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PRACTICAL ELECTRONICS

OCTOBER 1982

85p

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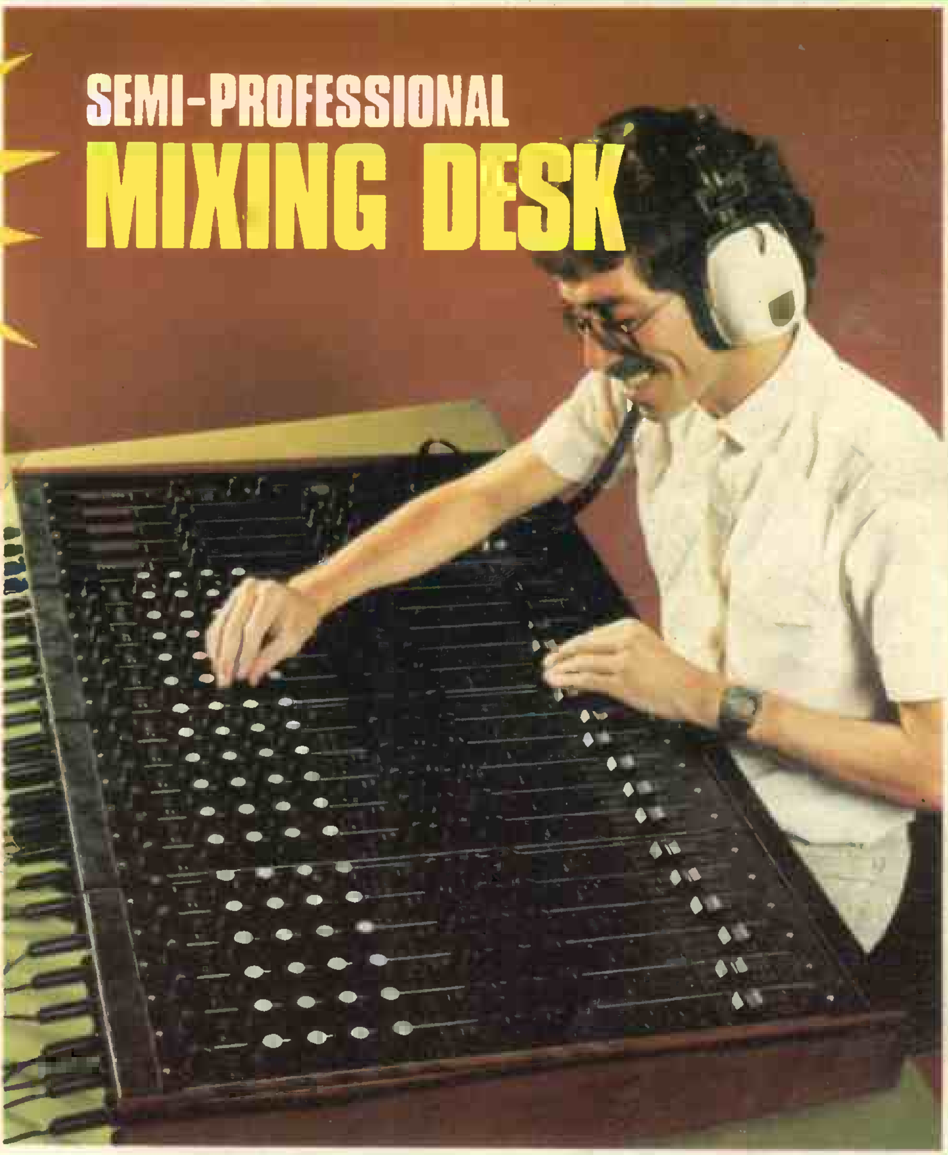
SEMI-PROFESSIONAL MIXING DESK



Also in this issue...

Security Alarm Controller

MICRO PROFESSOR COMPETITION

PRACTICAL
ELECTRONICS

VOLUME 18 No. 10 OCTOBER 1982

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR NOVEMBER ISSUE WILL BE ON SALE FRIDAY, OCTOBER 8th, 1982
(for details of contents see page 29)

WATFORD ELECTRONICS

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POLYESTER CAPACITORS: (Axial Lead) 400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2, 4µ7 85p. 1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n, 100n 50p.

POLYESTER RADIAL LEAD CAPACITORS: 250V; 10n, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1µ 23p; 1µ5 40p; 2µ2 46p.

ELECTROLYTIC CAPACITORS (Values in µF). 500V: 10µF 52p; 47 78p; 63V: 0.47, 1.0, 1.5, 2.2, 3.3, 8p; 4.7 9p; 10 10p; 15, 22 12p; 33 15p; 47 12p; 68 18p; 100 19p; 220 26p; 1000 70p; 2200 99p; 50V: 68 20p; 100 17p; 220 24p; 40V: 6.8 15p; 22 9p; 33 12p; 330, 470 32p; 1000 48p; 2200 90p; 25V: 50p; 3300 76p; 4700 92p; 16V: 2.5, 40 8p; 47, 68, 100 9p; 125 12p; 220 13p; 330 16p; 470 28p; 680 34p; 1000 27p; 1500 31p; 2200 36p; 4700 79p.

TAG-END TYPE: 64V: 4700 245p; 3300 198p; 2200 139p; 50V: 3300 154p; 2200 110p; 40V: 4700 160p; 25V: 4700 98p; 10,000 320p; 15,000 345p.

POTENTIOMETERS: Carbon Track. 0.25W Log & Linear Values.

500Ω, 1K & 2K (LIN ONLY) Single	30p
5KΩ-2MΩ single gang	30p
5KΩ-2MΩ single gang D/P switch	78p
5KΩ-2MΩ dual gang stereo	88p

TANTALUM BEAD CAPACITORS: 35V: 0.1µ, 0.22, 0.33 15p; 0.47, 0.68, 1.0, 1.5 16p; 2.2, 3.3 18p; 4.7, 6.8 22p; 10 28p; 16V: 2.2, 3.3 16p; 4.7, 6.8, 10 18p; 15 36p; 22 30p; 33, 47 40p; 100 75p; 220 88p. 10V: 15, 22 26p; 33, 47 35p; 100 55p.

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm track

5KΩ-500KΩ Single gang	70p
10KΩ-500KΩ Dual gang	110p

PRESET POTENTIOMETERS

0.1W 50Ω-2.2M Mini Vert. & Horiz.	7p
0.25W 100Ω-3.3MΩ Horiz. larger	10p
0.25W 250Ω-4.7MΩ Vert.	10p

SILVER MICA (pF)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 15p each
220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF 21p each
1000, 1200, 1800 30p each
3300, 4700 60p each

SIEMENS multilayer miniature capacitors
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n, 12n, 15n, 22n 7p; 18n, 27n, 33n, 47n 8p; 39n, 56n, 68n 9p.
100V: 100n, 120n, 10p; 150n 11p; 220n 13p; 330n 18p; 470n 23p; 680n 30p; 1µF 34p; 2µ2 50p.

RESISTORS—Hi-stab, Miniature, 5%, Carbon.

	RANGE	Val.	1-99	100+
0.25W	2Ω2-4M7	E24	2p	1p
0.5W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-10M	E12	5p	3p
2% Metal Film	10Ω-1M		6p	4p
1% Metal Film	51Ω-1M		8p	6p

MYLAR Film CAPACITORS

100V: 1nF, 2n, 4n, 4n7, 10	6p
15nF, 22, 30, 40, 47n	7p
56nF, 100, 200n	9p

POLYSTYRENE Caps:

10pF to 1nF	8p
1n5 to 12nF	10p

RESISTORS S.I.L. Package 2%
7 Commoned 100Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K 25p
8 Commoned: 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K 26p

CERAMIC Capacitors: 50V

Range 1pF to 6800pF	4p
10nF, 15n, 22, 33, 47nF	5p
100nf 30V 7p;	220n/6V 8p.

Programmable Multifunction

MUART 8256A	£35
Data Booklet	75p

TRANSISTORS

AC107	35	BC327/8	15	BFY52	23	TIP34A	74	2N1613	30	2SA671	250
AC125/6	35	BC337/8	15	BFY56	32	TIP34C	88	2N1671B	160	2SA715	60
AC127/8	35	BC441	34	BFY64	35	TIP35A	110	2N2160	295	2SC495/6	70
AC141/2	30	BC461	34	BFY81	120	TIP35C	128	2N2219A	28	2SC1061	250
AC176	28	BC477/8	40	BFY90	80	TIP36A	130	2N2220A	26	2SC1096	85
AC187/8	32	BC516/7	40	BRY39	40	TIP36C	140	2N2221A	26	2SC1162	30
ACY17/18	70	BC547/8	12	BSX20	20	TIP41A	50	2N2222A	25	2SC1172	125
ACY19/20	75	BC549C	14	BSX29	34	TIP418	52	2N2369A	18	2SC1173	125
ACY21/22	75	BC556/7	15	BSY95A	25	TIP42A	55	2N2646	45	2SC1306	100
ACY28	75	BC558/9	16	BU105	170	TIP428	58	2N2846	80	2SC1307	150
AD142	120	BCY70	16	BU205	190	TIP120	70	2N2904	28	2SC1449	85
AD149	79	BCY71/2	20	BU206	200	TIP121	73	2N2905A/6	26	2SC1679	190
AD161/2	42	BD121	95	BU208	200	TIP141	105	2N2907A	26	2SC1678	140
AF118	95	BD124	115	E421	250	TIP142	105	2N2926G	10	2SC1923	50
AF139	40	BD131/2	48	MD8001	250	TIP147	120	2N3053	26	2SC1945	225
AF239	56	BD133	60	MJ2955	70	TIP2955	60	2N3054	58	2SC1953	90
BC107/8	10	BD135	45	MJE340	54	TIP3055	60	2N3055	48	2SC1957	90
BC107B	12	BD136/7	40	MJE370	100	TIS43	32	2N3442	140	2SC1969	140
BC108	10	BD138/9	40	MJE371	100	TIS44/45	45	2N3565	15	2SC2028	85
BC108B	12	BD140	40	MJE520	95	TIS48	50	2N3614	199	2SC2029	210
BC108C	12	BD144	198	MJE2955	99	TIS88A	50	2N3615	199	2SC2078	170
BC109	10	BD205	110	MJE3055	70	TIS90	30	2N3663	15	2SC2091	85
BC109B	12	BD245	45	MPF102	40	TIS91/93	32	2N3702/3	10	2SC2166	165
BC109C	12	BD378	70	MPF103/4	30	UC734	65	2N3704/5	10	2SC2314	85
BC117/8	20	BD434	55	MPF105	30	VK1010	80	2N3706/7	10	2SC2465	125
BC140/42	30	BD517	75	MPF106	40	VN10KM	55	2N3708/9	10	2SC2547	30
BC143	30	BD695A	99	MPSA05	25	VN46AF	78	2N3710	10	2SD234	75
BC147/8	9	BD696A	99	MPSA06	25	VN66AF	80	2N3771	179	2SK45	90
BC147B	10	BDY56	180	MPSA12	32	VN88AF	94	2N3772	195	2SK288	225
BC148B	10	BDY60	160	MPSA55	30	VN89AF	96	2N3773	210	2SJ83	225
BC148C	10	BF115	35	MPSA56	30	ZTX107/8	11	2N3819	22	2SJ85	225
BC149	9	BF167	29	MPSA70	30	ZTX109	12	2N3820	38	3N128	112
BC149C	12	BF173	27	MPSU02	58	ZTX212	28	2N3822/3	45	3N140	112
BC153/4	27	BF177	25	MPSU05	55	ZTX300	13	2N3866	90	40097	120
BC157/8	10	BF178	30	MPSU06	55	ZTX301/2	16	2N3903/4	15	40100	215
BC159	11	BF179	35	MPSU52	65	ZTX303	25	2N3906/5	15	40101	130
BC160	45	BF180	38	MPSU55	60	ZTX304	17	2N4037	46	40250	95
BC167A	10	BF194/5	12	MPSU56	60	ZTX314	25	2N4058	10	40251	150
BC168C	10	BF196/7	12	OC23/26	170	ZTX320/26	30	2N4061/2	10	40311	60
BC169C	10	BF198/9	18	OC28/36	220	ZTX341	30	2N4069	45	40313	130
BC170	15	BF200	30	OC41/42	75	ZTX500/1	14	2N4427	80	40315	90
BC171/2	11	BF224	25	OC44	75	ZTX502/3	18	2N4859	78	40316	95
BC173	11	BF244A	29	OC45/70	40	ZTX504	25	2N4871	85	40317/20	80
BC177/8	16	BF256B	35	OC71/72	40	ZTX531	25	2N5135/6	20	40360	60
BC179/81	20	BF257/8	32	OC76	50	ZTX550	25	2N5138	18	40361/62	70
BC182/3	10	BF259	35	OC81/82	50	2N696	30	2N5172	18	40406/7	75
BC184	10	BF274	42	OC83/84	40	2N697	23	2N5179	45	40408	75
BC182L	10	BF336	40	OC170/1	50	2N698	40	2N5180	45	40411	285
BC183L	10	BF451	35	OC200/2	50	2N699	48	2N5191	75	40412	90
BC184L	10	BF594/5	30	TIP29A	32	2N706A	19	2N5194	80	40467	130
BC186/7	26	BFR39/40	23	TIP29C	38	2N708	19	2N5305	24	40468	85
BC212/3	10	BFR41/79	23	TIP30A	35	2N914/5	32	2N5457	30	40594	105
BC212L	10	BFR80/81	25	TIP30C	37	2N918	35	2N5458/9	30	40595	110
BC213L	10	BFR98	105	TIP31A	38	2N930	20	2N5485	36	40603	110
BC214	10	BFX29/84	28	TIP31C	37	2N1131/2	24	2N5777	45	40636	175
BC214L	10	BFX85/86	28	TIP32A	38	2N1303/4	65	2N6027	32	40673	85
BC237/8	14	BFX87/88	28	TIP32C	42	2N1305/7	60	2N6109	60	40871/2	90
BC307B	14	BFY50/51	23	TIP33A	65	2N1308	68	2N6290	70		
BC308B	16			TIP33C	78			2SA636	250		

LINEAR IC's

555 CMOS	80	LF398	475	NE570	410
702	75	LM10	325	NE571	400
709C 8 pin	36	LM301A	24	NE5534	150
710	48	LM307	45	OM335	705
741	14	LM308	95	RC4136D	69
747C 14 pin	65	LM311	70	S566B	225
748C 8 pin	36	LM318	150	SAB3209	425
753 8 pin	185	LM319	215	SAB3210	325
810	159	LM324	30	SAB3271	485
9400CJ	350	LM334Z	90	SAB4209	595
AY-1-1320	225	LM335	128	SAS560	150
AY-1-5050	99	LM339	47	SAS570	150
AY-1-5051	160	LM348	64	SG3402	295
AY-1-6720	210	LM349	115	SL490	350
AY-3-1270	730	LM358	115	SN76003N	350
AY-3-8910	375	LM377	175	SN76013N	350
AY-3-8912	625	LM379	480	SN76018	195
AY-5-1230	450	LM380	75	SN76023N	350
AY-5-1317A	630	LM381N	145	SN76033	350
AY-5-4007D	520	LM382	115	SN76115N	215
AY-5-8100	775	LM384	140	SN76131	125
CA3011	130	LM386	90	SN76227N	95
CA3012	175	LM387	120	SN76477	420
CA3014	275	LM389	95	SN76488	480
CA3018	86	LM393	100	SN76660	120
CA3019	80	LM394CH	290	SP8629	299
CA3020	210	LM725CN	325	TA7120	150
CA3023	210	LM733	70	TA7310	160
CA3028A	95	LM2917	195	TA7204	200
CA3035	255	LM3302	75	TA7205	90
CA3036	270	LM3900	50	TA7222	150
CA3043	275	LM3909	85	TA7310	150
CA3045	365	LM3911	125	TAA621AX1	295
CA3046	70	LM3914	180	TAA661A	190
CA3048	220	LM3915	200	TAA700	275
CA3059	285	LM3916	220	TAA900	395
CA3075	213	LM13600	110	TAA960	00
CA3080E	70	LS7220	280	TAD100	159
CA3081	190	M252AA	625	TBA120S	70
CA3086	48	M253AA	1150	TBA540	275
CA3089E	215	M51513L	230	TBA550Q	330
CA3090AQ	375	M51515L	320	TBA641-A12/BX1	290
CA3123	150	MB3712	220	TBA651	190
CA3130	90	M83756	440	TBA800	80
CA3140	40	MC1303	88	TBA810S	95
CA3160	95	MC1304P	260	TBA820	80
CA3161E	160	MC1310P	150	TBA920Q	200
CA3162E	450	MC1445	250	TBA990	350
CA3189	200	MC1458	35	TCA270	350
CA3240	110	MC1469	300	TCA940	175
HA1336W	240	MC1494	694	TCA965	120
HA1388	265	MC1495	350	TDA1002	00
ICL7106	750	MC1496L	70	TDA1004	290
ICL7107	975	MC1596	225	TDA1008	310
ICL7611	99	MC1648	290	TDA1010	198
ICL7660	190	MC1709G	90	TDA1022	499
ICL8038CC	300	MC3302	90	TDA1024	420
ICL8211	350	MC3340P	120	TDA1034	350
ICM7204	650	MC3360P	120	TDA1490	325
ICM7205	1150	MC3401	65	TDA2002	325
ICM7207	475	MC3403	75	TDA2004	495
ICM7215	1050	MC3405	150	TDA2006	300
ICM7216A	1950	MC3423P	80	TDA2020	320
ICM7216B	1950	MFC6040	75	TDA2030	295
ICM7216C	1950	MK50398	635	TDB0791	420
ICM7217A	790	ML924	275	TL061CP	40
ICM7224	785	MM5303	635	TL062CP	60
ICM7240	300	MM5307	1275	TL064CN	98
ICM7555	80	MM5387A	475	TL071CP	24
ICM7556	150	MSM5526	820	TL072CP	45
LA3350	250	NE515	275	TL074CN	100
LA4031P	340	NE529	225	TL081CP	24
LA4032	295	NE531	140	TL082CP	45
LA4400	440	NE543	225	TL083CP	75
LC7120	300	NE544	210	TL084CP	90
LC7130	340	NE555	16	TL091CP	55
LC7137	395	NE556DB	45	TL170	50
LF347	150	NE560	325	UA2240	120
LF351	48	NE561	395	UA78540	230
LF353	95	NE562B	410	UAA170	170
LF355	85	NE564	420	UAA180	170
LF356	95	NE565A	120	UAA1003-3	935
LF357	110	NE566	155	ULN2003	85
		NE567	140		

ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2240	120
XR2266	360
ZN414	80
ZN419CE	190
ZN423E	138
ZN424E	130
ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

COMPUTER IC's

1702	350	68821	00
1802CP	650	8080A	260
2101-2	150	8085A	450
2112-2	250	81LS95	85
2114L-300n	80	81LS96	85
2114L-200n	80	81LS97	85
2147-3	425	81LS98	85
2532-450n	350	8155	420
2564	£12	8123	125
2708	225	8202	£25
2716-5V	215	8212	150
2732-450n	350	8214	425
2764	£11	8215-300	300
3242	590	8216	70
4027	190	8224	180
4116-150	80	8226	250
4116-200	70	8228	250
4118-250	325	8251A	320
4164-200	75	8253	799
4334-3 (CMOS 2114)	325	8255	295
4816-100ns	225	8256A	£35
4864-3 64K	490	8257A	800
5101	220	8259	395
6116-150ns	390	8271	£36
6116L-120ns	550	8284	350
6117-100n	490	8T26A	99
6502 CPU	325	8T27	150
6503	600	8T28A	120
6504-250	550	8T31	350
6520	115	8T95N	90
6521	115	8T97N	90
6522 VIA	300	9364AP	550
6530 RRIOT	£11	9602	320
6532 RIOT	570	AM26LS31C	125
6545 CRTC	899	AM26LS32A	125
6551 ACIA	650	AY-3-1015	300
6592 PC	£20	AY-5-1013	300
6800	275	AY-5-1350	388
6802	335	AY-5-2376	600
6803	850	AY-5-3600	750
6804	160	COM8017	275
6805	670	COM8116	700
6808	520	DM8131	275
6809	820	DPB3048N	250
6810	115	DS3691N	320
6820	115	DS88LS120N	275
6821	115	FD1761	£15
6840	395	FD1771	£15
6843	£12	FD1791	£22
6845	720	FD1793	£23
6847	850	FD1795	£28
6850	135	FD1797	£28
6852	255	HD26501	75
6875	500	IM6402	380
68000	£59	INS8060N	1050
		INS8154N	£10
		MC1488	55
		MC1489	55
		MC14411	675
		MC14412	775
		MC3446	250
		MC3447P	315
		MK3886-2M	£7
		MM5280D	695
		MM58174	695
		RO-3-2513L	700
		RO-3-2513U	600
		SFF96364E	800
		TMS2716-3	725
		TMS6011	365
		TMS4164-15	475
		ULN2003	90
		UPD7002	440
		Z80CPU 2.5	299
		Z80ACPU4M	350
		Z80CTC	265
		Z80ACTC	290
		Z80DART	495
		Z80ADART	550
		Z80ADMA	00
		Z80DMA	895
		Z80P10	260
		Z80AP10	275
		Z80S10-1	850
		Z80AS10	980

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420

74S Series

74S00	30
74S02	32
74S04	32
74S10	40
74S20	40
74S30	40
74S32	70
74S74	75
74S132	110
74S133	60
74S138	125
74S139	150
74S158	195
74S188	210
74S189	158
74S194	320
74S201	350
74S225	525
74S241	390
74S260	50
74S262	850
74S287	300
74S288	210
74S289	290
74S301	000
74S365	000
74S374	365
74S470	325
74S471	620
74S472	1150
74S475	825
74S571	620

75 Series

75107/8	95
75110	90
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	65

TTL 7400

7400	11	7425	24	74164	48
7401	11	7426	28	74165	48
7402	11	7427	22	74166	48
7403	12	7428	25	74167	150
7404	13	7430	14	74170	125
74L04	85	7432	20	74172	275
7405	15	7433	22	74173	60
7406	20	7437	25	74174	54
7407	20	7438	25	74175	50
7408	14	7440	15	74176	40
7409	14	7441	68	74177	45
7410	14	7442	32	74178	80
7411	16	7443	90	74179	80
7412	18	7444	90	74180	40
7413	18	7445	55	74181	115
7414	20	7446	60	74182	60
7416	20	7447	35	74184	90
7417	20	7448	40	74185	95
7420	15	7450	16	74186	470
7421	20	7451	16	74188	250
7422	20	7453	16	74190	48
7423	20	7454	16	74191	46
		7460	16	74192	46
		7470	30	74193	45
		7472	24	74194	45
		7473	24	74195	46
		7474	20	74196	46
		7475	32	74197	46
		7476	30	74198	84
		7480	40	74199	84
		7481	120	74221	54
		7482	65	74246	120
		7483	38	74247	120
		7484	70	74248	120
		7485	60	74249	120
		7486	20	74251	65
		7489	205	74259	150
		7490	20	74265	55
		7491	35	74273	150
		7492	25	74276	120
		7493	25	74278	100
		7494	35	74279	50
		7495	35	74283	50
		7496	40	74284	199
		7497	90	74285	199
		74100	80	74290	105
		74104	50	74293	125
		74105	55	74297	236
		74107	20	74298	100
		74109	25	74351	195
		74110	35	74365	55
		74111	55	74366	55
		74112	170	74367	55
		74116	50	74368	55
		74118	60	74390	99
		74119	80	74393	99
		74120	60	74490	120
		74121	25		
		74122	40		
		74123	40		
		74125	35		
		74126	35		
		74128	35		
		74132	28		
		74136	28		
		74141	55		
		74142	175		
		74143	210		
		74144	210		
		74145	50		
		74147	90		
		74148	70		
		74150	50		
		74151	40		
		74153	40		
		74154	55		
		74155	40		
		74156	40		
		74157	30		
		74159	80		
		74160	60		
		74161	48		
		74162	48		
		74163	48		

