PRACTICAL
ELECTRONICS

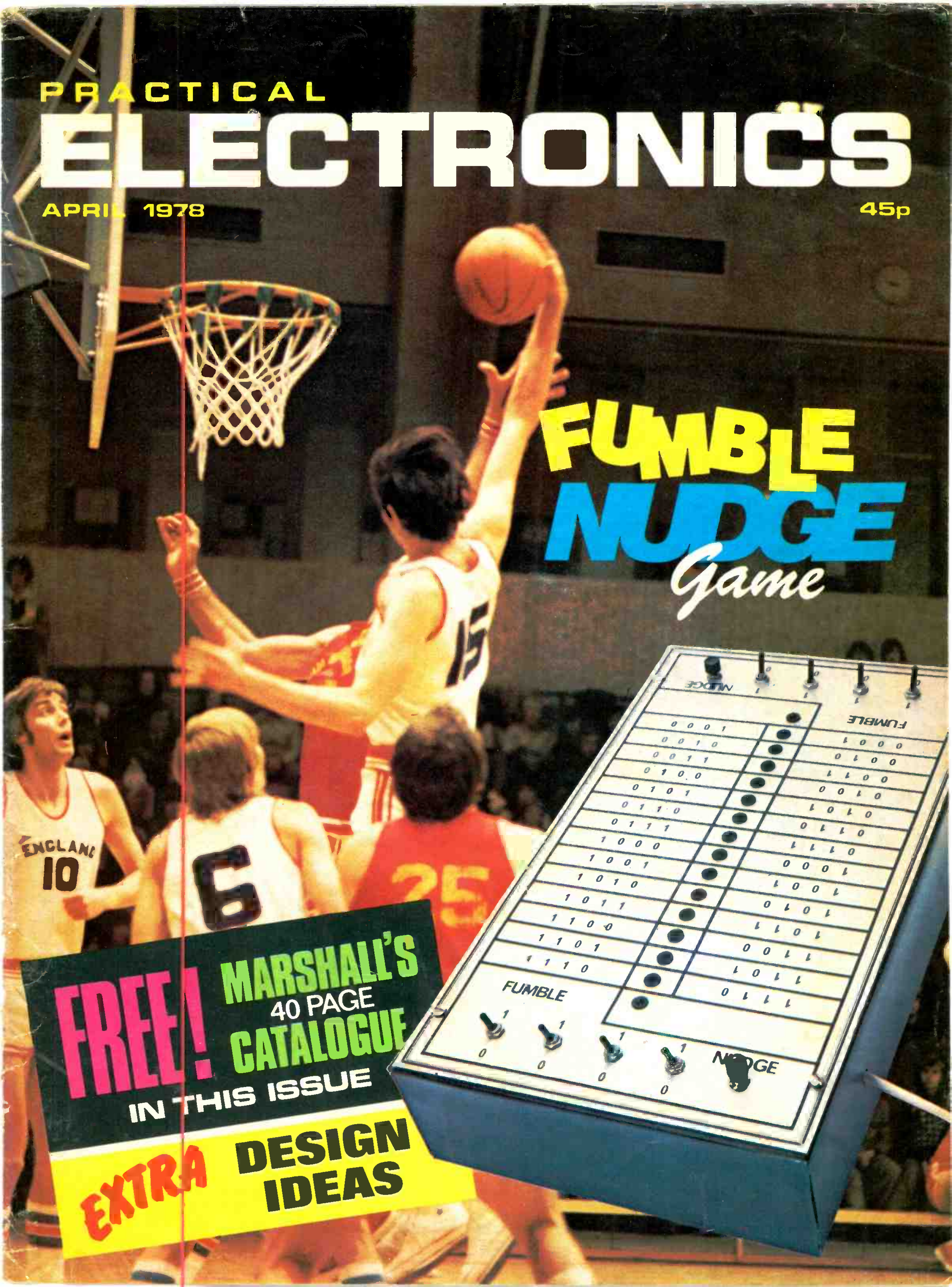
APRIL 1978

45p

FUMBLE NUDGE Game

FREE! MARSHALL'S 40 PAGE CATALOGUE IN THIS ISSUE

EXTRA DESIGN IDEAS



WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/ P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p* TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE.

MINIMUM ORDER £2.00 PLEASE.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 8% to devices marked ★. To the rest add 12½%.

We stock many more items. Send S.A.E. for our free list. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am – 6.00 pm. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type (Values are in µF)
400V: 0.001, 0.0015, 0.0022, 0.0033 **8p**; 0.0047, 0.0068, 0.01, 0.015, 0.018 **9p**; 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 **13p**; 0.33, 0.47 **22p**; 0.68, 1.0 **29p**; 1.5 **33p**; 2.2 **38p**; 4.7 **47p**.
DUBILIER: **1000V**: 0.01, 0.015 **16p**; 0.022 **18p**; 0.047 **16p**; 0.1 **34p**; 0.47 **43p**.

POLYESTER RADIAL LEAD (Values in µF) **250V**:
0-01, 0-015 **6p**; 0-022, 0-027 **7p**; 0-033, 0-047, 0-068, 0-1 **8p**; 0-15 **12p**; 0-22, 0-33 **14p**; 0-47 **16p**; 0-68 **20p**; 1-0 **24p**; 1-5 **27p**; 2-2 **31p**.

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF)
63V 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22 **9p**; 47, 32, 50 **12p**; 63, 100 **27p**; **50V**: 1.0 **7p**; 50, 100, 220 **25p**; 470 **50p**; 1000, 2200 **68p**; **40V**: 22, 33 **9p**; 100 **12p**; 3300 **62p**; 4700 **64p**; **35V**: 10, 33 **7p**; 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 **41p**; 3300 **52p**; 4700 **54p**; **16V**: 10, 40, 47, 68 **7p**; 100, 125, **8p**; 470 **16p**; 1000, 1500 **20p**; 2200 **34p**; **10V**: 4, 100 **6p**; 640 **10p**; 1000 **14p**.
TAG-END TYPE: **70V**: 2000 **98p**; 4700 **121p**; **50V**: 3000 **75p**; **40V**: 4000 **70p**; 2500 **65p**; **25V**: 4700 **48p**; 2000 **37p**; **40V**: 2000 + 2000 **95p**; **325V**: 200 + 100 + 50 + 100 **190p**.

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, 47 **6V**: 47, 68, 100, **3V**: 68, 100µF. **20p** each

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF **5p**
0.015, 0.02, 0.04, 0.05, 0.056µF **6p**
0.1µF, 0.15, 0.2 **7p**. **50V**: 0.47µF **10p**

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

POLYSTYRENE CAPACITORS
10pF to 1nF **6p**; 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 **9p** each
250, 300, 330, 360, 390, 600, 820 **16p** each
1000, 1800, 2000, 2200 **20p** each

CERAMIC TRIMMER CAPACITORS
2-7pF, 4-15pF, 6-25pF, 8-30pF **20p**

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 **25p**
100-500pF, 1250pF **38p**

POTENTIOMETERS (AB or EGEN)
Carbon Track, ¼W Log & ¼W Linear values
500Ω, 1K & 2K (lin only) Single **26p**
5KΩ-2MΩ single gang **26p**
5KΩ-2MΩ single gang D/P switch **55p**
5KΩ-2MΩ dual gang stereo **70p**

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **20p**

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

100 + price applies to Resistors of each type not mixed values

PE String ENSEMBLE
Components now available.

OPTO ELECTRONICS★
LEDs clip
TIL209 Red 13
TIL211 Grn 24
TIL212 Yellow 27
T110 20
2" Red 17
2" Yellow Green 21
OCP70 40
ORP12 68
2N5777 54
7 Seg Displays
TIL312 C An 3" 125
TIL313 C Cth 3" 125
TIL321 C An 5 130
TIL322 C Cth 5" 130
DL704 C Cth 99
DL707 C A 99
DL747 C A 180
FND 357 140
LCD 3½ digit
DWG 3902 975

SWITCHES★
TOGGLE 2A 250V
SPST **26p**
DPDT **35p**
4 pole on off **58p**
SUB-MIN TOGGLE
SP changeover **59p**
SPST on off **54p**
DPDT 6 tags **78p**
DPDT Centre off **92p**
DPDT Biased **115p**
SLIDE 250V
1A DPDT **14p**
1A DP c/over **16p**
½A DPDT **13p**
4 pole c/over **24p**
PUSH BUTTON
Spring loaded
SPST on/off **55p**
SPDT c/over **65p**
DPDT 6 Tag **85p**

	JACK PLUGS		SOCKETS		
	Screened chrome	Plastic body	open metal	moulded with break contacts	in line couplers
2.5mm	12p	8p	8p		11p
3.5mm	15p	10p	8p		12p
MONO	23p	15p	13p	20p	18p
STEREO	31p	18p	15p	24p	22p

	PLUGS	SOCKETS	In Line
DIN 2 PIN Loudspeaker, 3, 4, 5 Pin Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours	9p	5p single, 8p double	15p
Metal Screened	12p	10p 3-way	—
BANANA 4mm	10p	12p	—
2mm	10p	10p	—
1mm	8p	8p	—
WANDER 3mm	9p	9p	—

SWITCHES ★ Miniature Non-Locking
Push to Make **15p** Push to Break **25p**
ROCKER (white) 10A 250V SP changeover centre off **28p**
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 **42p**

DIL SOCKETS★ (Low Profile - Texas)
8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **20p**; 20 pin **26p**; 24 pin **30p**; 28 pin **42p**; 40 pin **58p**.

FIGARO
Gas and Smoke Detectors★

Types: 109, 308, 812 or 813. 355★each
Sockets for above 25p★

TV GAMES ICs.
AY-3-8500 **450p★**
AY-3-8550 **650p★**
AY-3-8600 **900p★**
"JOY STICK" **175p★**

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(TV Games & Rhythm Gen. Demonstration on at our shop)

RHYTHM GENERATOR

Build this PE (Jan. '78) Easi-build Low cost Rhythm Generator. We are the sole suppliers of the complete Kit including the case, pre-drilled printed front panel and the printed Circuit Boards.

Complete Kit price incl. VAT **£49.95** only. P & P £1.10 insured. Ready Built Units available in limited quantities at **£65.00** plus P & P. Send S.A.E. for descriptive leaflet.

DALO ETCH Resist Pen Spare Tip **75p★**

COPPER BOARDS★
Fibre Glass
Single Sided
6 x 6" **75p**
6 x 12" **130p**
SRBP
8 x 10" **70p**

VOLTAGE★ REGULATORS
723C **45p**
TBA625B **95p**
TO3 Can -Ve
1A 5V **140p**
1A 12V **145p**
1A 15V **145p**
1A 18V **150p**
LM323K **625p**
1A – 5V **220p**
1A – 12V **220p**
Plastic - Ve
1A 5V **99p**
1A 12V **99p**
1A 15V **99p**
1A 18V **99p**
1A 24V **99p**
0.1A 5V **51p**
0.1A 6V **51p**
0.1A 8V **51p**
0.1A 12V **51p**
0.1A 15V **51p**

BUY NOW ! ! ! SAVE £ £ £s

TTL 74★

7400	14	7494	85	74194	140		
7401	14	7495	70	74195	95		
7402	16	7496	82	74196	118		
7403	16	7497	262	74197	118		
7404	20	74100	125	74198	250		
7405	22	74105	62	75150	110		
7406	38	74107	33	75491	75		
7407	38	74109	54	75492	80		
7408	20	74110	54				
7409	20	74111	70				
7410	15	74112	90				
7411	24	74116	198				
7412	23	74118	90				
7413	37	74119	90				
7414	74	74120	115				
7416	35	74121	28				
7417	39	74122	48				
7420	16	74123	70				
7421	33	74125	65				
7422	24	74126	60				
7423	32	74128	77				
7425	30	74132	73				
7426	36	74136	73				
7427	36	74141	72				
7428	38	74142	280				
7430	18	74143	314				
7432	32	74144	314				
7433	40	74145	85				
7437	30	74147	175				
7438	33	74148	143				
7440	17	74150	118				
7441	74	74151	75				
7442	68	74153	75				
7443	115	74154	140				
7444	112	74155	82				
7445	94	74156	80				
7446	94	74157	80				
7447	82	74159	225				
7448	78	74160	116				
7450	17	74161	116				
7451	17	74162	116				
7453	17	74163	116				
7454	17	74164	121				
7460	17	74165	130				
7470	30	74166	141				
7472	28	74167	198				
7473	32	74170	240				
7474	32	74172	625				
7475	42	74173	175				
7476	30	74174	113				
7480	50	74175	90				
7481	97	74176	120				
7482	82	74177	116				
7483	95	74178	102				
7484	95	74180	142				
7485	110	74181	299				
7486	36	74182	126				
7489	320	74184	225				
7490	36	74185	146				
7491	80	74188	65				
7492	53	74190	140				
7493	35	74191	140				
		74192	140				
		74193	140				

CMOS★

4000	15	4056	134	4513	206	4518	102
4001	17	4057	2570	4514	265	4519	59
4002	17	4059	480	4515	299	4520	108
4006	105	4060	115	4516	125	4521	268
4007	18	4061	2380	4517	382	4522	199
4008	92	4062	999	4526	199		
4009	58	4063	110	4527	152		
4010	58	4066	58	4528	99		
4011	19	4067	380	4529	165		
4012	18	4068	22	4530	85		
4013	55	4069BE	22				
4014	99	4070	32				
4015	93	4071	21				
4016	52	4072	21				
4017	99	4073	21				
4018	99	4075	23				
4019	60	4076	129				
4020	102	4077	40				
4021	99	4078	21				
4022	90	4081	22				
4023	20	4082	21				
4024	76	4085	74				
4025	19	4086	73				
4026	180	4089	150				
4027	55	4093	85				
4028	90	4094	190				
4029	108	4095	105				
4030	58	4096	105				
4031	230	4097	372				
4032	100	4098	110				
4033	145	4099	190				
4034	196	4160	109				
4035	120	4161	109				
4036	325	4162	109				
4037	100	4163	109				
4038	108	4174	110				
4039	320	4175	99				
4040	105	4194	108				
4041	86	4408	720				
4042	81	4409	720				
4043	96	4410	720				
4044	95	4411	995				
4045	145	4412F	1650				
4046	130	4412F	1380				
4047	99	4415F	795				
4048	58	4415V	795				
4049	52	4419	280				
4050	52	4422	545				
4051	89	4433	1225				
4052	89	4435	825				
4053	89	4440	1275				
4054	120	4450	295				
4055	134	4451	295				
		4490F	695				
		4490V	525				
		4501	17				
		4502	120				
		4503	69				
		4506	51				
		4507	55				
		4508	298				
		4510	135				
		4511	168				
		4512	98				

LINEAR IC'S

702	75	MC1303L	148
709C 14 pin	35	MC1304P	260
710★	48	MC1310P	185
741C★ 8 pin	22	MC1312PQ	195
747C	70	MC1458P★	90
748C	36	MC1495	425
753	150	MC1496	101
810	159	MC14433L	1250
8038CC★	355	MC1710CG	79
AY-1-0212	580	MC3401	89
AY-1-1313	660	MC3360P	69
AY-1-5051	145	MFC4000B	85
AY-1-6721/6	195	MFC6040★	97
AY-3-8500★	510	MK50253★	550
AY-3-8550★	850	MK50362★	650
AY-5-1224★	349	MM2102-2	190
AY-5-1230★	490	MM2112-2N★	310
CA3011★	82	NE518A	210
CA3018★	82	NE555★	36
CA3020	170	NE556DB★	90
CA3023	170	NE560★	325
CA3028A★	95	NE561★	410
CA3035	140	NE562★	410
CA3036	180	NE565A★	185
CA3043	190	NE566★	180
CA3046	80	NE567★	157
CA3048	200	NE571	450
CA3075	175	RAM2102-2★	210
CA3080E	80	RC4136D★	120
CA3081	190	ROM2513★	700
CA3089E	210	SG3402★	255
CA3090AQ	390	SN72733N	125
CA3123E	200	SN76003N	240
CA3130★	94	SN76013N	240
CA3140	95	SN76023N	140
ICL7106Ev★	975	SN76033N	230
ICM7205★	1150	SN76115N	215
LM300H	170	SN76227N	175
LM301A	39	TAA621AX1	228
LM308	140	TAA661A	155
LM318	195	TAA700	353
LM324	79	TAA960	300
LM339	79	TBA120S	90
LM348	120	TBA540Q	220
LM379	398	TBA550Q	355
LM380	95	TBA641BX11	250
LM381	170	TBA651	180
LM381AN	241	TBA800	90
LM382	125	TBA810S	105
LM3900	65	TBA820	80
LM3909N	70	TBA920Q	350
LM3911	125	TDA1022	595
M252AA★	750	TDA2020	320
M253AA★	795	UAA170	198
		ZN414	110
		ZN424	130

TRANSISTORS

AC117	35	BC168C	12	BF195	10	OC43★	65	ZTX501	15	2N3614★	169
AC125★	19	BC169C	14	BF196	12	OC44★	35	ZTX502	19	2N3615★	135
AC126★	19	BC170	18	BF197	15	OC45★	35	ZTX503	19	2N3663	26
AC127★	18	BC171	11	BF198	18	OC46★	35	ZTX504	25	2N3702	10
AC128★	18	BC172	10	BF200	30	OC70★	30	ZTX531	28	2N3703	11
AC141★	24	BC177★	18	BF224A	18	OC71★	30	ZTX550	25	2N3704	10
AC141K★	38	BC178★	16	BF256★	50	OC72★	30	2N526★	58	2N3705	11
AC142★	24	BC179★	18	BF257★	29	OC77★	76	2N696★	35	2N3706	10
AC142K★	38	BC182	10	BF258★	29	OC79★	76	2N697★	21	2N3707	10
AC176★	18	BC182L	13	BF259★	30	OC81★	28	2N698★	39	2N3708	11
AC187★	20	BC183	10	BF394	22	OC82★	45	2N699★	50	2N3709	11
AC188★	20	BC183L	12	BF594	40	OC82D★	35	2N706A★	19	2N3710	16
ACY17	35	BC184	11	BF595	38	OC83★	48	2N707★	50	2N3711	12
ACY18★	40	BC184L	14	BFR39	25	OC84★	44	2N708★	19	2N3715★	250
ACY19★	40	BC186	24	BFR40	28	OC123★	115	2N914★	32	2N3772★	170
ACY20★	40	BC187★	28	BFR79	28	OC139★	140	2N916★	27	2N3773★	288
ACY21	35	BC212	11	BFR80	28	OC140★	125	2N918★	30	2N3819	22
ACY22★	40	BC212L	13	BFX29★	28	OC141★	157	2N920★	51	2N3820	38
ACY28★	40	BC213	11	BFX81★	130	OC170★	40	2N930★	18	2N3823★	65
ACY39	78	BC213L	14	BFX84★	24	OC171★	40	2N961★	61	2N3824★	70
ACY40★	48	BC214	14	BFX85★	28	OC201★	125	2N1131★	22	2N3866★	90
ACY44	39	BC214L	15	BFX86★	28	OC202★	140	2N1132★	22	2N3903	20
AD140	69	BC307B	20	BFX87★	23	OC203★	150	2N1302★	35	2N3904	18
AD149★	70	BC328	15	BFX88★	26	OC204★	150	2N1303★	50	2N3905	18
AD161★	42	BC338★	15	BFY18	50	TIP29	43	2N1304★	50	2N3906	17
AD162★	42	BC441★	45	BFY50★	17	TIP29A	44	2N1305★	28	2N4037★	52
AF114★	20	BC461★	38	BFY51★	17	TIP29C	60	2N1306★	35	2N4058	17
AF115★	20	BC462★	45	BFY52★	17	TIP30	52	2N1307★	50	2N4061	17
AF116★	20	BC547	12	BFY71	47	TIP30A	52	2N1308★	46	2N4064★	120
AF117★	22	BC548	12	BSX20	18	TIP30B	64	2N1613★	20	2N4236★	145
AF118★	55	BC549C	13	BSX20★	18	TIP30C	70	2N1671★	190	2N4289	20
AF121★	48	BC557	15	BSY65★	30	TIP31★	50	2N1671B★	195	2N4859	65
AF124★	55	BC558	15	BSY95A★	18	TIP31A★	50	2N1893★	28	2N5135	42
AF125★	35	BCY30★	57	BU105★	140	TIP31B★	58	2N1986	60	2N5136	42
AF127★	35	BCY34★	75	BU205★	190	TIP31C★	66	2N2160★	105	2N5138	20
AF139★	35	BCY39★	78	BU208★	225	TIP32★	55	2N2217★	48	2N5179★	60
AF178★	70	BCY40★	75	E5567	65	TIP32A★	60	2N2218A★	35	2N5180★	60
AF180★	70	BCY59★	90	MO8001★	158	TIP32B★	75	2N2219A★	22	2N5191★	65
AF186★	50	BCY70★	15	MJ4CO★	90	TIP32C★	77	2N2220A★	26	2N5305★	40
AF239★	42	BCY71★	20	MJ491★	160	TIP33★	85	2N2221A★	25	2N5457	35
ASY26★	40	BCY72★	15	MJ2955★	120	TIP33B★	100	2N2222★	20	2N5458	36
ASY27★	45	BD115★	62	MJE340★	45	TIP33C★	110	2N2297	45	2N5459	36
BC107★	9	BD121★	78	MJE370★	80	TIP34★	95	2N2303★	50	2N5485	38
BC107B★	10	BD123	98	MJE371★	80	TIP34A★	95	2N2368	25	2N5777	56
BC108★	9	BD124★	115	MJE520★	65	TIP34B★	120	2N2369★	15	2N6027	40
BC108B★	12	BD131★	38	MJE521★	74	TIP35★	219	2N2476	125	40311★	56
BC108C★	12	BD132★	38	MJE2955★	115	TIP35A	225	2N2483★	28	40313★	125
BC109★	9	BD133★	43	MJE3055★	80	TIP35C★	270	2N2484★	30	40316★	95
BC109B★	12	BD135	38	MPF102	36	TIP36A★	280	2N2646★	48	40317★	52
BC109C★	12	BD136	36	MPF103	36	TIP36C★	325	2N2784	55	40326★	52
BC113	17	BD137	36	MPF104	36	TIP41A★	66	2N2846	140	40327★	62
BC114	20	BD138	50	MPF105	36	TIP41B★	73	2N2894	30	40347★	99
BC115	20	BD139	34	MPF106	50	TIP42A★	72	2N2904A★	22	40348★	116
BC116	20	BD140	36	MPF107	50	TIP42B★	82	2N2905A★	20	40360★	43
BC117	20	BD142	59	MPSA05	32	TIP2955★	65	2N2906★	18	40361★	45
BC118	20	BD145★	198	MPSA06	32	TIP3055★	52	2N2907★	20	40362★	48
BC119	28	BD695	52	MPSA55	30	TIS43	36	2N2907A★	22	40411★	289
BC134	20	BD696★	52	MPSA56	30	TIS44	45	2N2926G	10	40412★	65
BC135	20	BDY17★	195	MPSA70	34	TIS46	45	2N2926O	8	40576★	190
BC136	18	BDY60★	110	MPSU02★	58	TIS50	47	2N2926R	8	40594★	98
BC137	20	BDY61★	165	MPSU05★	50	TIS74	47	2N2926Y	8	40603★	113
BC140★	35	BF115★	22	MPSU06★	56	TIS91	24	2N3011★	30	40636★	165
BC142★	28	BF154★	25	MPSU52★	65	ZTX107	22	2N3053★	17	40673★	68
BC143★	28	BF156★	29	MPSU55★	55	ZTX108	20	2N3054★	49		
BC147	7	BF173★	25	MPSU56★	60	ZTX109	25	2N3055★	60		
BC148	7	BF177★	24	MPU131★	39	ZTX300	16	2N3108	60		
BC149	8	BF178★	25	OC25★	120	ZTX301	16	2N3121	40		
BC153	27	BF179★	30	OC26★	170	ZTX302	25	2N3133	43		
BC154	27	BF180★	30	OC28★	105	ZTX303	25	2N3135	33		
BC157	10	BF181★	30	OC29★	160	ZTX304	24	2N3250	30		
BC158	11	BF182★	30	OC35★	100	ZTX311	17	2N3252	36		
BC159	11	BF183★	30	OC36★	170	ZTX314	24	2N3302	35		
BC160★	35	BF184★	20	OC41★	48	ZTX341	20	2N3442★	142		
BC167A	11	BF194	10	OC42★	40	ZTX500	17	2N3563	32		

Matched Pair 10p extra.

CHOKES
SC60 100mH 90

PRACTICAL
ELECTRONICS

VOLUME 14 No. 8 APRIL 1978

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

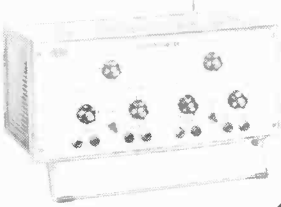
NEWS AND COMMENT

Our May issue will be on sale Friday, 14 April 1978
(for details of contents see page 604)

AMTRON UK

ELECTRONIC KITS

TO MAKE WAY FOR OUR EXCITING NEW RANGE OF KITS, WE ARE OFFERING OUR OBSOLETE MODELS AT TRADE PRICE!



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NEW RANGE OF KITS

RHYTHM GENERATORS—6 channel STEREO MIXERS, AMPLIFIERS, STEREO TUNERS, V.H.F. RECEIVERS & TEST EQUIPMENT.

AMTRON (UK) LTD.
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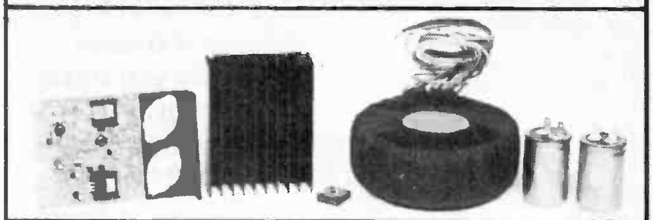
Telephone: (0424) 436004

TWO NEW SUPERMODULES: 170W INTO 4 OR 8 OHMS



By popular demand we have designed higher powered versions of our well known modules. The CE 1704 which gives 170W into 4 ohms and the CE 1708 which gives 170W into 8 ohms are physically similar to the original types and have the same combination of compatible performance features which makes CRIMSON amplification audibly superior to the competition and the only choice if you have an ear for music. We have also produced suitable power supplies which again use our superb TOROIDAL TRANSFORMERS, only 50mm high, with a 120-240 primary and single bolt fixing.

Write or phone for more information and biased opinions.

POWER AMPLIFIER MODULES	Home	Europe
CE 608 60W/8 ohms 35-0-35V	£16.30	£16.60
CE 1004 100W/4 ohms 35-0-35V	£19.22	£19.30
CE 1008 100W/8 ohms 45-0-45V	£23.22	£23.00
CE 1704 170W/4 ohms 45-0-45V	£29.12	£28.46
CE 1708 170W/8 ohms 60-0-60V	£31.90	£31.04
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CPS 1 for 2 x CE 608 or 1 x CE 1004	£14.47	£18.40
CPS 2 for 2 x CE 1004 or 2/4 x CE 608	£16.82	£20.57
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T.H.D.	TYPICALLY <·02% ANY POWER, 1kHz, 8 OHMS
T.I.D.	INSIGNIFICANT
SLEW RATE LIMIT	20V/μS
S/N RATIO	110dB
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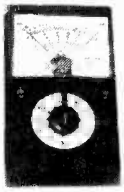
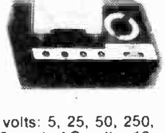
A special bulk purchase of Eagle Multimeters enables us to offer two from their range at up to 15% off Eagle's own Recommended Retail Price.

KEW 7 POCKET MULTIMETER



Handy pocket-size (3½" · 2½" · 1") 1000 opv meter with 'off' damping. Includes all basic ranges: DC volts 0 to 10, 50, 250, 1000. AC volts: 0 to 10, 50, 250, 1000. DC amps: 0 to 100 MA. Resistance: 0 to 150K ohms. Decibels: - 10 to + 22dB. **£5.97.** + 8% VAT with leads and battery.

C1095 20,000 OPV MULTIMETER



with hinged 4-position scale for easy reading bench use. Anti-parallax mirror, 3-colour scale, overload protection. Ranges: DC volts: 5, 25, 50, 250, 500, 2,500 (20,000 opv). AC volts: 10, 50, 100, 500, 1,000 (10,000 opv). DC amps: 50μA, 2.5mA, 250mA. Resistance: 50K ohms, 5 megohms. Decibels: - 20 to + 22dB. **£14.31** + 8% VAT.

EFFECTS PROJECTOR "150"
(150 watt)

Ideal for disco work, this versatile machine takes a range of accessories and is of a sturdy metal construction. Comes complete with bulb and 6in. Liquid Wheel. Ready to use.

A bargain at £34
+ 8% V.A.T.

3 KILOWATT PSYCHEDELIC LIGHT CONTROL UNIT (1000 Watt per channel)
Three channel: Bass, Middle, Treble. The input of this unit is connected to the loudspeaker terminals of an amplifier and the required lighting is connected to the output terminals of the unit thus enabling you to produce a fascinating sound to light display.
Full instructions supplied or S.A.E. for details.
Fantastic Value at £20·00
+ 8% V.A.T.

LOUDSPEAKER SELECTION
+ 12½% V.A.T.
2¼in. 8, 40, and 75 ohm at **£1·10** (please state which impedance is required)
5in. 8 ohm Ceramic at **£1·70**
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10in. "ELAC" Dual Cone 8 ohm 10 watt at **£4·75**

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Designed for use with TUAC power amplifier modules.

VA08
Vol. Treb. Mid. and Bass controls. HI. IMP. FET. I/P suitable Mid. Guitar, Radio Crystal/Ceramic P.U. Sensitivity 4mV. Treble + 35dB at 16kHz. Mid + 20 -15dB at 1kHz. Bass + 20 - 10dB at 40Hz.
£9.00

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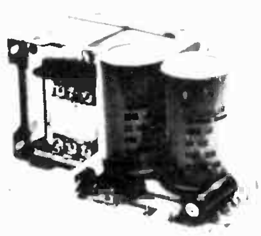
£7.75

SVA08 STEREO PRE AMP
Vol. Treb. Mid and Bass controls. I/P suitable Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble +35dB at 16kHz. Mid + 20 -7dB at 4kHz. Bass + 20 - 18dB at 30Hz Plus Full Balance Control. Fully I/C operation supply voltage ± 25VDC.
£15.00

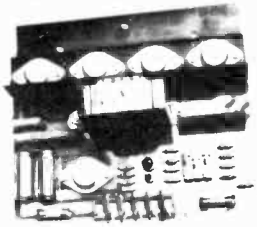
POWER SUPPLIES



Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

PS250 for supplying 2 TP125s	£28.50
PS200 for supply to TL100	£28.50
PS60/60 for supplying 2 TL60s	£17.75
PS125 ±45 volts for TP125	£16.25
PS100 ±43 volts for TL100	£16.25
PS60 ±38 volts for TL60	£15.25
PS30 ±25 volts for TL30	£11.75
PSU 2 for supplying disco mixer	£7.50

AMPLIFIER MODULES



TL30 D.C. COUPLED 5 × 5 × 1¼in.
- 30 watt R.M.S. continuous sine wave output
- 8 transistors 4 diodes

£12.75

TL60 5 × 5 × 3in
- 60 watt R.M.S. continuous sine wave output
- 2 R.C.A. 110 watt 15 amp transistors

£18.75

TL100 5 × 5 × 3in
- 100 watt R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£20.75

TP125 7 × 6½ × 3in
- 125 watt R.M.S. continuous sine wave output
- 4 R.C.A. 150 watt 15 amp output transistors

£25.75

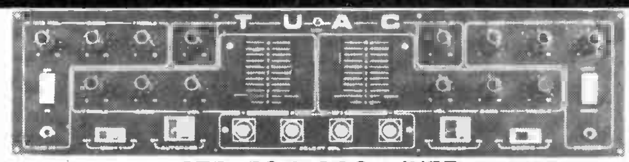
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER - 4LSMI

- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully supressed and fused
- Switched master control for sound operation from ½W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£20.75

Model 501 500W per channel as above without sound triggering
£12.25

STEREO DISCO MIXER



With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity mag., 3mV (R.I.A.A. comp.). Flat 50mV at 1kHz. Bass controls ± 18dB at 60Hz. Treble controls ± 18dB at 15kHz.
OUTPUT: Up to 3 volts (+ 12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz - 25kHz ± dB.
P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.
Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.
Size: 25in long × 6in high × 3in deep.
£129.00

Mono Disco Mixer with autofade **£45.00**

3 CHANNEL LIGHT MODULATOR SILMB

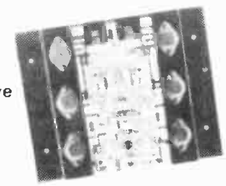
- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

£20.25

Single Channel Version 1500 Watts
£9.75

new from TUAC... ULTRA QUALITY HIGH POWER TD 500 POWER AMPLIFIER
New DC coupled design

Output power using PS250
300w into 2 Ohms
220w into 4 Ohms
140w into 8 Ohms
75w into 15 Ohms
RMS continuous sine wave output
INPUT Sensitivity 0.775V
RMS (ODB) at 25 KOHMS
Hum and Noise - 100dB
Relative full output
THD = at Full Power 0.1%



7" × 9" × 1¾" **£45**

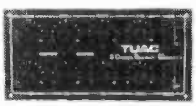
PIEZO SUPER HORN £10.95

FRONT PANEL FOR LIGHTING EFFECT MODULES
(complete with switches, neons and knobs) as illustrated

For S1LMB **£6.50**
Size 8" x 4½"

4LSM1 **£5.50**
Size 6½" x 4½"

FUZZ LIGHTS
Red, Green, Blue, Amber. **£23.50**

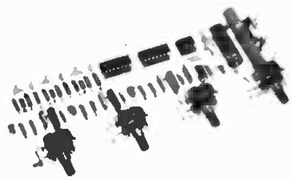


S1LMB **£7.50**
Size 9" x 4½"
Combined with 3SDM1

STOCKISTS - CALLERS ONLY

A1 Music, 88 Oxford Street, Manchester (Tel. 061-236 0340)
Geo Mathews, 85/87 Hurst Street, Birmingham (Tel. 021-622 1941)
Bristol Disco Centre, 25 The Promenade, Gloucester Road (Tel. Bristol 41666).
Soccodi, 9 The Friars (Tel. Canterbury 60948)
Cookies Disco Centre, 132 West Street (Tel. Crewe 4739).
Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
Luton Disco Centre, 88 Wellington Street, Luton (Tel. Luton 411733)
Mitchell Electronics, 7 Queen Street (Tel. Salisbury 23689).
Session Music, 163 Mitcham Road, Tooting (Tel. 01-672 3413).
Mon-Sat 9.30 a.m. - 5.30 p.m. Half Day Wed. 9.30 a.m. - 1 p.m.

ADD SEQUENCE CHASING + DIMMING EFFECTS FOR TUAC 3 CHANNEL LIGHT MODULATOR



- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel

3SDMI **£14.50**

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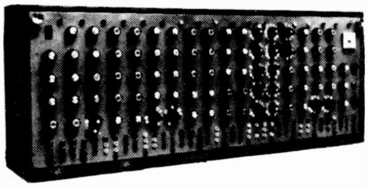
KITS FOR SYNTHESISERS, SOUND EFFECTS



COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, 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 designed by Phonosonics

PHOTOCOPIES of the 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, output amp and mixer, power supply

Set of basic component kits	from £64·25
Set of printed circuit boards	£9·71

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, notably P.E. Minisonic, Phasing Unit, Wind and Rain, Rhythm Generator, Sound Bender, Voltage Controlled Filter, Guitar Effects Pedal and Overdrive, Fuzz, Tremolo and Wah-Wah units.
The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists.

Set of basic component kits	£83·03
Set of printed circuit boards	£13·20

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument) 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in our lists.

Set of basic component kits	£48·18
Set of printed circuit boards	£7·66

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	£7·59
Alternative component set with panel mounting switches	£4·96
Printed circuit board	£1·43

SOUND BENDER (P E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.

Component set for above functions (excl SWs)	£7·84
Printed circuit board	£1·81

Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.

Component set (incl PCB)	£2·88

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)	£2·87

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)	£4·48

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	£17·69
Printed circuit board	£2·33

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)	£3·55

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	£7·27
Component set and PCB, with panel switches	£4·83

P.E. JOANNA (P.E. May/Sept. 75)
A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available
Main power supply, tone generator, 61 envelope shapers, voicing and pre-amp circuits

Set of basic component kits for above	£75·29
Set of printed circuit boards for above	£20·35
Power amplifier	£15·97
Printed circuit board for power amp	95p

ELECTRONIC ORGAN
5-octave electronic organ with 5 basic voices that can be used individually or together, 5 pitches (2ft, 4ft, 8ft, 16ft, 32ft), variable attack, tremolo, vibrato, phasing, and variable sustain. Details in our list.

ORGAN CONVERSION KIT
Converts the P.E Joanna electronic piano to also provide most of the facilities offered by the above electronic organ.

Basic component set and PCB	£12·34

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl sw.)	£7·45

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

SEE OTHER PAGE FOR KEYBOARDS, AND OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED

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

Component set (incl PCB)	£3·72

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	£6·86
Component set using dual rotary pot	£6·20
Printed circuit board	£1·62

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

Component set (incl PCB)	£2·03

TREMOLO UNIT
Based upon P E "Sound Design" circuit

Component set (incl PCB)	£3·64

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)	£2·40

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike

Main component set (incl. PCB)	£15·59
Power supply set (incl PCB)	£7·03

P.E. SYNCHRONOME (P E. Mar. 76)
An accented-beat electronic metronome, providing duple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply

Component set (incl loudspeaker)	£11·62
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TAPE NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs

Standard tolerance set of components	£2·96
Superior tolerance set of components	£3·76
Regulated power supply (will drive 2 sets)	£4·69

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)	£4·66

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	£4·52
Printed circuit board	£1·82

WAVEFORM CONVERTER
Slightly modified from a circuit published in a German edition of "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)	£8·19

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)	£8·22

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

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NOISE GENERATOR (P.E. Jan. 75)
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Size 2¾" x 1¾" x 1½"

Value	No.	Price
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0-500UA	1309	£5·50
0-1MA	1310	£5·50
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MR2P TYPE

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Sensitivity 1000 ohms/V
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DC CURRENT 0-1-100mA
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MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
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Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Voltages available by use of taps:
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2031	½ amp	£5·50*	P. & P. 86p
2032	1 amp	£6·60*	P. & P. 86p
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Fitted with phase lock-loop
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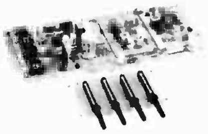
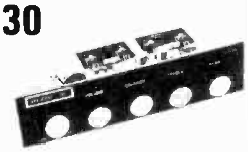


FREQUENCY RANGE	88 – 108 Mhz
SENSITIVITY	3.0 uV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22.5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm x 110mm x 32mm

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
£18·95 + 40p p&p



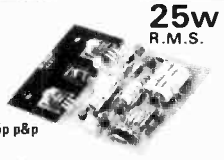
7 + 7w R.M.S.

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 100 Hz and 10 kHz
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 x 130mm x33mm

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
£4·55 + 25p p&p

25w R.M.S.

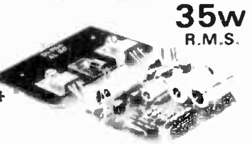


OUTPUT POWER	25 Watts RMS
SUPPLY	30 – 50 V
LOAD IMPEDANCE	8 – 16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x15mm

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
£7·15* + 25p p&p

35w R.M.S.

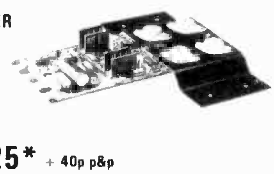


OUTPUT POWER	35 Watts RMS
SUPPLY	40 – 60 V
LOAD IMPEDANCE	8 – 16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

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.



£17·25* + 40p p&p

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	0.1%
50 WATTS into 8 ohms	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.

£3·75 + 25p p&p

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 5% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than .5% (Typically .03%)
LOAD IMPEDANCE	8 – 16 ohms
INPUT IMPEDANCE	50 K ohms
FREQUENCY RESPONSE	50 Hz – 25 kHz ± 3 dBs
SENSITIVITY	90 mV for full output
DIMENSIONS	90 x 64 x 30mm approx.

This low cost 10 watt module offers the utmost in reliability and performance, whilst being compact in size.

SPM80
STABILISED POWER SUPPLY
£4·25 + 25p p&p

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 x 63mm x 30mm

Designed to power two AL60's at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100
STEREO PRE-AMPLIFIER

£15·80 + 40p p&p

FREQUENCY RESPONSE	20 Hz to 20 kHz ± 1dB
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms) For an
2. RADIO TUNER	100 mV/100 K ohms) output
3. MAGNETIC P.U.	3.5 mV/50 K ohms) 250mV
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	300x90x33mm (less controls)

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution for 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.

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. **2036** Price: **£3·20** + 55p p&p
T2050 For use with Stereo 30
Order No. **2050** Price: **£3·25** + 55p p&p
BMT80 For use with AL60 SPM80
Order No. **2034** Price: **£5·40** + 86p p&p
BMT250 For use with AL250
Order No. **2035** Price: **£6·35** + £1·10 p&p

PS12 POWER SUPPLY

Designed for use with the AL30A S.450 and MPA30 in conjunction with transformer T538

INPUT VOLTAGE 17-20v AC
OUTPUT VOLTAGE 27-30v DC
OUTPUT CURRENT 800mA
SIZE 60mm x 43mm x 26mm

£1·30 25p p&p

MK60 AUDIO KIT

This kit enables you to build a complete 30w RMS stereo amplifier comprising of 2 x AL60 amplifiers – 1 x SPM80 stabilised power supply – 1 xBMT80 transformer – 1 x PA1000 pre-amplifier and a kit of parts to include front panel – knobs – head-phone socket, on/off switch, neon indicator, together with complete instructions for construction.

Price: £36·75 + 12½% V.A.T. + 62p p&p

TEAK 60 AUDIO KIT

This kit contains everything you require to put the finishing touches to your MK60 and give your amplifier that professional touch – contents: Teak veneered cabinet size: 16¾" x 11½" x 3¾" – aluminium chassis heatsink – front panel – bracket – back panel also sockets – nuts – bolts – fuse holders – solder tags etc.

Price: £13·25 + 12½% V.A.T. + 86p p&p

TEAK 60 CABINET

Teak veneered cabinet only, measuring 425mm x 290mm x 95mm as supplied in the above mentioned Teak 60 kit. Ideal for use with our PA100 pre-amplifier and one of the complimentary modules. The ideal amplifier sleeve has not front or back panel.

Order No. **140. Price: £7·00** x 12½% V.A.T. x 86p p&p.

TEAK 30 CABINET

Teak veneered cabinet designed mainly for use with our Stereo 30 chassis but had proved very useful to home constructors measuring 320mm x 235mm x 80mm comes complete with solid uncut front and back.

Order No. **139 Price: £5·45** + 12½% V.A.T. + 70p p&p

MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

£2·95 25p p&p

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	110x50x25mm (inc DIN socket)

PA12
STEREO PRE-AMPLIFIER

£7·10 30p p&p

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 x 84mm x 35mm

ORDERING

PLEASE WORD YOUR ORDERS EXACTLY AS PRINTED, NOT FORGETTING TO INCLUDE OUR PART NUMBER.

VAT

ADD VAT AT 12½% EXCEPT TO THOSE MARKED * WHICH ARE 8%.

BI-PAK

DEPT. PE4, P.O. Box 6, Ware, Herts

SAXON ENTERTAINMENTS LTD

THE PIONEERS OF MODULAR DISCO/P.A. EQUIPMENT
NOW OFFER PACKAGE DEALS AT INCOMPARABLE PRICES

CENTAUR STEREO DISCOS

C/W LIGHT SHOW & DISPLAY, TWIN SPEAKERS & LEADS

Standard 100W
£225 or Deposit £28.80
12 Months @ £21.18 or 24 Months @ £11.81

Super 200W
£275 or Deposit £32.80
12 Months @ £25.89 or 24 Months @ £14.44

GXL 200W (with twin 200 watt cabinets)
£349 or Deposit £42.72
12 Months @ £32.49 or 24 Months @ £18.11

COMPLETE STEREO ROADSHOWS – BUILT IN SOUND TO LIGHT/SEQUENCER & DISPLAY

TWO YEAR GUARANTEE

illustration shows GXL Centaur System

These systems feature full mixing for two decks tape & mic with monitoring facilities – override and are supplied complete with sound to light + sequencer, display, speaker leads etc.

JUST PLUG IN AND GO!

BSR Decks – 17,000 Line Loudspeakers – Rugged Aluminium Trimmed Cabinets – Cue Light And Phones Output – Slave Output – Deck Lights/Motor Starts (GXL)

MINI DISCO 100 WATT MONO SYSTEM

£179.50 Deposit £24.66
12 Months @ £16.95
or 24 Months @ £9.45

Similar in appearance to the Centaur and complete with loudspeakers and leads.

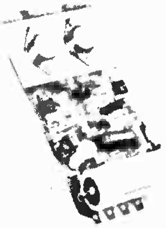
Headphones to suit any system	£7.50
EM507 Electret Mic	£15.00
ECM 81 Electret Mic	£19.95
Boom Stand	£15.50
Carriage on all disco and PA systems (Included in H.P. Prices)	£10.00

10% Deposit Terms On All Orders Over £150 – 12 or 24 Months – Low Interest

D.I.Y. MODULES FOR ALL DISCO/P.A. AMPLIFIERS

SA308 30W 8 ohms 45V	£9.95*	SUPPLY FOR TWO MODULES	£10.90*
SA604 60W 4 ohms 50V	£13.25	SUPPLY FOR TWO MODULES	£13.50
SA608 60W 8 ohms 65V	£14.25	SUPPLY FOR TWO MODULES	£13.50
SA1204 120W 4 ohms 75V	£15.95	SUPPLY FOR ONE MODULE	£13.50
SA1208 120W 8 ohms 95V	£21.00	SUPPLY FOR TWO MODULES	£22.50
SA2404 240W 4 ohms 95V	£29.50	SUPPLY FOR ONE MODULE	£22.50

0.2% Distortion, 30Hz-20, KHz ± 2dB, Fully Short/Open Circuit proof input sensitivity 240 mV to suit most mixers – D.C. & Output Fuses fitted.



TOP QUALITY COMPONENTS THROUGHOUT

DISCO MIXERS – COMPLETE OR MODULAR

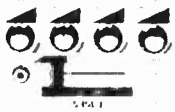
MONO OR STEREO WITH AUTOFADE

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.

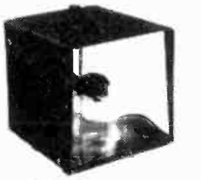
MODULES	
Mono module	£22.50
Stereo module	£33.50
Panel	£3.95
Kit of knobs/sockets etc	£5.50
COMPLETE MIXERS (with case)	
Mono 18V	£39.50
Stereo 18V	£57.50
Mono mains	£45.75
Stereo mains	£63.75

COMPLETE LIGHTING CONTROL AT YOUR FINGERTIPS!



Lighting Control Unit Mk II	£44.50
4kW Sequencer + Sound Light + Dimmers + Automatic Level Integrated Logic Circuitry	Module £32.50
	Panel £2.95
Three Channel Sound to Light	£26.75
3kW 1-240W input – master Plus channel controls	Module £19.75
	Panel £2.95

STROBE UNITS



Pro-Strobe 4-6 Joules £37.50
Super Strobe 2-3 Joules £22.50
(Pro-Strobe has external trigger facility).

SPARES & ACCESSORIES – LOUDSPEAKERS & CABINETS

Rope Lights – Red or Multicolour per 12 ft.	£22.00
Rope Light Controller for up to 120 ft	£30.00
Fuzz Lights–Red/Blue/Yellow/Green	£22.80
Magnetic Cartridge Equalisers	£3.50*
Melos Echo Chamber	£59.00
Headphones	£7.50*
Sirens: English Police, USA Police, Destroyer, Alien Voice Simulator	£7.50
Bulgin 8 way lighting plug/socket	£1.90

100 Watt Chassis Loudspeakers 12" £23.50 18" £47.50 (Add £1.50 carr.)

Empty Loudspeaker Cabinets: Small 12" £15.50, Large 2 x 12" £28 Large 12" £21.50 1 x 18" £29.50 Small 2 x 12" £22.50

Projector lamps: A1167 £2.90. M6 £5.65.
100W Spot lamps Red/Blue/Yellow/Green £1.50 ea £13.50 for 10
MD Spot Banks: 3-way 300W £19.50, 4-way 400W £22.50.
Bubble machines (optikinetics) £36.50

Strobe tubes 80W £8.50
ICI Vynide 50" wide £3.50 Metre
Kickproof Grille 24" wide £3.25 Metre
Kick Resistant Grill 50" wide £3.25 Metre.

FULL RANGE OF RE-AN PRODUCTS IN STOCK
SEND FOR OUR BROCHURE NOW!!

PROJECTORS – PLUTO – NEW LOW PRICES!!!
CHOICE OF WHEEL/CASSETTE

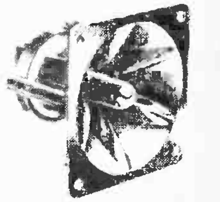
P150 150W Tungsten	£34.00
P500 100W Q.I.	£69.50
P500 250W Q.I.	£79.50
Liquid wheels	£7.50
Cassettes	£8.00
Picture wheels from (Wide choice available)	£4.75

PIEZO HORNS only £7.50
YES! – only £7.50

(As fitted to our package PA system)

Direct from Motorola Inc., USA at an UNBEATABLE PRICE

No crossover required 4kHz – 30kHz rated 75W/8 ohms 150W/4 ohms use two per 100W amplifier – Full instructions supplied.



GREENWELD

443 Millbrook Road Southampton
SO1 OHX Tel:(0703) 772501

BUY A COMPLETE RANGE OF COMPONENTS AND THESE PACKS WILL HELP YOU

- ***SAVE ON TIME** – No delays in waiting for parts to come or shops to open!*
- ***SAVE ON MONEY** – Bulk buying means lowest prices – just compare with others!*
- ***HAVE THE RIGHT PART** – No guesswork or substitution necessary!*

ALL PACKS CONTAIN FULL SPEC. BRAND NEW, MARKED DEVICES – SENT BY RETURN OF POST. VAT INCLUSIVE PRICES

K001 50V ceramic plate capacitors, 5%. 10 of each value 22pF to 100pF. Total 210, **£3.35**

K002 Extended range, 22pF to 0·1µF. 330 values **£4.90**

K003 Polyester capacitors. 10 each of these values: 0·01, 0·015, 0·022, 0·033, 0·047, 0·068, 0·1, 0·15, 0·22, 0·33, 0·47µF. 110 altogether for **£4.75**

K004 Mylar capacitors, min 100V type. 10 each all values from 1000pF to 10,000pF. Total 130 for **£3.75**

K005 Polystyrene capacitors. 10 each value from 10pF to 10,000pF. E12 series 5% 160V. Total 370 for **£12.30**

K006 Tantalum bead capacitors. 10 each of the following: 0·1, 0·15, 0·22, 0·33, 0·47, 0·68, 1, 2·2, 3·3, 4·7, 6·8, all 35V; 10/25 15/16 22/16 33/10 47/6 100/3. Total 170 tants for **£14.20**

K007 Electrolytic capacitors 25V working, small physical size. 10 each of these popular values: 1, 2·2, 4·7, 10, 22, 47, 100µF. Total 70 for **£3.50**

K008 Extended range, as above, also including 220, 470 and 1000µF. Total 100 for **£5.90**

K021 Miniature carbon film 5% resistors, CR25 or similar. 10 of each value from 10R to 1M. E12 series. Total 610 resistors, **£6.00**

K022 Extended range, total 850 resistors from 1R to 10M **£8.30**

K041 Zener diodes. 400mW 5%. BZY88 etc. 10 of each value from 27V to 36V, E24 series. Total 280 for **£15.30**

K042 As above but 5 of each value **£8.70**

PC ETCHING KIT MK III

Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. **£4.15.**

FERRIC CHLORIDE

Anhydrous technical quality in 1lb double sealed packs. 1lb **£1.00**; 3lb **£2.18**; 10lb **£5.60**; 100lb **£39.00**

SIRENS

Work off 4 x HP7 batteries, emit very loud noise. Overall size 110 x 75 x 60mm. Use as Burglar Alarm in car, house, workshop etc. ONLY **£1.95.**

VERO OFFCUTS

Pack A, All 0·1"; Pack B, All 0·15"; Pack C, Mixed; Pack D, All 0·1" plain. Each pack contains 7 or 8 pieces with a total area of 100 sq in. Each pack is **£1.50.** Also available by weight. 1lb **£4.20**, 10lb **£32.50.**

17 x 3½" strips: 0·1" 2.20, 10 for £15; 0·15" £1.96; 0·1" plain £1.83.

TEXAS 741
8 PIN DIL
FULL SPEC.
100 off £19.50
25 off £5.50

TRANSFORMERS

Special – 12V 8A for only **£4.00.** 6-0-6V 100mA **85p**; 9-0-9V 75mA **85p**; 12-0-12V 50mA **85p**; 100mA **95p**; 12-0-12V 1A **£2.90**; 20-0-20V 2A **£4.70**; 20V 2·75A **£4.**

VERO PLASTIC BOXES

Professional quality, two tone grey polystyrene with threaded inserts for mounting PC Boards.

Type		
2518	120 x 65 x 40mm	**£2.24**
2520	150 x 80 x 50mm	**£2.68**
2522	188 x 110 x 60mm	**£3.72**

Sloping front versions:

Type		
2523	220 x 174 x 100/52mm	**£6.90**
1798	171 x 121 x 75/37.5mm	**£4.65**

Gen. purpose plastic potting box 71 x 49 x 24. In black or white **40p.** Hand controller box, shaped for ease of use in the hand, 94 x 61 x 23mm **64p.**

S-DECS & T-DECS

S-DEC Breadboard **£2.25**
T-DEC Breadboard **£3.95**

RELAYS AND SOLENOIDS

Open construction relay with 2 10A c/o contacts, coil rated 24V AC, but works well on 6V DC **60p**

240V AC enclosed, 11 pin plug in base. 3 10A c/o contacts. **£1.20**

240V AC open, 2 15A c/o contacts **£1.50**

Solenoid, rated 48V DC, but work on 24V. 10mm push or pull action. Single hole fixing. Size 27 x 18 x 15mm. Made by Varley. Only **40p.**

1977/8 CATALOGUE NOW AVAILABLE – MUCH BIGGER AND BETTER, WITH 50p DISCOUNT VOUCHERS. ONLY 30p plus 15p POST.

WIRE AND FLEX

Flex pack – 5m of 5 diff colours, thick or thin. 25m for **30p.**

POWER PACK

Wood grained metal case 90 x 80 x 75mm containing mains transformer giving 6V at 200mA, 2 co-ax sockets, PC board with 1¼" fuseholder R's C's etc. Only **£1.**

EDGE CONNECTORS

Special purchase of these 0·1 pitch double-sided gold plated connectors enables us to offer them at less than ⅓rd their original list price! 18 way **41p** 21 way **47p** 32 way **72p** 40 way **90p** 49 way **111p.**

SOLAR CELLS

As used on space labs etc., these tiny cells give 50µA at 0·5V in sunlight. Ideal for powering small C-MOS projects etc. Can be banked for greater power output. Size 19 6.5mm. 3 for **£1**; 10 for **£3**; 25 for **£7**; 100 for **£25.**

CALCULATOR CHIP

Type C500 by GI – 8 digit 4 function + constant. Multiplexed for simple keyboard interfacing. Supplied with comprehensive data and 24 pin IC socket. Only **£1.50.**

DARLINGTON COMP. PAIR

Motorola type BD695A and BD696A 45V 8A 70W – gain 750 @ 4A PNP-NPN pair. Only **£1.50.**

MISCELLANEOUS IC's

All supplied with data.
MC3302 Quad comparator **£1.20.** ITT7105 LED Digit driver, 8 for **£1.** 710 TO99 case Diff. comparator **40p.** MC1469R Voltage reg. **£1.50.** ZN1034E Precision timer **£2.25.** LM1303 Dual stereo preamp **£1.40.** 733 Diff. video amp **£1.20.** LM301 Op amp **40p.** ITT326 2 x 2 & 2 x 3 i/p TTL nand gate. 10 for **£1.** SLD2128 Dual 128 bit static shift reg. **£1.50.**

Our retail shops at **21 Deptford Broadway, London, SE8 (01-692 2009)** and **38 Lower Addiscombe Road, Croydon (01-688 2950)** stock some of the advertised goods for personal callers only. Ring them for details.

All prices quoted include VAT and UK/BFPO postage. Most orders despatched on day of receipt. SAE with enquiries please. **MINIMUM ORDER VALUE £1.** Official orders accepted from schools, etc. (Minimum invoice charge £5). Export/wholesale enquiries welcome. Wholesale list now available for bona-fide traders. Surplus components always wanted.

PE SUSTAIN UNIT

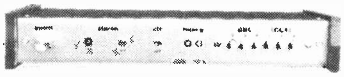
(OCT. 1977 PRACTICAL ELECTRONICS)

BUILD A SUSTAIN UNIT EQUAL TO THE BEST COMMERCIAL MODELS.

COMPLETE KIT – £7.95

ALL HIGH QUALITY COMPONENTS AS SPECIFIED.

DESIGNER APPROVED.



ORION tuner

Complete set of semiconductors	£4.99
LP1186 Tuner Head	£9.60
Glass fibre PCB, printed with component locations	£2.45

ORION amplifier

Complete set of semiconductors	£9.40
Glass fibre PCB, printed with component locations	£3.50

FERRANTI SEMICONDUCTORS — WE ARE THE EXPERTS!

BZV19		BFS98	16p	ZTX108	9p	ZTX320	16p	MOTOROLA	
all values	10p	ZS170	13p	ZTX109	11p	ZTX384	17p	BD699*	£1.14
BC415	17p	ZS178	54p	ZTX212	15p	ZTX384W	24p	BD700*	£1.28
BFS60	15p	ZS271*	23p	ZTX213	15p	ZTX450	16p	MC1310P	£1.80
BFS61	15p	ZTXA20	10p	ZTX214	17p	ZTX550	16p	MC1357PQ	£1.65
BFS97	15p	ZTX107	11p	ZTX239	10p	ZTX4403	16p	SN76660N	75p

We can supply any FERRANTI semiconductor device. SAE for Quotation.

ZNA116E* **£6.00** ZN1040E* **£7.50** ZN1034E* **£1.80** ZN424E **£1.20**

PE DIGITAL VOLTMETER (April 77) Send SAE for our special prices.

PE TV SOUND SEPARATOR

Complete set of semiconductors **£2·30,** High quality glass fibre p.c.b. **£1**
POSTAGE AND PACKING 15p per order. Orders over £5 post free. All devices are top grade, brand new and to full manufacturer's spec. We do not sell seconds or rejects. Send S.A.E. for our data sheet and price list.
Prices do not include VAT—add 8% to items marked*, and 12½% to all others

DAVIAN ELECTRONICS (MAIL ORDER ONLY)
13 Deepdale Avenue, Royton, Oldham OL2 6XD

24 HR. CLOCK/APPLIANCE TIMER KIT

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. £14.85
Special white box (56 × 131 × 71mm) with red Acrylic window – undrilled **£2.38**
drilled **£2.70**

TOUCH CONTROLLED LIGHTING KITS

These KITS replace conventional light switches and control 300W of lighting. No mains rewiring required. Insulated touch plates. Complete with easy to follow instructions.

TSD300K – TOUCHSWITCH and DIMER combined. ONE touchplate to switch light on or off. Brightness controlled by small knob. **£5.62**
TS300K – TOUCHSWITCH. TWO touch plates. One for ON one for OFF. **£4.32**
TSA300K – AUTOMATIC TOUCHSWITCH. ONE touch plate. Touch for ON and light stays on for preset time (variable from 2 secs. to 3½ mins.). Ideal for stairs and hall. **£4.32**

LD300K – 300W LIGHT DIMMER KIT. Replaces conventional light switches. **£3.02**

AY-5-1230 Clock/Appliance Timer I.C. £5.24
LM3911 Thermometer/Temperature Control IC (with data) £1.08
NE555 Timer I.C. 8 pin dil **39p** (3 for £1.08)
741 Op. Amp. I.C. 8 pin dil **26p** (5 for £1.08)

BC147	9p	BFY50	16p	2N6027 PUT	37p
BC148	9p	2N3055	43p	TIS43 UJT	26p
BC158	11p	TIP31A	54p	1N4148	5p
BC182L	9p	TIP32	54p	1N4004	5p

TRIAC BARGAINS

400V Plastic	**isolated tab
3A	68p
6.5A with trigger**	86p
8.5A**	85p
12A	91p
16A	112p
20A	178p
25A	192p
DIAC	23p
C106D 5A/400V	54p

CMOS LOW PRICES

4000	19p	4012	19p	4023	19p	4077	49p
4001	19p	4013	55p	4025	19p	4501	22p
4002	19p	4015	98p	4040	105p	4510	162p
4007	19p	4016	55p	4049	54p	4516	162p
4011	19p	4017	98p	4050	54p	4519	61p

MINI MAINS TRANSFORMERS

6-0-6V 100mA	92p
12-0-12V 100mA	103p

OPTO ELECTRONICS

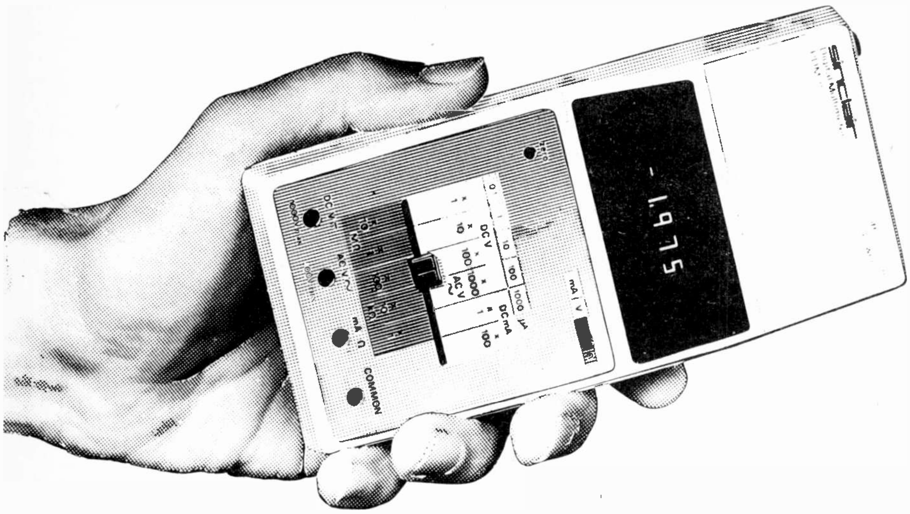
0.2" Red LED	11p
0.2" Green LED	23p
0.2" Yellow LED	27p
DL727 Dual 0.5" Display	£1.62

C280 Polyester Capacitors 250V d.c. (values in µF)
.01 5p; .022, .033, 0.47, 0.68 6p; 0.1 7p; .5 8p; .22 9p; .33 12p; .47 13p; .68 19p; 1.0 22p; 2.2 39p.
RESISTORS .33W 5% 22 ohm to 10M ohm 2p
Push Button, push to make 13p

QUANTITY DISCOUNTS ON REQUEST
PRICES VAT INCLUSIVE. ADD 25p P&P. MAIL ORDER ONLY TO:

T.K. ELECTRONICS (PE)
106 STUDLEY GRANGE ROAD, LONDON, W7 2LX.

The Sinclair PDM35.
A personal <u>digital</u> multimeter for only £29.95
(+8% VAT)



Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 gives you all the benefits of an ordinary digital multimeter – quick clear readings, high accuracy and resolution, high input impedence. Yet at £29.95 (+8% VAT), it costs less than you'd expect to pay for an analogue meter!

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

With its rugged construction and battery operation, the PDM35 is perfectly suited for hand work in the field, while its angled display and optional AC power facility make it just as useful on the bench.

What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ± 1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 μA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adaptor.
Industry standard 10 MΩ input impedance.

Compare it with an analogue meter!

The PDM 35's 1% of reading compares with 3% of full scale for a comparable analogue meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analogue meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analogue meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specification

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
Accuracy of reading: 1.0% ± 2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adaptor.
Sockets: Standard 4 mm for resilient plugs.
Options: AC adaptor for 240 V 50 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

Tried, tested, ready to go!

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PE VOLUME 14 No. 8 APRIL 1978

DESIGN IDEAS

THE STRENGTH of P.E. is mainly based on the readers and this point is amply demonstrated by the *Extra Design Ideas* contained in this issue, in the form of seven pages of *Ingenuity Unlimited*. We make no apologies for presenting a product you have partly made yourselves—and of course charging 45p for it! Don't forget that we pay, quite handsomely some may say, for every original idea published.

We feel that the I.U. section of P.E. is outstanding in the quality and, yes, ingenuity of the submissions. We must hasten to add that we do not put them to the test of actual construction and they are presented as design ideas for you—the ever inventive readers—to build upon or modify for your own ends.

However when you have modified and incorporated why not give others a chance to benefit from your further experiments by returning the design to us for further inclusion? We get many, many I.U.'s submitted and a good proportion of them are published, but if one of yours is, or has been, rejected do not despair—it may only have been because we already had similar ideas on file—by all means have another bash!

Very often we find that good and unusual projects come from I.U. ideas and we're always on the lookout for those too, so keep that in mind when you've built the latest "computer controlled egg timer" or "golf ball finder"!

READOUT

Even if you have no ideas to send we always like to see readers' comments on projects, features, the magazine in general and any other topical "electronic" subjects. Our *Readout* page appears irregularly but with some lively correspondence and comment from you we could improve on the regularity and present an interesting, topical and possibly controversial page for and from you each month. Such subjects as C.B. in Britain, hobby computers, electronic games, even the front cover of P.E. must at one time or another have aroused interest or disgust in some of you, so why not send us your views, get them aired in public and see how others feel.

If you want to start a computer club or arrange electronics evening classes in your area we can help by publicising that too. Take the trouble to write and say what you feel, we can't promise we will publish your letter but we will try and air as many views as possible, even if we don't agree with them. *Readout* could be such an interesting feature and we are sure most of you enjoy reading it when it does appear; **if you don't, let us know!**

CATALOGUES

The presentation of another catalogue within P.E. will no doubt meet with the approval of all readers. It is interesting to note the vast range of items stocked by many companies that are, and can, never be advertised; they only appear in the catalogue. For this reason we recommend you to investigate, not just those presented with P.E., but the catalogues of all our advertisers. We are sure you will find it worthwhile.

For those regular readers who did not read this page last month the colour is here to stay. We hope you like it, we feel it will improve our presentation. It is, in fact, just one of a number of moves to improve the product.

Mike Kenward

EDITORIAL

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Copies of PE are available by post, inland or overseas, for £10·60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH.

Back Numbers and Binders

Copies of most of our recent issues are available from: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 65p each including Inland/Overseas p & p.

Binders for PE are available from the same address at £2·85 each to UK addresses, £3·45 overseas, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Cheques and postal orders should be made payable to IPC Magazines Limited.

Letters

Queries regarding articles published in PE should be addressed to the Editor, at the Editorial Offices, and a stamped, addressed envelope enclosed. We cannot undertake to answer questions regarding other items, nor to answer technical queries over the telephone.

MARKET PLACE

Items mentioned in this feature 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.

PCB PRODUCTION KIT

An easy way to produce a number of p.c.b.s is to use master artwork and expose the circuit design onto the copper clad board using an ultraviolet exposure unit. All the necessary materials for this method of p.c.b. production have been available for sometime. Now a company called **Mega Electronics Limited** have introduced a complete p.c.b. kit. This kit enables the user to produce his own printed circuit boards, right from the preparation of the artwork to the finished circuit board.

The kit, which is called Photolab, consists of the ultraviolet exposure unit, drafting aid and film, positive resist coated epoxy glass laminate sheets, deloping and etching trays, labels, a high-speed drill and all the necessary developers.

This unit can handle boards up to 9 × 6in and is priced at £44·50 complete.

For further information contact **Mega Electronics Ltd., 9 Radwinter Road, Saffron Walden, Essex CB11 3HU.**

ELECTRONIC MULTIMETER

The Miselco "Tester Electronic" from **Alcon Instruments** is a 48 range instrument constructed with "Self Service" in mind. This facility allows a damaged board or movement to be quickly and easily replaced by the user.

The instrument offers a 1MΩ/V sensitivity for both a.c. and d.c. except on the 300V and 1kV ranges where it is 100kΩ/V.

Accuracy is 2·5 per cent on a.c., 1·5 per cent on the d.c. and resistance ranges. The very clear scaleplate includes an anti-parallax mirror and a centre zero scale for galvanometric and null detection applications.

Maximum current measurement is 1 amp f.s.d. on a.c. and d.c. whilst there are optional high voltage probes which extend the voltage range to 3kV on both a.c. and d.c. or 30kV on d.c. only. Five resistance ranges cover 10kΩ f.s.d. to 100MΩ f.s.d. and power measurements can be made from −70dB to +51dB.

An optional built in signal injector is capable of providing a 1kHz modulated 500kHz signal at 20V peak-to-peak, so rich in harmonics, as to be detectable up to 500MHz.

The Tester Electronic, complete with carrying case and leads costs £48·20 exclusive of VAT.

For further information contact **Alcon Instruments Limited, 19 Mulberry Walk, London SW3 6DZ.**

LOGIC ANALYSER

A new modular instrumentation system available from **Tektronix UK Limited** enables any oscilloscope or X-Y monitor with more than 500kHz bandwidth to be converted into a versatile logic analyser or word recogniser.

The LA501 logic analyser system incorporates 4096 bits of storage, which may be used as four channels of 1024 bits, eight channels of 512 bits or 16 channels of 256 bits according to the required application.

On the oscilloscope screen, stored data is displayed in the form of a timing diagram, in groups of four. Each trace displays high and low logic states and a magnifier provides the capability to zoom in on any segment of the timing diagram. Channel to channel timing comparisons are simple because any trace can be moved vertically and positioned next to any other.

The WR501 16 bit parallel word recogniser with digital delay produces trigger pulses when a preselected parallel word occurs, giving fast access to almost any unique word in the data stream.

For further information contact **Tektronix UK Ltd., Beaverton House, P.O. Box 69, Harpenden, Herts.**

NEW CASSETTE TAPE

An iron oxide tape, Ferro Super LH1, has been developed by **BASF** in Germany to give the optimum performance on the widest possible range of Japanese recorders using high bias currents in the record head.

Cassette recorder manufacturers in Japan have moved away from the DIN standard to a high bias situation. The standard was established by the DIN Committee with Philips, the inventors of the compact cassette. However, manufacturers have not adhered to the standard, each one preferring to choose his own personal bias setting.

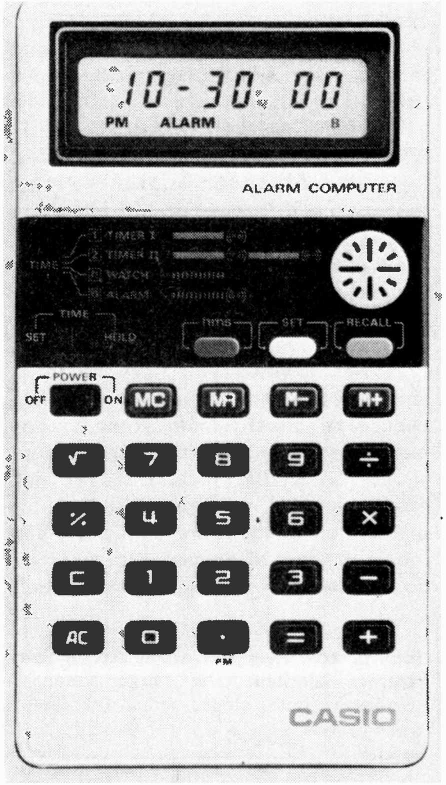
The majority of high bias recorders have bias settings in the range of 1·5dB to 2dB. Using this range as its datum, BASF developed Ferro Super LH1. The bias settings are midway between 1·5dB and 2·0dB making it suitable for a wide range of high bias recorders.

The tape is available in C60, C90 and C120 cassettes, with a suggested retail price of £1·66, £2·22 and £2·90 (exc. VAT at 8 per cent) respectively.

ALARM CALCULATOR

The latest calculator in the **Casio** range is the AQ810 alarm computer. This versatile unit has the normal range of calculating functions plus an alarm clock and two count down timers. It can be used as a calculator whenever required, irrespective of the timing mode it is in.

The calculator covers the four basic functions, square/powers, square roots, automatic access to memory, percentage and time calculations. The capacity of the unit for time calculations is 99 hours 59 mins 59 secs.



The clock can be used in the 12 or 24 hour mode and the alarm will sound for 10 secs after which it will automatically clear itself.

The two count down timers sound the alarm after a predetermined time period has elapsed, timer I automatically clears itself and timer II will repeat itself everytime the preset period has elapsed.

The accuracy of the clock is within ±3 secs per day, it has a liquid crystal display and the unit gives approximately 3000 hours continuous operation on two silver oxide batteries.

The calculator is housed in an attractive carry case and *really* is just the right size for the pocket. The flip top case allows rapid operation of the unit.

The calculator costs £19·95 inclusive of VAT, post and packing and further details can be obtained from **Tempus, Talk of the Town, 19–21 Fitzroy Street, Cambridge CB1 1EH.**

PULSE GENERATOR AND P.S.U.

The setting up of different types of power supply units for operating t.t.l., CMOS and op amps can be both time consuming and awkward.

The latest development of **Mechtric Engineering Ltd.** overcomes this problem by combining the essential power supplies necessary for CMOS, t.t.l. and op amps together with a pulse generator. The power supplies and generator outputs are all protected against short circuits.

The CMOS supply is variable from 4–16V d.c., the t.t.l. is 5V d.c. and the balanced op amp supply is variable from 6–21V d.c.

