYX10	0.38	OA47	0.07	1N5403	0.15
BA159	0.75	BY176	3.45	BYX55-350	0.45	OA70	0.07	1N5404	0.18
BA182	0.46	BY179	0.90	BYX55-600	0.55	OA71	0.38	1N5405	0.25
BA201	0.15	BY182	1.05	BYX71-350	0.90	OA81	0.12	1N5406	0.20
BA243	0.85	BY184	0.70	BYX71-600	1.15	OA85	0.12	1N5407	0.19
BAX13	0.06	BY187	1.30	BZX61 series	0.18	OA86	0.20	1N5408	0.20
BAX16	0.07	BY198	0.75	BZY88 series	0.08	OA90	0.07	1N5450A	6.75
BAX17	0.10	BY199	0.56	OK13	0.45	OA91	0.06	1N5761	0.60
BB105B	0.35	BY201-2	0.40	ITT44	0.10	OA95	0.06		

LINEAR INTEGRATED CIRCUITS

CA3020	1.75	SC9504P	2.00	TAA300	3.75	TBA400	2.26	TBA750Q	2.50
CA3046	0.80	SL414A	4.86	TAA310	3.15	TBA510	2.40	TBA800	0.90
CA3048	2.50	SL415A	6.30	TAA320	2.60	TBA510Q	2.50	TBA800Q	2.85
CA3065	1.58	SL901B	8.60	TAA350A	3.00	TBA520	2.50	TBA810A	3.40
CA3089E	7.88	SL917B	10.70	TAA435	3.40	TBA520Q	2.50	TBA810S	1.10
CA3090Q	4.60	SL1310	8.66	TAA550	0.50	TBA530	2.60	TBA820	0.80
ETT6016	4.96	SL1327	2.76	TAA550B	0.40	TBA530Q	2.50	TBA915	7.36
ETTR6016	4.96	SL3046	2.60	TAA570	2.86	TBA540	2.60	TBA920	3.00
MC1303L	1.60	SN76003N	2.60	TAA621	6.96	TBA540Q	2.25	TBA920Q	3.60
MC1304P	2.00	SN76003NO	2.16	TAA630	8.56	TBA550	3.60	TBA950-2	5.40
MC1305	8.15	SN76013N	1.60	TAA630S	8.10	TBA550Q	3.80	TBA950-2X	6.04
MC1307P	2.86	SN70613NO	2.16	TAA661A	1.70	TBA560	6.46	TBA990	4.95
MC1310P	1.00	SN76023N	1.50	TAA661B	1.80	TBA560C	4.60	TBA990Q	3.75
MC1327P	2.76	SN76023NO	2.15	TAA700	3.60	TBA560Q	7.36	TCA160	6.10
MC1327PO	2.60	SN76033N	2.40	TAA840	4.50	TBA560CQ	3.00	TCA270	3.00
MC1330P	1.26	SN76110N	1.50	TAD100	1.36	TBA570	2.00	TCA270B	3.60
MC1339P	3.96	SN76131N	2.00	TBA120A	3.06	TBA570Q	2.00	TCA270Q	3.60
MC1349	3.36	SN76226N	3.15	TBA120AS	1.60	TBA641A12	6.20	TCA270S	2.26
MC1351P	1.26	SN76226ND	3.15	TBA120S	2.70	TBA641B11	5.86	TCA270SQ	3.40
MC1352P	1.46	SN76227N	2.60	TBA120SB	1.80	TBA673	5.00	TCA800	6.40
MC1358PQ	3.86	SN76532N	3.16	TBA120SQ	1.60	TBA700	3.96	TCA800Q	12.40
SAA570	4.20	SN76533N	2.70	TBA281	4.70	TBA700Q	2.26	TCA830	3.10
SAA7008	10.15	SN76544N	1.80	TBA350A	3.00	TBA720	5.10	TDA440	6.75
SAS560	2.76	SN76550N	1.80	TBA396	1.80	TBA720A	5.10	TDA1327	2.85
SAS570	2.75	SN76660N	0.80	TBA440	3.60	TBA720AQ	2.10	TDA1327B	2.85
SBA750B	6.75	SN76666N	1.80	TBA440S	3.96	TBA750	2.40	TDA1330	1.60
SC9503P	2.00			TBA480Q	2.50			741	0.26

BRIDGE RECTIFIERS

CURRENT	VOLTAGE	ORDER CODE	PRICE
1A	50V	B1/50	0.26
1A	100V	B1/100	0.26
1A	200V	B1/200	0.28
1A	400V	B1/400	0.30
1A	800V	B1/800	0.34
2A	50V	B2/50	0.40
2A	100V	B2/100	0.45
2A	200V	B2/200	0.55
2A	400V	B2/400	0.65
2A	800V	B2/800	0.70
3A	200V	B3/200	0.70
3A	600V	B3/600	0.80
4A	100V	B4/100	0.90
4A	400V	B4/400	0.96
6A	50V	B6/50	0.95
6A	200V	B6/200	1.10
6A	400V	B6/400	1.20
10A	400V	B10/400	2.50
25A	50V	B25/50	4.00
25A	200V	B25/200	4.20
25A	400V	B25/400	4.30

I. C. SOCKETS

NO. OF PINS	ORDER CODE	PRICE
8	D8	0.10
14	D14	0.11
16	D16	0.13
20	D20	0.30
22	D22	0.35
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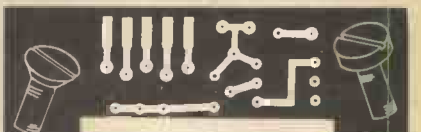

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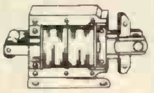

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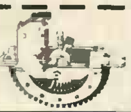

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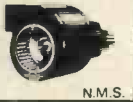

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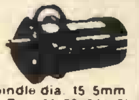

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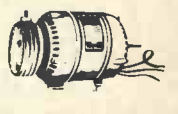

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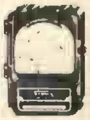

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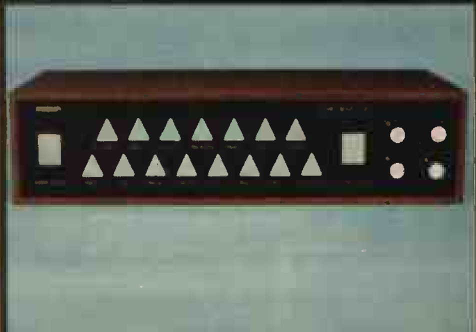

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