74LS

LS00	11	LS38	15	LS257	35
LS01	11	LS40	13	LS258	35
LS02	11	LS42	28	LS259	55
LS03	12	LS47	35	LS260	22
LS04	12	LS48	45	LS261	138
LS05	13	LS49	50	LS266	18
LS08	12	LS51	14	LS273	68
LS09	12	LS54	14	LS275	225
LS10	13	LS55	14	LS279	135
LS11	13	LS63	120	LS280	180
LS12	12	LS73	18	LS283	40
LS13	20	LS74	18	LS290	45
LS14	30	LS75	20	LS293	40
LS15	13	LS76	18	LS295	150
LS20	13	LS78	18	LS298	95
LS21	12	LS83	36	LS299	270
LS22	12	LS85	48	LS300	175
LS26	14	LS86	16	LS302	175
LS27	12	LS90	24	LS320	270
LS28	14	LS91	60	LS323	160
LS30	12	LS92	32	LS324	168
LS32	13	LS93	23	LS325	295
LS33	14	LS95	40	LS326	240
LS37	14	LS96	95	LS327	240
		LS107	40	LS347	95
		LS109	23	LS348	100
		LS112	22	LS352	65
		LS113	16	LS353	65
		LS114	22	LS362	750
		LS122	36	LS363	140
		LS123	38	LS364	140
		LS124	90	LS365	28
		LS125	24	LS366	28
		LS126	25	LS367	28
		LS132	40	LS368	40
		LS133	30	LS373	60
		LS136	24	LS374	55
		LS138	28	LS375	70
		LS139	28	LS377	70
		LS145	70	LS378	60
		LS147	150	LS379	65
		LS148	85	LS384	395
		LS151	40	LS385	250
		LS153	40	LS390	46
		LS154	80	LS393	42
		LS155	30	LS395	95
		LS156	36	LS399	175
		LS157	30	LS445	100
		LS158	30	LS471	620
		LS160	37	LS490	200
		LS161	37	LS540	100
		LS162	37	LS541	80
		LS163	37	LS640	180
		LS164	43	LS641	180
		LS165	60	LS645	180
		LS166	52	LS668	125
		LS168	85	LS669	120
		LS170	70	LS670	150
		LS173	55	LS673	550
		LS174	50		
		LS175	40		
		LS181	95		
		LS183	180		
		LS190	36		
		LS191	36		
		LS192	36		
		LS193	37		
		LS194	33		
		LS195	33		
		LS196	58		
		LS197	48		
		LS200	275		
		LS202	275		
		LS221	55		
		LS240	55		
		LS241	55		
		LS242	55		
		LS243	55		
		LS244	60		
		LS245	70		
		LS247	50		
		LS248	55		
		LS249	55		
		LS251	32		
		LS253	32		

CMOS

4000	10	4026	80	4502	60
4001	10	4027	20	4503	35
4002	12	4028	39	4504	75
4006	50	4029	45	4505	185
4007	14	4030	15	4506	35
4008	32	4031	125	4507	35
4009	24	4032	80	4508	130
4010	24	4033	125	4510	46
4011	10	4034	140	4511	46
4012	16	4035	45	4512	42
4013	20	4036	275	4513	199
4014	46	4037	115	4514	125
4015	40	4038	110	4515	125
4016	20	4039	290	4516	65
4017	32	4040	40	4517	275
4018	45	4041	40	4518	40
4019	25	4042	40	4519	30
4020	42	4043	40	4520	70
4021	40	4044	40	4521	130
4022	40	4045	105	4522	125
4023	13	4046	46	4526	60
4024	32	4047	40	4527	50
4025	13	4048	40	4528	50
		4049	25	4529	150
		4050	25	4530	90
		4051	45	4531	130
		4052	60	4532	50
		4053	50	4534	455
		4054	85	4536	275
		4055	85	4538	70
		4056	85	4539	90
		4057	1915	4541	140
		4059	435	4543	70
		4060	45	4544	150
		4061	1195	4548	40
		4062	995	4549	375
		4063	85	4553	245
		4066	24	4554	190
		4067	245	4555	35
		4068	14	4556	35
		4069	13	4557	320
		4070	13	4558	120
		4071	13	4559	395
		4072	13	4560	160
		4073	15	4561	104
		4075	13	4562	495
		4076	50	4566	165
		4077	13	4568	250
		4078	15	4569	175
		4081	13	4572	36
		4082	13	4580	460
		4085	50	4581	250
		4086	60	4582	99
		4089	125	4583	99
		4093	20	4584	48
		4094	70	4585	99
		4095	95	4597	330
		4096	70	4598	290
		4097	190	4599	290
		4098	75	40097	45
		4099	75	40098	42
		4160	95	40100	215
		4161	99	40101	130
		4162	99	40102	140
		4163	99	40103	175
		4174	99	40104	95
		4175	105	40105	115
		4194	105	40106	75
		4408	790	40107	60
		4409	790	40108	450
		4410	725	40109	100
		4411	690	40110	300
		4412	790	40114	240
		4415	480	40163	50
		4419	280	40174	45
		4422	770	40192	95
		4433	770	40193	95
		4435	850	40194	90
		4440	999	40195	80
		4450	350	40244	195
		4451	350	40245	195
		4490	350	40373	240
		4500	675	40374	245
		4501	28	45106	595

SPEAKERS
8Ω. 0 3W. 2": 2 25". 2 5". 3" 80p
0 3W. 2 5" 40Ω: 64Ω or 80Ω 80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

BRIDGE RECTIFIERS (plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ZENERS
Range 2V7 to 39V 400mW **8p each**
Range 3V3 to 33V 1 3W **15p each**

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

Noise Diode
Z5J 195

SCR's Thyristors

0·8A-100V	32
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	98
16A/400V	105
16A/800V	320
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

DIAC
ST2 25

SOLDERCON PINS
100 70p
500 325p

OPTO ELECTRONICS
LEDS including Clips

TIL209 Red 3mm	11
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 2" Red	12
0 2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0 2" Flashing LED Red	55
0 2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0 2" Tri colour LEDs Red/Green/Yellow	85
0 2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38 46; TIL81	82
TIL100	90

0·5" LIQUID CRYSTAL DISPLAYS

3½ digit	495
4 digit	530
6 digit	640

BPX25	195
BPW21	295
IL74	45
ILD74	99
ILQ74	185
TIL111	76
TIL117	90
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

7 Segment Displays

TIL321 5" C.An	115
TIL322 ·5" C.th	115
DL704 ·3" C.Cth	99
DL707 ·3" C.Anod	99
8" Orange C.A.	250
FND357 or 500	120
3" Green C.A.	140
±1·3" Red or Green	150
Bargraph 10 seg. Red	225
Bargraph NSM3914	500

ALUM. BOXES

3x2x1"	65
4x2½x2"	85
4x2¼x2¼"	103
4x4x2½"	120
5x4x2	105
5x2½x1½"	90
5x2½x2½"	130
5x4x1½"	99
5x4x2½"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4½x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

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

DALO ETCH RESIST
Pen + Spare tip 90p

COPPER CLAD BOARDS

	Fibre Glass	Single-sided	Double-sided	SRBP
	6"x6"	90p	110p	9·5"x8 5" 95p
	6"x12"	150p	195p	

VEROBOARDS 0·1"

	Clad	Plain
2½x3¾"	80p	—
2½x5"	91p	—
3¾x3¾"	91p	—
3¾x5"	105p	87p
3¾x17"	360p	232p
4¾x18"	470p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	135p	
Pin Insertion Tool	178p	

'VQ' Board	180
'DIP' Board	374
Vero Strip	144
S100 Board	£14

PROTO-DECs

Veroblock	405
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 350p
Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 250p

SPECIAL OFFER

	1+	25+
2114L-2	80p	75p
2532	350p	330p
2716	215p	199p
2732	350p	330p
4116	75p	70p
4816-100ns	225p	205p
6116-150ns	390p	360p
6520/21	115p	105p
6522	300p	280p
6820/6821	115p	105p
EPSON MX80T Printer	£249	

EPSON PRINTERS
- **MX80T** 10" Tractor Feed, 9x9 matrix, 80 column, 80 CPS, Bi-directional, Centronic Interface. Baud Rate 110-9600. **£275**
- **MX80T** Hi-Resolution Graphic. A set of 3 Roms. **£20**
- **MX80FT/3** Tractor & Friction feed. Has hi-resolution, bit image graphics, Subscript & Superscript, Italics & underlining facility plus all the MX80FT features. **£325**
- **NEC's PC-8023-C** 100CPS Dot Matrix Printer **£335**

ANTEX Soldering Irons

C15W	450
CX17W	475
CCN15W	490
X25W	500
Spare bits	66
Elements	210
Iron stands	165
Heat Shunt	30

Buy with Access
Just phone your order through, we do the rest.

ASTEC UHF MODULATORS
6MHz 280p
8MHz Wide Bandwidth 425p

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS

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

ZIF DIL SOCKET

16 way	475p
24 way	575p
28 way	850p
40 way	975p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
40	195p	218p

RIBBON CABLE (price per foot)

Ways	Grey	Color
10	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

WATFORD'S Ultimate Monitor IC.

A 4K Monitor Chip specially designed to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk In Practical Electronics, June 1981.
Price only £12.00 + 50p P&P

IDC CONNECTORS (Speed block type)

	PCB PLUG with latch Strt. Pins	PCB PLUG with latch Angle Pins	female Header Socket	PCB Plugs Unshrouded Male Strat.	PCB Plugs Unshrouded Male Angle
2 x 5 way	90p	99p	85p	60p	65p
2 x 8 way	130p	150p	110p	70p	78p
2 x 10 way	145p	166p	125p	80p	92p
2 x 13 way	175p	200p	150p	95p	110p
2 x 17 way	205p	236p	169p	110p	135p
2 x 20 way	220p	250p	190p	125p	150p
2 x 25 way	235p	270p	200p	150p	175p

EURO CONNECTORS

	SOCKETS Strt.	SOCKETS Angle	PLUGS Strt.	PLUGS Angle
DIN 41617	170p	—	—	175p
DIN 41612 2x32 way	280p	305p	200p	295p
DIN 41612 2-3x32 way	290p	310p	210p	300p
DIN 41612 3x32 way	350p	370p	250p	290p

'D' CONNECTORS: Miniature

Pins	9 way	15 way	25 way	37 way
PLUGS				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	385p
Strait	170p	160p	220p	310p
SOCKETS				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	95p	90p	100p	110p

IDC 25 way Plg. 385p, Skt. 450p.

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA 98p
6VA: 2x6V-·5A; 2x9V-·4A; 2x12V-0·3A; 2x15V-·25A 220p
12VA: 2x4V5-1·3A; 2x6V-1·2A; 2x12V-·5A, 2x15V-·4A 295p (35p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A 330p (60p p&p)
50VA: 2x6V-4A; 2x9V-2·5A; 2x12V-2A; 2x15V-1·5A; 2x20V-1·2A; 2x25V-2A; 2x30V-0·8A 465p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2·5A; 2x30V-1·5A; 2x40V-1·25A; 2x50V-1A 920p (60p p&p)

Amphenol Plugs
24 way IEEE 575p
36 way Centonics Parallel 550p

SIL Sockets 0·1"
20 way 65p

EDGE CONNECTORS Two rows

	·1	·156
2x10 way	—	135p
2x15 way	—	140p
2x18 way	180p	145p
2x22 way	199p	200p
2x23 way	210p	—
2x25 way	225p	220p
2x28 way	210p	—
2x30 way	245p	—
2x36 way	295p	—
2x40 way	315p	—
2x43 way	395p	—
2x75 way	550p	—

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	380p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

ID HEADER SOCKET Jumper Leads 24"

	20pin	26pin	34pin	40pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

COMPUTER CORNER

- **EPSON MX** Series Printers. Full range available. See box above for details.
- **SEIKOSHA GP100A** – Unihammer Printer, gives normal and double width characters as well as dot resolution graphics 10" Tractor feed. Parallel Interface standard. FREE 500 Sheets **£185**
- **RICOH FLOWRITER RP1600S** – Daisy Wheel Printer. 60CPS. Proportional Spacing. Centronics, IEEE, RS232C. Interfaces. **£1299**
- **SOFTY–2.** The complete microprocessor development system for Engineers & Beginners. New powerful instruction. Accepts any 24 pin 5V single rail EPROM. Supplied fully built, tested & enclosed in a black ABS case. Price including plug-in PSU & Watford's extended warranty. **£169**
- **12 MONITOR GREEN** Screen. Attractive Casing. Excellent resolution. **£85**
- **VIDEO MONITOR** 9" fully cased. B&W. Fully guaranteed. 15MHz bandwidth value for money. **£69**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with the Solid-State 30 minute Electronic Timer. **£43**
- **Spare** 'UV lamp bulbs **£9**
- **5V/5A PSU** Ready built and tested **£25**
- **MULTIRAIL PSU KIT.** Output: +5V/5A; +12V; +25V; –5V; –12V @ 1A. **£35**
- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£29**
- **Full ASC11** coded keyboard type '756' **£39**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 COMPUTER Cassettes** in Library Cases **40p**
- **STACK-PACK** Drawers rack including 10 x C12 Computer grade Cassettes. **550p**
- **8½.Fan fold paper** (500 sheets) (no VAT) **£5**
- **9½" Fan fold paper** (500 sheets) (no VAT) **£5**
- **Teleprinter Roll** (no VAT) **£3.50**

(P&P on most of the above items is extra)
Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

VOLTAGE REGULATORS

1A	T03 +ve		–ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	150p		—
1A	**T0220 Plastic Casing**			
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		
100mA	**T092 Plastic Casing**			
5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
78H05 5V/5A	550	LM317K	320
78H12 12V/5A	580	LM317P	99
78HG+5 to +24V 5A	599	LM323K	500
79HG –2.25V to –24V 5A	685	LM337T	175
		LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40
4 pole c/over	240

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

PUSH BUTTON Spring loaded

Latching or Momentary 6A SPDT c/over	99
DPDT c/over	145

SUB-MIN TOGGLE

SP changeover	60
SPST on off	54
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	75
DPDT C/OFF	88
DPDT on/on/on	185
DPDT Biased	145
3 pole c/over	205

MINIATURE Non Locking

Push to make	15p
Push break	25p

ROCKER: 5A, 250V, SPST 28p
ROCKER: 10A 250V SPST 38p
ROCKER: With neon lights red when on. 10A 250V. DPST 85p
ROCKER: (White) 10A/250V DPDT 72p
ROTARY: Make your own Multiway Switch. Shafting Assembly accommodates up to 6 wafers 90p
Break before make Wafers. Silver contacts 1 pole/12 way: 2 pole/6 way 3 pole, 4 way: 4 pole/3 way: 6 pole2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 6p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole, 2 to 4 way, 4 pole/2 to 3 way 45p
ROTARY: Mains 250V AC, 4 Amp 56p
DIL SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 99p; 10 way 135p; (SPDT) 4 way 190p.
THUMBWHEEL Mini front mounting
Decade Switch Module 220p
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32·768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1·008M	275
1·28MHz	392
1·5MHz	420
1·6MHz	395
1·8MHz	398
1·8432M	200
2·0MHz	225
2·4576M	200
2·5MHz	225
3·2768M	150
3·57954M	98
3·6864M	300
4·0MHz	150
4·032MHz	290
4·194304M	200
4·433619M	100
4·608MHz	200
4·80MHz	200
5·0MHz	160
5·185MHz	300
5·24288M	390
6·0MHz	140
6·144MHz	150
6·5536MHz	200
7·0MHz	150
7·168MHz	250
7·68MHz	200
8·0MHz	150
8·08333M	395
8·867237M	175
9·00MHz	200
9·375MHz	350
10·0MHz	175
10·5MHz	250
10·7MHz	150
10·24MHz	200
12·0MHz	175
12·528MHz	300
14·31818M	170
14·765MHz	250
15·0MHz	200
16·0MHz	200
18·0MHz	180
18·432M	150
19·968MHz	150
20·0MHz	150
24·0MHz	170
24·930MHz	325
26·69M	150
26·670MHz	325
27·125MHz	295
27·145M	190
27·648MHz	330
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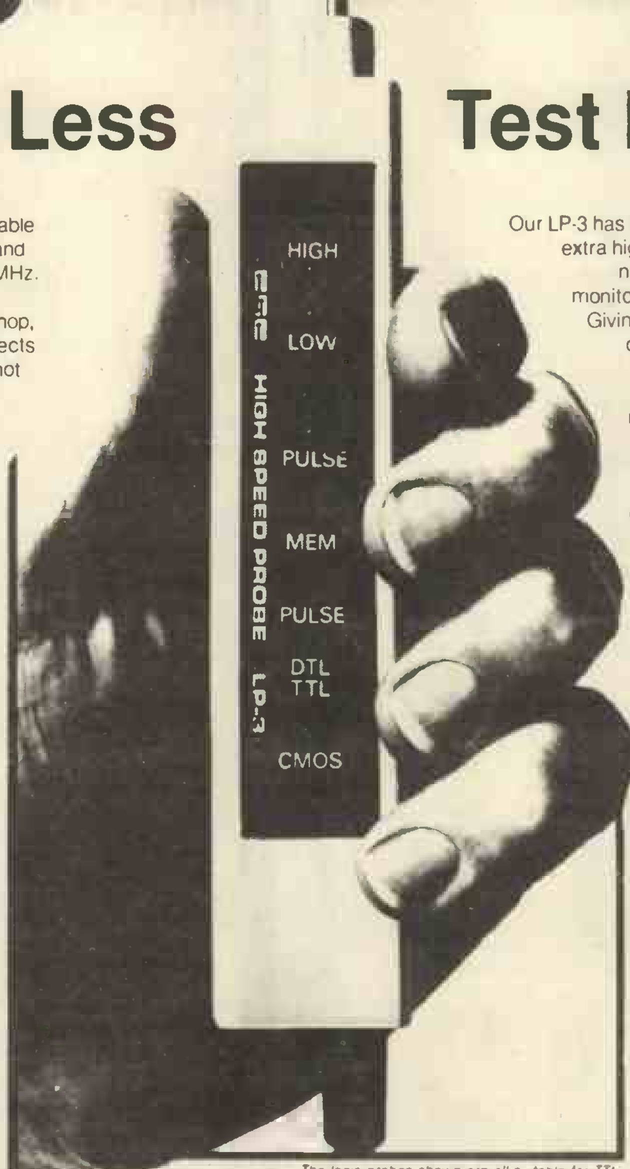

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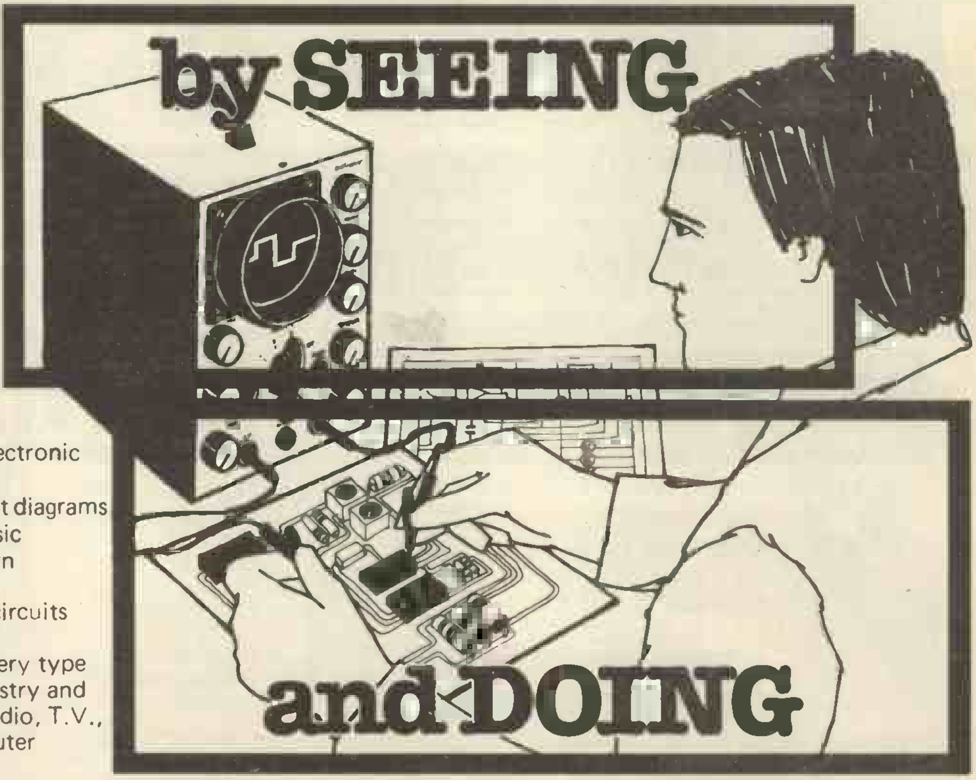

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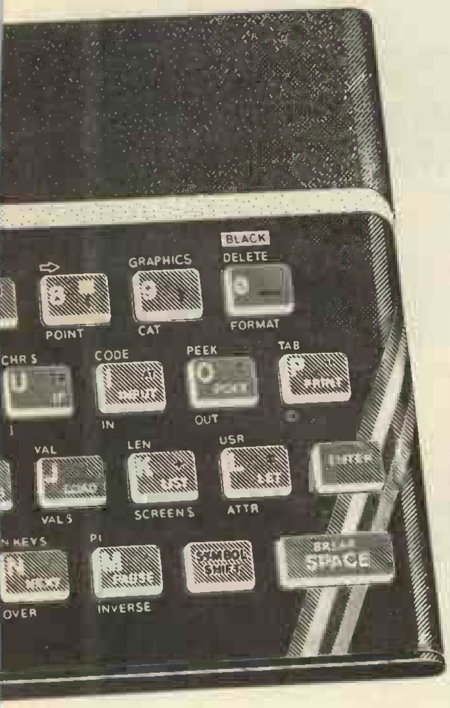

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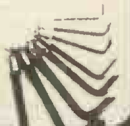

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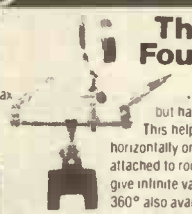

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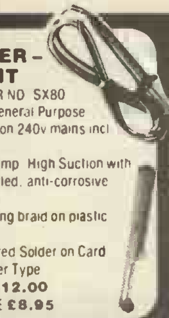

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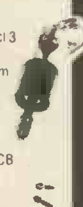

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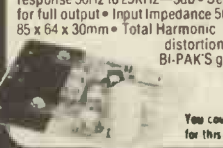

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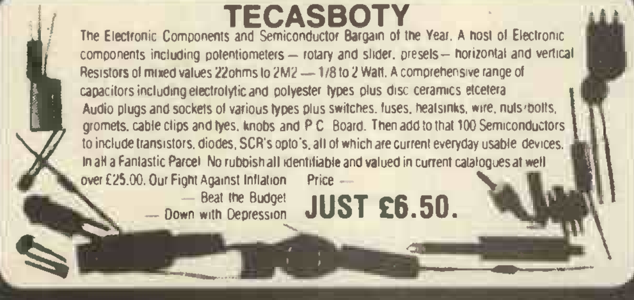

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PE VOLUME 18 No. 10 OCTOBER 1982

WATCH TV

Readers may have seen the various announcements recently concerning the development of a wrist watch style TV by Seiko. In case you missed them; basically Seiko intend to market this device for around £200 next spring. It consists of an l.c.d. display about 28mm across fitted in the face of a watch, with back up electronics in a walkman style case.