The instrument has two square wave outputs one leading the other by 90 degrees with a frequency range of 0·45Hz to 500kHz.

The price of the instrument is £198·00 excluding VAT and further details can be obtained from **Mechtric Engineering Ltd., 12 Brunel Road, Manor Trading Estate, Benfleet, Essex SS7 4PS.**

CABINET

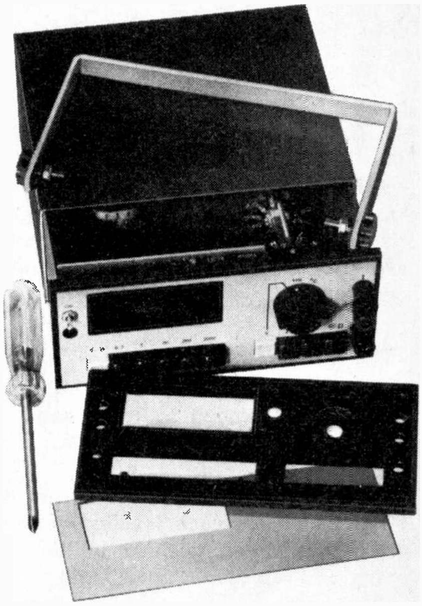
No more hole cutting! That's the theme behind the Instrument Case Type PDS by **Amatek.**

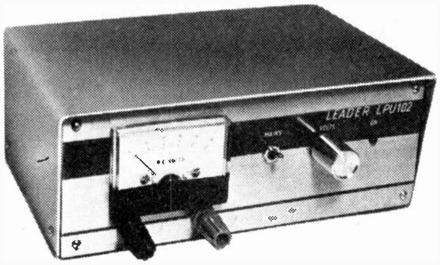
The moulded plastics front panel of this box is designed to take a wide combination of push buttons (including RS and Doram types), toggle switches, 4mm terminals, indicator lamps, and also has a location for a rotary switch. By laying on the lable plate and cutting with an art knife to expose the holes which are to be used, a piece of equipment can acquire an instant and effortless professional finish.

The case measures 178mm × 80mm × 152mm, is made of p.v.c. coated aluminium, and has a frontal display aperture of 70mm × 29mm.

Various accessories are available, including display modules, 4mm terminals, and fuse-holder and cable clamp kits.

The basic case costs £8·50 complete. For further details contact:
Amatek, 22 Bardsley Lane, Greenwich, London, SE10 9RF.





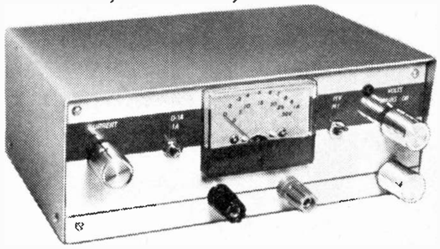
Bench Power Supply LPU102

ELECTRONIC KITS

A new range of Leader electronic kits is now available from **Arrow Electronics Limited.** The range which includes a digital clock, bench and laboratory power supply and a test bench oscillator have been extensively tested and are of guaranteed "bug proof" design.

With each kit is a comprehensive manual of building instructions, fully finished case/chassis including all the necessary nuts and bolts. The front panel is lettered and has a distinctive horizontal red stripe.

For further information contact **Arrow Electronics Limited, Leader House, Coptfold Road, Brentwood, Essex.**



Laboratory Power Supply LPU 103

P.E. will shortly be assembling and reviewing the Leader kit LPU103, Laboratory Power Supply.

DIGITAL WATCHES

Pulse, pulse, digital time is 10 : 58 and 50 seconds; press a button, digital month, date and day is 4 : 12 MO; press another button for Paris time, Kuwait time, Hong Kong time, Tokyo time, Honolulu time, San Francisco time, Chicago time, New York time, São Paulo time.

This all seems a long way from three chickens past Mickey Mouse but if you commute by Concorde then Casio's World Time LCD digital watch could well save you many frustrating synchronizations to local times. For the traveller interested in minimum "lift off" to "touch down" times the Casio Chronograph has a one hundredth second stopwatch which can be started then left to count away unobserved while normal time read out resumes display. For sports activity measurers the Chronograph can give normal time, net time, lap time and first and second place times.

The liquid crystal display is quick to change and easily viewed if the face of the watch is nearly at right angles to line of sight. At more than 45 degrees from vertical the structure of the LCD causes a faint, shadowed image. At dusk a third button supplies a bright white light across the display.

Time keeping is better than half a minute per month and with only the 29th February to be coped with (fourth and final button) the days of winding and setting to GMT appear to be past.

Chronograph, £64·95. World Time—Price and availability to be announced shortly.

Further information is available from: Tempus, 19–21 Fitzroy Street. Cambridge.

FUMBLE NUDGE Game

A. R. CUFF

THIS project should appeal to those constructors who already have a taste for electronic games, *and* those who are looking for an interesting application of a logic circuit on which to try their skill.

The game itself is essentially a contest of speed and manual dexterity between two players, and it has proved to have almost instant appeal to gamesmen of all ages. This attraction seems to be based on the fact that while beginners are quick to grasp the idea, the game is at all levels limited only by the players' dexterity; not by the circuitry. Thus there is never a point at which the game can be mastered and hence devoid of any further challenge.

THE GAME

Fumble-Nudge is an easy game to play, and only a few minutes are needed to understand the basic details, and reference to Fig. 1 will help while reading the following explanation.

The playfield consists of a row of 16 l.e.d.s, the inner 14 of which are each labelled with a four bit binary code representing their position in the row, while the l.e.d.s at either end represent "goals" and are unmarked.

The game begins with D15 (code 1000) being illuminated, and this l.e.d. represents the "ball" during play. The object of the game is for both players simultaneously to try to force the ball into the goal at their opponent's end of the field by a series of "fumble" and "nudge' sequences, which operate as follows:

Each player has in front of him four "Fumble" switches and a "Nudge" button, and in order to move the ball towards his opponent his four "Fumble" switches must first be set to equal the binary code directly alongside the ball (in this case 1000). Having done this the Nudge button becomes effective and when pressed it advances the ball a random one, two or three positions along the playfield.

Only the first valid Nudge signal is accepted by the circuitry so that the quicker of the two players succeeds in moving the ball towards his opponent. If, for example, the "Down" player wins the first exchange, the ball may

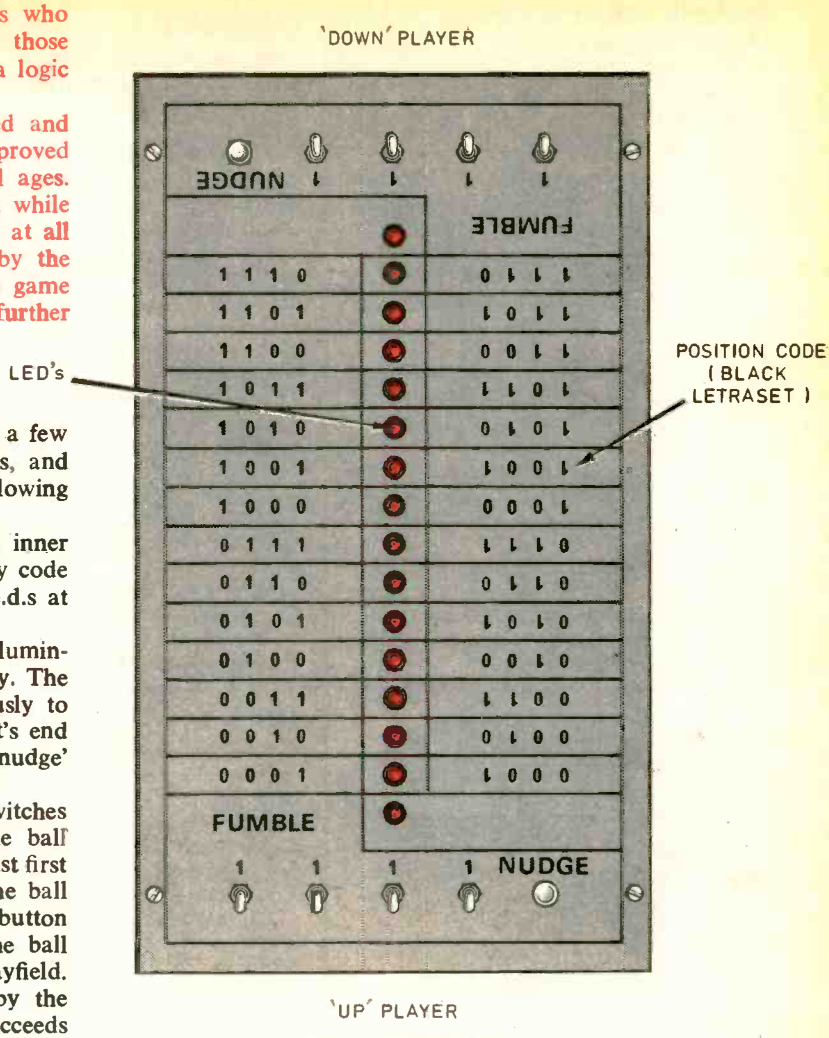
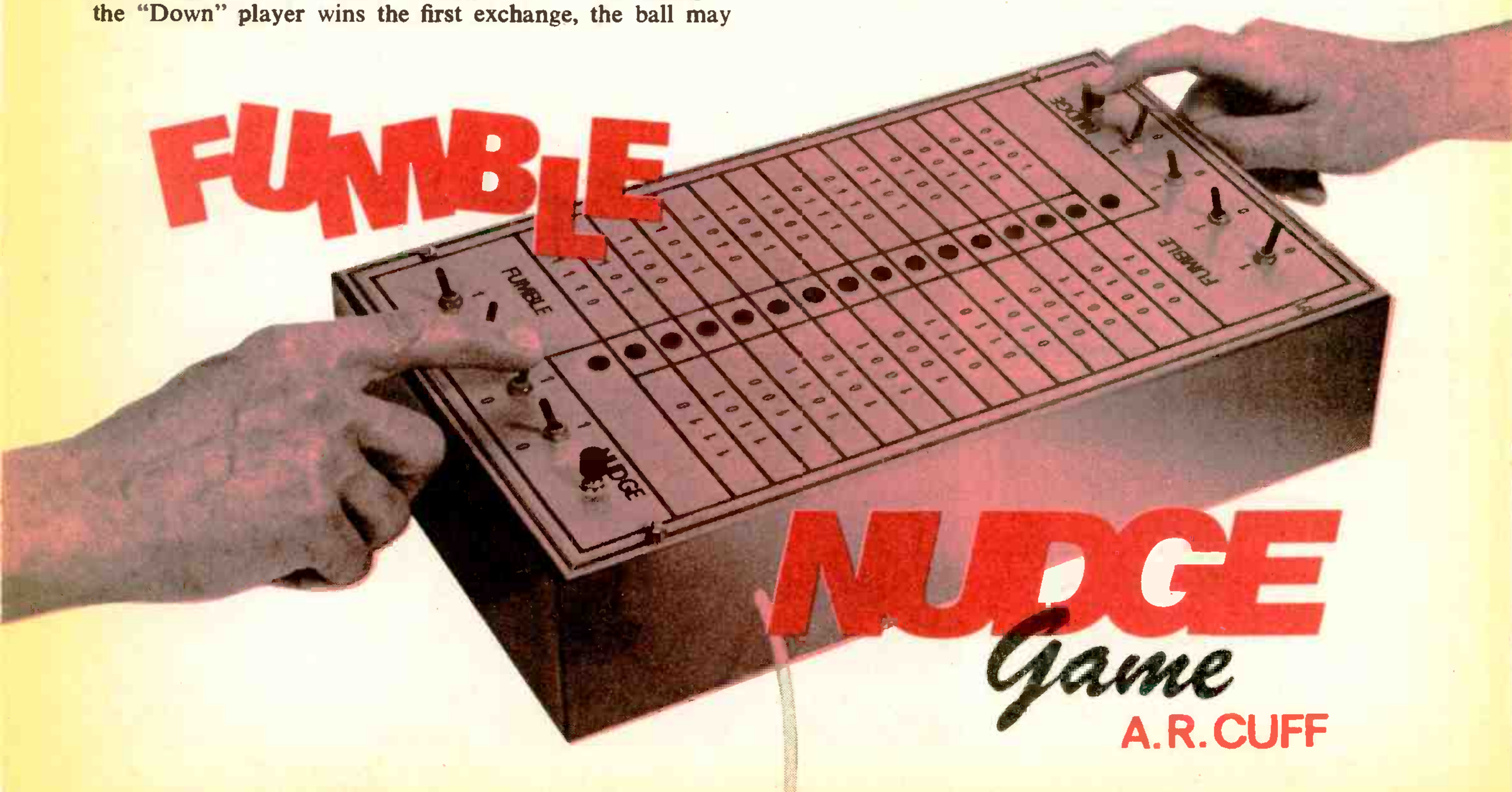


Fig. 1. Playfield



have advanced two positions and D13 (code 0110) is then lit.

To nudge the ball again both players must race to set up the new code (0110) on their "Fumble" switches before a second nudge is accepted. Thus the play continues until one player succeeds in nudging the ball into his opponent's goal to win the game.

CIRCUIT DETAILS

A block diagram illustrating the operation of the circuit is shown in Fig. 2. At the start of each game, the 74193 is preset to the 1000 position and D15 lights up. Each of the 4 ouptut bits of the 74193 is also fed to one input of an EXCLUSIVE-CR gate (7486), the other input of

Fig. 3. Circuit diagram

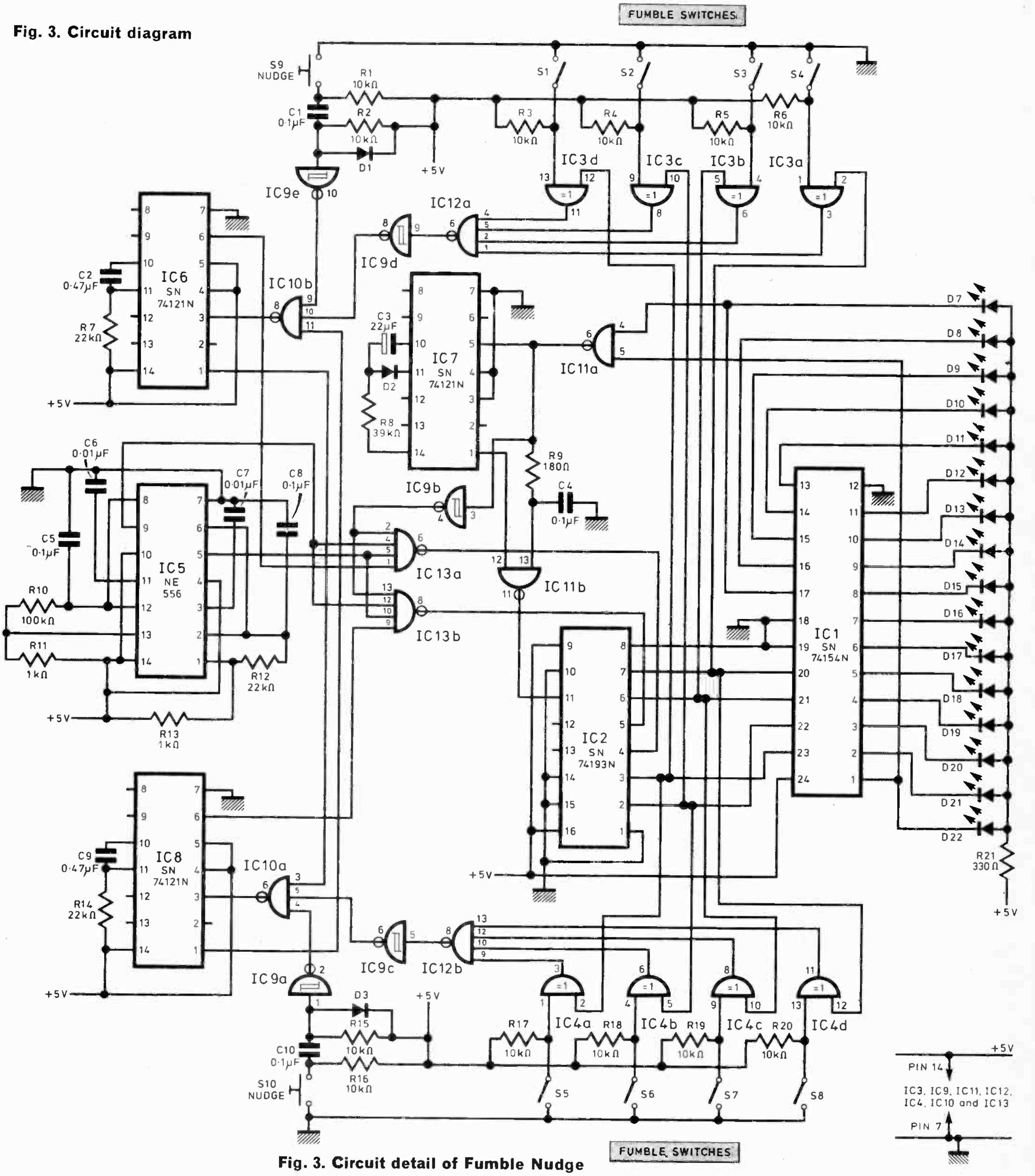


Fig. 3. Circuit detail of Fumble Nudge

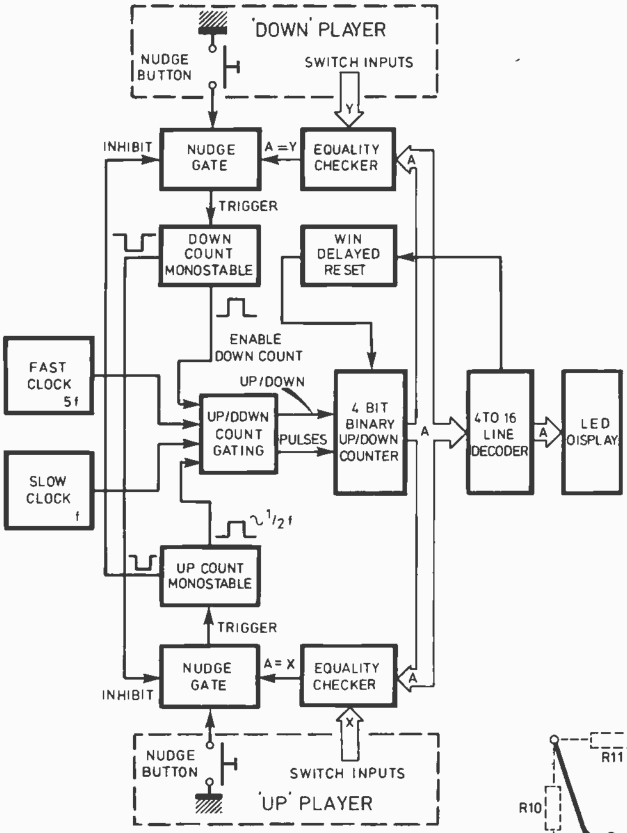


Fig. 2. Block diagram of Fumble Nudge

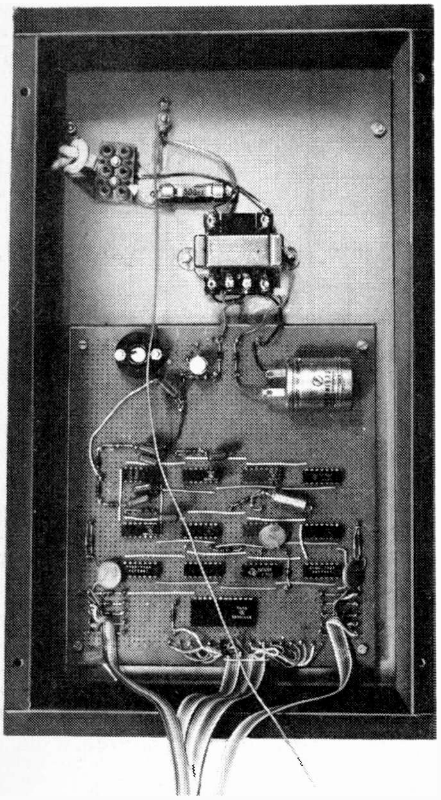


Fig. 7. Layout of power supply, i.c.s. and ribbon cabling

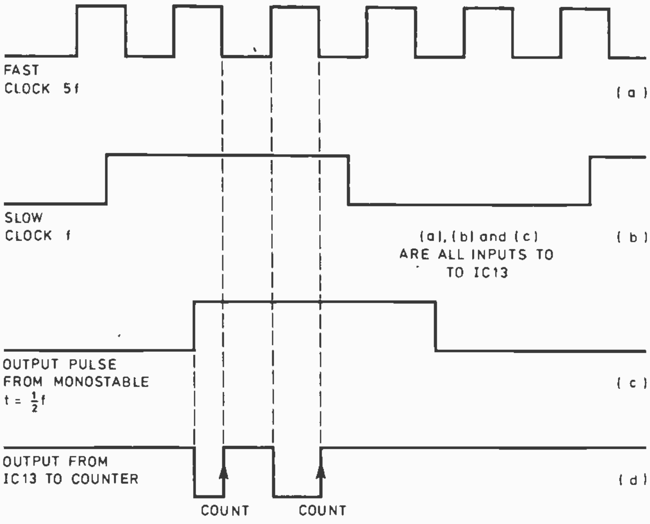


Fig. 4. Timing diagram

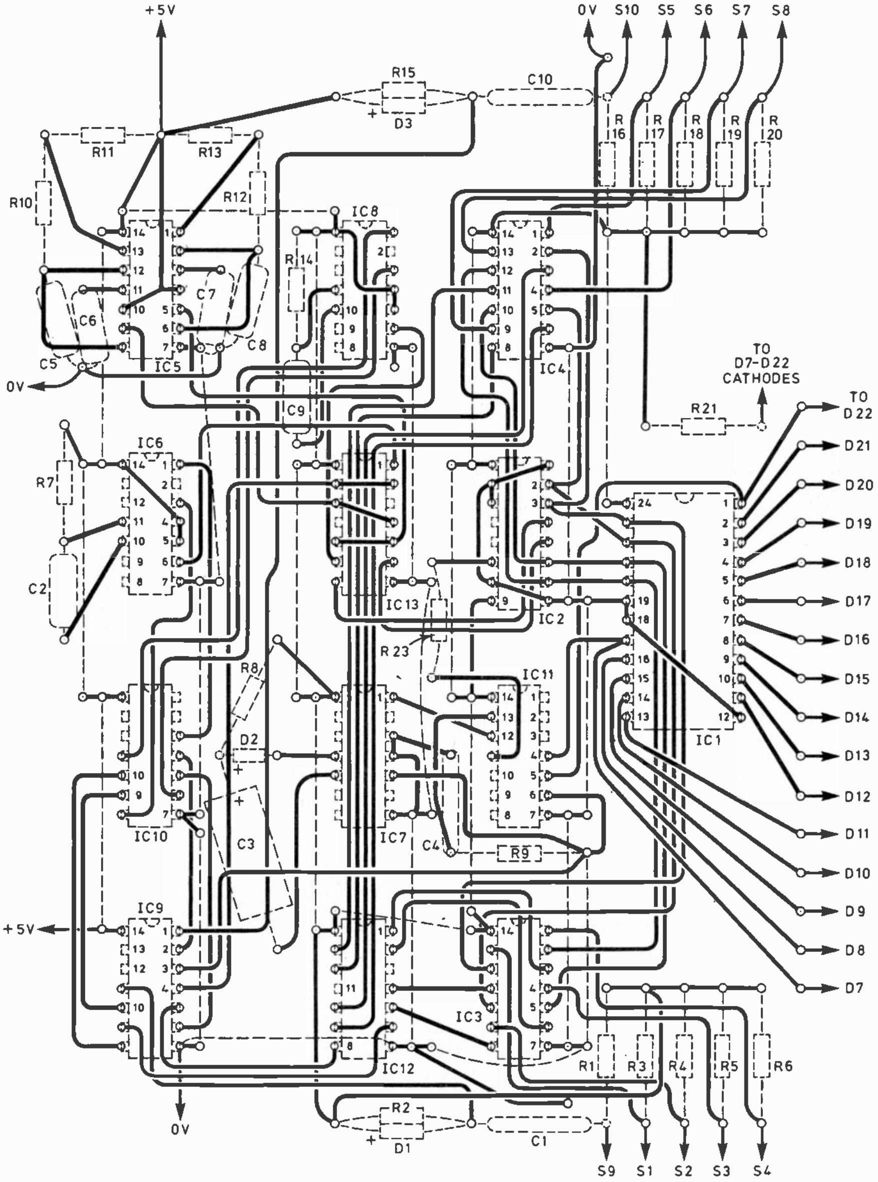


Fig. 6. i.c. layout and wiring

which is derived from one of the player's "Fumble" switches. Only when a player has set the correct code on his switches are the outputs from the EXCLUSIVE-OR gates all at logical 1. The occurrence of this condition is detected for each player by the NAND gate IC12 (7420), and is used to open the appropriate "Nudge" gate. Pressing the "Nudge" button gives a short pulse which, when passed through the "Nudge" gate, triggers a monostable (74121). Only the first player to nudge at this time gains access to his monostable since the UP COUNT inhibits the DOWN NUDGE gate, and vice versa.

If, for example, the "Up" player has been successful then the UP COUNT line of the 74193 is enabled for a time of approximately 1/2f seconds. During this period, the FAST- and SLOW-CLOCKS are also gated to the UP COUNT line via IC13. Their frequencies of fHz and approximately 5fHz are designed to give a random one, two or three counts for each nudge. (The operation of this can be seen in the timing diagram, Fig. 4).

The frequency f can be any convenient value. (In the prototype it is about 70 Hz).

After each nudge, the output from the EQUALITY CHECKERS are no longer "true" and the NUDGE buttons are inhibited until the new input code is set up. When the illuminated l.e.d. eventually reaches one end of the playfield this state is detected by IC11 and the WIN DELAYED RESET mono is triggered. This provides a short pause to enable the win to be noted before presetting the 74193 with the starting code for a new game.

Power for the game is provided from the mains via a simple series regulator (Fig. 5), and current consumption is 200-250 mA. Only one decoupling capacitor is used as this was found to be adequate, but for some layouts it may be necessary to fit one further 0·1μF capacitor for every three i.c.s to ensure freedom from supply noise problems.

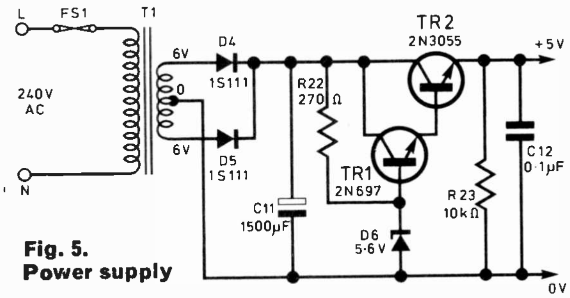


Fig. 5. Power supply

CONSTRUCTION

A suggested layout of the logic i.c.s is shown in Fig. 6. All the components together with the power supply can be accommodated on a single piece of Veroboard approximately 150mm square, and the arrangement is not critical.

The circuit board and the mains transformer are mounted on an aluminium sheet which then forms the base of the game box. The l.e.d.s and switches are fitted on a further aluminium panel which is painted and lettered to provide the playfield. The construction of the box and front panel are detailed in Figs. 1 and 7. ★

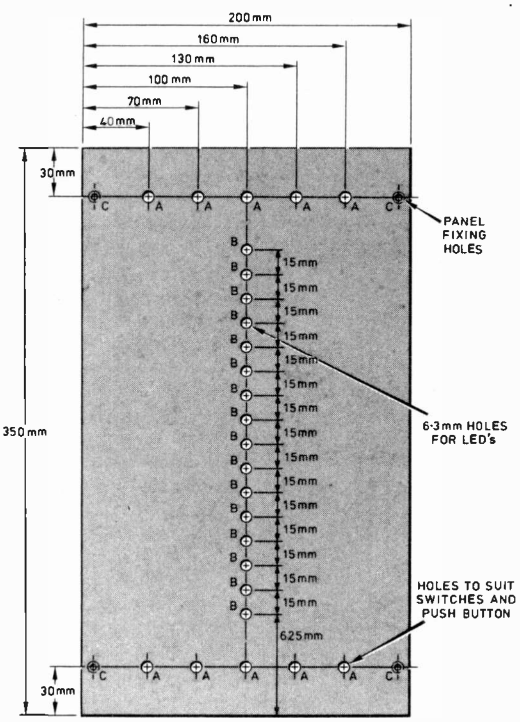


Fig. 8. Hole positions

COMPONENTS . . .

Resistors

R1–R6, R15–R20, R23	10kΩ (13 off)
R7, R14, R12	22kΩ (3 off)
R8	39kΩ
R9	180Ω
R10	100Ω
R11, R13	1kΩ (2 off)
R21	330Ω
R22	270Ω

All resistors ¼W 10%

Capacitors

C1, C4, C5, C8, C10, C12	0·1μF (6 off)
C2, C9	0·47μF (2 off)
C6, C7	0·01μF (2 off)
C11	1,500μF elect.
C3	22μF elect.

Diodes

D1–D5	1N4004 or similar
D6	5·6V Zener (400 mW)
D7–D22	TIL 209 or similar

Transistors

TR1 2N697
TR2 2N3055 or 2N697 with heatsink

Integrated Circuits

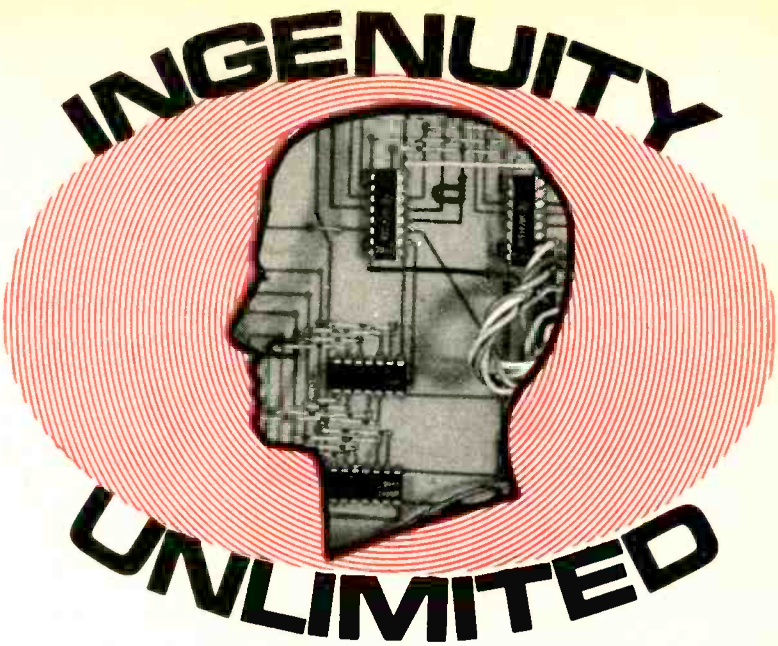
IC1	SN 74154N	4 to 16 line decoder
IC2	SN 74193N	Up/down counter
IC3, IC4	SN 7486N	Quad EXCLUSIVE OR
IC5	NE 556	Dual timer
IC6, IC7, IC8	SN 74121N	Monostable
IC9	SN 7414N	Hex Schmitt Inverter
IC10	SN 7410N	Triple 3 input NAND
IC11	SN 7400N	Quad 2 input NAND
IC12, IC13	SN 7420N	Dual 4 input NAND

Miscellaneous

S1 to S8	S.P.S.T. Toggle Switches (8 off)
S9, S10	S.P.S.T. Pushbuttons (2 off)
T1	Mains Transformer 6–0–6V at 300 mA
FS1	500mA

0·1 inch matrix Veroboard and pins, fuseholder, 2A terminal block, lettering for playfield

EXTRA DESIGN IDEAS



FAST NI-CAD BATTERY CHARGER

THE usual form of constant current nickel cadmium charger is designed to charge a battery of cells fully in 12–14 hours. However, it is often necessary to be able to charge a battery in a shorter time. This circuit is capable of charging 1–8 1·25V cells in 8 hours.

A flat battery is connected to the output terminals and the "Boost" button S1 depressed momentarily. The l.e.d. will then extinguish whilst a constant high charge current is delivered to the battery.

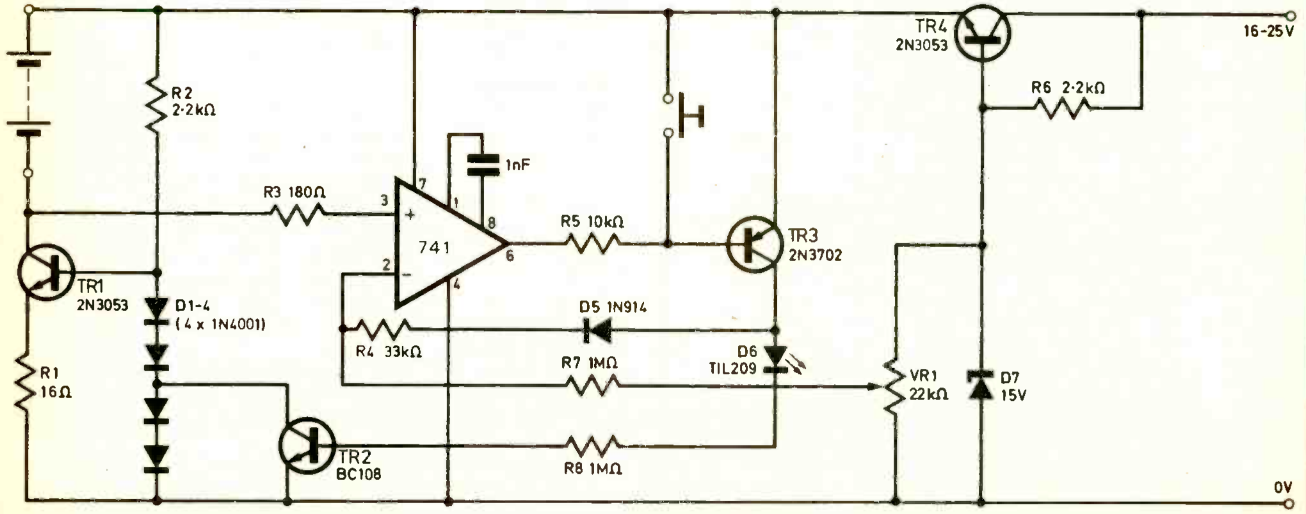
When the terminal voltage exceeds a preset level, the l.e.d. comes on and the battery is trickle charged until disconnected. The trickle charge current is approximately ⅓ of the high charge current. With the l.e.d. on, the battery can be left charging indefinitely without causing any damage.

A level about 10 per cent greater than the nominal battery voltage is set on the preset potentiometer. The charge current is set by the value of the emitter resistor of TR1. 16Ω gives a charge current of about 130mA which is satisfactory for charging HP7 size (AA) cells.

Both TR1 and TR4 should be mounted on adequate heatsinks.

R. Dudley,
Berkhampstead,
Herts.

Fig. 1



MAGNETIC TAPE SPEEDOMETER

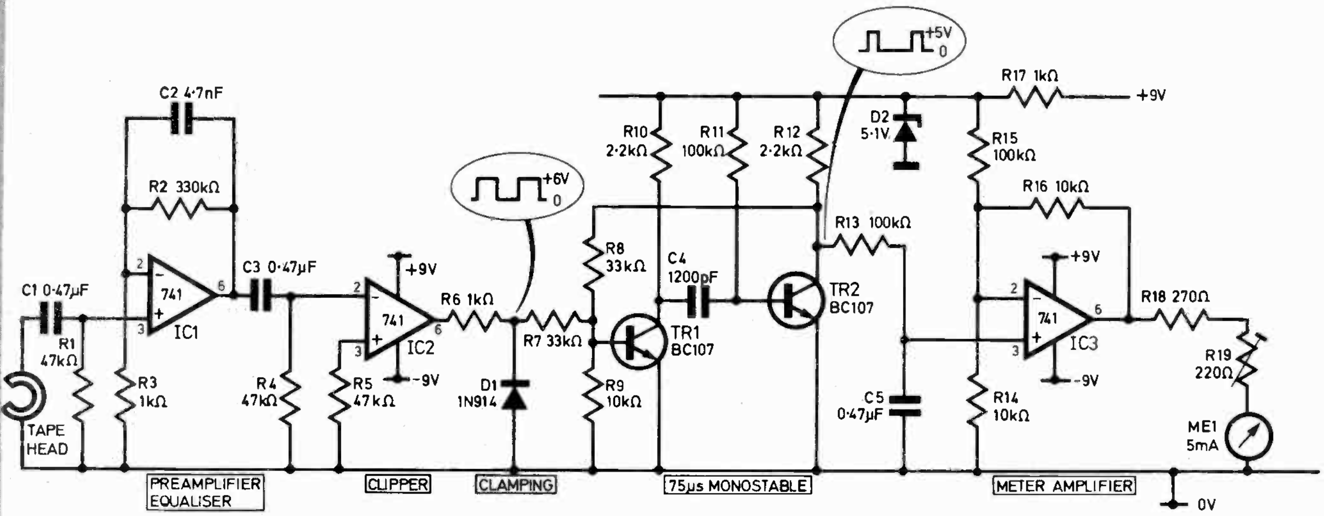


Fig. 1

Sq. wave recorded at $3\frac{3}{4}$ i.p.s.	F.s.d. of meter
5kHz	5cm/s
1kHz	25cm/s
500Hz	50cm/s
250Hz	1m/s

THIS circuit (Fig. 1) was designed as an aid to teaching about motion and collisions, as an alternative to the more usual "ticker-tape". No doubt readers could think of many other applications.

A square wave tone is recorded on an ordinary piece of recording tape (open reel), so that a fixed number of pulses is recorded on the tape per cm. The tape is attached to the trolley used in the motion experiment, and drawn past a playback head. The frequency of the signal from the playback head is proportional to the speed at which the tape is travelling. The circuit converts this frequency into a meter reading.

The circuit is designed to work under all sorts of adverse conditions, including mild tape "drop out", and ailing batteries. IC1 is a tape head preamplifier and equaliser. The output from most tape heads increases with frequency, and this is compensated by the capacitor C2 in the feedback network. The stage has a gain of about 50dB at low frequency, falling off at 20dB per decade above 100Hz.

The second stage, IC2, is a clipper, producing a square wave of the same frequency as the signal from the tape head, and this square wave triggers a monostable consisting of TR1 and TR2. The monostable produces pulses, each 75μs wide and 5·1V high, at the frequency of the incoming signal. It is worth mentioning the function of the Zener diode, D2, here. It is often not realised that during the action of a monostable (or for that matter an astable), the base of one of the transistors (TR2) goes negative by an amount equal to the supply rail. Now most modern small-signal transistors cannot sustain more than about 5V reverse bias across their base-emitter junctions before they avalanche, which would give a rather shorter pulse than expected. The Zener diode has been included for two reasons; to keep the supply rail down to 5V, and to stabilise the amplitude of the output pulse from the monostable.

The pulses from the monostable are then smoothed and amplified by IC3 to drive the meter. The waveform on the collector of TR2 does not actually go down to 0V, but to about 0·2V depending on the transistor. R15 has been included to offset this effect. If the meter gives a positive reading with no tape passing the head, R15 may need to be reduced (or increased if a negative reading is obtained).

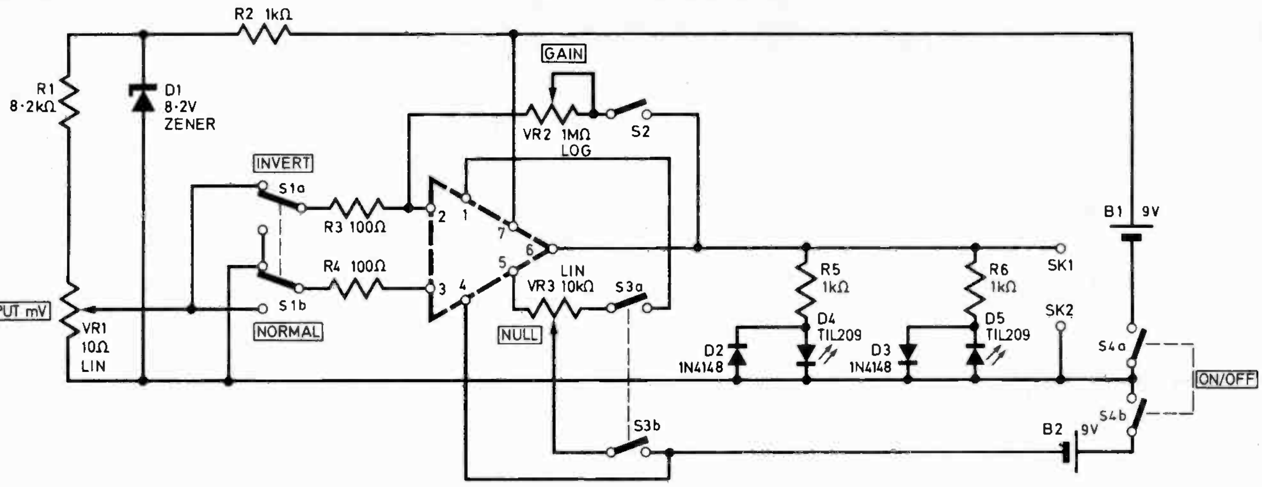
The prototype was built into a small box with a tape head, rescued from a defunct tape recorder, on the side. One of the biggest problems was friction at the head; for reliable operation a felt pressure pad had to be used. One way to overcome the effect of this friction would be to perform the motion experiment on a sloping runway. However, with a little experimentation with the position of the tape head and the path of the tape, it may be possible to do away with the pressure pad altogether.

A table of the square wave tones recorded on the tape is given.

Once the tapes have been made up they can be used for many experiments. R19 should be adjusted to give the correct full scale deflection on the meter with one of the tapes. One way to do this would be to use the 25cm/s tape, and arrange for it to be pulled past the head by a tape recorder movement running at $7\frac{1}{2}$ i.p.s. (19cm/s). Once R19 has been adjusted for one tape, the other tapes will give their correct f.s.d., provided, of course, that the frequencies of the recorded tones were reasonably accurate.

K. J. Dorrell,
Southampton, Hants.

741 TESTER



I RECENTLY acquired a bulk purchase of i.c.s which contained many 741 series op-amps said to be untested. Looking through articles for the past couple of years failed to give any circuits for this purpose (although digital i.c. testers and transistor testers were fairly numerous). I therefore built the tester illustrated in Fig. 1, a simple circuit which has proved quick and easy to use as well as being relatively cheap.

The input is tapped off a low impedance source, VR1 which can supply 0–10mV, and this was read off by using a knob with a skirt labelled 0–10 directly. This is supplied via switch S1 to either the inverting or normal input of the 8 pin d.i.l. socket and the gain set using VR2. With the values used for VR2, R3 and R4, the gain is continuously variable from around unity to 10,000, and the use of a log potentiometer enable gains up to 1,000 to be read off with fairly good resolution. The gain scale was in fact calibrated by using an ohmeter, marking off the 10kΩ, 50kΩ 100kΩ, 500kΩ and 1MΩ points and then labelling these points directly with the gain figures 100 to 10,000.

The output from pin 6 of the socket is taken across two l.e.d.s which on the panel are labelled normal for D4 and invert for D5, and this gives instant indication of the correct mode of operation of the i.c. under test. The diodes D2 and D3 limit the reverse voltage across the l.e.d.s to 0·6V.

The brightness of the l.e.d.s also should vary as both VR1 and VR2 are changed, and sockets are provided so that the output can be measured directly with a multimeter if more accurate data is required.

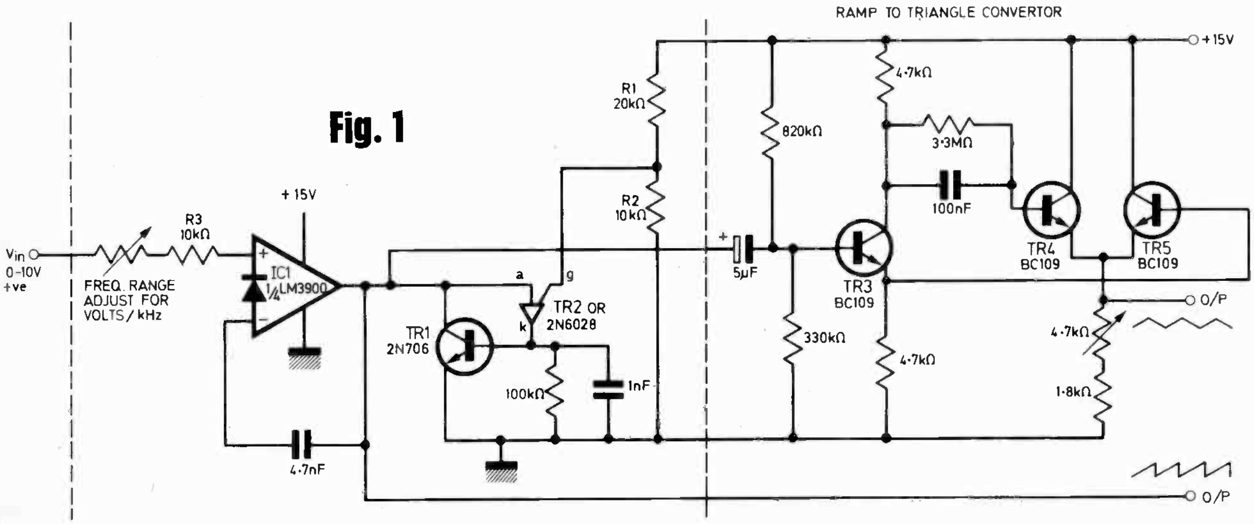
Finally S3 is used to switch in the offset null potentiometer VR3 which should cause the l.e.d.s to change over as it is slowly rotated.

When a "good" 741 i.c. was used to test the device, it was found that the open loop gain, i.e. with S2 open, gave a voltage saving of ±7·5V whereas the rails were ±9V, but this is probably due to the combined effect of R5 and R6 which give a load of about 500Ω compared to the output impedance of the i.c. of around 150Ω. However, this should not prove a problem during testing.

Using the 741 tester, it was possible to very quickly check all the main parameters on over forty 741 op-amps. It was unfortunate for me that only two proved fully functional!

T. Smales,
Wrexham,
Clwyd.

VERSATILE V.C.O.



"DOUBLE TREMOLO UNIT"

At present there are available a large number of both ready built tremolo units and plans for building them. Whilst providing a useful effect for guitars, they nearly all just regularly vary the amplitude of the signal and, if used a lot, they can become monotonous. This unit produces an effect totally different from normal tremolo or any other effect available at present.

Most electric guitars have two pick-ups, the idea behind this being that due to their different positions they give different tones, the guitar having a selector switch allowing both or either one of the pick-ups to be used. The novelty in this unit is that it regularly switches from one pick-up to the other, thus giving a regular change in the tone quality produced, however the effect is totally different from Wah-Wah and is very distinctive.

The circuit below is fairly simple, consisting of a multi-vibrator which alternatively switches on TR3 and TR4. Whichever transistor is "on" shorts out the pick-up which is in effect wired across it.

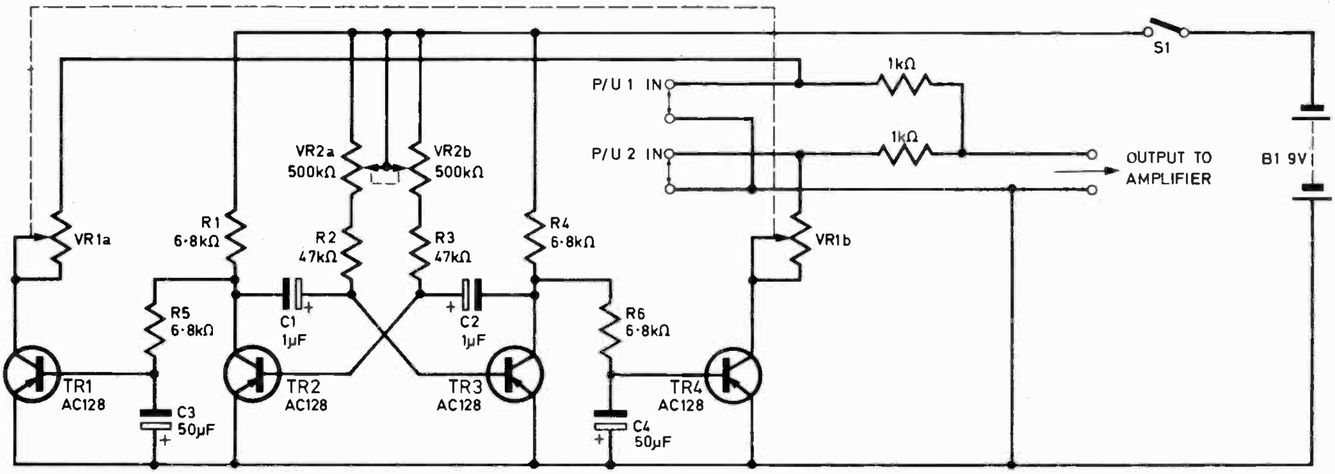
The value of VR1a/b depends upon the internal resistance of the guitar's pick-ups, and can easily be found by finding the lowest value of resistor which, when put in place of the variable resistors will just produce a noticeable effect with the unit on. This value should be under 1 kilohm.

As the outputs of the pick-ups are mixed together then fed to the guitar output socket it will be necessary to remove the mixing (usually the final) stage from the internal circuitry of the guitar and fit a stereo jack socket in place of the mono output socket, with one pick-up wired to each channel of the socket, the output of the guitar then being fed to the unit by a stereo lead, with the output of the unit going to the amplifier.

Alternatively (and preferably) the unit can be built into the guitar, with its controls mounted alongside the guitar controls on the scratchboard, with the output of the unit connected to the guitar's output socket. This method is preferable as it allows the unit's controls to be altered more quickly and a normal lead to be used to connect the guitar to the amplifier.

With a few minor alterations to the unit's input/output connections it could be used to tremolo in and out another effect such as Fuzz or even between two instruments alternatively, but by far the most effective use of the unit is in its original form.

S. J. Baxendale,
South Shields,
Tyne & Wear



The circuit to be described is the outcome of many months' experimenting in search for an accurate, versatile and cheap voltage controlled oscillator.

In Fig. 1, positive value of Vin produces a positive going ramp of about 5V peak. The ratio of R1/R2 controls the output voltage. The slightly unconventional configuration of the p.u.t. (TR2) is necessary as when using the standard u.j.t. replacement circuit the p.u.t. is liable to latch on and if a current limited power supply is not used, excessive current drain can result in the destruction of IC1 and the p.u.t. The circuit as shown produces a fool-proof stable circuit with a very fast reset time. A u.j.t. shows slower reset and this spoils the triangle wave symmetry at high frequencies. The ramp shows a small (10μs) reset pulse caused by the internal circuit of the LM3900. No way has been found to overcome it, however, it is of no consequence if the oscillator is used for audio work.

The maximum usable frequency is about 25kHz.

The ramp to triangle wave convertor consists of a phase splitter and a form of linear OR gate. The former produces two equal but opposite output which are fed into the differential pair. The b/e junctions of these "select" the highest possible voltage at any instant and combine the two ramps to produce a perfect triangle waveform, the symmetry of which is adjustable from ramp to triangle using the 4·7 kilohm potentiometer.

TR4/5 also act as emitter followers and produce a low impedance output.

Four v.c.o.s can be made with one LM3900 and if attention is paid to decoupling there is only very small interaction between each.

The best way of adjusting the frequency range over wide limits is by altering the integrator capacitor. For the value given the range is 1Hz–25kHz.

The resistor R3 can also be altered over a very wide range as IC1 input current requirements are low.

Some interesting and unusual effects can be obtained by driving one fast v.c.o. with a slow one (integrator capacitor about 1μF).

If a 1nF capacitor in series with a 500 kilohm potentiometer is wired between two p.u.t. anode gates the two v.c.o.s can be made to lock onto each others harmonics. With the reduction of potentiometer resistance to zero the slower running v.c.o. will speed up to the fast one in harmonic "jumps" until finally both run at the same speed.

J. A. Oliver,
Wellington,
New Zealand

CAR LIGHTS-ON INDICATOR

With the new laws calling for car lights to be used during daylight hours, when the visibility is poor, the great problem is in remembering to turn them off at the end of a journey. When motoring in daylight, if rain, sleet or snow begins to fall, the head lights are switched on. The panel illumination is too dim to see and if, at the end of the journey, the lights are left on a flat battery may result.

With this unit, if the engine is switched on, no warning tone will be generated during the day or night. If the engine is switched off during daylight, this will start a warning tone. This will stop when the driver switches off the lights.

Should the driver stop at night and leave the lights on, again no warning will be generated as leaving lights on at night is still necessary in poorly lit areas.

The unit is dormant until the lights are switched on, then power is applied to an audio oscillator. TR2 and TR3 form part of this with C2 and R6 in the feedback loop. These values can be adjusted to set the pitch of the tone (Fig. 1).

TR1 and surrounding components make up a NAND gate, where TR1 will be switched off as long as a positive d.c. potential is applied to its base. If the potential is removed TR1 will become biased through R3 and turn on, biasing TR2 and switching the audio oscillator on.

A d.c. positive potential is applied through D1 (from light sensor) or D2 from the ignition switch so that when the engine is running, 12V is continually holding TR1 off. Once the engine is switched off, this potential is removed leaving D1 holding the oscillator off.

In darkness R7 resistance will be very high, making pin 3 of IC1 positive and providing a positive ouptut to TR1 through D2.

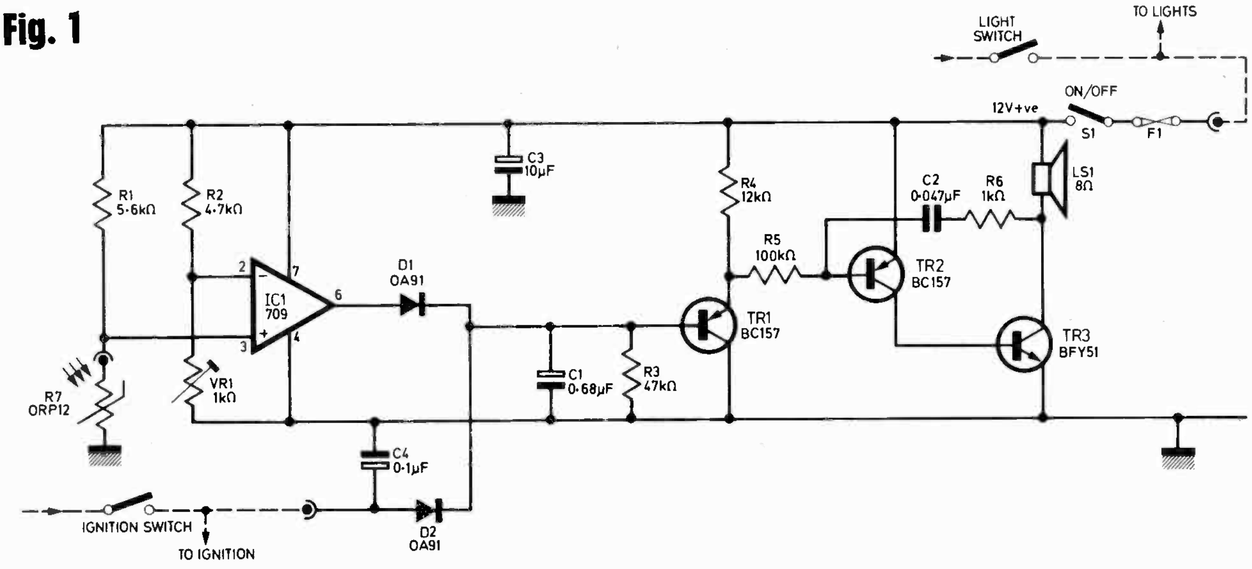
In daylight when the lights are on and ignition off, R7 resistance will be very low, making pin 2 drop in voltage to almost zero, and causing the output to drop to zero volts. The ignition is off, therefore D2 is off, it is daylight therefore pin 6 is at zero volts and so D1 is off, hence TR1 will turn on through R3, activating the oscillator.

The tone will be cancelled by turning off the lights (or switching off the device).

The unit was mounted behind the dashboard, out of view, with R7 in a position where it can best sense the general illumination level.

G. Luck,
Gosport, Hants

Fig. 1



QUIZ MASTER

PREVIOUSLY published circuits for multi-station "Quiz Masters" have relied on circuits similar to that shown in Fig. 1. If S1 is closed when all the inhibit lines are at "1", gate G1 ouptut will go to 0, thus inhibiting all other stations. (All stations except No. 1 will have one of their inputs connected to G1's inhibit line).

As soon as S1 is released, G1's output will go high and the other stations will no longer be inhibited.

This circuit can be adapted for different numbers of stations and can also use NOR gates (interchange resistor and switch—this arrangement uses less quiescent current), however, it does have the following disadvantages:

(a) Limited by the number of inputs on each gate (8 usually, unless additional circuitry is used).
(b) Limited by the fan-out of each gate (10 usually).
(c) Stations grow more complex as total number of stations increase.

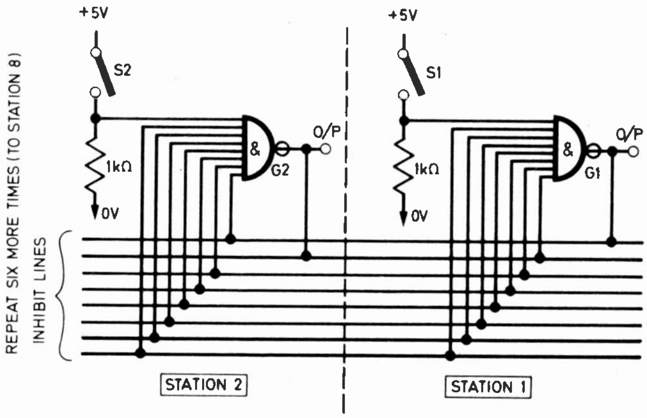


Fig. 1

The circuit shown in Fig. 2 solves all these problems, using only two inhibit lines, one the inverse of the other.

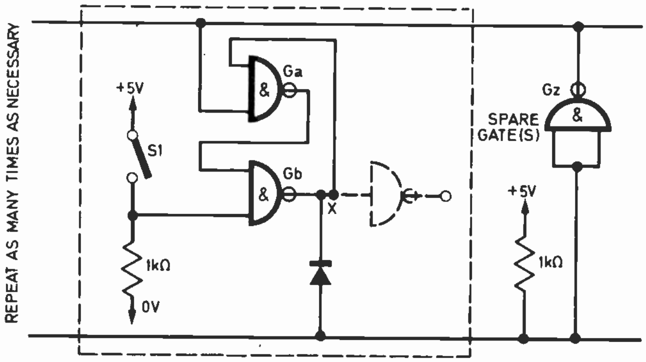
If S1 is closed when Gz's output is low, Gb will go low, sending Gz's output high via the diode. All other stations will now be inhibited but because S1 was closed before the inhibit line was activated, Gb will remain low until S1 is released. At this point the inhibit line will be deactivated and other stations will no longer be inhibited.

The prototype used silicon diodes and worked satisfactorily; however, germanium types are preferable. Gz uses any spare gates wired as invertors.

If the number of stations exceeds 10 (the normal fan-out) several gates can be wired in parallel or a power gate used (e.g. 7437 with fan-out of 30). An inverted (normally positive) low current output can be taken from point X (remembering it also has to sink current for Ga and Gz). Alternatively, this output can be inverted by a further gate as shown to give a non-inverted output with a fan-out of 10.

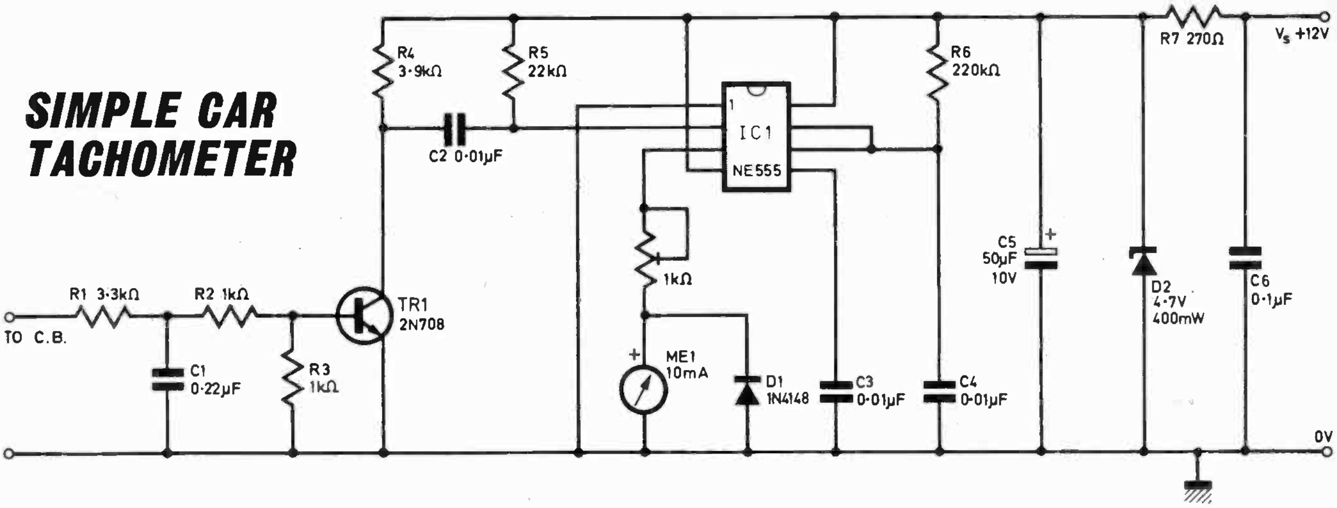
This circuit has several other applications. For example, the control of a vending machine selling several different brands or types of goods with a select button for each.

Fig. 2



T. Turner,
Stockport,
Cheshire

SIMPLE CAR TACHOMETER



I WAS recently asked to repair a car tachometer which had "self destructed". Research into back issues of *Practical Electronics* produced a suitable circuit which used an SN74121 monostable integrated circuit. However, I did not have a SN74121, but I did have a NE555 timer i.c. This was duly pressed into service as a monostable and the circuit shown is the result.

The circuit is designed to operate from a 12V supply, but other voltages may be used provided that R7 is altered using the following formula:

$$R7 = \frac{V_s - 4{\cdot}7}{0{\cdot}025}\ \Omega$$

The meter may be any type up to 10mA f.s.d. However, the value of the resistance in series with the meter may need to be altered to give the correct r.p.m. range.

Input pulses from the contact breaker drive TR1 into saturation which triggers the monostable via C2 producing pulses of fixed width at pin 3 of IC1 which are, in turn, used to drive the meter. The timing components R6 and C4 give a pulse width of approximately 2·5ms.

As the engine r.p.m. is increased, the monostable is triggered more frequently and therefore the average voltage seen by the meter is also increased.

The reverse biased diode D1 connected across the meter prevents spurious operation of the circuit due to the back e.m.f. generated by the meter with its pulsed operation.

The tachometer may be calibrated via VR1 using a signal generator. The corresponding meter readings for 4-stroke engines are given in Table 1; these should be halved for 2-stroke engines.

J. R. Shield,
Blaydon,
Tyne & Wear.

Table 1

No. of cylinders	R.p.m. corresponding to 50Hz input
2	3,000
4	1,500
6	1,000
8	750

HELIPOT SUBSTITUTE

WHEN there is a requirement for a variable resistor with a broad span and finely realisable accuracy one is generally recommended to a multi-turn helipot with suitable apologies for the high expense involved in such a purchase. Such occasions can arise when "setting-zero" on an operational amplifier.

The circuit shown in Fig. 1 achieves that of a "10-turn" potentiometer in sensitivity for the price of two common potentiometers.

Zero can be set by moving R2 to mid scale—zeroing as best possible with the "coarse" R1 and finally trimming with R2.

Although there are two knobs to twiddle, the 100kΩ potentiometer does give a × 10 resolution whilst the ganged potentiometer gives a full range coarse control.

O. Ormrod,
Auckland,
New Zealand

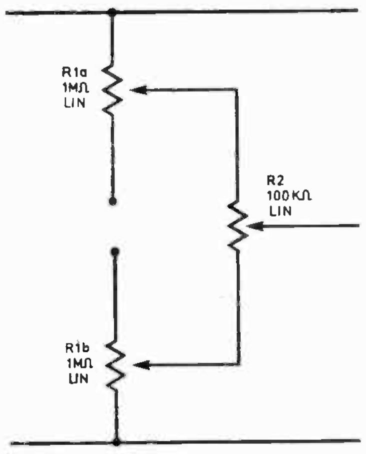
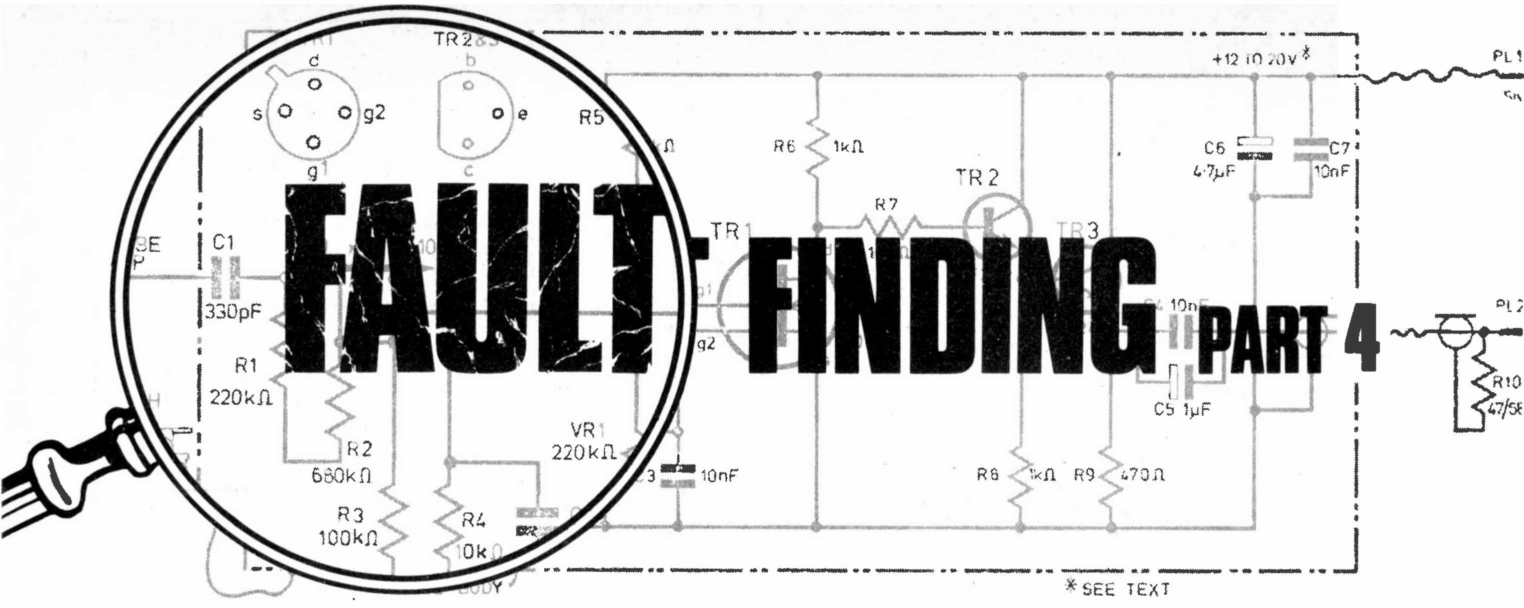


Fig. 1

INGENUITY UNLIMITED



FAULT FINDING PART 4

G. LOVEDAY

So far in this series we have introduced the basic concepts for fault finding in transistor and thyristor circuits, and methods used to locate faults in systems. Now we turn to perhaps the most important area of modern electronics, that of integrated circuits.

Most experimenters will have already used a few types of i.c. since most projects nowadays are built round either an analogue or digital type. The variety of i.c.s available for project work is very large and prices are really very modest.

I.C. BASICS

With this device the whole of a circuit function is contained inside one encapsulation. All the necessary diodes, transistors and resistors for a particular circuit function are diffused and interconnected in one piece of silicon. For example the popular 741 contains twenty transistors and eleven resistors and functions as a high gain differential amplifier. It's termed an analogue i.c. since it responds linearly to small changes of input signals.

A TTL i.c. on the other hand such as the SN7400N has four identical two input NAND gates so it contains sixteen transistors, four diodes and twenty resistors. Such an i.c. is termed digital since it switches between two logic states—its output being either high or low.

These two examples are of comparatively simple i.c.s. There are now several others available that contain many circuit functions inside the encapsulation making the whole i.c. almost a self contained system. The simpler circuits are grouped under the general heading of small scale integration, and as circuits become more complex they are termed Medium Scale Integration (MSI) typically between 15 and 100 equivalent gates per package, and finally Large Scale Integration (LSI) typically above the level of 100 equivalent gates per package.

DEVICE FAILURE

It follows from the preceding paragraph that a failure of one part of the i.c. renders the whole device useless, with a consequent complete loss of performance. It then has to be replaced.

I.c.s are designed to give very high reliability, in fact this is one of the benefits obtained by diffusing all the components into one piece of silicon, but failures will occur. Failures can result from any natural environmental stresses. Temperature cycling for example weakening an internal connecting lead and finally causing an open circuit. But more often the failures are caused by misuse such as exceeding the rated value of current, voltage and power.

High voltage 'spikes' on the supply leads will damage i.c.s in just the same way as other semiconductor devices. If relay coils are being switched ensure that they are properly suppressed.

It is also wise to keep in mind the maximum rated voltages for the type of i.c. you are using. TTL, for example, requires a regulated power supply of between 4·75V and 5·25V, and the absolute maximum voltage must not exceed 7·0 volts. Overvoltage would cause the i.c. to overheat and lead to possible damage.

Most i.c. power supplies are fitted with an overvoltage protection circuit—called a crowbar—which automatically switches the power off if the voltage rises above a preset value.

HANDLING AND TESTING

Apart from observing the maximum values of power supply voltages and input signal levels there are one or two other points worth noting when servicing units with i.c.s.

When making measurements don't use large test probes as these may short some of the i.c. pins together. If the i.c.s are mounted in sockets, never remove or plug them in while the power supply is switched on. Under these conditions large current surges can be taken by the i.c. which could destroy it like a fuse. It's also wise not to apply test signals while the power is off.

When fault finding, always check the power supply voltage at the actual pins of the i.c., not between board connections or on the printed circuit wiring. If, for example, you leave the −ve prod of the meter on chassis and put the +ve prod to the i.c. pin, a break in the ground line to the i.c. will not be indicated.

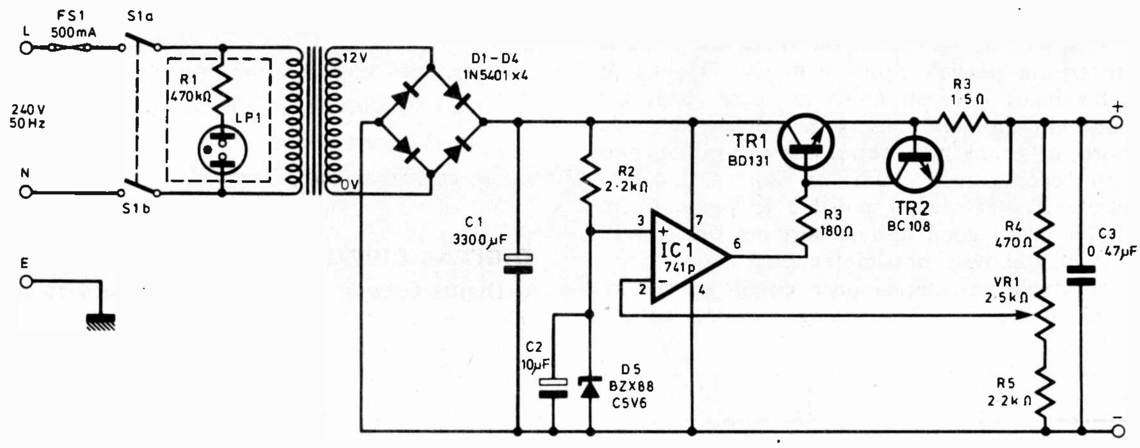


Fig. 4.1 Simple stabilised power unit

Having checked that power is present at the correct i.c. pins, next make sure that the required input signals are present, then finally test for the correct output. Since i.c.s are very reliable a lot of faults are caused by dry joints and breaks in copper tracks so always check visually and with a meter for any open or shorted connections.

If you are using an i.c. for the first time, before you switch on your project, double check the wiring and ensure that the i.c. is connected the right way round. A pin connection diagram of the i.c. is a must.

The best way to learn fault diagnosis is to practice on a few circuits so as an introduction we shall start with a project using a 741p op-amp.

STABILISED POWER UNIT

Since the 741p is a differential amplifier with very high gain it makes an ideal comparator and error amplifier for a linear series stabiliser. This gives a relatively simple circuit with quite a good performance. A circuit example is given in Fig. 4.1. The specification is as follows:

Output voltage range	7V to 12V
Max. output current	0·4A (current limited)
Ripple	2·5mV pk–pk.
Load regulation	Better than 0·02 per cent zero to full load
Line regulation	±10 per cent change in mains gives less than ±0·05 per cent change in output

The circuit is a conventional stabiliser, the non-inverting input (+) of the 741p amplifier being held at a constant voltage by the Zener diode (5·6V). The inverting input (−) is taken to a potentiometer. Since the 741 has such a high gain (100,000) it only requires a difference of a millivolt or so between the (+) and (−) input terminals for the output to be driven positive or negative by a large amount. If for example the input difference is 1mV negative the output would try to move several volts positive. The output therefore assumes a voltage which will cause the difference between the Zener voltage and the voltage on VR1 slider to be as small as possible.

Take the example when VR1 is set so that its slider is at the same point as the top of R5 (Fig.4.2). The voltage across R5 must be nearly 5·6 volts. This means that the voltage across R4 and VR1 is about 7 volts so that the total output voltage is just over 12 volts. By moving the slider of VR1 towards R4 the output voltage must reduce, giving an output of about 7V when the slider is at R4.