Various claims have been made for resolution and a new technique has been devised to mount the l.c.d. and CMOS i.c.s in the compact space, the screen consists of 32,000 dots, but Seiko are being very cagey about details. However, in this issue of PE you will find a description of the technique used to make the display. No, it's not an exclusive from Seiko nor do we have an industrial spy. In fact our source is wide open to everyone who cares to look and, at the present time, a publicity campaign is being mounted to get people to do just that.

So what is this wondrous source of information on new techniques that companies otherwise protect? When we tell you the data on Seiko's technique can be found in *Patents Review* it becomes clear!

PIN

We recently received a sample copy of PIN Bulletin (Patents Information Network), a quarterly publication issued free by the Science Reference Library. The publication is "intended to help bring, to wider attention, the wealth of technical and commercial information contained in patent specifications". It is available through SRL and the 26 other libraries of the UK Patents Information Network.

The bulletin is in itself quite interesting, giving a taste of the information available from various patents. Such items as Prestel, fibre optics, Enigma (the wartime code machine) and a time domain multiple access satellite communications system are outlined and their relevant patent numbers quoted. As you can see this source of free information is well worth exploiting.

The other patent we describe this month was taken out by an engineer who has been a PE contributor. We were not aware of his work in this area until Barry Fox, our *Patents Review* author, sent in the piece for publication. We can all learn from patents!

PAT OR PAY?

By the way Barry (an acknowleged expert in this field) informs us that the correct pronunciation of patent is *"pat* (as in cat)*–ent"*, not *"paytent"*. However, many people pronounce it the latter way and this point has caused much friendly argument in the PE office! Try talking it over at work, school or college, but don't rely on dictionaries for an answer — some give both pronunciations, others give one or other version!

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We regret that lengthy technical enquiries cannot be answered over the telephone

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Letters and Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to **one published project only.**

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders
Binders for PE are available from the same address as back numbers at £4·60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £13·00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Items mentioned are available through normal retail outlets unless otherwise specified. Prices correct at time of going to press.

Electronic Hobbies Fair

The Electronic Hobbies Fair has been launched in response to demand from both trade and hobbyists (following dissatisfaction with last year's Breadboard Exhibition) for a major national show of the highest quality. A visit to the new Alexandra Palace Pavilion from November 18–21 will illustrate how the hobby market is being expanded by the application of electronics.

In addition to the three sponsoring magazines (P.E., P.W. and E.E.) the following IPC titles will also have a presence at the fair Wireless World, Practical Computing, Your Computer, Practical Hi-Fi and Television. Virtually all the big names in the retail hobby supply business will be exhibiting and a few industrial suppliers now getting involved in the hobby scene will also be there.

Dubbed the "Palace of Light," the new Pavilion is set in 200 acres of London's most attractive parkland. To assist visitors to attend, a concessionary fare that includes admission to the show has been arranged with British Rail, from every major British Rail station in the country, direct to Alexandra Palace station with a free bus service to the Pavilion.

Admission is £2 for adults and £1 for children under 14, but money off vouchers will be published in PE, and the other sponsoring magazines, to enable our readers to come in at a special rate. Reductions will also be made for organised groups. There is ample free car parking and easy access from Alexandra Palace tube station. Opening times are 10·00–18·00hrs for the first three days and 10·00–17·00hrs on the final day. We hope to see you there!

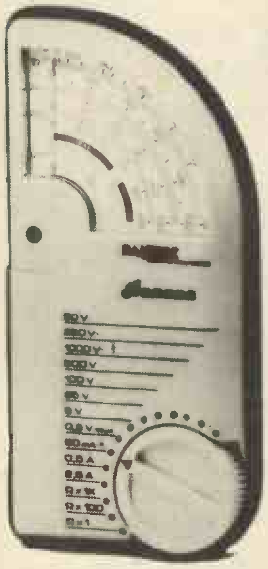
ELECTRONIC HOBBIES FAIR

TOP BANANA

Of course, were you to ask a monkey to design an analogue multimeter, a bright yellow banana-shaped end product would be no more than you deserved. Pantec's Banana 1, however, *has* a bright yellow skin and it's no slip up. It *is* banana-shaped, yet there are no chimps on the staff.

"The Banana" was designed for use by field service engineers working in difficult testing environments, and is a considerable departure from traditional designs. It is said to be shockproof, withstanding a two-metre drop to the floor. The range selector can be operated with one finger, and its probes are permanently connected for safety, as well as prevention against insertion errors.

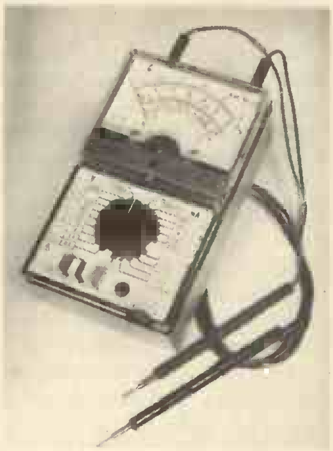
Voltages up to 750V a.c. can be measured in three ranges, with five d.c. ranges for readings up to 500V. Currents up to 2·5A d.c. in four ranges, and resistances up to 2M in three ranges are measurable. The Banana incorporates a continuity tester with a buzzer for resistances under 30Ω, and a visual battery check system. A coloured scale indicates the condition of its internal 1·5V battery.



A price was not available at the time of going to press, but details can be obtained from Solent Component Supplies, Warren Avenue, Milton, Portsmouth. Perhaps Bunch discounts will be considered.

ROBUST METER

The U4324 multimeter from Marco Trading is a robust instrument which is priced at just £10·50 plus £2·00 p&p. Rechargeable batteries are included or dry cells can be supplied if required (£1·50 plus VAT).



The meter has nine d.c. voltage ranges up to 1200V, eight a.c. voltage ranges up to 900V with six d.c. current ranges and five a.c. current ranges both measuring up to 3A. The five resistance ranges measure up to 5MΩ.

Test leads, probes and a range of clips are also included in the price. Marco Trading, The Maltings, High Street, Wem, Shropshire SY4 5EN (0939 32763).

ZX ADD ON

An independent add-on for the ZX spectrum is here, manufactured by Kempston (Micro) Electronics, and designed around an MOS chip to give a 24-line I/O port which presents virtually no d.c. load to the data lines, and only a slight a.c. load to the address lines. A two-slot Mother Board by the same company is also shown in the photograph, and this allows duplication of the spectrum's edge connector.

The I/O port makes use of the computer's IN and OUT commands and is port mapped, being accessed by one simple BASIC command. There are three 8-bit I/Os which may be configured in a variety of modes.

At £16·50, the port is available fully built and tested, together with a set of detailed instructions and control applications. Use the Mother Board and you'll need another £16·95 (stackable connectors £5·50 each). All prices include VAT. Single item postage is 70 pence (100 pence for two or more items). Further details available from Kempston (Micro) Electronics, 60 Adamson Court, Hillgrounds Road, Kempston, Bedford MK42 8QZ.

MARKET PLACE

REMOTE CONTROLLER

The XK112 remote control kit from TK Electronics has been developed to enable the user to control, via a hand held transmitter, any electrical appliance which is plugged into a domestic supply.

The 18-key transmitter which has 16 control keys and 2 command keys (on/off) modulates the domestic supply with a 470kHz signal. Each appliance is plugged into a receiver module which is coded using 4 wire links. Up to 16 receiver modules and therefore 16 appliances can be controlled via one transmitter unit.

A major advantage of this system is that the transmitter includes circuitry which allows it to be controlled by logic levels enabling automatic control of all appliances in the house from a central controller, such as a digital clock, microprocessor or other logic system without the need to run separate wires to each appliance.

The XK112 kit includes a transmitter and two receiver units. The transmitter kit includes an 18-key keyboard, l.e.d. indicator, p.c.b., components and a cone. The receiver kit includes the p.c.b. and components but a housing is not included as the unit is small enough to be built into existing equipment, although a suitable case can be supplied if required.

The XK112 is priced a £42·00 plus VAT or the transmitter (XK110) kit is available separately priced at £25·00 plus VAT. Separate receivers are also available, price £10·00 plus VAT.

TK Electronics have also made Mail Order easier by installing a new telephone No. which even the most forgetful constructor will have difficulty in forgetting. The number is 567 8910.

By dialling the above number and quoting your Access or Barclaycard number TK will despatch your order on the same day.

Also available from TK is a copy of their latest catalogue which can be obtained by writing and enclosing a s.a.e. (6" × 9") to the following address.

TK Electronics, 11 Boston Road, London W7 3SJ (01-579 9794).

CHIP QUACK

From the Softy people, Dataman Designs, now comes Microdoctor, an intelligent device which helps engineers to diagnose faults in computers and microprocessor controlled equipment. Whilst malfunctioning ROM, RAM, I/O and data line shorts are burdensome on labour time, the rather more conventional tools, such as scopes and logic analysers, are less than ideal in diagnostic work of this nature.

Microdoctor, which can be used by an unskilled operator, prints out the results of pre-programmed tests on all memory mapped chips, dynamic or static RAM.

Is this machine a doctor, or psychiatrist? Well, it cannot solve software problems, but it can, for example, memory map an unknown system for you, memory contents being printed out in Hex or ASCII.

Microdoctor is a Z80 based product, supplied with a free Z80 disassembler which may be used to print a disassembled listing of the ROM in any Z80 system. The machine is equally applicable to other µP systems as it stands, and disassemblers for other popular micro's will be available soon for low cost retrofit.

The Microdoctor has 4K of firmware and 1K of CMOS RAM with battery back-up, allowing up to 15 test sequences (of up to 12 tests each) to be retained in memory for several months whilst switched off.

On examining an unknown system, for example, a memory map print-out would find ROM, RAM and I/O. A dump in Hex or ASCII would find the data tables, and once the location of peripheral drivers were known a SEARCH would find the software routines, which could then be disassembled. There are numerous other features.

Microdoctor costs £295 + VAT and carriage, from: Dataman Designs, Lombard House, Cornwall Rd., Dorchester, Dorset DT1 1RX.

Briefly...

Many readers may not be aware of a PO service called Transcash. This service has been in operation for some time but was previously called Inpayment Service; it allows an order with cash to be placed for a minimal charge with any company (or individual) that has a Girobank account.

All you do is fill in a Transcash form, write your order or message in the space provided on the back and hand it in with the cash (no cheques) plus a 30p payment at any Post Office. The order and payment are then delivered to the Girobank account holder you nominate.

This service is now being advertised by Radio Component Specialists (see their ad. in this issue) and is obviously a simple, cheap (when compared to postal orders plus stamps etc.) and safe way of placing orders.

● ● ● ●

The paperless office, according to a report in Computer Weekly, may not be imminent after all. There is *growth* in the paper industry research is revealing, which in the UK is stated as increasing at two per cent per year, with business gobbling it up at twice that speed. The trouble is that messages and data sent by electronic communications systems are invariably delivered ultimately on paper. Indications are that new technology will not have any effect on paper consumption at least until the 1990s, and in many cases not before the end of the *next* century!

● ● ● ●

In Electronics Times it was reported recently that the US Defence Department believes that the Soviets are developing a computer-based airborne combat system which allows a pilot to manoeuvre, aim and fire his weapons simply by thinking! The Russians, we are told, have taken a version of their MIG-25, now known as the MIG-29, and modified the on-board computer for control by thought.

● ● ● ●

Another report in Electronics Times tells of two British companies, which have joined forces, one being DJ'AI' of "Last One" fame (the self-programing computer program, you may remember), to produce the "Hyperspatial" RAM. No technical details, of course; but Micro Xeno, the other half of the arrangement, have worked on the problem of bulk storage from the hardware end, and DJ'AI' from the software end. The report described Micro Xeno as having been the subject of controversy in the computer industry since it claimed to be able to make a 9·9 gigabyte solid state memory using only 8K bytes of normal memory!

Merchant of Menace

Caverns Of Doom, Deadly Triangle and Warp War are but a mere glimpse of the lethal range of software available from Premier Publications. Yet for the peace-loving Earth man, particularly he who flies UK 101/OHIO systems? Yes, disk for the couple of examples: BASIC X. This adds 25 new BASIC words to your interpreter for around £20. Approximately 80p a word is not bad! What about the disk system for UK 101/OH10 systems? Yes, disk for the 101! The card plugs into J1. Single or double drive units. Single or double density mode. ROMDOS or OS65–D, cables etc. 80k capacity (90k under Premier Forth) at 125k bits per second.

What will really interest the computerist is the TRS/GENIE/OHIO/UK 101 REPAIR SERVICE. You have to put £35 up front for repair and postage, and if extra money is required to complete the work, you are informed first (so we are informed). However, generally there is a rebate, if anything. Turn-around can be from two to eight weeks, and you are asked to put through a prior telephone call to make arrangements. Both computers *and* peripherals are taken into care.

If it's a case of *ve vont information* then there's the CUSTOMER SERVICE for "enquiries, moans or a chat" (ring 01-659 7131) between 7 and 9 p.m., Monday evenings, when incidentally the new shop is open in addition to normal hours. General technical enquiries are accepted between 4 and 6 p.m., except Wednesdays and weekends. Most UK 101 owners will pin their ears back to learn that just about all spares for their machine are available from Premier—except the p.c.b.

The Newsletter, which goes out to regular customers is *highly* informative and easy to follow.

The new, and much expanded site for Premier Publications is at 208 Croydon Rd., Anerley, London SE20 7YX. The "large white" building is opposite the junction at Croydon Rd. and Thornsett Rd., not far from Norwood Junction Station. There are two Croydon Roads, apparently, so watch out!

POINTS ARISING . . .

AUTOMATIC PHOTOGRAPHER (August '82)

In Fig. 3, R3 should be 4k7. In the components list for the circuit of Fig. 4, C2 should be 1uF electrolytic.

PROGRAMMABLE TIMER CONTROLLER (May, June '82)

In Figs 3 and 4 an extra copper track appears which should be deleted. The unwanted track joins the track of D15 to A25 to the track of D27 to D20.

In Fig. 8 the capacitor nearest C1 should be C2 not C4. Also R1 should be R39.

In Fig. 11 there are two C15 connecting points. The one nearest T1 should be C14.

COMBO AMPLIFIER-I (Aug '82)

Refer to Fig. 3, circuit diagram: IC2b & IC3a pins 4 should correct to −15V (not 0V).

VR3 should be VOLUME CH.2 & VR4 should be CH.1. C13 is shown with reversed polarity.

IC1a, IC2a, IC3a—all pins marked 7 should be 1.

Refer Fig. 4, p.c.b. & 5, overlay: R35 should be connected to 0V (not floating).

Terminal pin between pins 20 & 22 should be 21 (not 12).

Terminal pin connecting to C11 should be pin 1 (not pin 7).

Terminal pin connecting to C7 should be 23 (not R3).

Junction of R5 & R6 should have track joining it to pin 1 of IC1.

Refer to components list: R8 listed twice! First R8 should be R28.

C17 listed twice! Second C17 should be C6.

Countdown . . .

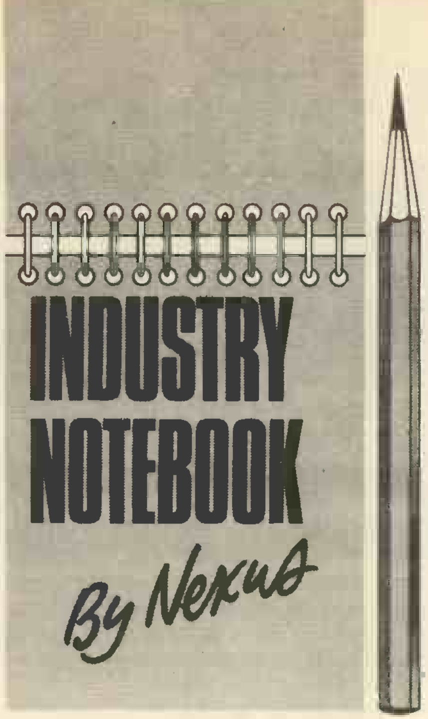
Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here.

Laboratory London Sept. 14–16. Grosvenor Ho. Park Lane, London **E**
ElectroWEST Sept. 14–16. Bristol Exhibition Cntr **Q**
Two Countries Fair Sept. 15–18. Plymouth Exhibition Cntr. Millbay, Devon **T**
IBC (Int. Broadcasting Convention) Sept. 18–21. Metropole, Brighton **N**
Microprocessors In Audiology Sept. 24 **A7**
Holographic Techniques Sept. 30–Nov. 28. Light Fantastic Gallery, Covent Gdn. London **A8**
Video Show Oct. 16–18. West Cntr. Hotel, London **Z1**
Computer Graphics Oct. 19–21. Royal Gdn. & Bloomsbury Cntr. London **O**
Testmex Oct. 26–28. Wembley Conf. Cntr. **T**
BEX Southampton Oct. 27–28. Polygon Hotel **K**
ISSEC (Safety, Security, Fire) Nov. 9–11. Royal Dublin Society Hall, Ireland **V**
BEX Plymouth Nov. Nov. 10–11. Holiday Inn **K**
Compec Nov. 16–19. Olympia **Z1**
Hobby Electronics Fair (*—see last Countdown*) Nov. 18–21. Alexandra Palace, London **Z1**
INTRON Nov. 23–25. RDS Dublin, Ireland **V**
BEX Bristol Nov. 24–25. Holiday Inn **K**
Northern Computer Fair Nov. 25–27. Belle Vue, Manchester **Z1**
Christmas Holography (+ items for sale) Dec. 2–Mar. (1983) Light Fantastic Gallery, London **A8**

A7 Institute Of Acoustics ✆031 225 2143
E Evan Steadman ✆0799 22612
I Industrial Trade Fairs ✆021 705 6707
K Douglas Temple Studios ✆0202 20533
L1 World Trade Cntr., Europe Ho., London E1
N Institute Electrical & Electronics Engineers
O Online ✆09274 28211
Q Exhibitions For Industry ✆08833 4371
T Trident ✆0822 4671
V SDL Exhibitions ✆Dublin 763 871
Z1 IPC Exhibitions ✆01-643 8040

Courses

Apple For Beginners. Sept. 13–14, '82
Apple Getting More From. Sept. 15–17, '82
Pet For Beginners. Sept. 20–21, '82
Sept. 27–28, '82
Pet Getting More From. Sept. 22–23, '82
Sept. 29–30, '82
Pet In Control. Sept. 24, '82
Pet M/c Intro. Oct. 1, '82
All above: University Of Salford. ✆ 061–736 5843
ZX81 Science On. 6× Fri. eve's (6.00 till 8.00) from Nov. 12, '82
ZX81 30 Hour BASIC. Home study + visits to tutor (C&G option)
Fundamentals of Micro Engineering
μP Systems & Fault Finding
μP Interfacing & Applications
Above: Mid-Kent College. ✆ Medway 407391. The last three are ten weeks of ½ day tuition and labwork.



Defence

The defence sector continues buoyant and, if anything, reinforced by the aftermath of the Falklands crisis. Recently announced contracts would have been in negotiation for some months and not necessarily due to operations in the South Atlantic. In fact the £30 million contract for the full development of BATES (Battlefield Artillery Target Engagement System) is a culmination of five years of feasibility and project definition studies at Marconi Space and Defence Systems think tank at Frimley. The system design is based on assessment of the European mainland scenario in which multiple engagement of highly mobile targets is envisaged. It is fully modular, entirely digital and operates at all levels of artillery command from Battery to Corps. Computer-based, it provides commanders with information on target priorities and artillery resources with which to engage them, as well as firing-data to enhance accuracy.

MSDS's earlier system FACE (Field Artillery Computer Equipment) was sold to 16 countries. More recently MSDS was jointly engaged in conjunction with Norden Systems on BCS (Battery Computer System) developed for the U.S. Artillery and now in full production.

Similarly the £20 million contract for advanced electronic warfare equipment to be fitted to Royal Navy submarines was probably in negotiation with Decca Radar before that company was acquired by Racal Electronics Group as it appears to be a natural advanced follow-on from Decca EW systems currently in service on all Royal Navy fleet nuclear and Polaris submarines.

On the export front Racal-SMS, another of the re-vamped Decca companies, has a £250,000 order from the Portuguese Navy for a ship navigational simulator to be installed at a training school on the River Targus, Lisbon. One that Racal didn't get was the contract from the Swedish government for new-generation frequency-hopping tactical radios. Racal was bidding with Jaguar-V which had already built itself a fine reputation. Plessey were also in the bidding as was the Israeli company Tadiran. Winner, however, was Marconi Space and Defence Systems with Scimitar-V which was offered in collaboration with the Swedish company SRA. The contract could be worth more than £20 million to MSDS.

Another MSDS winner is the Clansman vehicle radio which has clocked up £15 million worth of exports this year. Latest buyer is an unspecified Asian country and part of the deal is local manufacture of Scimitar-V at a later date. The practice of overseas buyers to insist on an element of local assembly is now widespread. It automatically involves a transfer of technology and that is why it is so important that a country like Britain should retain a lead in technology. As other countries learn how to build equipment employing local, generally cheaper, labour it is the only way, long-term, that we can stay in business.

Marconi Avionics recently entertained the Secretary of State for Industry, Mr Patrick Jenkins. This was a joyful day celebrating the hand-over of the 1,000th head-up display (HUD) for the Central Dynamics F-16 combat aircraft. At the same time a senior executive of General Dynamics from Fort Worth, Texas, handed over a further order worth 23 million dollars which will keep the F-16 HUD system production line active until 1985.

Over 5,000 HUD's for 40 different aircraft types have been produced by Marconi Avionics since they produced their first for RAF Buccaneers 21 years ago which, incidentally, is still in service. The company claims that this total exceeds the rest of the world's combined production and in the broad field of avionics the company generates over half of all British output. Marconi Avionics now employs 12,000 people, an increase of 4,000 since 1977.

New orders directly attributable to the Falklands will be additional to those already in the pipeline. Replacements for lost Harriers plus an increase in Harrier establishments, replacement Sea Kings and other helicopters, new frigates will all require a full complement of electronics which will load the production lines of specialist manufacturers, perhaps to bursting point.

Vitality

Once again while "old-fashioned" industry remains wallowing in recession the capital goods sector of electronics continues to romp ahead. By mid-year Ferranti, GEC, Plessey and Racal had all announced big gains in turnover and profit, well ahead of inflation and generally at the optimistic end of stockbrokers forecasts. Racal, for example, where City pundits were tipping £98 million pre-tax profits turned in a comfortable £102·6 million, an increase of 40·2 per cent on a sales increase of 20 per cent. Seventy per cent of Racal's business was overseas. Ferranti, on a smaller scale had a 31 per cent profit growth to £23·8 million.

Talking point in the City was the prospect of a bid for Ferranti by one of the big three. What had once seemed a probability diminished to only a possibility in the light of Ferranti results. True, Racal would be delighted to slot in Ferranti's avionics business into complementary activities of its own but Ferranti is no longer cheaply acquired and Racal is but recently recovering from spending £101 million in acquiring Decca.

A new factor is that Ferranti's great recovery has generated a cash balance enabling it, in turn, to become a predator, albeit on a modest scale. Compared with GEC's cash mountain, Ferranti's is a molehill but sufficient to acquire new interests. And with an order book said to be worth £400 million before adding in Falklands extras the company should further strenghten its relative position. GEC could comfortably afford to pay, say, £300 million in cash but could meet Monopolies opposition. Plessey might be too timid to bid. Racal would have to increase borrowing to win the prize but the City would provide the backing.

The consumer/entertainment sector is still in the doldrums except for a few exceptions like home computers. But I notice quite a few of these are appearing in the small ads for second-hand sale (*just look at Bazaar—Ed*). It is not yet clear whether users are upgrading their computers or are disillusioned or just can't get the hang of the thing. Meantime production soars and people are finding the money to buy them.

Why Commute?

Fifty years ago a new technology, electrification of the railways fostered the idea of living out of town. The old London Metropolitan Railway promoted Metroland as the new Mecca. The old Southern Railway advertised the joy of living in places like Herne Bay. The bait was cheap, fast, comfortable and reliable travel and it was true.

Alas, no longer true. Among the most pitiful spectacles today is that of London commuters transported by rail in conditions which would be condemned if commuters were animals and, to add to the misery, the uncertainty of the service not to mention the cost of a season ticket in the £500–1,000 a year bracket.

But is their journey really necessary? With transport costs rising and telecommunications costs relatively falling a good percentage could easily and comfortably do their work at home. All those now tied to a v.d.u. and a computer in a city office block could just as easily have the same equipment at home or in a local centre and the economics should make sense with fuel and transport costs plus office rent savings outweighing increased telecommunication costs. There could be a big net saving in cash, not to mention improved mental health and other benefits. It's worth thinking about. The technology is available today.

DIGITAL STOPWATCH

T. J. JOHNSON

THIS four function, high precision digital stopwatch has a standard seven segment, eight digit display and is capable of timing events from 1/100th of a second up to 24 hours. The oscillator used in the design has a typical stability of 1ppm.

The circuit is very simple, consisting of an i.c., crystal, trimmer capacitor, switches and of course batteries and displays. The i.c. used is an improved version of the ICM7205.

BLOCK DIAGRAM

A block diagram for the Digital Stopwatch is shown in Fig. 1. The circuit takes the 6·5536MHz oscillator frequency and by way of a series of dividers takes the frequency down to 100Hz. Some of the divider outputs are used to generate multiplex waveforms, typically at 800Hz.

The 100Hz signal is then processed in the counters according to the type of control signal from the controller (e.g. standard, split modes etc.).

The processed signals are then passed to the latches where they are either stored as required, or allowed to pass to the multiplexer thus providing a 'moving' display. From the multiplexer and decoder the time interval is presented to the eight seven segment displays. The pin configuration for the i.c. is shown in Fig. 2.

CIRCUIT

The full circuit for the Digital Stopwatch is shown in Fig. 3. The power requirement for the circuit is nominally between 2·5V and 4·5V, and can conveniently be supplied by three 1·2V ni-cads giving 3·6V when fully charged. A jack socket is provided in series with the batteries, so that an external charger may be connected without removing the batteries from the case. The current requirement is dependent on whether the displays are on or off. In their off state, the current is typically 1mA or less. With all the displays on, the current rises to a maximum of 150mA.

Selection of each of the four modes, Standard, Sequential, Split and Rally, is accomplished by means of the four slide switches S4 to S7. They are connected so that only one input is connected to +ve at any one time. It is important to note this, as problems could occur if more than one input was connected to the supply.

The on/off switch and the reset switch are both s.p.s.t. miniature toggle switches. The display and start/stop switches are s.p.d.t. toggle switches, and are used to ensure the operation is free from any contact bounce which may occur if push switches are used. The switches used in the prototype were not biased in their normally closed position although these types could of course be tried.

Although the circuit is shown with a trimmer capacitor, it will probably be found that little if no adjustment is required to achieve a high precision. If a very high precision is required then a frequency meter can be used to trim the crystal to precisely 6·5536MHz.

Sufficient accuracy was obtained with the prototype when the trimmer capacitor was approximately half enmeshed.

CONSTRUCTION

Construction is quite straightforward, although some care is required when fitting the p.c.b. and switches into the case and when drilling the front panel.

The p.c.b. design is shown in Fig. 4 with the component layout shown in Fig. 5. Note the various wire links on the underside of the p.c.b., and also the flying leads. These connect direct to the i.c. pads and should be soldered with care to prevent short circuits etc.

The crystal is mounted on the underside and is fixed in place with a piece of double sided foam pad.

The four miniature toggle switches should be mounted as shown in the photographs, with any unused tags cut off, and the used tags bent upwards at approximately 45°. Bend the tags as carefully as possible and check after bending that the switches operate correctly because the tags can be pulled out of alignment within the casing of the switch.

It is important to obtain switches which will comfortably fit in the case. Switches advertised as sub-miniature toggles are generally acceptable. The same also applies to the slide switches, although the maximum size should not exceed 15×12×10mm.

Drilling details for the front panel are shown in Fig. 6. These dimensions will need to be varied according to the size of slide switches used. It is very important to ensure that the proposed drilling details will enable the front panel to fit

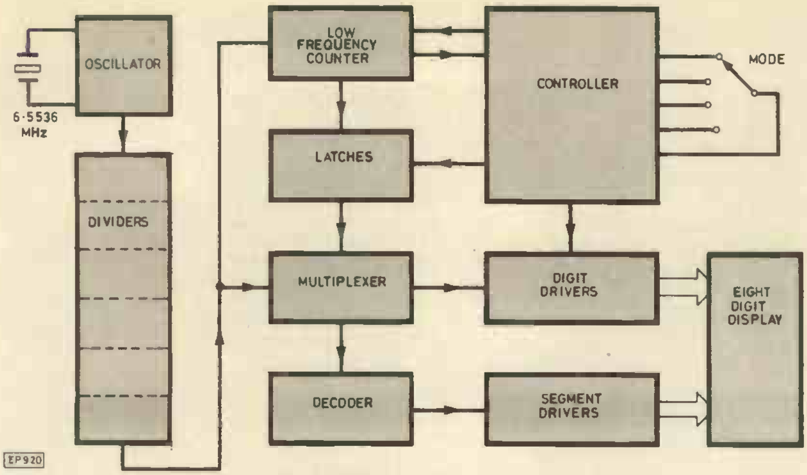


Fig. 1. Block diagram

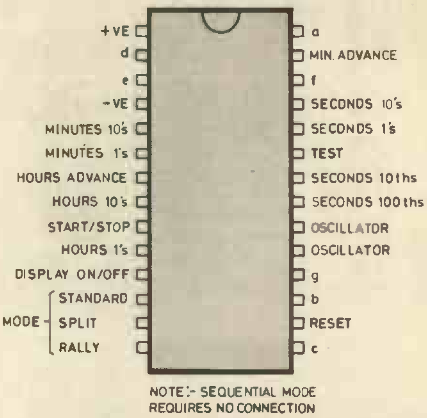


Fig. 2. Pin configuration for IC1

correctly. A check can be made using a dummy plastic or paxolin panel with the switches then being mounted and fitted in the case. Once the correct positions have been found they can then be transferred to the aluminium panel.

The final wiring shown in Fig. 7 can then be completed. When soldering the leads to the ni-cads, ensure that the batteries do not overheat in any way.

If the recommended case is being used then the four mounting pillars near the top of the case should be cut down to a height of about 4mm. The height of the pillars may need slight variation according to the thickness of the Perspexs used for the filter. The p.c.b. should be gently placed into position as near to the top of the case as possible. Ensure that the connecting wires underneath the board do not get trapped between it and the pillars. The three batteries are placed into position and are held in place with a small piece of foam affixed to the front panel. Finally the front panel may be fixed into place, ensuring that no wires become trapped, and that the front panel sits flat. The success of this operation depends on the accuracy achieved when trying out the dummy front panel as mentioned earlier.

MODES OF OPERATION

RESET

When the stopwatch is first switched on, the reset switch will normally be operated. This puts the stopwatch into a ready condition by:

1. Resetting all the circuitry.
2. Blanking the display except for the 100's and 10ths of a second.
3. Turning on the display if it was previously turned off.

Having reset the stopwatch it is ready for use. Before going on to describe the functions it is important to note the correct way to operate the reset/display on-off/start-stop switches.

When operating the start/stop, reset, and display on/off switches the toggle must first be thrown to one position to achieve the desired operation and then returned to its normal rest position. If this simple procedure is not followed then subsequent operations of the switch toggle will not achieve the desired result.

SEQUENTIAL MODE

The sequential mode is used for timing events which consist of more than one leg. For example relays, multi-lap races etc.

After the initial reset (as mentioned above), the start/stop switch is operated at the beginning of the event. A second operation of the start/stop switch stops the timing and halts the display, allowing the time to be read, and at the same time resets the timer to zero allowing a further leg to be timed. This sequence can continue indefinitely.

If it is desired to see the display moving after a time has been recorded then the display unlock switch S2 should be operated, to release the dis-

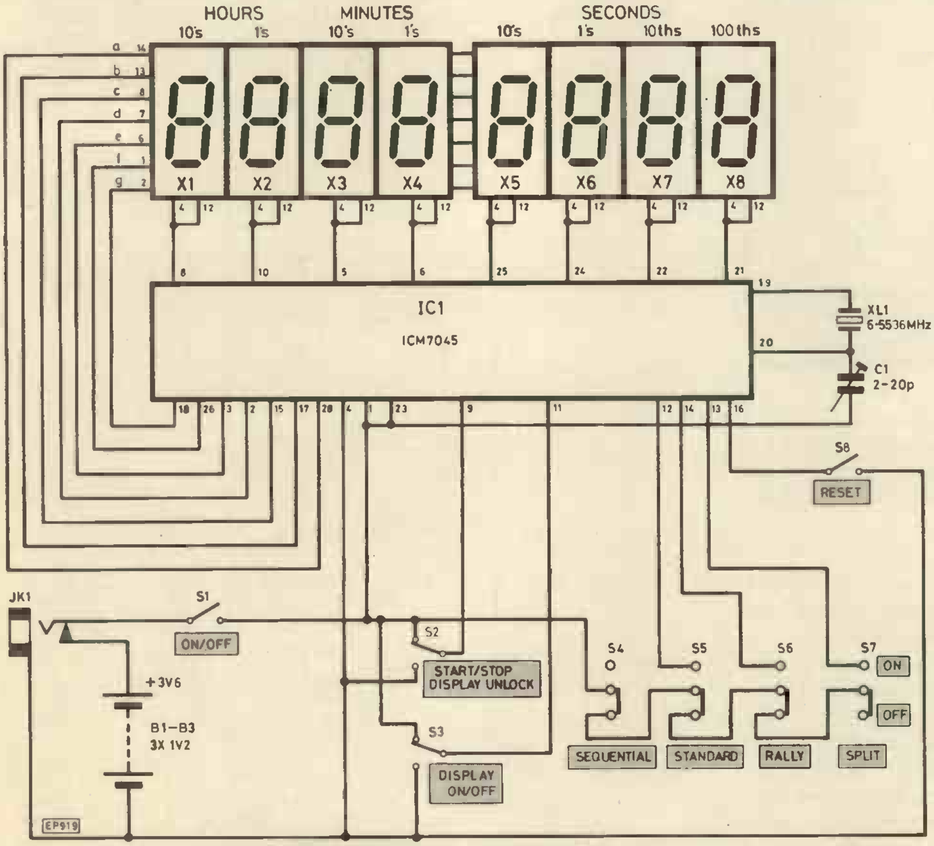


Fig. 3. Circuit diagram of the Digital Stopwatch

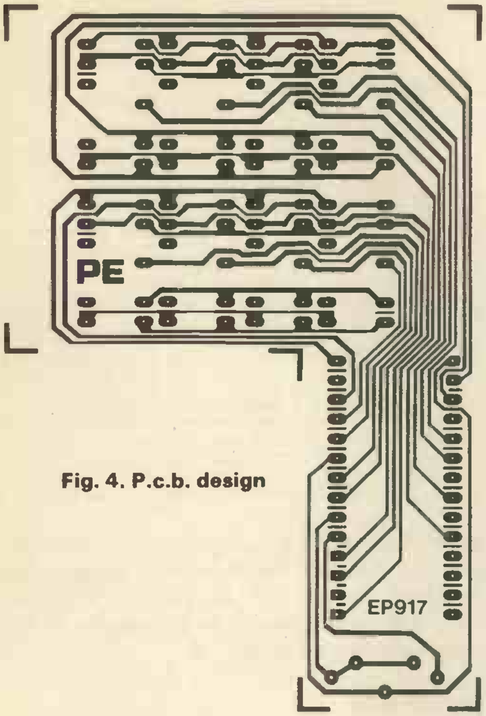


Fig. 4. P.c.b. design

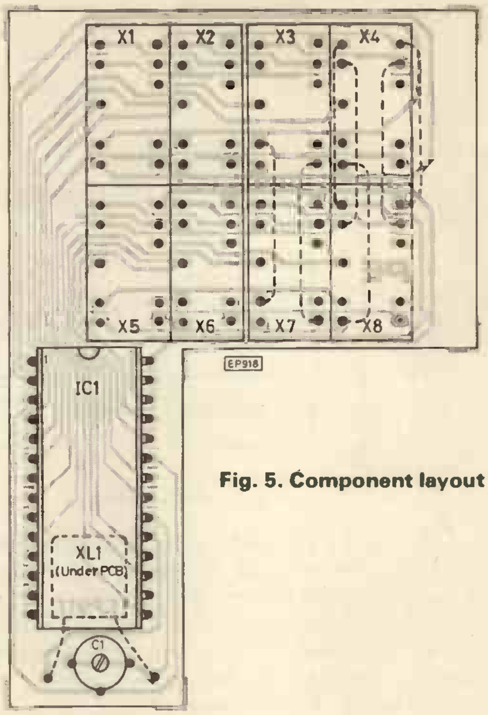


Fig. 5. Component layout

COMPONENTS . . .

Semiconductor
IC1 ICM7045

Displays
X1–X8 DL704, MAN74 etc. 0·3" 7-segment common cathode display (8 off)

Switches
S1 s.p.s.t. sub-miniature toggle
S2 s.p.d.t. sub-miniature toggle
S3 s.p.d.t. sub-miniature toggle
S4–S7 s.p.d.t. miniature slide (4 off)
S8 s.p.s.t. sub-miniature toggle

Miscellaneous
XL1 6·5536MHz crystal
VC1 2–20pF plastic foil trimmer
B1–B3 1·2V 450mA ni-cads (3 off)
JK1 2·5mm jack socket
Printed circuit board, red Perspex, Vero flip-top box No. 21317D.

play and allow it to catch up with the event being timed.

The reset switch may be operated at any time during event timing. The display cannot be switched off in this particular mode.

STANDARD MODE

This mode is perhaps the most useful of the four, as it is very similar to a normal non-electronic stopwatch.

In this mode, after the normal reset has taken place, the start/stop switch is operated. The timer and display follow each other allowing the time to be read at any instant.

A second operation of the start/stop switch halts the timer and allows the total elapsed time to be read. For timing the next event there are two options. The first is to operate the start/stop switch; this will momentarily reset the timer and the display so that the second event timing starts from zero. A further operation of the start/stop switch halts the timer and display, allowing the time of the second event to read. The second option is to operate the reset switch after the first event is finished. This will then reset the timer ready for the second event to be timed.

It should be clear from the above, that operation of the reset allows a 'rest' interval between events, whereas before, when the start/stop switch was operated no such interval was accommodated — the timing of the second event began immediately.

The display may be turned off at any time in this mode which results in a considerable saving in battery power.

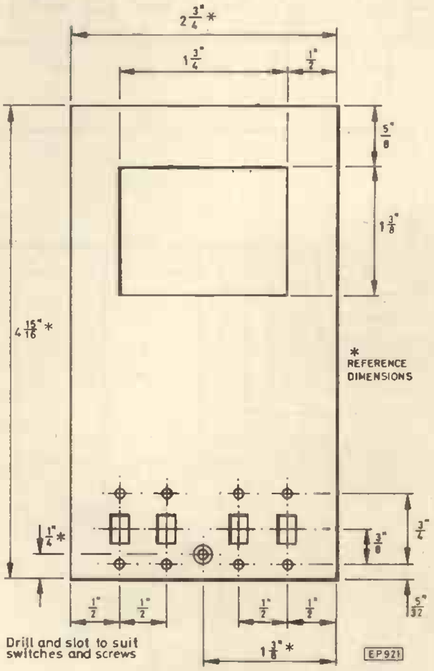
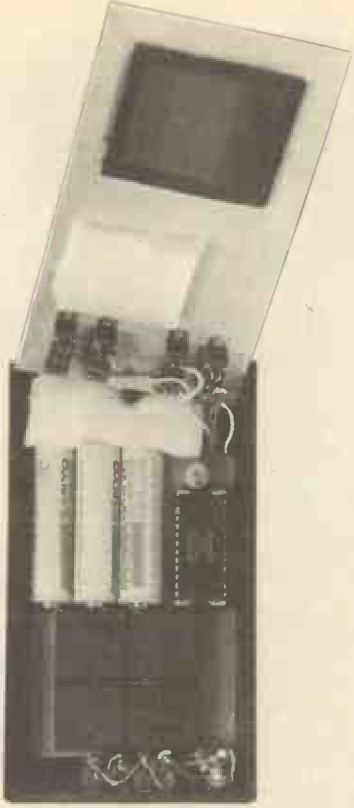
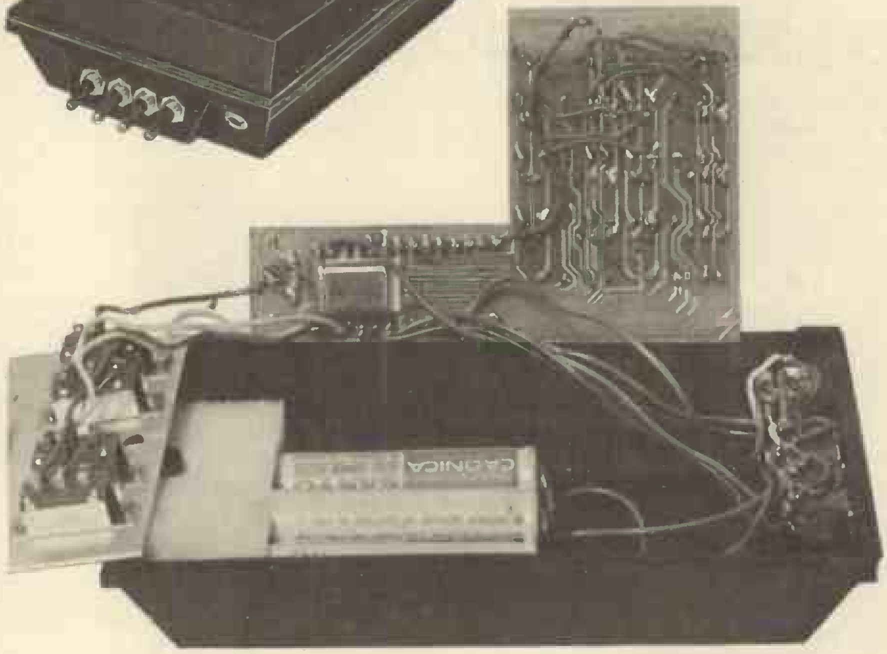


Fig. 6. Front panel drilling details





INTERNAL AND EXTERNAL VIEWS OF THE STOPWATCH

RALLY MODE

This mode is used for timing events which are both long in duration and have long periods of interruption between successive legs. The most obvious example is in car rallies.

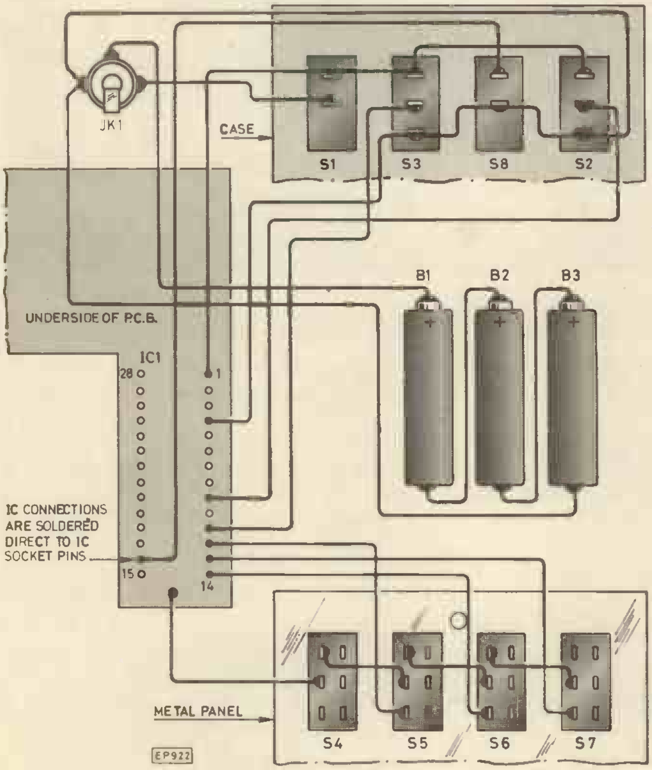


Fig. 7. Wiring diagram

Before the stopwatch is switched on, the rally mode switch should be placed in the off position. It is important that the stopwatch is switched on in another mode apart from the rally mode otherwise the timer and display will not be able to be reset. It is good practice to return all mode switches to their off positions when the stopwatch is not being used.

After the initial reset, the start/stop switch is operated at the beginning of the rally. At this point the reset is disabled to prevent accidental resets during long timing periods. After the first leg of the rally, the start/stop switch is operated. This then stops both the timer and the display, allowing the time to be read.