Neglecting the action of the current limit we can see how the circuit operates to hold the output constant by imagining a fall in output caused by an increased load. This would provide at IC1's inverting input a net negative input. The output will go positive causing TR1 (the series element) to conduct more, thus forcing the output back to very nearly its initial value. The opposite will occur if the output rises for any reason.

The changes in output voltage from zero to full load current are very small because of the very high gain of the 741. Thus one i.c. gives this relatively simple power supply very good performance.

The maximum output current is limited to about 0·4A. If the current increases beyond this the voltage across R3 causes TR2 to conduct and the output voltage falls. Thus, if TR1 is mounted on a small heat sink no damage occurs if the output is accidentally short circuited.

We have to understand how a circuit operates before we can do some fault diagnosis so having grasped the operation let's turn to some faults.

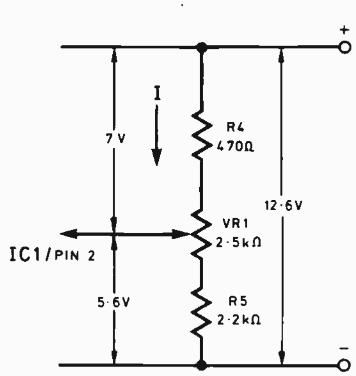


Fig. 4.2 Illustrating voltage control at IC1

SOME FAULTS

To start with we will ignore all the other components and concentrate on possible faults with the 741p i.c. It is possible for many different faults to occur inside the actual silicon chip and for faults in the connecting leads. Internal shorts or opens may occur, the connecting pins or track can become open circuit or short to adjacent pins. Naturally it isn't always possible to pinpoint the actual fault but it's a good idea to sort out the type of fault since it may show a possible external cause.

Take for example an internal open circuit on the inverting input of the 741. The voltage reading with a 100mA load are:

Pin No.	2	3	7	6	Output
Voltage	+9·3V	5·7V	16·2V	15·1V	12·5V

Symptom is no control and poor regulation.

Since the inverting lead is open circuit the output of the 741 has been driven hard positive forcing the output to rise. VR1 will have no control. Note that that there is an excessive positive difference signal between 2 and 3 which should drive the output down, not up.

If the output going high is a symptom for an open circuit pin 2 then we must expect the reverse effect if pin 3 were open circuit. This is in fact the case as indicated:

Pin No.	2	3	7	6	
Voltage	1·7V	5·7V	16·2V	3·5V	No control

It's important to note that similar symptoms would be produced if the Zener or C2 became short circuit, or if R1 went open, except for the fact that pin 3 would then read zero volts. We have to sort out the difference between possible i.c. faults and those of external components.

(a) What would be the fault on the i.c. that gives the following?

Pin No.	2	3	7	6	Output
Voltage	0V	5·7V	16·2V	0V	0V

Can you work out the symptoms for the following faults?

(b) Open circuit connecting lead to pin 7

(c) VR1 slider open circuit

(d) R5 open circuit.

(Answers at end of article.)

DIGITAL CIRCUITS

Digital circuits are those that respond to logic signals. The outputs being switched between two well defined states. With TTL logic '0' is typically 200mV (not greater than 400mV) and '1' is typically 3·3V (not less than 2·4V). Faults in digital circuits can then be stated as output "stuck at 1" or "stuck at 0". However, if an output is stuck, don't necessarily assume that the fault is with that particular i.c., since the required inputs signals also have to be present.

LOGIC GROUPS

In general, digital logic circuits can be grouped into combinational and sequential types. With combinational logic various input conditions have to be met simultaneously to give an output. Whereas in sequential logic the elements are in series, the output of one feeding the input of the next and so on. A frequency standard unit with divider chain is a good example of this (Fig. 4.3). A 1MHz crystal is used to provide the stable frequency and SN7490 decade dividers the various lower frequencies.

This can be a handy unit to have since the spot frequencies can be used to calibrate oscilloscopes, signal generators and frequency meters.

Now fault diagnosis on sequential circuits is relatively straightforward since a failure of one i.c. or its connections can easily be checked using the beginning to end method, or if the divider chain is long, the half split.

In the example imagine that there is a fault such that there is no 100Hz output although the 10kHz signal is present. The fault can only lie with IC4 or IC5 or their connections.

First check the input of IC5 on pin 1, this should be

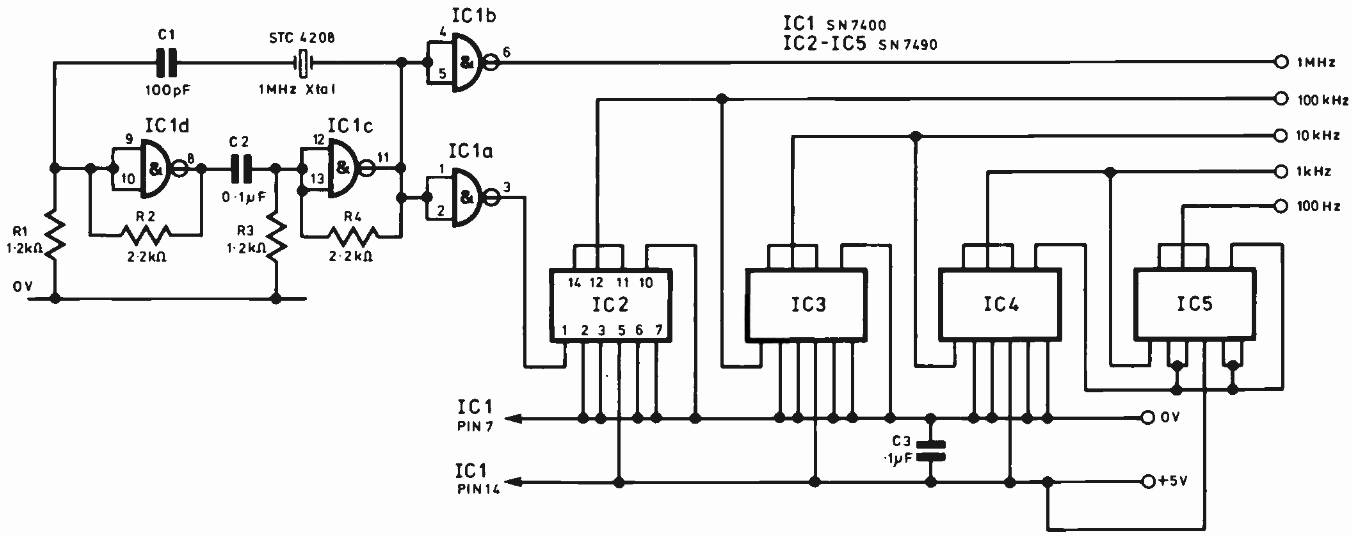


Fig. 4.3 Frequency standard unit

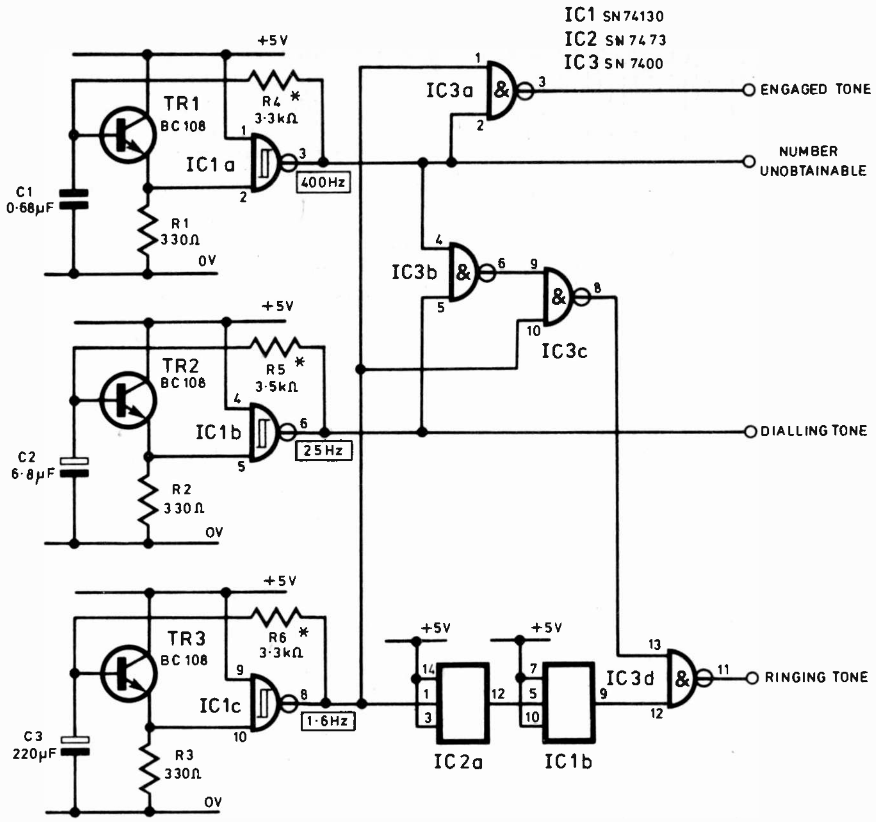


Fig. 4.4 Telephone tone generator

a 1kHz square wave. If this signal is present the fault must lie in this chip. Measure the power supply between pins 5 and 3, check all connections and then if necessary replace it.

What would be the symptoms for the following faults?

(a) IC3 open circuit track from +5V line to pin 5

(b) IC1b output stuck at 1

(c) C2 open circuit

TELEPHONE TONE GENERATOR

This generator (Fig. 4.4) was developed as a simulator of the four tones and as part of a demonstration telephone system. It is also a useful unit for learning about logic and fault diagnosis.

Three TTL i.c.s are used. A 74132 Quad Schmidt to generate three frequencies of approximately 400Hz, 25Hz, and 1·6Hz. The other two i.c.s are a 7400, used for gating the signals and a 7473 dual JK bistable, wired to divide by 4, so generating a 0·4Hz square wave from the 1·6Hz output.

The simultaneous outputs are:

Dialling tone	25Hz approx.
Number unobtainable	400Hz
Engaged	400Hz gated with 1·6Hz
Ringing tone	400Hz modulated at 25Hz gated first with 1·6Hz then with 0·4Hz.

The outputs can readily be checked by a small speaker via an emitter follower as shown (Fig. 4.5) so no special test gear is required.

The circuit is really a mixture of combinational and sequential logic. The Nand gates of the SN7400 being the combinational portion. With Nand gates both inputs must be at logic 1 (high) for the output to be at logic '0'

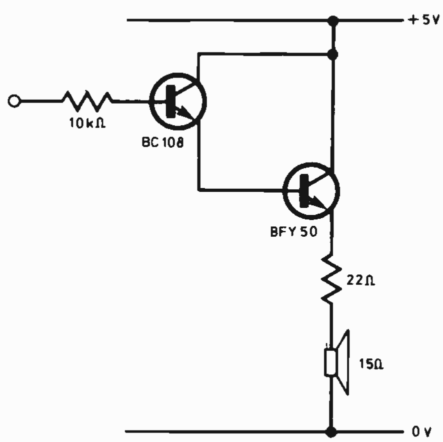


Fig. 4.5 Audio amplifier for tone generator

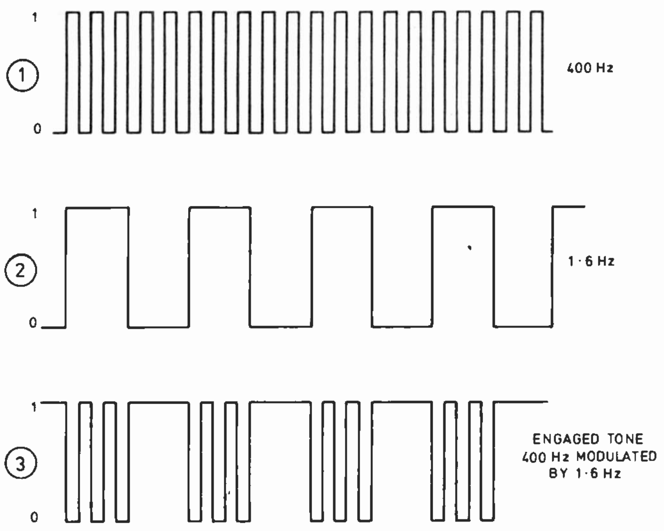


Fig. 4.6 Output waveforms at IC3

(low). Take IC3a for example, the waveforms at pins 1 and 2 will be as shown in Fig. 4.6. If the 1·6Hz oscillator failed with its output stuck at 0 the symptoms would be no outputs on the "Engaged" or "Ringing" tones (since IC3a and IC3c gates would be closed). On the other hand if this oscillator failed with its output stuck at 1, the output on the engaged tone would be 400Hz. A fault such as this last one would occur if C3 became short.

Consider fault symptons of the ringing tone being almost the same as the engaged tone. Obviously all the oscillators are functioning correctly, and also the four gates of the 7400 are working. The fault can only be that the output (pin 9) of the 7473 bistable is stuck at 1. Verify this for yourself.

Now try and diagnose the component faults from the following symptoms. Assume outputs are correct unless stated otherwise.

(a) No ringing tone available—although an engaged tone is present on pin 13 of the 7400

(b) No dialling tone available

(c) No engaged tone available.

What would be the symptoms for the following faults?

(d) TR1 base emitter open

(e) IC3c output stuck at 1

(f) Open circuit connection 1·6Hz o/p to pin 1 IC3a.

CONCLUSION

This series is only intended as an introduction to fault diagnosis. We haven't explored the more troublesome faults such as intermittent shorts and opens, these can really be frustrating. It's hoped that the articles have given some encouragement to newcomers, and shown that successful fault diagnosis is mostly combining an understanding of circuit operation with logical investigations and measurements.

My thanks to Pitmans for permission to use some of the material from my book on Electronic Fault Diagnosis. ★

ANSWERS

Power supply

(a) Open circuit output or internal supply lead of 741.

Symptom	2	3	7	6	Output
(b)	0V	5·7V	0V	0V	0V
(c)	0V	5·7V	16·2V	14V	13·3V
(d)	5·7V	5·7V	16·2V	6·5V	5·8V

Frequency standard

(a) No 10kHz, 1kHz or 100Hz output. No +5V to pin 5 on IC3.

(b) No 1MHz output, although rest of output frequencies will be present.

(c) No outputs. Since oscillator will not function.

Tone generator

(a) Output from bistable (pin 9) stuck at 0.

(b) 25Hz oscillator circuit failed, output high.

(c) IC3a failure or open circuit connections.

(d) 400Hz oscillator fails output high.
Therefore engaged tone will be 1·6Hz
'Number unobtainable' will be dead.
Dialling tone will be o.k.
Ringing tone will be 1·6Hz gated with 0·4Hz.

(e) Ringing tone will be 0·4Hz.

(f) With an open circuit on a TTL Nand gate the gate will be open. Therefore the engaged tone will be 400Hz only.

BOOK REVIEWS

TELEVISION & RADIO 1978
Editor Eric Croston
Published by Independent Broadcasting Authority
224 pages, 230mm × 190mm. Price £1.85

IBA's prestigiously published year book is thoughtfully designed and well endowed with colour photographs. The bulk of the book is concerned with interesting details about programmes; News, Current Affairs, Documentary, Children's Television, Science, Drama, Arts, Sport, Educational TV, Religion and Light Entertainment.

Independent Local Radio has a large mention and station coverage is mapped out, as are the television areas. An engineering section on better viewing and listening heralds the possibilities of the 'all digital studio', 'digital VTR', the 'suitcase transposer', 'surround-sound', ORACLE, adaptive aerials, and the studio caption machine which has become a 'character generator' programmed by a 'video typographer'. This section also explains some studio jargon which inevitably creeps into the TV programme magazines.

For a producer's approach to developing a major drama series an article on 'Love for Lydia' gives the low down on how a special atmosphere can be created for a story set in the Midlands in the 1930's.

PE CHAMP

R.W. COLES B. CULLEN

PART EIGHT

CHAMP-PROG

THOSE readers who have successfully completed the construction of CHAMP can now look forward to many interesting and rewarding hours of programming and experimentation. Their systems can be used as learning aids to gain practical experience of the exciting new microprocessor technology, and as development aid to encourage the fulfillment of a multitude of software and hardware ambitions. When CHAMP is used in the latter mode, as a proving ground for hardware circuits and software programs which perform some useful function, there will come a time when programs tried out in CHAMP program RAM will need to be committed to a more permanent kind of storage for eventual use in some other small, dedicated, 4040 based system. This is when CHAMP-PROG and CHAMP-U.V. become very useful, if not essential, as additions to the CHAMP family. CHAMP-PROG is a PROM programming attachment which allows the user to copy a program stored in CHAMP program RAM into a 4702A device mounted in a "zero insertion force" (z.i.f.) front panel socket. CHAMP-U.V. is a simple erase light unit for 4702A and similar PROMS which allows a single device to be programmed and reprogrammed many times over.

These facilities make for extremely low cost program amendment or enhancement when it is required, and represent a big improvement over the one-shot fusible-link PROM techniques sometimes used in m.p.u. system development.

This month we shall be looking at the operating principles and circuit of CHAMP-PROG, and how this unit is integrated with CHAMP itself.

CHAMP-PROG

As you can see from the title picture, CHAMP-PROG is built using the same system principles which were developed for CHAMP itself. The circuitry is carried on a fairly large sheet of Veroboard, which is mounted above a stylish low profile plinth made of wood and aluminium. The front panel carries a mains ON/OFF rocker switch in addition to the special 24 pin programming socket for the PROM being programmed. CHAMP-PROG has its own separate mains connector, and housed inside the plinth is a special +80V programming supply. The standard +5V and −10V supplies also required are provided by the main CHAMP power source over the same 16 way connector that is used to transmit and receive programming data. In accordance with standard CHAMP techniques, the 16 way umbilical link terminates at low cost 16 pin d.i.l. sockets, the link itself being made from d.i.l. header plugs, and ribbon or multiway cable.

The programming operation requires the application of voltage pulses with an amplitude considerably in excess of the 15 Volts used during normal operation, and the level and timing of these pulses must be kept within tight limits. The CHAMP-PROG board carries all the voltage regulation, switching, and timing functions required for successful programming of 4702A type PROMS, together with the necessary data and address drivers which are driven in their turn by two 4265 programmable interface chips.

PROMPT

The programming operation is carried out under the control of a program called PROMPT (PROM Programming Technique) which is housed in a 4702A PROM plugged into the second socket on the CHAMP main board (Chip-One). PROMPT is an interactive program which uses the keyboard interrupt routine and display driver subroutine of the CHOMP program, which *must* also be present in the Chip-Zero socket (as usual) before programming can take place. PROMPT is entered via CHOMP on the depression of the TEST button on the CHAMP front panel. (You may recall that when TEST is detected, CHOMP carries out a JUN to 100H, which is the start of PROMPT when *it* is resident in the Chip-One socket). After the depression of TEST, the 7 segment display will show "Adr 1" which is a cue to the user that a three digit hexadecimal address is required which corresponds with the *start* of the source data block in CHAMP program memory. After entering a suitable address, which will appear as usual on the left of the display, the ENTER DATA button is pressed to confirm that entry is complete. The display will now change to show "Adr 2", and a similar procedure is followed to enter an address which indicates the *end* of the source data block in CHAMP program memory. A display of "Adr 3" is next, and on this cue an address is entered which represents the *start* of the destination area in the PROM to be programmed. Although the last address need only be a two digit hexadecimal quantity (because there are only 256 locations in a 4702A PROM), a three digit address is nevertheless expected by PROMPT since this makes the initialisation procedure as uniform as possible. The most significant digit, or chip-select hexadecimal digit, is in fact ignored, and so you can enter anything you like in this position; but usually a zero of course to prevent confusion!

After the entry of Adr 3, but *before* depression of the ENTER DATA key, the PROGRAM POWER switch adjacent to the programming socket is turned ON. Subsequent depression of the ENTER DATA key starts the programming sequence which takes about 2·5 minutes for 256 locations. Completion is signalled by a display of "done", but if any location was not erased properly, or failed to program at any point in the sequence, programming will stop prematurely and a display of "Fail" will result.

THREE ADDRESS SYSTEM

The fact that PROMPT uses a three address system makes CHAMP-PROG extremely versatile since blocks of data from CHAMP program memory can be moved to new locations in the PROM being programmed, and a PROM can be loaded with blocks of data from several sources if necessary. For example:

(i) To duplicate Chip-Zero, (CHOMP), Adr 1 is entered as 000H, Adr 2 as OFFH, and Adr 3 as 000H.

(ii) To put the first half of Chip-Two into the second half of the PROM being programmed, Adr 1 = 200H, Adr 2 = 27FH, Adr 3 = 080H.

(iii) To put the single line of data at address 300H into address 020H of the PROM Adr 1 = 300H, Adr 2 = 300H, Adr 3 = 020H.

Of course, when relocating blocks of data in this way, account must be taken of the label destinations of any JUN, JMS, JCN, or ISZ instructions in the source block because these will probably be incorrect when loaded into the PROM. In the usual case the source block will be in program RAM, Chip-Two or Chip-Three, and so these label destination addresses can be temporarily changed (using CHOMP), to those applicable in the new PROM *and* its intended hardware system. (Obviously the 12 bit JUN and JMS addresses must also refer to the correct *chips* in the new system).

FAMOS PROMS

The 4702A is an MOS device using the FAMOS (Floating gate, Avalanche injection, Metal, Oxide, Semiconductor) technology to store data in the form of isolated charges on the gates of an array of MOSFET transistors. Each of the 2,048 memory cells (Fig. 8.1) consists of a single MOSFET with its gate electrode unconnected and isolated by means of a silicon dioxide insulating layer. When a cell is unprogrammed or erased there is no charge on the gate, and the source-to-drain resistance, RDS, is very high. To program a logic one into a cell, a drain to source voltage of about 47 volts is applied for a short period of time and this causes an avalanche breakdown between the drain and the substrate material. Electrons are swept across the junction, and some are energetic enough to penetrate the silicon dioxide insulator to become trapped on the buried gate electrode. A negative charge builds up on the gate and this opens a low resistance channel between source and drain in normal enhancement mode MOSFET fashion. The charge accumulated on the buried gate is proportional to both the programming voltage and to the length of time that the voltage is applied, and so these must be carefully controlled by the programmer circuitry.

In addition, the avalanche action generates considerable heat, and so the programming must be carried out not with one long pulse but with a succession of narrow pulses with a "cooling-off" period between each one. Fortunately the 4702A data sheet (Page 5-153, MCS40 manual) contains full details of the voltages and duty cycles which must be used to provide reliable programming without overheating.

BLOCK DIAGRAM

The CHAMP-PROG design is based on an original circuit supplied by Intel and used in their "Intellec" development systems. The circuit has been simplified and in many cases components have been changed to make them easier to obtain in this country. The full circuit (Fig. 8.2) is still quite complex, and contains facilities such as current limiting and crowbar overvoltage protection to protect the PROM being programmed.

The best way to appreciate the way it works is to first study the block diagram Fig. 8.3. The voltage regulator block is required to generate the programming waveforms, and it actually contains two separate regulators, one a high current +47V circuit from which the VCCS, CS, Vgg, Vdd and Program pulses are derived, and the other a +60V low current circuit which supplies Vbb. The outputs from the regulator block are not continuous d.c. voltages, but pulses of accurately determined amplitude, and the switching which generates these pulses is carried out in the regulator block under the control of the timing circuit. This consists of a chain of t.t.l. monostables

Fig. 8.1. Memory cell used in the 1702A PROM. The cell is an f.e.t. whose gate has no lead. Source to drain resistance is a function of gate charge

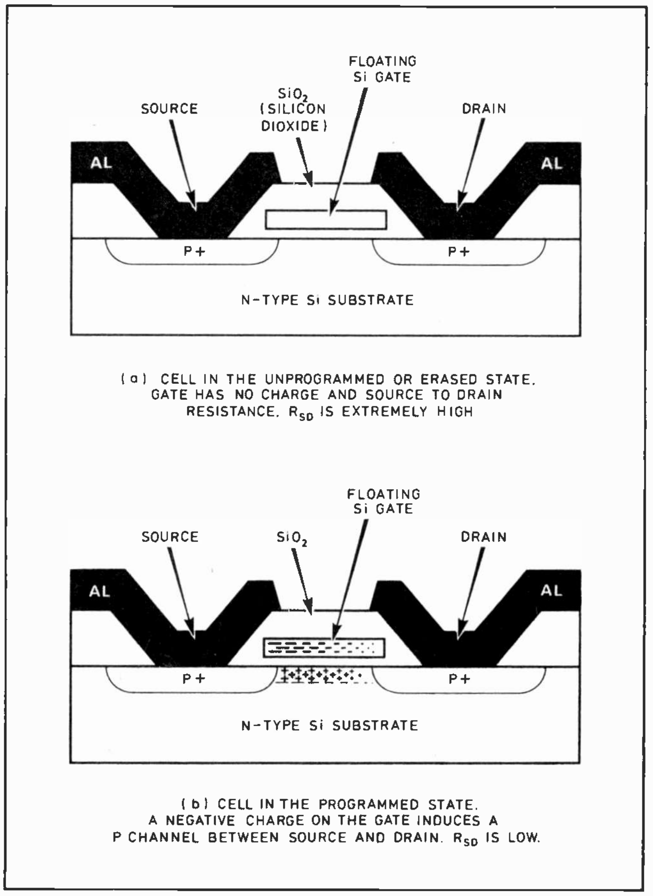
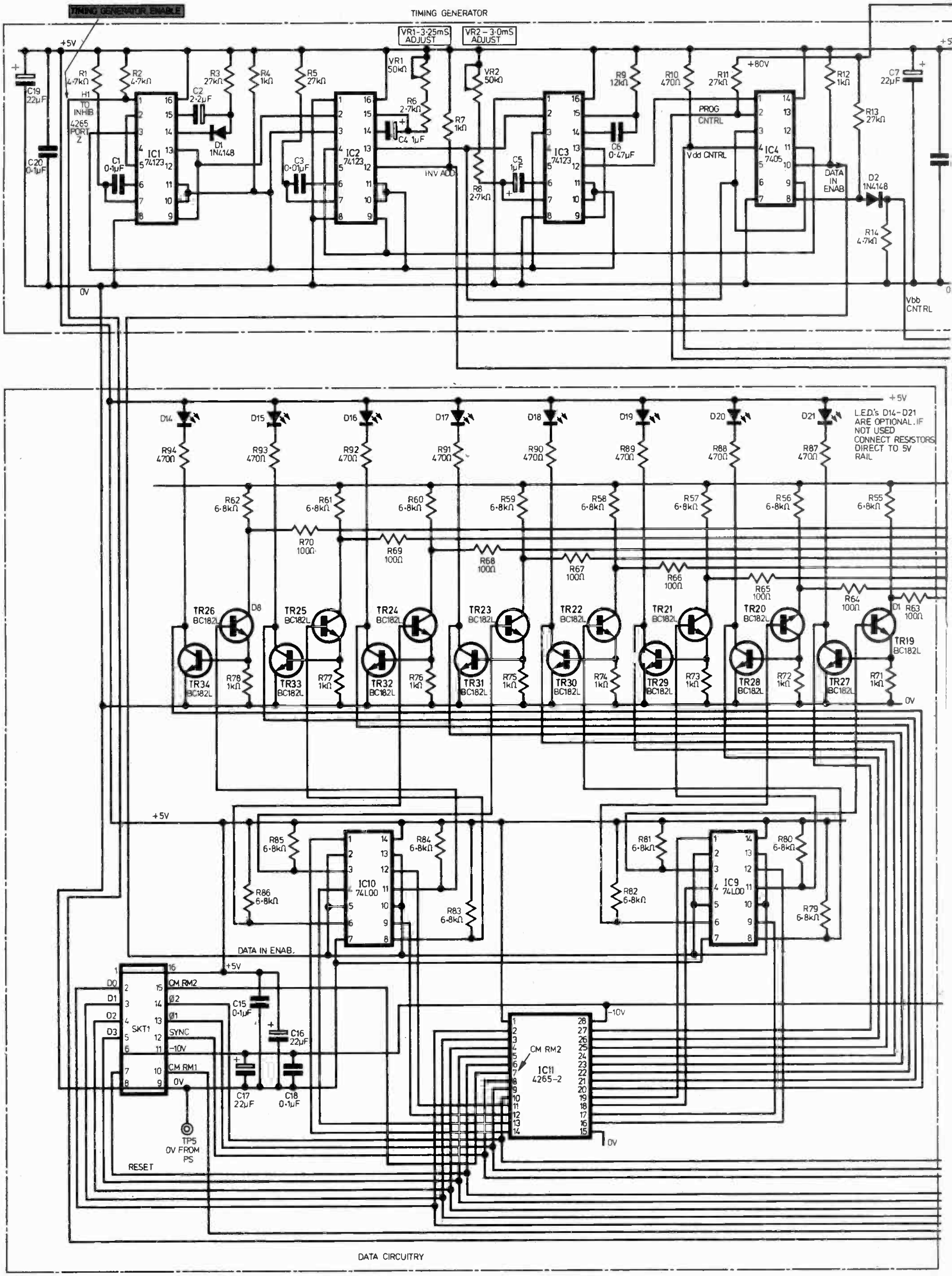


Fig. 8.2. CHAMP-PROG circuit diagram



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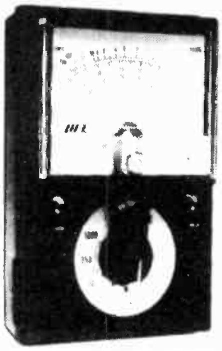

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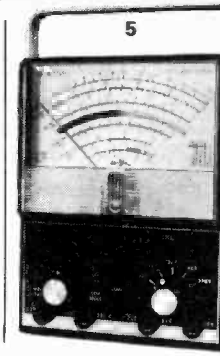

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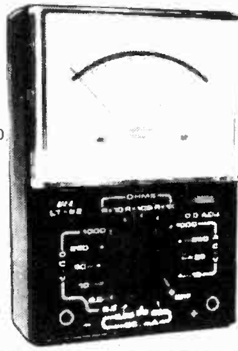

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4 MM11-7081GN
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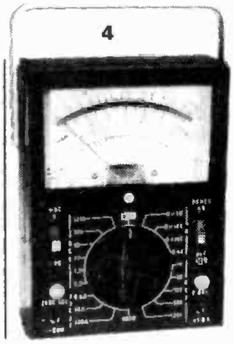

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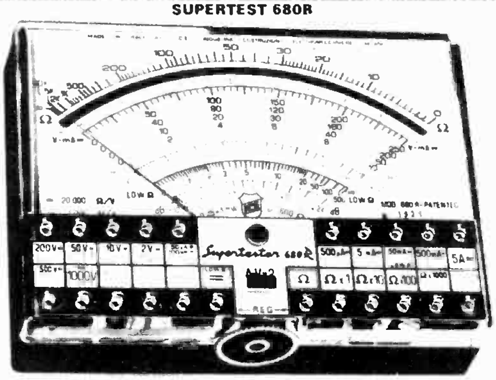

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Ohms	6 ranges	1Ω-100megΩ
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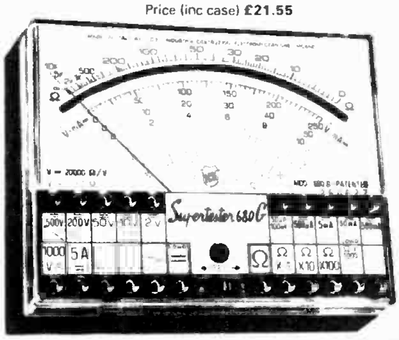
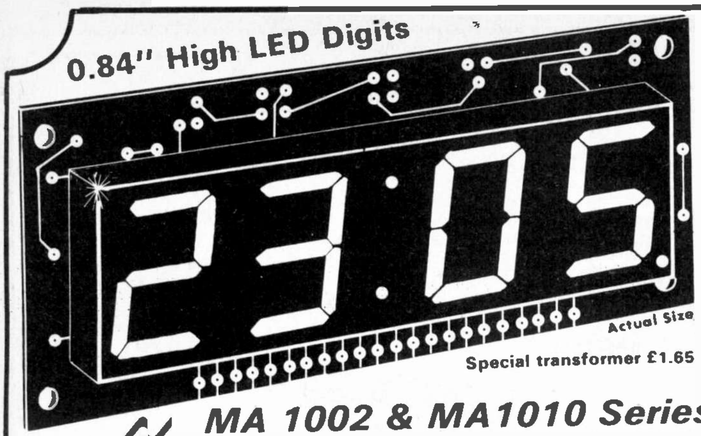
Size 105 x 84 x 32mm
Price (inc case) **£21.55**



BRISTOL
0272-654201

VAT INCLUSIVE PRICES

GLASGOW
041-332 4133



NEW DIGITAL ALARM CLOCK MODULES

MA1002F 12-hr	£10.45	MA1010E 12-hr.	£13.75
MA1002H 24-hr	£10.45	MA1010G 24-hr.	£13.75

MA 1002 & MA1010 Series Electronic Clock Modules

NATIONAL

The MA1002 & MA1010 Series Electronic Clock Modules are assembled and pretested modules which combine a monolithic MOS-LSI integrated clock circuit, 4-digit LED display power supply and other associated discrete components on a single printed circuit board to form a complete electronic clock movement. The user need add only a transformer and switches to construct a digital clock for application in clock-radios alarm or instrument panel clocks. Timekeeping may be from 50 or 60 Hz inputs and 12- or 24-hour display formats may be chosen. Direct LED drive eliminates RF interference. Time setting is made easy through use of Fast and Slow scanning controls.

For 50Hz operation connect pin 16 & 17 on MA1010

The MA1002F and MA1010E have a 12-hour display with an AM and PM indicator. The MA1002H and MA1010G have a 24-hour display.

Features include alarm on and PM indicators sleep and snooze timers and variable brightness control capability. The modules are extremely compact the MA1002 measuring 1.375" by 3.05" the MA1010 measuring 1.75" by 3.75". This small size is achieved by bonding the I.C. to the back of the circuit board.

It is highly recommended that the transformer be obtained with the clock module as it is a special dual secondary type not otherwise readily available.

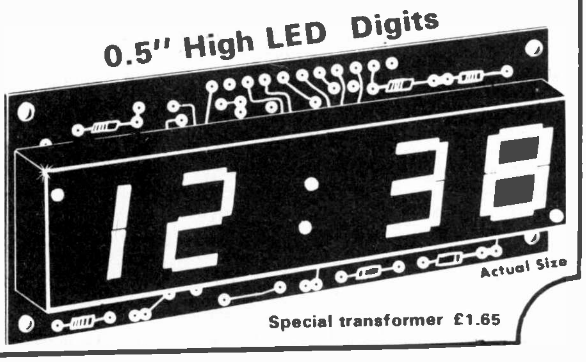


PHOTO TRANSISTORS

		PRICE
2N5777	Darlington Amplifier	£0.88
2N5778	Darlington Amplifier	£0.99
2N5779	Darlington Amplifier	£1.30
BPX25	General Purpose Silicon	£1.80
BPX29	General Purpose Silicon	£1.80
BPX80	General Purpose Silicon Array (10)	£7.20
BPX81	General Purpose Silicon	£0.86
BPX86	General Purpose Silicon (5)	£5.75
TIL63	General Purpose Silicon	£1.60
TIL64	General Purpose Silicon	£1.87
TIL65	General Purpose Silicon	£2.15
TIL66	General Purpose Silicon	£2.20
TIL67	General Purpose Silicon	£2.30
OCP71	Germanium Photo Transistor	£2.20
TIL78	Photo Transistor	£0.75

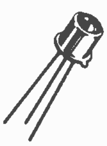


PHOTO DIODES

		PRICE
BPW32	Low Dark Current Silicon	£2.87
TIL32	I/R Diode	£1.10
BPX48	Differential (Precision)	£4.28
BPX60	High Output Voltage	£4.75
BPX61	10 MHz	£3.95
BPX63	Ultra Sensitive Silicon	£2.20
BPX65	High Speed Silicon	£5.17
BPX97	General Purpose Silicon	£1.78
BPX68	General Purpose Silicon	£2.00

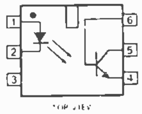
SOLAR CELLS

		PRICE
BP100	Miniature Solar Cell	£0.93
BPX79	Miniature Solar Cell Blue Sensitive	£4.17
BPY64	General Purpose Solar Cell	£4.17

OPTO COUPLERS

		PRICE
4N25	Opto Couplers	£2.36
CNY17	Opto Couplers	£2.36
TIL116	Opto Coupler	£1.55

4N25 8 PIN DIL
2500V Isolation

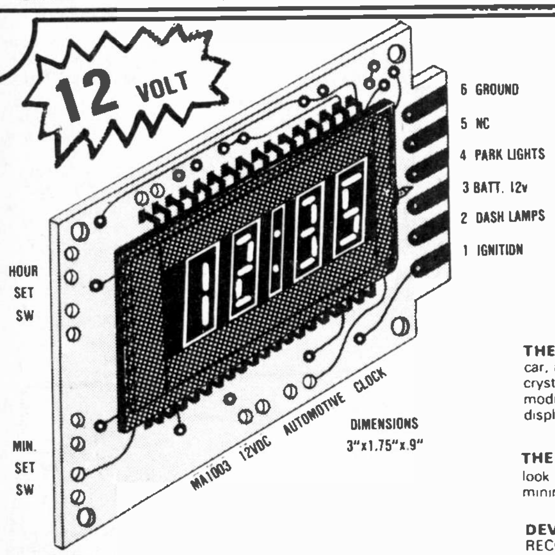


LIGHT SWITCHES

		PRICE
TIL138	Transmissive Source & Sensor	£2.20
TIL139	Reflective Source & Sensor	£2.20

MISCELLANEOUS

		PRICE
ORP12	Photo Conductive Cell Cad Sulph	£0.90
ORP61	Photo Conductive Cell Cad.Sulph	£0.77
FW9802	Photo Conductive Cell Cad Sulph	£0.82
RPY60	Photo Conductive Cell Cad Sulphoselen	£3.96
RPY63	Photo Conductive Cell Cad.Sulphoselen	£3.96



NEW DIGITAL CAR CLOCK MODULE

NATIONAL

THE MA1003 ready-built module was specially built and designed for the American market, with the luxury car, aircraft and boat in mind. Unlike conventional quartz clocks, this unit operates from a very high frequency crystal resonating at over 2MHz for extra accuracy and stability. Stringent safety regulations dictate that this module is completely suitable for use in hostile environments and "shake, rattle and roll" conditions. Automatic display blanking is included when ignition is turned off, to consume a miserly 3mA.

THE BRIGHT GREEN DISPLAY, fluorescent, can be filtered from green to blue to give that personalised look. The compact and rugged design enables the module to be mounted anywhere, easily and with the minimum of effort. Works from any 12 volt supply. First time in Europe.

DEVELOPED BY NATIONAL SEMICONDUCTORS. A name known worldwide and respected. RECOMMENDED TO RETAIL AT £29.95+VAT

- INTERNAL CRYSTAL TIMEBASE ±.5 SEC/DAY
- COMPLETE, TESTED MODULE. JUST ADD SWITCHES
- BRIGHT 0.3" DISPLAY — GREEN FOR SAFETY.
- TRANSIENT PROTECTED, TIMEKEEPING DOWN TO 9V.
- EASILY INSTALLED, COMPACT AND RUGGED DESIGN
- DIMS TO 50% BRIGHTNESS WHEN CAR LIGHTS ON
- LOW POWER CONSUMPTION — FOR PORTABLE USE
- IDEAL FOR CARS, BOATS, AIRCRAFT OR CARAVAN

PRICE £14.95 INC. VAT

ALSO AVAILABLE

Specially designed case, with cut out centre front, black rexine finish for dash mounting.

Price **£1.35**

CRICKLEWOOD 01-452 0161 | **VAT INCLUSIVE PRICES** | **EDGWARE ROAD 01-723 4242**

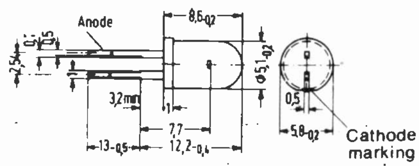
OPTOELECTRONICS

LED LAMPS

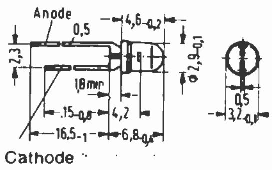
		LUMINOUS INT. MCD	PRICE
LARGE	**STANDARD**		
LD52	Red	1.2–2.4	£0.20
LD55	Yellow	3–6	£0.20
LD57	Green	2–4	£0.20
LARGE	**EXTRA BRIGHT**		
LD52C	Bright Red	15–30	£0.40
LD56C	Bright Yellow	10–20	£0.40
LD57C	Bright Green	20–40	£0.40
MEDIUM	**WIDE ANGLE**		
CQX23	Red	2–4	£0.28
CQX33	Yellow	1.6–3.2	£0.28
CQX13	Green	2.5–5	£0.28
SMALL			
LD30A	Red	0.8	£0.18
LD35A	Yellow	1.5	£0.19
LD37A	Green	0.8	£0.19
TIL209	Red	0.8	£0.18
TIL211	Green	0.8	£0.19
MICRO			
LD461A	Red	1.0	£0.25
LD466	Red Array (5 LEDS)		£1.85
LD469	Red Array (9 LEDS)		£3.00
LD471A	Green	0.8	£0.38
LD476	Green Array (5 LEDS)		£2.20
LD479	Green Array (9 LEDS)		£4.00
LD481A	Yellow	1.0	£0.33
LD486	Yellow Array (5 LEDS)		£2.45
LD489	Yellow Array (9 LEDS)		£4.00
INFRA RED			
LD242	Micro IR LED Transmitter		£1.10
BPW34	I.R. Photo Diode Receiver		£2.10
LD271	Large I.R. LED Transmitter		£0.55
BP104	I.R. Photo Receiver for above		£1.45

THE BRIGHT ONES "SIEMENS"

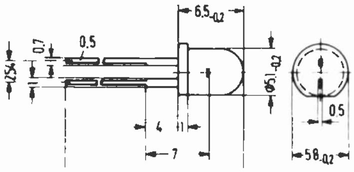
LARGE



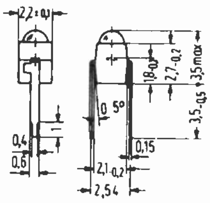
SMALL



MEDIUM



MICRO



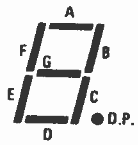
National

SEVEN SEGMENT DISPLAYS FOUR DIGIT MULTIPLEXED

Specially designed four digit multiplexed seven segment LED displays from National semiconductors. Many applications – smart in presentation and can be banked end to end to produce as many digits as required. Available in common anode or common cathode in .5" digit height.

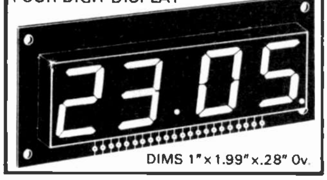
NSB5881	COM CATHODE	Pin con are given for com cathode type. For com anode read anode for cathode and vice versa.	£5.95
NSB5882	COM ANODE		£5.95

0.5" DIGIT HEIGHT



SEGMENT IDENTITY
(See Pinning)

FOUR DIGIT DISPLAY



PINNING

PIN
1 – ANODE A
2 – NC
3 – ANODE D
4 – COM CATH DIGIT 1
5 – NC
6 – NC
7 – COM CATH DIGIT 2
8 – ANODE C
9 – NC
10 – COM CATH DIGIT 3
11 – ANODE B
12 – ANODE F
13 – ANODE E
14 – COM CATH DIGIT 4
15 – ANODE D.P.
16 – ANODE G

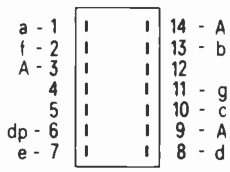
FOR COMMON ANODE TYPE, ANODE & CATHODE ARE INTERCHANGED.

SEVEN SEGMENT LED DISPLAYS – SIEMENS

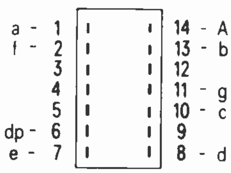
A unique, high quality range of displays to suit all applications. Extra bright red display. Sizes quoted are in mm.

Current per segment	20mA
Luminous intensity segment	.3 mcd
Forward voltage at 20mA	2.0 volts

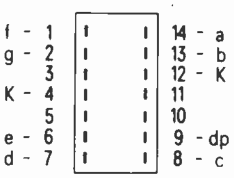
PIN CONNECTIONS – TOP VIEW



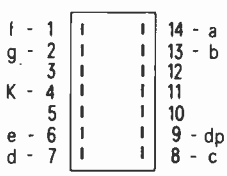
A = common anode
HA 1081



A = common anode
HA 1101



K = common cathode
HA 1083

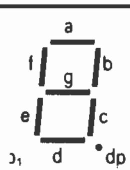


K = common cathode
HA 1103

DESCRIPTION		PRICE
8mm CHARACTERS		
HA1081	C An	£1.50
HA1083	C Cath	£1.50
10mm CHARACTERS		
HA1101	C An	£1.55
HA1103	C Cath	£1.55
14mm CHARACTERS		
HA1141	C An	£1.57
HA1143	C Cath	£1.57
18mm CHARACTERS		
HA1181	C An	£1.85
HA1183	C Cath	£1.85

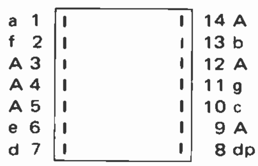
NB.
DL707 replaced by HA1081
DL704 replaced by HA1083

Single Digit Displays

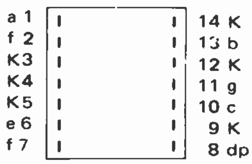


SIEMENS
QUALITY

HA 1181

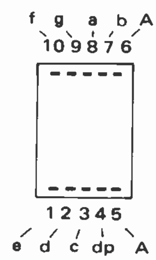


HA 1183

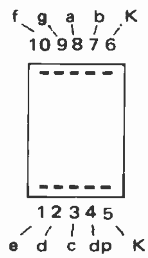


A = common anode K = common cathode

HA 1141

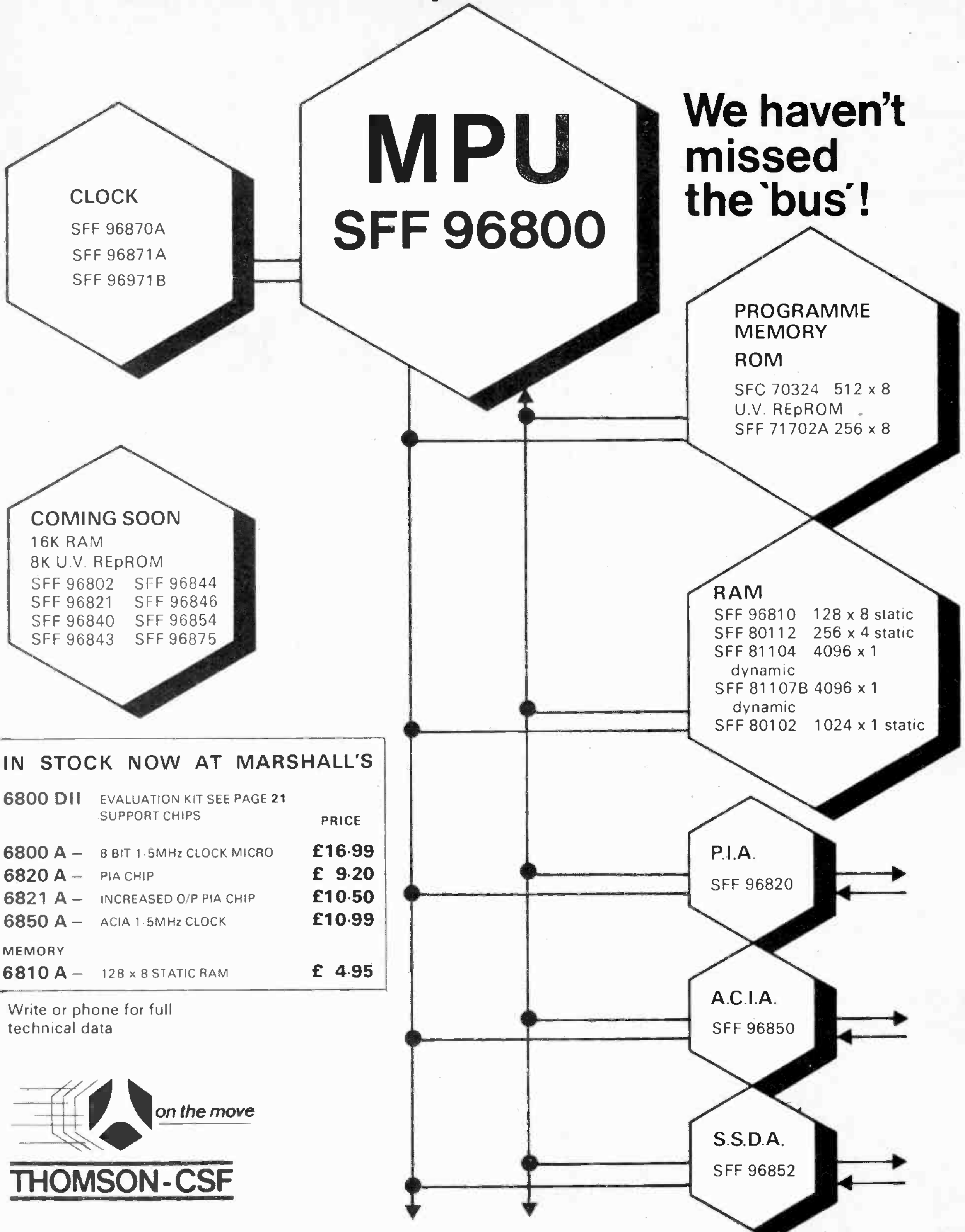


HA 1143



A = common anode K = common cathode

Thomson-CSF...a European second source for the 6800 microprocessor



We haven't missed the 'bus'!

IN STOCK NOW AT MARSHALL'S

6800 DII	EVALUATION KIT SEE PAGE 21	
	SUPPORT CHIPS	PRICE
6800 A –	8 BIT 1·5MHz CLOCK MICRO	£16·99
6820 A –	PIA CHIP	£ 9·20
6821 A –	INCREASED O/P PIA CHIP	£10·50
6850 A –	ACIA 1·5MHz CLOCK	£10·99
MEMORY		
6810 A –	128 x 8 STATIC RAM	£ 4·95

Write or phone for full technical data

on the move

THOMSON-CSF

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EDGWARE ROAD
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SILICON POWER TRANSISTOR SELECTION CHART

★ *NB. COMPLEMENTARY PAIRS SHOW NPN TRANSISTOR FIRST (AT TOP). IF NO PAIR IS SHOWN TRANSISTOR IS NPN.*

V \ A	1A	2A	3A	4A	5A	6A	7A	10A	12A	15A	16A	20A	25A	30A	40A	50A
40V	BD135 BD136	BFR41 BFR81	BD131 BD132	2N6121 2N6124	2N4913 2N4901	BD233 BD234	BD201 BD202	BD181	40514	BD142				2N3771		
60V	BD137 BD138	BFR40 BFR80	TIP31A TIP32A	2N6122 2N6125	2N4914 2N4902	TIP41A TIP42A	BD203 BD204	TIP33A TIP34A		2N3055 MJ2955		2N3772	TIP35A TIP36A			
80V	BD139 BD140	40594 40595	2N4923 2N4920	2N6123 2N6126	2N4915 2N4903	BDY24		2N3715 2N3790		BD183			BDY57	40411		
100V	TIP29C TIP30C	BD237 BD238	TIP31C TIP32C			TIP41C TIP42C	40871 40872	TIP33C TIP34C					TIP35C TIP36C	MJ802 MJ4502		
120V			2N3441	40373	2N4347	BDY25		2N3442	BDY54	BDY56	2N3773		BDY58			BUX20
150V	40412				40374		25025									
200V			2N3738		2N5239										BUX21	
250V	2N3440 2N5415	2N3584													BUX22	
300V	2N3439 2N5416	2N3585	2N3902											BUX23		
400V							BU104					BUX24				
500V										BUX25						
700V			BU205			BU126	BU208									
800V			BU206									A. MARSHALL (LON) LTD 01-452 0161				
1kV				BDX32												

THIS TABLE IS ONLY INTENDED AS A GENERAL GUIDE; COST EFFECTIVENESS, PACKAGE DETAILS, FREQUENCY RESPONSE AND OTHER FACTORS ARE NOT TAKEN INTO ACCOUNT – CONSULT MANUFACTURERS DATA SHEET FOR DETAILED APPLICATIONS.

MARSHALL'S TRANSISTOR GUIDE

Type	Data	Price
2C111	N73	5.20
2G301	P70	.70
2G303	P70	.80
2G309	P70	.70
2G339A	P70	.70
2G344A	P54	.70
2G345A	P54	.70
2G371	P54	.70
2G374	P54	.70
2G374B	P54	.70
2G381A	P54	.55
2G417	P70	.65
2N335	N70	3.00
2N388	N70	.80
2N388A	N70	.77
2N398	P70	.80
2N456	P66	2.20
2N489	U71	4.90
2N489A	U71	5.40
2N489B	U71	5.90
2N490	U71	4.99
2N490B	U71	6.50
2N490C	U71	6.90
2N491A	U71	5.75
2N491B	U71	6.25
2N491	U71	7.50
2N492	U71	6.25
2N492A	U71	6.75
2N492B	U71	7.75
2N492C	U71	10.00
2N493A	U71	7.99
2N493B	U71	8.75
2N494	U71	6.90
2N494A	U71	7.65
2N494B	U71	8.40
2N494C	U71	9.35
2N549	N70	3.25
2N681	THY72	2.20
2N696	N70	.39
2N697	N70	.31
2N698	N70	.49
2N699	N70	.58
2N706	N70	.30
2N706A	N70	.30
2N708	N70	.30
2N718	N70	.30
2N718A	N70	.54
2N720A	N70	.85
2N721	P70	1.05
2N722	P70	.45
2N727	P70	.50
2N744	N70	.35
2N753	N70	.35
2N760	N70	.35
2N869	P70	.35
2N914	N70	.38
2N916	N70	.33
2N917	N65	.38
2N918	N65	.45
2N929	N70	.37
2N929A	N70	.37
2N930	N70	.37
2N930A	N70	.95
2N1131	P70	.32
2N1132	P70	.35
2N1204	P70	1.65
2N1302	N70	.80
2N1303	P70	.80
2N1304	N70	.80
2N1305	P70	.80
2N1306	N70	1.00
2N1307	P70	1.00
2N1308	N70	1.10
2N1309	P70	1.10
2N1370	P70	.55
2N1420	N70	.55
2N1483	N70	1.85
2N1485	N70	2.20
2N1507	N70	.35
2N1524	P54	.60
2N1553	P66	1.50
2N1613	N70	.30
2N1637	P70	.72
2N1638	P54	.70
2N1711	N70	.30
2N1889	N70	.30
2N1890	N70	.30
2N1893	N70	.30
2N1907	P66	5.95
2N1974	N70	.98
2N1990	N70	1.45
2N1991	P70	1.10
2N2060	N73	7.00
2N2102	N70	.50
2N2147	P66	1.55
2N2160	U71	1.55
2N2192	N70	.58
2N2193	N70	.50
2N2193A	N70	.52
2N2194	N70	.42
2N2194A	N70	.45
2N2195	N70	.49
2N2195A	N70	.49
2N2217	N70	.55
2N2218	N70	.35
2N2218A	N70	.38

Type	Data	Price
2N2219	N70	.38
2N2219A	N70	.39
2N2220	N70	.39
2N2221	N70	.25
2N2221A	N70	.25
2N2222	N70	.25
2N2222A	N70	.25
2N2223	N73	3.99
2N2223A	N73	4.99
2N2270	N70	.49
2N2303	P70	.50
2N2368	N70	.27
2N2369	N70	.27
2N2369A	N70	.27
2N2405	N70	.66
2N2410	N70	1.40
2N2411	P70	.80
2N2412	P70	.80
2N2477	N70	1.10
2N2483	N70	.30
2N2484	N70	.30
2N2491	P58	2.40
2N2613	P59	.90
2N2614	P59	.70
2N2646	U71	.80
2N2647	U71	1.55
2N2696	P70	1.35
•2N2711	N50	.30
•2N2712	N50	.18
•2N2713	N50	.25
•2N2714	N50	.22
2N2848	N70	1.10
2N2865	N75	2.20
2N2890	N70	2.50
2N2891	N70	2.50
2N2892	N70	10.00
2N2894	P70	.50
2N2903	N73	1.60
2N2904	P70	.31
2N2904A	P70	.31
2N2905	P70	.31
2N2905A	P70	.31
2N2906	P70	.25
2N2906A	P70	.25
2N2907	P70	.25
2N2907A	P70	.25
2N2920	N73	3.30
•2N2923	N50	.17
•2N2924	N50	.17
•2N2925	N50	.19
•2N2926	N50	.17
2N3010	N70	1.10
2N3011	N70	.37
2N3012	P70	.37
2N3013	N70	.37
2N3015	N70	.47
2N3019	N70	.55
2N3020	N70	.75
2N3053	N70	.25
2N3054	N28	.72
2N3055	N66	.75
2N3107	N70	.55
2N3108	N70	.75
2N3109	N70	.80
2N3119	P70	4.00
2N3133	P70	.50
2N3134	P70	.85
2N3135	P70	.72
2N3136	P70	.91
2N3232	N66	1.50
2N3242	N70	.68
2N3242A	N70	.90
2N3250	P70	.33
2N3251	P70	.39
2N3300	N70	.45
2N3301	N70	.45
2N3302	N70	.39
2N3367	NF76	1.35
•2N3390	N50	.50
•2N3391	N50	.40
•2N3391A	N50	.45
•2N3392	N50	.17
•2N3393	N50	.17
•2N3394	N50	.17
•2N3395	N50	.19
•2N3396	N50	.19
•2N3397	N50	.19
•2N3402	N57	.45
•2N3404	N57	.55
•2N3405	N57	.58
•2N3414	N50	.18
•2N3415	N50	.18
•2N3416	N50	.21
2N3417	N50	.25
2N3420	N70	12.50
2N3439	N70	.85
2N3440	N70	.75
2N3441	N28	.92
2N3442	N66	1.45
2N3444	N70	1.35
2N3445	N66	6.50

Type	Data	Price
2N3446	N66	10.00
2N3447	N66	10.50
2N3448	N66	12.00
2N3468	P70	1.32
2N3507	N70	10.00
2N3512	N70	1.10
2N3553	N70	3.25
•2N3563	N54	.25
•2N3564	N54	.25
•2N3565	N54	.25
•2N3566	N70	.25
•2N3567	N70	.25
2N3570	N65	4.50
2N3571	N65	1.90
2N3572	N65	1.75
2N3583	N66	1.25
2N3584	N66	1.35
2N3585	N66	1.55
•2N3605	N50	.18
•2N3606	N50	.18
•2N3607	N50	.18
2N3632	N10	12.75
•2N3638	N70	.17
•2N3638A	P70	.17
•2N3639	P70	.33
•2N3640	P70	.25
•2N3641	N70	.25
•2N3642	N70	.22
•2N3643	N70	.38
•2N3644	P70	.40
•2N3645	P70	.38
•2N3646	N54	.26
•2N3662	N50	.25
•2N3663	N50	.29
•2N3690	N59	.45
•2N3691	N54	.45
•2N3692	N54	.45
•2N3693	N54	.50
•2N3694	N54	.50
•2N3702	P50	.14
•2N3703	P50	.14
•2N3704	N50	.14
•2N3705	N50	.14
•2N3706	N50	.14
•2N3707	N50	.14
•2N3708	N50	.12
•2N3709	N50	.12
•2N3710	N50	.12
•2N3711	N50	.12
2N3712	N70	1.35
2N3713	N66	1.50
2N3714	N66	1.55
2N3715	N66	1.55
2N3716	N66	1.70
2N3724	N70	.65
2N3725	N70	.60
2N3732	P66	2.00
2N3734	N70	.75
2N3735	N70	7.00
2N3738	N66	1.35
2N3740	P28	2.10
2N3741	P28	2.20
2N3766	N28	1.50
2N3771	N66	2.15
2N3772	N66	2.20
2N3773	N66	3.15
2N3789	P66	1.95
2N3790	P66	2.05
2N3791	P66	2.25
2N3792	P66	2.40
•2N3794	N77	.21
•2N3819	NF78	.36
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2N3821	NF79	.95
2N3822	NF79	.85
2N3823	NF79	.85
2N3824	NF79	.80
2N3826	N50	1.70
•2N3827	N50	.27
2N3831	N70	4.50
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•2N3858	N50	.22
•2N3858A	N50	.22
•2N3859	N50	.22
•2N3859A	N50	.22
•2N3860	N50	.20
2N3866	N70	1.98
•2N3877	N50	.28
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2N3879	N66	2.20
•2N3900	N50	.28
•2N3901	N50	.30
2N3902	N66	7.00
•2N3903	N57	.20
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2N3945	N70	.60

Type	Data	Price
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2N4030	P70	.53
2N4031	P70	.55
2N4032	P70	.65
2N4033	P70	.65
2N4036	P70	.72
2N4037	P70	.60
•2N4058	P50	.22
•2N4059	P50	.17
•2N4060	P50	.22
•2N4061	P50	.19
•2N4062	P50	.20
2N4064	N81	1.35
2N4074	N70	2.65
2N4091	NF79	1.35
2N4092	NF79	.82
2N4093	NF79	1.10
•2N4121	P54	.27
•2N4122	P54	.27
•2N4123	N57	.19
•2N4124	N57	.19
•2N4125	P57	.19
•2N4126	N57	.19
2N4220	NF82	.87
2N4221	NF82	.80
2N4222	NF82	.78
2N4223	NF82	.78
2N4224	NF82	.78
2N4234	P70	1.35
2N4235	P70	1.65
2N4236	P70	1.65
2N4237	N70	.99
2N4238	N70	1.28
2N4239	N70	1.55
2N4240	N66	1.70
•2N4248	P54	.22
•2N4249	P54	.20
•2N4250	P54	.26
•2N4254	N51	.83
•2N4258	P54	.50
•2N4266	N57	.22
•2N4274	P54	.27
•2N4275	N54	.33
•2N4284	P77	.38
•2N4286	N77	.22
•2N4287	N77	.22
•2N4288	P77	.22
•2N4289	P77	.22
•2N4290	P77	.22
•2N4291	P77	.22
•2N4292	N77	.27
•2N4294	N77	.22
•2N4297	N66	.33
•2N4302	NF83	.31
•2N4303	NF83	.33
•2N4304	NF83	.28
2N4313	P70	.60
2N4342	PF83	.50
2N4343	PF83	.77
2N4347	N66	2.20
2N4348	N66	2.65
•2N4360	PF83	.36
•2N4390	N70	.45
2N4400	N57	.16
•2N4401	N57	.20
•2N4402	P57	.20
•2N4403	P57	.20
•2N4409	N57	.20
•2N4410	N57	.20
2N4416	NF79	.88
2N4440	N10	8.50
•2N4822	N51	.83
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•2N4889	P59	.75
2N4891	U85	1.30
2N4898	P66	1.55
2N4901	P66	1.65
2N4902	P66	2.20
2N4903	P66	2.75
2N4904	P66	1.85
2N4905	P66	2.40
2N4906	P66	2.99
2N4907	P66	4.90
2N4908	P66	7.00
2N4909	P66	7.30
2N4910	N66	1.20
2N4913	N66	1.45
2N4914	N66	1.65
2N4915	N66	2.40
•2N4916	P54	.22
•2N4917	PP2	.27
2N4918	PP2	.65
2N4919	P2	.70
2N4920	P2	.83
2N4921	N2	.54
2N4922	N2	.60
2N4923	N2	.75
2N4924	N70	1.15

Type	Data	Price
2N4926	N70	1.70
2N4927	N70	1.70
2N4928	P70	2.20
2N4944	N54	.30
•2N4945	N54	.30
•2N4964	P70	.28
•2N4965	P70	.28
•2N4966	N54	.28
•2N4967	N54	.28
•2N4968	N54	.28
•2N4969	N54	.28
2N5010	N70	5.75
2N5011	N70	8.25
•2N5030	N50	.22
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2N5035	N84	1.10
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•2N5127	N54	.22
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•2N5129	N54	.22
•2N5130	N54	.22
•2N5131	N54	.22
•2N5133	N54	.22
•2N5137	N54	.22
•2N5138	P54	.22
•2N5139	P54	.22
•2N5140	P54	.22
•2N5142	P70	.22
•2N5143	P70	.22
•2N5172	NF83	.24
2N5179	N50	.15
2N5180	N65	.58
2N5181	N20	.55
2N5182	N20	.70
2N5183	N20	1.20
2N5188	N70	.44
2N5189	N70	.49
2N5190	N2	.65
2N5191	N2	.75
2N5192	N2	.80
2N5193	P2	.75
2N5194	P2	.80
2N5195	P2	.97
•2N5209	N57	.35
•2N5210	N57	.38
•2N5219	N57	.16
•2N5220	N57	.15
•2N5221	P57	.16
•2N5222	N57	.20
•2N5223	N57	.16
•2N5224	N57	.16
•2N5225	N57	.16
•2N5226	P57	.16
•2N5227	P57	.16
•2N5232	N51	.22
•2N5232A	N51	.23
2N5239	N66	2.25
•2N5245	NF78	.37
•2N5246	NF78	.38
•2N5247	NF78	.44
•2N5248	NF78	.44
•2N5249	NF79	.38
2N5266	PF80	3.00
2N5293	N38	.44
2N5294	N37	.44
2N5295	N38	.44
2N5296	N37	.44
2N5298	N37	.44
2N5301	N70	4.00
2N5303	N70	5.50
•2N5305	N70	.26
•2N5306	N050	.33
•2N5307	N050	.30
•2N5308	N050	.33
•2N5323	N70	.97
•2N5354	P70	.27
•2N5355	P41	.20
•2N5356	NF82	.23
2N5358	P41	1.75
•2N5365	P41	.24
•2N5400	P57	.33
•2N5401	P57	.44
2N5416	P70	1.65
•2N5447	P51	.16
•2N5448	P51	.16
•2N5449	N51	.20
•2N5450	N51	.16
•2N5451	N51	.16
•2N5457	NF86	.35
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•2N5459	NF86	.32
•2N5460	NF86	.65
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Type	Data	Price
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2N5492	N37	.64
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2N5496	N37	.67
2N5543	NF76	7.50
•2N5550	N57	.38
•2N5551	N57	.44
•2N5555	NF86	.65
•2N5638	NF86	.45
•2N5640	NF86	.45
•2N5654	NF86	.55
•2N5655	N37	.55
•2N5656	N37	.65
•2N5657	N37	.75
2N5661	N66	17.00
2N5786	N70	.98
2N5813	N70	.55
•2N6027	PU88	.64
2N6099	N37	.62
2N6107	P37	.45
2N6108	P37	.55
2N6109	P37	.55
2N6111	P37	.49
2N6121	N37	.41
2N6122	N37	.44
2N6123	P37	.48
2N6124	P37	.45
2N6125	P37	.47
2N6126	P37	.48
2N6129	N37	.60
2N6130	N37	.65
2N6131	N37	.70
2N6132	P37	.70
2N6133	P37	.70
2N6134	P37	.70
2N6179	N36	.77
2N6180	P36	1.05
2N6181	P36	.88
2N6253	N66	1.00
2N6254	N66	1.45
2N6288	N67	.50
2N6289	N38	.50
2N6290	N37	.50
2N6291	N37	.50
2N6292	N37	.50
2N6293	N37	.50
2S002	N70	6.00
2S005	N70	8.25
2S018	N70	9.75
2S020	N70	9.75
2S024	N89	13.00
2S025	N89	15.50
2S095A	N70	3.25
2S102	N70	1.28
2S103	N70	.83
2S104	N70	.55
2S301	P70	1.65
2S302	P70	1.65
2S306	P70	3.25
2S307	P70	3.55
2S322	P70	1.35
2S324	P70	1.90
2S502	N70	.55
2S503	N70	.50
2S702	N70	3.30
2S703	N70	3.95
2S732	N70	.65
2S733	N70	.55
2S745	N70	3.30
2S745A	N70	3.85
3N81	SCS90	3.50
3N83	SCS90	2.25
3N128	NF82	1.35
3N139	NF82	1.60
3N140	NF92	1.10
3N141	NF92	.95
3N142	NF82	.70
3N143	NF82	.88
3N152	NF82	1.10
3N153	NF82	.89
3N154	NF82	.99
3N159	NF92	1.35
3N187	NF92	1.80
3N200	NF92	2.85
3N201	NF92	1.35
40050	P66	1.70
40081	N70	1.20
40232	N70	.60
40233	N70	.70
40235	N65	.65
40237	N65	.45
40242	N65	.66
40251	N66	1.15
40254	P66	.66
40264	N70	.95
40280	N70	3.70
40309	N70	.60
40310	N28	.85
40311	N70	.55
40312	N28	.99

Type	Data	Price
40313	N28	1.38
40315	N70	.60
40316	N28	.95
40317	N70	.60
40324	N66	.95
40325	N66	1.35
40326	N70	.60
40327	N70	.73
40348	N70	1.10
40349	N70	1.45
40360	N70	.55
40361	N70	.55
40362	P70	.55
40363	N66	1.45
40364	N27	1.45
40372	N66	1.15
40373	N66	1.65
40374	N66	1.65
40389	N70	.70
40390	N70	1.05
40391	N70	.90
40392	N27	.70
40394	P27	.90
40395	P59	1.45
40396	P&N59	1.45
40406	P70	.73
40407	N70	.57
40408	N70	.82
40409	N70	.82
40410	P70	.82
40411	N66	3.10
40412	N68	.68
40414	N65	4.99
40422	N66	2.20
40440	P66	.70
40447	P70	3.30
40462	P66	.90
40467A	NF82	1.05
40468A	NF82	.70
40512	O95	1.70
40513	N84	1.60
40514	N84	1.60
40537	P70	.66
40543	N84	1.50
40559A	NF82	.50
40576	TR193	2.20
40594	N70	.87
40595	P70	.98
40600	NF92	.82
40601	NF92	.82
40602	NF92	.60
40603	NF92	.70
40604	NF92	.70
40608	N70	1.65
40625	N68	.60
40626	P66	1.05
40631	N38	.70
40632	N38	.95
40633	N84	1.20
40635	N70	.58
40636	N66	1.37
40673	NF92	.80
40669	TR196	1.30
40822	NF92	.66
40842	TR197	1.25
AC126	P69	.48
AC127	N69	.48
AC128	P69	.48
AC151	P69	.43
AC152	P69	.54
AC153	P69	.59
AC153K	P69	.59
AC176K	N69	.70
AC176	N69	.54
AC187	N69	.59
AC187K	P69	.65
AC188	P69	.54
AC188K	P69	.65
ACY17	P70	1.00
ACY22	P70	.65
ACY28	P70	.65
ACY30	P70	.86
ACY44	P70	.86
AD136	P59	2.75
AD142	P66	1.45
AD143	P66	1.45
AD149	P66	2.85
AD150	P66	3.10
AD161	N66	1.00
AD162	P66	1.00
AF106	P65	.60
AF109	P65	.82
AF114	P64	.70
AF115	P64	.70
AF116	P64	.70
AF117	P64	.70
AF118	P64	.70
AF124	P20	.70
AF125	P20	.70
AF126	P20	.70
AF139	P65	.75

Type	Data	Price
AF172	P98	.70
AF178	P64	1.30
AF186	P65	.55
AF200	P20	1.30
AF201	P20	1.30
AF239	P65	.70
AF240	P65	1.25
•AF279	P99	.88
•AF280	P99	.95
AFY42	P65	1.65
ASY28	N70	1.30
ASY50	P69	1.10
ASY53	N54	.82
ASY54	P54	.82
ASY55	P69	.70
•AU110	P66	2.70
•AU113	P66	2.70
BC107	N70	.16
BC107A	N70	.16
BC107B	N70	.16
BC108	N70	.16
BC108A	N70	.16
BC108B	N70	.16
BC108C	N70	.17
BC109	N70	.16
BC109B	N70	.17
BC109C	N70	.18
•BC113	N54	.22
•BC114	N54	.22
•BC115	N66	.22
•BC116	P59	.21
•BC116A	P59	.22
•BC117	N59	.22
•BC118	N54	.22
BC119	N70	.33
•BC123	N100	.65
•BC125	N70	.22
•BC132	N54	.33
•BC134	N54	.22
•BC135	N54	.22
•BC136	N54	.21
•BC137	P70	.22
BC138	N70	.44
BC140	N70	.30
BC141	N70	.32
BC142	N70	.32
BC143	P70	.32
•BC147	N61	.13
•BC147B	N61	.13
•BC148	N61	.13
•BC148B	N61	.13
•BC148C	N61	.13
•BC149	N61	.15
•BC149C	N61	.15
•BC152	N50	.38
•BC153	N54	.30
•BC154	N54	.30
•BC157A	N61	.15
•BC158A	N61	.15
•BC158B	N61	.15
•BC159A	N61	.17
•BC159B	N61	.17
BC160	P67	.38
BC161	P67	.38
•BC167	N50	.13
•BC167B	N50	.13
•BC168A	N50	.13
•BC168B	N50	.13
•BC168C	N50	.13
•BC169B	N50	.13
•BC169C	N50	.13
•BC170	N51	.19
•BC170B	N51	.19
•BC170C	N51	.19
•BC171	N51	.17
•BC171A	N51	.17
•BC171B	N51	.17
•BC172	N51	.15
•BC172A	N51	.15
•BC172B	N51	.15
•BC172C	N51	.15
•BC173	N51	.17
•BC173B	N51	.17
•BC173C	N51	.17
•BC174A	N51	.26
•BC174B	N51	.28
BC175	N50	.43
BC177	P70	.22
BC177A	P70	.22
BC177B	P70	.25
BC178	P70	.22
BC178A	P70	.25
BC178B	P70	.35
BC179	P70	.25
BC179A	P70	.25
BC179B	P70	.25
BC179C	P70	.28
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BC182A	N51	.12
BC182B	N51	.13
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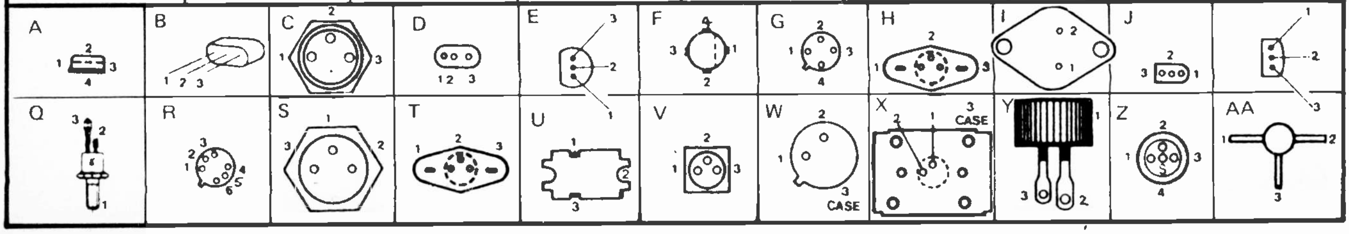