After a suitable rest period the second leg starts with operation of the start/stop switch. The timer restarts and the display shows the moving time. The timer and display immediately follow each other and show the cumulative time so far for the total event, i.e. each successive leg is added to the previous.

In this mode the reset switch has no effect. The display may be turned off at any time to conserve battery power.

SPLIT MODE

This mode is also for timing multi-leg events, but in contrast to the sequential mode its effect is cumulative.

From the usual reset at switch-on, the start/stop switch is operated, the timer and display follow each other allowing the time elapsed to be read at any instant. A second operation of the start/stop switch halts the display to allow the leg time to be read while the timer continues counting. A further half-operation of the start/stop unlocks the display and allows the display to follow the timer. The reset can be operated at any time and resets the stopwatch to zero.

The display cannot be turned off in this mode. ★

IC INSERTION TOOL

The I.C. INSERTION TOOL attached to the front cover of this issue has been specially designed and manufactured for P.E. and is **exclusive to this magazine.** The tool can be used to insert any standard size d.i.l. i.c.s with up to 16 pins, and enables insertion without the problems of pin misalignment or handling; the tool is made of anti-static plastic.

A limited quantity of extra tools are available for 50p each including postage and VAT etc. Order by sending cheque or P.O., crossed and made payable to IPC Magazines Ltd., to the editorial offices.

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

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

SEMICONDUCTOR UPDATE

R.W.Coles

FEATURING AD594 i APX 186 TSC9403

COLD COMFORT

One very popular type of temperature transducer, especially useful when fast response or operation at a high temperature is required, is the very simple thermocouple. These devices consist of nothing more than a junction between two dissimilar metals, and rely for their operation on the Seebeck or thermoelectric effect which recognises that across the junction there will be a difference in electric potential called the contact potential which varies with the junction temperature.

As with most simple phenomena, there is a catch. Before the contact potential can be measured, two extra junctions have to be created between the thermocouple wires and the copper wires of the measuring circuitry, and these new junctions are also subject to the thermoelectric effect. To use the thermocouple as a practical transducer, these new junctions must be at the same, constant, temperature so that their contributions are fixed and therefore act as a reference level against which the output of the transducer junction can be measured. The actual temperature at which the reference junctions are maintained is not important provided that it does not change, but a common technique has been to use 0 degrees C as defined by an ice/water mixture. This has resulted in the term "cold junction" being applied to this sort of reference.

Our once simple thermocouple sensor, now armed with a frequently replenished ice/water reference cell is beginning to look a bit cumbersome, but, thanks to electronics, it has been possible for some time now to dispense with the reference-on-the-rocks and use what is commonly called an "automatic cold junction" which is not actually cold at all! Using this technique the reference junction is allowed to follow the ambient temperature which is itself measured (not by a thermocouple!) and used to generate an appropriate compensating voltage which when added to the thermocouple output gives a direct indication of sensor temperature.

Well, so far so good, but the circuitry required to use our thermocouple is getting quite complex, at least a circuit-board-full of op-amps and stuff, so what we really need to make the thermocouple simple to use is a complete conditioning system in a single integrated circuit. I bet you guessed, but that's exactly what Analog Devices have just produced in the form of their AD594 thermocouple signal conditioner device.

Now to measure temperature, you just connect your thermocouple probe to two pins of the AD594 and get 10 millivolts per degree Celsius out the other end. The chip is optimised for use with type J thermocouples which use the metals Iron and Constantan, but other types can be accommodated by the addition of external compensating components. To correct for ambient temperature changes the AD594 adds two temperature controlled suppression voltages (+T and −T) to the input signal from the sensor. The +T level creates a positive temperature coefficient term in the output signal while −T generates a negative term and adds an offset which establishes the output voltage at 0 degrees C as 0 volts. The difference between +T and −T results in a sensitivity of 52 microvolts per degree C, which just happens to be the 25 degrees C temperature sensitivity of the type J couple, so variations in ambient temperature are cancelled by the compensating signal to give the appearance that the reference junction is maintained at 0 degrees C. One interesting side effect is that the AD594 itself can be used as a temperature sensor over a limited range. If its inputs are connected to ground, a 10 mV per degree C output is generated!

In addition to providing a direct temperature analogue output, the AD594 can be operated as a set point controller which switches on a load above or below a reference point, and to warn of open or short circuited thermocouples there is an alarm output pin which can be used to drive an l.e.d.

The AD594 comes in a 14 pin ceramic d.i.p. and in two accuracy grades.

SOUPED UP '86

Up to now you have probably been happy to jog along with your trusty 8 bit microprocessor, and you may have eyed those 16 bit monsters with some trepidation. Several megabytes of memory addressing range can seem a somewhat academic advantage, as you gaze wistfully at the price tag on the 16K ZX81 RAMPACK while rattling the sadly depleted piggy bank. But don't be put off, the price of 64K dynamic RAM chips is already plummeting, and Uncle Clive is probably even now considering a 16 bit successor to the ZX81 and the Spectrum. Far be it from me to interfere, but he could find it useful to cast his eyes over the data sheet on the new 16 bit offering from Intel, the so-called i APX 186.

Intel were the first with a powerful and practical 16 bit processor (I don't count the 9900!) but since the introduction of their 8086, they have seen lots of competition from the bigger and sexier Zilog Z8000, Motorola 68000, and more recently the National 16000 and the Texas 99000. To re-establish contact with those whose eyes have been distracted by these attractive newcomers, Intel have joined in the leapfrog game with two new devices, namely the i APX 286 and the i APX 186, both of which are upwards compatible with their 8086. The 286 is certainly a mighty machine, but it is the 186 which interests me at the moment since not only does it provide a higher performance than the 8086, but, more important, it holds out the promise of more affordable *systems* by cramming a whole board full of 16 bit features on to just one chip.

The 186 is fabricated in Intel's new HMOS III technology and runs at about twice the speed of the 8086 with ten new instructions which add several powerful new features without making existing 8086 software obsolete. In addition to being a better, faster, processor than its predecessor, the new chip also includes many features which had to be provided externally in 8086 systems. Three on-chip 16 bit timers are provided to allow waveform generation, event timing and time delays to be programmed, and a multilevel vectored interrupt controller is available to handle internal or external service requests. Another important feature is an on-chip clock generator, and to speed up data transfer with fast peripherals such as disc controllers the 186 has two independent Direct Memory Access (D.M.A.) channels capable of moving up to 2 Megabytes per second.

POWER SHIFT

To drive high power loads such as relays, lamps, and numerical displays from a microprocessor system the usual ploy is to use a parallel port chip and a high current/high voltage driver chip. If you need 16 parallel outputs you will have to use a complex port chip such as the 8255 and a couple of octal drivers which together may have as many as eighty pins with all the attendant implications for the circuit board area and the bank balance.

A device from Teledyne could make the job a lot simpler for some applications since the new TSC 9403 power shift register lives in a compact 24 pin package and yet provides 16 parallel outputs each capable of sinking 60 milliamps at 20 volts. To save package pins the TSC 9403 is not loaded in parallel. Instead, the 16 data bits are shifted in serially at clock rates of up to 3MHz under the control of the microprocessor. Compared with a parallel load scheme this method is rather slow, but this is not always a limitation especially if the output data changes only infrequently.

The outputs of the TSC 9403 are driven by common source open drain MOS transistors having a maximum saturation level of 0·5 volts at 60 milliamps and maximum OFF leakage of 100 microamps at 20 volts.

all in your

NOVEMBER

issue!

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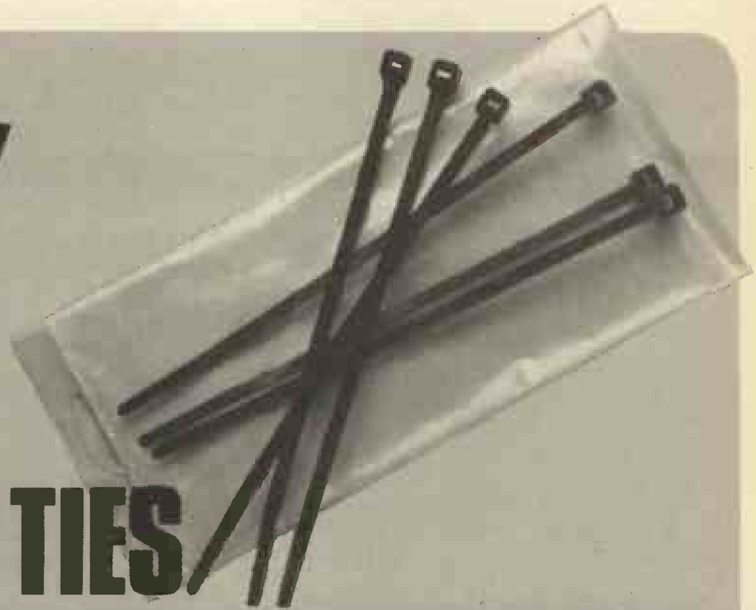
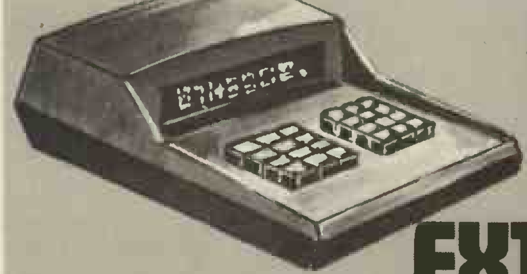


Plus... MICRO CONTROLLER



This Micro Controller board is a universal control system which is based around the 6800 microprocessor. The system will be the subject of a special offer to *PE* readers and includes a p.s.u., keyboard, display and main controller board which features four PIA's, a real time clock and a monitor.

EXTRA 8 PAGE PULLOUT

PE MICRO-FILE

First of a series of pull-outs giving information and data on a wide range of microprocessor chips. MICRO-FILE will lay bare the essential characteristics of the most popular processors so that readers can choose and use the correct processor for their needs. Don't miss the start of this invaluable series, it details the 8080A/8085A.

Also... COMPUTER INTERFACE Part 1

PRACTICAL

ELECTRONICS

NOVEMBER ISSUE ON SALE FRIDAY, OCTOBER 8

SEMI-PROFESSIONAL MIXING DESK

PART ONE

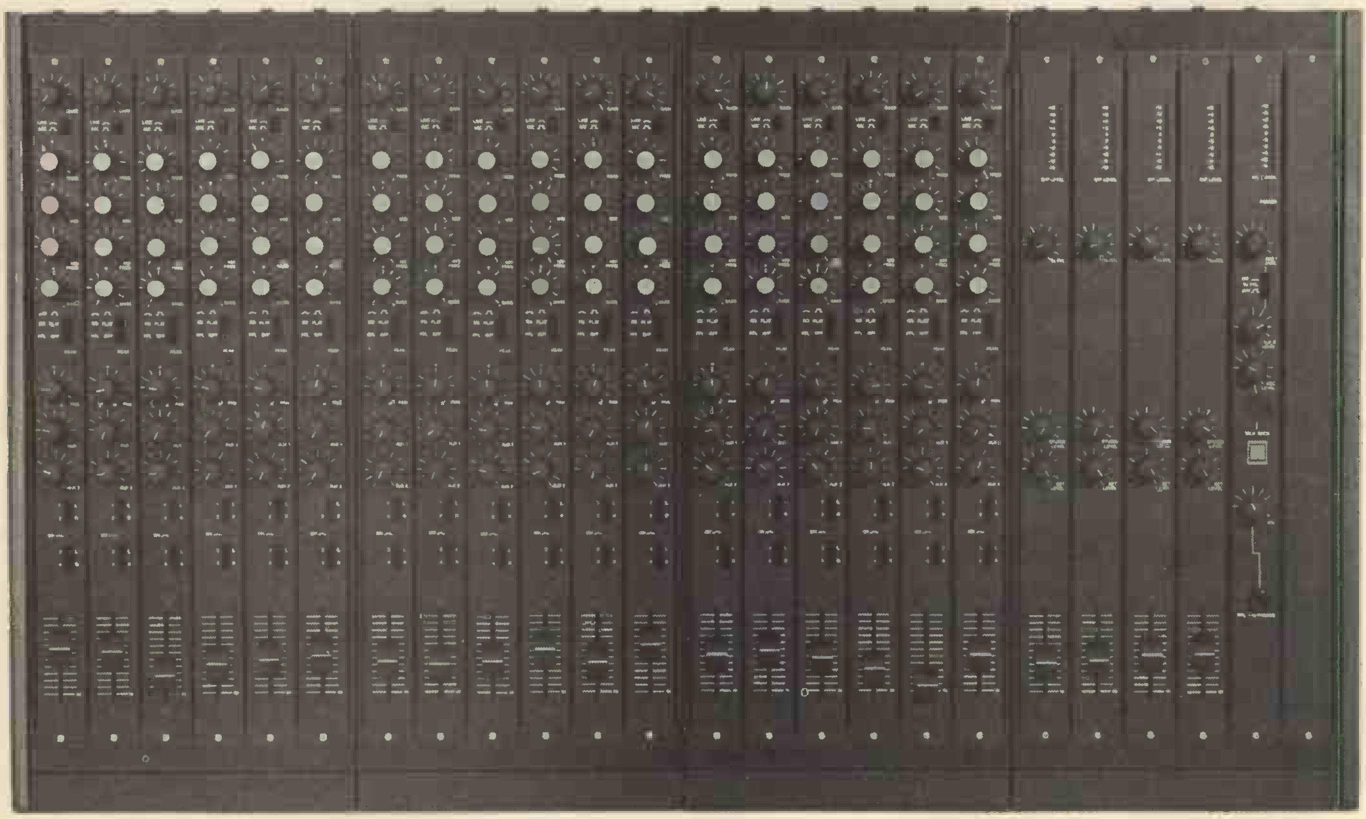
TIM ORR

THE mixer described in this article is constructed from a range of input and output modules all of which plug into a common bus. Even the mixer chassis is modular. It comes in 6 module sections which can be bolted together. The mixer can be assembled with up to 18 inputs (you could even have 24 inputs if you are that keen) and 4 output channels. For example, if you wanted a 6 into 2 mixer then all you would need is 6 input modules, 2 output modules, 1 auxiliary module (optional) and three blanking panels. The power supply for the system is contained in an external box.

INPUT MODULE

The circuit diagram of the input module is shown in Fig. 1. IC1 forms an unbalanced low noise preamplifier with switched and variable gain. The system is designed to run with a signal level of 0dBm (0·775Vr.m.s. or 2·2Vpp) and it is the job of input stage to amplify/attenuate the input signal to this level. For a 0dBm signal level at IC1 pin 1, the microphone signal level can vary between −56 to −16dBm and the line level signal from −24 to +11dBm. Therefore the preamplifier can accept input levels from −56dBm to +11dBm for a 0dBm output. Also the maximum level at IC1 pin 1 before clipping is +18dBm and so there is 18dB of headroom when operating at a signal level of 0dBm.

The tone control has a conventional treble and bass circuit plus a parametric section. The parametric equaliser is constructed from a variable-frequency state-variable bandpass filter which can be used to provide feedforeward (lift) or feedback (cut) around an amplifier section (IC2b). Fig. 2 shows the tone control frequency responses. The equaliser can be bypassed by using the FLAT/EQ switch.



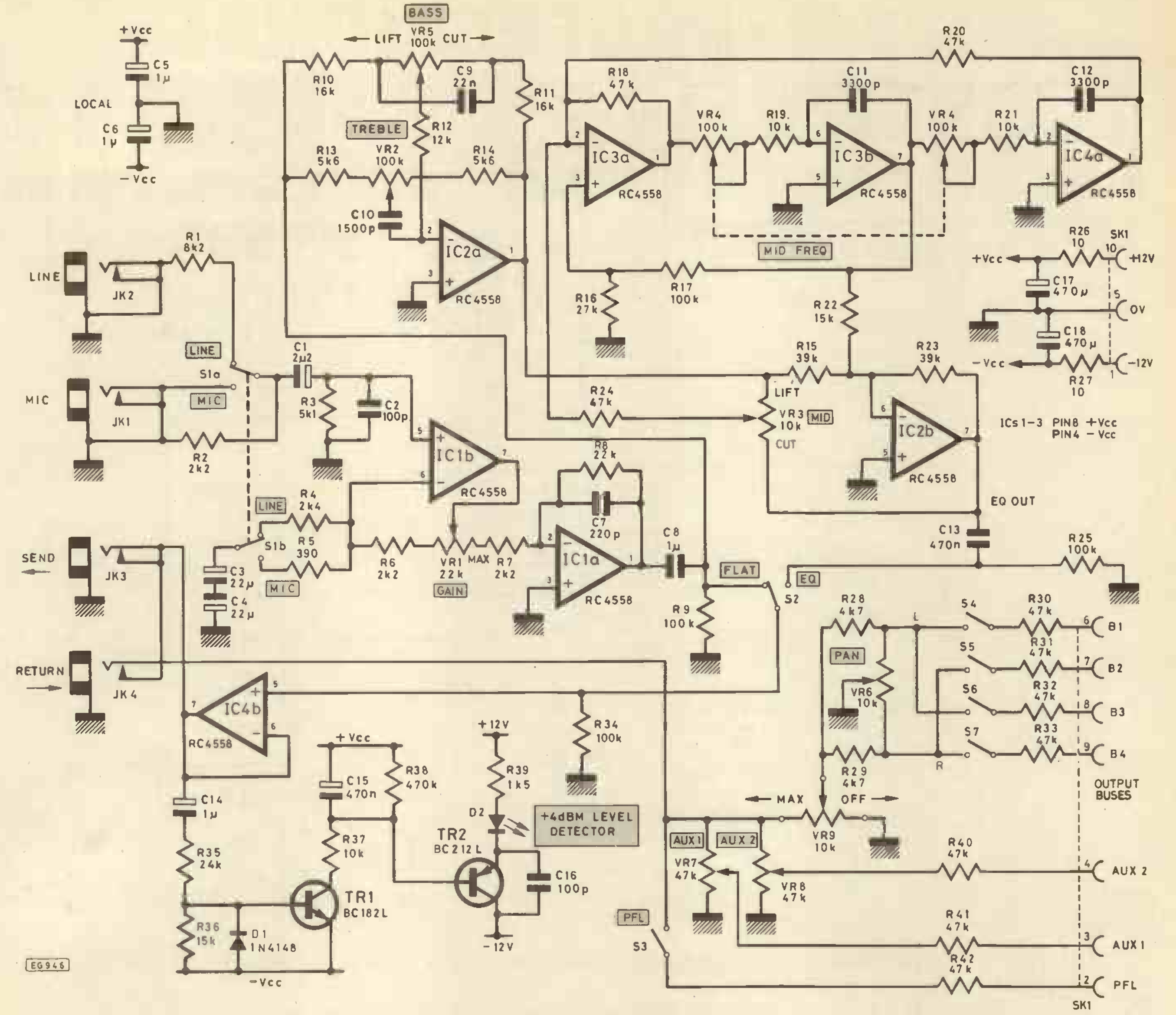


Fig. 1. Circuit diagram of the Input Module

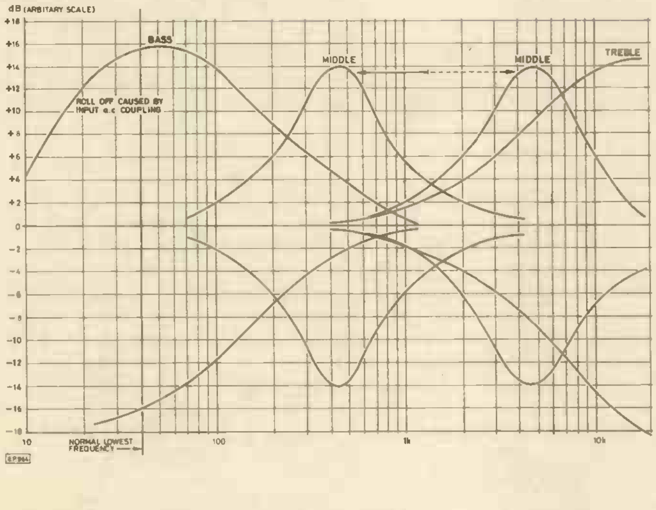


Fig. 2. Tone control frequency responses

The input module can be used to send the amplified signal to an external effects unit via the SEND jack. This signal can then be re-inserted via the RETURN jack. The RETURN jack has a break contact, but the SEND jack has not. Therefore you can use the SEND output to drive foldback monitors without interrupting the signal path. PPM signal level monitoring per input channel is very expensive and so a simple peak level detector has been used. This device lights up a l.e.d. when the signal level exceeds +4dBm. When this l.e.d. turns on it produces a very dirty current which can cause an annoying background noise. However by *not* dumping this current down the ground rail (the current travels from one supply rail to the other) this effect can be avoided. In fact throughout the mixer all currents that are dirty have *not* been dumped into the ground rail.

The output signal from the input module can be sent to up to 7 different ouputs. Before the channel fader it can be switched to the PFL (pre-fade-listen) bus. This route has a fixed unity gain and it enables the mixer operator to monitor the channel signal level on the PFL PPM (this is on the AUX channel) and also to listen to the signal on its own, on either headphones or monitor speakers. Also there are two aux-

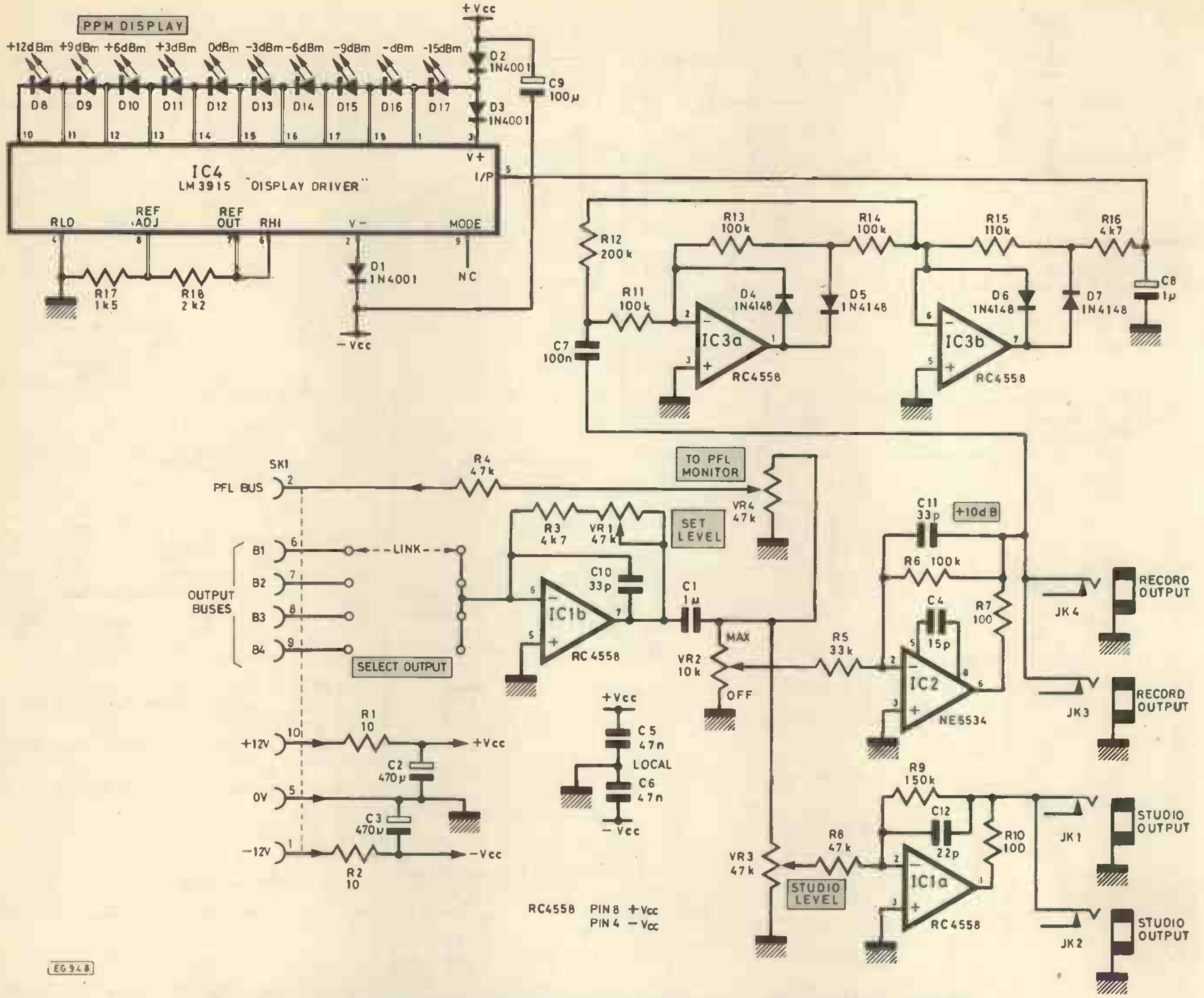


Fig. 4. Circuit diagram of the Output Channel. Note D1 to D3 should be 1N4002

iliary buses (AUX1 and AUX2) which can be used to produce mixes separate to the 4 main outputs. After the channel fader the signal is split up by a pan pot and can then be sent (via selector switches) to the 4 output channel buses. Outputs 1 and 3 are left hand channels and 2 and 4 are right hand channels. The block diagram of the input, output and auxiliary channels are shown in Figs. 6, 7 and 8.