Type	Data	Price
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BC183LB	N50	.15
BC183LC	N50	.15
*BC184	N51	.12
BC184B	N51	.13
BC184C	N51	.13
*BC184L	N50	.15
BC184LB	N50	.15
BC184LC	N50	.15
*BC204	P54	.17
*BC205	P54	.17
*BC206	P54	.17
*BC207	N54	.17
*BC208	N54	.17
*BC209	N54	.17
*BC212	P51	.15
*BC212A	P51	.15
BC212B	P51	.15
*BC212L	N50	.18
*BC212LA	P50	.18
BC212LB	P50	.18
*BC213	P51	.15
BC213A	P51	.15
BC213B	P51	.15
BC213C	P51	.15
*BC213L	P50	.17
*BC213LA	P50	.17
BC213LB	P50	.17
BC213LC	P50	.17
*BC214	P51	.17
*BC214B	P51	.17
BC214C	P51	.17
*BC214L	P50	.18
*BC214LB	P50	.18
BC214LC	P50	.18
*BC237B	N51	.15
*BC238A	N51	.13
*BC238B	N51	.13
*BC238C	N51	.13
*BC239B	N51	.16
*BC239C	N51	.17
*BC250A	P51	.17
*BC250C	P51	.18
*BC251	P51	.17
*BC251A	P51	.17
*BC251C	P51	.17
*BC252	P51	.20
*BC252C	P51	.22
*BC253	P51	.24
*BC253B	N51	.24
*BC253C	P51	.24
*BC256A	P51	.29
*BC257A	P57	.18
*BC258A	P57	.18
*BC258B	P57	.19
*BC259B	P57	.19
BC260B	P70	.17
BC260C	P70	.18
BC261A	P70	.25
BC261B	P70	.27
BC261C	P70	.26
BC262A	P70	.26
BC262B	P70	.26
BC262C	P70	.27
BC263B	P70	.26
BC263	P70	.32
BC264B	P70	.65
BC266A	P70	.34
BC266B	P70	.35
BC300	N70	.43
BC301	N70	.43
BC302	N70	.37
BC303	P70	.54
BC304	P70	.60
*BC307	P51	.16
*BC307A	P51	.16
*BC307B	P51	.16
*BC308	P51	.16
*BC308B	P51	.16
*BC309A	P51	.16
*BC309B	P51	.16
*BC309C	P51	.16
*BC317	N57	.15
*BC318	N57	.14
*BC321	P57	.19
*BC322	P57	.19
*BC323	N70	.41
*BC327	P51	.22
*BC328	P51	.20
*BC337	N51	.20
*BC338	N51	.23
*BC382	N57	.21
*BC382L	N50	.21

Type	Data	Price
*BC383	N57	.19
*BC383L	N50	.19
*BC384	N57	.21
*BC384L	N50	.21
*BC407B	N54	.27
*BC408B	N54	.27
*BC409B	N54	.27
*BC413	N57	.16
*BC414	N57	.17
BC415	P57	.16
BC416	P57	.17
*BC547	N51	.13
BC547A	N51	.13
BC547B	N51	.13
BC548	N51	.13
*BC549	N51	.14
*BC549B	N51	.14
*BC549C	N51	.15
*BC557	P51	.14
*BC558	P51	.13
*BC559	P51	.15
BCY10	P68	1.10
BCY30	P70	1.10
BCY31	P70	1.10
BCY32	P70	1.10
BCY33	P70	1.10
BCY34	P70	1.10
BCY38	P70	2.20
BCY40	P70	1.05
BCY42	N70	.65
BCY43	N70	.76
BCY54	P70	2.40
BCY58	N70	.27
BCY59	N70	.27
BCY66	N70	2.20
BCY67	P70	2.70
BCY70	P70	.21
BCY71	P70	.26
BCY72	P70	.18
BCY77	P70	.70
BCY78	P70	.43
BCY79	P70	.41
BCY87	N101	5.35
BCY88	N101	3.99
BCY89	N101	3.80
BCZ10	P68	1.65
BD115	N70	.88
BD116	N66	1.35
BD121	N66	2.20
BD124	N66	2.20
BD131	N67	.55
BD132	P67	.75
*BD135	N67	.40
*BD136	P67	.40
*BD137	N67	.41
*BD138	P67	.41
*BD139	N67	.43
*BD140	P67	.43
BD142	N66	.70
BD153	N67	1.05
BD155	N67	1.10
BD157	N67	.70
BD158	N67	.70
BD159	N67	.70
BD160	N66	3.40
BD181	N66	1.90
BD182	N66	2.20
BD183	N66	2.35
BD187	N67	.95
BD201	N37	1.10
BD202	P37	1.25
BD203	N37	1.28
BD204	P37	1.35
BD220	N37	.66
BD221	N37	.66
BD222	N37	.66
BD223	P37	.75
BD224	P37	.75
BD232	N2	.75
BD233	N2	.45
BD234	P2	.46
BD235	N2	.46
BD236	P2	.44
BD237	N2	.44
BD238	P2	.44
BD239A	N37	.44
BD239C	N37	.59
BD240A	P37	.49
BD240C	P37	.59
BD241A	N37	.49
BD241C	N37	.65
BD242A	P37	.55
BD242C	P37	.62
BD243A	N37	.65
BD243C	N37	.87
BD244A	P37	.70
BD244C	P37	.87
BD245A	N37	.69
BD245C	N37	.85
BD246A	P37	.72

Type	Data	Price
BD246C	P37	.93
BD249A	N37	2.40
BD249C	N37	3.00
BD250A	P37	2.75
BD250C	P37	3.40
BDX32	N66	2.70
BDY54	N66	1.55
BUX20	N66	15.25
BUX21	N66	17.50
BUX22	N66	19.50
BUX23	N66	24.00
BUX24	N66	26.00
BUX25	N66	28.00
BD433	N2	.44
BD434	P2	.46
BD435	N2	.46
BD436	P2	.46
BD437	N2	.55
BD438	P2	.55
BD441	N2	.44
BD442	P2	.44
*BD529	N36	.49
*BD530	P36	.55
BD535	N37	.70
BD536	P37	.70
BD537	N37	.74
BD538	P37	.77
BD539	P37	.60
BD540	P37	.60
BD581	N37	1.10
BD582	P37	1.30
BD675	ND2	.60
BD676	PD2	.65
BD677	NP2	.70
BD678	PD2	.82
BDX14	P28	1.32
BDX18	P66	1.90
BDY11	N66	3.30
BDY17	N66	3.30
BDY18	N66	3.80
BDY20	N66	1.10
BDY23	N66	2.45
BDY24	N66	2.65
BDY25	N66	2.85
BDY38	N66	1.10
BDY55	N66	1.90
BDY56	N66	2.10
BDY57	N66	5.90
BDY58	N66	6.50
BDY60	N66	1.65
BDY61	N66	2.75
BDY62	N66	2.75
BDY92	N66	2.75
BF115	N20	.39
BF119	N70	1.10
BF121	N19	.60
BF123	N19	.60
BF134	N59	.60
BF137	N70	.60
BF152	N54	.27
BF153	N54	.27
BF154	N54	.27
BF157	N70	.48
BF158	N54	.37
BF160	N54	.33
BF161	N65	.65
BF166	N65	.44
BF167	N20	.37
BF170	N70	.76
BF173	N20	.37
BF177	N70	.27
BF178	N70	.27
BF179	N70	.33
BF180	N65	.37
BF181	N65	.37
BF182	N65	.37
BF183	N65	.44
BF184	N20	.41
BF185	N20	.41
*BF194	N60	.16
*BF195	N60	.16
*BF196	N60	.16
*BF197	N60	.18
*BF198	N52	.19
*BF199	N52	.19
BF200	N65	.38
*BF224J	N18	.22
*BF225J	N18	.27
BF238	N18	.55
BF240	N52	.24
BF241	N52	.24
*BF244A	NF78	.38
*BF244B	NF78	.33
*BF245A	NF103	.44
*BF245B	NF103	.44
*BF246A	NF78	.82
BF246B	NF78	.82
BF247A	NF78	.49
BF247B	NF78	.49
BF254	N52	.26

Type	Data	Price
BF255	N52	.26
BF257	N70	.35
BF258	N70	.35
BF259	N70	.35
BF262	N99	.66
BF263	N99	.75
BF270	N65	.55
BF271	N65	.27
BF273	N53	.55
BF274	N53	.55
*BF324	P51	.35
*BF336	N70	.42
*BF337	N70	.49
*BF338	N70	.52
*BF355	N70	.53
*BF362	N104	.53
*BF363	N104	.53
BF450	P52	.24
BF451	P52	.22
*BF457	N2	.44
*BF458	N2	.49
*BF459	N2	.55
*BFR39	N50	.30
*BFR40	N50	.29
*BFR41	N50	.30
*BFR79	P50	.30
*BFR80	P50	.30
*BFR81	P50	.30
BFS21A	NF79	2.90
BFS28	NF79	1.50
*BFS61	N48	.33
*BFS98	P48	.33
BFW10	NF79	.83
BFW11	NF78	.83
BFW30	N65	2.45
BFW43	P70	1.65
BFW59	N61	1.75
BFW87	P61	1.75
BFW90	P61	1.75
BFX12	P70	.35
BFX13	P70	.33
BFX19	N65	.49
BFX29	P70	.34
BFX30	P70	.34
BFX34	N70	.66
BFX37	P70	.49
BFX68	P70	1.10
BFX84	N70	.30
BFX85	N70	.38
BFX86	N70	.30
BFX87	P70	.35
BFX88	P70	.30
BFX89	N70	1.37
BFY10	N70	1.10
BFY18	N70	1.10
BFY19	N70	1.10
BFY37	N70	1.10
BFY39	N70	.38
BFY41	N70	.88
BFY50	N70	.27
BFY51	N70	.27
BFY52	N70	.27
BFY53	N70	.37
BFY72	N70	.99
BFY75	N70	.77
BFY76	N70	1.10
BFY90	N65	1.35
BR101		.55
BRY30	THY106	.55
BRY39	SCS90	.55
*BRY56	THY106	.38
BSW41	N70	1.65
BSW66	N70	.90
BSW67	N70	1.09
BSW70	N70	1.65
BSX19	N70	.35
BSX20	N70	.35
BSX21	N70	.35
BSX26	N70	.88
BSX27	N70	.82
BSX29	P70	.53
BSX39	N70	1.20
BSX60	N70	.71
BSX61	N70	.53
BSX76	N70	.60
BSX77	N70	.60
BSY10	N70	1.10
BSY24	N70	.52
BSY25	N70	.65
BSY26	N70	.55
BSY27	N70	.55
BSY28	N70	.44
BSY29	N70	1.10
BSY38	N70	.33
BSY39	N70	.33
BSY51	N70	.33
BSY52	N70	.33
BSY53	N70	.33
BSY54	N70	.36
BSY65	N70	.45

Type	Data	Price
BSY78	N70	1.00
BSY79	N70	1.42
BSY95A	N70	.37
*BU104	N66	1.80
*BU105	N66	1.55
*BU126	N66	2.08
*BU204	N66	2.20
*BU205	N66	2.40
*BU206	N66	2.70
*BU208	N66	2.70
*ME0401	P54	.22
*ME0402	P54	.22
*ME0404	P54	.17
*ME0411	P54	.22
*ME0412	P54	.22
*ME0413	P54	.17
*ME0414	P54	.22
*ME0461	P54	.27
*ME0462	P54	.27
*ME1001	N54	.17
*ME1002	N54	.17
*ME1075	N54	.22
*ME1100	N54	.22
*ME1120	N54	.27
*ME3002	N54	.27
*ME4001	N54	.16
*ME4002	N54	.16
*ME4003	N54	.16
*ME4101	N54	.11
*ME4102	N54	.11
*ME4103	N54	.11
*ME4104	N54	.11
*ME6001	N54	.16
*ME6002	N54	.16
*ME6003	N54	.16
*ME6101	N54	.22
*ME6102	N54	.22
*ME8001	N70	.22
*ME8002	N70	.22
*ME8003	N70	.22
*ME9001	N54	.22
*ME9002	N54	.22
MJ400	N66	1.45
MJ430	P70	1.45
MJ481	N66	1.70
MJ490	P66	1.49
MJ491	P66	2.10
MJ901	PD66	2.45
MJ1001	ND66	2.10
MJ2500	PD66	2.70
MJ2501	PD66	2.75
MJ2955	P66	1.35
MJ3000	ND66	2.15
MJ3001	ND66	2.35
MJ4502	P66	4.90
*MJE340	N2	.62
MJE370	P2	.62
MJE371	P2	.66
*MJE520	N2	.50
MJE521	N2	.70
MJE2955	P2	1.65
MJE3055	N2	1.05
MPB111	N111	.40
MPB112	N111	.45
MPB113	N111	.50
MPB121	N111	.40
MPB122	N111	.45
MPB123	N111	.50
MPB513	N111	.50
*MPF102	NF86	.33
MPF103	NF86	.44
*MPF104	NF86	.44
MPF105	NF86	.44
*MPF111	NF86	.30
*MPF112	NF86	.30
MPS005	N57	1.10
MPS3563	N57	.20
MPS3638	P57	.22
MPS3640	P57	.23
MPSA05	N57	.27
MPSA06	N57	.27
MPSA10	N57	.22
MPSA12	ND57	.44
*MPSA14	ND57	.33
*MPSA16	N57	.22
*MPSA18	N57	.22
MPSA55	P57	.27
MPSA56	P57	.27
MPSL01	N57	.32
MPSL51	P57	.32
*MPSU01	N36	.49
MPSU05	N36	.55
MPSU06	N36	.60
MPSU07	N36	.60
MPSU51	P36	.55
MPSU55	P36	.60
MPSU56	P36	.65
MPSU57	P36	.70
OC20	P66	3.50
OC22	P66	3.30

Type	Data	Price
OC24	P66	3.00
OC25	P28	3.00
OC26	P66	1.65
OC28	P66	2.20
OC29	P66	2.20
OC35	P66	1.65
OC36	P66	1.65
OC42	P54	.55
OC43	P54	1.30
OC45	P54	.82
OC70	P54	.55
OC71	P54	.49
OC72	P68	.49
OC81	P54	.82
OC81D	P54	.82
OC82	P54	.82
OC83	P54	.55
OC139	P54	1.60
OC170	P68	.82
OC201	P54	.82
OC204	P54	2.20
OC205	P54	2.75
OC206	P54	2.75
R2008B	N66	2.45
R2010B	N66	2.15
*TIP29A	N37	.49
*TIP29C	N37	.65
*TIP30A	P37	.54
*TIP30C	P37	.70
TIP31A	N37	.54
TIP31C	N37	.72
TIP32A	P37	.59
TIP32C	P37	.82
TIP33A	N37	.86
TIP33C	N37	1.18
TIP34A	P37	.97
TIP34C	P37	1.31
TIP35A	N37	2.70
TIP36A	P37	3.00
TIP41A	N37	.76
TIP41C	N37	.97
TIP42A	P37	.86
TIP42C	P37	1.08
TIP2955	P37	.70
TIP3055	N37	.59
*TIS34	N51	1.05
*TIS42	NF78	.50
*TIS43	U110	.47
*TIS45	N50	.76
*TIS46	N50	.55
*TIS49	N50	.55
*TIS50	P50	.59
*TIS52	N50	.82
*TIS53	P50	1.55
*TIS54	P50	.88
*TIS58	NF78	.88
*TIS60	N50	.20
*TIS61	P50	.25
*TIS62	N51	.50
*TIS64	N51	.50
*TIS88A	NF78	.44
*TIS90	N50	.22
*TIS91	P50	.27
*TIS92	N51	.33
*TIS93	P51	.36
*ZTX300	N48	.17
*ZTX301	N48	.17
*ZTX302	N48	.27
*ZTX303	N48	.27
*ZTX304	N48	.27
*ZTX310	N48	.17
*ZTX311	N48	.18
*ZTX312	N48	.19
*ZTX313	N48	.21
*ZTX314	N48	.27
*ZTX320	N48	.33
*ZTX330	N48	.22
*ZTX341	N48	.22
*ZTX500	P48	.16
*ZTX501	P48	.17
*ZTX502	P48	.19
*ZTX503	P48	.16
*ZTX504	P48	.29
*ZTX510	P48	.18
*ZTX530	P48	.25
*ZTX531	P48	.27

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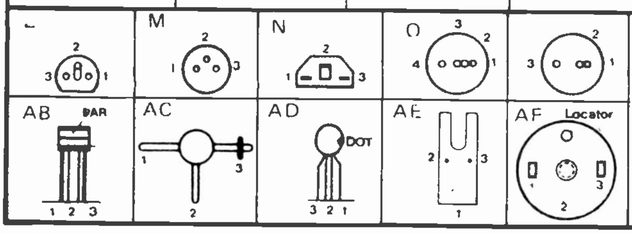
PIN CONNECTIONS

Data Ref	Drwg Ref	1	2	3	4	5	6
2	A	E	C	B	C	—	—
4	B	E	C	B	—	—	—
10	C	E	B	C	—	—	—
16	D	B	C	E	—	—	—
18	E	C	E	B	—	—	—
19	F	C	S	B	E	—	—
20	G	B	E	C	S	—	—
27	H	E	B	C	—	—	—
28	I	E	B	C	—	—	—
36	A	E	B	C	C	—	—
37	A	B	C	E	C	—	—
38	A	B	—	E	C	—	—
41	J	C	B	E	—	—	—
48	K	C	B	E	—	—	—
50	E	E	C	B	—	—	—
51	L	E	B	C	—	—	—
52	L	C	E	B	—	—	—
53	M	B	E	C	—	—	—
54	M	E	B	C	—	—	—
57	E	E	B	C	—	—	—
58	AF	E	C	B	—	—	—
59	M	E	C	B	—	—	—
60	N	B	C	E	—	—	—
61	N	E	B	C	—	—	—
64	P	E	B	C	S	—	—
65	G	E	B	C	S	—	—
66	I	E	B	C	—	—	—
67	A	E	C	B	C	—	—
68	P	E	B	C	—	—	—
69	M	E	B	C	—	—	—
70	G	E	B	C	—	—	—
71	G	E	B_1	—	B_2	—	—
72	Q	A	G	K	—	—	—
73	R	C	B	E	E	B	C
74	S	C	E	B	—	—	—
76	G	S	D	G	—	—	—
77	J	E	C	B	—	—	—
78	E	S	G	D	—	—	—
79	G	S	D	G	—	—	—
80	G	S	D	G	Sub		—
81	T	E	B	C	—	—	—
82	G	D	S	G	Sub		—
83	M	S	D	G	—	—	—
84	U	E	C	B	—	—	—
85	E	B_1	E	B_2	—	—	—
86	E	D	S	G	—	—	—
87	G	1	G	2	—	—	—
88	E	A	K	G	—	—	—
89	V	E	B	C	—	—	—
90	G	K	GK		GA		A
91	G	S	G_1	D	G_2		—
92	G	D	G_2	G_1	S	—	—
93	I	1	G	2	—	—	—
94	W	1	G	2	—	—	—
95	X	1	G	2	—	—	—
96	Y	2	1	G	—	—	—
97	A	1	2	G	2	—	—
98	Z	E	B	C	S	—	—
99	AA	E	B	C	—	—	—
100	AB	B	C	E	—	—	—
101	R	E_1	E_2	C_2	C_1	B_1	B_2
102	A	E	B	C	—	—	—
103	E	G	S	D	—	—	—
104	AC	E	B	C	—	—	—
105	AD	E	C	B	—	—	—
106	G	K	G	A	—	—	—
107	E	A	G	K	—	—	—
109	G	C	E	B	—	—	—
110	E	E	B_2	B_1	—	—	—
111	AE	C	B	E	—	—	—



PREFIX CODES

N	=	NPN or N-Channel
P	=	PNP or P-Channel
U	=	Unijunction
F	=	F.E.T. or Field Effect Trans
THY	=	Thyristor
TRI	=	Triac
D	=	Darlington
PU	=	P.U.T.
SCS	=	Silicon Controlled Switch
Q	=	Quadrac

HOW TO USE THIS GUIDE

Example 2N706 in price list has a data code "N70." The prefix "N" denotes "NPN" transistor (see left). The data ref "70" in table of pin connections is cross referenced to drawing NR G. From drawing "G" we see pin 1 = emmitter, pin 2 = base and pin 3 = collector

LONDON: 01-452 0161
GLASGOW: 041-332 4133
BRISTOL: 027-2654201

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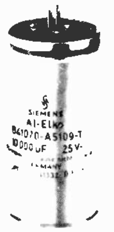
Miniature electrolytics By SIEMENS and MULLARD Types B41313 B41283 B41010, 015 - 016

UF	Volts	Size mm	Price 1—99	UF	Volts	Size mm	Price 1—99
47	100	4.5 x 11	£0.14	47	40	8.5 x 15	£0.12
1.0	40	3.2 x 11	£0.14	47	63	8.5 x 20	£0.15
1.0	100	4.5 x 11	£0.14	68	16	6.7 x 18.5	£0.10
1.5	63	6.1 x 12.5	£0.10	100	16	8.5 x 15	£0.13
2.2	25	3.2 x 11	£0.14	100	25	8.5 x 17.5	£0.14
2.2	63	4.5 x 11	£0.14	100	40	10 x 20	£0.16
2.2	100	5.8 x 11	£0.15	100	63	10 x 25	£0.22
3.3	63	6.1 x 12.5	£0.10	100	100	14 x 30	£0.30
4.7	16	3.2 x 11	£0.14	150	16	8.3 x 18.5	£0.13
4.7	40	4.5 x 11	£0.14	150	25	10.3 x 18.5	£0.15
4.7	63	5.8 x 11	£0.15	220	16	8.5 x 20	£0.15
4.7	100	6.5 x 17.5	£0.11	220	25	10 x 20	£0.18
6.8	40	4.8 x 12.5	£0.09	220	40	10 x 25	£0.22
6.8	63	6.1 x 12.5	£0.09	220	63	14 x 30	£0.31
10	25	4.5 x 11	£0.14	220	100	18 x 30	£0.42
10	40	5.8 x 11	£0.15	470	16	10 x 25	£0.20
10	63	6.5 x 17.5	£0.12	470	25	12 x 30	£0.23
10	100	8.5 x 15	£0.13	470	40	14 x 30	£0.28
15	16	4.8 x 12.5	£0.09	470	63	18 x 30	£0.44
15	40	6.1 x 12.5	£0.09	470	100	21 x 40	£0.66
15	63	6.7 x 18.5	£0.09	1000	16	14 x 30	£0.27
22	25	5.8 x 11	£0.15	1000	25	16 x 30	£0.38
22	40	6.5 x 17.5	£0.12	1000	40	18 x 35	£0.47
22	63	8.5 x 15	£0.12	1000	63	21 x 40	£0.66
22	100	8.5 x 20	£0.15	2200	16	18 x 35	£0.46
33	16	6.1 x 12.5	£0.09	2200	25	21 x 40	£0.55
33	40	6.7 x 18.5	£0.10	2200	40	25 x 40	£0.60
47	16	6.5 x 20	£0.12	4700	16	21 x 40	£0.66
47	25	6.5 x 17.5	£0.12	4700	25	25 x 40	£0.90

ELECTROLYTIC—RADIAL

HIGH RIPPLE



UF	Volts DC	Size mm	Price 1—99
1000	40	25 x 35	£1.02
1000	63	25 x 45	£1.15
2200	25	25 x 45	£1.10
2000	40	30 x 45	£1.18
2200	63	30 x 55	£1.43
2200	100	30 x 55	£1.65
4700	25	30 x 45	£1.26
4700	40	35 x 55	£1.50
4700	63	40 x 74	£2.20
10000	25	35 x 55	£1.98

Tol +50% −10%

SEIMENS B41070

ELECTROLYTIC—PLUGGABLE

TYPE B41316/7 SIEMENS

UF	Volts DC	Size mm	PRICE 1—99
1.0	63	8.7 x 12.6	£0.13
2.2	63	8.7 x 12.5	£0.13
4.7	63	8.7 x 12.5	£0.13
10	63	8.7 x 12.5	£0.13
22	63	10.7 x 12.5	£0.13
47	63	12.7 x 16.5	£0.16
100	63	15 x 20	£0.21
220	16	12.7 x 16.5	£0.15
470	16	15 x 20	£0.20
1000	16	15 x 30	£0.30

Tol +100% −10%

TANTALUM BEAD

UF	Volt DC	Size mm	Price 1—99
0.1	35	9 x 5	£0.17
0.22	35	9 x 5	£0.17
0.47	35	9 x 5	£0.17
1.0	35	9 x 5	£0.17
2.2	16	9 x 5	£0.17
2.2	35	10 x 5.5	£0.17
4.7	16	10 x 15	£0.17
4.7	35	11 x 6	£0.21

UF	Volts	Size mm	Price
10	6.3	10 x 5.5	£0.17
10	16	11 x 6	£0.21
15	15	12 x 7	£0.23
15	25	12 x 7.5	£0.25
22	6.3	11 x 6	£0.21
33	10	11 x 6	£0.23
47	6.3	12 x 7.5	£0.23
100	3	12 x 7.5	£0.23

TYPE B45134 SIEMENS
Radial lead Tol ± 20%
MINIATURE TANTALUM BEAD

CERAMIC DISC 63V

SIEMENS B37448/9

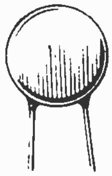
Flat Ceramic Capacitors from a New Material with Dielectric Constant of 50,000

The development of a new titanate ceramic material represents a step towards reducing capacitor size which is significant for capacitors used for coupling and decoupling in AF circuits.

UF	VDC	Size mm	1-99 Price
.01	63	4 x 2.5 x 4	£0.07
.022	63	4 x 2.5 x 4	£0.07
.033	63	4 x 2.5 x 6	£0.07
.047	63	4 x 2.5 x 8	£0.07
.068	63	4 x 2.5 x 10	£0.09
.1	63	4 x 2.5 x 9	£0.09
.22	63	6 x 2.5 x 18	£0.19

HIGH VOLTAGE CERAMIC DISC

Capacitance VDC	Price	Capacitance VDC	Price
100pf 1kv	£0.08	2,200pf 2kv	£0.10
100pf 2kv	£0.10	2,200pf 4kv	£0.13
100pf 3kv	£0.10	2,200pf 5kv	£0.19
100pf 4kv	£0.10	3,300pf 2kv	£0.12
220pf 6kv	£0.08	3,300pf 4kv	£0.16
470pf 2kv	£0.08	4,700pf 2kv	£0.12
470pf 6kv	£0.11	4,700pf 4kv	£0.20
1,000 2kv	£0.08	10,000pf 2kv	£0.14
1,000pf 4kv	£0.10	10,000pf 3kv	£0.19
1,000pf 6kv	£0.17		



HIGH VOLTAGE

CERAMIC PLATE

MULLARD

ALL 63 VDC WORKING 6p EACH
Values available pF
Quantity Price on request

1pF	10	100	1000
1.2	12	120	1200
1.5	15	150	1500
1.8	18	180	1800
2.2	22	220	2200
2.7	27	270	2700
3.3	33	330	3300
3.9	39	390	3900
4.7	47	470	4700
5.6	56	560	5600
6.8	68	680	6800
8.2	82	820	10000

Tolerance
1-10pF ± 25%
10-330pF ± 2%
390-1000pF ± 5%
1000pF-10kpF ± 10%

VERY NEAT AND COMPAT 1" PIN SPACING

pF	Size	Dmns
1.8-22	1	3.5 x 4 5mm
27-47	2	4 5 x 5.5mm
56-68	3	5 5 x 6 5mm
82-100	4	6.5 x 7.5mm
120-150	5	6 5 x 10.5mm
180-220	4	6.5 x 7 5mm
270-330	5	6 5 x 10.5mm

POLYSTYRENE

Close tolerance Polystyrene capacitors from Siemens B31110/B31310

5% Tolerance. 160v working

Values available

Price 1—99

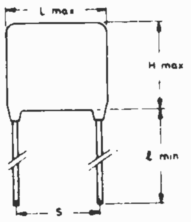
10pf. 15pf. 22pf. 33pf. 47pf. 68pf. 100pf. 150pf. 220pf. 330pf. 470pf. 680pf. 1000pf — **6p each**

1500pf. 2200pf. 3300pf. 4700pf. 6800pf. 10000pf — **10p each**

POLYESTER

MULLARD C280 SERIES
AN INEXPENSIVE WIDELY USED CAPACITOR — DIMENSIONS IN MM

250 VDC-RADIAL LEADS
Metallized film capacitors
Tol .01 — .22 ± 20%
.33 — 2.2uf ± 10%



MULLARD

UF	Price	S	T	L	H
0.01	£0.06	10.2	4	12.5	9
0.015	£0.06	10.2	4	12.5	9
0.022	£0.06	10.2	4	12.5	9
0.033	£0.06	10.2	4	12.5	9
0.047	£0.06	10.2	4	12.5	9
0.068	£0.06	10.2	5	12.5	10
0.1	£0.06	10.2	6	12.5	11
0.15	£0.08	15.3	6	17.5	11
0.22	£0.09	15.3	7	17.5	12
0.33	£0.12	20.3	6.5	22.5	11.5
0.47	£0.14	20.3	7.5	22.5	12.5
0.68	£0.20	20.3	9.5	22.5	14.5
1	£0.24	27.9	9.5	30	14.5
1.5	£0.36	27.9	10.5	30	18
2.2	£0.37	27.9	12.5	30	20.5

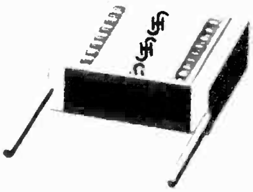
ATTRACTIVE QUANTITY DISCOUNTS

CAPACITORS

POLYCARBONATE

Polycarbonate—Polyester **B32540/60 SIEMENS**

7.5mm lead spacing tinned



7.5 and 10mm spacing

250 Volt working		1—99 Price
.001	9 x 2.6 x 7.3	£0.07
.0022	9 x 2.6 x 7.3	£0.07
.0033	9 x 2.3 x 7.3	£0.07
.0047	9 x 2.3 x 7.3	£0.07
.0068	9 x 2.7 x 7.3	£0.07
.0082	9 x 2.7 x 7.3	£0.07
.01	9 x 2.3 x 7.3	£0.07
.012	9 x 2.5 x 7.3	£0.07
.015	9 x 2.9 x 7.3	£0.07
.022	9 x 2.6 x 7.3	£0.07
.027	9 x 2.4 x 7.3	£0.07
.033	9 x 2.6 x 7.3	£0.07
.039	9 x 2.9 x 7.3	£0.07
.047	9 x 3.2 x 7.3	£0.07
.056	9 x 3.5 x 7.5	£0.07
.068	9 x 3.5 x 7.5	£0.09
.082	9 x 3.5 x 11	£0.11
.1	9 x 3.9 x 11	£0.11

100 Volt DC		1—99 Price
.12	9 x 3.5 x 8.3	£0.10
.15	9 x 3.6 x 10	£0.10
.18	9 x 4.1 x 10	£0.12
.22	9 x 4.7 x 10	£0.12
.27	9 x 5.0 x 11	£0.16
.33	9 x 5.5 x 11.5	£0.16
.39	9 x 6.6 x 11.5	£0.20
.47	9 x 7.2 x 12.5	£0.20
.56	9 x 8.4 x 12.5	£0.25
.68	9 x 8 x 13	£0.25

Self-healing layer capacitor with polycarbonate as dielectric. In accordance with DIN 41379 these types are designated MKC capacitors.

B32541/61 Polycarbonate/Polyester as B32540/60 but 10mm lead spacing — also available in 100 and 250 volt DC working

250 Volt working UF	Dimensions mm	1—99 Price
.01	11.5 x 3.2 x 6.6	£0.07
.015	11.5 x 3.2 x 6.6	£0.07
.022	11.5 x 3.2 x 6.6	£0.07
.047	11.5 x 3.2 x 6.6	£0.07
.068	11.5 x 3.2 x 6.6	£0.07

UF	Dimensions mm	1—99 Price
.1	11.5 x 3.5 x 8.3	£0.09
.15	11.5 x 4.2 x 9.6	£0.11
.22	11.5 x 4.9 x 11.5	£0.13
100 Volt working		
.22	11.5 x 3.9 x 9.5	£0.11
.47	11.5 x 5.3 x 11.5	£0.17
1.0	11.5 x 9.8 x 11.5	£0.31
2.2		£0.60

POLYESTER

SIEMENS B32234 MKH 20% Tol

Self healing flat capacitor winding with polyethelene-terephtalene dielectric to DIN 41379 spec. Encapsulated and epoxy resin sealed. The case is provided with spacers to improve solderability in solder bath, parrallel leads, plug in, suitable for printed circuits

B 32234

100Vot DC uF	Dimensions mm	1—99 Price
.1	4 x 9.5 x 13	£0.14
.15	5 x 10.5 x 13	£0.16
.22	6 x 11.5 x 13	£0.17
.33	5.5 x 11 x 18	£0.20
.47	5.5 x 11 x 18	£0.25
.68	7 x 13 x 18	£0.30
1.0	9 x 14.5 x 18	£0.36
1.5	7 x 16.5 x 27	£0.47
2.2	8.5 x 18.5 x 27	£0.54
3.3	10.5 x 19 x 27	£0.70
4.7	11 x 20 x 32	£0.82
6.8	13 x 22.5 x 32	£1.11

250Volt DC uF	Dimensions	1—99 Price
.047	4 x 9.5 x 13	£0.13
.1	5.5 x 11 x 18	£0.14
.22	7 x 13 x 18	£0.15
1.0	8.5 x 18.5 x 27	£0.35
400 Volt DC		
.01	4 x 9.5 x 13	£0.11
.015	4 x 9.5 x 13	£0.11
.022	4 x 9.5 x 13	£0.11
.047	5.5 x 11 x 18	£0.15

PLASTIC FOIL—HIGH RELIABILITY

SIEMENS B32110
High reliability plastic foil
Axial lead 20% Tol MKL

63 Volt working uF	Dimensions	1—99 Price
.15	5.4 x 18.5	£0.53
.22	5.4 x 18.5	£0.56
.33	6.4 x 18.5	£0.59
.47	7.4 x 18.5	£0.66
.68	7.4 x 18.5	£0.70
1.0	7.4 x 21	£0.78
1.5	8.4 x 21	£0.80
2.2	10.7 x 21	£1.37

uF	Dimensions	1—99 Price
3.3	9.4 x 25	£1.55
4.7	10.7 x 25	£1.62
6.8	10.7 x 34	£2.20
10	12.7 x 34	£2.80
100 Volt Working		
.1	5.4 x 18.5	£0.61
1.0	9.4 x 21	£1.16

Self-healing tubular capacitor winding with cellulose acetate as dielectric. In accordance with DIN 41379 these types are designated MKU capacitors.
Enclosed in tubular metal case, shrunk sleeve insulated, epoxy resin sealed face ends. Central axial leads.

TRIMMERS

MINIATURE FILM DIELECTRIC

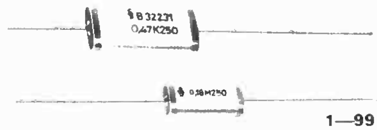
Type	Capacitance swing pF	Minimum capacitance pF	£.p
808 00005	8	2	£0.20
808 00006	20	2	£0.22
808 01001	59.5	5.5	£0.27

MULLARD

METALLISED POLYESTER up to 630 volt

B32231 metallised Polyester from SIEMENS

Axial leads
Tolerance 20%
Type MKH similar to Mullard C281 range available in three voltages 250, 400 and 630 VDC



250 Volt DC uF	Dimensions mm	1—99 Price
.047	4.5 x 8.5 x 14	£0.14
.068	5.5 x 9 x 14	£0.15
.1	6 x 9 x 14	£0.15
.22	4.5 x 10.5 x 19	£0.16
.33	7 x 11 x 19	£0.19
.47	4.5 x 13.5 x 26.5	£0.22
.68	6 x 15 x 26.5	£0.26
1.0	8 x 17 x 26.5	£0.35
1.5	8.5 x 20.5 x 29	£0.42
2.2	10.5 x 22.5 x 29	£0.54
4.7	12 x 27.5 x 44	£1.16
10	19.5 x 34.5 x 44	£1.94

400 Vot DC		1—99 Price
.022	4.5 x 7.5 x 14	£0.14
.047	4.5 x 8 x 19	£0.15
.1	5.5 x 8.5 x 19	£0.16
630 Volt DC		
.01	4.5 x 8 x 14	£0.13
.015	4.5 x 8 x 14	£0.14
.022	5 x 8.5 x 14	£0.15
.047	5 x 10.5 x 19	£0.16
.1	5 x 12.5 x 26.5	£0.30
.15	6.5 x 14 x 26.5	£0.31
.22	7.5 x 16.5 x 26.5	£0.32
.47	10 x 22 x 29	£0.53

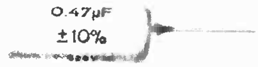
NB. 630 V.d.c. rating equivalent 250V rms.

Self-heating flat capacitor winding with polyethylene-teraphtalate as dielectric. In accordance with DIN 41379 these types are esignated MKT capacitors.

Capacitor winding coated with insulating material, epoxy resin sealed face ends.

METALLISED POLYESTER EXTENDED FOIL-MULLARD

MULLARD C296 SERIES
400 VDC WORKING
10% Tolerance
Temp range — 40 to +80 C



uF	Dimensions		Price
0.001	21	7.5	£0.11
0.0015	**21**	**7.5**	**£0.11**
0.0022	21	7.5	£0.11
0.0033	21	7.5	£0.11
0.0047	21	7.5	£0.11
0.0068	21	7.5	£0.11
0.01	21	7.5	£0.12
0.015	21	7.5	£0.12
0.022	21	8.5	£0.12

uF	Dimensions		Price
0.033	21	10	£0.14
0.047	21	11.5	£0.16
0.068	35	9.5	£0.17
0.1	35	11	£0.20
0.15	35	12.5	£0.25
0.22	35	14.5	£0.33
0.33	35	17	£0.47
0.47	35	19.5	£0.56

Radial leads

MICA

Close tolerance — suitable for pulse operation Tol ± 5pF below 50pF ± 1% for 50pF and higher

SILVERED MICA CAPS
500 VDC WORKING

Values available in pF	Price
2.2, 3.3, 5, 10, 18, 20, 22	10p
25, 27, 30, 33, 39, 47, 50	10p
56, 68, 75, 82, 100, 120, 150	10p
180, 200, 220pf	10p
250, 270, 300, 390, 470	13p
500, 560, 580, 820;F	13p
1,000	18p

DIODES AND RECTIFIERS

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
AA116	£0.13	BA243	£0.38	BY206	£0.22	DK110	£0.36	Z344	£0.28	IN4009	£0.27
AA118	£0.13	BA244	£0.55	BY207	£0.22	GEX23A	£0.08	IN345	£0.17	IN4148	£0.08
AA119	£0.14	BA316	£0.07	BYW11-600	£2.60	ITT33	£0.08	IN461	£0.15	IN4150	£0.20
AA129	£0.10	BA317	£0.07	BYW11-800	£3.25	ITT44	£0.08	IN659	£0.08	IN4154	£0.22
AA144	£0.11	BA318	£0.07	BYW11-1000	£4.00	ITT210	£0.75	IN821	£0.35	IN4446	£0.15
AAY30	£0.18	*BAV10	£0.09	BYW12-100	£2.00	ITT920	£0.11	IN823	£0.55	IN4448	£0.09
AAY32	£0.18	*BAV19	£0.11	BYW12-200	£2.25	ITT921	£0.12	IN825	£0.65	IN4517	£0.12
AAY33	£0.20	*BAV20	£0.12	BYW12-400	£2.65	ITT922	£0.13	IN914	£0.08	IN5172	£0.19
AAY43	£0.20	BAW49	£0.17	BYX10	£0.30	ITT923	£0.20	IN916	£0.08	IN5176	£0.30
AAZ13	£0.35	*BAX13	£0.07	BYX97-600	£3.90	ITT2001	£0.12	IN1183R	£1.00	IN5233A	£0.30
AAZ15	£0.25	*BAX16	£0.08	BYX97-1200	£4.35	ITT2002	£0.13	IN1188	£2.50	IN5400	£0.15
AAZ17	£0.20	BAY31	£0.17	BYX99-600	£1.55	ITT2003	£0.25	IN1190	£2.75	IN5401	£0.17
BA100	£0.20	BAY36	£0.28	BYX99-1200	£1.80	OA10	£0.60	IN1194	£1.25	IN5402	£0.18
BA102	£0.20	BAY38	£0.28	CL1506	£0.95	OA47	£0.15	IN1194A	£1.30	IN5404	£0.19
BA111	£0.30	BAY44	£0.17	CL1507	£1.05	OA85	£0.20	IN1196	£1.80	IN5406	£0.25
BA115	£0.17	BAY71	£0.18	CV7047	£0.70	OA90	£0.09	IN1198A	£2.75	IN5407	£0.30
BA127	£0.22	BAY72	£0.22	CV7071	£0.55	OA91	£0.09	IN1201A	£0.80	IN5408	£0.45
BA130	£0.11	BAY74	£0.19	CV7130	£0.28	OA95	£0.11	IN3492	£0.88	IS44	£0.08
BA133	£0.28	BB103	£0.35	CV7641	£0.55	OA200	£0.11	IN3493	£0.95	IS120	£0.16
BA138	£0.25	*BB104	£0.44	*DD000	£0.17	OA202	£0.15	IN3595	£0.33	IS121	£0.16
BA142	£0.19	*BB105A	£0.33	D1300A	£0.50	OA211	£0.27	IN3602	£0.17	IS130	£0.11
BA144	£0.14	*BB105B	£0.33	DK13	£0.24	OAZ200	£0.30	IN3604	£0.17	IS131	£0.11
BA145	£0.20	*BB105G	£0.40	DK14	£0.24	OAZ201	£0.30	IN3766	£3.95	IS132	£0.25
BA154	£0.11	*BB109	£0.40			OAZ204	£0.30	IN3766R	£4.00	IS134	£0.25
BA155	£0.13	*BB139	£1.25			OAZ206	£0.30	IN3768R	£4.75	IS136	£0.45
BA156	£0.16	BY103	£0.55			OAZ209	£0.30	IN3826	£1.35	IS420	£0.80
BA157	£0.32	BY126	£0.32			OAZ212	£0.30	IN4001	£0.07	IS421	£0.85
BA158	£0.42	BY127	£0.39			OAZ237	£0.30	IN4002	£0.08	IS423	£0.90
BA159	£0.55	BY133	£0.35			OAZ241	£0.30	IN4003	£0.09	IS425	£0.95
BA182	£0.22	BY134	£0.33			OAZ244	£0.20	IN4004	£0.09	IS427	£1.10
BA201	£0.10	BY182	£1.65			OAZ245	£0.20	IN4005	£0.11	IS429	£1.45
BA202	£0.10	BY189	£3.75			OAZ270	£0.20	IN4006	£0.12	IS940	£0.07
BA203	£0.13	BY190	£3.70			TV12	£0.17	IN4007	£0.13	IS941	£0.08
										IS961	£0.16

RECTIFIER DIODE FINDER CHART

AMPS \ P.I.V.	50V	100V	200V	400V	600V	800V	1000V	1200V
1 AMP	IN4001	IN4002	IN4003	IN4004	IN4005	IN4006	IN4007	BY127
3 AMPS	IN5400	IN5401	IN5402	IN5404	IN5406	IN5407	IN5408	—
6 AMPS	—	—	—	—	BYW11-600	BYW11-800	BYW11-1000	—
10 AMPS	—	IS420	IS421	IS423	IS425	IS427	IS429	—
15 AMPS	—	BYW12-100	BYW12-200	BYW12-400	BYX99-600	—	—	BYX99-1200
47 AMPS	—	—	—	—	BYX97-600	—	—	BYX97-1200

* NB. BYW11 & BYW12 ARE FAST RECOVERY RECTIFIERS.

ZENERS

ZENERS-400mW – 12p

BZX83	C2.7
BZX83	C3.0
BZX83	C3.3
BZX83	C3.6
BZX83	C3.9
BZX83	C4.3
BZX83	C4.7
BZX83	C5.1
BZX83	C5.6
BZX83	C6V2
BZX83	C6V8
BZX83	C7V5
BZX83	C8V2
BZX83	C9V1
BZX83	C10
BZX83	C11
BZX83	C12
BZX83	C13
BZX83	C15
BZX83	C16
BZX83	C18
BZX83	C20
BZX83	C22
BZX83	C24
BZX83	C27
BZX83	C30
BZX83	C33
BZX83	C36
BZX83	C39
BZX83	C43
BZX83	C47

ZENERS-1W – 19p

IN4728A	3.3
IN4729A	3.6
IN4730A	3.9
IN4731A	4.3
IN4732A	4.7
IN4733A	5.1
IN4734A	5.6
IN4735A	6.2
IN4736A	6.8
IN4737A	7.3
IN4738A	8.2
IN4739A	9.1
IN4740A	10
IN4741A	11
IN4742A	12
IN4743A	13
IN4744A	15
IN4745A	16
IN4746A	18
IN4747A	20
IN4748A	22
IN4750A	27
IN4751A	30
IN4752A	33
IN4753A	36
IN4754A	39
IN4755A	43
IN4756A	47
IN4757A	51
IN4758A	54
IN4759A	62

ZENERS-1.5W – 30p

BZY97	C3V9
BZY97	C4V7
BZY97	C5V6
BZY97	C6V8
BZY97	C8V2
BZY97	C10V
BZY97	C12V
BZY97	C15V
BZY97	C18V
BZY97	C27V
BZY97	C33V

ZENERS-2.5W – 65p

BZX70	C7V5
BZX70	C8V2
BZX70	C9V1
BZX70	C10
BZX70	C11
BZX70	C12
BZX70	C13
BZX70	C15
BZX70	C16
BZX70	C18
BZX70	C20
BZX70	C22
BZX70	C24
BZX70	C27
BZX70	C30
BZX70	C33
BZX70	C36
BZX70	C39
BZX70	C43
BZX70	C47
BZX70	C51
BZX70	C56
BZX70	C62
BZX70	C68
BZX70	C75

ZENERS-5W – 76p

BZV40	C3V3
BZV40	C3V6
BZV40	C3V9
BZV40	C4V3
BZV40	C4V7
BZV40	C5V1
BZV40	C5V6
BZV40	C6V2
BZV40	C6V8
BZV40	C7V5
BZV40	C8V2
BZV40	C8V7
BZV40	C9V1
BZV40	C10V
BZV40	C11V
BZV40	C12V
BZV40	C15V
BZV40	C33V
BZV40	C68V
BZV40	C120V

ZENERS-20W – 95p

BZY93	C6V8
BZY93	C7V5
BZY93	8V2
BZY93	9V1
BZY93	10
BZY93	11
BZY93	12
BZY93	C13V
BZY93	15
BZY93	16
BZY93	18
BZY93	20
BZY93	22
BZY93	24
BZY93	27
BZY93	30
BZY93	33
BZY93	36
BZY93	39
BZY93	43
BZY93	47
BZY93	51
BZY93	56
BZY93	62
BZY93	68
BZY93	75

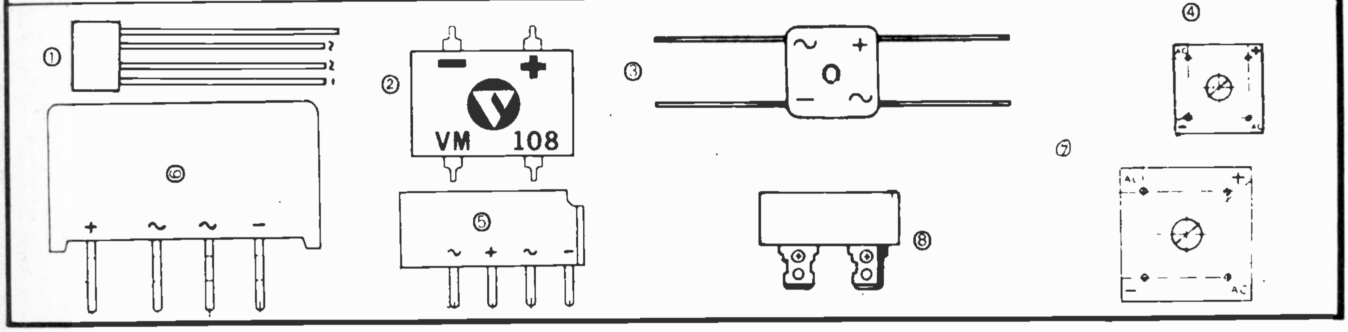
MULLARD SIEMENS AND SESCOSEM

BRIDGE RECTIFIERS

TYPE	RATING		CASE	PRICE
W005/T1005	1A	50v		£0.28
W01	1A	100V	Case 1	£0.30
W02	1A	200v		£0.32
W04	1A	400v		£0.40
W06	1A	600v		£0.50
VM18	1A	100v	New Dual in line 2	£0.44
VM28	1A	200v		£0.48
VM48	1A	400v		£0.50
S005	2A	50v		£0.39
S01	2A	100v		£0.44
BY179				£0.90

TYPE	RATING		CASE	PRICE
S02	2A	200v	Case 4	£0.48
S04	2A	400v		£0.60
S06	2A	600v		£0.70
S08	2A	800v		£0.84
6A600	6A	600v	Leads	£1.35
BY164	1.4A	120v		£0.75
840C1500	1.5A	100v	Case 5 & 6	£0.53
B40C3200	3.2A	100v		£1.20
B80C1500	1.5A	200v		£0.82
880C3200	3.2A	200v		£1.25
PW005	6A	50v		£0.90

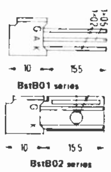
TYPE	RATING		CASE	PRICE
PW01	6A	100v	Case 7	£0.95
PW02	6A	200v		£0.97
PW04	6A	400v		£1.08
PW06	6A	600v		£1.18
PW08	6A	800v		£1.28
K005	25A	50v		£2.20
KO1	25A	100v	Case 8	£2.37
KO2	25A	200v		£2.75
KO4	25A	400v		£3.40
KO6	25A	600v		£3.99



THYRISTORS

TYPE	RATING		CASE	PRICE
*TIC44†	0.6A	30v	TO18	**£0.35**
*TIC46†	0.6A	100v	TO18	**£0.50**
*TIC47†	0.6A	200v	TO18	**£0.73**
*2N5060	0.5A	25v	TO18	**£0.32**
*2N5061	0.5A	50v	TO18	**£0.33**
*2N5062	0.5A	100v	TO18	**£0.40**
*2N5063	0.5A	150v	TO18	**£0.43**
*2N5064	0.5A	200v	TO18	**£0.45**

*BstB0126	1.2A	400v	Plastic	**£0.74**
*BstB0140	1.2A	600v	Plastic	**£1.05**
*BstB0146	1.2A	700v	Plastic	**£1.37**
BstB0206	4.7A	100v	M478	**£0.72**
BstB0213	4.7A	200v	Plastic	**£0.82**
BstB0226	4.7A	400v	Plastic	**£0.92**
BstB0240	4.7A	600v	Plastic	**£1.25**
BstB0246	4.7A	700v	Plastic	**£1.48**
BT106			Stud Mounting	**£1.10**

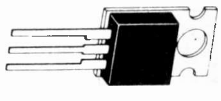


POWER THYRISTORS

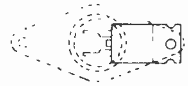
C106A†	4A	100v	Plastic	**£0.38**
C106B†	4A	200v	Plastic	**£0.44**
C106C†	4A	300v	Plastic	**£0.48**
C106D†	4A	400v	Plastic	**£0.54**
C116A	8A	100v	Plastic	**£0.47**
C116B	8A	200v	Plastic	**£0.54**
C116C	8A	300v	Plastic	**£0.61**
C116D	8A	400v	Plastic	**£0.68**
C116M	8A	600v	Plastic	**£0.80**
C126A	12A	100v	Plastic	**£0.63**
C126B	12A	200v	Plastic	**£0.70**
C126C	12A	300v	Plastic	**£0.80**
C126D	12A	400v	Plastic	**£0.90**
C126M	12A	600v	Plastic	**£1.07**

PLASTIC POWER

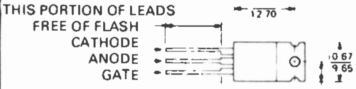
PLASTIC TO66 FROM TEXAS INST. QUALITY AND RELIABILITY



MECHANICAL INTERCHANGEABILITY OF THE PLASTIC PACKAGE WITH TO 66 OUTLINE



LOW COST
HIGH STANDARDS



TRIACS-DIACS QUADRACS

TYPE			
ST2	DIAC		**£0.22**
BR100	DIAC— Mullard		**£0.55**

TRIACS

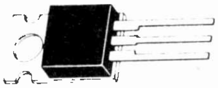
SC35D	3A	400v	Stud Mounting	**£1.55**
TC4/40	4A	400v	Press Fitting	**£1.48**
SC40D	6A	400v	Stud Mounting	**£1.56**
SC45D	10A	400v	Stud Mounting	**£2.09**
BTW37-600	12A	600v	TO64	**£3.63**
BTW37-1	12A	1000v	TO64	**£4.75**
BT123	14A	500v	TO127	**£2.75**
BTX94-200	25A	200v	TO48	**£6.90**
BTX94-400	25A	400v	TO48	**£9.50**
BTX94-600	25A	600v	TO48	**£12.50**
40512			Quadrac	**£1.70**

POWER TRIACS AT UNBEATABLE PRICES

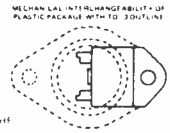
TIC206D	Plastic TO66	400v	4A	**£0.72**
TIC225D	Plastic TO66	400v	6A	**£0.77**
TIC226D	Plastic TO66	400v	8A	**£0.82**
TIC236D	Plastic TO66	400v	12A	**£0.93**
TIC246D	Plastic TO66	400v	16A	**£1.21**
TIC253D	Plastic TO3	400v	20A	**£1.87**
TIC263D	Plastic TO3	400v	25A	**£2.20**

FROM TEXAS INSTRUMENTS

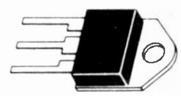
PLASTIC TO66

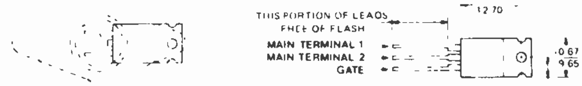


MECHANICAL INTERCHANGEABILITY OF PLASTIC PACKAGE WITH TO 66 OUTLINE



PLASTIC TO3



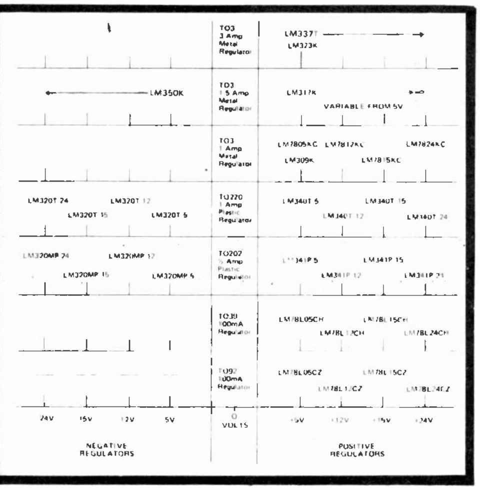


VOLTAGE REGULATORS

TYPE	DESCRIPTION	PRICE
LM309KC	1A 5v Reg Pos TO3	**£1.95**
LM317MP	500mA variable TO202 ..	**£1.35**
LM317T	1.5A variable TO220......	**£2.20**
LM317K	1.5A variable TO3	**£3.35**
LM320T-5	1A 5v—ve TO220	**£2.15**
LM320T-12	1A 12v—ve TO220	**£2.15**
LM320T-15	1A 15v—ve TO220	**£2.15**
LM320T-24	1A 24v—ve TO220	**£2.15**
LM320MP-5	0.5A 5v—ve TO202	**£1.15**
LM320MP-12	0.5A 12v—ve TO202	**£1.15**
LM320MP-15	0.5A 15v—ve TO202	**£1.15**
LM320MP-24	0.5A 24v—ve TO202	**£1.15**
LM323K	3A 5v+ve TO3	**£6.95**
* LM337T	1.5A negative variable	**£2.99**
LM350K	3A version LM317K	**£6.45**
* LM340T-5	1A 5v+ve TO220	**£0.88**
LM340T-12	1A 12v+ve TO220	**£0.88**
LM340T-15	1A 15v+ve TO220	**£0.88**
LM340T-24	1A 24v+ve TO220	**£0.88**
LM341P-5	5A 5v+ve TO202	**£0.80**
LM341P-12	5A 12v+ve TO202	**£0.80**
LM341P-15	5A 15v+ve TO202	**£0.80**
LM341P-24	5A 24v+ve TO202	**£0.80**
LM78L05CH	100mA 5v+ve TO5	**£0.85**
LM78L12CH	100mA 12v+ve TO5	**£0.85**
LM78L15CH	100mA 15v+ve TO5	**£0.85**
LM78L24CH	100mA 24v+ve TO5	**£0.85**
LM7805KC	1A 5v+ve TO3	**£1.75**
LM7812KC	1A 12v+ve TO3	**£1.75**
LM7815KC	1A 15v+ve TO3	**£1.75**
LM7824KC	1A 24v+ve TO3	**£1.75**
LM78L05CZ	100mA 5v+ve TO92	**£0.30**
LM78L12CZ	100mA 12v+ve TO92	**£0.30**
LM78L15CZ	100mA 15v+ve TO92	**£0.30**
LM78L24CZ	100mA 24v+ve TO92	**£0.30**

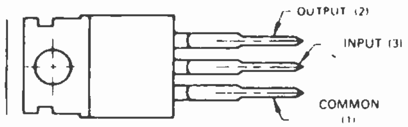
National

VOLTAGE REGULATOR SELECTOR GUIDE



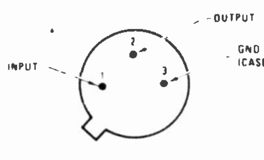
A SELECTED RANGE FROM NATIONAL SEMICONDUCTORS MAKERS OF QUALITY COMPONENTS

In cases of supply difficulty, we reserve the right to supply an equivalent device from another manufacturer at our own discretion.

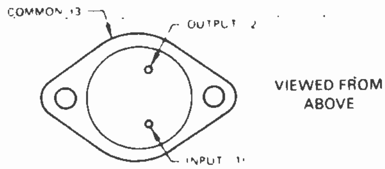


TO220/202 NEGATIVE REGS ONLY

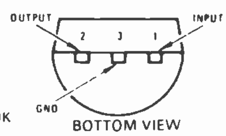
THE SELECTOR GUIDE INDICATES THE RANGE OF REGULATORS NORMALLY KEPT IN STOCK, AND LISTS THEM IN ORDER OF THEIR RATINGS FOR QUICK REFERENCE



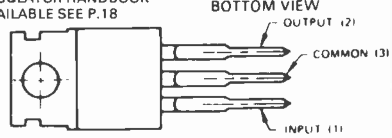
BOTTOM VIEW
TO-5 Metal Can Package (H)



N.B. THESE PIN CONNECTIONS DO NOT APPLY TO THE ADJUSTABLE REGS LM317, 337, 350 REFER TO VOLTAGE REGULATOR HANDBOOK AVAILABLE SEE P.18



BOTTOM VIEW



TO220/202 POSITIVE REGS ONLY

INTEGRATED CIRCUITS

AY-3-8500	B/W TV Games Chip G.I.	£6.50
AY-3-8710	Tank Battle TV Game	£21.95
CA3000	Temp. Comp. Diff. Amp. DC to 30MHZ	£3.30
CA3001	Temp. Comp. Diff. Amp. LOZ out DC to 30MHZ	£4.25
CA3002	Temp. Comp. Diff. Amp.	£3.30
CA3005	RF Amplifier	£2.50
CA3006	RF Amplifier	£4.60
CA3007	Aud. Driver for Class B C/P	£4.15
CA3008	Wide Band Op. Am. Unty. GN. at 50MHZ	£2.55
CA3012	IF Ltg. Amp. 100KHZ to 20MHZ	£1.65
CA3013	IF Ltg. Amp. with Discrim. 100KHZ to 20MHZ	£1.85
CA3014	IF Ltg. Amp. with Discrim. 100KHZ to 20MHZ	£2.20
*CA3018	Transistor Array	£0.75
*CA3018A	Transistor Array	£1.10
*CA3020	Wide Band Pwr. Amp. 8MHZ/0.5W	£2.20
*CA3020A	Wide Band Pwr. Amp. 8MHZ/1.0W	£2.50
*CA3021	Lo. Pwr. Video 4MW/2MHZ 8W	£2.40
*CA3022	Lo. Pwr. Video 12.5MW/7.5MHZ 8W	£2.20
*CA3023	Lo. Pwr. Video 35MW/160MHZ 8W	£2.20
*CA3026	Dual Differential Amplifier	£0.80
CA3028A	Diff./Cascade Amp. DC to 120MHZ	£0.90
CA3028B	Premium Diff./Cascade Amp. DC to 120MHZ	£1.25
CA3029	Wide Band Op. Amp. FT at 60MHZ	£0.75
CA3029A	Precision Wide Band Op. Amp. FT at 60MHZ	£0.90
CA3030	Wide Band Op. Amp. FT at 60MHZ	£1.50
CA3030A	Premium Wide Band Op. Amp. FT at 60MHZ	£2.20
CA3033	High Pwr. O/P Op. Amp. 1.2W	£3.70
CA3034	Phase Detector	£2.75
CA3035	Ultra. Hi. Gain 3 Amp. ARR. 129DB at 40KHZ	£1.95
*CA3036	Dual Darlington Array	£1.21
CA3038	Operational Amplifier	£2.90
CA3038A	Operational Amplifier	£4.10
CA3039	Diode Array	£0.77
CA3040	Wide Band Amp. DC to 200MHZ	£3.75
*CA3041	TV Sound Section/Driver – Tubes	£1.65
*CA3042	TV Sound Section Dvr. Trans.	£1.65
*CA3043	FM Receiver System to 20MHZ	£2.20
CA3045	5 VHF Trans. Arr. DC to 120MHZ	£1.55
*CA3046	5 Transistor Array (npn)	£0.77
CA3047	Medium Pwr. Op. Amp. 0.75W	£2.20
CA3047A	Premium Medium Pwr. Op. Amp. 0.75W	£3.70
*CA3048	Quad-Low Noise Amp. NF 0.6DB	£2.45
CA3049	Dual Differential Amp.	£1.98
CA3050	Dual Differential Amp.	£2.66
CA3051	Dual Differential Amp.	£1.83
*CA3052	Quad-Audio Preamps 300KHZ BW	£1.78
CA3053	Diff./Cascade Amp.	£0.77
CA3054	Dual Differential Amp.	£1.10
CA3059	Zero Voltage Trigger S.C.R., Triac	£2.10
CA3062	Photo Det. and Pwr. Amp. 100MA O/P	£3.75
*CA3064	Aft. System. Gen. Purpose and TV	£1.10
*CA3065	Sound IF Amp. Det. DC Vol. Cont.	£1.10
*CA3068	TV Video IF System	£3.80
*CA3070	TV Chrome Sig. Proc	£1.90
*CA3071	TV Chrome Amp.	£1.90
*CA3072	TV Chrome Demod.	£1.90
*CA3075	FM-IF Amp./Limited Det.	£1.70
*CA3076	Hi-Gain IF Amp./Limiter	£2.12
CA3080	Op. Transconductance Amp.	£0.85
CA3080A	Op. Transductance Amp.	£2.10
*CA3086	Transistor Array (N-P-N)	£0.50
*CA3088F	AM Receiver Sub. Sys. Network	£1.87
*CA3089E	FM-IF System	£2.90
*CA3090Q	FM stereo Multiplex Decoder	£4.40
CA3130	FET Operational Amplifier	£1.06
CA3140	FET Operational Amplifier	£1.04
CD4000	Dual 3-Input NOR gate plus Inverter	£0.22
CD4001B	Quad 2-Input NOR Gate	£0.22
CD4002	Dual 4-Input NOR Gate	£0.22
CD4006	10-Stage Static Shift Register	£1.25
CD4007	Dual Complementary Pair Plus Inverter	£0.22
CD4008B	4-Bit full Adder with Parallel Carry	£0.99
CD4009	Hex Buffer/Converter (Inverting)	£0.58
CD4010	Hex Buffer/Converter (Non-Inverting)	£0.58
CD4011B	Quad 2-Input NAND Gate	£0.22
CD4012	Dual 4-Input NAND Gate	£0.22
CD4013B	Dual "D" Flip-Flop with Set/Reset	£0.52
CD4014	8-Stage Static Shift Register	£1.00
CD4015	Dual 4-Stage Static Shift Register	£1.05
CD4016	Quad Bilateral Switch	£0.52
CD4017B	Decade Counter/Divider	£1.05
CD4018B	Presettable Divide-By "N" Counter	£1.05
CD4019B	Quad AND-OR Select Gate	£0.52
CD4020B	14-Stage Binary Ripple Counter	£1.15
CD4021	8-Stage Static Shift Register	£1.05
CD4022B	Divide-by-8 Counter/Divider	£1.00
CD4023B	Triple 3-Input NAND Gate	£0.22
CD4024B	7-Stage Binary Counter	£0.76
CD4025B	Triple 3-Input NOR Gate	£0.22
CD4027B	Dual J-K Master Slave Flip-Flop	£0.55
CD4028B	BCD-TO-Decimal Decoder	£0.92
CD4029B	Presettable Up/Down Counter	£1.10
CD4030	Quad Exclusive-OR Gate	£0.64
CD4031B	64-Stage Static Shift Register	£2.25
CD4035B	4-Stage Parallel IN/OUT Shift Register	£1.30
CD4037	Triple AND/OR Bi-Phase Pairs	£1.20
CD4041B	Quad True/Complement Buffer	£0.86
CD4042B	Quad Clocked "D" Latch	£0.86
CD4043	Quad 3-State NOR R/S Latch	£1.05
CD4044	Quad 3-State NAND R/S Latch	£1.00
CD4045	21-Stage Counter	£1.75
CD4046B	Micropower Phase-Locked Loop	£1.50
CD4047B	Monostable/Astable Multivibrator	£0.95
CD4049	Hex. Buf./Con. (Invtg.)	£0.55
CD4050B	Hex. Buf./Con. Non-Inverting	£0.55
CD4051B	Single 8-Channel Multiplexer	£0.85
CD4052B	Dual 4-Channel Multiplexer	£0.85
CD4053B	Triple 2-Channel Multiplexer	£0.85
CD4054	4-Line LIQ-XTAL Display Driver	£1.45
CD4055	BCD 7 Segment Decoder/Driver	£1.65
CD4056	BCD 7 Segment Decoder/Driver	£1.65
CD4059	Programmable Divide-By-N Counter	£6.00
CD4060B	12-Stage Counter and Oscillator	£1.15
CD4063	4-Bit Magnitude Comparator	£1.35
CD4066B	Quad Bilateral Switch	£0.75
CD4067	1.16 Multiplexer	£4.65
CD4068	8 Input NAND Gate	£0.27
CD4069B	Hex. Inverter	£0.24
CD4070B	Quad Exclusive or Gate 2 Input	£0.65
CD4071B	Quad 2 Input or Gate	£0.24
CD4072	Dual 4 Input or Gate	£0.27
CD4073B	Triple 3 Input NAND Gate	£0.24
CD4075B	Triple 3 Input NOR Gate	£0.24
CD4076B	Quad "D" Type Flip-Flop	£0.99
CD4077	Quad Exclusive NOR Gate	£0.70
CD4078	8 Input NOR Gate	£0.27
CD4081B	Quad 2 Input and Gate	£0.24
CD4082	Dual 4 Input and Gate	£0.27
CD4085	Dual 2 Wide 2 Input AOI Gate	£0.89
CD4086	Expendable 4 Wide 2 Input AOI Gate	£0.89
CD4089B	Binary Rate Multiplier	£2.10
CD4093B	Quad 2 Input NAND Schmitt Trigger	£1.60
CD4094	8 Bit Serial Parallel Holding Bus Register	£2.30
CD4095	Gated J-K Flip-Flop	£1.30
CD4096	Gated J-K Flip-Flop	£1.30
CD4097	Dual 8-1 Multiplexer	£4.65
CD4099B	8 Bit Addressable Latch	£1.60
CD4510B	Presettable Up/Down Counter (BCD)	£1.20
CD4511	Decade Counter/Driver 7 Segment	£1.75
CD4516	Presettable Binary Up/Down Counter	£2.10
CD4518B	Dual BCD Up Counters	£1.20
CD4520B	Dual Binary Up Counters	£1.20
DM8131	Hex. Comparator	£2.70
DM8280	Presettable Decade Counter	£1.65
DM8281	Presettable Binary Counter	£1.65
DM8288	Presettable Divide by Twelve Counter	£1.65
DM8300	4-Bit Parallel-in-Out Shift Register	£1.65
DM8601	Retriggerable Monostable Multivibrator	£1.75
DM9601	Retriggerable Monostable Multivibrator	£1.75
DM9097	Dual J-K Flip-Flop Common Clock (2k)	£0.87
DM9099	Dual J-K Flip-Flop Common Clock (6k)	£0.87
FH101	8-Input NAND Gate without RC	£2.75
FJL151	BCD-Decimal Decoder	£1.65
FJ101	Dual 4-Input Expander	£1.85
FJH111	TTL Dual 4in NAND	£2.75
LOO5T1	5V-Voltage Reg. TO3 SGS	£2.25
LM114H	High Gain Matched Dual Mono Lithic	£2.75
*LM301AH	Improved Operational Amplifier TO99	£0.50
*LM301-8	Improved Operational Amp. 8 Pin D.I.L.	£0.30
LM304	Negative Voltage Regulator	£2.60
LM307N	General Purpose Compensated Op. Amp.	£0.50
*LM308H	Super Gain Op. Amp. TO5 Multi-Lead	£1.20
*LM308N	Super Gain Op. Amp. 8 Pin D.I.L.	£0.95
LM309KC	5 Volt. Regulator 1A TO3 Case	£1.95
LM317K	Also available in other cases. See p.13	£3.35
LM318N	High Slew Rate Op. Amp.	£2.45
LM320T-5	1.00 Amp. Negative 5 Volt. Reg. TO220	£2.15
LM320T-12	1.00 Amp. Negative 12 Volt. Reg. TO220	£2.15
LM320T-15	1.00 Amp. Negative 15 Volt. Reg. TO220	£2.15
LM320T-24	1.00 Amp. Negative 24 Volt. Reg. TO220	£2.15
LM320MP-5	0.5 Amp. Negative 5 Volt. Reg. TO202	£1.15
LM320MP-12	0.5 Amp. Negative 12 Volt. Reg. TO202	£1.15
LM320MP-15	0.5 Amp. Negative 15 Volt. Reg. TO202	£1.15
LM320MP-24	0.5 Amp. Negative 24 Volt. Reg. TO202	£1.15
LM323K	Five Volt. 3 Amp. Regulator	£6.95
LM324	Quad op Amp	£0.75
LM339N	Quad Comparator	£0.60
LM340T-5	Positive 3 Terminal 5 Volt. Reg. 1A TO220	£0.86
LM340T-12	Positive 3 Terminal 12 Volt. Reg 1A TO220	£0.88
LM340T-15	Positive 3 Terminal 15 Volt. Reg. 1A TO220	£0.88
LM340T-24	Positive 3 Terminal 24 Volt. Reg. 1A TO220	£0.88
LM341P-5	Positive 3 Terminal 5 Volt. Reg. 5A TO202	£0.80
LM341P-12	Positive 3 Terminal 12 Volt. Reg. 5A TO202	£0.80
LM341P-15	Positive 3 Terminal 15 Volt. Reg. 5A TO202	£0.80
LM341P-24	Positive 3 Terminal 24 Volt. Reg. 5A TO202	£0.80
LM348N	Quad 741 Operational Amplifier	£0.95
LM358N	Low Power Dual Operational Amplifier	£0.60
LM360N	High Speed Comparator	£3.00
*LM370N	AGC/Squelch Amplifier 14 Pin	£3.30
*LM371H	Integrated RF/IF Amplifier	£2.35
*LM350K	3 Amp. Version LM317. See p.13	£6.45
*LM373N	AM/FM/SSB Strip (14 Pin)	£3.35
*LM374N	AM/FM/SSB IF Video Amp.	£3.35
*LM377N	Dual 2W Power Amp.	£1.80
*LM378N	Dual 4W Audio Amp.	£2.40
*LM379S	Dual 6W Audio Amp.	£4.25
*LM380N-8	0.6 Watt Audio Amplifier 8 Pin D.I.L	£0.96
*LM380N-14	2 Watt Audio Power Amp. 14 Pin D.I.L.	£1.08
*LM381AN	Low Noise Dual Pre-Amp. D.I.L. Package	£2.70
*LM381N	Low Noise Dual Pre-Amp.	£1.69
*LM382N	Low Noise Dual Pre-Amp.	£1.32
*LM384N	5 Watt Audio Amp.	£1.55
*LM386N	Low Voltage Audio Amp	£0.88
*LM387N	Low Noise Dual Pre-Amp.	£1.10
*LM388N	1.5 Watt Audio Amp.	£1.00
*LM389N	Low Volt. Aud. pwr. amp. with NPN tran array	£1.00
*LM555CN	See NE555 atimer	£0.33
*LM565CN	See NE565	£1.39
LM701B	Operational Amplifier TO99	£2.99
*LM701C	Operational Amplifier TC99	£2.99
*LM702C	Wide Band D.C. Amp. Commercial TO99	£0.81
*LM703LN	IF Limiting Amplifier	£1.15
*LM709	Operational Amplifier TO5 Multi Lead	£0.70
*LM709-8	Operational Amplifier 8 Pin D.I.L.	£0.50
*LM709-14	Operational Amplifier 14 Pin D.I.L.	£0.49
LM710	Differential Comparator TO5	£0.67
LM710-14	Differential Comparator 14 Pin D I.L.	£0.64
*LM711CN	Differential Comparator – Dual 14 D.I.L.	£0.72
LM723C	Precision Voltage Reg. TO5	£0.75
LM723C-14	Precision Voltage Reg. 14 Pin D.I.L.	£0.45
*LM726	Temp. Controlled Diff Pair TO99	£5.80
*LM741C	Compensated Op. Amp. TO5	£0.70
*LM741C-8	Compensated Op. Amp. 8 D.I.L.	£0.30
*LM741C-14	Compensated Op. Amp. 14 D.I.L.	£0.30
*LM747CN	14 Pin D.I.L. Dual Comp. Op. Amp	£0.99
*LM748-8	Operational Amp. 8 D.I.L.	£0.50
*LM748-14	Operational Amp 14 D.I.L	£0.50
LM716	National Semiconductor I/C Op Amp.	£1.00
LM900	Buffer	£0.50
LM911	4-Input or NOR Gate	£0.50
LM921	Dual 2-Input Gate Expander	£0.50
LM923	J-K Flip-Flop	£0.50
*LM1303N	Stereo Pre-Amp. (0-70°) MC1303	£1.15
*LM1304N	F.M. Multiplexer Stereo Demodulator	£1.52
*LM1305N	F.M. Multiplexer Stereo Demodulator	£1.52
*LM1307N	F.M. Multiplexer Stereo Demodulator	£1.22
*LM1310N	Stereo Demodulator MC1310	£2.10
*LM1351N	F.M. Detector Limiter and Audio Pre-Amp.	£1.30
*LM1458N	Dual Comp. Op. Amp. (0-70°) 8 Pin D.I.L.	£0.45
*LM1496N	Balanced MOD/Demodulator (0-70°)	£0.97
*LM1800N	PLL Demodulator	£1.94
*LM1808N	Mono Lithic TV Sound System	£2.10
LM1812N	Ultrasonic transceiver	£6.20
*LM1820N	AM Radio	£1.16
*LM1828N	Chroma Demodulator	£1.90
LM1830N	Fluid level dector	£1.90
*LM1841N	F.M. Detector Limiter	£1.90
LM1845N	TV Signal Processor	£1.50
LM1848N	Chroma Demodulator	£1.98
LM1850N	Ground Fault Interrupter	£1.90
LM1889N	TV video modulator	£4.90
LM2907N-8	F to V converter	£1.80
LM2917N-8	F to V converter and zener	£1.80
LM3301N	Quad Amplifier	£0.60
LM3302N	Quad Comparator	£0.55
LM3401N	Quad Amplifier	£0.55
*LM3900N	Quad Amplifier D.I.L. 14 Pin	£0.68
LM3905N	Precision Timer	£1.15
*LM3909N	Led Flisher/Oscillator D.I.L. 8 Pin	£0.78
LM3911N	Temperature Controller	£1.10
LM4250CN	Programmable Op. Amp.	£1.30
LM78L05CH	5 Volt. Regulator TO5 100mA Positive	£0.85
LM78L12CH	12 Volt. Regulator TO5 100mA Positive	£0.85
LM78L15CH	15 Volt. Regulator TO5 100mA Positive	£0.85
LM7824CH	24 Volt. Regulator TO5 100mA Positive	£0.85
LM7805KC	Positive 3 Terminal 5 Volt. Reg. 1A TO3	£1.75
LM7812KC	Positive 3 Terminal 12 Volt. Reg. 1A TO3	£1.75
LM7815KC	Positive 3 Terminal 15 Volt. Reg. 1A TO3	£1.75
LM7824KC	Positive 3 Terminal 24 Volt. Reg. 1A TO3	£1.75
LM78L05CZ	Positive 3 Terminal 5 Volt. Reg. 100mA TO92	£0.30
LM78L12CZ	Positive 3 Terminal 12 Volt. Reg. 100mA TO92	£0.30
LM78L15CZ	Positive 3 Terminal 15 Volt. Reg. 100mA TO92	£0.30
LM78L24CZ	Positive 3 Terminal 24 Volt. Reg. 100mA TO92	£0.30
MC667P	DTL Delay Line – Variable	£2.75
MC671P	Triple 3-Input NAND/NOR Gate – ACTIVE Output	£1.75
MC672P	Quad 2-Input NAND/NOR Gate – ACTIVE Output	£1.75
MC724P	Quad 2-Input NOR Gate	£2.10
MC789P	Hex. Inverter	£1.80
MC790P	Dual J-K Flip-Flop	£3.10
MC798P	Dual 2-Input Buffer	£2.20
MC799P	Dual Buffer	£2.20
MC832P	Dual 4-Input NAND/NOR Buffer	£0.70
MC833P	Dual 4-Input Expander	£0.70
MC836P	Hex. Inverter	£0.82
MC837P	Hex. Inverter with Fast Rise Time	£0.82
MC838P	Synchronous 4 Bit Decade Counter	£1.65
MC840P	Hex. Inverter without Input Diodes	£1.65
MC844P	Dual 4-Input NAND/NOR Power Gate	£0.70
MC846P	Quad 2-Input NAND/NOR Gate	£0.70
MC848P	Flip-Flop with Set and Clear	£1.10
MC849P	Quad 2-Input NAND/NOR – Fast Rise Time	£0.70
MC857P	Quad 2-Input NAND Buffer Gate	£0.85
MC861P	Dual 4-Input NAND/NOR Fast Rise Time	£0.85
MC1035P	Triple Line Receiver	£1.90
*MC1327P	Dual Chroma Demodulator	£1.70
MC1330P	3rd IF and Video Detector	£1.10
*MC1352P	TV Vid. IF Amp.	£1.20
*MC1433G	Operational Amp. Non-Comp.	£3.65
*MC1435G	Operational Amp. Non-Comp.	£2.20
*MC1439G	Power Booster/Drivers	£1.75
MC1440G	Operational Amplifier	£1.20
*MC1456G	Op. Amp. Internally Compensated	£2.75
MC1463R	Neg. Voltage Reg. ½A to -40V	£3.80
MC1468L	Dual 115V. Tracking Reg.	£3.85
MC1469R	Positive Voltage Reg. ½A 2 5V. 37V	£3.10
MC1488L	Quad Line Driver	£4.25
*MC1495L	Linear Four-Quadrant Multiplier Chip	£5.50
*MC1529G	Diff. Video Amplifier	£7.10
MC4024P	Dual Voltage Controlled Multivibrator	£2.20
MC14000AE	See CD4000 Series CMOS	
MM5314	Digital Clock IC or 24 Hr. or 6 Digits	£4.60
MM5316	Digital Clock IC as above and Alarm (40 Pin)	£4.60
MM5330N	4½ Digit Digital Voltmeter Chip	£4.20
NE555	Precision Timer	£0.33
NE556	Dual Precision Timer	£0.65
NE558N	Quad Timer	£1.98
NE560	Phase Locked Loop	£4.50
NE561	Phase Locked Loop	£4.50
NE562	Phase Locked Loop	£4.50
NE565	Phase Locked Loop	£1.39
NE566	Voltage Controlled Oscillator	£1.75
NE567	Tone Decoder Phase Locked Loop	£1.90
NE571N	Compandor	£4.95
SAS560	Switching Amp. for 4 Ch Touch Switch	£2.70
SASS570	Switching Amp. dor 4 Ch Touch Switch	£2.70
*SAS580	Touch tuner amplifier	£2.40
SAS590	Touch tuner amplifier	£2.40
SN7400N	Quad 2 Input NAND	£0.17
SN7401N	Quad 2 Input NAND O/C	£0.17
SN7402N	Quad 2 Input NOR	£0.17
SN7403N	Quad 2 Input NAND O/C	£0.17
SN7404N	Hex Inverter	£0.17
SN7405N	Hex. Inverter O/C	£0.22
SN7406N	Hex. Inverter/Buffer 30V. O/P	£0.55
SN7407N	Hex. Buffer 30V. O/P	£0.55
SN7408N	Quad 2 Input and Gate	£0.22
SN7409N	Quad 2 Input and Gate	£0.22
SN7410N	Triple 3 Input NAND	£0.20
SN7411N	Triple 3 Input and Gate	£0.26
SN7412N	Triple 3 Input NAND O/Circuit	£0.20
SN7413N	Dual 4 Input NAND Schmitt	£0.36
SN7414N	Hex. Schmitt Trigger	£0.60
SN7416N	Hex. Inverter/Buffer 15V O/C	£0.36
SN7417N	Hex. Buffer 15V O/C	£0.36
SN7420N	Dual 4 Input NAND	£0.22
SN7423N	Expandable Dual 4 Input NOR Gate	£0.32
SN7425N	Dual 4 Input NOR-Strobe	£0.32
SN7427N	Triple 3 Input NOR	£0.32
SN7430N	8 Input NAND	£0.22
SN7432N	Quad 2 Input OR	£0.30
SN7437N	Quad 2 Input NAND Buffer	£0.38
SN7438N	Quad 2 Input NAND Buffer O/C	£0.32
SN7440N	Dual 4 Input NAND Buffer	£0.20
SN7441AN	BCD to Decimal Decoder/Driver	£0.84
SN7442N	BCD-Decimal Decoder	£0.78
SN7445N	BCD-Decimal Decoder 30V O/C	£1.40
SN7446AN	BCD-Seven Segment Decoder 30V	£0.90
SN7447AN	BCD-Seven Segment Decoder 15V.	£0.80
SN7448N	BCD to 7 Segment Decoder/Driver	£0.80
SN7450N	Dual-2-Wide-2-Input A/O/Inv	£0.22
SN7451N	Dual-2-Wide-2-Input A/O/Inv	£0.22
SN7453N	4-wide A/O/1	£0.22
SN7454N	4-wide A/O/1	£0.22
SN7460N	Dual 4-Input Expander	£0.22
SN7470N	J-K Flip-Flop Edge Trig and Gate	£0.45
SN7472N	J-K Flip-Flop and Gated M.S FF PS/CL	£0.30
SN7473N	Dual J-K Flip-Flop	£0.44
SN7474N	Dual D-Type Flip-Flop	£0.32
SN7475N	Quad Latch	£0.60
SN7476N	Dual J-K Flip-Flop	£0.45
SN7480N	Gated Full Adder	£0.60
SN7481N	16 Bit Memory	£1.00
SN7482N	2 Bit Binary Full Adder	£0.80
SN7483N	4 Bit Binary Full Adder	£1.05
SN7484N	Gated Input 16 Bit Memory	£1.20
SN7485N	4 Bit Comparator	£1.35
SN7486N	Quad Exclusive OR	£0.36
SN7489	64 Bit Ram	£2.45
SN7490AN	Decade Counter	£0.45
SN7491AN	8 Bit Shift Register SISO	£0.85
SN7492N	Divide-By-12 Counter	£0.45
SN7493N	4 Bit Binary Counter	£0.45
SN7494N	4 Bit Shift Register PISO	£0.90
SN7495N	4 Bit Shift Register PIPO	£0.76
SN7496N	5 Bit Shift Register PIPO	£0.70
SN7497N	6 Bit Binary Counter	£1.95
SN74100N	Dual Quad Latch	£1.40
SN74107N	Dual J-K Flip-Flop	£0.35
SN74118N	Hex. S-R Latch	£0.95
SN74119N	Hex. S-R Latch	£1.40
SN74148	8/3 Priority Encoder	£1.35
SN74121N	Monostable Multivibrator	£0.28
SN74122N	Monostable Multivibrator	£0.55
SN74123N	Dual Monostable Multivibrator	£0.55
SN74125N	Tristate Quad Buffer	£0.45
SN74141N	BCD-Decimal Decoder/Driver	£0.65
SN74145N	BCD to Decimal Dec./Driver	£0.85
SN74150N	16 Bit Data Selector	£1.20
SN74151N	8-Bit Data Selector	£0.78

INTEGRATED CIRCUITS

SN74153N	Dual 4-to-1-Line Selector	£0.76
SN74154N	4-16 Line Decoder	£1.20
SN74155N	Dual 2 and 4 Demultiplexer	£0.70
SN74157N	Quad 2 Input Data Selector	£0.78
SN74160AN	Synchronous Decade Counter	£1.10
SN74161AN	Synchronous Binary Counter	£1.10
SN74162AN	Synchronous Decade Counter	£1.10
SN74163AN	Synchronous Binary Counter	£1.10
SN74164N	8 Bit Shift Register SIPD	£1.35
SN74165N	8 Bit Shift Register PISO	£1.35
SN74167N	Synchronous Decade Decimal Rate Multiplier	£2.50
SN74174N	Hex D-Type Flip-Flop Quad	£1.00
SN74175N	Quad D-Type Flip-Flop Hex	£1.00
SN74176N	Decode Counter	£0.90
SN74177N	Binary Counter	£0.90
SN74180N	8 Bit Parity Generator	£1.00
SN74181N	4 Bit Arithmetic Logic Unit	£2.00
SN74182N	Carry Look Ahead	£0.80
SN74184N	BCD to Binary Converter	£1.50
SN74185AN	BCD to Binary Converter	£1.50
SN74188AN	256 Bit Field Prog Rom	£3.25
SN74189N	TR1 State 64 Bit Ram (DM8599)	£2.60
SN74190N	Synch. Decade Up/Down Counter	£1.40
SN74191N	Synchronous Binary Up/Down Counter	£1.20
SN74192N	Reversible Decade Counter	£1.20
SN74193N	Reversible Binary Counter	£1.20
SN74196N	Decade Counter	£1.20
SN74197N	Binary Counter	£1.00
SN74198N	Parallel In and Out 8 Bit Shift Reg.	£2.00
SN74199N	Parallel In and Out 8 Bit Shift Reg	£2.00
SAJ110	Frequency divider for electronic organs	£2.10
S041P	FM if amplifier & demodulator	£1.35
S042P	Mixer to 200MHz	£1.35
SN74H00N	High Speed TTL	£0.55
SN74H01N	High Speed TTL	£0.55
SN740H04N	High Speed TTL	£0.60
SN74H05N	High Speed TTL	£0.60
SN74H10N	High Speed TTL	£0.55
SN74H11N	High Speed TTL	£0.65
SN74H20N	High Speed TTL	£0.55
SN74H21N	High Speed TTL	£0.65
SN74H30N	High Speed TTL	£0.55
SN75H40N	High Speed TTL	£0.55
SN74H51N	High Speed TTL	£0.55
SN74H53N	High Speed TTL	£0.55
SN74H54N	High Speed TTL	£0.55
SN74H55N	High Speed TTL	£0.65
SN74H60N	High Speed TTL	£0.55
SN74H62N	High Speed TTL	£0.55
SN74S00	Schottky TTL	£0.77
SN74S03	Schottky TTL	£0.77
SN74S04	Schottky TTL	£0.94
SN74S10	Schottky TTL	£0.77
SN74S20	Schottky TTL	£0.77
SN74S40	Schottky TTL	£0.77
SN74S64	Schottky TTL	£0.77
SN74S65	Schottky TTL	£0.77
SN74S112	Schottky TTL	£1.70
SN74S114	Schottky TTL	£1.70
SN74S140	Schottky TTL	£1.30
SN74S262	Schottky TTL	£12.50
SN74L00	Low Power TTL	£0.55
SN74L02	Low Power TTL	£0.55
SN74L04	Low Power TTL	£0.60
SN74L47	Low Power TTL	£4.00
SN74L74	Low Power TTL	£0.90
SN74L85	Low Power TTL	£3.50
SN74L93	Low Power TTL	£2.75
SN75451BP	Dual Peripheral Drivers	£0.70
SN75452BP	Dual Peripheral Drivers	£0.70

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*SN76001N	1 Watt Power Amplifier	£1.30
*SN76003N	Audio Amp & HT Sink 4W 35V, 15R	£2.38
*SN76008KE	10 Watt Audio Amp 5 Pin	£1.60
*SN76013N	Audio Amp and HT Sink 4W, 24V 8R	£1.50
*SN76012ND	As above, no HT Sink	£1.30
*SN76013ND	10 Watt Audio Amp, 5 Pin	£1.60
*SN76023N	Audio Amp, and HT Sink 4W, 24V, 8R	£1.50
*SN76023ND	As above, without HT Sink	£1.30
*SN76033N	Audio Amp and HT Sink	£2.35
*SN76110N	Stereo Demodulator	£1.30
*SN76115N	Stereo Demodulator	£1.65
*SN76116M	Stereo Decoder (Radiogram)	£1.80
*SN76131N	Dual Preamplifier	£1.30
*SN76226N	Colour (Pal) Decoder	£1.68
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*SN76532N	Line Frame Processor (Spares Only)	£1.55
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*SN76544N	Line Frame Processor	£1.60
*SN76545N	Line Frame Processor	£1.80
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*SN76550-2	Tuner Control Voltage Stabiliser	£0.38
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*SN76570N	Video IF	£1.80
*SN76620AN	Sound IF	£0.99
*SN76650N	Video IF	£1.20
*SN76660N	Sound IF	£0.66
*SN76666N	Sound IF	£0.99
*SL610C	RF Amplifier	£2.75
*SL611C	RF Amplifier	£2.75
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*SL620C	Vogad	£3.85
*SL621C	AGC Generator	£3.75
*SL623C	AM Det. & AGC Amp. + SSB Demod	£6.25
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*TAA621	4 Watt 24V Audio Amplifier	£2.50
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*TAD100	Pre-amp. Stages of AM Receiver	£2.00
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*TBA500	Colour Processing-TV Luminence Combination	£2.24
*TBA500Q	Quad-in-Line Version of above	£2.34
*TBA510	Colour Processing – Chrominance Comb	£2.35
*TBA510Q	Quad-in-Line Version of above	£2.48
*TBA520	Colour Demodulation Circuit	£2.60
*TBA520Q	Q11 Version of above	£2.70
*TBA530	R G B. Matrix Preamplifier	£2.35
*TBA530Q	Q I L. Version of above	£2.45
*TBA540	Reference Oscillator Circuit	£2.60
*TBA540Q	Q I.L. Version of above	£2.70
*TBA550	Signal Processing – TV Receivers	£3.60
*TBA550Q	Q I.L Version of above	£3.80
*TBA560CQ	Luminance & Chrome Control	£3.00
*TBA570	AM/FM Radio Receiver Circuit 6V	£2.10
*TBA570Q	Q.I L. Version of above	£2.20
*TBA641B	Audio Power Amp 4.5W (1kV-4R)	£3.00
*TBA651	Tuner and IF Amplifier	£2.50
*TBA700Q	AM/FM Radio Receiver 1W Output	£2.20
*TBA720AQ	Line Oscillator combination for TV	£2.06
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*TBA750Q	Q.I.L Version of above	£2.45
*TBA800	5 Watt Audio Amp 24V 16R	£1.30
*TBA810S	7 Watt Audio Amp. 16V 4R	£1.30
*TBA820	2 Watt Audio Amp 12V 8R	£0.80
*TBA920	Line Oscillator Combination (Mullard)	£2.99
*TBA920Q	Line Oscillator Combination (Mullard)	£3.09
*TBA990Q	I.C. Colour Demodulator for TV	£2.75
*TCA160C	Audio Amp 2 watt battery op 5 16V and Ht Sink	£2.66
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*TCA270	Synchronous Demodulator & Processing	£2.99
*TCA280A	Trigger I C for Thyristors & Triacs	£2.42
*TCA290A	Stereo Decoder for F.M. 15V Supply	£2.84
*TCA420A	10 7MHZ Limiter I.F Amp for F M. Recept	£2.60
*TCA730	D.C. Stereo Audio Vol & Balance Circuit	£4.50
*TCA740	D C. Stereo Audio tone Control Circuit	£4.50
*TCA750	Multi-Stabilizer for Elec. Tuning	£3.00
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*TCA800	I C Colour Demod. with Feed Back Clamps for TV	£3.75
TCA105	Threshold switch	£1.49
TCA440	AM receiver circuit	£1.65
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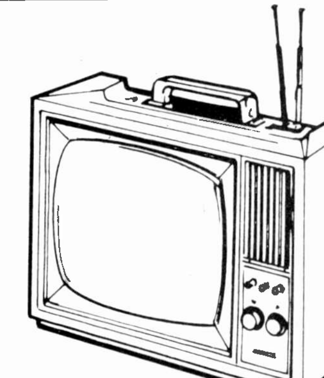

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Mos Memories

INTEL	TEXAS ORDER CODE	£ 1-99	£ 100+
	TMS4027NL	6.10	3.81
2101-1	TMS4033NL	2.04	1.27
2102-2	TMS4034NL	1.94	1.22
2102	TMS4035NL	1.88	1.17
—	TMS4036	3.11	1.94
2101	TMS4039NL	3.37	2.11
2101-2	TMS4039-1NL	3.63	2.27
2101-1	TMS4039-2NL	4.20	2.62
2111	TMS4042NL	3.37	2.11
2111-2	TMS4042-1NL	3.63	2.27
2111-1	TMS4042-2NL	4.20	2.62
2112	TMS4043NL	3.37	2.11
2112-2	TMS4043-1NL	3.63	2.27
2112-1	TMS4043-2NL	4.20	2.62
—	TMS4044NL-45	15.88	9.92
2114	TMS4045NL-45	15.88	9.92
2107A/B	TMS4060NL	7.69	4.81
2107A/B	TMS4060-1NL	8.47	5.29
2107A/B	TMS4060-2NL	9.31	5.82
5270* NS	TMS4050NL	7.43	4.30
5270* NS	TMS4050-1NL	7.58	4.74
5270* NS	TMS4050-2NL	8.35	5.22
2116*	TMS4116JL	36.55	22.84

Bipolar Memories

NSC (DM)	INTEL (—) OR HARRIS	ORDER CODE T.I.	£ 1-99	£ 100+
8577	7602	SN74S188N	2.70	1.67
8578	7603	SN74S288N	2.70	1.67
—	NPROM 512	SN74186N	10.71	6.70
8574	3621	SN74S287N	4.32	2.70
8573	3601	SN74S387N	4.32	2.70
74S470	—	SN74S470N	8.53	5.33
74S471	—	SN74S471N	8.53	5.33
74S472	—	SN74S472N	13.48	8.42
74S473	—	SN74S473N	13.48	8.42
87S296	3624	SN74S474N	13.48	8.42
87S295	3604	SN74S475N	13.48	8.42
FSC (—)				
93403	3101A	SN74S189N	1.81	1.13
93404	—	SN74S289N	1.81	1.13
93411	3106	SN74S201N	3.71	2.32
93410	3107	SN74S301N	3.71	2.32
93411	3106A	SN74S200AN	5.06	3.16
93410A	3107A	SN74S300N	5.06	3.16
—	*27LS01	SN74LS200AN	5.89	3.48
—	*27LS00	SN74LS300N	5.89	3.48

Static Random-Access Memories

DEVICE	ORGANIZATION	MAX. ACCESS/ MIN. CYCLE	TYPICAL POWER DISS.	PACKAGE TYPE	PINS
TMS 2101 /4039	256 × 4	1000 ns	175 mW	CDIP/Plas	22
TMS 2101-2/4039-1	256 × 4	650 ns	175 mW	CDIP/Plas	22
TMS 2101-1/4039-2	256 × 4	450 ns	175 mW	CDIP/Plas	22
TMS 2102-1/4033	1024 × 1	450 ns	225 mW	CDIP/Plas	16
TMS 2102-2/4034	1024 × 1	650 ns	225 mW	CDIP/Plas	16
TMS 2102 /4035	1024 × 1	1000 ns	225 mW	CDIP/Plas	16
TMS 2111 /4042	256 × 4	1000 ns	175 mW	CDIP/Plas	18
TMS 2111-2/4042-1	256 × 4	650 ns	175 mW	CDIP/Plas	18
TMS 2111-1/4042-2	256 × 4	450 ns	175 mW	CDIP/Plas	18
TMS 2112 /4043	256 × 4	1000 ns	175 mW	CDIP/Plas	16
TMS 2112-2/4043-1	256 × 4	650 ns	175 mW	CDIP/Plas	16
TMS 4043-2	256 × 4	450 ns	175 mW	CDIP/Plas	16
TMS 4036	64 × 8	1000 ns	250 mW	Plas	20
TMS 4036-1	64 × 8	650 ns	250 mW	Plas	20
TMS 4036-2	64 × 8	450 ns	250 mW	Plas	20
TMS 4044	4096 × 1	200 ns	450 mW	CDIP/Plas	18
TMS 4045	1024 × 4	200 ns	450 mW	CDIP/Plas	18

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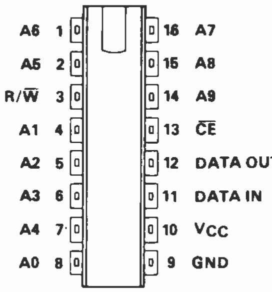
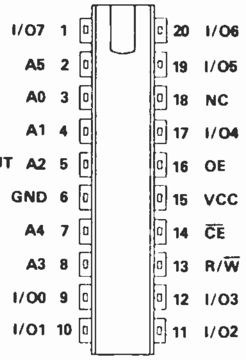


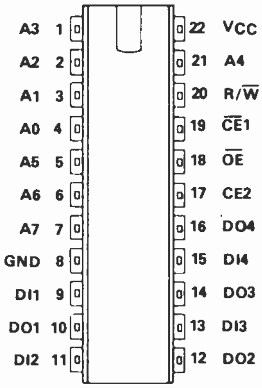
TMS 4033/34/35

20-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



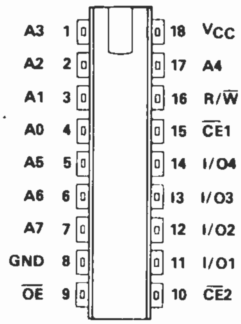
TMS 4036

22-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4039

18-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4042

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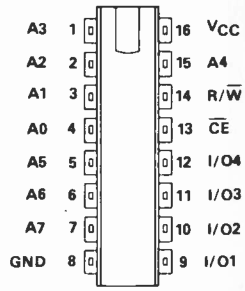

TMS 4043

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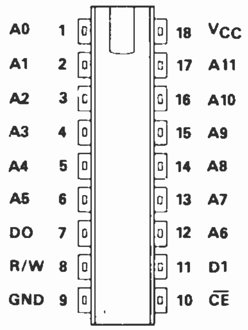
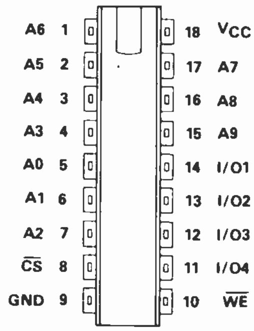


TMS 4044

18-PIN CERAMIC AND PLASTIC DUAL-IN-LINE PACKAGES (TOP VIEW)



TMS 4045/2114

TI Static RAM's feature:

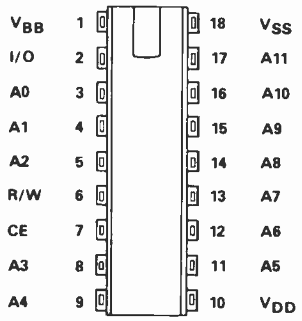
- Reliability, same process as TI's industry standard 4K RAM's
- Economy, high volume production techniques and choice of plastic or ceramic packaging
- Extremely low standby power (typically 2-3 mW) due to TI's enhancement mode design
- Complete range of speeds for design optimization
- Easy to use 8-bit byte organization (64 × 8) along with industry-standard 256 × 4 and 1024 × 1 organizations

All TI Static RAM's are easy to use:

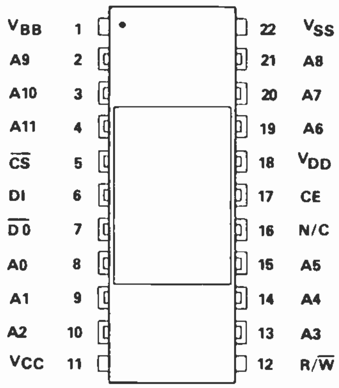
- No clocks — no refresh
- I/O fully TTL compatible
- 3-state output for OR-tie capability
- Single + 5V supply
- Simple, fully decoded addressing

Dynamic Random-Access Memories

DEVICE	ORGANIZATION	NO. CLOCKS	MAX ACCESS (ns)	MIN CYCLE (ns)	NOMINAL SUPPLY VOLTAGES				TYP. POWER DISS (mW)		PACKAGE	
					V_{CC}	V_{DD}	V_{SS}	V_{BB}	STANDBY	ACTIVE	TYPE	PINS
TMS 4050 JR, JL, NL	4096 x 1	1	300	470	N/A	12	0	−5	0.1	420	CDIP/Plas	18
TMS 4050-1 JR, JL, NL	4096 x 1	1	250	430	N/A	12	0	−5	0.1	420	CDIP/Plas	18
TMS 4050-2 JR, JL, NL	4096 x 1	1	200	400	N/A	12	0	−5	0.1	420	CDIP/Plas	18
TMS 4051 JL, NL	4096 x 1	1	300	470	N/A	12	0	−5	60	460	CDIP/Plas	18
TMS 4051-1 JL, NL	4096 x 1	1	250	430	N/A	12	0	−5	60	460	CDIP/Plas	18
TMS 4060 JR, JL, NL	4096 x 1	1	300	470	5	12	0	−5	0.2	400	CDIP/Plas	22
TMS 4060-1 JR, JL, NL	4096 x 1	1	250	430	5	12	0	−5	0.2	400	CDIP/Plas	22
TMS 4060-2 JR, JL, NL	4096 x 1	1	200	400	5	12	0	−5	0.2	400	CDIP/Plas	22
SMC 4050 JR	4099 x 1	1	(same as TMS 4050s)		N/A	12	0	−5	0.1	420	CDIP	18
SMC 4060 JR	4096 x 1	1	(same as TMS 4060s)		5	12	0	−5	0.2	400	CDIP	22
TMS 4116 JL	16384 x 1	2	350	500	5	12	0	−5	10	600	CDIP	16
TMS 4027 NL	4096 x 1	1	250	430	N/A	12	0	−5	0.1	420	CDIP	16

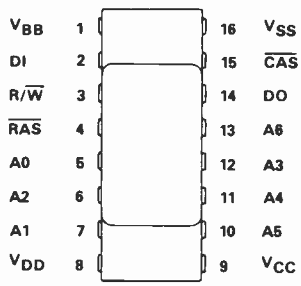


TMS 4050/51



TMS 4060/30

16-PIN CERAMIC DUAL-IN-LINE PACKAGE (TOP VIEW)



TMS 4070

T.I. DYNAMIC RAM FEATURES

- **Low cost per bit storage**
- **Low power on stand by combined with high performance**
- **Fully TTL compatible I/Os**
- **Standard N channel Silicon gate process**

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MM1702AQ.....	256x8	EPROM	**£8.10**
MM5204Q	512x8	EPROM	**£11.00**
MM2708Q	1024x8	EPROM	**£13.00**
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- All Inputs and Outputs Fully TTL-Compatible
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- N-Channel Silicon-Gate Technology
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- MM2708 Features
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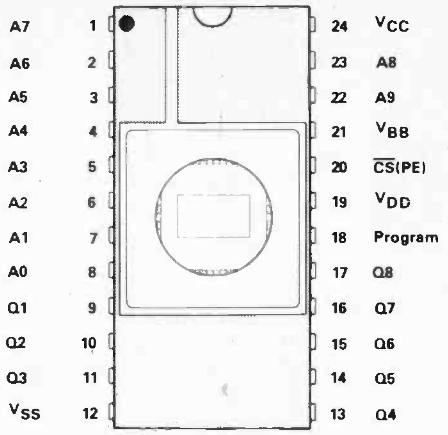
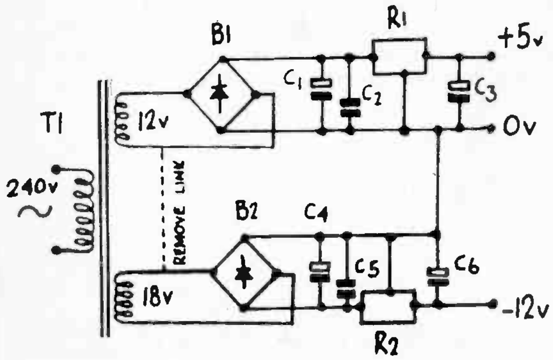
  - — 2 standard TTL loads drive capability

24-PIN CERAMIC DUAL-IN-LINE PACKAGE (TOP VIEW)



SC/MP POWER SUPPLY

POWER SUPPLY FOR SC/MP INTROKIT



Note: Disconnect common secondary winding

Parts list:	
T1 MT 79AT	C1 1000µF 25v B41010
R1 LM309K	C2 0.22µF B37449
R2 LM 320-12	C3 2.2µF TANT B45134
B1, B2 W005	C4 220µF 40v B41283
	C5 0.22µF B37449
	C6 2.2µF TANT B45134

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DM74LS02N	0.26	0.16
DM74LS03N	0.26	0.16
DM74LS04N	0.29	0.18
DM74LS05N	0.29	0.18
DM74LS08N	0.26	0.16
DM74LS09N	0.26	0.16
DM74LS10N	0.26	0.16
DM74LS11N	0.27	0.16
DM74LS12N	0.26	0.16
DM74LS13N	0.58	0.39
DM74LS14N	1.43	1.05
DM74LS15N	0.26	0.16
DM74LS20N	0.26	0.16
DM74LS21N	0.27	0.16
DM74LS22N	0.26	0.16
DM74LS26N	0.39	0.21
DM74LS27N	0.50	0.38
DM74LS28N	0.42	0.32
DM74LS30N	0.26	0.16
DM74LS32N	0.27	0.23
DM74LS33N	0.35	0.27
DM74LS37N	0.32	0.23
DM74LS38N	0.32	0.23
DM74LS40N	0.29	0.16
DM74LS42N	1.07	0.43
DM74LS47N	1.09	0.80
DM74LS48N	1.09	0.80
DM74LS49N	1.09	0.80
DM74LS51N	0.26	0.16
DM74LS54N	0.26	0.16
DM74LS55N	0.26	0.16
DM74LS73N	0.42	0.25
DM74LS74N	0.42	0.28
DM74LS75N	0.58	0.38
DM74LS76N	0.42	0.25
DM74LS78N	0.42	0.25
DM74LS83AN	1.20	0.64
DM74LS85N	1.10	0.73
DM74LS86N	0.44	0.28
DM74LS90N	1.10	0.80
DM74LS91N	1.20	0.86
DM74LS92N	0.86	0.63
DM74LS93N	1.10	0.80
DM74LS95AN	1.10	0.80
DM74LS96N	1.35	1.00
DM74LS107N	0.42	0.29
DM74LS109N	0.42	0.29
DM74LS112N	0.42	0.39
DM74LS113N	0.42	0.29
DM74LS114N	0.42	0.29
DM74LS122N	0.80	0.62
DM74LS123N	0.83	0.65
DM74LS124N	2.70	2.15
DM74LS125N	0.50	0.36
DM74LS126N	0.50	0.36
DM74LS132N	0.85	0.56
DM74LS136N	0.44	0.33
DM74LS138N	0.65	0.43

TYPE	1 + £	100 + £
DM74LS139N	0.65	0.43
DM74LS145N	1.30	0.99
DM74LS151N	1.07	1.00
DM74LS153N	0.58	0.39
DM74LS154N	1.45	0.98
DM74LS155N	1.20	0.71
DM74LS156N	1.20	0.71
DM74LS157N	0.60	0.39
DM74LS158N	0.65	0.43
DM74LS160N	1.43	1.02
DM74LS161N	0.85	0.56
DM74LS162N	1.43	1.02
DM74LS163N	0.85	0.56
DM74LS164N	1.43	0.98
DM74LS168N	2.43	1.68
DM74LS169N	2.43	1.68
DM74LS170N	2.20	1.47
DM74LS173N	1.30	0.87
DM74LS174N	1.33	0.98
DM74LS175N	1.26	0.91
DM74LS181N	3.95	3.00
DM74LS189N	3.74	2.34
DM74LS190N	1.00	0.66
DM74LS191N	1.00	0.66
DM74LS192N	1.98	1.54
DM74LS193N	1.98	1.54
DM74LS196N	1.28	1.00
DM74LS197N	1.28	1.00
DM74LS221N	1.20	0.92
DM74LS247N	1.09	0.80
DM74LS248N	1.09	0.80
DM74LS249N	1.09	0.80
DM74LS251N	1.00	0.75
DM74LS253N	1.20	0.87
DM74LS257N	1.26	0.91
DM74LS258N	1.26	0.91
DM74LS261N	3.25	2.45
DM74LS266N	0.44	0.32
DM74LS279N	0.58	0.41
DM74LS283N	1.20	0.82
DM74LS289N	3.74	2.34
DM74LS290N	1.00	0.75
DM74LS293N	1.00	0.75
DM74LS295N	1.35	1.02
DM74LS298N	1.75	1.40
DM74LS352N	1.07	0.80
DM74LS353N	1.20	0.87
DM74LS365N	0.55	0.41
DM74LS366N	0.55	0.41
DM74LS367N	0.55	0.41
DM74LS368N	0.55	0.41
DM74LS386N	0.44	0.31
DM74LS670N	2.45	1.66
DM81LS95N	1.36	0.94
DM81LS96N	1.36	0.94
DM81LS97N	1.36	0.94
DM81LS98N	1.36	0.94
DM86LS52N	2.60	1.90

THE ADVANTAGES OF LS OVERALL

With the new reduced cost, low power Schottky is becoming the leading logic family – eliminates the need for large power supplies + no loss of speed over standard TTL.

Family Type	Delay Per Gate	Average Power Per Gate
74LS series	10 nano seconds	2 milliwatts
74 series	10 nano seconds	10 milliwatts
74S series	3 nano seconds	20 milliwatts
74H series	6 nano seconds	23 milliwatts
74L series	33 nano seconds	1 milliwatt

74C SERIES CMOS

TYPE	1 + £	100 + £
MM74C00N	0.24	0.175
MM74C02N	0.24	0.175
MM74C04N	0.24	0.175
MM74C08N	0.24	0.175
MM74C10N	0.24	0.175
MM74C14N	1.41	1.00
MM74C20N	0.24	0.175
MM74C30N	0.24	0.175
MM74C32N	0.24	0.175
MM74C42N	0.92	0.70
MM74C48N	1.38	1.00
MM74C73N	0.54	0.50
MM74C74N	0.56	0.43
MM74C76N	0.54	0.50
MM74C83N	1.30	0.96
MM74C85N	1.30	0.96
MM74C86N	0.64	0.49
MM74C89N	4.39	3.35
MM74C90N	0.85	0.61
MM74C93N	0.85	0.61
MM74C95N	1.04	0.78
MM74C107N	1.22	0.88
MM74C150N	4.14	2.98
MM74C151N	2.47	1.80
MM74C154N	3.68	2.67
MM74C157N	2.21	1.60
MM74C160N	1.11	0.82
MM74C161N	1.11	0.82
MM74C162N	1.11	0.82
MM74C163N	1.11	0.82
MM74C164N	1.04	0.78
MM74C165N	1.04	0.78
MM74C173N	0.90	0.82
MM74C174N	0.90	0.82
MM74C175N	0.90	0.82
MM74C192N	1.11	0.82
MM74C193N	1.11	0.82
MM74C195N	1.04	0.78
MM74C200N	6.70	4.99
MM74C221N	1.36	1.05
MM74C901N	0.54	0.50
MM74C902N	0.54	0.50
MM74C903N	0.54	0.50
MM74C904N	0.54	0.50
MM74C905N	7.28	5.25
MM74C906N	0.54	0.50
MM74C907N	0.54	0.50
MM74C908N	0.96	0.71
MM74C909N	1.63	1.18
MM74C910N	6.79	4.88
MM74C914N	1.41	1.01
MM74C915N	1.11	0.82
MM74C918N	2.72	1.85
MM74C920D	11.83	8.65
MM74C921D	11.83	8.65
MM74C922N	3.90	2.70
MM74C923N	3.74	2.83
MM74C925N	5.36	3.87
MM74C926N	5.36	3.87
MM74C927N	5.36	3.87
MM74C928N	5.36	3.87
MM74C929D	11.83	8.65
MM74C930D	11.83	8.65
MM74C935N	12.60	9.85
MM74C935N-1	10.20	7.00
MM80C95N	0.54	0.50
MM80C96N	0.61	0.55
MM80C97N	0.54	0.50
MM80C98N	0.61	0.55
MM82C19N	4.14	2.85
MM88C29N	1.93	1.40
MM88C30N	1.93	1.40

TV-CRT CONTROLLER — SF.F 96364 £17.20

GENERAL DESCRIPTION

A 1024 six bit word size (at least) static or dynamic memory and a character generator (7 x 5) used with the SF.F 96364 allows to change any TV set into a visual display for computing system.

This processor preforms text refreshment, characters writing and cursor management on TV screen.

Line erasing, line end erasing and other special functions capabilities make it strictly compatible with any computing system (computer or microprocessor).

An internal top generator, CCIR compatible, ensures control of any TV set.

The SF.F 96364 is manufactured in MOS N channel silicon gate technology.

PRINCIPAL FEATURES

- Single power supply +5 V
- TTL-LS compatible
- 250 mW typical power
- 1,6 MHz typical clock freq.
- Dual in line 28 pins pack
- 16 lines 64 characters disp.
- Text shifts up when index reaches the end of a page
- Pages linking capability
- Variable display size
- Character flickering
- Brilliancy increasement
- Automatic line erase
- Automatic end of line erasing
- Read cursor address
- Read refresh memory
- Flickering cursor (2 Hz)
- Mobile in the 4 directions
- "Hard copy coupling"
- Static or dynamic memory
- Memory refresh
- Light pen capability

NEW FROM SESCOSEM SEND 30p FOR DATA NOW

INS 8080A

The National 8080 direct plug in replacement for Intel 8080A – 8 bit micro now at a fantastic price!

SEND 30p FOR DATA **£7.42**

INS 8900D

The latest addition to the family of National micro's – 16 bit system and equal in price to many 8 bits. Low power schottky compatible and capable of interfacing with all 8080A memory and peripheral chips.

SEND 30p FOR DATA **£15.00**

TMS 9900

The powerful and now famous TMS 9900 micro from Texas Instruments. 16 bit system – now available.

SEND 30p FOR DATA **£61.50**

SEE PAGE 6

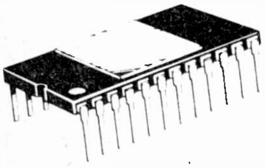
MC 6800P

Made famous by Motorola now 2nd sourced from Thomson CSF **£16.99**

SC-MP

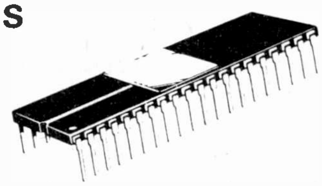
Very popular 8 bit from National

SC-MP I **£12.96** SC-MP II **£10.80**



MICROPROCESSOR SUPPORT DEVICES

LISTED BELOW IS OUR COMPREHENSIVE RANGE OF MICRO SUPPORT DEVICES TOTAL SYSTEM SUPPORT AT COMPETITIVE PRICES



PART No.	DESCRIPTION	PRICE/EQUIV.
8080A	8 Bit CPU 2μS Cycle	**£7.42**
8060N	SC-MP II 8 Bit CPU (ISP 8A-600N)	**£10.80**
8900D	16 Bit CPU	**£15.00**
8224N	Clock Generator	**£4.58**
8228N	System Controller	**£5.85**
8238N	System Controller	**£5.85**
DIGITAL I/O		
8202	Tri State 8 Bit Bus Driver/Buffer	**DM8ILS95**
8203	Tri State 8 Bit Bus Driver Inverting	**DM8ILS96**
82LS05	1 out of 8 Binary Decoder	**74LS138**
82C06	8 Bit I/O Latch	**£1.99**
8208	8 Bit Bi-directional Bus Driver	**£6.41**
8212	8 Bit Input/Output Port	**£3.10**
8213	Bi-directional 8 Bit I/O Port	**£15.00**
8216	4 Bit Bi-directional Bus Driver	**£2.60**
8226	4 Bit Bi-directional Bus Inverting	**£2.60**
PERIPHERAL CONTROL CHIPS		
8244	90-Key Keyboard Encoder	**£7.23**
8245	16-Key Keyboard Encoder	**MM74C922**
8246	20-Key Keyboard Encoder	**MM74C923**
8247	4 Digit Display Control	**£7.50**
8248	6 Digit Display Control	**£7.50**
8253	Programmable Interval Timer	**£11.38**
8254	Bit Programmable Peripheral Interface	**£4.50**
8255	Programmable Peripheral Interface	**£6.27**
8257	Programmable DMA Controller	**£11.93**
8259	Programmable Interrupt Controller	**£11.37**
8272	Floppy Disk Formatter/Control	**£22.00**
8276	CRT Controller	**£12.95**
8285	Character Generator	**DM8678CABN**
8292	8 Bit A/D Converter + 16CH·ANA MUX	**£20.00**
8298	LLL 80BAA "Basic" Interp. + HEX DEBUG	**£72.75**

PART No.	DESCRIPTION	PRICE/EQUIV.
COMMUNICATIONS		
8250	Async. Communications Element (ACE)	**£8.99**
8251	Program. Communications Interface	**£8.18**
8252	Advanced Communications Interface	**£17.80**
8261	Program. Communications Subsystem	**£15.75**
8274	Multi-Protocol Communications	**£13.90**
Memory (See Page 16, 17 & 18)		
8154	128 x 8 Static Ram with 16-Bit I/O Ram I/O Chip ISP-8A/650D	**£8.83**
MM74C920	256 x 4 Stat Ram + Separate I/O CMOS	**£11.83**
MM74C921	256 x 4 CMOS Static Ram + Comm. I/O	**£11.83**
MM74C929	1024 x 1 CMOS Static Ram	**£11.83**
TEXAS THS9900		
TMS9900	16 Bit Microprocessor	**£61.50**
TMS9980NL	16 Bit Microprocessor	**£29.89**
TMS9901NL	Program. Interrupt and I/O Interface	**£10.65**
TMS9902NL	Async. Communications Controller	**£9.15**
TMS9903NL	Binary Synch Interface	**TBA**
TIM9904N	Four Phase Clock Driver	**£7.56**
TIM9905N	Data Selector/Multiplex	**74LS251**
CALCULATOR ORIENTED PROCESSOR SYSTEMS – COPS		
MM57109N	Number Cruncher	**£12.75**
MM57160N	"Stac" Standard Timer and Controller	**£10.25**
MM57161N	"Sit" Standard Interval Timer	**£10.25**
EXTRAS		
MM5307AA/N	Baud Rate Generator	**£13.69**
MM5303N	UART	**£6.85**
AY-3-1013	UART Replaced Pin for Pin BY	**TMS6011NC**
TMS6011NC	UART 5-8 Bit 200 kHz	**£5.35**
DMB678CABN	CRT Character Generator 5 x 7 UC	**£15.40**
AY-2513	CRT Character Generator 5 x 7 UC	**£8.75**

— THE "ONE-STOP" SHOP FOR ALL YOUR MICROPROCESSOR COMPONENTS —

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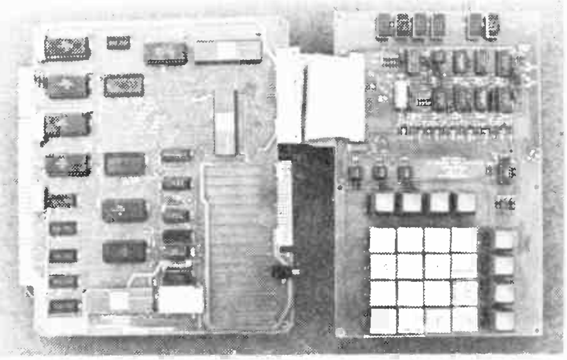
NEW FROM MOTOROLA MEK 6800 DII
A SELF-CONTAINED MICROCOMPUTER KIT

The kit, when assembled, is a fully functional microcomputer. The integral keyboard/display module can be used in conjunction with monitor program. For entering and debugging of user programs, a second P.I.A. allows operation via TTY or other input/outputs.

FEATURES

- 72 basic instructions
- 7 addressing modes
- On board monitor program
- On board cassette interface — connecting direct to cassette mike and earphone socket
- Spare prewired sockets for additional ROM/RAM, etc., + space for user's extra circuitry
- Expandable via data bus to 65k words using inbuilt motherboard techniques
- 256 words of RAM + monitor program
- Comprehensive literature/fact pack

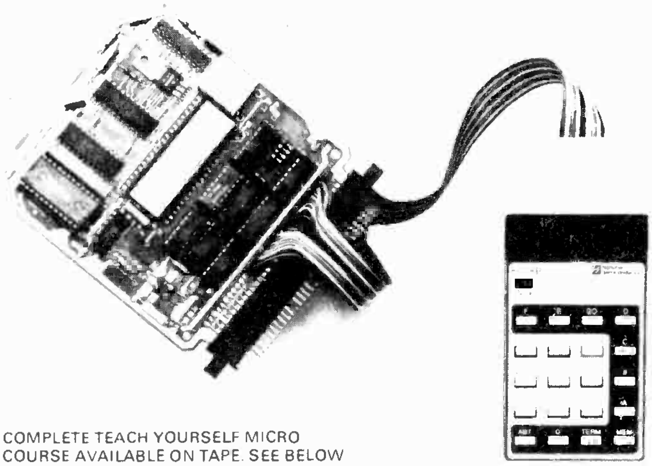


A FULL RANGE OF SUPPORT DEVICES
WILL BE AVAILABLE SHORTLY

PRICE £205 INC. VAT **DATA 30p+Sae**

Now second sourced from Thomson-CSF
See page 6 for details of chips

SC/MP MICROPROCESSOR



COMPLETE TEACH YOURSELF MICRO
COURSE AVAILABLE ON TAPE. SEE BELOW

SC/MP MICROPROCESSOR FAMILY

1SP-8A/500D	SC/MP CPU chip	**£12.96**
1SP-8A/600N	N-channel CPU chip (NEW Nº INS 8060N)	**£10.80**

INTROKIT — NATIONAL — Price £71.63 INCL. VAT

SC/MP, the Microprocessor kit from **National Semiconductor** includes everything yu need to build a completely functional microprocessor system — featuring the National SC/MP microprocessor — the low cost microprocessor for every application. Test Systems and Instrument Control, Machine Tool Control, Small Business Machines, Word Processing Systems, Educational Systems, Multiprocessors Systems, Process Controllers, Terminal Control, Laboratory Instrumentation, Sophisticated Games; Automotive Controller and Appliance Controllers.

The kit, neatly packaged with all the components and literature you need, in a looseleaf binder, includes: The SC/MP Microprocessor — a single-chip Central Processing Unit in a 40-pin, dual in-line package. Features static operations, forty-six intruction types, single-byte and double-byte, software controlled interrupt structure, built in serial input/output ports, bidirectional 8-bit TRI-STATER bus, parrallel data/port and latched 12-bit TRI-STATER address port. ROM — 512 bytes (8-bits/byte) of pre-programmed Read-Only-memory containing KITBUG—a monitor and debugging program to assist int he development of your application programs. KITBUGprovides teletypewrite input/output routines and allows examination, modification, and controlled execution of your programs. RAM-256 bytes of static read/write memory for storage of your application programs. Transfers of data to and from RAM are controlled by SC/MP and KITBUG. Teletypewriter Interface including buffer and drive capability for 20 MA current loop interface. Voltage REgulator. Data Buffer-providing interface between memory and bidirectional data lines. All the literature you need, including schematics and programming manuals. Timing Crystal—providing 1.000 MHz timing signal. Plus all the passive compnents and circuit board with 72 pin edge connector required to build and interconnect your microprocessor system with external hardware.

KEYBOARD KIT — National Semiconductors £68.74 INCL. VAT

Replaces the need for a conventional teletype terminal for input/output data. The calculator type keyboard provides manual input commands to the SC/MP and a six digit hex display provides visual output. An umbilical cord connects it to the Introkit P.C.B. Using the keyboard, programmes can be entered in hexadecimal (easier to use than binary). As well as the 16 hexadecimal keys (0-9, A, B, C, D, E and F) there are 4 control keys, which allow the contents of any RAM address to be examined or modified.

ISP 8K-400

NEW DATA ACQUISITION CHIP
SINGLE CHIP 8-BIT DATA ACQUISITION SYSTEM

The ADC0816, ADC0817 (MM74C948) data acquisition components are monolithic CMOS devices with an 8-bit analog-to-digital converter, a 16-channel multiplexer and microprocessor compatible control logic. The 8-bit A/D converter uses successive approximation as the conversion technique. The converter features a high impedance chopper stabilized comparator, a 256R voltage divider with analog switch tree and a successive approximation register. The 16-channel multiplexer can directly access any one of 16 single-ended analog signals and provides the logic for additional channel expansion. Signal conditioning of any analog input signal is eased by direct access to the input of the 8-bit A/D converter.

The device eliminates the need for external zero and full-scale adjustments and features an absolute accuracy ≤ 1 LSB including quantitizing error. Easy interfacing to microprocessors is provided by the latched and decoded address inputs and latched TTL TRI-STATE® outputs.

★ ADC8017CCN STOCKED. **PRICE £18.92** INCL. VAT

DATA SHEET AVAILABLE **PRICE 30p** + SAE

SC/MP RETROFIT ★ KIT ★ £13.38

ISP 8K-205 Kit National

- Kit contains all the components including the CPU & Crystal etc. To convert existing SC/MPI users over to the new N channel SC/MP complete with literature.

ELEKTOR SC/MP
"EXPERIMENTING WITH SC/MP"

ELEKTOR PROJECTS WORK!

A series of articles and constructional projects using SC/MP Micro to build into a hexadecimal – 7-segment Micro computer with cassette interface. (Video/TV interface + full keyboard – to come). Build as much or as little as your budget allows. All components available.

+ PCB + Back Issues etc. **+ 4k RAM CARD**

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"WHAT IS A MICROPROCESSOR?" COMPLETE TEACH YOURSELF COURSE

The amazing response we experienced at our last two microprocessor forums in London — and the tremendous interest shown by individuals in microprocessor technology, has prompted us to release an edited recording of the lecture on cassette accompanied by a 72-page booklet keyed to the tapes — the forum was arranged by National Semiconductors, Practical Electronics and ourselves in an effort to remove the problems and uncertainties arising for anyone not familiar with this new and increasingly important subject. The lecture (on 1 x C90 and 1 x C60 cassettes) was given by two of National Semiconductors' leading microprocessor engineers. **£9.95** incl. VAT & P/P

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	PRICE
0.25 watt ± 5% Tol. Available in E12 range 10Ω to 1 meg	**2p** each
0.5 watt ± 5% Tol. Available in E12 range 10Ω to 10 meg	**3p** each
1.0 watt ± 10% Tol. Available in E12 range 10Ω to 10 meg	**5p** each
2.0 watt ± 10% Tol. Available in E12 range 10Ω to 10 meg	**9p** each

WIRE WOUND

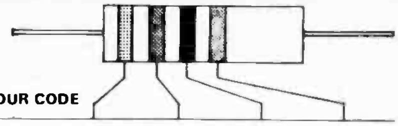
2.5 watt ± 5% Tol. Available in the following values only .... **10p** each
Ohms 1, .22, .33, .5, 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330

5 watt ± 5% Tol. Available in the following values only .... **12p** each
.5, 1, 2.2, 3.3, 3.9, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 25, 33, 39, 47, 60, 75, 82, 100, 120, 130, 150, 180, 220, 250, 270, 300, 330, 470, 500, 560, 680, 820, 1k, 1k2, 1k5, 2k, 2k2, 2k5, 3k3, 4k7, 5k6, 6k8, 7k5, 8k2, 10k, 12k.

10 watt ± 5% Tol. Available in the following values only .... **14p** each
1, 2.2, 3.3, 4.7, 6.8, 7.5, 8.2, 10, 12, 15, 18, 22, 25, 33, 39, 47, 70, 82, 100, 120, 150, 200, 250, 330, 470, 560, 680, 750, 1k, 1k2, 1k5, 1k8, 2k, 2k2, 2k7, 3k, 3k5, 4k7, 5k, 5k6, 6k8, 10k, 15k, 18k, 20k, 25k.

METAL OXIDE **MULLARD MR25 SERIES**
0.5 watt ± 2% Tol. Available in E24 range 10Ω to 1 meg .... **4p** each

RESISTOR COLOUR CODES



COLOUR CODE

Color	1st Digit	2nd Digit	Multiplier	Tolerance
Black	—	0	1	—
Brown	1	1	10	1%
Red	2	2	100	2%
Orange	3	3	1000	—
Yellow	3	4	10000	—
Green	5	5	100000	—
Blue	6	6	1000,000	—
Violet	7	7	—	—
Grey	8	8	—	—
White	9	9	—	—
Gold	—	—	0.1	5%
Silver	—	—	0.01	10%

E24 series = 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91, 100 PLUS DECADES.
E12 Series = 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100 PLUS DECADES.

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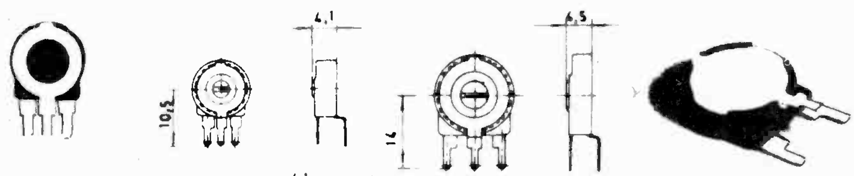
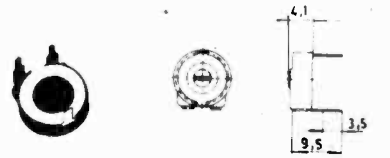
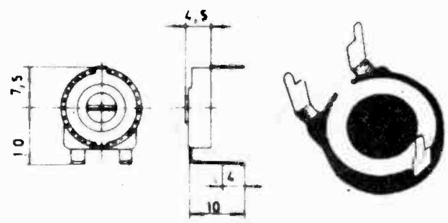
PT10 SERIES (FULLY ENCLOSED) **13p**
PT10h (2.5) vertical mounting 0.15 watt at 40°C.
PT10V horizontal mounting 0.15 watt at 40°C.
Tol. 20%.
Price **13p** each. Please specify horizontal or vertical.



PT15 SERIES (FULLY ENCLOSED) **15p**
PT15 Nh vertical mounting 0.3 watt at 40°C.
PT15 Nv horizontal mounting 0.3 watt at 40°C.
Tol. 20%.
Price **15p** each. Please specify horizontal or vertical. The PT15 range has the extra facility of clip in thumb wheels or spindles for easy adjustment without a screwdriver.
Thumb wheels .... **5p** each
Spindles .... **5p** each



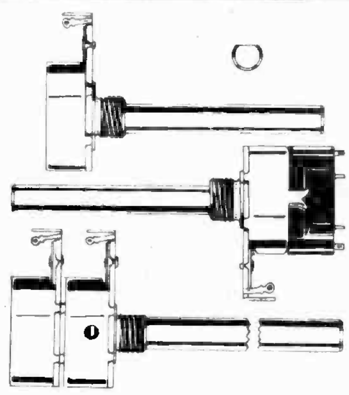


VALUES AVAILABLE: PT10 and PT15, 100R, 250R, 500R, 1k, 2.5k, 5k, 10k, 25k, 100k, 250k, 500k, 1M, 2.5M, 5M, 10M, 50k.

POTENTIOMETER-VOLUME CONTROLS

ROTARY POTENTIOMETERS. All standard ¼" spindles

35p	1) SINGLE LESS SWITCH		5k	10k	LIN
	Long spindle, double wiper,	25k	50k	100k	or
	available in following values	250k	500k	1Meg	LOG
75p	2) SINGLE SWITCHED	5k	10k	25k	LIN
	As above but with 2 Pole	50k	100k	250k	or
	Switch 2 Amp 250V AC	500k	1Meg		LOG
95p	3) DUAL GANGED-STEREO	5k	10k	25k	LIN
	As above, but dual *No Switch*	50k	100k	250k	or
		500k	1Meg		LOG



SLIDER POTENTIOMETERS

1) SINGLE—LOG OR LINEAR in following values 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M. Price **55p** includes Knob.

2) DUAL GANGED-STEREO—LOG OR LINEAR, matched to 2dB. 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M. Price **95p** includes Knob.

NON LINEAR RESISTORS

Thermistors	R at 25° C.	Price
1) Rod type 0.6w Dissipation		
VA10665	4.7k	£0.22
VA10555	15k	£0.22
VA10565	47k	£0.22
VA10655	150k	£0.22
2) Disc Type 0.6w Dissipation		
VA1096	150	£0.20
VA1097	470	£0.20
VA1098	1.5k	£0.20
VA1109	4.7k	£0.24
VA1108	15k	£0.24
VA1112	22k	£0.24
VA1111	33k	£0.24
3) Disc Types 1w Dissipation		
VA1086	2.2	£0.18
VA1033	4	£0.18
VA1074	6	£0.18
VA1053	8	£0.18
VA1110	10	£0.18
VA1100	15	£0.18
VA1077	32	—
VA1034	50	£0.18
VA1040	130	£0.20
VA1039	500	£0.22

VOLTAGE DEPENDENT

		Price
1) Rod Types		
E298ED/A258	1500	£0.22
E298ED/A260	1800	£0.22
E298ED/A262	2200	£0.22
E298ED/A265	2400	£0.22
E298ED/P268	3000	£0.22
E298ZZ/06	3020	£0.22
2) Disc Types		
E299DD/P116	14	£0.20
E299DD/P118	18	£0.20
E299DD/P120	21	£0.20
E299DD/P216	25	£0.20
E299DD/P218	32	£0.20
E299DD/P220	40	£0.20
E299DD/P224	57	£0.20
E299DD/P226	60	£0.20
E299DD/P228	70	£0.20
E299DD/P230	85	£0.20
E299DD/P232	100	£0.20
E299DD/P336	190	£0.20
E299DD/P338	230	£0.20
E299DD/P340	300	£0.20
E299DD/P342	350	£0.20
E299DD/P344	400	£0.20
E299DD/P346	500	£0.20
E299DD/P348	600	£0.20
E299DD/P350	750	£0.20
E299DD/P352	900	£0.20
E299DD/P354	1100	£0.20

TRANSFORMERS DOUGLAS AND REPANCO

TYPE No	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT111CS	0-12+0-12 (24 volt)	250mA	275g	60p	**£2.50**
MT213CT	0-12+0-12 (24 volt)	500mA	450g	60p	**£3.15**
MT71AT	0-12+0-12 (24 volt)	1 amp	825g	90p	**£4.90**
MT68AT	0-12+0-12 (24 volt)	1.5 amp	1.05kg	£1 00	**£5.50**
MT18AT	0-12+0-12 (24 volt)	2 amps	980g	90p	**£6.00**
MT85AT	0-12+0-12 (24 volt)	2.5 amps	1.3kg	£1.00	**£6.50**

MT111CT - MT85AT may have their secondaries parallel to give 0-12v at twice the secondary current ratings; i.e MT71AT to give 0-12v at 2A or 0-24v at 1A.

TYPE No	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT112CT	0, 12, 15, 20, 24, 30v	500mA	575g	60p	**£3.30**
MT79AT	0, 12, 15, 20, 24, 30v	1 amp	725g	60p	**£4.50**
MT3AT	0, 12, 15, 20, 24, 30v	2 amp	1 35kg	£1.00	**£6.20**
MT20AT	0, 12, 15, 20, 24, 30v	3 amp	1 95kg	£1.00	**£7.25**
MT21AT	0, 12 15, 20, 24 30v	4 amp	2.73kg	£1 25	**£8.70**
MT51AT	0, 12, 15, 20, 24, 30v	5 amp	3.025kg	£1 50	**£11.00**

Secondary output of MT112CT to MT51AT may be taken from between any of the following voltages 2, 4 5, 6, 8, 9, 10, 12, 15 18, 20, 24, 30v or 15-0-15v

TYPE No	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT102AT	0, 19, 25 33, 40, 50v	500mA	800g	90p	**£4.90**
MT103AT	0 19, 25, 33, 40, 50v	1A	1 3kg	£1 00	**£5.50**
MT104AT	0, 19, 25, 33, 40, 50v	2A	2.35kg	£1 25	**£8.25**
MT105AT	0, 19, 25, 33, 40, 50v	3A	2 9kgm	£1 25	**£9.90**
MT107AT	0 19 25, 33, 40, 50v	4A	5 25kgm	£2.00	**£16.50**

The secondary output of MT102AT to MT107AT may be taken from between any of the above tappings to give the voltages: 6, 7, 8, 10, 14, 15, 17, 19, 21, 25, 31, 33, 40, 50v or 25-0-25v.

TYPE No	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT124AT	0, 24, 30, 40, 48, 60v	500mA	700gm	60p	**£4.90**
MT126AT	0, 24 30, 40, 48, 60v	1A	1 4 kgm	£1 00	**£6.75**
MT127AT	0, 24, 30, 40, 48, 60v	2A	2 4 kgm	£1 25	**£8.80**
MT123AT	0, 24, 30, 40, 48, 60v	4A	5 25 kgm	£2.00	**£14.50**

Following voltages available from secondary tappings, MT124AT to MT123AT 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60v or 30-0-30v

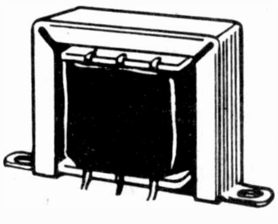
MINIATURE MAINS TRANSFORMERS

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT6	6-0-6v	500mA	200g	40p	**£1.65**
MT12	12-0-12v	250mA	200g	40p	**£1.65**
MT20	20-0-20v	150mA	200g	40p	**£1.65**

SUB MINIATURE MAINS TRANSFORMERS

TYPE No	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
TR1	6-0-6	100mA	75 9	40p	**£1.10**
TR2	9-0-9	75mA	75 9	40p	**£1.10**
TR3	12-0-12	50mA	75 9	40p	**£1.20**
TR4	12-0-12	100mA	75.9	40p	**£1.35**

TYPE No	SECONDARY VOLTAGES	CURRENT	WEIGHT	PRICE
MT207CT	0, 8, 9v	500mA	510g	**£3.75**



SIZES IN MM OF TRANSFORMERS

MT6	60x40x45	MT79AT	70x60x70
MT12	60x40x45	MT85AT	95x70x70
MT20	60x40x45	MT102AT	75x75x65
TR1	45x25x27	MT103AT	80x60x65
TR2	45x25x27	MT104AT	80x70x100
TR3	45x25x27	MT105AT	100x90x90
TR4	50x27x30	MT107AT	140x105x120
MT3AT	75x55x90	MT112CT	70x65x60
MT18AT	95x60x70	MT123AT	125x100x100
MT20AT	100x75x85	MT124AT	75x75x65
MT21AT	100x90x85	MT126AT	100x70x85
MT51AT	120x80x110	MT127AT	
MT68AT	85x80x75	MT207CT	75x50x60
MT71AT	75x75x75	MT213CA	81x45x45

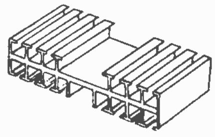
DON'T FORGET POSTAGE

HEATSINKS-REDPOINT

Y-TYPE POWERSINKS

			PRICE
2Y1 Undrilled	6.2 C/W	55gms	**£0.55**
2Y2 1 x TO3	6.2 C/W	55gms	**£0.60**
4Y1 Undrilled	3.9 C/W	110gms	**£0.85**
4Y4 2 x TO3	3.9 C/W	110gms	**£1.10**
4Y5 2 x TO66	3.9 C/W	110gms	**£1.32**

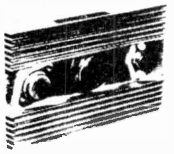
Compact design stocked in 2 lengths 2" and 4". For moderate power involvement.



W-TYPE POWERSINKS

ORDER CODE	RATING	WEIGHT	PRICE
2W1 Undrilled	1.9 C/W	150gms	**£0.90**
4W1 Undrilled	1.3 C/W	280gms	**£1.37**
4W4 2 x TO3	1.3 C/W	280gms	**£1.65**
6W1 Undrilled	1.1 C/W	425gms	**£1.98**
6W4 2 x TO3	1 1 C/W	425gms	**£2.35**

Stocked as Standard HT-Sink in three lengths 2", 4" and 6" with Transistor Drillings as shown.



M-TYPE POWERSINKS

2M1 Undrilled	4.2° C/W	90gms	**£0.60**
2M2 1 x TO3	4.2 C/W	90gms	**£0.71**
2M3 1 x TO66	4.2 C/W	90gms	**£0.90**
4M1 Undrilled	2.8 C/W	170gms	**£1.05**
4M2 1 x TO3	2.8 C/W	170gms	**£1.10**
4M3 1 x TO66	2.8 C/W	170gms	**£1.25**

Stocked in 2" and 4" lengths Transistor Mountings as shown.

CH-TYPE HEATSINK

PRICE		
35p	CH77	23 C/Watt for TO126 Plastic and Motorola Case 77 19 x 8 x 25mm
35p	CH90	18 C/Watt for TO127 Plastic and Motorola Case 90 19 x 8 x 32mm
35p	CH106	18 C/Watt for C106D etc 19 x 8 x 32mm

F-TYPE HEATSINK

12p	18F	50 C/Watt Clip on for TO-5 Case
12p	5F	50 C/Watt clip on for TO-18 Case

TV-TYPE HEATSINK

35p	TV-2	10.5 C/Watt for TO66 Power
35p	TV-3	10 5 C/Watt for TO3 Power
35p	TV-4	10 5 C/Watt for Plastic Power

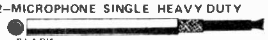
CABLE

AUDIO-SCREENED CABLE

Price per metre

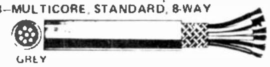
Z.1–MICROPHONE, SINGLE (STANDARD) **12p**

Z.2–MICROPHONE SINGLE HEAVY DUTY **17p**



Z.3–MICROPHONE, TWIN **19p**

Z.8–MULTICORE, STANDARD, 8-WAY **45p**



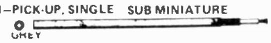
Z.12–MULTICORE, STANDARD 12-WAY **55p**

Z.14–MULTICORE, MINIATURE, 4-WAY **30p**

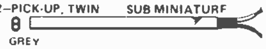
Z.19–MULTICORE, MINIATURE, 9-WAY **45p**

Z.20–MULTISCREENED 4 WAY **28p**

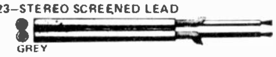
Z.21–PICK-UP, SINGLE SUB MINIATURE **12p**



Z.22–PICK-UP, TWIN SUB MINIATURE **14p**



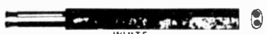
Z.23–STEREO SCREENED LEAD **18p**



MAINS CABLE

Z.25–FIGURE 8–RIB POLARISED **10p**

Z.31–2 CORE OVAL – 2½ AMPS **12p**



18p Z.33–3 CORE ROUND, STANDARD 2½ AMPS

28p Z.34–3 CORE ROUND, HEAVY DUTY, RIBBED

COAXIAL CABLES

24p Z.41–U.H.F. (BANDS I-V) 75 OHMS

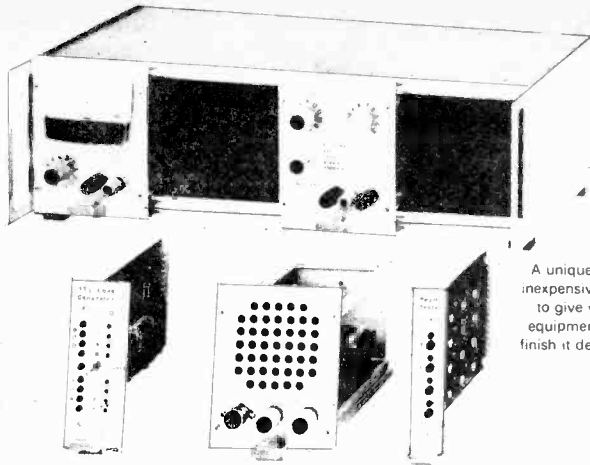
18p Z.45–V.H.F. (BANDS I-III) 75OHMS

V.H.F. FEEDER CABLES

12p Z.50–V.H.F./F.M. TWIN RIBBON FEEDER

INSTRUMENT CASE

THE PROFESSIONAL TOUCH!



A unique and inexpensive way to give your equipment the finish it deserves

A wide range of combinations for the amateur and electronics lab

CASE—A housing unit for plug in Eurocards (100x160) and/or modules. Can be used free standing or in 19" racking. Consists of aluminium frame, 34 prs. of guides and separate mounting rail for 31-way connectors — top, rear and base removable — blue PVC clad aluminium — base and rear are ventilated — inside width is 17" — to take a combination of modules and front panels.

4" MODULE—Consists of 4" front panel, 4 guide rails with fixing holes, a rear and base plate — rigid construction.

FRONT PANELS available 1" or 2" wide made of anodised aluminium — easily attached to Eurocards with mounting angles and screws — economic way of building control units.

CARDS—Standard Eurocards — designed to slide in and out easily.

CONNECTORS—A 31-way plug and socket array — designed to work quickly and efficiently — accurately guided together when cards are inserted.