POWER SUPPLY

The p.s.u. circuit is shown in Fig. 3. The power supply can deliver up to ±1 amp at ±12V. It is mounted externally to the mixer to avoid mains hum problems. An RC filter in the circuit (R2, R3 & C3, C4) smoothes out the unregulated rail so that the regulators are presented with a very small ripple (about 100mVpp at full load). An 18 into 4 mixer consumes about 500mA from each rail. This current increases when the PPM displays, peak l.e.d.s and headphone amplifier are on. Make certain that both regulators are insulated from the metal work and that all mains wiring is covered with rubber sleeving.

OUTPUT CHANNEL

The output channel which consists of three virtual earth amplifiers and a PPM circuit is shown in Fig. 4. Both the 'Record' and the 'Studio' output stages have +10dBs of gain. The 'Record' output uses a high performance op-amp which is capable of driving a +18dBm 20kHz sinewave into 600 ohms without anything nasty happening! This is the best output to use; the PPM circuit monitors the signal level at this output. The PPM (peak programme meter) consists of a precision full wave rectifier, a peak level detector and a National Semiconductor logarithmic bar graph driver, IC4.

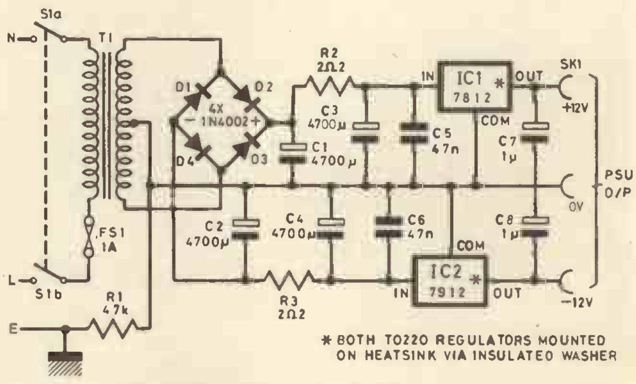


Fig 3 P.s.u. circuit diagram

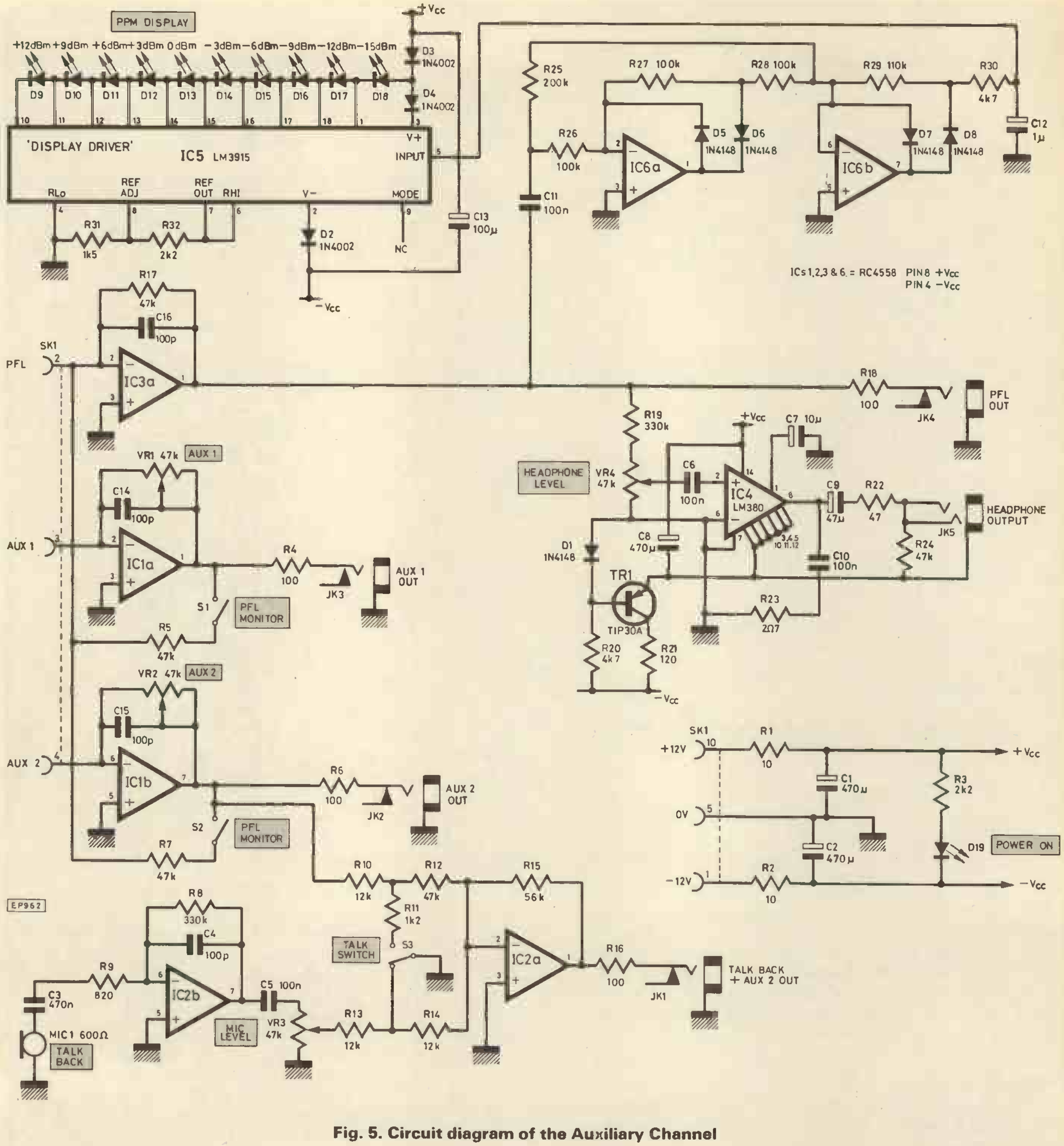


Fig. 5. Circuit diagram of the Auxiliary Channel

The display has been designed to consume very little current. IC4 is run in its dot mode, so that only one output is on at any time. However the current being sunk into any display output also lights up all the l.e.d.s below it. In this way the dot mode is transformed into a bar graph. The display current is only 10mA and is constant even though 10 l.e.d.s may be on. Note that none of the l.e.d. current is dumped into the ground rail.

It is important that the l.e.d.s protrude through the panel to the same height, otherwise the PPM display looks rather nasty. A small metal or wooden jig should be constructed so that all the l.e.d.s can be bent to exactly the same length.

AUX CHANNEL

Both the auxiliary channels in Fig. 5 are simple virtual earth amplifiers. AUX2 is available as a direct signal and as a mix with the mixer talk back signal. When the talk switch is pressed the AUX2 level is attenuated and the talk back microphone signal is enabled.

The PFL amplifier has unity gain (fixed) so that the signal level in any input channel can be monitored on the PFL PPM unit. A small power amplifier (IC4) provides a headphone monitor for the PFL signal. Note that a synthetic ground rail (TR1) has been produced so that the large headphone current is not dumped down the real ground rail.

COMPONENTS . . .

INPUT CHANNEL

Resistors

R1	8k2
R2, R6, R7	2k2 (3 off)
R3	5k1
R4	2k4
R5	390
R8	22k
R9, R17, R25, R34	100k (4 off)
R10, R11	16k (2 off)
R12	12k
R13, R14	5k6 (2 off)
R15, R23	39k (2 off)
R16	27k
R18, R20, R24, R30, R31, R32, R33, R40, R41, R42	47k (10 off)
R19, R21, R37	10k (3 off)
R22, R36	15k (2 off)
R26, R27	10 (2 off)
R28, R29	4k7 (2 off)
R35	24k
R38	470k
R39	1k5

All resistors $\frac{1}{4}$ W metal film

Potentiometers

VR1	22k lin
VR2, VR5	100k lin (2 off)
VR3, VR6	10k lin (2 off)
VR4	100k reverse log dual pot
VR7, VR8	47k log pot with p.c. bracket (2 off)
VR9	10k log slider ALPS 191M10kA

Capacitors

C1	2μ2 16V tant
C2, C16	100p ceramic (2 off)
C3, C4	22μ 10V tant (2 off)
C5, C6, C14	1μ 35V elect (3 off)
C7	220p ceramic
C8	1μ B32560
C9	22n B32560
C10	1n5 B32560
C11, C12	3n3 B32560 (2 off)
C13	470n B32560
C15	470n 35V elect
C17, C18	470μ 16V elect (2 off)

Semiconductors

D1	1N4148
D2	0·2in red l.e.d.
TR1	BC182L
TR2	BC212L
IC1–IC4	RC4558 (4 off)

Miscellaneous

SK1–SK4	$\frac{1}{4}$in mono jack socket plus shorting tip pin (4 off)
S1–S7	Push switches p.c.b. mounting d.p.d.t. (7 off)
	Knobs $\frac{1}{4}$in (8 off)
	Caps with line, black (4 off)
	Caps with line, black (4 off)
	p.c.b.
	10 way Molex 0·156in p.c. socket
	8 pin d.i.l. sockets (4 off)

OUTPUT CHANNEL

Resistors

R1, R2	10 (2 off)
R3, R16	4k7 (2 off)
R4, R8	47k (2 off)
R5	33k
R6, R11, R13, R14	100k (4 off)
R7, R10	100 (2 off)
R9	150k
R12	200k
R15	110k
R17	1k5
R18	2k2

All resistors $\frac{1}{4}$ W metal film

Potentiometers

VR1, VR3, VR4	47k log pot with a p.c. bracket (3 off)
VR2	10k log slider 191 M10kA

Capacitors

C1	1μ B32560
C2, C3	470μ 16V elect (2 off)
C4	15p ceramic
C5, C6	47n 35V ceramic (2 off)
C7	100n B32560
C8	1μ 16V elect
C9	100μ 40V elect
C10, C11	33p ceramic (2 off)
C12	22p ceramic

Semiconductors

D1, D2, D3	1N4002 (3 off)
D4, D5, D6, D7	1N4148 (4 off)
D8–D17	0·2in l.e.d. (10 off)
IC1, IC3	RC4558 (2 off)
IC2	NE5534
IC4	LM3915

Miscellaneous

SK1–SK4	$\frac{1}{4}$in mono jack socket with shorting tip pin (4 off)
	$\frac{1}{4}$in knobs (3 off)
	Caps with line, black (3 off)
	Slider knob (CS9)
	P.c.b.
	10 way Molex p.c. socket
	8 pin d.i.l. socket (3 off)
	18 pin d.i.l. socket

GENERAL PARTS

Chassis units
Wooden end cheeks
Wooden front pieces
Bus p.c.b. (with 6 x 10 way Molex pins)
Rubber feet
Grommet
Ty-rap base
Ty-rap
3 core lead
3 pin 180° inline plug

AUX CHANNEL

Resistors

R1, R2	10 (2 off)
R3	2k2 1W
R4, R6, R16, R18	100 (4 off)
R5, R7, R12, R17, R24	47k (5 off)
R8, R19	330k (2 off)
R9	820
R10, R13, R14	12k (3 off)
R11	1k2
R15	56k
R20, R30	4k7 (2 off)
R21	120
R22	47
R23	2Ω7
R25	200k
R26, R27, R28	100k (3 off)
R29	110k
R31	1k5
R32	2k2

All resistors ¼W metal film unless otherwise stated

Potentiometers

VR1–VR4	47k log pot with p.c. bracket

Capacitors

C1, C2, C8	470µ 16V elect (3 off)
C3	470n B32560
C4, C14, C15, C16	100p ceramic (4 off)
C5, C6, C10, C11	100n B32560 (4 off)
C7	10µ 16V elect
C9	47µ 16V elect
C12	1µ 16V elect
C13	100µ 40V elect

Semiconductors

D1, D5, D6, D7, D8	1N4148 (5 off)
D2, D3, D4	1N4002 (3 off)
D9–D18	0·2in square red l.e.d. (10 off)
D19	0·2in in red l.e.d.
TR1	TIP30A
IC1, IC2, IC3, IC6	RC4558 (4 off)
IC4	LM380
IC5	LM3915

Miscellaneous

SK1–SK4	¼in mono jack socket plus shorting tip pin (4 off)
SK5	¼in stereo jack socket
VR1–VR4	47k log pot plus p.c. bracket (4 off)
S1, S2	Push switch p.c. mounting d.p.d.t.
	¼in knob (4 off)
	Cap with line, black (4 off)
S3	push switch 8125–J81 3/3
	10 way Molex p.c. socket
	p.c.b.
	8 pin d.i.l. socket (4 off)
	14 pin d.i.l. socket
	18 pin d.i.l. socket
	600 Ω microphone

POWER SUPPLY UNIT

Resistors

R1	4k7 ¼W
R2, R3	2k2 2·5W

Capacitors

C1–C4	4700µ 25V elect (4 off)
C5, C6	47n 35V ceramic disc (2 off)
C7, C8	1µ 16V tant (2 off)

Semiconductors

D1–D4	1N4002 (4 off)
IC1	7812 with insulating kit
IC2	7912 with insulating kit

Miscellaneous

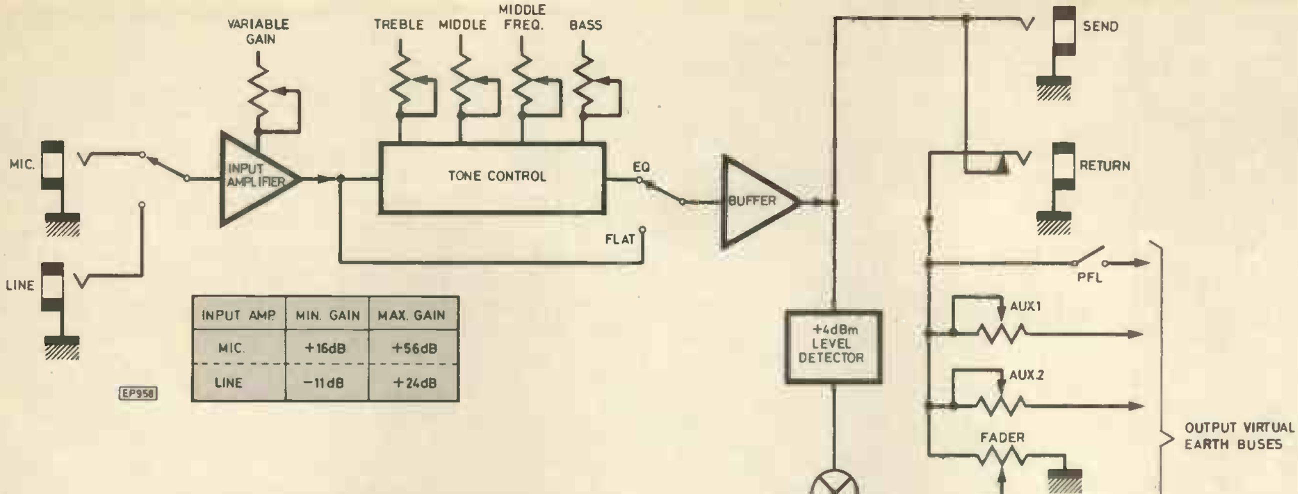
S1	Mains switch d.p.s.t.
T1	15–0–15V torroid at 30VA
FS1	20mm 1A fuse
	20mm fuseholder
	Rubber feet
	Heat sink bracket
	P.c.b.
	Mains grommet
	P.s.u. case
	4 way screw block
	3 pin 180° din socket

Constructor's Note

Complete kits of parts for this project can be obtained from Powertran Electronics, Portway Industrial Estate, Andover, Hants SP10 3WN (0264 64455)

Input channel (including p.c.b., panel and controls)	£19·90
Output channel (including p.c.b., panel and controls)	£18·50
Auxiliary channel (including p.c.b., panel and controls)	£22·50
Blank panel	£3·00
Base unit for up to 6 channels (including wooden front)	£27·50
Pair of dark mahogany end cheeks	£12·50
Power supply (including transformer and cabinet)	£19·50

All prices subject to 15% VAT. No charge is made for carriage



INPUT AMP	MIN. GAIN	MAX. GAIN
MIC.	+16dB	+56dB
LINE	−11dB	+24dB

Fig. 6. Block diagram of the Input Channel

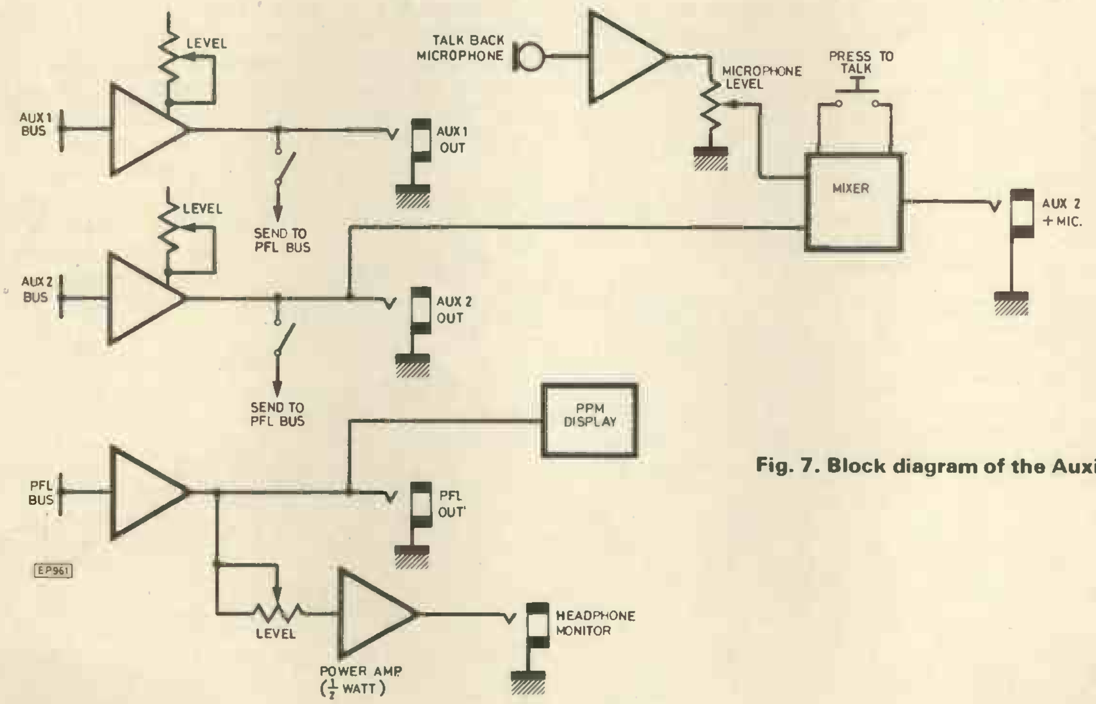


Fig. 7. Block diagram of the Auxiliary Channel

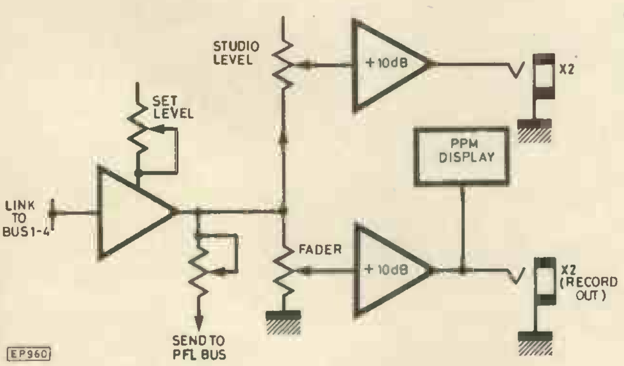


Fig. 8. Block diagram of the Output Channel

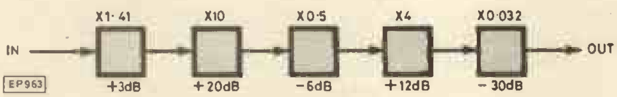
THE dB, THE dBm AND NOISE

The dB (deci-Bell) is always used to describe gains and losses in audio networks. If a signal passes through an audio network with a multiplicative gain of X, then that gain in dBs is $20\log_{10}(X)$. At first sight it may seem that the dB is just a complicated way of describing gain and loss. It is not. If a signal passes through several stages of gain then the total gain is the product of all the multiplicative gains in the system. However if you use dBs to describe the gain then the overall gain is merely the sum of the gains. It is generally easier to add than to multiply. Table 1 illustrates the advantages of using the dB.