Description		Price
● **CASE** (including guides)	71-3841-L	**£23.00**
● **4" MODULE**	71-3844G	**£3.50**
● **2" F**	71-3845-G	**£1.10**
● **1" FRONT PANEL**	71-3846-H	**£1.05**
● **VEROBOARD**	09-1034F	**£1.32**
● **DIP BOARD**	10-1041J	**£3.60**
● **31-WAY PLUG**	17-0267H	**£1.40**
● **31-WAY SOCKET**	17-0268C	**£1.65**

POSTAGE
Although the case comes flat, please allow an extra **£1.20** for postage. Many thanks.

19" CARD FRAME/CASE SYSTEM FOR YOUR ELECTRONIC EQUIPMENT

THE SYSTEM **verowire**

Verowire is basically a new kind of interconnecting system for P.C. Boards enabling maximum density to be achieved using integrated and/or discrete components.
The Verowire wiring system is ideal for prototypes, bread boards and limited production runs. Finished results are of a high standard with a neat and orderly appearance achieved in significantly less time than required by more conventional methods previously available.

Spare Pen
Plus 1 Spool **£2.75**

KIT CONTAINS

Wiring Pen	1
Circuit Board	1
Reels of Wire, 38 AWG. (Red) (one reel fitted to wiring pen)	3
Reels of Wire, 34 AWG. (Green)	2
Half pins	100
Shouldered Terminal Pins	100
Plastic Wiring Comb	20
Lead deformation tool	1
Pin insertions tool	1
Cutters	1
Inspection magnifier	1

PRICE **£19.00** FULL KIT

4 spare spools
8 SWG for **£2.55**

WIRE WRAPPING/ UNWRAPPING TOOL

PRICE **£6.50**

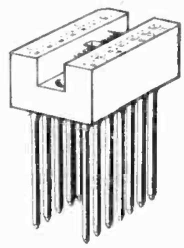
This tool does the job of two at less cost and with less weight. It is quick, convenient and easy-to-use.
TYPE 58-1908K

WIRE WRAPPING WIRE

Standard packs of 500 x 4" lengths of Kynar insulated wire — Silver plated soft copper wire — pre-stripped ready for use.
59-1766L PACK OF 500 4" **£6.00**

WIRE WRAPPING SOCKETS

8 PIN DIL	**£35p**
14 PIN DIL	**45p**
16 PIN DIL	**50p**
24 PIN DIL	**75p**



High quality sockets designed to provide max. reliability at a most economical cost. Excellent performance.

NEW

VEROBOARDS

● .1 MATRIX COPPER BACKED

10345/P16	2.5"×5"	**£0.55**
10346/P16	2.5"x3.75"	**£0.46**
13236/P16	2.5"x17"	**£1.69**
10347/P16	3.75"x5"	**£0.62**
10348/P16	3.75"x3.75"	**£0.55**
13237/P16	3.75"x17"	**£2.18**
Packets of 5pcs	2.5"x1"	**£0.67**
126/P16	4.7"x17.5"	**£2.81**
14354/P16	2.5"x1"	**£0.15**

● PLAIN BOARD .1

520	2.5"x3.75"	**£0.31**
521	3.75"x5"	**£0.50**
522	3.75"x17"	**£1.41**

● INDUSTRIAL BOARD .1

VB111001	9.95"x4.4"	**£2.50**
VB111004	6.95"x7.9"	**£3.25**
VB111005	9.95"×7.9"	**£4.20**
VB124	7.05"x17.9"	**£4.40**

● .15 PLAIN BOARD

441/4501	2.5"x17"	**£0.92**
442/4505	3.75"x17"	**£1.20**
444/8023	4.95"x17"	**£1.83**
14352	3.75"x5"	**£0.43**
11990	2.5"x5"	**£0.31**
11991	2.5"x1.75"	**£0.24**

.15 STANDARD COPPER BACKED

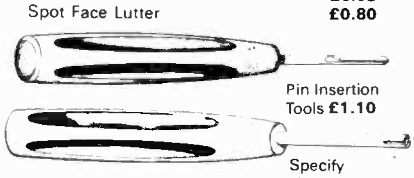
41/P16	2.5"x17"	**£1.35**
42/P16	2.5"x5"	**£0.50**
43/P16	2.5"x3.75"	**£0.36**
44/P16	3.75"x17"	**£1.80**
45/P16	3.75"x5"	**£0.67**
46/P16	3.75"x3.75"	**£0.50**
Pkts. of 5 pcs	2.5"x1"	**£0.62**
14353/P16	2.5"x1"	**£0.15**

.2 PITCH

4/1101/P16	4.80"x18"	**£2.30**

GROUP BOARDS

11986 (0.15)	8.4"x1.5"	**£0.53**
13897 (0.1)	8.4"x1.5"	**£0.53**
Spot Face Lutter		**£0.80**



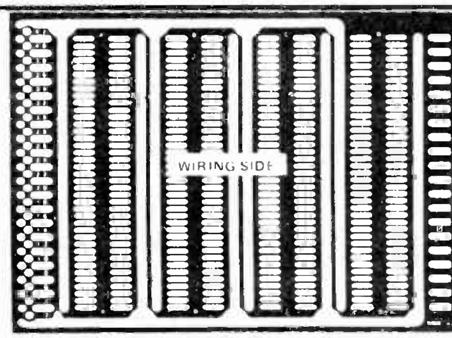
Pin Insertion Tools **£1.10**

Specify .1 or .15

PINS

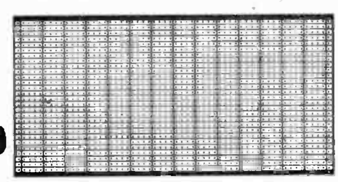
Available in .1 & .15
Price per bag

	.1	.15
36 Pins	**£0.39**	**£0.39**
200 Pins	**£1.42**	**£1.39**
1000 Pins	**£5.26**	**£4.90**



IC BREADBOARD (DIP) **£2.68**
VERO TYPE 13401, 4.15" x 6.15"
Most popular integrated circuit Breadboard.

VERO V-Q BOARD



150 x 75mm
SPECIAL DESIGN FOR DIL IC's – 14 x 4 hole SEGMENTS
ELIMINATES TRACK CUTTING – 28 STRIPS **£0.90**

CRICKLEWOOD
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VAT INCLUSIVE PRICES

EDGWARE ROAD
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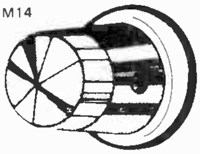
STANDARD KNOBS

M14

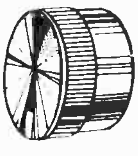


STANDARD INSTRUMENT KNOBS

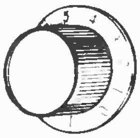
M1

- M1 Black plastic with mach. metal insert 25mm dia **£0.25**
- M2 As M1 but 33mm dia with pointer **£0.31**
- M3 Black plastic with machined metal insert and skirt 36mm dia **£0.37**
- M4 Black plastic with machined metal insert and skirt 36mm dia **£0.37**
- M5 Black plastic with machined metal insert and skirt 30mm dia **£0.33**
- M6 Black plastic body with metal inlay 21mm diameter . . . **£0.18**
- M7 Heavy metal matt black inlay – compact and very stylish, diameter 24mm **£0.52**
- M8 As above but 28mm dia **£0.62**
- M10 Highly polished metal clad with pointer, serrated top edge, diam 15mm **£0.30**
- M11 As above but 25mm diameter **£0.35**
- M12 As above but 30mm diameter **£0.42**
- M13 As above but 35mm diameter **£0.45**
- M14 Black plastic with chrome top and skirt for car radios, dia 24mm depth 30mm **£0.39**
- M15 Black plastic pointer knob with white marker. OD 18mm (skirt) pointer 31mm long **£0.15**
- M16 Highly polished metal clad and pointer, diameter 22mm **£0.20**

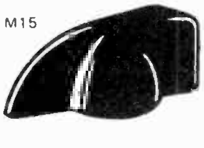
M10



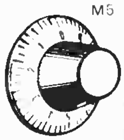
M4



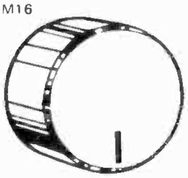
M15



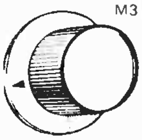
M5



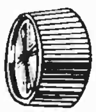
M16



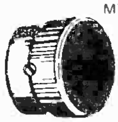
M3



M6



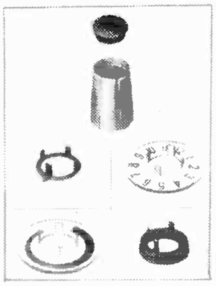
M7



ALL KNOBS ARE FOR ¼" SPINDLEX EXCEPT M14

INSTRUMENT KNOBS

SIFAM COLLET KNOBS



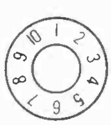
Function, styling, handling & simplicity of assembly are the main features of this new range of collet knobs. The various accessories – caps, pointers & nut covers – are simply plugged into basic knobs to form a vibration proof unit. Full size illustrations shown here indicate the possible combinations of colours available.

Two basic ranges are stocked along with related accessories, these are a 15mm diameter range and a 21mm diameter range

KNOBS available in black or grey	
S150 – 15mm short knob, plain	**£0.30**
S151 – 15mm short knob and line pointer	**£0.33**
K150 – 15mm standard knob and plain	**£0.33**
K151 – 15mm standard knob and line pointer	**£0.36**
W151 – 15mm wing knob and line pointer	**£0.38**
K210 – 21mm standard knob, plain	**£0.38**
K11 – 21mm standard knob and line pointer	**£0.42**
W211 – 21mm wing knob and line pointer	**£0.44**
CAPS available in black, red, grey, green, blue or yellow	
C150 – cap for 15mm knob, specify colour	**£0.02**
C210 – cap for 21mm knob, specify colour	**£0.02**
POINTERS available in same colours as caps	
P150 – pointer for 15mm knobs	**£0.03**
P210 – pointer for 21mm knobs	**£0.03**
NUT COVERS available black, red, grey	
N150 – nut cover for 15mm knobs	**£0.03**
Nut covers not needed on 21mm knobs	

FIGURE DIALS available as shown

Black with white pointer	15mm	**12p**	21mm	**15p**	each
Grey with black pointer	15mm	**12p**	21mm	**15p**	each
Clear with black taper	15mm	**12p**	21mm	**15p**	each
Figure dial 1-10 clear	15mm	**13p**	21mm	**15p**	each



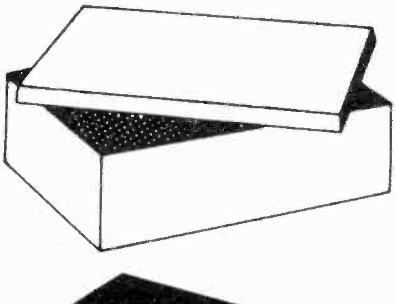
ALL KNOBS ARE FOR ¼" SPINDLES

DON'T FORGET TO SPECIFY COLOUR REQD

BOXES AND CASES

ALUMINIUM BOXES

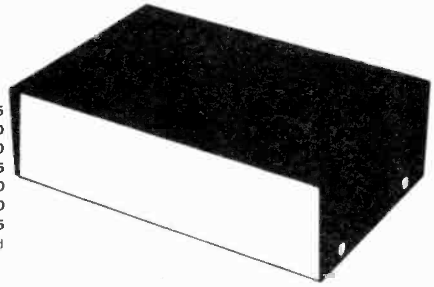
BA1	2¾x5¼x1½"	**72p**
BA2	4x4x1½"	**77p**
BA3	4x2¾"x1½"	**72p**
BA4	4x5¼x1½"	**93p**
BA5	4x2½x2"	**83p**
BA6	3x1x2"	**55p**
BA7	6x4x2"	**£1.10**
BA8	7x5x2½"	**£1.32**
BA9	8x6x3"	**£1.65**
BA10	10x7x3"	**£2.20**
BA11	10x4½x3"	**£1.98**
BA12	12x5x3"	**£2.15**
BA13	12x8x3"	**£2.58**



REXINE COVERED

RB1	6x4½x1¾"	**£1.55**
RB2	8x5x2"	**£1.80**
RB3	9x5x2½"	**£2.10**
RB4	11x6x3"	**£2.55**
RB5	11x7½x3½"	**£3.20**
RB6	13x8x4½"	**£4.40**
RB7	15x8x4"	**£4.65**

Complete with screws and feet



VERO POTTING BOXES

VPB1	2x3x1 Black	**50p**
VPB2	2x3x1 White	**50p**

A small high quality ABS plastic box supplied complete with lid and screws – 75-1413E.

HAND HELD CONTROL BOX

The new Vero Hand Held Control Box – ideal for remote control uses – specially designed for the purpose. White ABS plastic. Measures 94x61x22.6mm Price **68p**

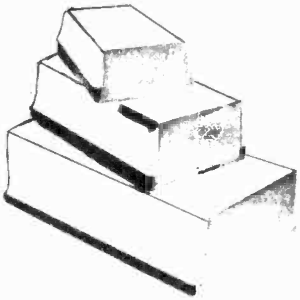
VERO CASES

1 PLASTIC BOXES

VB1–65x120x40mm **£2.50**
CODE 65-2518H

VB2–80x150x50mm **£2.80**
CODE 65-2520J

VB3–110x188x160mm **£3.75**
CODE 65-2522K

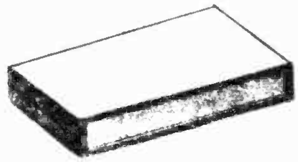


Moulded in 2 tone high impact polystyrene – screw fixing – very strong – ideal for wall mounting or bench use – threaded brass inserts for P.C. mounting

2 PLASTIC CASES

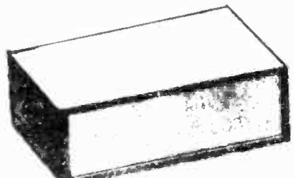
a) illustrated

VC1–205x140x40mm **£3.20**
CODE 75-1410J



VC2–205x140x75mm **£3.60**
CODE 75-1411D

VC3–205x140x110mm **£4.70**
CODE 75-1412K



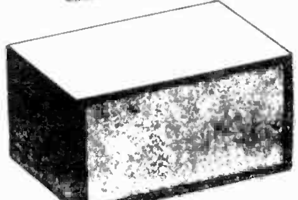
Moulded in light grey high impact ABS – includes internal P.C.B. fixing screws and anodised aluminium front panel held in place by the two halves of the case – screw fixing plus rubber feet

3 PLASTIC CLIP CASES

VCC1–85x40x154mm **£2.27**
CODE 75-1237J

VCC2–85x60x154mm **£2.85**
CODE 75-123BD

VCC3–85x80x154mm **£3.40**
CODE 75-1239K

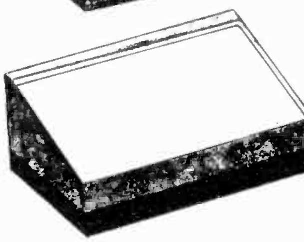


Similar to plastic boxes (1) but with anodised aluminium front panel, two tone halves clip together solidly without screws for ease of access. P.C.B. fixings inside

4 PLASTIC SLOPING CASE

VSC1–220x174x100/50mm **£6.95**
CODE 65-2523E

VSC2–171x121x75/37.5mm **£4.20**
CODE 75-1798K



Two tone case – removable anodised ali. front panel and recess at rear for cable entry, ideal instrument case

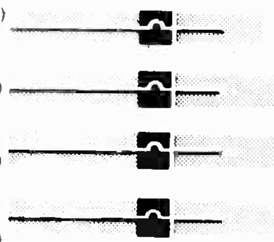
MODEL C15 — 15 watt

£3.69

Miniature soldering iron. Bits slide on and off stainless steel shaft. Efficient heat transfer. Length 16cm.

Spare Elements **£1.58**

SPARE BITS AVAILABLE



(2)	2.3	3/32	All Bits are Nickel Plated Price **50p**
(3)	4	5/32	
(4)	4.7	3/16	
(6)	1	3/64	

MODEL CCN15 — 15 watt

£3.96

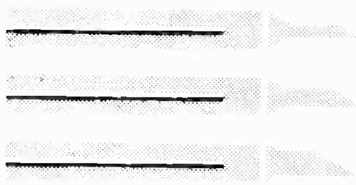
Unique Ceramic shaft—no measurable leakage. Capacitance 30pf. Tested at 2kV A.C. Length 16 cm.

Elements **£2.06**

CCN

15 watt 240 volts miniature soldering iron with ceramic shaft to ensure perfect insulation.

SPARE BITS AVAILABLE



1100	2.3	3/32	All Bits are Iron Coated Price **50p**
1101	3	1/8	
1102	4.7	3/16	

MODEL X25 — 25 watt

£3.69

Near perfect insulation. Breakdown voltage 1.500v A.C. Leakage 3.5uA. Stainless steel shaft and phenolic handle. Length 22cms. weight 50g.

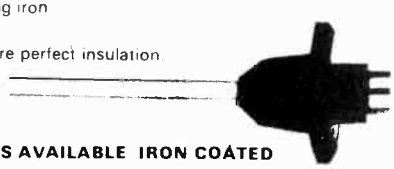
Element **£1.74**

25 watt 240 volts soldering iron

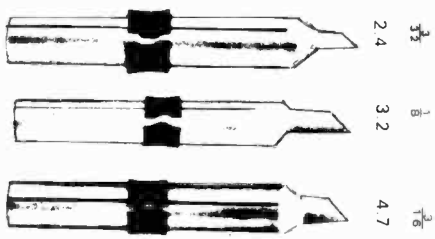
X25 Soldering Iron

with ceramic shaft to ensure perfect insulation.

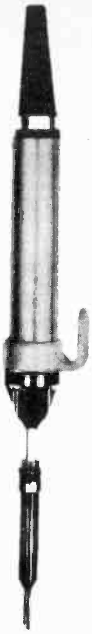
Element X25E



SPARE BITS AVAILABLE IRON COATED



No. 50	2.4	3/32	Price **54p**
No. 51	3.2	1/8	
No. 52	4.7	3/16	



THE 17 WATT MODEL CX

NEW PRICE £3.69

Model CX is manufactured on the same principle as the model X.25 which has proved such as success since its introduction.

The *double shaft* principle of the X.25 has now been applied to a miniature iron, giving it the strength of the model C and the superb insulation of the CCN and the X.25. It is virtually *free of current leakage*, like model CCN, but it is not so delicate as that model. The addition of a steel shaft has of course meant that it has an *earth contact* and it is supplied with 3-core flexible cable.

Specification

Voltage range:	220-250 volts A.C./D.C.
Power consumption:	17 watts at maximum voltage
Breakdown voltage:	4000 volts A.C.
Current leakage:	3-5 uA.
Lead:	3-core
Length:	19cm (7½")
Weight:	40 grams (without lead)

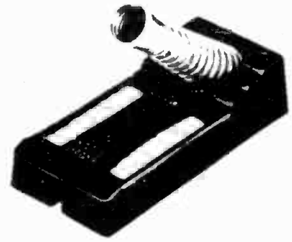
Spare Elements available Price **£1.58**

Uses same tips as Model CCN i.e. No. 1100, 1101 & 1102

PRICE 50p

ST3 Stand

Price £1.53



This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands.

The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration.

DESOLDERING TOOL. £5.94

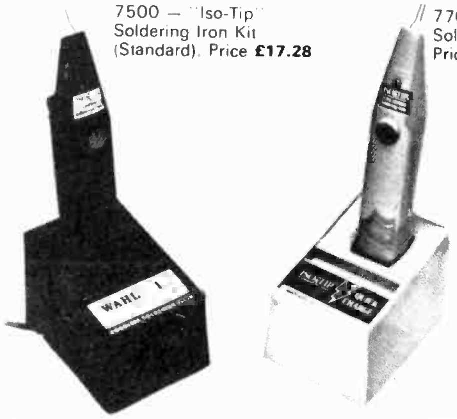
SPARE TIPS **65p**

A new and improved model to deal with solder removal where components are tightly grouped or otherwise inaccessible. Instantly removes all unwanted solder from printed circuits and all other solder joints. Simple, reliable, speedy and accurate.

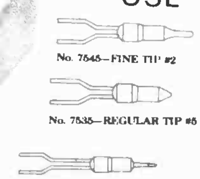
CORDLESS SOLDERING IRONS

7500 — "Iso-Tip" Soldering Iron Kit (Standard). Price **£17.28**

7700 — Quick Charge Soldering Iron Kit Price **£19.98**



NEW AND EASY TO USE



No. 7545—FINE TIP #2

No. 7535—REGULAR TIP #5

No. 7566—MICRO SOLDERING TIP

● Quick charge iron comes complete with one spare tip. **£2.50**

CRICKLEWOOD 01-452 0161

VAT INCLUSIVE PRICES

EDGWARE ROAD 01-723 4242

The Oryx Super 30 £3.78

The Oryx Super 30 gives you these features as standard.

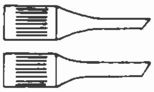
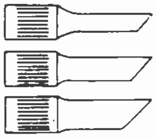
- A long life screw-on iron coated tip.
- Extended element life through current phase control built into the handle.
- Neon light in handle – a unique safety feature.
- Robust – very rigid construction.
- Stainless steel shaft and clip-on hook.
- Beautifully styled handle designed.

The Oryx Super 50 £9.61
TEMPERATURE-CONTROLLED

Temperature controlled iron so small, light and because it runs at an even temperature, it can be set to a lower heat than conventional uncontrolled irons. This is an important advantage when dealing with P.C. boards, I.C.s etc.
50 watts, 210/250 volts, Heating: 45 secs., Length 8"/200mm. Weight 2¾ ozs/77 grms. Safety, Range of tips as for Oryx 75.

☆ Temperature range from 200°C to 400°C±2°C.
☆ Long life iron coated tip fitted as standard
☆ Built-in indicator lamp operates with thermostat
☆ Aluminium heat sink keep handle cooler

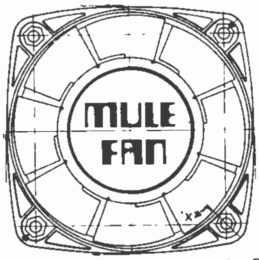
SPARE TIPS **£0.95**

LL/SF/16
LL/SF/24

LL/SF/32
LL/SF/48
LL/SF/64


COOLING FANS

The new 'Mule' fan represents a breakthrough in slim axial fan design
It reverses the drive principle in normal use with this type of fan by employing an outer stator/inner rotor design.
The result is up to 20% more output than other fans of its size (up to 60cfm) and a large saving in production costs.
The impeller is glass re-inforced nylon with a specially-developed aerofoil section for maximum performance
The fan is designed to be mounted either way round to enable induction or extraction and can be positioned inside or outside the cabinet
Built to the highest standards of safety, the unit incorporates a thermal cut-out to eliminate overheating problems should the fan be jammed
It will be of great use in electronics, vending machines, refrigeration, air conditioning, and other fields

New design means
Lower price
Up to 20% more output than other fans of its size
Easily mounted for either induction or extraction
High performance g r n impellers
Thermal cut-out to protect unit and installation.



STAY COOL!

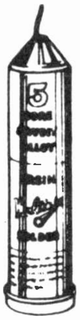
USE MULE

THE NEW LOW COST FAN

It's 95mm x 50mm thick at the Slim Price **£9.70**

ERSIN Multicore 5 CORE SOLDER

HANDY SOLDER DISPENSER
Size 5 **£0.50**
Contains 2.3 metres of SAVBIT SOLDER
Postage/Packing 45p on Size 10 & 12



Ref.	Alloy	Daim. mm	Length metres approx	Use	Price
Size 10	60/40 Tin/Lead	0 7	39 6	For fine wires, small components and printed circuits	**£1.84**
Size 12	SAVBIT	1.2	13.7	For radio, TV and similar work Increases copper-bit life tenfold	**£1.84**

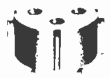
PRINTED CIRCUIT KIT

ideal PCB kit for the enthusiastic printed circuit board designer.
Contains
Printed Circuit Board
Circuit Marker Pen
Etching Crystals
Solvent
Kit. Price **£3.50**

PCB KIT

SOCKETS & HOLDERS

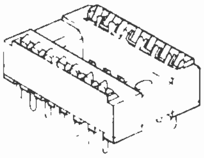
			Price
TO18	4 pin holder	A1236/4L	**£0.18p**
TO5	3 pin holder	A1192	**£0.19p**
TO18	3 pin holder	A1236	**£0.16p**
TO99	8 pin holder	A23 2013	**£0.44p**
TO99	10 pin holder	A23 A2014	**£0.49p**
TO99	12 pin holder	A1200	**£1.30p**



DUAL-IN LINE SOCKETS

NEW LOW PROFILE

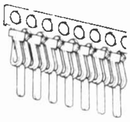
8 pin D I L	**£0.15p**
14 pin D I L	**£0.16p**
16 pin D I L	**£0.18p**
18 pin D I L	**£0.27p**
22 pin D I L	**£0.30p**
24 pin D I L	**£0.35p**
28 pin D I L	**£0.45p**
40 pin D I L	**£0.55p**



TRANSISTOR COVERS

TO3C	Plastic cover	**£0.11p**
TO66C	Plastic cover	**£0.11p**

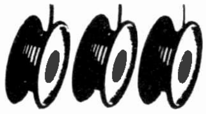
SOLDERCON PINS
FOR LOW COST
IC SOCKETS £0.55/100 STRIP
Strip of 100 pins for those odd moments you find yourself without a socket



ENAMELLED COPPERWIRE

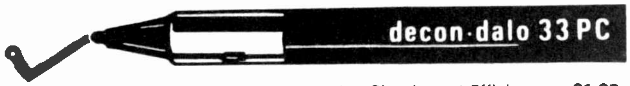
Available on 2oz Reels in the following guages

20z REELS



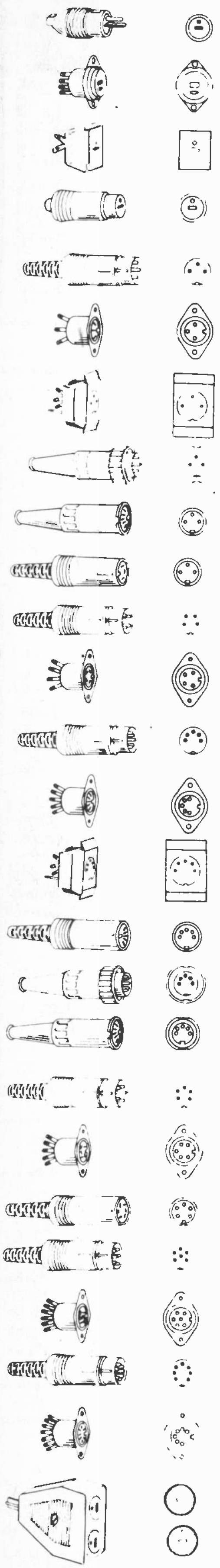
SWG	Price	SWG	Price
16	**£0.44**	28	**£0.55**
18	**£0.44**	30	**£0.60**
20	**£0.44**	32	**£0.60**
22	**£0.50**	34	**£0.65**
24	**£0.50**	36	**£0.65**
26	**£0.55**	38	**£0.70**

ETCH RESIST PEN



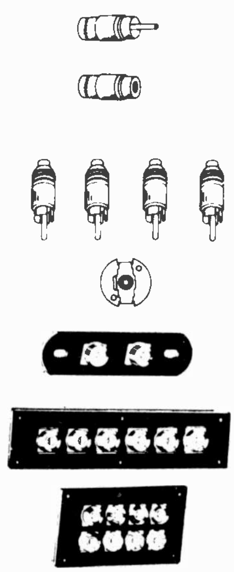
Etch Resist Pen for Printed Circuit Boards—Simple and Efficient **£1.08**

DIN PLUGS & SOCKETS



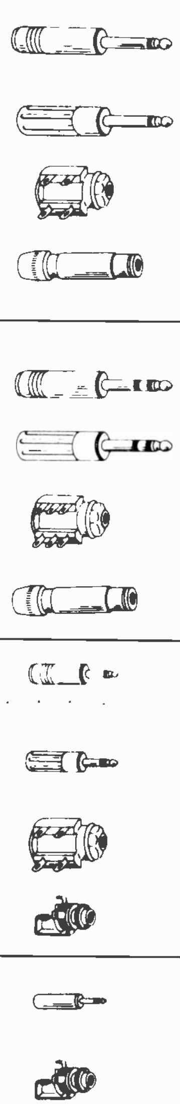
2 PIN LOUDSPEAKER PLUG	11p
2 PIN LOUDSPEAKER CHASSIS SOCKET	8p
2 PIN LOUDSPEAKER SNAP-IN SOCKET	11p
2 PIN LOUDSPEAKER LINE SOCKET	11p
3 PIN PLUG FULLY SCREENED	16p
3 PIN CHASSIS SOCKET	13p
3 PIN CHASSIS SNAP-IN SOCKET	13p
3 PIN SCREENED LOCKING PLUG	75p
3 PIN LOCKING LINE SOCKET	66p
3 PIN LINE SOCKET	16p
4 PIN PLUG	16p
4 PIN SOCKET CHASSIS MOUNTING	13p
5 PIN 180° PLUG FULLY SCREENED	16p
5 PIN 180 CHASSIS SOCKET	13p
5 PIN 180 CHASSIS SNAP-IN SOCKET	13p
5 PIN 180 LINE SOCKET	16p
5 PIN 180 LOCKING PLUG	85p
5 PIN 180 LOCKING LINE SOCKET	85p
5 PIN 240° PLUG FULLY SCREENED	16p
5 PIN 240 CHASSIS SOCKET	13p
5 PIN 240` LINE SOCKET	16p
6 PIN PLUG FULLY SCREENED	16p
6 PIN CHASSIS SOCKET	13p
7 PIN PLUG FULLY SCREENED	16p
7 PIN PLUG FULLY SCREENED	13p
ADAPTOR 2 PIN SPEAKER PLUG TO TWO 2 PIN SOCKETS	66p

PHONO PLUGS & SOCKETS



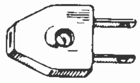
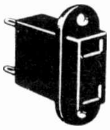
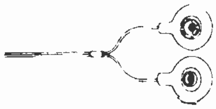
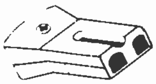
PHONO PLUG—METAL FULLY SCREENED	16p
PHONO LINE SOCKET FULLY SCREENED	16p
PHONO PLUGS & LINE SOCKETS—SCREW TOP PLASTIC RED, BLACK, WHITE GREEN & YELLOW	11p
PHONO SINGLE CHASSIS SOCKET ON PAXOLIN	8p
DOUBLE PHONO SOCKET	11p
FOUR-WAY PHONO SOCKET	22p
SIX-WAY PHONO SOCKET	27p
EIGHT-WAY PHONO SOCKET ON PAXOLIN	38p

JACK PLUGS & SOCKETS

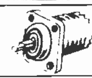
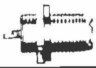


MONO	
¼" STANDARD JACK PLUG — FULLY SCREENED	29p
¼" STANDARD JACK PLUG — UNSCREENED	17p
¼" STANDARD JACK CHASSIS SOCKET SWITCHED	22p
¼" STANDARD LINE SOCKET PLASTIC	22p
or METAL	33p
STEREO	
¼" STEREO JACK PLUG FULLY SCREENED	38p
¼" STEREO JACK PLUG UNSCREENED	27p
¼" STEREO JACK CHASSIS SOCKET—SWITCHED	27p
¼" STEREO LINE SOCKET 1) METAL	49p
2) PLASTIC	27p
3.5mm JACK PLUG FULLY SCREENED PLUG	17p
LINE SOCKET	17p
3.5mm JACK PLUG PLASTIC—UNSCREENED	11p
LINE SOCKET	11p
3.5mm JACK SOCKET CHASSIS—PLASTIC	13p
3.5mm JACK SOCKET CHASSIS—METAL	11p
2.5mm JACK PLUG PLASTIC	11p
METAL	16p
2.5mm JACK SOCKET CHASSIS, SWITCHED PLASTIC	11p

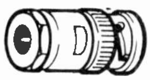
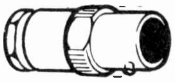
POWER CONNECTORS

33p	12 WAY FLEXIBLE CONNECTOR BLOCK 2 AMPS	
10p	BANANA PLUGS RED OR BLACK	
7p	BANANA SOCKET RED OR BLACK	
16p	POWER PLUG USA 2 PIN MAINS CONNECTOR PLASTIC	
16p	USA MAINS POWER LINE SOCKET PLASTIC	
16p	USA MAINS POWER CHASSIS SOCKET PLASTIC	
11p	PP3 BATTERY SNAPS	
15p	PP9 BATTERY SNAPS	
20p	MAINS CONNECTOR NON-REVERSIBLE 2 PIN CALCULATOR PLUG	
35p	NON-REVERSIBLE CHASSIS MOUNTING CALCULATOR SOCKET	
15p	ROCA PLUG—BATTERY USE, SLIDING SLEEVE	
13p	ROCA SOCKET SWITCHED FOR BATTERY CONNECTION	

U.S.A. COAXIAL CONNECTORS

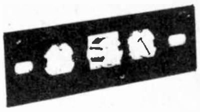
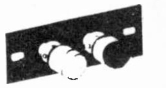
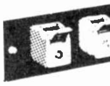
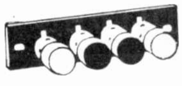
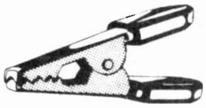
£0·65	UHF Plug suits Uniradio 67	PL259	
£0·55	UHF Chassis Mounting Square Socket 18 x 18 x 3.2 Fixing	S0239	
£0·55	UHF Round Socket Panel Mounting	S0239SH	
£0·70	UHF Double Ended Female Coupler	PL258	

BNC CONNECTORS (75R)

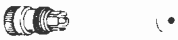
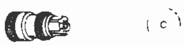
		
TYPE FS75	TYPE FP75	TYPE CP75
£0·82	**£0·82**	**£0·82**

75Ω COAXIAL CONNECTORS BY GREENPAR

TERMINALS & CLIPS

21p	TWO POLARISED SCREWS &/OR PHONO SOCKET 2-3/8" x ¾"	
37p	DOUBLE, SPRING LOADED PUSH TO RELEASE CABLE TERMINAL ONE RED ONE BLACK	
55p	DOUBLE SPRING LOADED TRIGGER TERMINALS ONE RED ONE BLACK	
£1·00	FOUR WAY SPRING LOADED TRIGGER TERMINALS 2 RED & 2 BLACK	
80p	FOUR WAY SPRING LOADED PUSH TO RELEASE CABLE TERMINAL	
7p	CROCODILE CLIPS 1½" long Red or Black PLASTIC HANDLES	
15p	2mm METER PLUG 4mm METER PLUG Red or Black	
11p	2mm CHASSIS SOCKET 4mm CHASSIS SOCKET Red or Black. Not insulated	
16p	SPADE TERMINALS Red or Black	
22p	TERMINAL POST—Will accept 4mm Meter Plug Red or Black	
11p	4mm LINE COUPLER Red or Black	
27p	CROC CLIP 4mm PLASTIC—Red or Black— Takes 4mm plug	
7p	CROC CLIP MINIATURE FULLY INSULATED Red or Black	

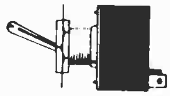
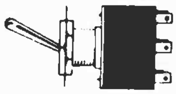
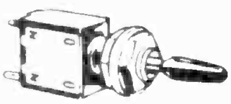
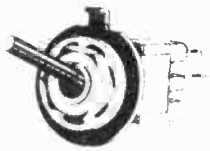
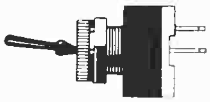
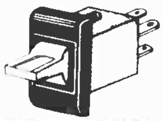
COAXIAL CONNECTORS

16p	COAXIAL TV AERIAL ALUMINIUM PLUG	
11p	COAXIAL PLASTIC PLUG	
15p	COAXIAL CHASSIS SOCKET Plastic or metal	
17p	COAXIAL SNAP-IN CHASSIS SOCKET	
60p	COAXIAL LINE SOCKET METAL	
11p	COAXIAL IN LINE ALUMINIUM COUPLER	
17p	CAR AERIAL PLUG	

SWITCHES

QUANTITY DISCOUNTS
CONTACT US NOW

STANDARD TOGGLES

		PRICE
	**STANDARD** SPST (2 tags) 2A 250V Chrome toggle—on/off plate DIMS 25x14x14mm	**39p**
	**DPDT** (6 tags) 2A 250V Extra long toggle + plate DIMS 29x18x17mm	**48p**
	**SUB MINIATURE** 2A 250V SPST (2 tags) 12x6x9mm Red toggle	**70p**
	SPDT (3 tags) 12x6x9mm Red toggle	**77p**
	DPDT (6 tags) 12x11x9mm Red toggle	**85p**
	DPDT (6 tags) 12x11x9mm Centre off Red toggle	**95p**
	**MICRO MINIATURE** 2A 250V SPST (2 tags) 8x5x7mm Chrome toggle	**60p**
	SPDT (3 tags) 8x5x7mm Chrome toggle	**65p**
	DPDT (6 tags) 8x7x7mm Chrome toggle	**70p**
	**STANDARD** SPST (2 tags) 24x16x17mm 6A 250 extra long paddle shaped chrome toggle	**45p**
	250v. 15 amp. SPST (2 tags) Body dims 24x13x14mm Black plastic toggle	**40p**
	**FLAT TOGGLE** 250V. 3 amp. SPST (2 tags)	**88p**
	Flat toggle, two screw fixing eschtcheon covers screws As above but SPCO (3 tags)	**95p**

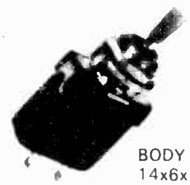
QUALITY TOGGLES ARROW

CT SERIES Approved to BS3955 Spec.
2A 250V AC, 5A 29V DC

Low cost subminiature toggle switches, designed for applications where compact size, low weight and rugged construction are required. Fitted with solder lug terminals of silver alloy, moving contacts of silver alloy and fixed contacts of silver alloy.

Initial Contact Resistance	10M Max (at 4Vd.c. IA)
Proof Voltage	2000V r.m.s. at sea level
Insulation Resistance	1000M Min.
Electrical Life	50,000 cycles Min.
Mechanical Life	100,000 cycles Min.
Operational Force	150-200 grms
Temp. Range	−40 C to +80 C
Angular Movement	24 ÷3

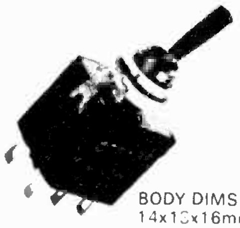
1 POLE, 2 AND 3 POSITIONS — 3 TAGS



BODY DIMS
14x6x16mm

		Price
CTS3	S.P. Change Over	**£1.00**
CTM3	S. P. Biased C/Over	**£1.10**
CTC3	S.P. Centre Off	**£1.00**
CTE3	S.P. Centre Off ½ Biased	**£1.10**
CTG3	S.P. Biased Centre Off	**£1.10**

2 POLE, 2 AND 3 POSITIONS — 6 TAGS



BODY DIMS
14x13x16mm

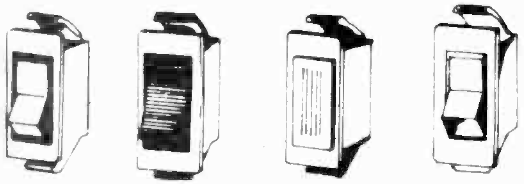
		Price
CTS6	D.P. Change Over	**£1.35**
CTM6	D.P. Biased C/Over	**£1.45**
CTC6	D.P. Centre Off	**£1.42**
CTE6	D.P. Centre Off ½ Biased	**£1.45**
CTG6	D.P. Biased Centre Off	**£1.45**

ROCKER SWITCHES

ARROW

SPECIFICATION: 16A, 250 Volts A.C. Contact Rating
Dimensions
1600 Series Cutout 27.4 x 12.3 mm.
2600 Series Cutout 27.4 x 22x3mm.

FEATURES:
- **Low cost**
- **Compact design with popular snap-in fixing.**
- **Choice of colour and termination.**
- **Complementary pilot lights and illuminated switches.**
- **Slow, make and break action providing Class B disconnections as defined in BS. 3955 Part 3, 1972.**
- **Overseas approved.**
- **Choice of single pole 1600 Series or double pole 2600.**



1 POLE 2 AND 3 POSITION

		PRICE
1600-22E	1 Pole On-Off (2 tags)	**£0.45**
1602-22E	1P2W Changeover 3 tags	**£0.51**
1603-22E	1P2W Changeover biased one way 3 tags	**£0.53**
1604-22E	1P2W Changeover 3 position centre off 3 tags	**£0.54**
1622-R22E	1 Pole On/Off with 250v red neon	**£1.10**

2 POLE 2 AND 3 POSITION

2600-22E	2 Pole On-Off (4 tags)	**£0.53**
2602-22E	2P2W Changeover 6 tags	**£0.67**
2603-22E	2P2W Changeover biased one way 6 tags	**£0.68**
2604-22E	2P2W Changeover 3 position centre off	**£0.71**
2600-R22E	2 Pole On/Off with red mains neon 4 tags	**£1.07**
2600-R52E	As above but for 12v filament indicator	**£1.02**

PILOT LIGHTS/INDICATORS

1609-R22E	250v Red mains neon indicator	**£0.53**
1609-G22E	250v Green mains neon indicator	**£0.78**
1609-R52E	12v Filament indicator red	**£0.48**
1609-G52E	12v Filament indicator green	**£0.48**

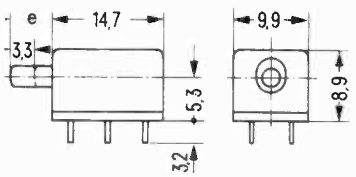
SIEMENS MINIATURE PCB SWITCHES

A new range of miniature quality switches specifically designed for the professional

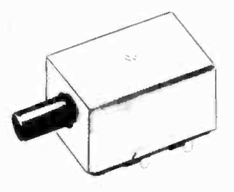
- Extremely reliable
- Break before make
- Double pole double throw
- P.C.B. mounting

Available in push buttons or slide version

Side slide versions	A60-A2	£1.70
Push button	A60-A3	£1.70
Slide switch top	A60-A1	£1.70

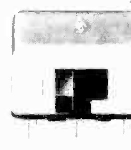


push button switch



C42315-A60-A3

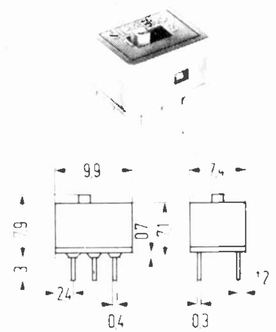
Side Slide switch



C42315-A60-A2

SIEMENS

SIEMENS MICRO MINI SLIDE SWITCH



The new slide switch (smallest version*) for P.C.B. mounting break before make contacts. The contact parts are gold-plated, 2 double-throw contacts. Further information available.

Part number C42315-A68-A1

£1.45 EACH.

QUALITY & RELIABILITY

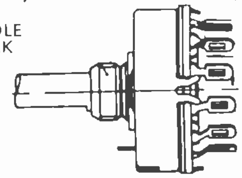
ROTARY SWITCHES

Available in four types all having adjustable rotation limit stop (Located under fixing nut and washer)

RSW12	1 Pole—Adjustable from 2 to 12 Way	**£0.54**
RSW6	2 Pole—Adjustable from 2 to 6 Way	**£0.54**
RSW4	3 Pole—Adjustable from 2 to 4 Way	**£0.54**
RSW3	4 Pole—Adjustable from 2 to 3 Way	**£0.54**

STANDARD ¼" SPINDLE
MAKE BEFORE BREAK

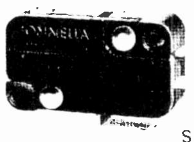
See Page 25 for knobs to suit.



MICROSWITCHES

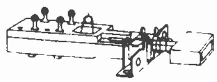
Miniature Microswitches—10A 250v AV Changeover type BODY DIMS. 28 x 16 x 10mm. Available as standard (S160) Or with free action lever-roller 17mm long (S162)

Price **54p**

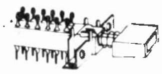


S.160

S.162



MAINS SWITCH **£0.50**



4 POLE BUSH-BUTTON **£0.45**

8-WAY MOUNTING FRAME **£0.15**

Both the push-button and the mains switch are supplied with a single mounting frame, which can be removed enabling them to be mounted on the mounting frame—up to 8 Way. The push-button is a latching action, Push-on, Push-off but can be converted to momentary contact by removal of the locating pin. All switches include knobs. Independent action.

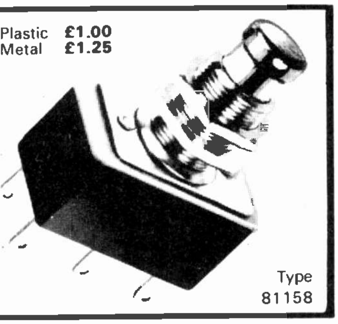
FOOT SWITCH

Plastic **£1.00**
Metal **£1.25**

2 Pole Change Over
Alternate Action
(Latching)

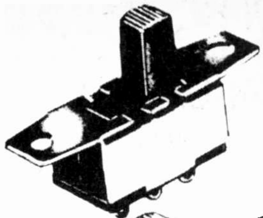
A Professional Switch – sturdy and rugged construction with strong metal or plastic button
Body DIMS
17 x 32 x 18mm
Rated 3A 250 AC

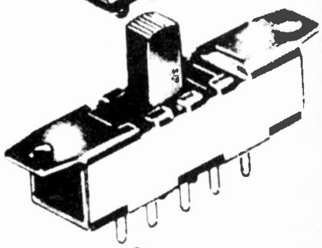
ARROW



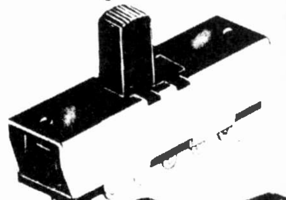
Type 81158

SLIDE SWITCHES



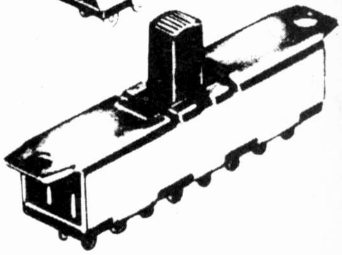


STANDARD	PRICE
DPDT 1A 250V Small 15 x 8 x 12	**17p**
DPDT 1A 250V Medium 16 x 17 x 9	**17p**
DPDT 1A 250V Large 22 x 13 x 8	**17p**
DPDT 1A 250V Large 22 x 13 x 8 Centre off	**17p**



MULTIPOSITION

2 POLE-3 POSITION 5295CS	**25p**
2 POLE-4 POSITION 5295CS	**25p**



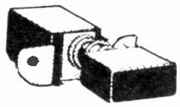
MULTIPOLE

4 POLE-2 POSITION 5289CS	**30p**
4 POLE-3 POSITION 5293CS	**30p**

PUSH BUTTONS

16p Push to make—Spring off
1A 250V Red, Yellow, Green
DIMS 16 x 6mm (dia)

25p Push to break—as above—Black

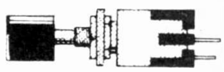


50p Push On/Push Off DPDT (6 tags)
DIMS 20 x 12 x 13mm
Red or Black

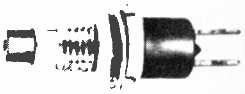
85p SPST (2 tags) DIMS 11 x 7 x 17mm
Spring loaded Red top

90p SPDT (3 tags) DIMS 11 x 7 x 17mm
Spring loaded Red top

ALTERNATE ACTION



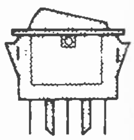
£1.08 DPDT (6 tags) DIMS 11 x 11 x 17mm
Spring loaded Red top latching



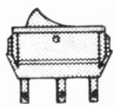
15p Push to make—Spring off
1A 250V
DIMS 14 x 6mm Diameter
Red, Yellow, Green, Blue and Black Top

ROCKERS

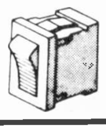
PRICE EACH



75p SP On-Off (3 tags) 3A 250V
White, See Saw
When on, Neon Lights
DIMS: 29 x 11 x 21



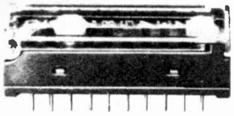
45p On-Off-On 10A 250V
British made, Rocks on-Off-On
DIMS. 29 x 11 x 18



22p SPST (2 tags) 6A 250V
White, miniature
BODY DIMS: 21 x 15 x 13mm

SIEMENS TURN-SLIDE SWITCHES

NEW



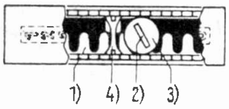
TYPE V42264-V1503-D13

This new version of the rotary switch is especially suitable for setting programs. The rotary switch is of a 3 elements 3 stops

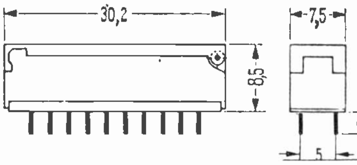
Voltage rating ≦60 V≃
Current rating ≦0.5 A≃

fixed contacts gold-plated

PRICE **£4.40**



[1]) Rack
[2]) Screwdriver slot
[3]) Switching element
[4]) Stop



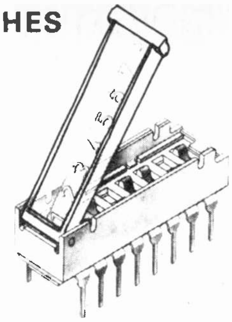
SIEMENS DIL SWITCHES

The new dual-in-line switch of printed circuits.

The transparent cover protects the contacts against dust.

Voltage rating ≦24 V≂
Current rating ≦0.5 A

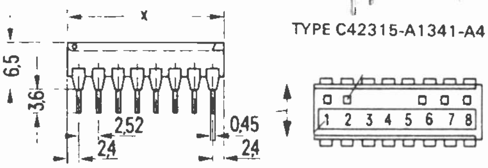
All contact parts are nickel plated and gold plated.



TYPE C42315-A1341-A4

8 WAY D.I.L.

£2.75



RELAYS—DIL

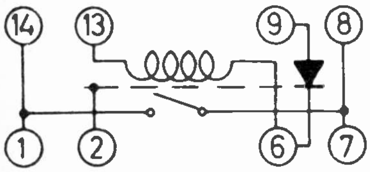
D.I.L. REED RELAYS

Low power drive — 35 mW — for operation direct from TTL
5, 12 and 24 V nominal coils available
Contact rating 10 VA switched to carry 1 A
Optional internal diode and electrostatic screen
Isolation between coil and contacts.
10,000 M-ohms — proof tested to 500 V min
At present available with 1 form A contact configuration

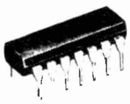
	Coil Resistance	VOLTAGE DC Operate	Release	Max	Nom	PRICE
15002	530	8	2	18	12	**£2.55**
15003	2000	16	4	32	24	**£2.55**
15005	360	3.5 (FROM TTL O/P)	1	15	5	**£2.55**
15005AB	360	3.5 (FROM TTL O/P)	1	15	5	**£3.25**
15005B	360	3.5 (FROM TTL O/P)	1	15	5	**£2.75**
15015AB	2000	11.5	4	32	15	**£3.35**

Modification 'A' — Electrostatic shield connected to pin 2.
Modification 'B' — Diode connected between pin 6 and 9.

PIN CONNECTIONS



DIL PACKAGE

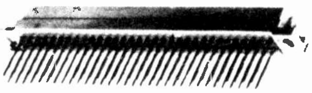


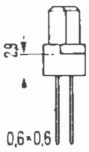
PICOREED

64 WAY PCB PLUG AND SOCKET

PCB SOCKET

£6.00

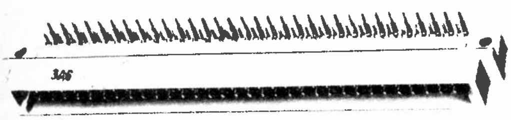


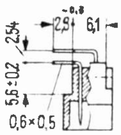


PCB PLUG

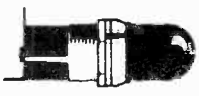
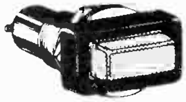
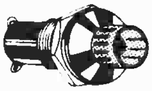
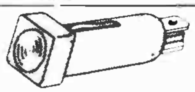
£3.95

BOTH PLUG & SOCKET FIT STANDARD EUROCARD AND ARE SUITABLE FOR ELEKTOR SC/MP PROJECT





INDICATORS & LAMPS

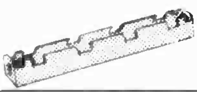
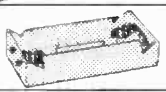
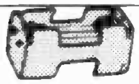
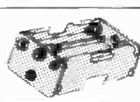
					Price
IN1	M575		RED	10mm HOLE	24p
IN2	M575		BLUE		
IN3	M575		GREEN		
IN4	M575		YELLOW		
IN5	M575		WHITE		
IN6	B215		RED	11mm HOLE	28p
IN7	B215		GREEN		
IN8	B215		BLUE		
IN9	B215		YELLOW		
IN10	B218		RED	11mm HOLE	30p
IN11	B218		GREEN		
IN12	B218		BLUE		
IN17	TB31S		GREEN RED	Neon. 240v.	35p
IN18	JH12R		RED	Neon. 240v	30p
IN19	JH12R		AMBER	Neon. 240v.	
IN20	JH12S		RED	Neon. 240v	30p
IN21	JH12S		AMBER	Neon. 240v.	

BULBS

To fit Indicators M575, B215 and B218

BU1	12v	12 volt. 0.1 amp. Lilliput screw	10p
BU2	6v	6 volt. 0.2 amp. Lilliput screw	

BATTERY HOLDERS

B1	B205		Moulded. To take four SP11 HP11 batteries in line. Tag terminals	32p
B2	B203		Moulded. To take four SP11. HP11 batteries Two by two. Snap terminals	32p
B3	A302		Moulded. To take four penlight batteries. Two by two. Snap terminals	20p
B4	A303		Moulded. To take four penlight batteries. Side by side. Snap terminals	20p
B4A	A304		Moulded. To take six penlight batteries. Three by three. Side by side. Snap terminals	28p

SERVICE AIDS

ELECTROLUBE — SERVICE AIDS

Product Description		Price
Electro-mechanical lubricant	340g	£1.00
Electronic cleaning solvent	340g	£1.00
Freezer	340g	·95
Contact treatment oil	170g	£1.00
Contact treatment grease	170g	£1.15
Anti-static foam cleanser	397g	·80
Clear protective lacquer	397g	£1.70
Electro-mechanical lubricant	5cc pen	·55
Contact cleaning strips	(20 strips)	·50

Postage **50p** per can

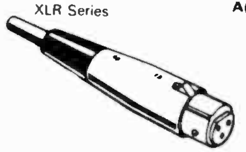
Reliable and safe to use

ELECTROLUBE

AUDIO CONNECTORS

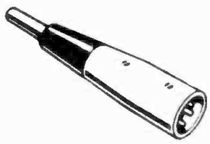
SWITCHCRAFT INC.®

Compatible with Cannon XLR Series



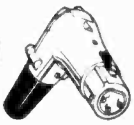
A(')F CORD PLUGS

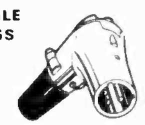
Fresh, streamlined design includes rugged, diecast zinc body, satin nickel finish, high-impact resistant thermosetting plastic socket insert, moulded latchlock, dual pressure plates, keyed neoprene relief bushing. Features "Ground Terminal" and "Ground Contactors" offers 4-, 5-, 6-, and 7-contact versatility. Mates with Switchcraft A( )M and other connectors with similar contact arrangements. Overall length 3 7/32"; diameter ¾".



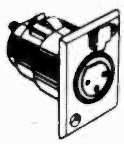
Has "Captive Design" insert screw, one-piece pin insert assembly easily removable for fast soldering. Polarizing groove. Die-cast zinc shell, satin nickel finish. Mates with Switchcraft A( )F and other connectors with similar contact arrangements. Brass, silver plated chromate dipped pins to resist tarnishing. Overall length 2 25/32"; dia. ¾".

RIGHT-ANGLE CORD PLUGS

A 

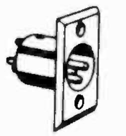
 B

Newly styled right angle cord plugs with rugged die-cast housings in two types. A R( )F female and, B R( )M male. Ideal for equipment with limited space for connectors. Satin nickel finish, high-impact resistant thermosetting plastic insert, moulded latch-lock, dual pressure plates. Features "Ground Terminal" and "Ground Contactors". Mates with Switchcraft A( )M, R( )M, S( )FM and other connectors and receptacles with similar contact arrangements.



D(')F RECEPTACLES

Rectangular flange design receptacle permits close mounting on crowded panel or chassis. Features "Captive Design" loss-proof insert screw, positive latch locking device and high impact thermosetting socket insert. Mates with Switchcraft A( )M and other connectors with similar contact arrangements. Dimensions: Flange 1 1/16" × 1 7/16"; Barrel 1 13/64" overall, pin extension ¼".



D(')M RECEPTACLES

Narrow, rectangular flange design receptacle for mounting on compact panel or chassis. Mates with Switchcraft A( )F and other connectors with similar contact arrangements. Dimensions: Flange ⅞" x 1 7/16"; Barrel 13/16" overall; pin extension 9/32".

THE ABOVE ARE AVAILABLE IN 3 & 5 PIN VERSIONS

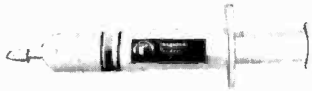
A3F	3 Pin	£1.90	R3M	3 Pin	£4.10
A5F	5 Pin	£3.85	D3F	3 Pin	£2.75
A3M	3 Pin	£1.65	D5F	5 Pin	£4.10
A5M	5 Pin	£3.30	D3M	3 Pin	£1.60
R3F	3 Pin	£4.50	D5M	5 Pin	£2.85

15% DISCOUNT for 50-piece Mix

THE PROFESSIONAL CONNECTION

SILICON GREASE

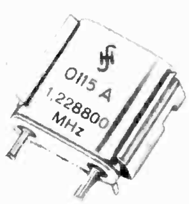
Thermpath 167 — When mounting semiconductors this material improves thermal resistance by up to 40%. The compound is stable over a wide temp. range and maintains insulation.



12gm vial (not illustrated)	£0.40
20ml. syringe (46gms)	£1.20

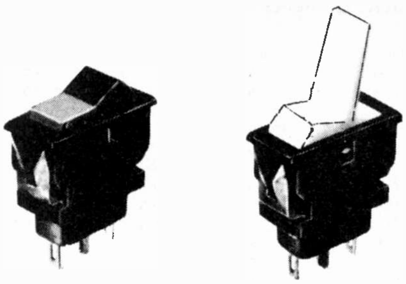
QUARTZ CRYSTALS

100 kHz	HC13/µ	£3.75
200 kHz	HC6/µ	£4.75
1 MHz	HC6/µ	£3.75
2 MHz	HC33/µ	£2.00
3.2768 MHz	HC33/µ	£2.75
4 MHz	HC18µ	£2.75
4.194304 MHz	HC18µ	£2.75
4.433619 MHz	HC33µ	£1.10
10 MHz	HC18µ	£2.50
10.7 MHz	HC6/µ	£2.75
18 MHz	HC18µ	£2.75
100 MHz	HC18µ	£3.95



FOR MICROPROCESSORS – CLOCKS – TV & GENERAL APPLICATIONS.

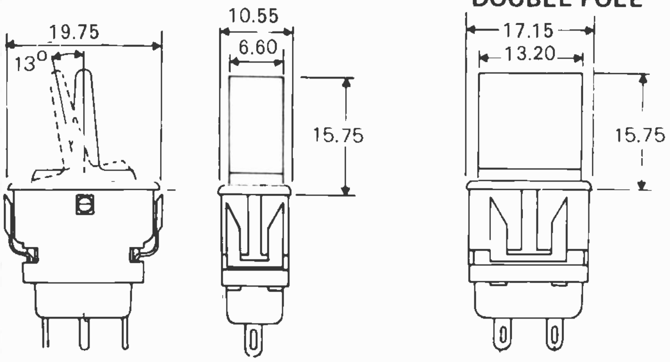
C SERIES SNAP-IN ROCKER & PADDLE LEVER SUBMINIATURE SWITCHES



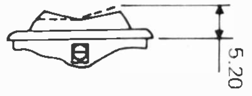
ARROW

■ Robust ■ Positive action ■ Light weight ■ Long operational life
■ Lever choice ■ Special requirements by enquiry

CP (Paddle lever)

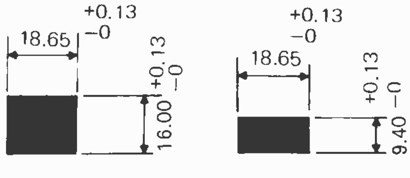


CR (alternative rocker lever)



other dimensions as for CP switch

Recommended panel cut outs



Panel thickness 3.2 max.

TYPE NUMBERS

1 POLE 2 & 3 POSITION	ROCKER	PADDLE
Single Pole Change over	CRS3	CPS3
,, ,, Biased C/off	CRM3	CPM3
,, ,, Centre Off	CRC3	CPC3
,, ,, C/off ½ Biased	CRE3	CPE3
,, ,, Biased C/off	CRG3	CPG3

2 POLE 2 & 3 POSITIONS – 6 TAGS		
Double Pole Change over	CRS6	CPS6
,, ,, Biased C/off	CRM6	CPM6
,, ,, Centre off	CRC6	CPC6
,, ,, C/off ½ Biased	CRE6	CPE6
,, ,, Biased C/off	CRG6	CPG6

Specification	2 Amps 250 Volts
Base Moulding	glass filled phenolic
Contacts	silver and silver/ copper alloy (gold plated to order)
Weight	4 grms. approx. 1 pole 6 grms. approx. 2 pole
Contact Resistance	10 milliohms maximum at 4v DC 1 amp.
Proof Voltage	2000v RMS
Insulation Resistance	100 megohms
Electrical Life	50,000 operations
Mechanical Life	100,000 operations (50,000 momentary action)
Temperature Range	−40°C to +80°C

OUR PRICES INCLUDE VAT

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
CRS3	**£0.90**	CRS6	**£1.25**	CPS3	**£0.90**	CPS6	**£1.25**
CRM3	**£1.10**	CRM6	**£1.40**	CPM3	**£1.10**	CPM6	**£1.35**
CRC3	**£0.95**	CRC6	**£1.35**	CPC3	**£0.95**	CPC6	**£1.35**
CRE3	**£1.10**	CRE6	**£1.45**	CPE3	**£1.10**	CPE6	**£1.45**
CRG3	**£1.10**	CRG6	**£1.40**	CPG3	**£1.10**	CPG6	**£1.40**

WHEN QUALITY, RELIABILITY AND STYLE REALLY COUNTS USE ARROW

MULLARD VALVES

QUALITY VALVES BY MULLARD

Type	Price	Type	Price	Type	Price
DY87/802	£1.05	GY501	£2.55	PCL805/8S	£1.55
ECC82	£1.15	GZ34	£1.90	PD500	£3.90
ECC83	£1.15	PC86	£2.05	PFL200	£1.97
ECC84	£1.35	PC88	£2.05	PL36	£2.05
ECC88	£1.90	PC97	£1.15	PL83	£2.55
ECF80	£1.35	PC900	£1.27	PL84	£1.55
ECH84	£2.45	PCC84	£1.37	PL95	£1.27
ECL80	£1.52	PCC85	£1.52	PL504	£2.15
ECL82	£1.52	PCC89	£1.55	PL508	£2.55
ECL86	£1.55	PCC189	£1.90	PL509	£3.65
EF80	£1.05	PCF80	£1.37	PL519	£5.20
EF85	£1.05	PCF86	£1.55	PL802	£3.45
EF86	£2.62	PCF200	£2.45	PY800	£1.27
EF183	£1.35	PCF201	£2.45	PY88	£1.40
EF184	£1.45	PCF801	£1.55	PY500A	£2.20
EL34	£2.25	PCF802	£1.55	UCH81	£2.67
EL36	£2.25	PCF806	£1.55	UCL82	£1.65
EL84	£1.15	PCH200	£2.58	UCL83	£1.65
EL86	£2.15	PCL82	£1.37	UL84	£1.85
EL95	£1.52	PCL84	£1.45		
EY86/802	£1.05	PCL86	£1.55		

WHY SETTLE FOR ANYTHING LESS – ASK FOR MULLARD

MULLARD AUDIO MODULES

TYPE	FUNCTION	PRICE
LP1173	Audio Amplifier Module 10 watts	£10.50
LP1181	AM, IF Amplifier Module	£6.30
LP1183/2	Stereo Pre-Amplifier Module	£7.70
LP1184/2	Stereo Pre-Amplifier Module	£11.90
LP1186	FM Tuner Module with Diode Tuning	£11.20
LP1400	Stereo Decoder Module	£11.90

All modules built and factory tested.
Full data with each module or send 5p + S.A.E.

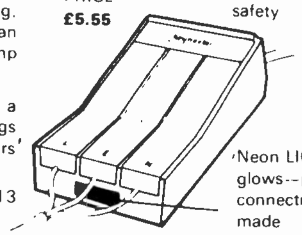
MAINS KEYNECTOR

PRICE **£5.55**

Ideal for high speed bench testing, shop demonstrations etc. It can take connections up to 13 amp maximum.

Connects electrical equipment to a mains supply in seconds. No plugs or sockets needed. No dangers from touching a live-wire circuit.

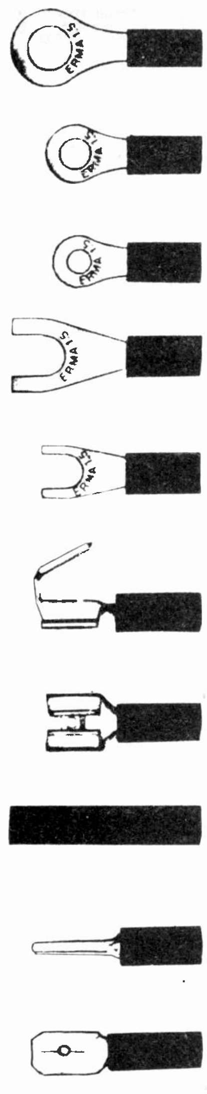
●Built-in safety switch with 13 amp fuse.



Fuse housing shut-keys cannot be depressed – circuit closed complete safety

Neon LIGHT glows – proper connection made

SOLDERLESS TERMINALS



	Red	Blue	
RING TONGUE			
	15715 **£1.65**	15735 **£1.65**	15715 M5 2BA
	15714 **£1.45**	15734 **£1.45**	15714 M4 6BA
	15713 **£1.35**	15733 **£1.35**	15713 M3 6BA
FORK TONGUE			
	15607 **£1.90**	15617 **£1.90**	15607 M5 2BA
	15606 **£1.60**	15616 **£1.60**	15606 M4 4BA
PIGGY-BACK ADAPTOR			
	15652 **£2.75**	15653 **£2.75**	15652 6.3x0.8 0.250x0.03
SLIDE-ON SOCKET			
	15671 **£1.60**	15673 **£1.60**	15671 6.3x0.8 0.250x0.03
BUTT CONNECTOR			
	15666 **£1.45**	15667 **£1.45**	15666 25.0 long 1.0 long
WIRE PIN			
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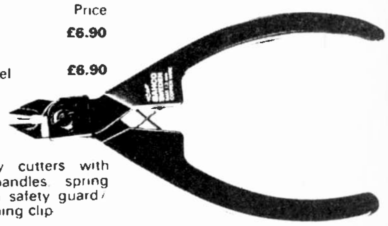
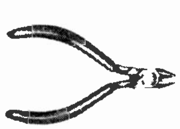
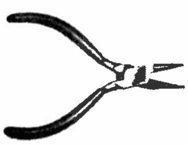


New safety cutters with insulated handles, spring loaded with safety guard/offcut retaining clip

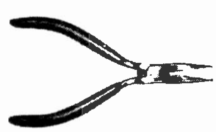
DIAGONAL



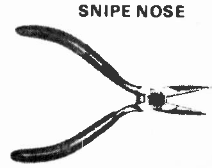
ROUND NOSE



FLAT NOSE



SNIPE NOSE



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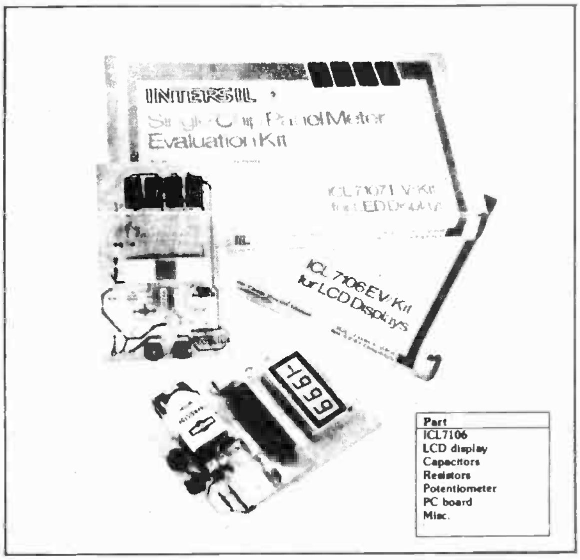

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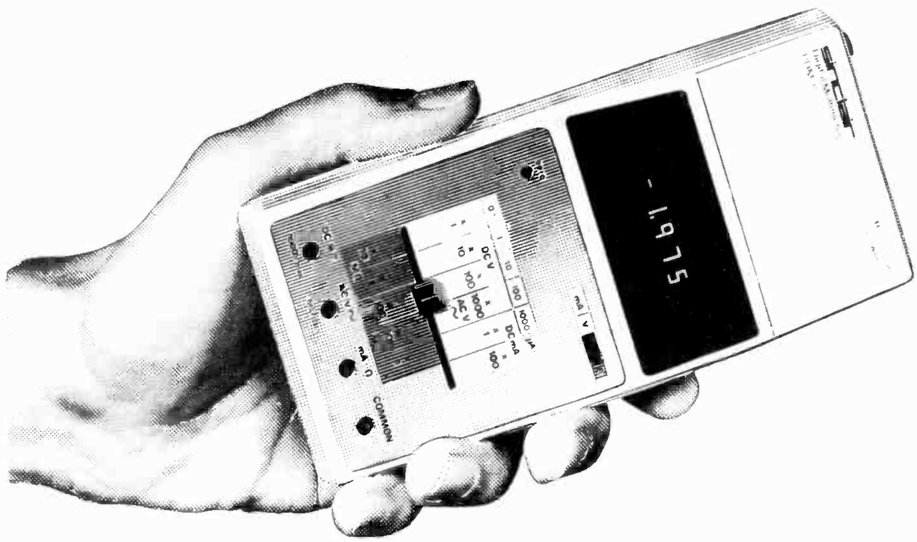

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What you get with a PDM35

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Sharp, bright, easily read LED display, reading to ±1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001μA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adaptor.
Industry standard 10 MΩ input impedance.