The dBm is a logarithmic method of measuring voltage. If a voltage of −10dBm is passed through an amplifier with a

dB	Multiplier	Rule of thumb approximation
+80	x10,000	10,000
+70	x3,162	3,000
+60	x1,000	1,000
+50	x316·2	300
+40	x100	100
+30	x31·62	30
+20	x10	10
+18	x7·94	8
+12	x3·98	4
+10	x3·16	3
+6	x1·99	2
+3	x1·41	1·4
0	x1·00	1·0
−3	x0·708	0·7
−6	x0·501	0·5
−10	x0·316	0·3
−12	x0·251	0·25
−18	x0·125	0·125
−20	x0·100	0·100
−30	x0·032	0·03
−40	x0·01	0·01
−50	x0·0032	0·003
−60	x0·001	0·001
−70	x0·00032	0·0003
−80	x0·0001	0·0001

TABLE 1



Voltage gain = 1·41 x 10 x 0·5 x 4 x 0·032
or in dBs
Voltage gain = 3 + 20·6 + 12 − 30 dBs
Typical system

dBm	Vr.m.s.	Vpp
+18	6·16V	17·47V
+12	3·08V	8·76V
+10	2·45V	6·95V
+6	1·55V	4·39V
0	0·775V	2·2V
−6	388mV	1·10V
−12	197mV	553mV
−18	97·6mV	277mV
−20	77·5mV	220mV
−30	24·5mV	69·5mV
−40	7·75mV	22mV
−50	2·45mV	6·95mV
−60	775μV	2·2mV
−70	245μV	695μV
−80	77·5μV	220μV
−90	24·5μV	69·5μV
−100	7·75μV	22μV
−110	2·45μV	6·95μV
−120	775nV	2·2μV
−130	245nV	695nV

Signal levels and the dBm.

TABLE 2

gain of +12dB, then the output voltage from the amplifier is +12−10=+2dBm. 0dBm is defined as the voltage that dissipates 1mW of power into a 600 ohm load.

Power$=\frac{V^2}{R}$, where V is measured in Vr.m.s. and R in ohms.

Therefore, if R=600 ohms and power=0·001watt, then $V=\sqrt{600 \times 0{\cdot}001}=0{\cdot}775$Vr.m.s. Table 2 shows a chart of commonly used signal levels in audio work. Note that 0dBm is 0·775Vr.m.s. or 2·2Vpp. Studio level or line level is typically 0dBm to +6dBm. This level is large enough to avoid noise problems and small enough to allow 14 to 20dBs of headroom in mixers and other equipment.

Noise is always a problem in mixers. The signal from a low impedance microphone is usually quite small (maybe 20mV) and so a low noise amplifier is needed if a respectable signal to noise ratio is to be obtained. A mixer might be using 6 microphone channels which will result in 6 lots of noise being fed to the output channels. Noise is a random phenomena and so the 6 noise voltages will not add up linearly, but add up as the square root of the sum of their squares! If the 6 noise voltages are A,B,C,D,E & F then their combined voltage is

$$=\sqrt{(A^2 + B^2 + C^2 + D^2 + E^2 + F^2)}$$

This means that the largest noise voltage predominates. The internally generated noise of a preamplifier is usually referred to as the equivalent input noise. This is the theoretical input noise seen at the input of the amplifier. This noise is multiplied by the gain of the amplifier in just the same way as the input signal is amplified. The equivalent input noise (Ein) can be specified in dBm (this is commonly used in mixer specifications) or in μVr.m.s. or in nV/$\sqrt{Hz}$. The noise of an amplifier is measured by band limiting it to the audio bandwidth and then reading it with a true r.m.s. a.c. voltmeter. The Raytheon op-amp (RC4558) that was used in the mixer has a specified input noise of 10nV/$\sqrt{Hz}$. If we multiply this by the square root of the audio bandwidth we obtain the equivalent input noise in μVr.m.s. Therefore Ein=10nV x $\sqrt{20{,}000}$=10nVx141=1·41μVr.m.s. The measured noise from the input stage (microphone mode, input shorted to ground) was 1·46μV, which is amazingly close to the theoretical value! 1·46μVr.m.s. is equivalent to a signal level of −114·5dBm. Once we know the value of Ein it is easy to calculate the signal to noise ratio for a given input signal level. If we are using a microphone that delivers a signal level of −40dBm and the input noise is −114·5dBm, then the signal to noise ratio is

114·5−40=74·5dB. We could work this out the long way, just to show the power of the dB. The microphone signal level of −40dBm is 7·75mVr.m.s. The noise level (Ein) is 1·46μVr.m.s. Therefore the signal to noise ratio is 20log $\frac{(7{\cdot}75\text{mV})}{1{\cdot}46\mu\text{V}}$=20log (5308·2)=74·49dB. Impossible to calculate without a calculator!

NEXT MONTH: Construction

ELECTROLUBE *Review*

CM100 CIRCUIT MAKER

GLANCING through a selection of hobby electronics magazines, it soon becomes apparent that the vast majority of projects published use printed circuit boards. Yet, until now, most constructors have not had the means of producing professional quality p.c.b.s, and have had to rely on kit or specialist manufacturers to supply their needs, or resort to such laborious tasks as re-drawing designs on copper-clad boards with etch-resistant pens. Which brings us to Electrolube.

Electrolube is a company that specialises in products such as electrical contact treatments and maintenance chemicals. Recently they entered the field of hobby electronics, introducing the CM100 Circuit Maker, a unique new kit, which, say Electrolube, contains everything the home constructor needs to produce professional quality p.c.b.s from artwork printed in magazines. As the kit is boasted to be almost foolproof, we decided to put Electrolube's claim to the test.

FILM POSITIVE

The problem for constructors has until now been in transferring a p.c.b. design in "etch resist form" onto a copper-clad board. While boards pre-coated with a photo-sensitive etch-resist coating have been available, one still needs a film-positive of the p.c.b. to lay over the pre-sensitised board before exposing. Producing this film-positive has until now been impossible without expensive specialist photographic equipment.

This is where the CM100 really scores. Supplied in the kit is Autopositive film (FPF). To produce a film-positive, simply lay a piece of FPF *over* the printed p.c.b. design; expose; and develop in the chemicals provided. It really is as simple as that. Incidentally, producing the film-positive turned out to be the simplest stage in the p.c.b. making process.

The next stage in the process is to coat the board in photo-resist. I mentioned earlier that pre-coated boards *are* available, but Electrolube have chosen to supply bare copper-clad boards and a jar of photo-resist. The board *must* be thoroughly cleaned before the photo-resist is applied, and once applied the 'resist *must* be left to dry properly. Electrolube say an hour is enough, but we found that it was necessary to allow a coated board several hours to dry—preferably overnight—otherwise *all* the photo-resist would come off in the developer *(Electrolube have now changed their instructions to recommend over night drying—Ed).* This brings us to exposure and developing of the coated board; again a simple process. Place the film positive over the board, expose (for about 25 minutes in normal daylight), and develop. The board is then ready for etching.

Contents of the CM100 p.c.b. kit

ETCHING

Anybody who has ever etched a p.c.b. will know how messy a process it can be. Ferric chloride has an annoying habit of finding a way into the wrong places, and once there, is difficult to clean off. The etching kit supplied with the CM100 is a different story altogether. Everything takes place in a long, narrow and very thick plastic bag. With the aid of a couple of clips, the bag can be sectioned off into compartments so that the whole etching process can be carried out without any mess or fuss. When the etchant is finally finished with (it should last for several boards), a bag of neutralizing powder supplied with the kit turns the etching solution into a solid, harmless lump which can then be disposed of. All that remains is for the photo-resist to be cleaned of the p.c.b. tracks, holes drilled and flux lacquer applied.

The CM100 does provide a simple and almost foolproof means of producing professional quality p.c.b.s from magazine designs. The kit *is* comprehensive, down to a length of sponge for applying the photo-resist, a scouring pad for cleaning the boards, and a very useful frame to hold the film during exposure (which can also be used as an assembly frame to hold the p.c.b. when inserting and soldering components). The instructions supplied with the kit are clear and comprehensive, and replacement supplies of film, chemicals and boards are available.

COATING

The main drawback lies in the process of coating the boards. This is by far the most messy, time consuming and unreliable stage in the whole process. As I have already mentioned, the photo-resist takes some time to set and it is dificult to keep the boards dust free, which they should be, both before and after application of the photo-resist. It would not add much to the cost of the kit to supply pre-coated boards, and would, as we found out, enable the whole process to be completed in an afternoon rather than spread over two days. However as Electrolube point out the system employed does have the advantage that any boards messed up at the exposing stage can be re-coated and used, whereas pre-coated boards would be unusable. Also, most of the p.c.b.s that we wanted to produce were single sided, but as all the boards supplied in the kit are double sided, the etching solution became exhausted much quicker than it need to have been.

To conclude, I would strongly recommend the CM100 to the serious constructor or school/college lab, despite the drawbacks mentioned (and of course there is nothing to stop you buying your own pre-coated boards), and the relatively high initial retail price of £65. Perhaps Electrolube might consider supplying just the film producing parts of the kit separately, as many constructors must already have p.c.b. etching equipment.

The CM100 Circuit Maker is available from a number of retail outlets, for details contact Electrolube Ltd., Blake Road, Wargrave, Berkshire RG10 8AW (073 522 3014).

Jasper Scott.

Note: The p.c.b. used in our *Seat Belt Reminder* (last month) was made by this process, from a photostat of the original artwork, with excellent results.

ECDKBAJL

FREE ENTRY COMPETITION

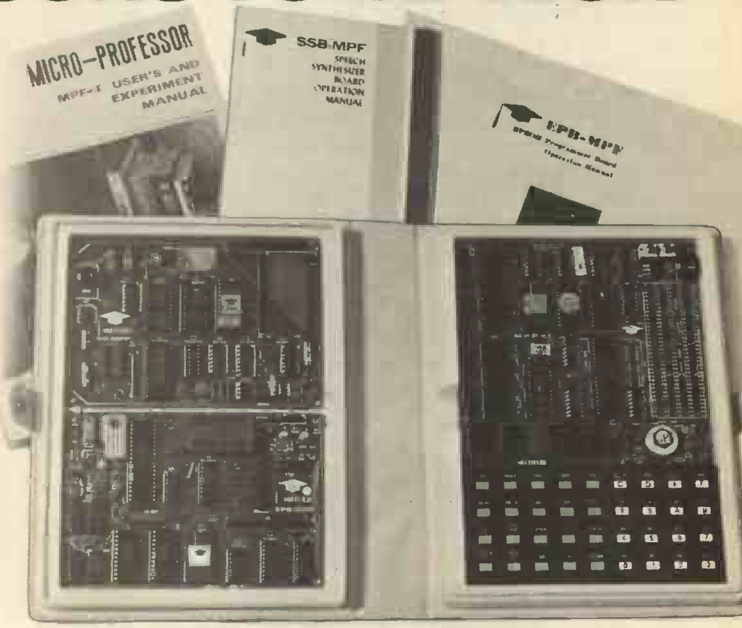
OVER £500 WORTH OF MICRO-PROFESSORS TO BE WON

In the August issue of PE our contributor, Michael Tooley, reviewed the Micro-Professor MPF-1 low cost learning, teaching and prototyping tool. We are now pleased to be able to arrange this competition with Flight Electronics Ltd., the sole U.K. agents for the system.

The prizes presented by Flight will be:

1st Prize: A full system comprising MPF-1B Micro-Professor (which includes MPF 2K BASIC Interpreter), an MPF-EPB EPROM programming board, an MPF-SSB Speech Synthesiser board

2nd, 3rd, 4th & 5th Prizes: Micro-Professor MPF-1B microcomputers



HOW TO ENTER

For the purposes of this competition we'd like to assume that you are a student who has a basic understanding of electronics but wants to learn about microprocessors and machine code programming. Listed here are eight features of a microcomputer teaching aid, such as the MPF-1. In what order do you consider they warrant the greatest consideration when purchasing such a unit?

If, for example, you consider that "cassette interface" is the most important feature of them all, put "K" in the first space on your entry coupon. The letter of your next choice goes under 2 and so on for all eight. Complete the coupon with your full name and address and post in a sealed envelope to PE Micro-Professor Competition, 55 Ewer Street, London SE99 6YP, to arrive no later than **Friday, 29th October, 1982, the closing date.**

A — quality moving key keyboard
B — clear, easy to read display
C — comprehensive user manual
D — easy memory expansion
E — high quality construction
J — audio output
K — cassette interface
L — BASIC programming ability.

C D E K

E C D K B A J

IMPORTANT

Before sealing, copy out on the outside back of the envelope the eight key letters in exactly the same order as they appear on your entry coupon. FAILURE TO DO SO MAY RESULT IN YOUR ENTRY BEING DISQUALIFIED. Do not enclose any correspondence or matter other than the entry coupon.

RULES

There is no entry fee but each attempt must be on a proper entry coupon cut from Practical Electronics and must bear the entrant's own name and address.

All accepted entries will be examined and the first prize awarded to the entrant who, in the judges' opinion, has shown the greatest skill and judgement in placing the eight features of a microcomputer teaching aid in order of importance to the described student. Remaining prizes will be awarded for the next best attempts in order of merit. No entrant may win more than one award.

In the event of a tie for any prize(s) those tying will take part in a postal eliminating contest to determine such winner(s) or winning order.

Entries arriving after the closing date will be disqualified as will any received incomplete, illegible, mutilated or altered or not complying with the rules and instructions exactly. No responsibility can be accepted for entries lost or delayed in the post. Decisions of the Judges and those of the Editor in all matters affecting this competition will be final and legally binding.

The competition is open to all readers in Great Britain, Northern Ireland, Eire, the Channel Islands and the Isle of Man, other than employees and their families of IPC Magazines Ltd., the printers of Practical Electronics or of Flight Electronics Ltd.

Winners will be notified and the result published later in Practical Electronics.

Audio Sweep Oscillator

EQUIPMENT for displaying the frequency responses of filter systems range from a simple sinewave generator and meter (also requiring graph paper and a great deal of patience!), to real-time spectrum analysers costing thousands of pounds. Sweep Oscillators fall somewhere between these extremes, using an oscilloscope to display the response in near-real time. They are immensely useful in the audio design or repair workshop, though ready-built models are unaffordable luxuries to most amateurs. This project uses a special i.c. to overcome the major design problems at low cost, and is also simple to build and set up.

The *P.E.* Audio Sweep Oscillator provides a low-distortion sinewave whose frequency can be swept over the audio range by an internal rampwave generator. The sinewave is fed to the system under test while the output is viewed on an oscilloscope with the sweep voltage from the oscillator controlling the horizontal deflection. The response of the system is displayed as a graph of amplitude against frequency, with the frequency axis logarithmic since the signal frequency is an exponential function of the sweep voltage. For oscilloscopes without a horizontal input, a pulse that marks the start of each sweep is provided to trigger the internal timebase.

A squarewave output is also provided, allowing the unit to double as a general purpose test oscillator, along with option of using an external ± 15V regulated supply.

SINEWAVE GENERATION

This design employs an unusual approach to sinewave generation, in that the triangle output of a voltage-controlled oscillator is fed to a tracking low-pass filter which removes the harmonics from the signal (see the block diagram in Fig. 1). The result is a sinewave which covers the whole audio range without switching and has less than 1% distortion. This would not be a practical alternative to designs based upon quadrature oscillators or diode shaping networks but for the availability of the SSM2040, manufactured by Solid State Micro Technology specifically for low-cost audio applications. This i.c., with one external op-amp, provides the VCO and matched 3-pole filter, plus the exponential control voltage converter required for a logarithmic frequency axis.

CIRCUIT DESCRIPTION

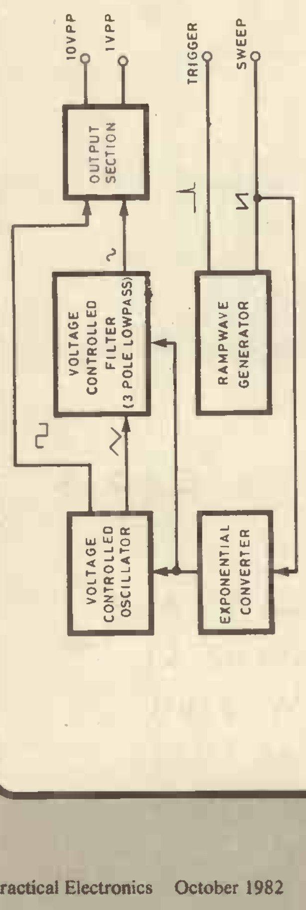
The circuit diagram appears in Fig. 2. The oscillator is based around one of the four gain cell-buffer pairs of the SSM2040 (IC3 pins 15, 14, 13) and IC4, which form the integrator and schmitt trigger respectively of the familiar triangle/squarewave generator arrangement. The gain cell outputs a current proportional to the input voltage and the exponential converter current. This is used to charge and discharge C7 between fixed thresholds of + and − 0·6V, producing triangle and square waves with voltage-controlled frequency. R1 injects a small current into R2 to allow the effect of gain cell input offset and unequal maximum and minimum output voltages of IC4 to be trimmed out for best waveform symmetry.

The Voltage Controlled Filter consists of three identical low-pass stage in series. Looking at the first stage (using IC3 pins 12, 11, 10), the arrangement is seen to be similar to the integrator, but with feedback provided by R8. At input frequencies below the filter breakpoint C8 has little effect and the negative feedback produces a virtual earth at the gain cell input. Hence the stage acts as an inverting amplifier with gain equal to R8/R6, in this case unity. At higher frequencies the voltage on C8 lags behind the input signal, the difference between the two appearing at the input of the gain cell. This causes the voltage on C8 to approach each new value of the inverted input signal exponentially, and the result is a low-pass filtered signal at the buffer output. The exponential generator current controls the current delivered to C8 and therefore the break frequency of the filter.

The filter breakpoint is set to track slightly below the VCO frequency, so that even though the total passband gain of the filter is one, the fundamental sinewave is actually slightly attenuated. This ensures that maximum slope exists between the fundamental and the third harmonic (there being no second harmonic in a triangle wave) so that within component tolerances a higher or lower cut-off frequency will only affect the sinewave amplitude, with the purity remaining at maximum.

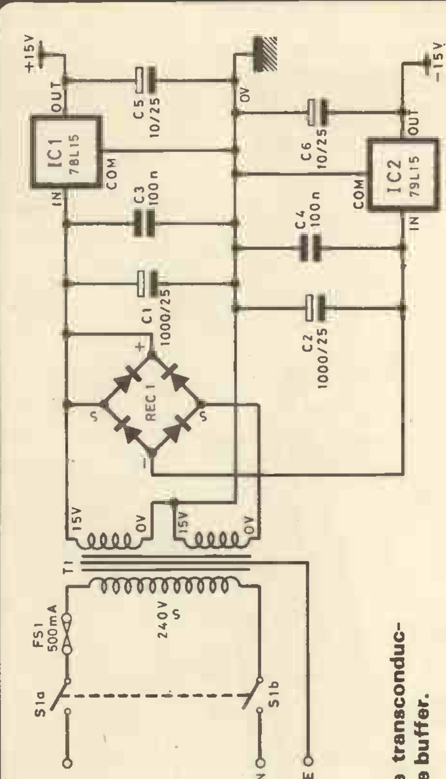
A piece of test equipment which allows your 'scope to become a real-time bandwidth analyser

C.J.F. JORDAN



EG933

Fig. 1. Block diagram of Audio Sweep Oscillator



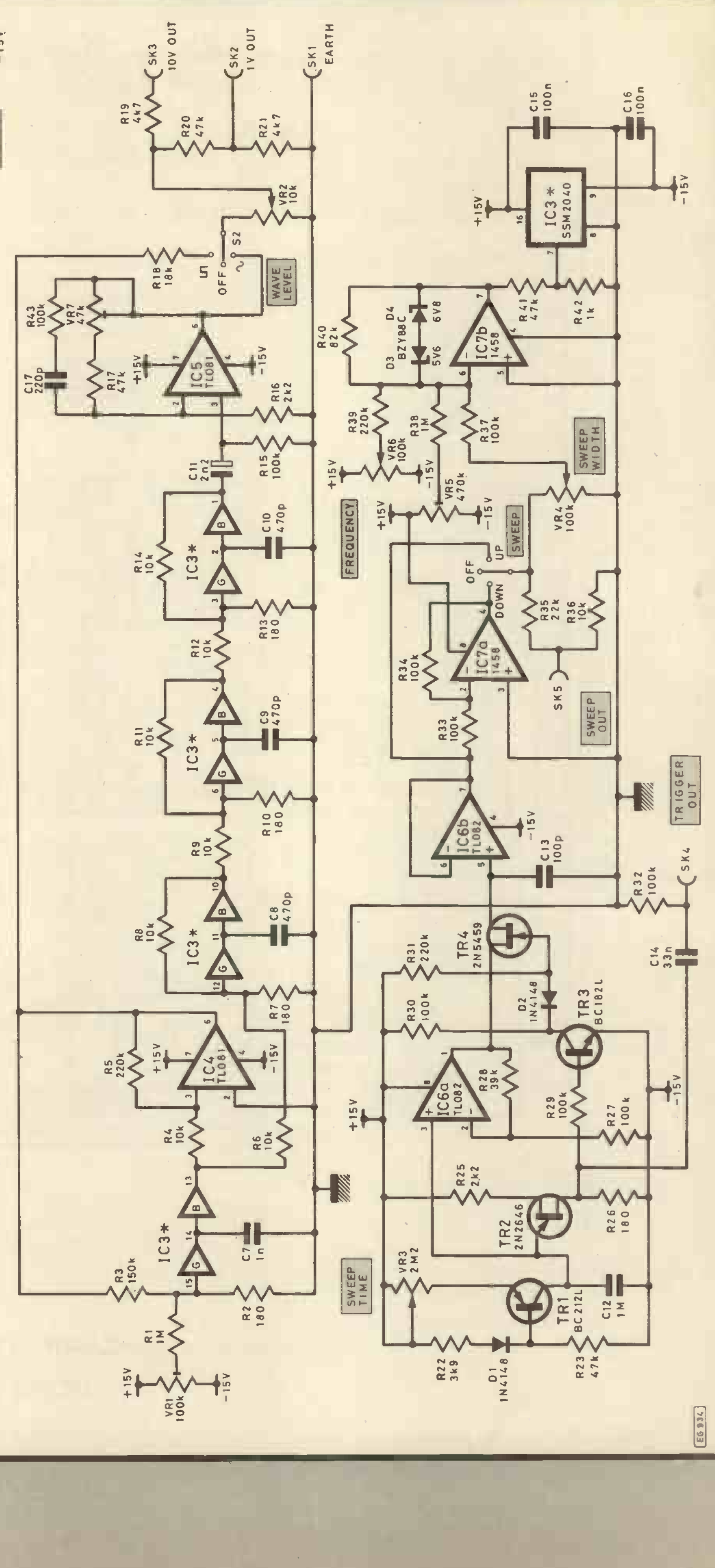


Fig. 2. Full circuit diagram. G=variable transconductance amplifier. B=high input impedance buffer.