PDM35 – Meter	**£32.35**
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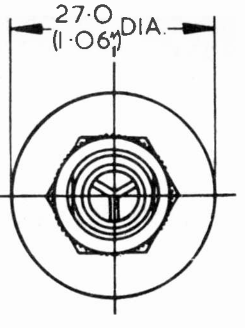
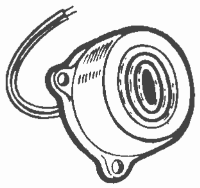


BUZZERS



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CH3	RF Choke	7.5 mH	**55p**
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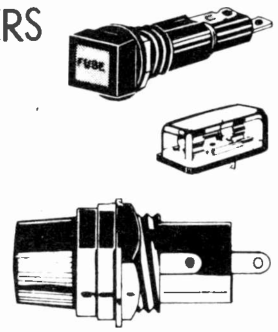

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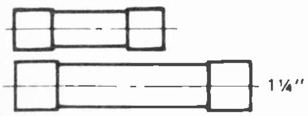
VALUE	QUICK BLOW	ANTI-SURGE
100mA	£.06	£.22
150mA	.06	.22
250mA	.06	.13
500mA	.06	.13
750mA	.06	.13
1AMP	.06	.13
1.5A	.06	.13
2 AMP	.06	.13
3 AMP	.06	.13
5 AMP	.06	.13
7 AMP	.06	.13
10 AMP	.06	.13
15 AMP	.06	—
20 AMP	.06	—
25 AMP	.06	—

FUSES 20mm

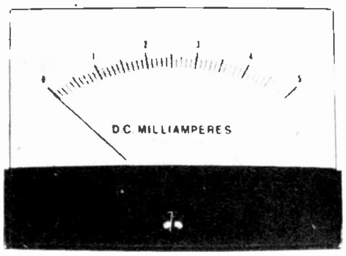
VALUE	QUICK BLOW	ANTI-SURGE
100mA	£.06	£.22
125mA	.06	—
160mA	.06	.22
200mA	.06	—
250mA	.06	.13
315mA	.06	.13
400mA	.06	.13
500mA	.06	.13
630mA	.06	.13
800mA	.06	.13
1 AMP	.06	.13
1.25A	.06	.13
1.6A	.06	.13
2 AMP	.06	.13
3.15	.06	.13
4A	.06	.13
5A	.06	.13
6.3A	.06	.13



Both 20mm and 1¼" fuses are available in quick blow or anti-surge Please specify

PANEL METERS

REF	CAT	F.S.D.
ME1	T21	0-50 UA
ME2	T22	0-100 UA
ME3	T23	0-500 UA
ME4	T24	0-1 MA
ME5	T25	0-5 MA
ME6	T26	0-10 MA
ME7	T27	0-50 MA
ME8	T28	0-100 MA
ME9	T29	0-500 MA
ME10	T30	0-1 AMP
ME11	T33	0-50v.AC
ME12	T34	0-300v.AC
ME13	T35	"S"
ME14	T36	"VU"
ME15	T40	50-0-50 UA
ME16	T41	100-0-100 UA
ME17	T42	500-0-500 UA



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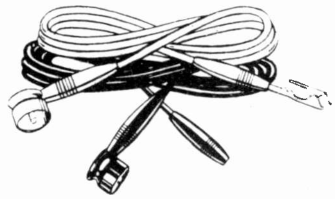

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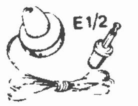
EAR PIECE
Magnetic **25p**
3.5mm PLUGS



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Complete with long reach prods - banana plugs, pin plugs, spades and crocodile clips — all push on fittings
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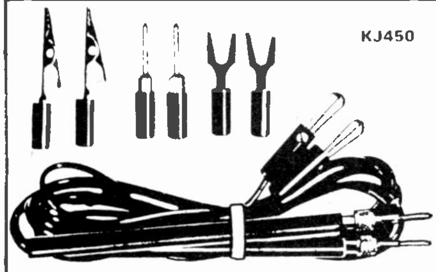

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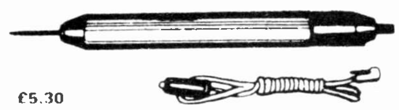
Unusually stable trouble-shooter — for checking TV, Radio, amp. etc. One hand operation — penlight battery. Output approx. 1.4v RP. at nom. 1kc/s + harmonics up to VHF measures 7" x .6"



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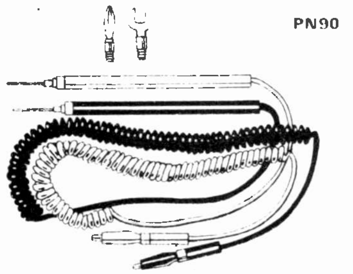
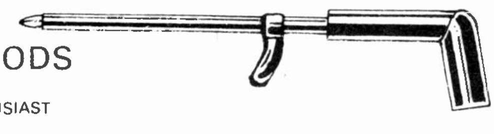
Complete luxury kit – curly leads, long reach prods — supplied with quality alternative ends, banana plug, pin plug, Spade terminal and croc clip. PRICE **£3.50**/SET



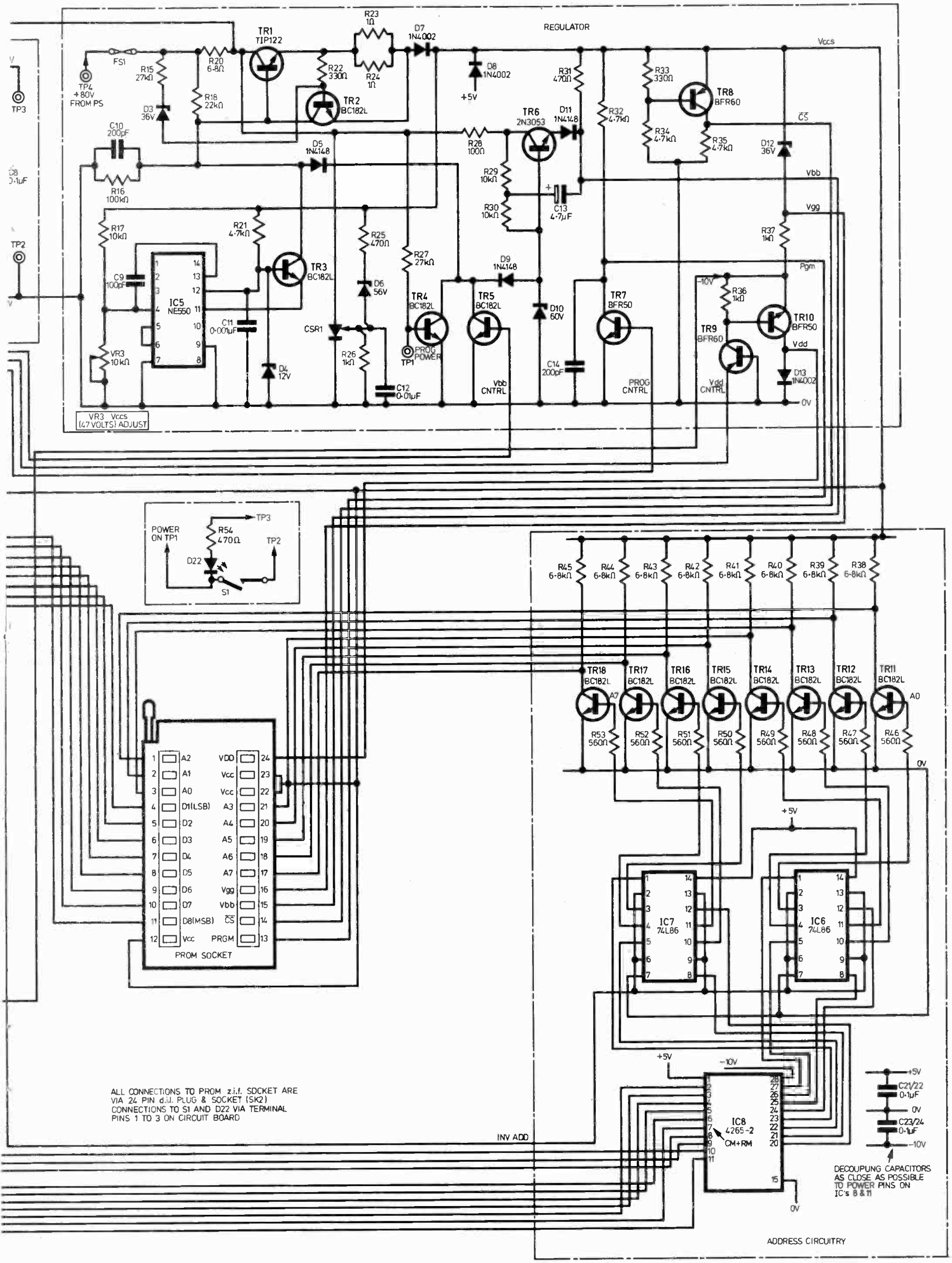
TEST PRODS



IDEAL EXTRA
FOR ANY ENTHUSIAST

SET OF 1 RED 1 BLACK PRICE **£1.55**/SET

INDEX


REGULATOR
ADDRESS CIRCUITRY
PROM SOCKET
VR3 Vccs (4.7 VOLTS) ADJUST
ALL CONNECTIONS TO PROM z.i.f. SOCKET ARE VIA 24 PIN d.i.l. PLUG & SOCKET (SK2) CONNECTIONS TO S1 AND D22 VIA TERMINAL PINS 1 TO 3 ON CIRCUIT BOARD
DECOUPLING CAPACITORS AS CLOSE AS POSSIBLE TO POWER PINS ON IC's 8 & 11
POWER ON TP1
INV ADD

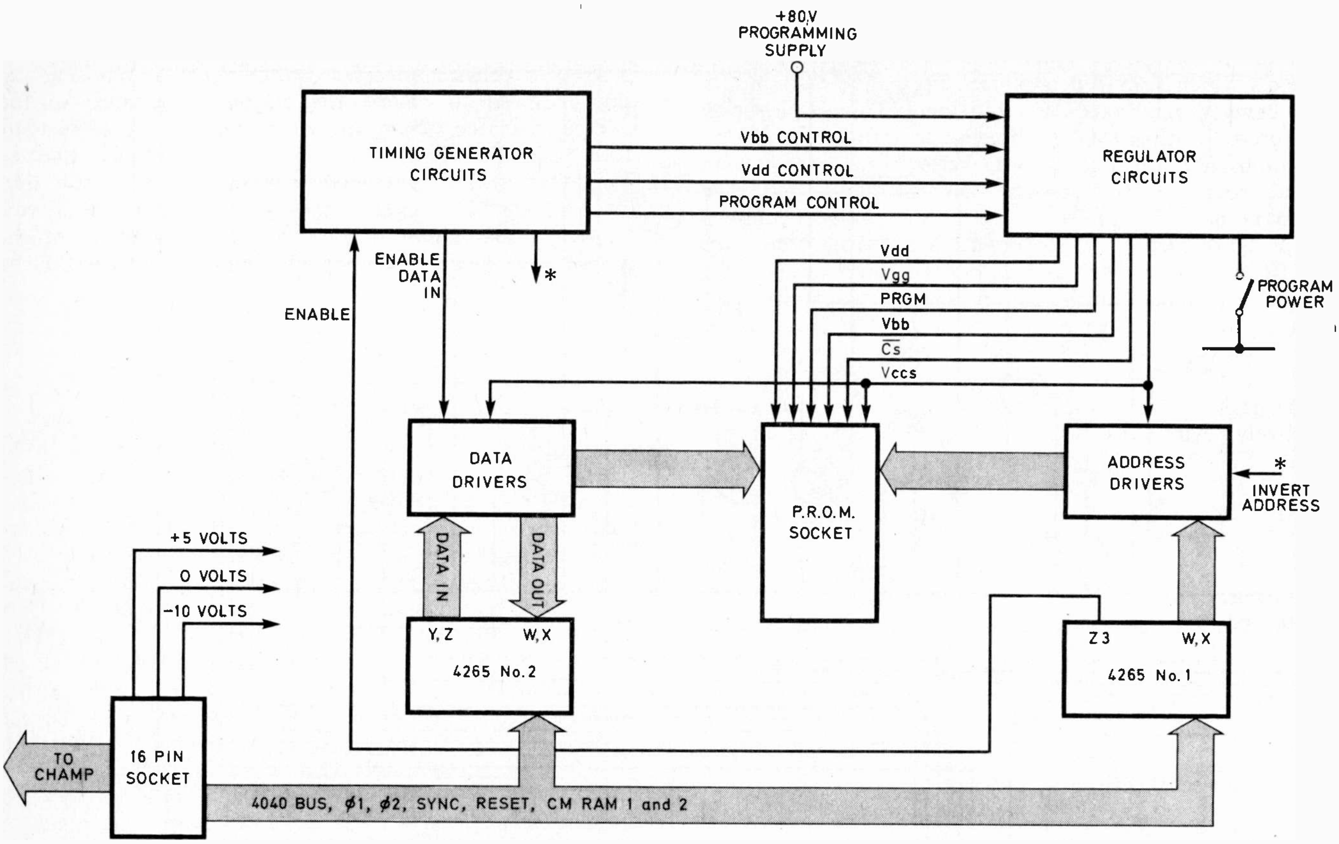


Fig. 8.3. CHAMP-PROG block diagram

that trigger each other continuously in the presence of a logic zero on the output of 4265 Number 1 port Z3. The timing generator produces a 3ms program pulse every 15ms, to give a 5:1 duty cycle, and also provides pulses to enable the program data input, and to invert the address information while Vdd and Vgg are in transition.

Because of the need to control the pulse timings to within tens of microseconds the timing function could not be carried out effectively by the 4040 itself, and so *it* has to be content with merely controlling the total *number* of 3ms pulses applied by means of port Z3 of 4265 Number 1. At present about thirty five consecutive pulses are applied, and this is determined by a 540ms software delay controlled by PROMPT. Some commercial PROM programmers operate in a slightly different way in that they provide four times the number of program pulses initially required to program a particular location, and thus adjust themselves to the needs of individual locations, using *less* pulses than CHAMP-PROG for most locations, but *more* for the stubborn ones. This latter technique has the advantage of faster (and some say more reliable) programming, but needs more complicated software. We mention it here in case anyone would care to modify the PROMPT software and try it, but there's no need to worry about this since we have never had a programming failure, and none of our PROMs ever forget! Intel themselves use the fixed duration programming techniques.

CHAMP INTERFACE

As mentioned earlier, all data, address, and control information is passed to and from the CHAMP-PROG circuit over the four-bit 4040 main data bus which is interfaced to two 4265 chips on the programmer circuit board. Up to four 4265's (including the one on the CHAMP main board) can be used with the basic CHAMP system, one to each CM-RAM line where it will respond to the RAM Chip-Two SRC address, 80H. 4265 Number 1 (IC8) is controlled by CM RAM 1 and is set to mode 4 (four four-bit output ports) as soon as PROMPT is initialised. This chip provides an eight bit address to select a PROM location on ports W and X, and uses output Z3 to control the timing generator. The other outputs are unused. 4265 number two (IC11) is set to mode 6 (two four-bit input ports, two four-bit output ports) and provides the data to be programmed on ports Y and Z, and monitors the data from the PROM between program pulses, using ports W and X. Monitoring the results of a programming sequence is necessary because after programming a location PROMPT checks the data output against the data sent earlier to ports Y and Z, to ensure that they are the same. Any discrepancy results in a program abort and a FAIL message. During programming, the data and address inputs to the PROM must take up voltage levels commensurate with the programming supplies, and so the outputs of the 4265 chips are connected to the PROM via discrete transistor drive circuits and low power t.t.l. gates. The address drivers are fed by 74L86 EXCLUSIVE OR gates which are controlled by the timing generator and used to invert the address information from 4265 number one during the transition period of 60 microseconds.

If you are wondering how the input data is presented to the 4702A when these devices do not *have* any inputs, the answer is that the data *outputs* are used as inputs during programming.

LED DISPLAY

On the prototype of CHAMP-PROG, an in-line array of l.e.d.s which provided a binary display of data in the PROM being programmed, was provided. This display was very pretty but was later thought to provide little information that was not available elsewhere, and so was deleted from the final version, with the happy result of a gain in noise immunity at the inputs to 4265 number two ports W and X. These l.e.d.s are shown dotted on the circuit and can be used if desired, they do at least provide helpful data during circuit debugging operations!

The output data from the PROM is monitored in a rather unusual way. The emitters of the PROM data line drivers (i.e. TR19) have a resistor in series, and in between program pulses the collector of this driver transistor is effectively "wire-ORed" with the PROM output driver. If the stored data is a logic 1, the collector voltage of the driver becomes +5V, and a voltage is developed across the emitter resistor due to the current through the transistor. If a logic 0 is stored however, the driver transistor collector is clamped to zero volts and it turns OFF, therefore no voltage is developed across the emitter resistor. Thus, the emitter resistor voltage is an indicator of the stored data, and this voltage is used to control another transistor (TR27) which provides a 5 Volt logic level at its collector to drive the 4265 inputs and the l.e.d.s if fitted.

TIMING GENERATOR CIRCUIT

The timing generator and voltage regulator sections of Fig. 8.2 are complicated enough to deserve a more complete explanation. IC's 1, 2 and 3 form the heart of the timing generator, and are 74123 (or 74L123 if you can get them) dual monostable circuits. IC1 provides the basic 15 millisecond P.R.F. and is a free running multivibrator which produces narrow negative going pulses at the pin 13 Q output. These pulses trigger IC2a which provides an accurately timed pulse of 3·25ms, its length being adjustable by means of VR1. The leading edge of this pulse triggers IC3a which provides a 155μs delay before triggering the actual program pulse monostable (IC3b). IC3b is set to 3·0ms by VR2. IC2b is triggered at the same time as IC3a, and this mono provides a pulse of about 60μs to invert the 4702A addresses while the supplies move to their programming levels. Four separate control outputs are produced by the timing generator, and these are buffered by means of 7405 (not low power) open collector inverters before distribution. The timing of these outputs is summarised in Fig. 8.4.

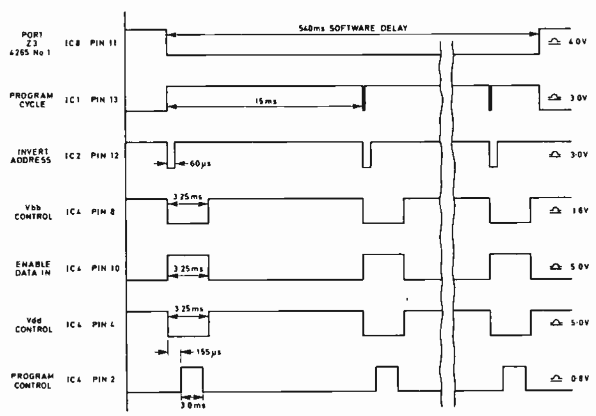


Fig. 8.4. Timing generator waveforms (not to scale)

You may have noticed that two of the 7405 outputs are returned, via 27 kΩ resistors to the +80V rail. This is done to provide superfast switching by minimising the time required to charge the wiring capacitance to the voltage regulator switch transistors, but the use of 80 volts does mean that these outputs should *never* be disconnected from their following transistor stage (during circuit testing for example), because the 7405 would be destroyed. Under normal circumstances the clamping effect of the base-emitter diode of the switch transistors makes the use of an 80V supply quite safe.

VOLTAGE REGULATOR CIRCUIT

The heart of the +47V regulator circuit is formed with IC5, TR3 and TR1. IC5 is a 14-pin 200mA regulator chip type NE550, similar to the more common LM123, and this device is used to provide the basic voltage reference and error amplifier functions required by any regulator circuit. The output of this chip controls the collector current of TR3, which has its base clamped to +12V by D4 and operates in the unusual "common base" mode. The collector load of TR3 is returned to the +80V supply rail, and the collector itself drives the base of TR1, which is the device which forms the "business end" of the regulator. TR1 has 80V at its collector, and during programming provides a +47V output at its emitter whilst passing current pulses of up to 0·5A. Obviously this is a demanding job, and the transistor chosen is a Texas TIP 122 monolithic darlington with a 100V 5A specification, and a current gain of at least 1,000 at 3A. The output voltage of the regulator is sensed at the cathode of D7 via a resistive divider, R17 and VR3, and is fed to the non-inverting input of the error amplifier in IC5. VR3 is of course used to set the output voltage to the required 47·0V.

PROTECTION

A double measure of protection is provided by the regulator circuit. TR2 acts as a current limiter when turned on by a voltage drop across R23||24 (0·5 ohms) which exceeds its Vbe threshold, thus diverting TR1 base current which clamps the output current to a level low enough to prevent destruction of the regulator during short-circuits. CSR1 and D6 act as a crowbar overvoltage protection circuit to prevent damage to other regulator components on the PROM being programmed should TR1 ever fail. On the appearance of a potential in excess of about 56V at the cathode of D7, D6 turns on and triggers CSR1 causing it to short out the 80V supply via R20 and blow FS1 (1A). A ruthless procedure perhaps, but without doubt the simplest and neatest way to disconnect supplies in an emergency!

Transistor TR6 and D10 form the other 60V regulator circuit, and in this case a simple Zener/emitter follower combination is all that is necessary.

SWITCHING CIRCUITS

Up to now I have referred to the regulators as though they were standard d.c. circuits, but of course they are not, because pulsed operation is necessary for proper programming. Both regulators are turned off by means of the clamp transistor TR5 which when not turned off itself by means of the 3·25ms Vbb CNTRL pulse from the timing generator, conducts to clamp the bases of TR1 and TR6 to a low voltage so that they cease to function.

In parallel with TR5 is TR4, and this transistor is capable of the same clamping action, but in this case it is controlled manually by means of the PROGRAM POWER switch on the front panel.

PROGRAMMING SUPPLIES

The other active components, TR7, TR8, TR9 and TR10 are used to generate the required PRGM, Cs, Vgg and Vdd voltage pulses from the "raw material" provided by the 47V Vccs line, the +5V line and the −10V line. The full complement of program voltage waveforms is shown in Fig. 8.5, and no doubt most readers will be able to see for themselves just how these are generated by the circuit. The Vccs line actually switches between +5V and +47V, and D8 provides the clamping action to maintain the +5V level in the absence of program pulses. Notice also that the 3·0ms PRGM pulse itself is actually a *negative* going waveform (+47V to 0V).

COMPONENTS . . .

Resistors

2 off 1Ω 1W 5%	R23, R24
1 off 6·8Ω 5W 5%	R20
1 off 100Ω 1W	R28
8 off 100Ω	R63–R70
2 off 330Ω	R22, R33
11 off 470Ω	R10, R25, R31, R87–R94
8 off 560Ω	R46–R53
14 off 1kΩ	R4, R7, R12, R26, R36, R37, R71–R78
2 off 2·7kΩ	R6, R8
7 off 4·7kΩ	R1, R2, R14, R21, R32, R34, R35
24 off 6·8Ω	R38–R45, R55–R62, R79–R86
3 off 10kΩ	R17, R29, R30
1 off 12kΩ	R9
1 off 22kΩ	R18
6 off 27kΩ	R3, R5, R11, R13, R15, R27
1 off 100kΩ	R16

All resistors ⅛W 2% unless otherwise stated, R87–R94 are optional l.e.d. resistors

Potentiometers

1 off 10kΩ 20 turn min preset	VR3
2 off 50kΩ 20 turn min preset (Doram)	VR1, VR2

Capacitors

1 off 100pF polyester	C9
2 off 200pF polyester	C10, C14
1 off 0·001μF ceramic	C11
2 off 0·01μF	C3, C12
9 off 0·1μF disc ceramic (2 for IC8 and 2 for IC11)	C1, C8, C15, C18, C20–C24
1 off 0·47μF ceramic	C6
2 off 1μF	C4, C5
1 off 2·2μF/35V tant bead	C2
1 off 4·7μF/35V tant bead	C13
4 off 22μF/25V tant bead	C7, C16, C17, C19

Diodes and Rectifiers

5 off 1N4148	D1, D2, D5, D9, D11
3 off 1N4002	D7, D8, D13
1 off 12V zener 1W	D4
2 off 36V zener 1W	D3, D12
1 off 56V zener 1W	D6
1 off 60V zener 1W	D10
8 off Min red l.e.d. (optional)	D14–D21
1 off Front panel red l.e.d.	D22
1 off Thyristor 400V/4A	CSR1

Transistors

1 off TIP122	TR1
28 off BC182L	TR2–TR5, TR11–TR34
1 off ZN3053	TR6
2 off BFR50	TR7, TR10
2 off BFR60	TR8, TR9

Integrated Circuits

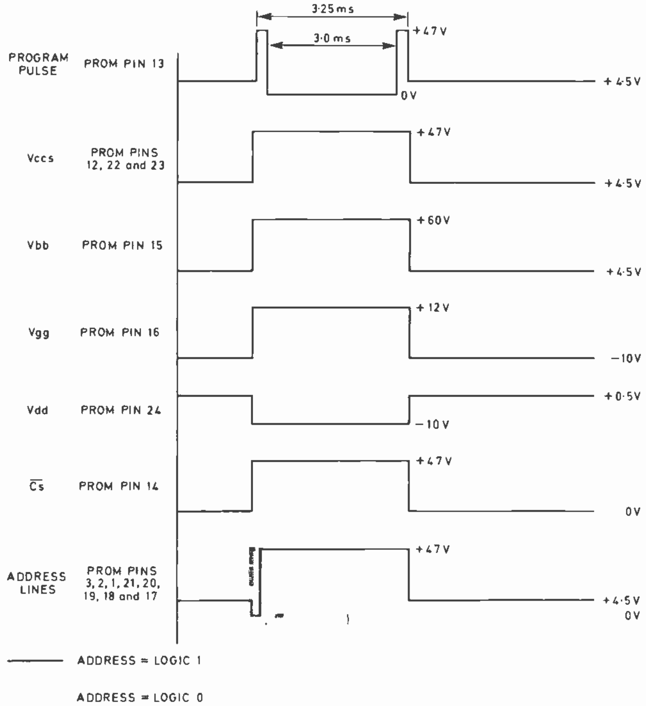
3 off 74123 or 74L123	IC1–IC3
1 off 7405	IC4
1 off Signetics NE550	IC5
2 off 74L86	IC6–IC7
2 off 4265–2	IC8, IC11
2 off 74L00	IC9, IC10

Miscellaneous

PROM socket 2, which is a 24-pin d.i.l. low profile p.c.b. type. Also a 24-pin d.i.l. header plug and suitable miniature flexible wire to form a loom.
Zero insertion force 24-pin PROM socket.
Fuse holder (p.c.b. type) and 1A fuse.
Reel of Kynar wire or similar
Piece of VB24 Veroboard cut to 88 holes × 160mm.
Soldercon pins (approx 200).
Terminal pins (0·1 inch).
One single sided 16-way d.i.l. low profile p.c.b. socket, complete with two 16-way d.i.l. header plugs joined by a 16-way ribbon cable to form a link between CHAMP and CHAMP-PROG, approx. 300mm long.
Fine 4BA plastics pillars cut to 20mm and glued to p.c.b.
Thin clear perspex sheet 650 × 220mm (to be fastened to pillars).

Constructor's Note

The zero insertion force 24-pin PROM socket (*Type 2, part No. 224-3344-00-0602*) is available from:
B.F.I. Electronics, Sinclair House, The Avenue, West Ealing, London W13.



SUCCESSFUL

CHAMP-PROG has proved to be a really useful addition to the CHAMP system, and the prototype has been used to program a total of more than 50 PROMS of mixed origin without a failure.

Intel 4702A and 1702A devices have been tried together with low cost surplus devices of unknown origin, and CHAMP-PROG has coped with them all. Anyone who has tried to develop their own software while using the CHAMP "postal programming service" will know just how expensive and unsatisfactory this can be. CHAMP-PROG will enable CHAMP programmers to be completely independent in their activities, and consequently very productive! ★

NEXT MONTH: CHAMP-PROG construction and PROMPT

A number of Intel MCS-40 User's Manuals and 4004/4040 Programming Manuals are held by P.E. at Poole, which we are willing to give away in sets on a "first come first serve" basis to anyone supplying a strong 11 × 13 inch s.a.e. with 54p stamp (67p 1st class).

Fig. 8.5. Address lines and regulator circuit outputs during program pulse

NEWS BRIEFS

Ring A Rig

COULD a worker on a North Sea oil rig 150 miles north-east of the Shetlands, pick up a normal telephone and dial directly to anywhere on the mainland? The answer is yes! Thanks to a £5 million top priority Post Office project, even the most distant oil platform, Thistle "A", came into the telephone network last November, giving workers there a telephone dial capable of calling 355 million phones in 67 different countries, just like subscribers on the mainland!

Over the next 15 months there are a number of platforms still to be linked into the system, known as the technique of trans-horizon radio, and which has never before been used by the PO. It all relies on the tropospheric scattering of microwave frequencies normally used for line-of-sight communication, but which are still visible to aerials far beyond the horizon. Turbulence in the troposphere (Earth's lower atmosphere) will cause this "fringe" of radio signals in much the same way as the glow from a distant searchlight might be seen, even when the beam itself is out of sight.

A powerful signal is beamed in the direction of the production platform, and a signal reduced in strength by something in the order of $1/10^{10}$ will reach the directional aerial waiting for it.

The control station is located near Fraserburgh, Aberdeenshire, and two relay stations are sited on South Shetland. Two separate troposcatter paths link land to a pair of platforms up to 30 miles apart, which are linked to each other by line-of-sight microwave. This completes the triangle for alternative path operation, giving high service reliability.

Traffic Computer

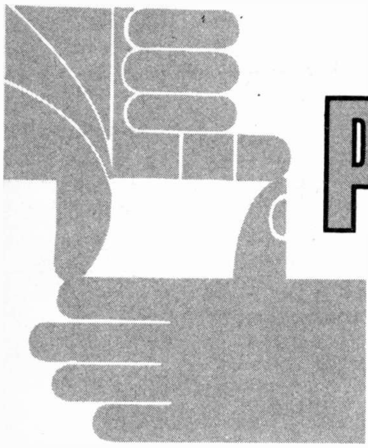
NOT all drivers in the Leicester area will realise that they are being told what to do by a computer, and have been since the Leicester Area Traffic Control Scheme became operational in October 1974.

The traffic plan swung into action with 96 traffic signals and Pelican crossings linked to a central computer via Telecommand/5 remote control systems, built by Plessey Controls Ltd of Poole, Dorset. As additional urban area signals were installed, they too were connected to the computer, bringing the total to 128 signals with expansion capability to 192.

Some of that spare capacity is now being used with an extension of the traffic control system to Loughborough, 11 miles away. Fourteen extra signals, including 7 on the A6, will spread the improved traffic flow situation, which was found in Leicester to give a 12 per cent decrease in delays to general traffic, and save travel time to buses of about 6 per cent during peak periods. There are now also 53 *special* detectors continuously relaying traffic information.

The Leicester Control Centre monitors both cities, where consoles comprising VDUs, closed circuit television, and a large mosaic map showing the condition at each intersection can be used to call up reserve plans for relieving congestion. Be it caused by a breakdown, an accident or any other unexpected event, the use of a reserve plan will activate a warning light at the appropriate point on the mosaic map. Any predictable problems such as the rush hour or football matches, will be dealt with by one of the computerised traffic plans.

A side-benefit of this system is immediate location of the majority of traffic light faults, and the computer even runs a special program during the night to check out all the signal timings and report any errors.



PATENTS REVIEW...

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

NAVIGATION AID   BP 1 484 183

In BP 1 484 183, Shell Internationale of the Hague, describes an interesting electronic movement sensing system for a ship. The need for a ship's captain to know exactly where he is, at exactly what speed, and in what direction he is travelling is obvious. Previous systems have used fixed master radars on a jetty with transponders on board the ship, or acoustic transducers underneath the ship's hull to set a fix on the sea bed. But transponders are only useful where there is a pair of master radars close by, and operation of the acoustic transducers is often upset by aeration effects under the ship created by the propeller during manœuvring. The Shell plan is to use a series of sensors along the ship and correlate the information they produce. At the ship's stern, where there is no aeration, a crossed pair of acoustic transducers or laser logs, working on the doppler principle, are mounted.

Element (5) provides a longitudinal speed signal and element (7), lateral velocity. At the side, amidships, there is mounted a rate of turn transducer, which can work on the tuning fork, gyroscope or laser principle.

A processor (12), has three inputs, one for the longitudinal speed signal, one for the rate of turn, and one for the lateral speed. The first signal, longitudinal speed, is amplified, and fed to a servo system to provide direct readout of forward/aft velocity. The rate of turn signal is amplified and fed both to a servosystem for direct read-out, and also to an operational amplifier 20, with three preset potentiometer positions. These represent the stern, midship and bow of the ship, and serve to introduce into the rate of turn signal the three longitudinal components of the distance between the positions on board ship and the location of the velocity transducer. The selected output signal is summed at (32) with the lateral speed signal.

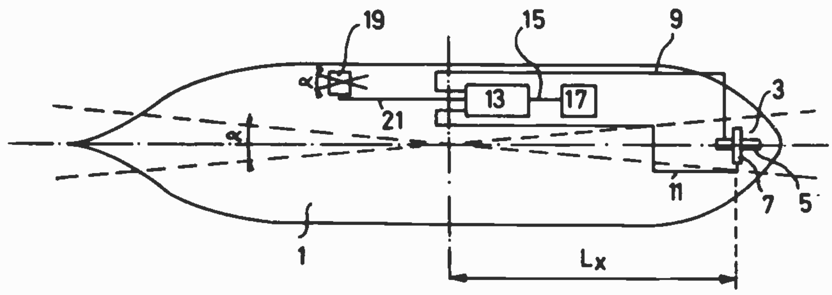


Fig. 1

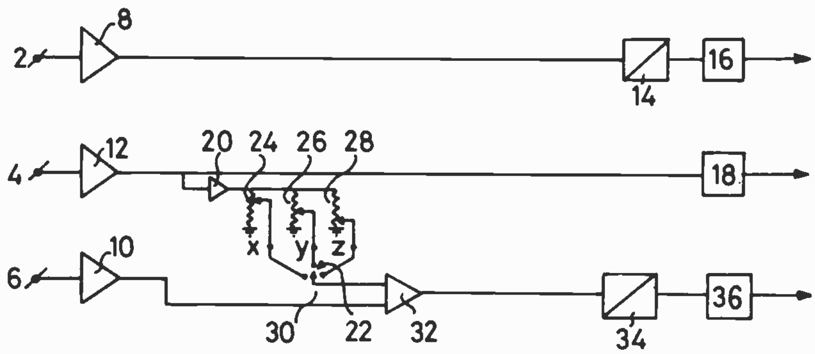


Fig. 2

The captain switches the presets to provide a signal representative of the absolute lateral velocity at the stern, midship or bow station. The claim is that this signal summation technique will, when the midship station is selected, cause any unwanted oscillatory rate of turn signal to cancel any unwanted oscillatory lateral velocity signal. This clever approach permits absolute velocity of the ship to be displayed, without any need for the signal damping techniques which are normally necessary to obviate high seas motion and so preserve readability of the data display. Damping is of course undesirable because it reduces accuracy of the display. The algebraic theory behind the invention is detailed by Shell, and it is likely that it would be applicable to private yachts.

Semiconductor UPDATE...

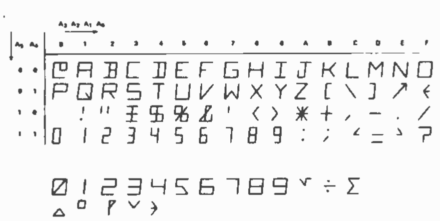
FEATURING : HDSP 6504/6508 MC6875 1435

R.W. Coles

SHOWING THE FLAG

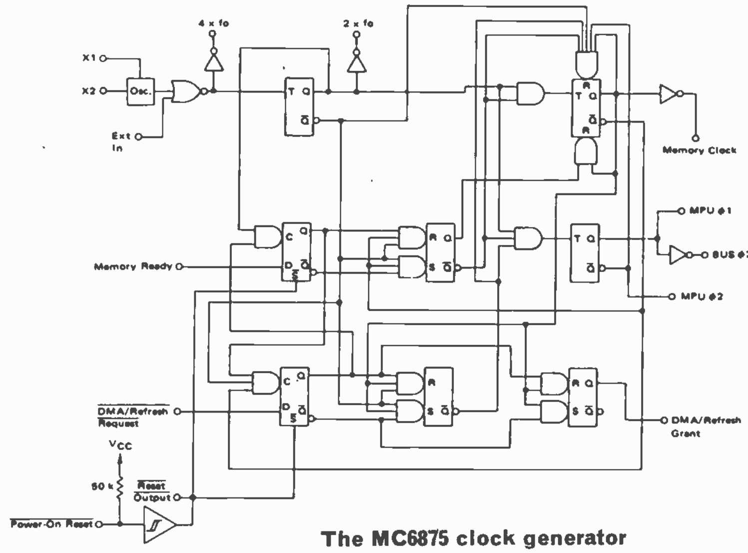
When you are desperate, it is *possible* to display a sort of Alphabet on cheap seven segment indicators, but be warned that the resulting mixture of upper and lower case, with a few inverted letters like M and W, is usually quite unintelligible to the uninitiated! There can of course be excellent reasons for using this revolutionary new kind of script, and you will discover the most important of these when you examine the cost of buying and driving a multi-character, true alphanumeric, l.e.d. dot matrix type of display. A very sobering experience indeed! At this point you either have to resign yourself to that weird new alphabet that you invented or, if you need a lot of characters, you can deprive the family of "Kojak" and rewire the family T.V. set as a V.D.U. (This solution will cost you about £50 and a couple of front teeth.)

Before you pursue either of these alternatives, cast an eye in the direction of two new displays from Hewlett Packard, the **HDSP 6504** and the **HDSP 6508,** because these may be offering you a compromise too good to miss. The new displays are l.e.d. segment units, but they boast not seven but *sixteen* segments arranged as a sort of "upended Union Jack" which can handle not just the alphabet, but the full 64 character ASCII set which includes punctuation marks and arithmetical signs.



"Union Jack" display fount of the HDSP6504/6508 display

Driving these displays is just like driving the seven segment types only more so, a job easily handled by your pet microprocessor using a 128 byte look-up table and a few I/O ports. The "Union Jack" format is not new, and was available in the older gas discharge type of display families, but what Hewlett Packard have done is to put together potentially cheap, multi character display "sticks" of 0·15 inch character height, which are almost as easy to drive as any other multiplexed l.e.d. display. The 6504 has four characters, and the 6508 has eight, and these may be used together and stacked end to end to give a line of any reasonable length. The availability of these displays gives us a viable alternative to the v.d.u. where only a single line of data is really needed, or where space is a problem.

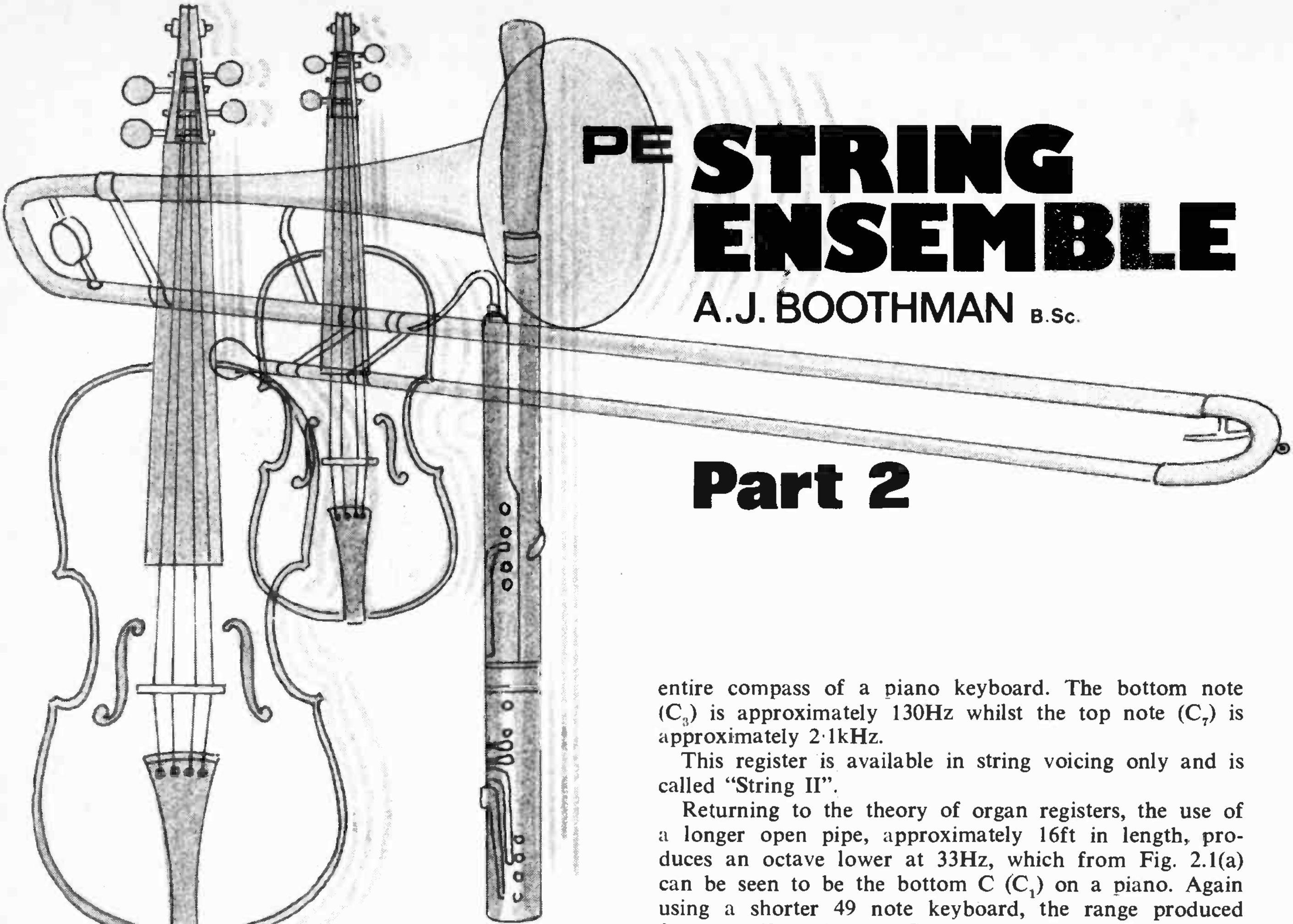


The MC6875 clock generator

CHEAPER CLOCKS

Anyone who uses the 6800 micro from Motorola is probably very pleased about the easy-to-use, 5 volt operation of their system, but perhaps not so pleased about the requirement for an external clock generator in not-so-cheap hybrid form. This requirement probably wouldn't bother anyone using a ready made system, but when you want to put together a dedicated system, like an electronic door bell, low cost is vital and an on-chip clock can save a lot of money. Well, I can't offer a new 6800 with an on-chip clock, but Motorola *have* made it possible to build a cheap off-chip clock, by introducing the **MC6875** monolithic clock generator. This chip can be used instead of the existing hybrid module designs MC6870A, MC6871A, and MC6871B, and offers other advantages like a built in power-on reset circuit and logic for implementing various DMA (Direct Memory Access) schemes. The hybrid modules did have the unique advantage of an internal crystal, whereas the MC6875 requires a separate crystal, but the new device is more flexible because it can be used over a wide range of frequencies, and for ultra low cost designs the crystal can be replaced by a simple RC network.

The new chip makes possible the use of sophisticated DMA schemes and dynamic RAM refresh systems with a 6800 processor, because in addition to the clock and reset logic the MC6875 contains circuitry to stretch clock cycles on demand. For this purpose a DMA/REFRESH REQUEST input and a DMA/REFRESH GRANT output are provided. The chip uses high speed Shottky t.t.l. logic and is housed in a 16 pin ceramic d.i.p.



PE STRING ENSEMBLE

A.J. BOOTHMAN B.Sc.

Part 2

THE Tone Generator system described last month provides up to 96 square wave frequencies, 85 of which are used in the String Ensemble to facilitate a number of combinations of register for both hands, and up to three even harmonics above the fundamental over the entire keyboard range.

For simple reference in playing the instrument I, II and III indicate the register of the fundamental range of each control, and equate to the organ terminology of 16ft, 8ft and 4ft respectively.

FOOTAGES

The use of the term "footage" arose in organ parlance due to the length of pipe required to produce a particular fundamental frequency. An open pipe approximately eight feet long produces 65Hz, which is two octaves below middle C on a piano, and on a classical organ with a 61 note manual the range would extend for five octaves to three octaves above middle C (261Hz) up to approximately 2·1kHz, and this would be known as the 8ft pitch, normal pitch, or 8ft register. A spinet type of organ, which is the format normally employed in entertainment type organs uses either 49 note or 44 note keyboards, and in the 8ft register of the upper manual maintains the same number of octaves above middle C, with a reduced number of notes below middle C.

The String Ensemble follows the recognised practice for the latter type of organ and it can be seen from Figs. 2.1(a) and 2.1(b) how the 8ft register relates to the entire compass of a piano keyboard. The bottom note (C_3) is approximately 130Hz whilst the top note (C_7) is approximately 2·1kHz.

This register is available in string voicing only and is called "String II".

Returning to the theory of organ registers, the use of a longer open pipe, approximately 16ft in length, produces an octave lower at 33Hz, which from Fig. 2.1(a) can be seen to be the bottom C (C_1) on a piano. Again using a shorter 49 note keyboard, the range produced from a 16ft register is C_2 at approximately 65Hz to C_6 at approximately 1·05kHz with middle C (C_4) exactly half-way up the keyboard. This 16ft register shown in Fig. 2.1(c) is available in string, woodwind, and brass voicing and is the fundamental orchestral register (I) used in the String Ensemble.

LOWER KEYBOARD SPLIT

With the "Couple" push button control depressed all 49 notes give a continuous range, at either 16ft (I) or 8ft (II), for the voices selected on the Upper Voice sliders. However three further push puttons allow the keyboard to be split such that the lower 16 notes are independent of the upper 33 notes.

Fig. 2.1(d) indicates the "String I" button depressed, and under these conditions the upper 33 notes remain under the control of the sliders, whilst the lower 16 notes convert to 16ft (I) strings only.

The lower range is C_2 to E^{b}_{3} at approximate frequencies between 65Hz and 156Hz. Depression of "String" (II) converts the lower section to 8ft, ranging from approximately 130Hz to 311Hz (C_3 to E^{b}_{4}), Fig. 2.1(e), now converting middle C (C_4) into the left hand, in addition to remaining within the compass of the 16ft (I) setting, Fig. 2.1(c), of the upper section of the keyboard which is played by the right hand.

The "String III" push button converts the lower section to 4ft pitch (C_4 to E^{b}_{5}), which as shown in Fig. 2.1(f) commences at middle C on the piano compass and it can now be seen that the lower section clearly rises in register above the middle of the upper keyboard section, with a fundamental range of approximately 261Hz to 622Hz.

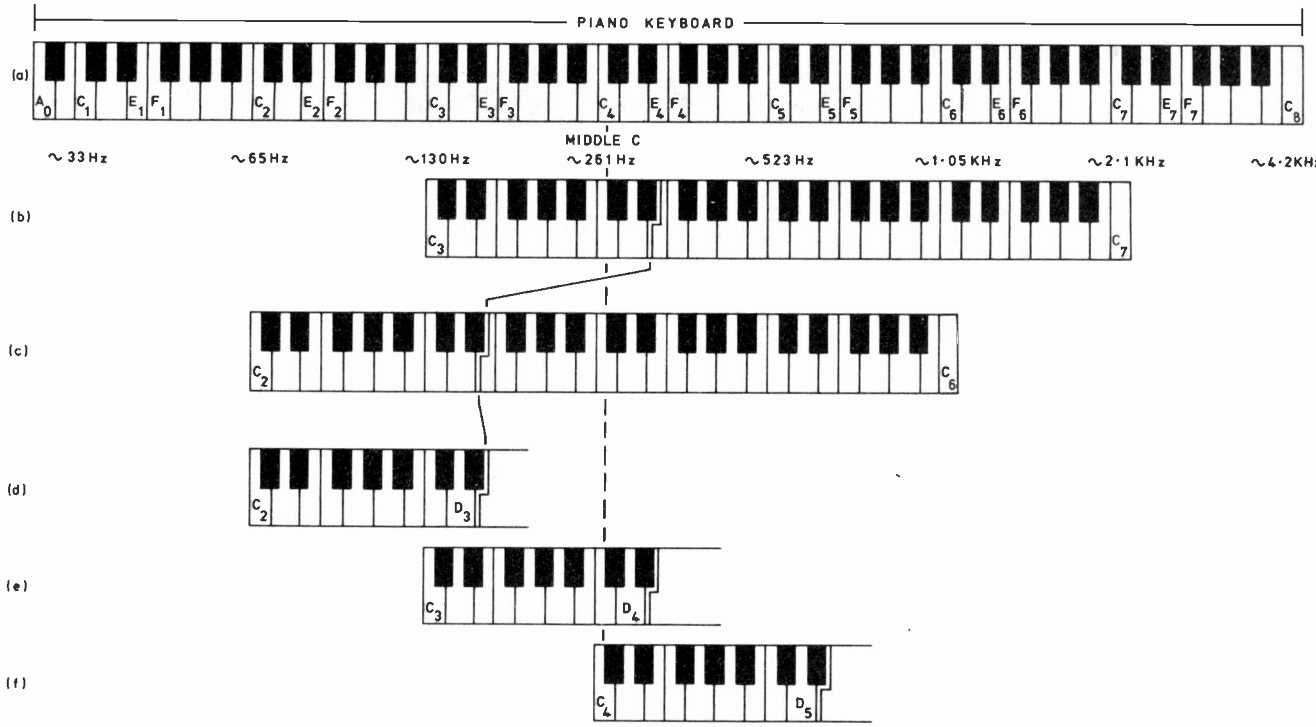


Fig. 2.1. Keyboard registers of the String Ensemble relative to a piano compass (a) Piano compass (b) Ensemble 8ft register—"String II" (c) 16ft register (String I, woodwind and brass) (d) Lower keyboard split—16ft "String I" depressed (e) Lower keyboard split 8ft String II depressed

ADDITIONAL FREQUENCIES

The highest fundamental frequency shown for the instrument is indicated in Fig. 2.1(b) as approximately 2.1kHz (C_7). Frequencies up to approximately 8·4kHz are available from the Tone Generator system and these are used to give additional even harmonics to be described later in association with the voice circuitry.

FREQUENCY SWITCHING

The switching of the large number of frequencies, including harmonics, described above is complex by traditional means in which direct signal keying by multi-mechanical contacts has been used. Many modern electronic organs simplify this problem by the use of electronic keying utilising diode, transistor, or integrated circuit elements with single mechanical contacts.

Diode keyswitching has been adopted in the String Ensemble.

COMPONENTS . . .

DIODE GATES (49 required)

Resistors
R5 3·3k Ω (49 off)
R6–R13 120k Ω (392 off)
R14 10k Ω (49 off)
¼W 5% carbon film

Capacitors
C13 4·7μF elect. 25V (49 off)

Potentiometers
VR6 10k Ω linear slider
VR7 4·7k Ω log slider

Diodes
D14–D22 1N4148 (441 off)
D23–D30 1N4148 (8 off)

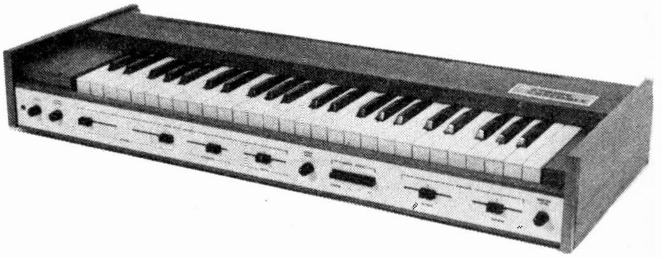
Miscellaneous
3 printed circuit boards
49 note keyboard (Italian style) with set of keyswitch components—(Clef Products)

DIODE KEYING

Switching of the Tone Generator frequencies through to the voice circuits is accomplished by diode gating circuits shown in Fig. 2.2. One circuit within the shaded area is required for each note of the keyboard such that whilst that key is down four octave related square waves corresponding to the note concerned, are switched independently onto busbars identified as 16ft, 8ft, 4ft and 2ft.

SHAPING FOR ATTACK

On depression of the key the moving keyswitch makes contact with a keyswitch rod which is at a positive potential thus charging C13 via R5 with a relatively slow time constant to simulate the slow attack of a string section. The keyswitch rod receives its potential via a slider potentiometer VR6 which further slows the charging rate of C13, and the optimum string attack rate is chosen to coincide with VR6 in its mid position.



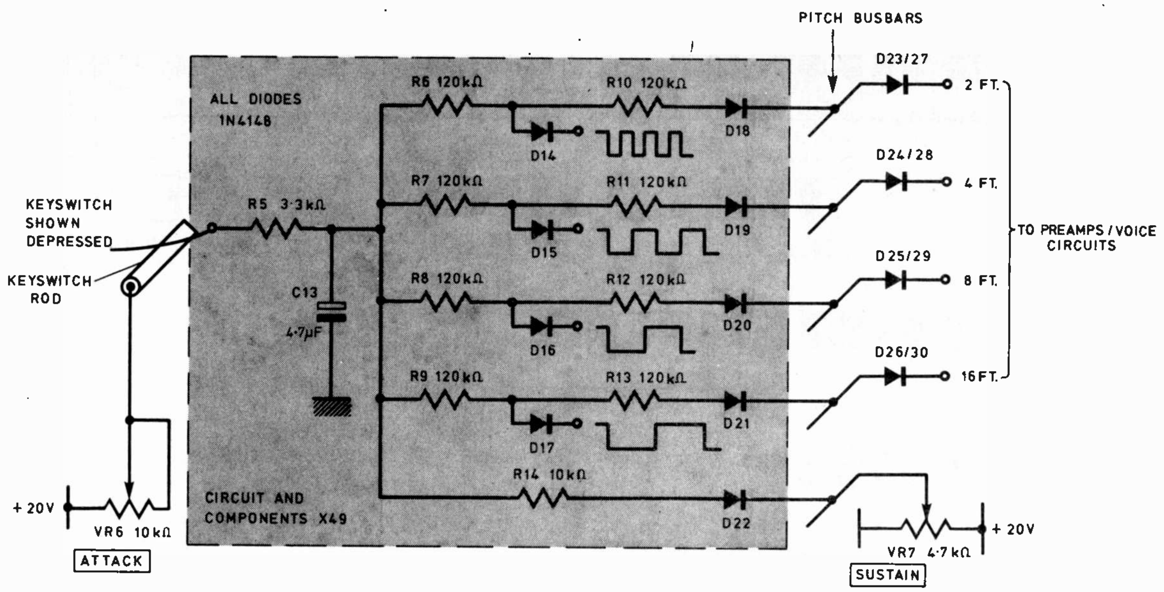


Fig. 2.2. Diode gating circuits

This simple "Attack Control" produces a degree of automatic levelling of the overall output as the number of notes depressed changes which is useful in simulating the smooth flow of the string section, but the slowest attack position can introduce the effect to an excessive degree, whilst in the fastest attack position the keyboard section is fully additive.

SUSTAIN

When the key is released the capacitor C13 is discharged at a rate dependent on the time constant of C13 coupled with the combined effect of resistors R6–13, which are eventually grounded via terminating resistors on the busbars, but modified by the effect of R14 which is returned via D22 to a potential set on slider potentiometer VR7. When the potential is high it is isolated from C13 by D22, but when VR7 is at minimum potential (0V) the low value of R14 dominates over the R6–13 combination to produce a short sustain. As the potential from VR7 is set at an increased level, the domination of R14 ceases when the falling potential on C13 approaches that on VR7 such that the longer time constant associated with R6–13 comes in earlier giving an overall increased length of sustain.

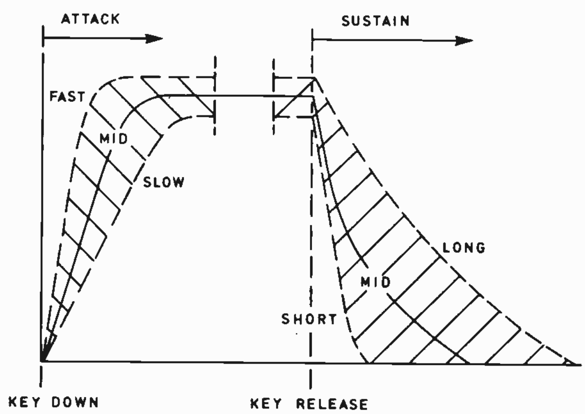


Fig. 2.3. Envelope shapes produced by the Diode Gate circuits

The resulting envelope shapes available are shown in Fig. 2.3, indicating the variations possible from the mid position each of the slider potentiometer controls.

TONE SWITCHING

The required octave related square waves for a particular note are connected to the cathodes of D14–17, and have amplitudes of approximately 14 volts. Assuming the key is at rest with the keyswitch in the open circuit condition then C13 will be discharged and the junction of R5 and C13 at zero potential. Thus the anodes of D14–17 will also be at zero potential and the reverse characteristics of the diodes will block the Tone Generator signals.

Whilst a positive potential is present on C13 during the envelope generation process, the signals will pull down the voltages on R6–9 via D14–17 allowing signals to pass through R10–13 which are proportional to the envelope amplitude.

BEEHIVE REDUCTION

"Beehive" is the term used to describe the effect of all frequencies in the Tone Generator breaking through into the amplifier circuits in chorus, producing a background level of sound which gives considerable annoyance. There are many routes in a polyphonic instrument by which this can occur, related to screening, cable looming and earthing of the various sub-assemblies, but the first route to consider is the direct transmission of low level tones through the keyswitch system when it is supposedly in its quiescent state.

Diodes D18–22 first isolate each gate from the other 48 such that from the point of view of one signal it does not see the 120 kilohm resistors in all other notes of the same pitch, only considering the terminating resistor at the end of the busbar in determining its final level at the preamplifier. Secondly the diodes block the sum total of signals from the keys depressed feeding back to C13 and providing a small positive potential for the signal to modulate in a supposedly quiescent note. The diodes also

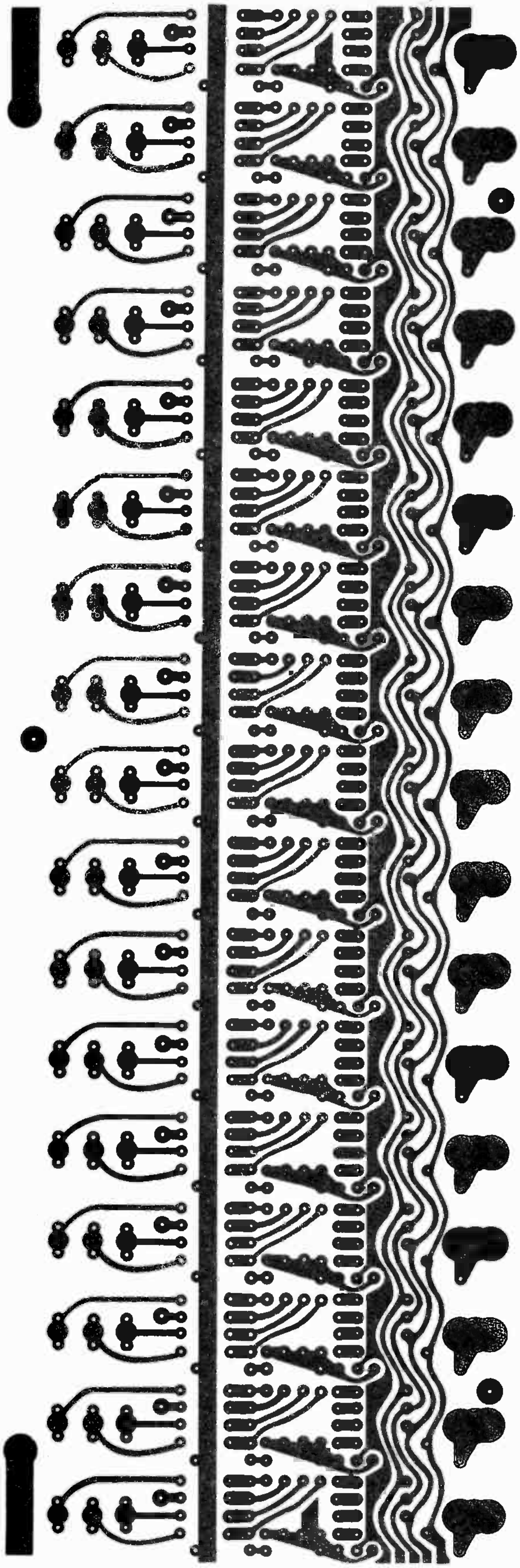


Fig. 2.4. Track layout of Diode Gate p.c.b.

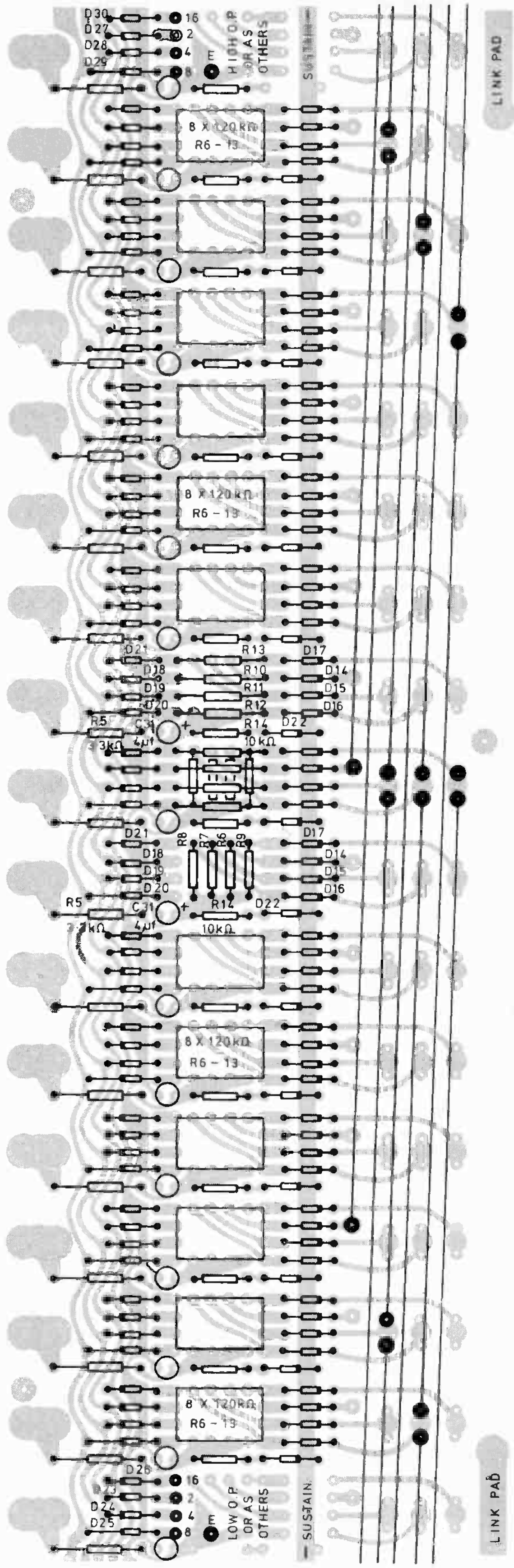
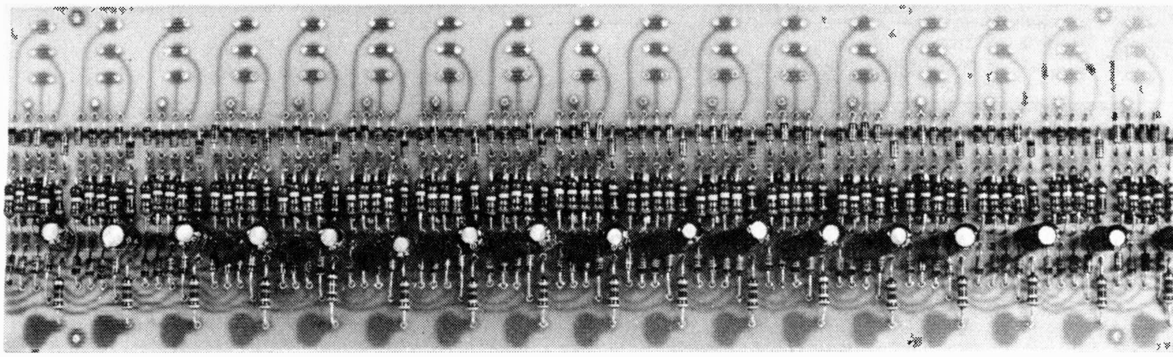


Fig. 2.5. P.c.b. component layout



have a high impedance in the forward direction at low voltages to assist the blocking of any small residual voltage on C13, and effectively increase the values of D18–22 in this condition.

Finally it has to be accepted that even when reversed biased D14–17 allow low level spike signals to pass due to internal capacitance, and the small finite stray capacitance of D18–22 further reduces to a small degree the onward transmission of signals from this source.

THRESHOLD DIODES

Even at this stage beehive signals are present on the pitch busbars in the quiescent state and diodes D23–30 are used to further block the breakthrough from reaching the preamplifiers. Since the keyboard is split with two independent sets of outputs from the keyswitch circuits, two sets of threshold diodes are required, D23–26 for the lower section of the keyboard and D27–30 for the upper end of the keyboard.

The overall result is negligible beehive due to transmission through the Diode Gate circuits, and since all signals are in square wave form, with a common baseline potential, the signal harmonic content or distortion level is not modified.

DIODE GATE P.C.B. CONSTRUCTION

All Diode Gate circuits are mounted on three printed circuit boards, the etching and drilling details of which are given in Fig. 2.4, with the component assembly details in Fig. 2.5. The boards are designed to accommodate 49 identical circuits of the type previously described within the shaded area of Fig. 2.2. Since each board has a pattern to cover 17 notes, two are omitted, one at each end of the final three board assembly, and the remaining spaces are used to accommodate the threshold diodes D23–30. Thus in Fig. 2.6 it can be seen that PCB1 is at the lower end of the keyboard and contains 16 notes plus threshold diodes D23–26 on the left hand end, PCB2 contains 17 notes, whilst PCB3 contains 16 notes plus threshold diodes D27–30 at its right hand end at the upper end of the keyboard.

To assemble the Diode Gate p.c.b.s resistors R5, R14 and R6–9 should first be fitted to the board, omitting R10–13 at this stage. All diodes, including D23–30, should then be soldered followed by R10–13, and finally C13. Care should be taken when fitting R10–13, which are mounted across R6–9, that none of the resistor lead ends are positioned such that shorting can occur.

CLOSE INSPECTION

Experience has shown that whilst repetitive soldering of the type involved in this project is easy, ninety percent of problems occurring in similar projects can be eliminated by *close* physical inspection of the completed p.c.b. The most common fault is to completely miss a solder connection, such that after cropping the waste leads a superficial check on the board indicates that all connections are made. On closer more careful inspection it can then be seen that a component wire is simply passing through a hole without any solder present.

A second possible fault is the creation of a solder bridge

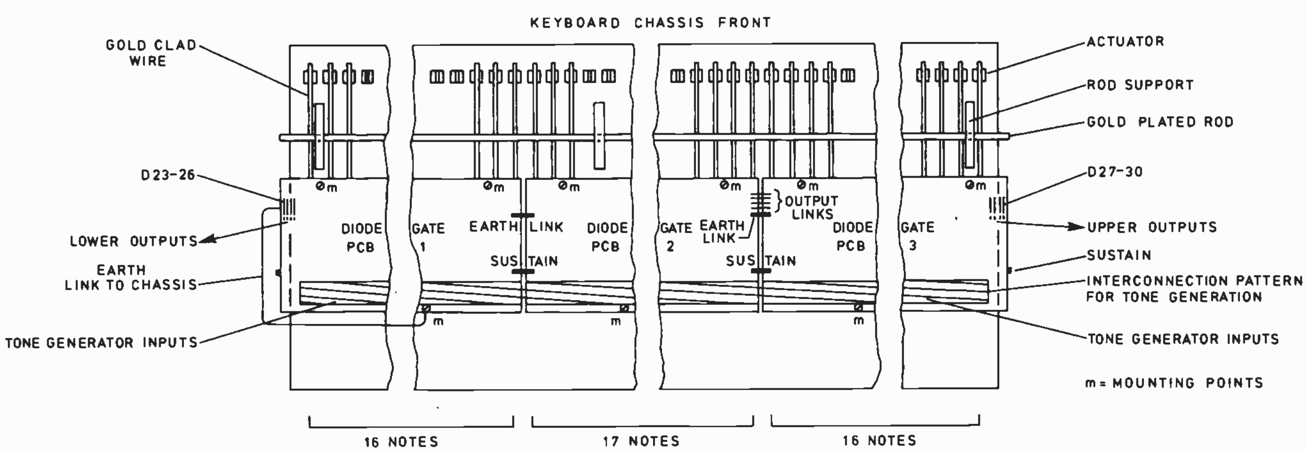


Fig. 2.6. Assembly of Diode Gate p.c.b.s under Veroboard

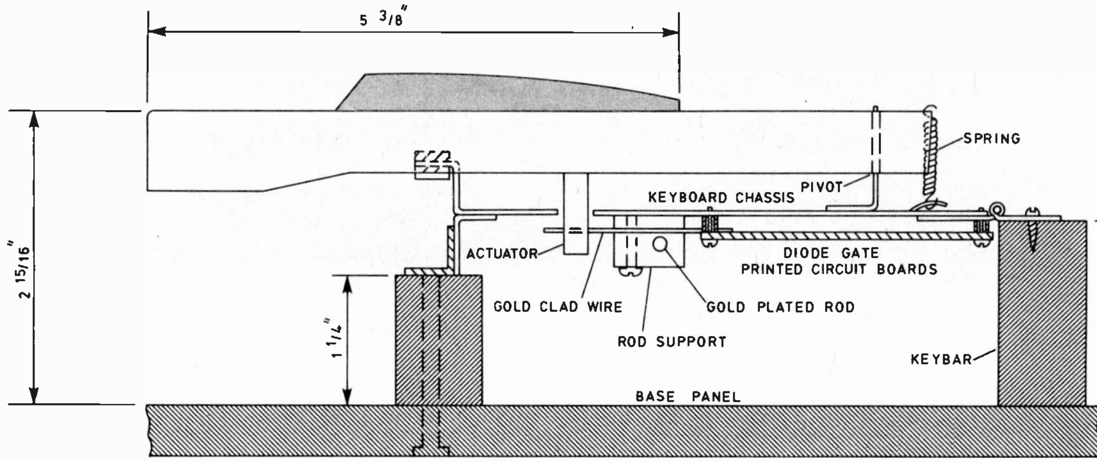


Fig. 2.7. Keyswitch and Diode Gate p.c.b. mounting detail

between two adjacent lands or tracks which again requires careful inspection to detect.

Whilst on the subject of faults the one other error which does occur is the incorrect reading of resistor or capacitor values by factors of ten. Careful attention to these three points in a positive manner leads to a very high degree of complete project success first time when using modern reliable components.

GATE CONTROLS AND P.C.B. MOUNTING

The "Attack" and "Sustain" controls, VR6 and VR7 respectively, are mounted on the front panel at a later stage, and are unnecessary in any tests carried out after assembly of the Diode Gate p.c.b.s and keyswitch.

Referring back to Fig. 2.6 the position of the Gate p.c.b.'s can be seen and before any interwiring is carried out the mounting points (m) for the p.c.b.s can be marked on the keyboard chassis using both Figs. 2.6 and 2.7. Fig. 2.6 also indicates connections between each of the diode gate p.c.b.s.

The interconnection pattern to distribute the signals from the Tone Generator is given in detail later, but it should be noted that earth and sustain links are required both between PCB1 and 2 and between PCB2 and 3. A link should also be made from an earth track to the keyboard chassis to provide an additional screening effect. A further four output links are required between PCBs 2 and 3 which together constitute the 33 notes of the upper section of the keyboard. Outputs for this section are taken from diodes D27–30 and for the lower section from diodes D23–26.

Output footages are marked in Fig. 2.5, with a point E for connecting the four-core cable screen.

KEYBOARD AND KEYSWITCH

The keyswitch action is integrated with the Diode Gate p.c.b.s and consists of gold clad springy wires approximately 2 inches long soldered onto lands provided on the p.c.b.s. Details are shown in **Fig. 2.7.**

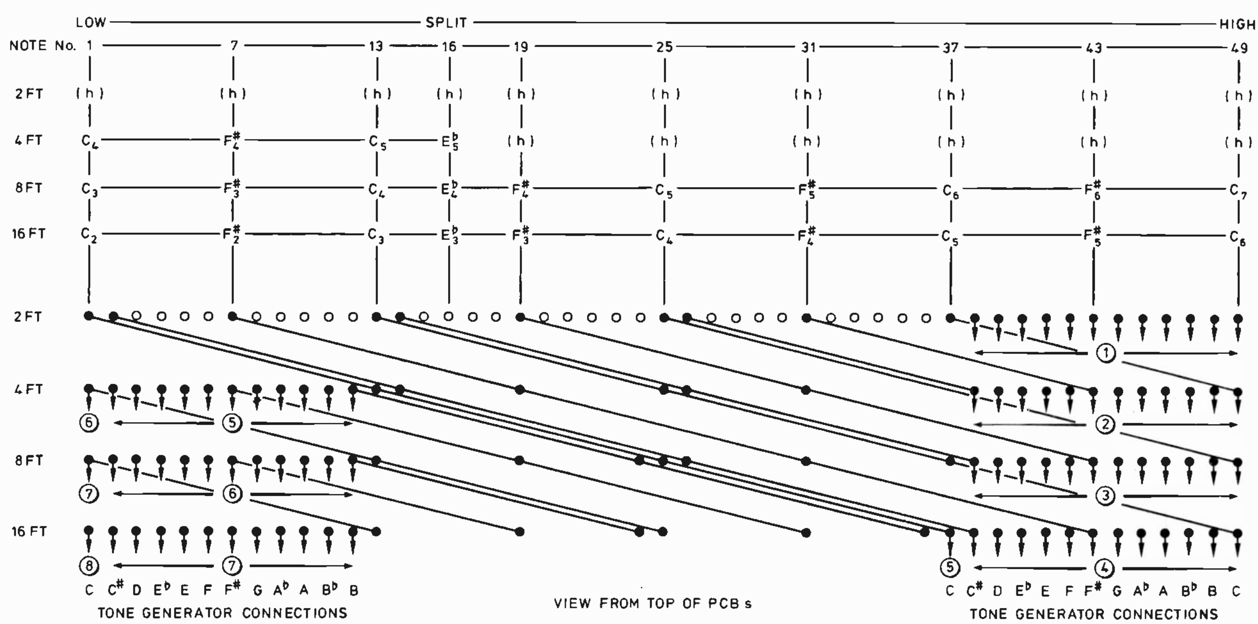
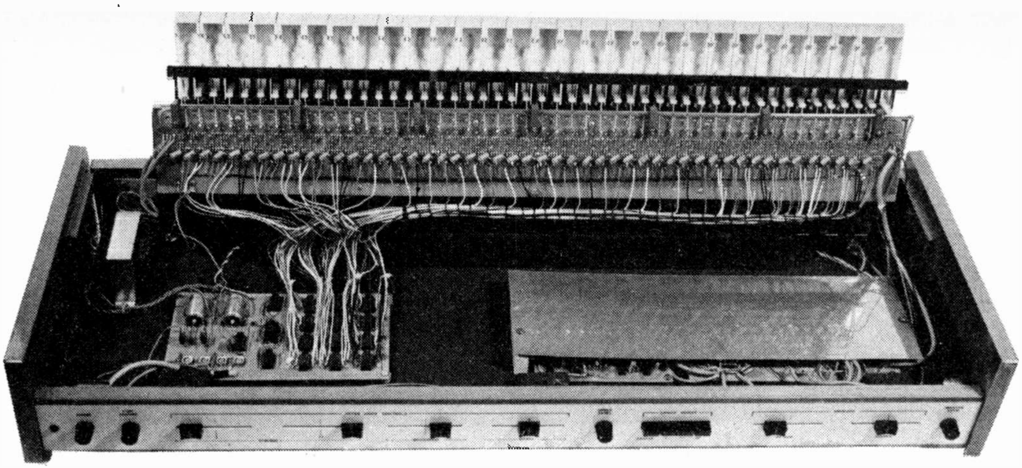


Fig. 2.8. Interconnection pattern for Diode Gate p.c.b. and connections to Tone Generator



The Diode Gate p.c.b.s are shown fixed to the underside of the keyboard with stand off insulated washers.

INTERCONNECTION PATTERN

In order to distribute signals at the four pitches 16ft, 8ft, 4ft and 2ft from the Tone Generator to each note on the keyboard an interconnection process to the pattern shown in Fig. 2.8 is required. This is carried out on the Diode Gate p.c.b.s, a continuous wire linking for example the 2ft gate input for note No. 7 with the 4ft gate input for note No. 19, the 8ft gate input for note No. 31, and the 16ft gate input for note No. 43, then continuing as the interconnecting lead to the Tone Generator board output F♯(4).

All notes in this example are F♯'s and it can be seen from Fig. 2.8 how the same F♯(4) tone generator frequency acts as the fundamental where F♯5 in the piano keyboard, shown in Fig. 2.1(a), occurs, i.e. at 16ft and 8ft in notes 43 and 31 respectively, whilst in note 19 it acts as the fourth harmonic for F♯3 at 16ft and the second harmonic for F♯4 at 8ft, and in note 7 as the eighth harmonic for F♯2 at 16ft, the fourth harmonic for F♯3 at 8ft and the second harmonic for F♯4 at 4ft.

This pattern is repeated for every pitch of every note until a complete matrix is made up with 85 interconnecting leads to the Tone Generator board.

MATRIX CONSTRUCTION

The three Diode Gate board assembly is constructed before it is fixed to the keyboard. The three boards should be temporarily clamped in line using nuts, bolts and washers at the front and rear of each junction, or in a temporary timber frame which allows the boards to sit in slots during assembly.

The first process is to solder the earth and output linkages previously described and shown in Fig. 2.6. Two extra link pads are also provided on the p.c.b.

Copper wire of approximately 28 s.w.g. with a solderable insulated coating is used to build the matrix. A few guidelines for the pattern are given on the p.c.b. component identification diagram in Fig. 2.5. A continuous wire both interconnects the relevant pitch on each note and acts as a lead between the Diode Gate p.c.b.s and the Tone Generator. A solder land is provided on the Gate board for each pitch of each note and has two holes one on each side of the land.

The copper wire is threaded through one hole from the top of the board and then returned through the remaining hole. All interconnect wires can be "knitted" in this way prior to soldering and then as a final process a hot iron is used to melt the insulation providing the solder connection to each land. A cross section of the joint is shown in Fig. 2.9.

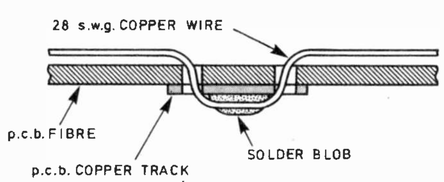


Fig. 2.9. Cross section of solder joint and method of threading copper wire through Diode Gate p.c.b.s

TONE GENERATOR CONNECTION

The points at which interconnect wires are taken from the Diode Gate boards to the Tone Generator are shown in Fig. 2.8. The corresponding Tone Generator frequency reference numbers are also given in this diagram, i.e. C(1) to C(8).

When threading the wires to construct the matrix, an extra length should be allowed to reach the Tone Generator. For connections taken from the left hand group in Fig. 2.8 an extra 16 inches should be allowed, and for connections taken from the right hand group an extra 30 inches should be allowed.

As each wire is fitted to the matrix, labels can be attached to the tone generator end of the lead identifying the tone generator reference numbers, or alternatively identification can be ignorsd whilst interwiring and a multi-meter used to locate the leads at a later stage.

TESTING THE GATE/KEYSWITCH ASSEMBLY

A test of the system can be carried out at this stage by terminating each of the output busbars with 10 kilohm resistors to ground giving simple square wave outputs at 16ft, 8ft, 4ft and 2ft, from lower and upper parts of the keyboard. The Keyswitch rod should be fed direct from the +20 Volt supply on the Tone Generator board, and the sustain line may be fed from either +20 Volts or ground to give maximum and minimum sustain respectively.

Note: In Fig. 1.6 the copper track between pins 1 and 14 should be broken.

Next Month: Cabinet assembly and Chorus System description.

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74162	102p
74163	102p
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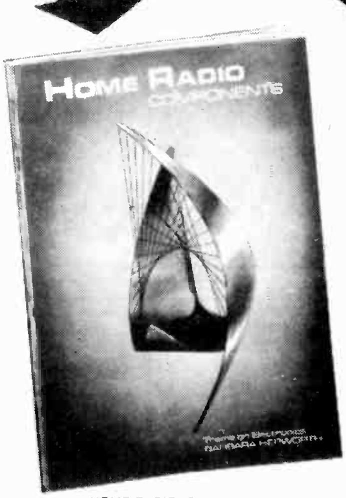

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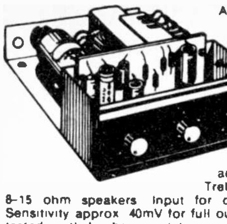

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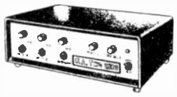

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2 2	04½p	05p	05½p	06p
3 3	04½p	05p	05½p	06p
4 7	04½p	05p	05½p	06p
6 8	05p	05½p	06p	07p
10	05p	06p	07p	09p
22	06p	07p	09p	13p
33	07p	08½p	10p	15p
47	08p	10p	12p	19p
68	09p	12p	18p	23p
100	10p	13p	18p	26p
150	11p	15p	20p	28p
220	12p	16p	22p	32p
330	14p	18p	26p	36p
470	16p	20p	29p	40p
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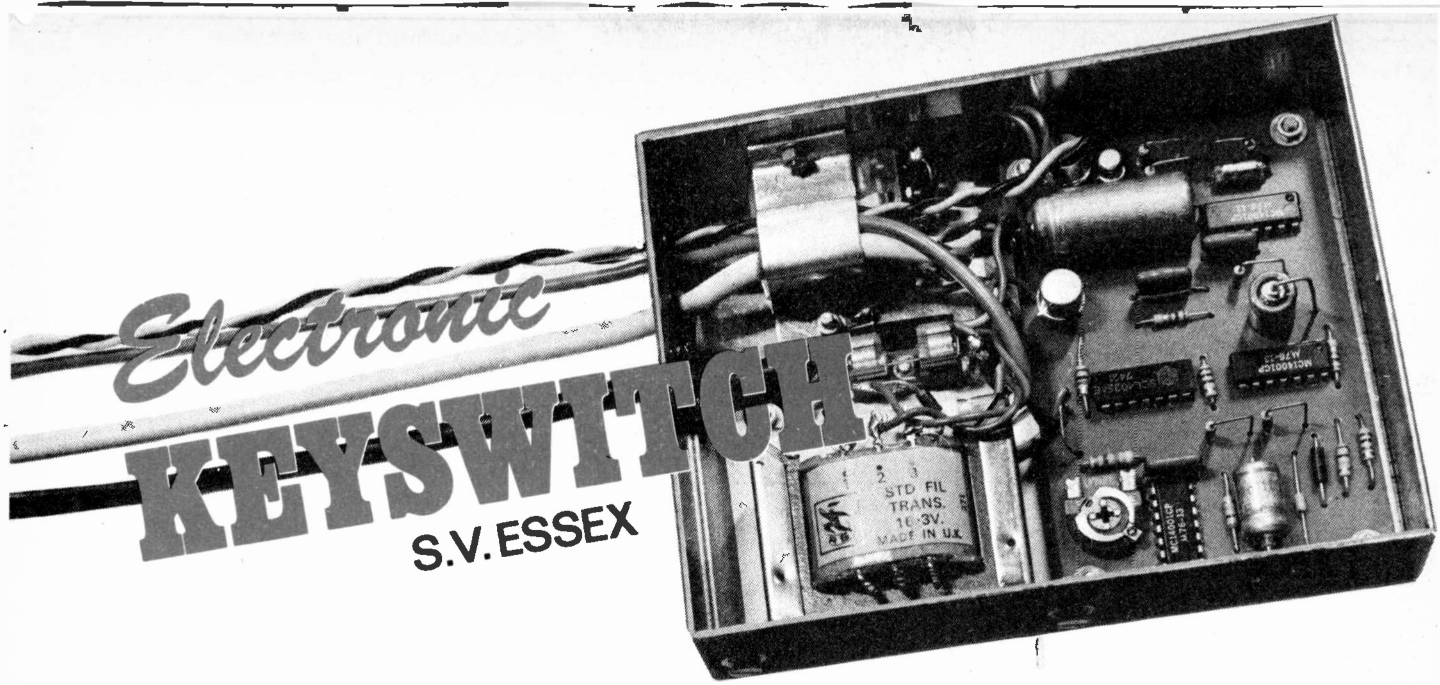

ELECTRONIC locks have always held a strange fascination for electronics constructors; they are primarily novelties, although one can always think of many more serious applications; for instance the "keyswitch" can be used as a safety device to isolate the power to a piece of equipment unless someone authorised to use it is available to insert the key.

The basic design is very flexible, since the keyswitch can be considered in terms of building blocks, which can be altered to fulfil the requirements of most applications. The basic version of the design uses four CMOS logic integrated circuits, which are readily available, easy to use, and inexpensive. The key is in fact a jack plug, the two terminals of which are connected to a resistor housed in its body.

CIRCUIT DESCRIPTION

The complete circuit diagram of the keyswitch is shown in Fig. 1 with the four CMOS i.c.s. enclosed within the dotted lines.

The operation of the circuit can first be considered without a key inserted in the socket. In this quiescent state the diode (D1) is reverse biased and the output of the comparator (IC1) is low. The 'inhibit 1' input to the gating circuit (IC3) is high, holding off the monostable and alarm circuits. When the output of IC1 is low the outputs of the schmitt trigger (IC2) and the gating circuit remain low with the transistor (TR1) reverse biased and the relay de-energised.

When a key is inserted into the socket its resistance is measured by the comparator and if its value is within an acceptable range, D1 is forward biased and the 'inhibit 1' input is switched to a low state. At the same time the schmitt trigger receives a positive pulse from IC1; before the gating circuit can use this pulse without error it must be modified into a square wave by the schmitt trigger. On receiving a correct signal from the schmitt trigger, output (a) of the gating circuit switches to its high state turning on TR1 and energising the relay.

The schmitt trigger output holds the monostable and alarm circuits off in place of the inhibit 1 input which is switched low.

If an incorrect input is applied to the circuit the comparator, schmitt trigger and gating outputs all remain in their low state with TR1 switched off and the relay de-energised. The diode D1 will be forward biased, the 'inhibit 1' input to IC3 will be switched low and the monostable IC4 triggered. The output of the monostable will remain high for a time period determined by the values of C3 and R9. The inhibit 2 input to IC3 ensures that any input applied to the keyswitch is disregarded until the monostable returns to its quiescent state and turns off the alarm.

CONSTRUCTION

Nearly all the components can be mounted on one printed circuit board: the p.c.b. layout is shown in Fig. 2. Fig. 3 shows the component locations on the board. The cable connecting the keyswitch input socket to the main circuit should be screened, with the braiding connected to the 0V supply rail; this can be earthed for safety. Microphone cable is quite satisfactory for this.

The prototype keyswitch was housed in an aluminium box, type AB10, with dimensions 101mm × 133mm × 38mm, which is probably the smallest size that the circuit can be fitted into, if it is powered from the mains.

The mains transformer was bolted to one side of the box: and to save space, the two rectifier diodes were soldered direct to the transformer secondary connections.

The output device in the prototype was controlled by a relay, which was held in place by an aluminium clamp which also held the input and output cables. The diode, D4, was connected directly across the relay coil connections, and D5 was connected directly across the speaker coil.

When assembling the components on the printed circuit

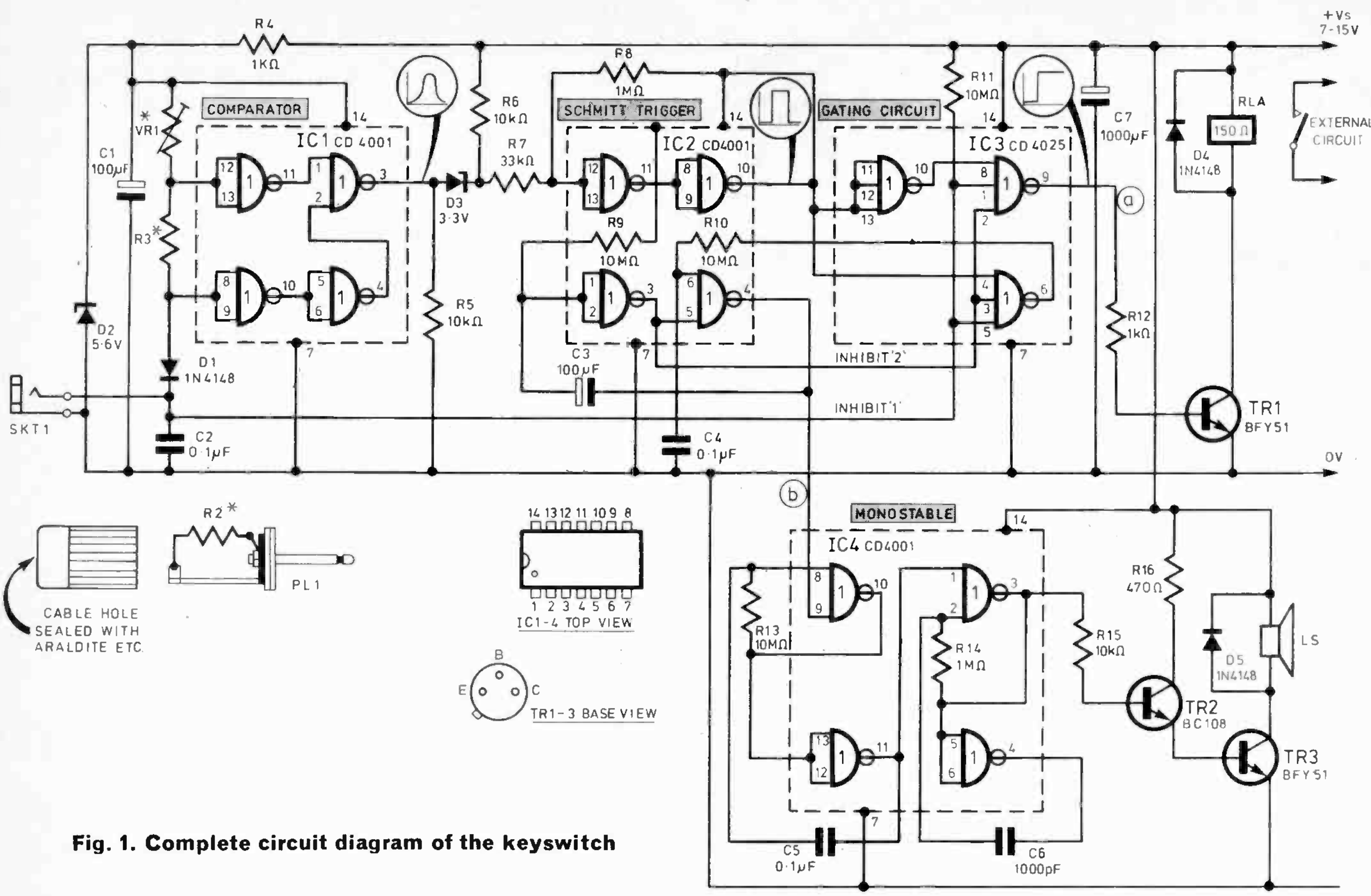

Fig. 1. Complete circuit diagram of the keyswitch

COMPONENTS . . .

Resistors

R1, R2, R3	See text
R4, R12	1kΩ (2 off)
R5, R6, R15	10kΩ (3 off)
R7	33kΩ
R8, R14	1MΩ (2 off)
R9, R10, R11, R13	10MΩ (4 off)
R16	470Ω ½W 10% carbon

All resistors ¼W 10% carbon except where stated

Capacitors

C1	100µF 10V elect.
C2, C4, C5	0·1µF polyester (3 off)
C3	100µF 16V elect.
C6	1,000pf polystyrene
C7	1,000µF 25V elect.

Semiconductors

TR1, TR3	BFY 51 (2 off)
TR2	BC108
D1, D4, D5	IN4148 (3 off)
D2	5·6V 400mW Zener
D3	3·3V 400mW Zener

Integrated Circuits

IC1, IC2, IC4	CD4001 (3 off)
IC3	CD4025

Miscellaneous

PL1, SKTA	2-pole 0·25in jack plug and socket
RLA	12V/150Ω relay
LS1	35Ω loudspeaker

board, the insertion of the four CMOS i.c.s should be left to last and they should be handled as little as possible, to avoid any static discharges damaging them.

CHOOSING R1, R2 AND R3

The key resistance R2 can be given any value between 4·7kΩ and 1MΩ. R1 should be a linear preset with a value twice that of R2 and if R3 has a resistance of R2/10, the circuit will have a sensitivity of ±10 per cent, this figure can be improved to ±3 per cent if a preset is used for R3.

POWER SUPPLIES

The circuit draws only a modest current from the supply in its quiescent state—around 6mA at 12V—and will work on any voltage in the range 7–15V; battery operation is therefore possible, although of course mains operation is desirable if the circuit is to be operated for any long period of time.

A simple full wave or bridge rectifier is all that is required for mains operation. Fig. 4 shows the arrangement used in the prototype. It must be borne in mind that transformer manufacturers usually use more windings for the secondary than is strictly necessary, to allow for the voltage drop in the secondary winding resistance; hence off-load rectifier voltage outputs can be at least 10 per cent higher than expected. It is important that the supply voltage to the CMOS i.c.s is never allowed to exceed 15V. D6 and D7 are shown as 1N4001's; these are suitable for output currents of up to 1A.

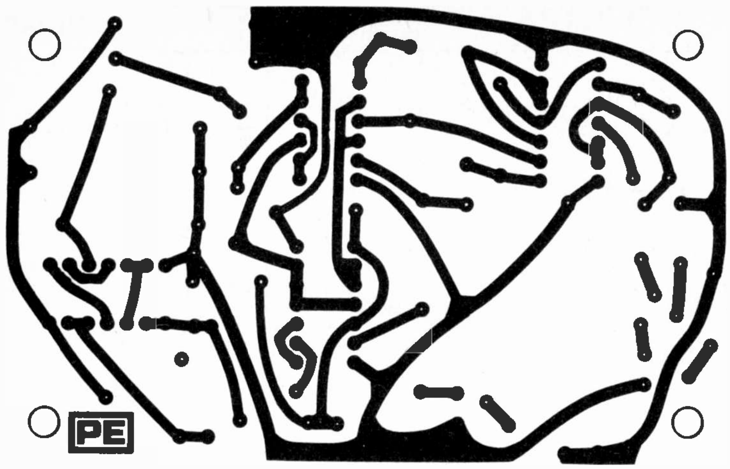

Fig. 2. Printed circuit board layout

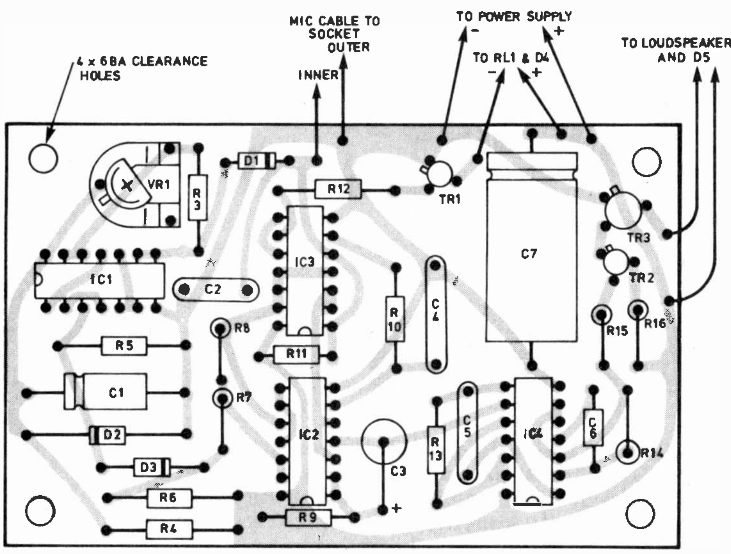

Fig. 3. Component layout for p.c.b.

BATTERY OPERATION

It is possible to incorporate automatic battery switch-over in the event of a mains failure, using the circuit shown in Fig. 5. When the mains supply fails, D8 conducts (it is normally revers-biased), and the 9V battery powers the circuit until the mains voltage is re-established. The voltage drop from 14V to 9V should not affect the circuit, unless R3 (if it is made preset) is set too close to the limit (i.e. to give a very small acceptance range).

If the circuit is to be permanently battery powered, some form of battery voltage check will be required to ensure that the batteries are changed before their voltage drops below 7V.

ALARM OPTIONS

There are several alternatives to using an alarm tone generator and loudspeaker; an electric bell or any other load (e.g. a light mounted above the doorway) can be controlled in the same way, using a relay or transistor.

INPUT PROTECTION

If a high voltage is applied to the input socket, the effect on the circuitry is rather unpredictable; although it is unlikely that such an action would result in the

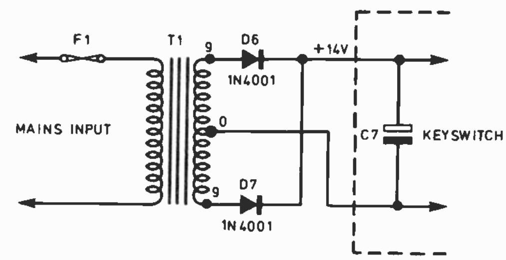

Fig. 4. Power supply

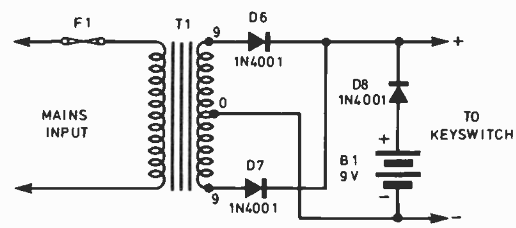

Fig. 5. Standby battery supply

external circuit being activated, the possibility of it doing so is still present.

The CMOS gates would probably be the first casualties if this should happen, but damage can be prevented by wiring 1 Megohm resistors in series with the gate inputs; these will not affect the circuit operation in any way (since the input impedance of a CMOS gate is typically 10^{12} ohms), but will limit the input currents to very low values.

SETTING UP

Because of the long monostable time constant, setting up would be extremely time-consuming and tedious, unless a 470 kilohms resistor is temporarily connected in parallel with R9; the alarm circuit then only operates for a few seconds, rather than the usual 12 minutes. The setting-up procedure for the basic circuit is as follows:

With the circuit operating from its normal supply voltage, connect a multimeter across the output of the schmitt trigged and the 0V line: with the key inserted, adjust R1 for a high output voltage. It will be found that this voltage is high for variations in R1 over a small range: R1 should be set to the middle of this range. No further setting up should be necessary.

If a preset is used for R3, the following procedure should be followed:

Set R3 to maximum, and adjust R1 in the same way as for the basic circuit: it will be found that the possible variation of R1 is quite large. Now R3 should be reduced in value until the schmitt trigger voltage drops, when R1 should be readjusted. R3 and R1 should be adjusted in turn until no further adjustment is possible. Although in this state the circuit is very sensitive, R3 should be increased in value by a small amount, to give some allowance for supply voltage and temperature changes.

The keyswitch is then ready for use. ★

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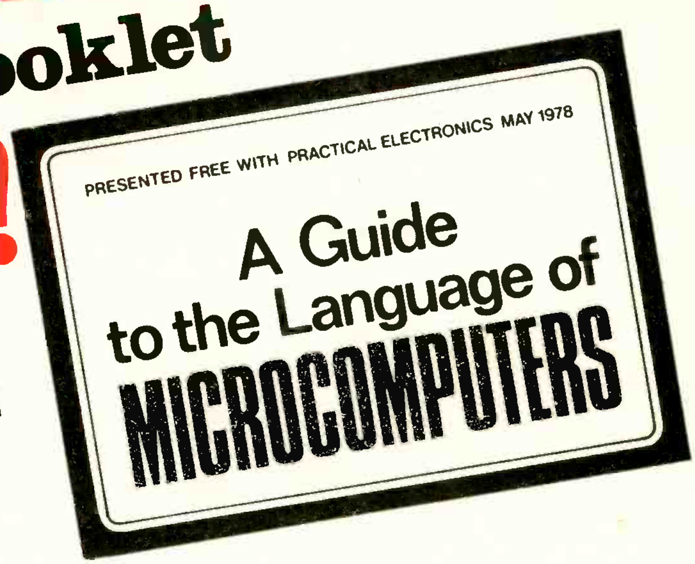
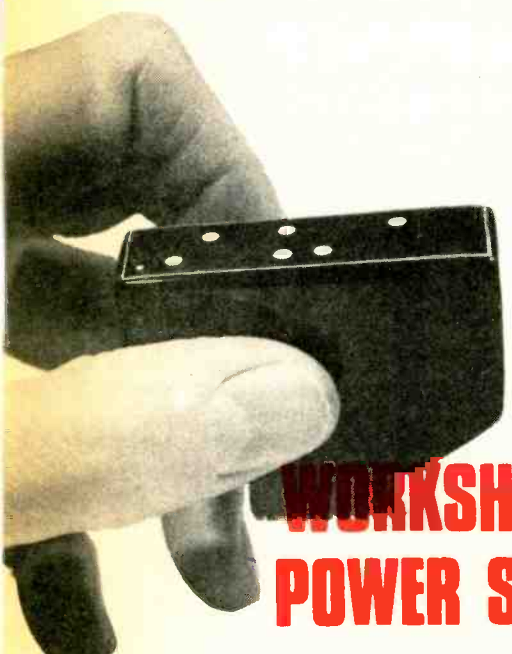


The literature of the computer world is riddled with its own brand of mystifying esoteric jargon which can make the understanding of this vital technology a hard slog. This handy reference offers to simplify such endeavours with explanations of the basic vocabulary.

TTL TEST CLIP

A compact unit which is capable of testing all 74 series 14 and 16 pin packages. It has a clip on action and l.e.d.'s are used to indicate the logic states '1' and '0'. Its specification matches many of the more expensive ready built types.



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This p.s.u. has an adjustable output up to 25 volts with over voltage protection. The current is variable to a maximum of 1·5 amps.

PRACTICAL
ELECTRONICS

OUR MAY ISSUE WILL BE ON SALE FRIDAY, 14 APRIL, 1978

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

FOUR MICROS COMPARED

THIS month's Micro-Bus looks at and compares the four microprocessors which have so far proved most popular with home programmers: SC/MP, M6800, MCS6502, and Z80. Obviously it would be possible to devote several pages of detailed description to each one, but since such data is available from the manufacturer or a distributor this article will concentrate on the differences between them from a programming point of view.

This should help people familiar with one micro to understand programs intended for another. To this end each of these micros' approaches to solving the same simple problem will be presented. The choice of a suitable "benchmark" problem is tricky because a particular micro may handle certain operations with an ease that does not reflect its general capability; for example, the Z80 can move blocks of data with a single instruction, and SC/MP has a delay instruction.

The task chosen does not favour any particular micro: the sorting of an array of numbers in memory using an "exchange sort". Although for large amounts of data a more efficient algorithm could certainly be found, this was chosen for its simplicity. It involves scanning through the array exchanging pairs of elements which are out of order; this is repeated until a complete scan has been done without any exchanges, when the array must be in correct order and the program stops.

Additionally it was specified that the length of the array should be less than 256 bytes and passed to the routine in a suitable register, and that the array could reside anywhere in memory, its address being also passed to the routine.

The programs for each micro are given in Fig. 1. These are assembler listings, and the formats are similar in that the addresses and machine code are in hexadecimal on the left, and the symbolic form of each instruction appears to their right. Assembler is a symbolic language which makes it possible to think about and write programs in terms of mnemonic words rather than numbers, and without having to calculate details inessential to the logic of the program (such as addresses and relative jumps). A program called "the assembler" takes the program in symbolic form—the right-hand side of the listings—and calculates the corresponding addresses and op-codes. In addition the assembler can be told to perform other operations, such as reserving storage for variables and positioning the program in memory. Such "assembler directives" tend to differ between manufacturers; for example, the symbol for the current address is ., *, or $ for these four micros.

The programs are believed to be the shortest possible, but we would be pleased to hear from anyone who feels that a particular micro has had an unfair presentation.

NATIONAL'S SC/MP

SC/MP (pronounced "scamp") is one of the cheapest micros available, and it has a very simple and symmetrical instruction set. There are three 16-bit pointer registers, P1, P2, and P3, and all memory addressing (apart from immediate) is indexed either using one of these, or relative to the program counter—effectively a fourth pointer P0. Jumps are similarly either PC-relative or pointer-relative. There is one 8-bit accumulator, AC, which is used in all operations, and an 8-bit "extension" register which can be specified instead of a memory address in most dual-operand instructions, or used as a temporary store.

In SC/MP's version of the sort routine, Fig. 1 (a), P1 is used to point to the pair of elements being compared. The dual-operand instructions may also auto-increment/decrement the pointer register; for example, the instruction LD @1 (1) in the program increments the pointer by 1 *after* loading the AC with the value it addressed. Besides saving instructions, this facility makes it possible to implement stacks quite neatly.

Subroutine calls are performed by the XPPC instruction which exchanges the specified pointer register with the program counter, causing a jump. The current value of the program counter is thus saved in the register, and a second XPPC will return control to the calling program. The subroutine address must first have been loaded into the register, and this unfortunately takes four instructions—a fact which tends to discourage the liberal use of subroutines. The other three micros all automatically stack the program counter on a subroutine call and restore it on a return, so nested or recursive subroutine calls are no problem.

SC/MP's instruction set has been pared down to the essentials, and its version of the sort routine is longer than for the other micros. It also seems to be harder to understand programs written for it due to the need for non-obvious tricks; for example, there is no "jump if carry clear" instruction; instead one must first copy the status word to the AC and then, since the carry is the top bit of the status word, a "jump if positive" achieves the required result. Nevertheless its three index registers, auto increment/decrement, and the ability to write relocatable programs, all make it an attractive micro once such tricks have been mastered.

MOTOROLA'S M6800

The sort routine for the M6800 is shown in Fig. 1 (b). The M6800 differs from the other micros considered here in having two primary accumulators, A and B, either of which can be specified as an operand in the majority of instructions. This saves instructions where otherwise temporary variables would be needed, as for example in the section of the routine which swaps the two adjacent elements.

All the memory reference instructions use either direct or indexed addressing. With direct addressing the address is given in the instruction and the single-operand instructions such as increment, decrement, or clear, can therefore operate

(a)

```
                ; SORT ROUTINE FOR SC/MP
                ; ON ENTRY: P1 POINTS TO DATA
                ;          AC CONTAINS LENGTH
0000                    .=0F1B
0F1B            COUNT:  .=.+1
0F1C            LEN:    .=.+1
0F1D            FLAG:   .=.+1
0F1E            PTR:    .=.+2
                ;
0F20 C8FB       SORT:   ST      LEN
0F22 B8F9               DLD     LEN         ;SUBTRACT 1
0F24 35                 XPAH    1
0F25 C8F8               ST      PTR
0F27 31                 XPAL    1
0F28 C8F6               ST      PTR+1       ;SAVE P1
0F2A C4FF       NEW:    LDI     -1
0F2C C8F0               ST      FLAG        ;CLEAR FLAG
0F2E C0EF               LD      PTR
0F30 35                 XPAH    1
0F31 C0ED               LD      PTR+1
0F33 31                 XPAL    1           ;RESTORE P1
0F34 C0E7               LD      LEN
0F36 C8E4               ST      COUNT       ;RESET COUNTER
0F38 C501       MORE:   LD      @+1(1)      ;AUTO INCREMENT
0F3A 02                 CCL
0F3B F900               CAD     (1)         ;COMPLEMENT & ADD
0F3D 06                 CSA                 ;COPY STATUS TO AC
0F3E 940C               JP      NOEX        ;JUMP IF POSITIVE
0F40 C100       EXCH:   LD      (1)
0F42 01                 XAE                 ;SAVE IN EXTENSION
0F43 C1FF               LD      -1(1)
0F45 C900               ST      (1)
0F47 01                 XAE                 ;BRING IT BACK
0F48 C9FF               ST      -1(1)
0F4A A8D2               ILD     FLAG
0F4C B8CE       NOEX:   DLD     COUNT
0F4E 9CE8               JNZ     MORE        ;FINISHED 1 PASS?
0F50 A8CC               ILD     FLAG        ;FLAG UNCHANGED?
0F52 9CD6               JNZ     NEW         ;IF SO, DO AGAIN
0F54 3F                 XPPC    3           ;RETURN
```

(b)

```
               * SORT ROUTINE FOR M6800
               * ON ENTRY: X CONTAINS ADDRESS OF DATA
               *           A CONTAINS NUMBER OF ELEMENTS
0000 0002      PTR     RMB     2
0002 0003      LEN     RMB     1
0003 0004      FLAG    RMB     1
0004 0005      COUNT   RMB     1
               *
0005 DF 00     SORT    STX     PTR
0007 4A                DEC A
0008 97 02             STA A   LEN       NO. OF PAIRS
000A 7F 0003           CLR     FLAG
000D 96 02     AGAIN   LDA A   LEN       SET UP COUNTER
000F 97 04             STA A   COUNT
0011 DE 00             LDX     PTR       RESET POINTER
0013 A6 00     NEXT    LDA A   0,X
0015 A1 01             CMP A   1,X       COMPARE PAIR
0017 23 09             BLS     NOSWAP    EQUAL OR CARRY SET?
0019 E6 01     SWAP    LDA B   1,X
001B A7 01             STA A   1,X
001D E7 00             STA B   0,X
001F 7C 0003           INC     FLAG      RECORD EXCHANGE
0022 08        NOSWAP  INX
0023 7A 0004           DEC     COUNT
0026 26 EB             BNE     NEXT      MORE TO DO
0028 7D 0003           TST     FLAG
002B 26 DD             BNE     AGAIN
002D 39                RTS               RETURN
               *
```

(c)

```
              ; ON ENTRY: X CONTAINS HIGH BYTE OF ADDRESS
              ;           Y CONTAINS LOW BYTE OF ADDRESS
              ;           A CONTAINS LENGTH OF ARRAY
0000          PTR    *=*+2
0002          LEN    *=*+1
              ;
0003  86 01   SORT   STX PTR+1
0005  84 00          STY PTR           SAVE ADDRESS
0007  85 02          STA LEN           SAVE LENGTH
0009  A4 02   AGAIN  LDY LEN
000B  A2 00          LDX £0            CLEAR FLAG
000D  B1 00   NEXT   LDA (PTR),Y
000F  88             DEY               POINT TO NEXT
0010  D1 00          CMP (PTR),Y
0012  B0 0C          BCS NOSWAP
0014  AA      SWAP   TAX               SAVE IT
0015  B1 00          LDA (PTR),Y
0017  C8             INY
0018  91 00          STA (PTR),Y
001A  88             DEY
001B  8A             TXA               GET IT BACK
001C  91 00          STA (PTR),Y
001E  A2 FF          LDX £$FF          SET FLAG
0020  C0 00   NOSWAP CPY £0
0022  D0 E9          BNE NEXT
0024  E8             INX
0025  F0 E2          BEQ AGAIN         ANY EXCHANGES?
0027  60             RTS               IF NOT - RETURN
```

(d)

```
                  ; ON ENTRY: HL CONTAINS ADDRESS OF DATA
                  ;           C CONTAINS NUMBER OF ELEMENTS
                  ;
0000  222600      SORT:   LD    (DATA),HL    ;SAVE DATA ADDRESS
0003  CB84        LOOP:   RES   0,H          ;INITIALIZE FLAG
0005  41                  LD    B,C          ;INITIALIZE LENGTH
0006  05                  DEC   B            ; COUNTER
0007  DD2A2600            LD    IX,(DATA)    ;INITIALIZE POINTER
000B  DD7E00      NEXT:   LD    A,(IX)
000E  57                  LD    D,A          ;TEMPORARY STORE
000F  DD5E01              LD    E,(IX+1)
0012  93                  SUB   E            ;COMPARE
0013  3008                JR    NC,NOEX-$
0015  DD7300              LD    (IX),E       ;EXCHANGE ELEMENTS
0018  DD7201              LD    (IX+1),D
001B  CBC4                SET   0,H          ;SET FLAG
001D  DD23        NOEX:   INC   IX           ;POINT TO NEXT ONE
001F  10EA                DJNZ  NEXT-$       ;REPEAT IF MORE
0021  CB44                BIT   0,H          ;EXCHANGES?
0023  20DE                JR    NZ,LOOP-$    ;IF SO CONTINUE
0025  C9                  RET                ;OTHERWISE EXIT.
                  ;
0026              DATA:   DEFS  2            ;STORAGE FOR ADDS.
                  ;
```

Fig. 1. Four microprocessors approaching the same programming problem of sorting an array of numbers into ascending order using an "exchange sort" algorithm. (a) SC/MP. (b) M6800. (c) MCS6502. (d) Z80.

directly on memory without using an accumulator. Indexed addressing adds the contents of the 16-bit index register to the second byte of the instruction to give the effective address, thus making it possible to service arrays of any length and positioned anywhere in memory.

The orderliness of the instruction set and the variety of branch-on-condition instructions available make it possible to implement most problems directly and in a comprehensible way. The only real limitation is in the provision of only one index register which makes it necessary, when processing two independent arrays of data as in multibyte arithmetic, to save and load its value to and from memory between operations on each array. The other three micros are more fortunate in this respect.

An upward-compatible addition to the family due out later this year, the 6809, will overcome this by providing an extra 16-bit index register together with several new addressing modes.

MOS TECHNOLOGY'S MCS6502

The MCS6502 is a member of the MCS5600 range of micros, all with different hardware options but the same instruction set. They were designed with the same basic philosophy as the M6800 and at first sight programs for them look similar. However, MOS Technology have made a number of simplifications and improvements to the M6800 instruction set resulting in a machine which tends to execute programs faster, and which solves certain types of problems more efficiently.

The M6800's 16-bit index register has been replaced by two 8-bit index registers, X and Y, and there is only one accumulator, A. As well as normal indexed addressing, which can use either of the index registers, two addressing modes are provided which are not found in the M6800 or indeed in either of the other two micros: pre-indexed and post-indexed indirect addressing.

THE MODES DESCRIBED

With pre-indexed indirect addressing the contents of the X register and the second instruction byte are added to give an address in the first 256 bytes of memory—page zero—and the two bytes of data at that address are taken as the indirect address for the operation. This mode of addressing is useful for servicing a set of independent locations whose addresses are kept in a table in page zero.

With post-indexed indirect addressing, the mode used in the MCS6502's version of the sort routine in Fig. 1 (c), the second byte of the instruction specifies an address in page zero where an indirect address is found. The contents of the Y register are added to this to give the effective address.

Post-indexed indirect addressing makes it possible to index arrays whose positions could be anywhere in memory, as in the sort program. The address of the array in this program is stored in page zero at PTR, and this indirect address is indexed by Y to select elements of the array. Note that this makes the SWAP part of the routine rather inelegant; this could be improved if the address of the array were known in advance. The array is scanned backwards from the end in this version because the program works out shorter this way.

ZILOG'S Z80

The Z80 is an improved version of the popular 8080A and contains all its codes as a subset of its instruction set. To it have been added an additional set of seven 8-bit registers, a large number of new instructions, program-relative jumps, and indexed addressing. The indexed addressing uses one of the two 16-bit index registers, IX or IY, and the codes have been obtained by prefixing the existing indirect addressing code, which takes the address from the register pair HL, by one of two modifiers which were unassigned codes on the 8080A, "DD" or "FD". The displacement, where applicable, is the last byte of the instruction, resulting in lengths of four bytes for the indexed addressing operations.

Th Z80's version of the sort routine is taken from the Z80-CPU Technical Manual and it illustrates several of the additions to the 8080A instruction set: the "decrement and jump if non-zero" uses the B register as a counter to provide very neat loop control, and the bit clear (RES), set (SET), and test (BIT) instructions each achieve what would otherwise take two or three instructions.

The question arises: is it worth paying the price of a messy instruction set for the advantage of upward compatibility with the 8080A? Firms with 8080A software already written are one matter, but as far as amateurs intending to program in machine code are concerned the answer seems to be no. Instruction set design has come some way since the 8080A and yet the Z80 has retained its basic design philosophy resulting in a confusing mixture of low-level and high-level operations.

SYSTEMS AND PRICES	RAM (bytes)	Monitor (bytes)	Available from	Price (ex. VAT)
SC/MP				
MPU chip (*N* channel)			Marshalls	£10·00
SCRUMPI 1 kit. Binary programmed (Reviewed P.E. Aug. 77)	256	—	Bywood	£46·30
SCRUMPI 3 kit. Hex programmed from keyboard. TV, cassette, TTY interfaces	128	1 K	Bywood	£154·92
Introkit. Hex programmed from TTY	256	½K KITBUG	Marshalls	£68·61
Keyboard kit. Converts Introkit for programming from hex keyboard. (Reviewed P.E. April 77)	256	½K SCMPKB	Marshalls	£65·84
MK14 kit. Hex programmed from keyboard	256	½K SCMPKB	Science of Cambridge	£39·95
M6800				
MPU chip			Newbear	£14·00
D2 kit. Hex programmed from keyboard Cassette interface. (Reviewed P.E. July 77)	256	1K JBUG	Cramer	£175·00
77–68 kit. Binary programmed from	256	—	Newbear	£102.77
MP–68 kit. Hex programmed from TTY	4K	1K MIKBUG	Computer Workshop	£275·00
MCS6502				
MPU chip			Newbear	£14·93
KIM-1 built. Hex programmed from keyboard. Cassette, TTY interfaces. (Reviewed P.E. Feb. 78)	1¼K	2K	G.R. Electronics	£199·00
Z80				
MPU chip (2·5 MHz)			Newbear	£15·50
Z8OZ. TTY interface	4K	2K	Sintel	£398·00
NASCOM 1. Qwerty keyboard, TV, cassette, TTY interfaces.	2K	1K	Lynx	£197·50
KONTRON kit. Hex programmed from keyboard. Cassette, TTY interfaces	256	1K	Cramer	£215·00

Low cost systems currently known to be available for the four popular microprocessors discussed in this article.

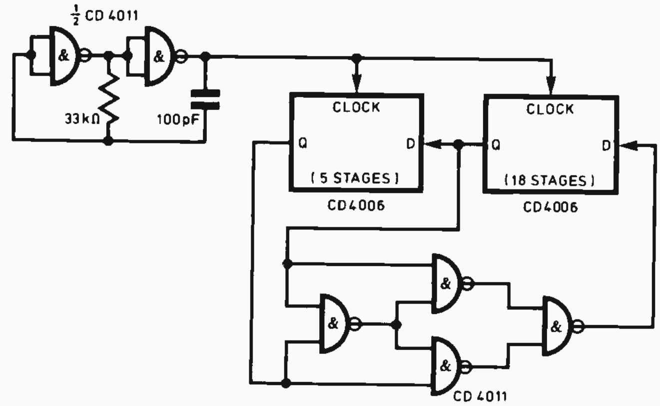


Fig. 2. Maximal-length sequence generator using CMOS gates and shift registers. The output, taken from any stage, is a random noise.

```
                    NAM PRN
               * PSEUDO-RANDOM NOISE
               *
0000 0002      LAST    RMB    2
     8004      PIAREG  EQU    $8004
               *
0002 CE FF04   ENTER   LDX    £$FF04
0005 FF 8004           STX    PIAREG    CONFIGURE PIA
0008 96 00     NOISE   LDA A  LAST
000A 84 42             AND A  £%01000010
000C 8B 3E             ADD A  £%00111110
000E 48                ASL A
000F 48                ASL A
0010 79 8004           ROL    PIAREG
0013 79 0001           ROL    LAST+1
0016 79 0000           ROL    LAST
0019 20 ED             BRA    NOISE
```

Fig. 3. Complete program for the M6800 which generates a pseudo-random sequence of bits in a way analogous to the circuit of Fig. 2.

RANDOM NOISE

Electronics constructors with no computing background should not despair at the thought of programming microprocessor systems; in many cases programs can be derived directly from a consideration of how the same task is carried out in hardware. To illustrate this a circuit to generate random noise is given together with an analogous program written for a M6800 micro. There should be no problems in converting this for other micros.

The circuit in Fig. 2 shows how a 23-stage shift register can be arranged to produce a maximal-length sequence of bits by connecting the outputs from stages 18 and 23 back to the input by an exclusive-OR gate.

ANALOGOUS PROGRAM

In the analagous program, shown in Fig. 2, the shift registers are replaced by three 8-bit memory locations designated LAST, LAST+1, and PIAREG. The third of these is contained in a versatile input/output chip, Motorola's MC6802 Peripheral Interface Adapter, and the first two lines of the program are for configuring this so that the contents of the location PIAREG are available at the PIA's eight output pins PAO-PA7. The first of these locations is ANDed with binary 01000010 to isolate bits 23 and 18, and adding 00111110 then sets bit 23 to the exclusive-OR of these two bits. This is then shifted into the carry bit, and from there into the bottom bit of the three locations.

The sequence is $2^{23}-1$ or 8,388,607 bits long and with the program as it stands the output, which can be taken from any stage, is a white noise with a power spectrum substantially flat over the audible frequency region. With a delay inserted into the loop the sequence of bits can be used as random-coin tosses for use in games, modelling, or psychological experiments. If the bits are generated at a rate of 1 per second the sequence will repeat itself only after 97 days; for most practical purposes it is random!

Addresses for Firms in table

Bywood Electronics, 68 Ebberns Road, Hemel Hempstead, Herts HP3 9QRC.

Cramer Electronics, 16 Uxbridge Road, London W5 2BP.

Computer Workshop, 174 Ifield Road, London SW10 9AG.

G. R. Electronics Ltd., 80 Church Road, Newport, Gwent.

Lynx Electronics (London) Ltd., 92 Broad Street, Chesham, Bucks.

A. Marshall (London) Ltd., 40-42 Cricklewood Broadway, London NW2 3ET.

The Newbear Computing Store, 7 Bone Lane, Newbury.

Science of Cambridge Ltd., 6 King's Parade, Cambridge CB2 1SN.

Sintel, P.O. Box 75A, Oxford.

FRANK W. HYDE

THE NEXT FEW MONTHS

During the next few months the American space programme is a full one. One of the major events is the mission of two probes to Venus for an extensive investigation of that planet's atmosphere and surface. This mission has already been specially described in *Spacewatch* for March.

A new Earth spacecraft called Seasat will be launched in May. This vehicle will be of particular value to meteorologists. Seasat will measure the dynamics of the Earth. In particular it will measure the changing shape of ocean surfaces, the heights of waves and the movements of the many ocean currents. It will track icebergs and locate oil slicks using radar. In addition there will be a special watch on eddies and tides.

The extent of these activities is another step forward in this technology. The benefits will be felt in many other areas apart from meteorology. Oceanography will have access to valuable data and the world shipping and fishing industries will also benefit from the knowledge of the daily conditions.

Another mission, HCMM (Heat Capacity Mapping Mission), is devoted to the measurement of land temperatures. Special sensors on the spacecraft will monitor land surface temperatures at daytime maximum and night time minimum. From the changes that are noted in the way that solar heat is retained in trees, in surface rocks and soil it is hoped that the types of rock may be deduced, plant temperatures indicating stress of disease, water cycles and soil moisture.

Some success in this area has already been achieved with previous Earth Resources Satellites. The wider activities of the HCMM mission will make soundings in temperature over snow covered areas, hot springs and detect man made pollution.

Another new programme is an astronomical observatory; the IUE, International Ultraviolet Explorer. This mission is a joint activity involving science and industry. The European Space Agency and the American National Agency for Space Administration (NASA) are joining to study objects which generate, reflect or re-radiate ultraviolet light. Some young hot stars radiate mostly in the ultraviolet region of the spectrum. In consequence they are almost invisible at other wavelengths. There are also other targets for this mission and among these are studies of the Seyfert Galaxies and observation of the gas and dust between stars where absorption and re-emission of ultraviolet takes place.

Another mission launched in July; this is the third ISEE spacecraft (International Sun-Earth Explorer) which will join the two that were launched in 1977. Each of these craft will be stationed at a different point between the Earth and the Sun. They will be observing the relationships between solar events and magnetic phenomena in the outer environment of the Earth. Recent work has indicated a relationship between magnetic storms and the weather. This co-operative venture involves all the nations of ESA.

The launch schedules in addition to those already mentioned include a third Landsat Earth Resources satellite and the second HEAO. This latter will deal with High-Energy Astronomy. It is an observatory mainly for the study of X-rays and Gamma rays. HEAO 1 launched in August 1977 has observed a dense star which seems to be a good candidate for the title of Black Hole.

THE HOT LINE

The Hot Line between Washington and the USSR has now entered the space age; two independent systems of communication via two satellites. The new line, officially known as Direct Communications Link (DCL), will be more efficient and less liable to failure during times of emergency. The link is less vulnerable than the old system since it depends to a much lesser degree on the extensive microwave links. It also makes it possible for direct communication without a third country being involved. Like its predecessor DCL, contrary to popular belief, makes possible the exchange of printed messages and not telephone calls. The advantage of the printed message is that the language barrier is overcome. It avoids the misunderstanding by translators and provides a written record of the communication. The main purpose of this link is to provide direct communication between the President of the United States and the President of the Soviet Union.

SOVIET CARGO SPACESHIP

Work on the Soviet Cargo Spaceship Progress 1 was put in hand when the space station proper was commenced. According to Konstatin Feoktistov, speaking on this subject, it was realised that there were a number of items which could not be kept in space over long periods of time. Also there were items which might need replacement because of malfunction, replenishment of such things as fuel for control and gas stocks for the atmosphere within the spacecraft. There was also the question of water for showers and washing of linen etc.

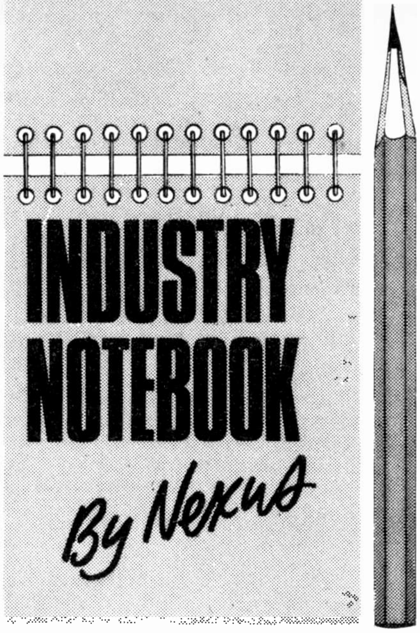
It is estimated that each cosmonaut requires about 30 kilogrammes of materials per day. The cargo ship is similar in basic design to the Soyus spacecraft. The unit module has remained unchanged but the size of the instrument module has been increased. Special tanks for liquid cargoes and a compartment for dry cargo were added. The freight compartment is hermetically sealed so that, after docking, the cosmonauts can work in it to transfer cargo to Salyut-6. Because the power circuit and the layout of the spacecraft were substantially changed, a new set of intensive tests for rigidity, strength, vibration and heat cycles, was made. Since the movement of even small things takes time in space, the design changes were for making such work by the cosmonauts easier and more comfortable.

Progress 1 docked after two days instead of one, as would be normal. This was because the cargo ship was unmanned and the ground commands by radio take longer. Also it was considered that it was better not to hurry the operation.

The cosmonauts aboard Salyut-6 performed the role of a standby system for the automatic control during docking. During the approach phase, data on the speed of Progress 1 and its orientation were transmitted to Salyut-6. The crew watched the approach and would have, if malfunction had occurred, aborted the docking, or, if the craft was approaching dangerously fast, started the motors and escaped from impact. None of this was necessary as the whole operation was carried out according to plan.

PUTTING THE RECORD STRAIGHT

In the January issue of *Spacewatch* reference was made to the Kettering School Station. Unfortunately the name of the master who is its director was given as Mr. Cooper. This error on the writer's part is regretted. The more so because in the early days of the space scene we were in close contact. G. E. Perry MBE, FInstP is famous for his activities in the field of monitoring, particularly in the case of Soviet launchings. On a number of occasions launches were detected and announced from Kettering before official news was given. On a number of occasions *Spacewatch* has mentioned Mr. Perry and the school.



OUTLOOK

All indicators suggest this will be a good year for the European electronics industry and not least for the UK. Even the depressed consumer sector can take heart from the pre-election sweetener of big tax concessions which will encourage consumer spending.

An interesting point is that taking Western Europe as a whole the balance of trade with the rest of the world is only just favourable, with total imports only marginally lower than total exports. But this has to be accepted in a world industry like electronics. The time to worry is when the balance is wholly and consistently unfavourable.

Meantime, the structural shake-up of the British electronics industry, a big talking point in the latter half of 1977, is only barely being kept alive. Plessey, one of the favourites for chopping up and merging with others in a huge regroup, turned in a reasonable if not sparkling performance last year. Decca, another candidate according to industry gossip, still has founder Sir Edward Lewis in the chair who is said not to be in favour. Some recent 'kite-flying' suggests that STC, at present wholly owned by the US giant ITT, might be a catalyst but only if STC shares were made available to British buyers so that the company could claim to be 'British', or partly so. There is talk of government intervention. But my own thought, shared by a large part of what is a very successful industry, is that this would be the kiss of death.

The proposed government support for microelectronics development in the UK is, however, welcome. The idea is that £25 million invested by the industry itself should be matched by an equal amount from the taxpayers. It sounds generous until you compare it with the reported £135 million which the Japanese government is spending on similar projects. And when you compare £25 million with the hundreds of millions spent supporting loss-making industries like steel and shipbuilding it looks downright mean. A sound business maxim is to back your winners and shed your losers. But logic counts little in an election year.

ATE

The final round-up of Automatic Test 77, held late last year at Brighton, reveals an even higher level of interest as well as increased attendance. Membrain, as usual, had one of the biggest stands. There had been industry rumours for some time that the six-year-young dynamic company was on the market but it was only after the exhibition that a terse announcement came that Membrain had been acquired by Schlumberger Measurement and Control (UK) Ltd, who already have Solartron and Sangamo Weston under their belt. Membrain, however, will continue to operate as a separate company. Among its recent successes is a contract connected with development of the British Army Ptarmigan communications system.

Because of the huge international interest in automatic test equipment, this year's show and conference will be staged by the British organisers in Paris.

ATE is now showing through as a great money-saver. It is super-efficient. But for ATE, according to one company, they would have to employ 250 test engineers instead of only 50. Looked at in another way, ATE throws people out of work. Which illustrates the difference between wealth-creation and job-creation.

RAILWAY SIMULATOR

Redifon Simulation Ltd, world leaders in flight simulators, are firmly on the ground with their latest project, an order for three railway cab simulators for training drivers on the new underground system in Hong Kong. As in flight simulators, the trainees will have a lively and realistic experience with vision and sound effects while the instructors will be able to introduce various faults which, in real life, could be catastrophic.

MIDDLE EAST

The £1·6 billion sale-of-the-century telecommunications contract for Saudi-Arabia left Britain out in the cold. The winning consortium was Philips/Ericsson/Bell (Canada).

Philips and Ericsson will build the equipment and Bell (Canada) will operate and maintain it. The contracts will solve many problems for Ericsson in Sweden and Philips in Holland, both of whom had been shedding labour in their telecommunications factories but are now recruiting again.

A consolation prize for Britain is a £40 million contract with Egypt for the Swingfire anti-tank guided weapon. Britain has now supplanted the Soviet Union as a major weapons supplier to Egypt but the long-term penalty is that eventually Egypt will, with British assistance, build up her own independent industry. A purpose-built factory is being erected near Cairo where the missiles will be assembled from UK-made components. Ultimately the whole project will move to Egypt.

This pattern is already being followed in Egypt by at least one British electronics company. A British executive tells me there is now no alternative to this type of agreement. If you turn it down you get no business at all. Such arrangements are not confined to the Middle East. The £128 million contract for Hawk trainer aircraft for Finland gives the Finns the opportunity of assembling the aircraft from piece parts, many of them being also manufactured in that country. We thus not only train overseas customers in what, to them, is advanced technology but also transfer the know-how. It is therefore more than ever important to stay one stage ahead in advanced technology.

ENGINEERING INQUIRY

Of the chairman and 17 members serving on the Committee of Inquiry into the Engineering Profession only one member is identifiable as having deep practical knowledge of the electronics industry. He is Dr. John A. Powell, managing director of EMI Ltd.

The IEE was among the first to make a submission to the Inquiry. Calling for tougher entry qualifications and more demanding degree courses the IEE stated that entry standards have fallen and this has encouraged students to undertake theoretical studies that are beyond their intellectual capacity. The implication is that the weaker students should go for HNC or diploma courses and emerge as first-class technician engineers rather than third-rate graduates.

DIGITAL BROADCASTING

Two sessions on digital techniques in broadcasting were held at the IEE recently. It was a joint presentation by the BBC, IBA, ITCA and the Post Office and as well as the usual propagation methods there was a demonstration of digital techniques transmitted through fibre-optics. We shall be hearing a great deal more on this topic in the future.

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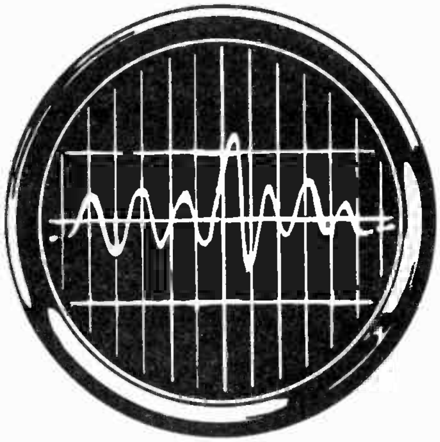

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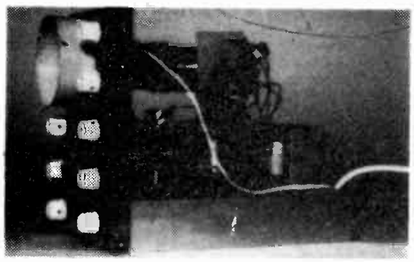

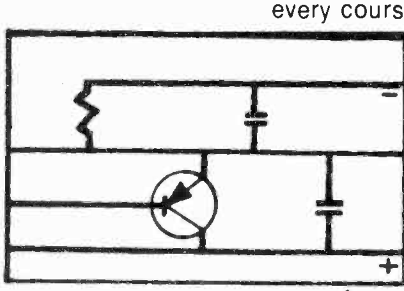

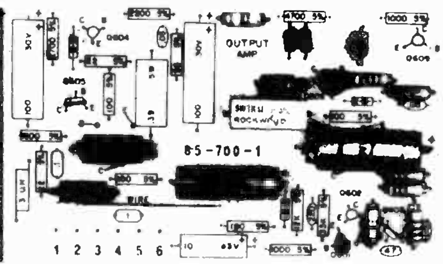

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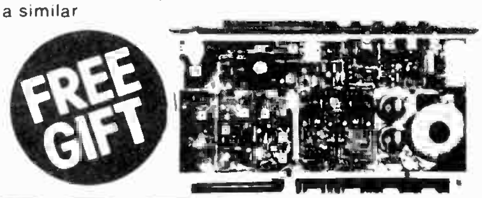

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7400	13p	7441	74p	7494	83p	CD4000	18p	CD4022	94p	CD4050	60p	CD4082	23p
7401	15p	7442	74p	7495	70p	CD4001	18p	CD4023	21p	CD4054	120p	CD4086	24p
7402	16p	7445	123p	7496	83p	CD4002	18p	CD4024	83p	CD4055	140p	CD4088	POA
7403	18p	7446	123p	74100	130p	CD4006	110p	CD4025	20p	CD4056	140p	CD4501	POA
7404	22p	7447	102p	74107	38p	CD4007	20p	CD4026	180p	CD4060	117p	CD4502	130p
7405	22p	7448	130p	74118	125p	CD4008	87p	CD4027	50p	CD4066	70p	CD4507	50p
7406	44p	7454	18p	74121	38p	CD4009	62p	CD4028	98p	CD4067	410p	CD4510	132p
7407	44p	7470	30p	74122	55p	CD4010	62p	CD4029	118p	CD4068	24p	CD4511	173p
7408	23p	7472	28p	74123	103p	CD4011	19p	CD4030	62p	CD4069	22p	CD4516	132p
7409	23p	7473	38p	74144	340p	CD4012	20p	CD4035	138p	CD4070	60p	CD4518	110p
7410	16p	7474	33p	74145	83p	CD4013	50p	CD4041	87p	CD4071	22p	CD4520	114p
7411	24p	7475	48p	74153	62p	CD4015	87p	CD4042	85p	CD4072	23p	CD4522	POA
7412	24p	7476	40p	74154	138p	CD4016	50p	CD4043	98p	CD4076	187p	CD4526	POA
7413	38p	7480	48p	74165	115p	CD4017	98p	CD4044	98p	CD4077	85p	CD4528	POA
7414	41p	7482	81p	74174	132p	CD4018	99p	CD4045	150p	CD4078	24p	CD4572	POA
7416	33p	7483	90p	74175	79p	CD4019	85p	CD4046	131p	CD4081	23p	CD4583	POA
7417	33p	7485	106p	74180	85p	CD4020	119p	CD4047	85p				
7420	16p	7486	38p	74181	295p	CD4021	99p	CD4049	65p				
7425	28p	7489	399p	74190	142p								
7427	28p	7490	57p	74191	131p								
7430	20p	7491	82p	74192	131p								
7432	28p	7492	57p	74193	131p								
7437	29p	7493	57p	74196	130p								
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CA3089	238p	NE565	138p
CA3090	327p	NE566	128p
CA3130	113p	NE567	175p
CA3140	74p	SN76003	185p
CA3160	140p	SN76013	165p
LM301	39p	SN76023	160p
LM308	54p	SN76033	259p
LM380	100p	TAA621	257p
LM381	120p	TAA661	175p
LM710	41p	TBA540	236p
LM741	24p	TBA641	281p
LM747	73p	TBA800	102p
LM748	38p	TBA810	113p
LM3900	73p	TBA820	90p
MC1304	292p	µA723	57p
MC1310	187p		
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MC1458	78p		

DIODES

BY127	18p
OA47	9p
OA70	9p
OA79	14p
OA81	15p
OA85	14p
OA91	7p
OA95	9p
OA200	9p
OA202	9p
IN914	4p
IN916	6p
IN4001	6p
IN4002	6p
IN4003	6p
IN4004	7p
IN4005	10p
IN4006	10p
IN4007	11p
3 amp 50 PIV	16p
3 amp 100 PIV	16p
3 amp 200 PIV	18p
3 amp 400 PIV	20p
3 amp 600 PIV	25p

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10 amp 200 PIV	28p
10 amp 400 PIV	38p
10 amp 600 PIV	42p

BRIDGE RECS

1 amp 50 PIV	22p
1 amp 100 PIV	24p
1 amp 200 PIV	27p
1 amp 400 PIV	30p
1 amp 600 PIV	34p
2 amp 50 PIV	34p
2 amp 100 PIV	38p
2 amp 200 PIV	38p
2 amp 400 PIV	40p
2 amp 600 PIV	42p

TRIACS

2 amp 100 PIV	28p
2 amp 200 PIV	42p
2 amp 400 PIV	71p
6 amp 100 PIV	50p
6 amp 200 PIV	66p
6 amp 400 PIV	81p
10 amp 100 PIV	68p
10 amp 200 PIV	100p
10 amp 400 PIV	113p
10 amp 400 Plastic	130p
15 amp 400 PIV	420p
30 amp 400 PIV	430p

D32 Diac	20p
BR100 Diac	20p

SCR

1 amp 50 PIV	28p
1 amp 100 PIV	30p
1 amp 200 PIV	38p
1 amp 400 PIV	40p
1 amp 600 PIV	58p
1 amp 800 PIV	68p
3 amp 50 PIV	34p
3 amp 100 PIV	38p
3 amp 200 PIV	38p
3 amp 400 PIV	51p
3 amp 600 PIV	60p
3 amp 800 PIV	99p
5 amp 200 PIV	50p
5 amp 400 PIV	59p
5 amp 600 PIV	75p
7 amp 200 PIV	68p
7 amp 400 PIV	75p
7 amp 600 PIV	123p
10 amp 200 PIV	67p
10 amp 400 PIV	70p
10 amp 600 PIV	83p

ZENERS
Range 2 2 35 volts

400m watts	10p
1 3 watts	20p

TRANSISTORS

AC126	21p	BC148	10p	BC547	14p	BF183	37p	MJ2955	99p	2N1305	21p
AC127	21p	BC149	10p	BC548	14p	BF194	13p	MJE340	64p	2N1306	27p
AC128	21p	BC157	11p	Bc549	27p	BF195	13p	MJE2955	99p	2N1711	21p
AC176	21p	BC158	11p	BC557	14p	BF196	13p	MJE3055	68p	2N2219	21p
AC187	23p	BC159	11p	BCY34	74p	BF197	16p	OC28	108p	2N2904	21p
AC188	23p	BC168	12p	BCY70	17p	BF200	38p	OC35	108p	2N2905	21p
AD149	85p	BC169	12p	BCY71	20p	BF224	18p	OC71	19p	2N2906	17p
AD161	50p	BC171	12p	BCY72	17p	BF257	37p	OC84	48p	2N2926G	9p
AD162	50p	BC172	12p	BD115	59p	BF258	40p	TIP29C	50p	2N2926R	9p
AF114	30p	BC173	12p	BD124	97p	BF259	44p	TIP30	52p	2N2955	130p
AF115	27p	BC177	18p	BD131	47p	BFR39	30p	TIP31A	47p	2N3053	17p
AF116	25p	BC178	16p	BD132	47p	BFX29	34p	TIP32A	51p	2N3054	54p
AF117	23p	BC179	18p	BD135	43p	BFX30	38p	TIP33	90p	2N3055	54p
AF118	30p	BC182L	13p	BD136	50p	BFX84	27p	TIP34	195p	2N3702	10p
AF124	42p	BC183L	11p	BD137	50p	BFX85	34p	TIP35	292p	2N3703	10p
AF125	42p	BC184L	13p	BD138	51p	BFX86	31p	TIP36	389p	2N3704	10p
AF126	25p	BC212L	13p	BD139	51p	BFX87	31p	TIP41A	54p	2N3705	10p
AF139	40p	BC213L	13p	BD140	52p	BFX88	31p	TIP42A	54p	2N3706	10p
AF239	53p	BC214L	14p	BF173	30p	BFY50	17p	TIP2955	126p	2N3708	10p
BC107	9p	BC238	14p	BF179	37p	BFY51	17p	TIP3055	64p	2N3709	10p
BC108	9p	BC303	30p	BF180	37p	BFY52	17p	ZTX108	12p	2N3711	10p
BC109	9p	BC328	15p	BF181	37p	BSX20	21p	ZTX300	13p		
BC147	10p	BC338	15p	BF182	37p	BU105	191p	ZTX500	15p		

SWITCHES

Toggle Large	SPST	27p
	DPST	29p
	DPDT	35p
STD	SPST	66p
	SPDT	70p
	DPDT	75p
MIN	SPST	54p
	SPDT	58p
	DPDT	70p
	DPDT c off	90p
SUB MIN	SPST	48p
	SPDT	52p
	DPDT	60p

Push Button SPST Locking	60p
Push Button SPDT Locking	69p
Push Button DPDT Locking	91p
Bias push to make	15p
Bias push to break	20p
Slide DPDT SUB MIN	13p
Slide DPDT STD	13p
Slide DPDT c off	15p

ROTARY SWITCHES

1 Pole 12 way	46p
2 Pole 2 way	46p
2 Pole 4 way	46p
2 Pole 6 way	46p
3 Pole 3 way	46p
3 Pole 4 way	46p
4 Pole 2 way	46p
4 Pole 3 way	46p
Mains DPDT	45p
BULGIN Foot Switch DPDT	180p
SPST	115p

OPTO

TIL 209 Red	14p
TIL 209 Green	24p
TIL 209 Yellow	24p
2 Red	18p
2 Yellow	30p
2 Green	30p
TIL 209 Clip	4p
2 Clip	5p

TRANSFORMERS (Mains prim 220 240V)

LT44		60p	6-0-6	1 5A	345p
LT700		60p	9-0-9	1A	280p
6-0-6	100MA	93p	9-0-9	2A	398p
9-0-9	74MA	97p	12-0-12	1A	317p
12-0-12	100MA	99p	15-0-15	1A	350p
0-6-0-6	280MA	140p	20-0-20	2A	544p
0-12-0-12	150MA	150p	25-0-25	2A	585p
6 3V-1 5a		284p	30-0-30	2A	825p

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12-15-20-24-30 Tapped 2 amp	857p
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Presets sub min. vert. Horiz. 100Ω-1MΩ	10p
Slider Bezzels 21p Slider Knobs	10p

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1¾in	8Ω	72p
2in	8Ω	72p
2½in	8Ω	64p
2½in	8Ω	64p
2½in	64Ω	72p
2¾in	8Ω	76p
2¾in	80Ω	118p

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0 5W 10Ω 10MΩ E24	2½p
2 5W 0 22Ω 10Ω w w	23p
5W 4 7Ω 10kΩ w w	12p
10W 10Ω-10kΩ w w	15p
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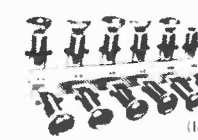

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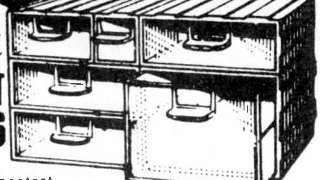

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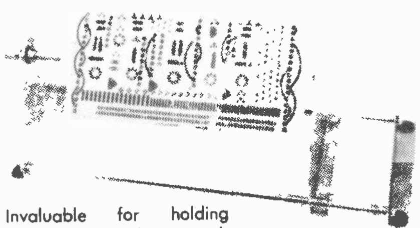

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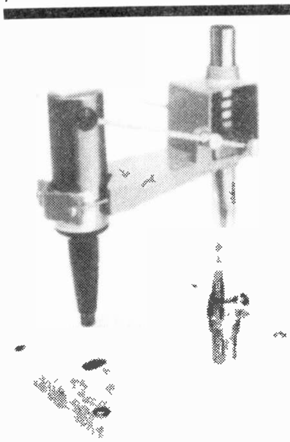

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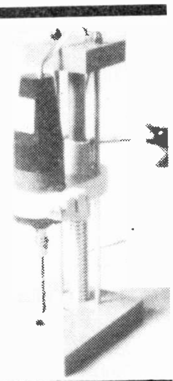

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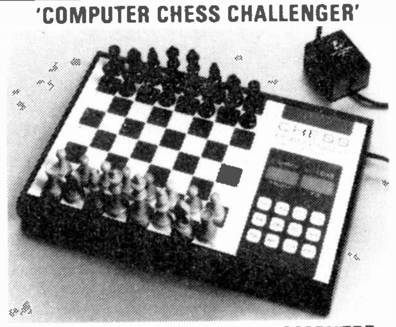

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FEATURES: complete pre-amplifier in single pack, multi-function equalisation low noise, low distortion, high overload, two simply combined for stereo
APPLICATIONS: hi-fi, mixers, disco, guitar and organ, public address
SPECIFICATION: Inputs–magnetic pick-up 3mV ceramic pick-up 30mV, tuner 100mV, microphone 10mV, auxiliary 3–100mV, input impedance 47kΩ at 1kHz Outputs—tape 100mV, main output 500mV R.M.S Active Tone Controls—treble ±12dB at 10kHz bass ±12dB at 100Hz Distortion—0 1% at 1kHz, signal/noise ratio 68dB Overload—38dB on magnetic pick-up Supply Voltage—±16-50V

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FEATURES: complete kit, low distortion, short, open and thermal protection, easy to build
APPLICATIONS: updating audio equipment guitar practice amplifier, test amplifier audio oscillator
SPECIFICATION: Output Power—15W R M S into 8Ω Distortion—0 1% at 15W Input Sensitivity—500mV Frequency Response—10Hz-16kHz –3dB

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HY50
25W into 8Ω

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FEATURES: low distortion integral heatsink only five connections 7 amp output transistors no external components
APPLICATIONS: medium power hi-fi systems low power disco guitar amplifier
SPECIFICATION: Input Sensitivity—500mV Output Power—25W R M S into 8Ω Load Impedance—4-16Ω Distortion—0 04% at 25W at 1kHz Signal Noise Ratio—75dB Frequency Response—10Hz-45kHz –3dB Supply Voltage—±25V Size—105 × 50 × 25mm

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HY120
60W into 8Ω

The HY120 is the baby of I.L.P. s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design

FEATURES: very low distortion integral heatsink load line protection thermal protection five connections, no external components
APPLICATIONS: hi-fi high quality disco, public address monitor amplifier guitar and organ
SPECIFICATION: Input Sensitivity—500mV Output Power—60W R M S into 8Ω Load Impedance—4-16Ω Distortion—0 04% at 60W at 1kHz Signal Noise Ratio—90dB Frequency Response—10Hz-45kHz –3dB Supply Voltage—±35V Size—114 × 50 × 85mm

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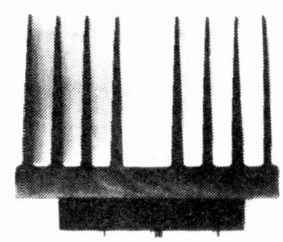


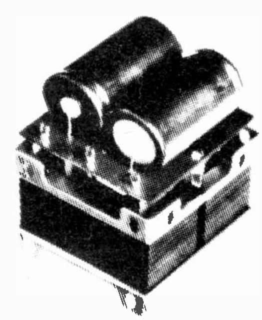
HY200
120W into 8Ω

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown very low distortion load line protection integral heatsink no external components
APPLICATIONS: hi-fi disco monitor power slave industrial public address
SPECIFICATION: Input Sensitivity—500mV Output Power—120W R.M S into 8Ω Load Impedance—4-16Ω Distortion—0 05% at 100W at 1kHz Signal Noise Ratio—96dB Frequency Response—10Hz-45kHz–3dB Supply Voltage—±45V Size—114 × 50 × 85mm

Price **£23·32** + £1·87 VAT. P. & P. free

HY400
240W into 4Ω



The HY400 is I.L.P. s Big Daddy of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: thermal shutdown very low distortion load line protection no external components
APPLICATIONS: public address disco power slave industrial
SPECIFICATION: Output Power—240W R M S into 4Ω Load Impedance—4-16Ω Distortion—0 1% at 240W at 1kHz Signal Noise Ratio—94dB Frequency Response—10Hz-45kHz –3dB Supply Voltage—±45V Input Sensitivity—500mV Size—114 × 100 × 85mm

Price **£32·17** + £2·75 VAT. P. & P. free

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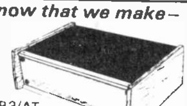
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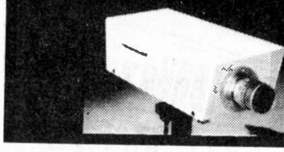

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