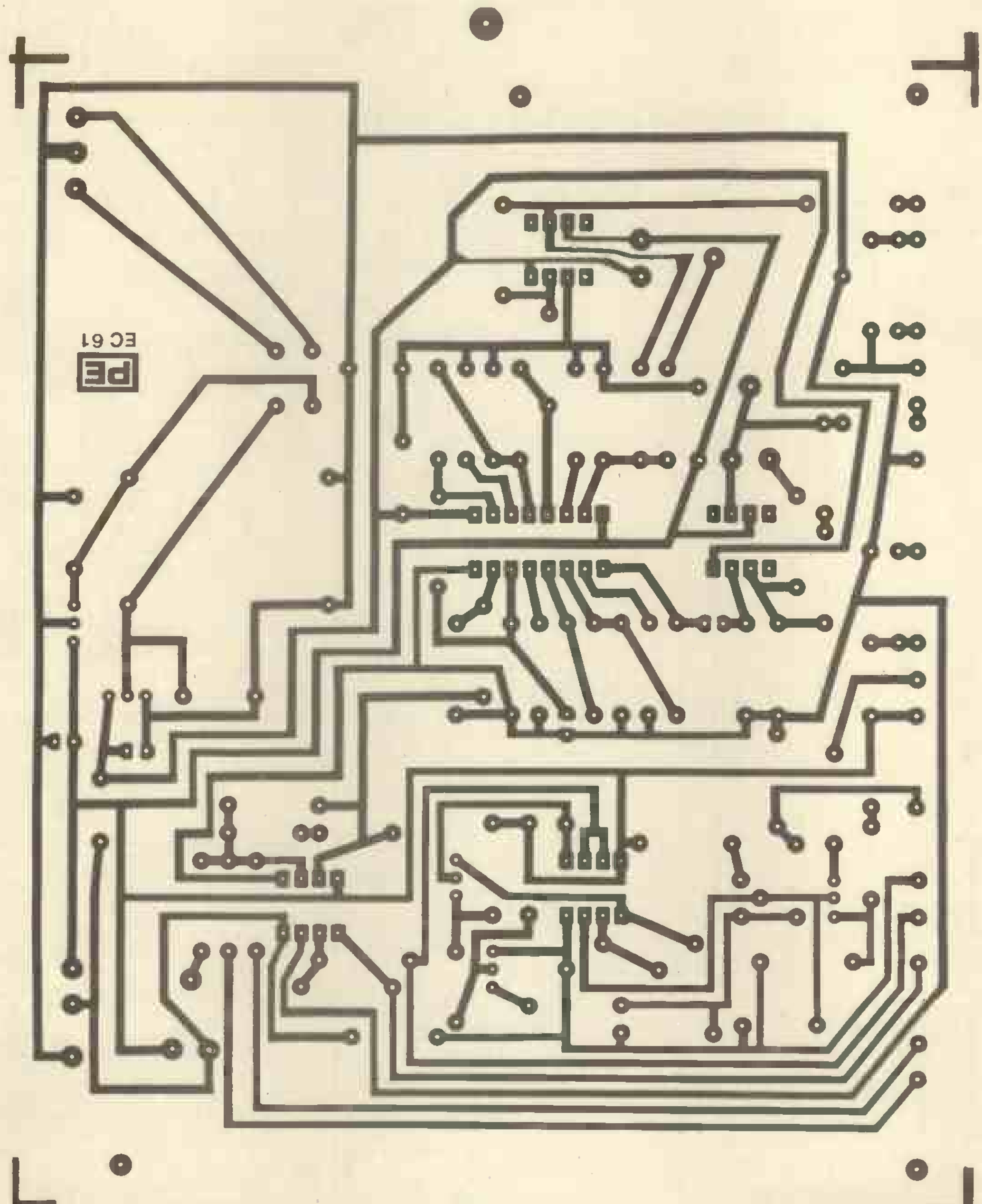


Fig. 3. Printed circuit layout (actual size)

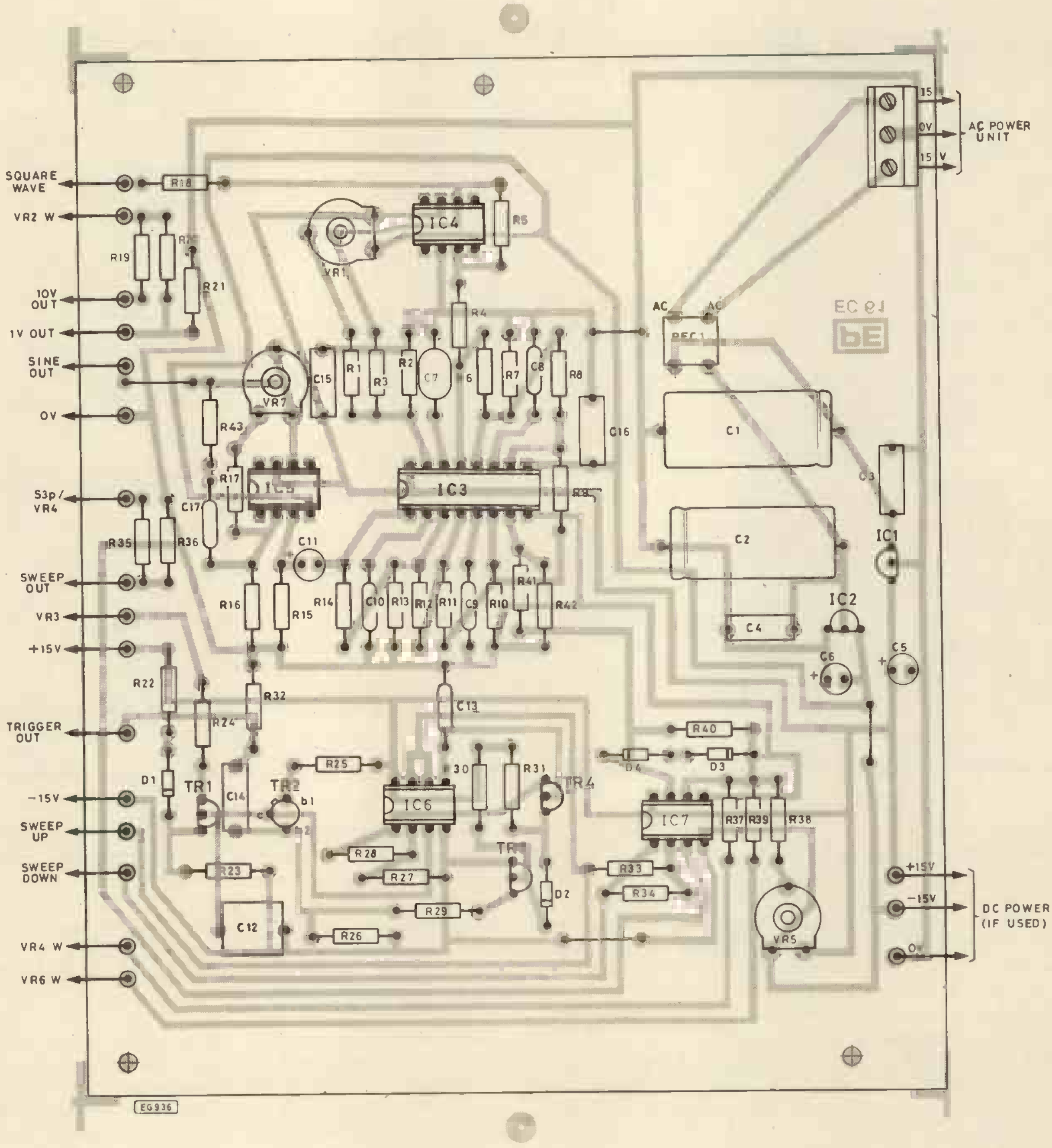


Fig. 4. Component layout

COMPONENTS . . .

Resistors

R1,R38	1M0 (2 off)
R2,R7,R10,R13,R26	180R (5 off)
R3	150k
R4,R6,R8,R9,R11,R12, R14,R36	10k (8 off)
R5,R31,R39	220k (3 off)
R15,R27,R29,R30, R32,R33,R34,R37,R43	100k (9 off)
R16,R25	2k2 (2 off)
R17,R20,R23,R41	47k (4 off)
R18	18k
R19,R21,R24	4k7 (3 off)
R22	3k9
R28	39k
R35	22k
R40	82k
R42	1k0

Potentiometers

VR1	100k sub-min. preset
VR2	10k log. pot.
VR3	2M2 log. pot.
VR4,6	100k lin. pot.
VR5	470k sub-min preset
VR7	47k sub-min preset

Capacitors

C1,C2	1000µ 25V elect. (p.c.b. type) (2 off)
C3,C4,C15,C16	100n polyester (4 off)
C5,C6	10µ 25V elect. (p.c.b. type) (2 off)
C7	1n polystyrene
C8-C10	470p polystyrene (3 off)
C11	2µ2 63V elect. (p.c.b. type)
C12	1n MKH polyester
C13	100p polystyrene
C14	33n polyester
C17	220p polystyrene

Integrated Circuits

IC1	78L15 100mA regulator
IC2	79L15 100mA regulator
IC3	SSM2040
IC4,5	TL081 (2 off)
IC6	TL082
IC7	1458

Transistors and Diodes

REC1	0·9A d.i.l.-type bridge rectifier
TR1	BC212L
TR2	2N2646
TR3	BC182L
TR4	2N5459
D1,D2	1N4148 (2 off)
D3	BZY88C5V6 Zener
D4	BZY88C6V8 Zener

Miscellaneous

T1	Transformer, 240V prim. 0-15, 0-15 sec. 3VA
FS1	Fuse, 500mA
S1	Toggle switch, DPST
S2,3	Miniature toggle switch, centre-off SPCO (2 off)
SK1	4mm socket, green
SK2-5	4mm socket, red (4 off)
	Case, West Hyde TEKO, Code TEK A23L
	I.c. sockets, 1mm Veropins, hookup wire, control knobs, fuseholder, mains cable, etc.

Constructors' Note

The SSM2040 i.c. is available from Digisound Ltd., 14/16 Queen St., Blackpool, Lancashire FY1 1PQ. The price is £5.90 inclusive of VAT and postage

Device IC5 boosts the sinewave amplitude and VR7 allows it to be set to exactly 10V p.p. C15 and R43 provide h.f. roll-off to compensate for the increase in amplitude of the triangle wave at high frequencies, due to the SSM2040's limited bandwidth when used in oscillator mode. The variation in the level of the resultant sinewave is within ± 1dB over the full range. S2 selects the output waveform, VR2 controls the level, and R20 & R21 attenuate the 10V p.p. signal for the 1V p.p. output.

The sweep generator is based around a unijunction transistor, TR2. TR1 forms a constant-current source that charges C12. When the voltage reaches +2·5V, TR2 turns on and C12 is rapidly discharged to −11V through R26. Charging then continues and the cycle is repeated, generating a rising rampwave whose frequency is dependent on the values of the fixed thresholds and the charge current set by VR3. This gives a sweep time range of 12sec.-30ms. A log. pot. is used with maximum sweep time at the clockwise end, giving the best distribution of times over the range of the control.

Device IC6a buffers the voltage on C12 and shifts the rampwave to be symmetrical about 0V. To avoid a visible flyback on the screen, the falling edge of the ramp must be speeded up—this is the function of the track-and-hold circuit around TR14, C13 and IC6b. During the rising section of the waveform TR4 is on, and both the voltage on C13 (and the output of IC6b, the buffer) track the output of IC6a. While the ramp is resetting, TR3 holds TR4 off and the buffered voltage remains at the peak value. At the end of the reset pulse, TR4 turns on again and the output of IC6b falls very rapidly to the new ramp voltage. The reset pulse is also coupled to the trigger socket.

Device IC7a inverts the sweep voltage and S3 selects the non-inverted or inverted version for upwards or downwards sweep respectively. R35 and R36 attenuate it to suit the horizontal inputs of most oscilloscopes; if the trace is too wide or too narrow, the value of R36 should be adjusted accordingly. IC7b sums the voltages from the frequency pot VR6, the sweep width pot VR4, and the range preset VR5, using D3 and D4 to limit the output voltage swing to the required range. The exponential converter input (pin 7 of IC3) has a sensitivity of 18mV/octave, and R41 & R42 divide the output of IC7b to suit this.

The power supply is conventional, using two 100mA monolithic regulators for the ± 15V rails. Current consumption is about 20mA from each during normal operation.

CONSTRUCTION

Assemble the p.c.b. in the usual order, i.e. resistors first, then capacitors, followed by semiconductors, using the component overlay in Fig. 4 as a guide. Solder in the i.c. sockets (strongly recommended) and Veropins. The p.c.b. has provision for accepting an external ± 15V supply, and if this option is used, all the power supply components can be omitted. Check the underside of the board for solder bridges etc., paying particular attention to the area around the SSM2040. The inputs and outputs of this device are not protected, and a short to either supply is likely to destroy it. Fit the pots, switches and sockets to the front panel, and fix the board to the bottom of the case with the screws supplied. Connect up the front panel components and the board, making separate connections rather than grouping them together. To avoid the sinewave output picking up the squarewave edges at low output levels, use miniature screened cable between the level pot, the board and both output sockets. Earth the screens at the pot end, and also earth the front panel by connecting the earthed tag of the pot to its body, filing the metal first to ensure a good joint.

MAINS ALTERNATIVE

If the internal PSU option is being used, the mains should be brought to the unit via an IEC plug mounted on the back panel of the case. Also on this panel are the fuse and transformer, and these components should now be fitted and wired up, with the transformer located in the top right-hand corner as viewed from the front of the case. All bare mains connections must be sleeved or protected with insulating tape before proceeding to the setting-up stage. Finally, check all the connections to the board from the front and back panel components.

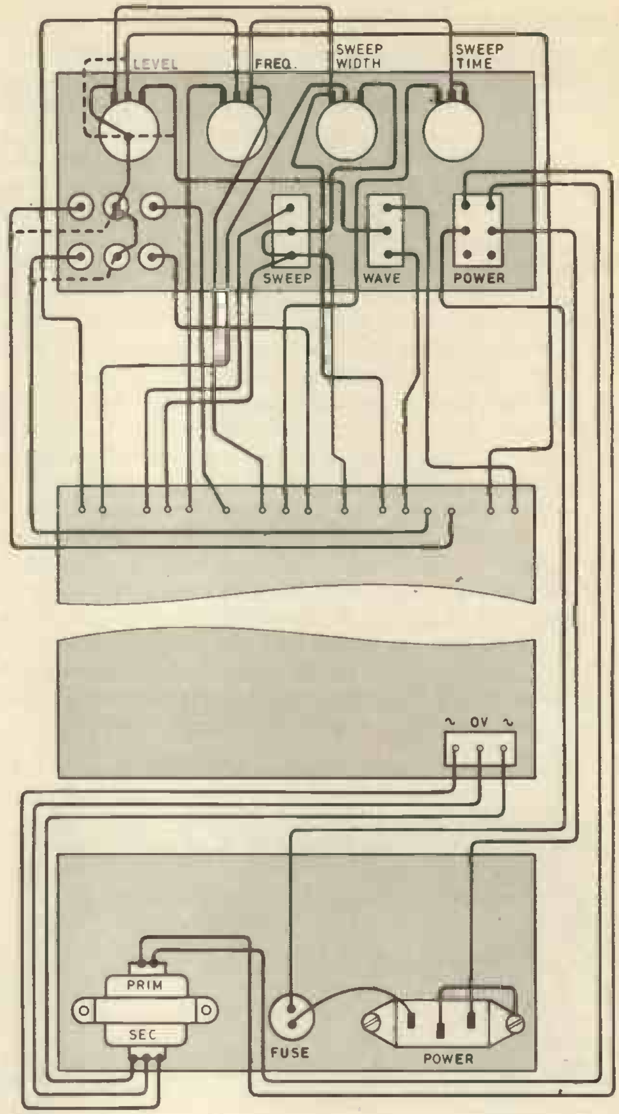
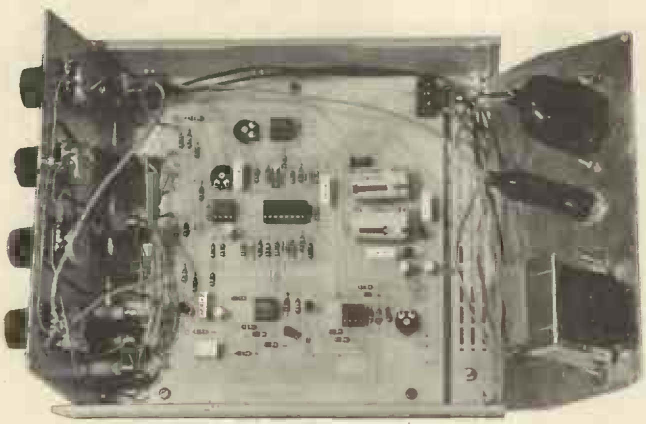
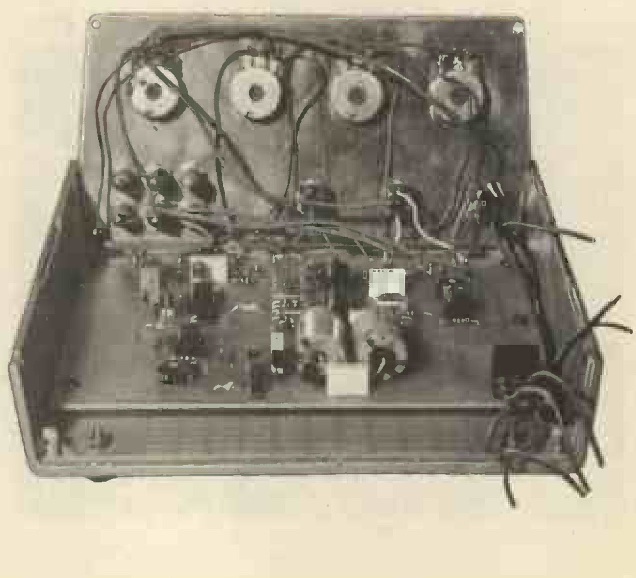


Fig. 5. Wiring diagram. Dotted lines represent the braid of screened wire.

ASSEMBLY DETAILS





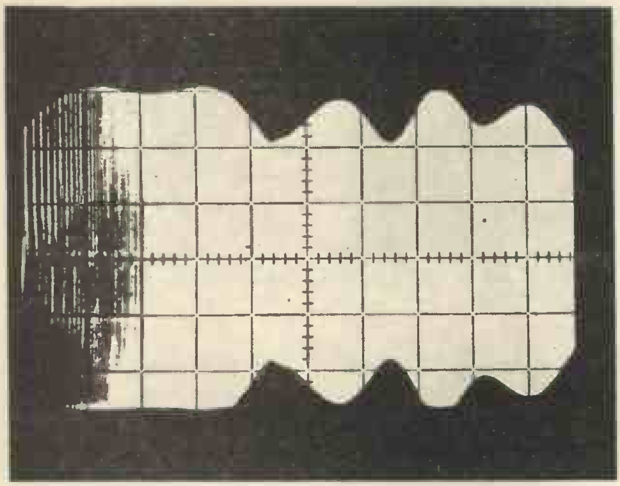
SETTING-UP

Power-up the unit and with the frequency and level controls at their mid-points, examine the 10V and 1V outputs with an oscilloscope. The wave switch should give the expected sine and square waves at both. Check that the sweep controls are functioning correctly, remembering that the sweep time control should produce the longest time at the clockwise end. Without the sweep in use and with the level initially at minimum, connect the 1V output to an audio amplifier and speaker. Monitor the squarewave at a frequency of around 100Hz and carefully adjust VR1 until the point is found where only odd harmonics are heard, with even harmonics being introduced to each side. Those constructors who do not feel confident about trimming a pulse wave to 50% mark/space ratio by ear can attempt this visually on the scope screen, but after a little experimentation with the preset, most should be able to obtain much better results by the aural method.

After VR1 has been properly set, the sinewave will have minimum distortion. The other two adjustments are straightforward. With the frequency control at maximum, set VR5 for a frequency of 20kHz. Then turn the frequency control to its mid-point and adjust VR7 for a sinewave amplitude of precisely 10V p.p at the 10V output.

Before screwing the case together check the sweep and trigger outputs with the scope, and if any modification of the sweep width is needed, make it as previously described.

a



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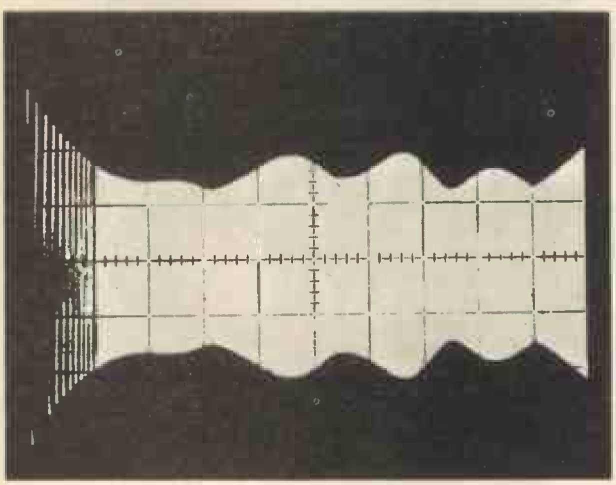

IN USE

Connect the input of the system under test to the appropriate output of the sweep oscillator, and its output to the Y-input of the oscilloscope. Select external input for the X-amplifier and connect the sweep output of the oscillator. With the level control set to suit the input of the audio device and all other rotary controls at their central positions, adjust the scope controls for the best trace. The wave switch should be on sine, and the sweep switch on up or down sweep.

Best results will be obtained with a slow sweep, but since this makes the trace difficult to read, a compromise must be arrived at. A sweep time of around 0·5s gives good results with most filters and medium persistence CRT's, but with high Q-factors or low frequencies, longer times are needed. Short sweep times should be reserved for examining responses at high frequencies, or over a narrow band.

The range of the oscillator is limited to the values corresponding to the ends of the frequency control, so for use at maximum sweep width this must be at its mid-point if the actual sweep is to cover the full range. Reducing the sweep width 'zooms in' on the centre of the displayed section of the response, and altering the frequency moves the 'window' up and down.

Fig. 6a and b are examples of displayed frequency responses, in this case of a 5-band graphic equaliser with the boost/cut controls at different positions. Fig. 7 is an example of use as a general test oscillator. The display shows severe ringing at the output of a system driven by the squarewave from the Sweep Oscillator.

To use the trigger facility, the trigger output should be routed to the external trigger socket of the oscilloscope and the trigger level adjusted for a stable trace. Experiment with the sweep rate to give a single full sweep of the oscillator frequency in each timebase period. ★

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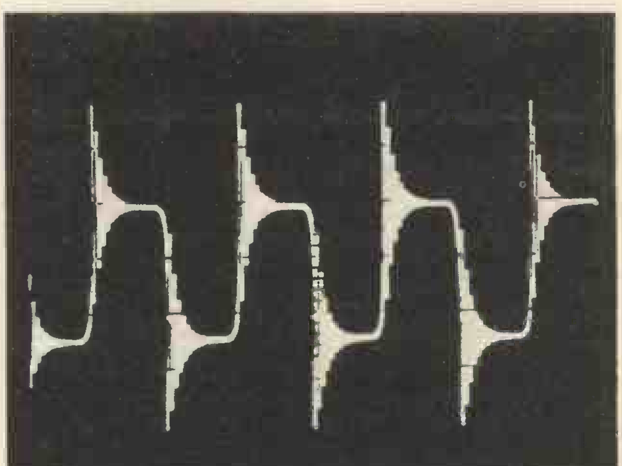
Fig. 6 (a) & (b). Graphic equaliser output examples

Fig. 7 (below). Squarewave test signal upon which the system under test has superimposed severe ringing



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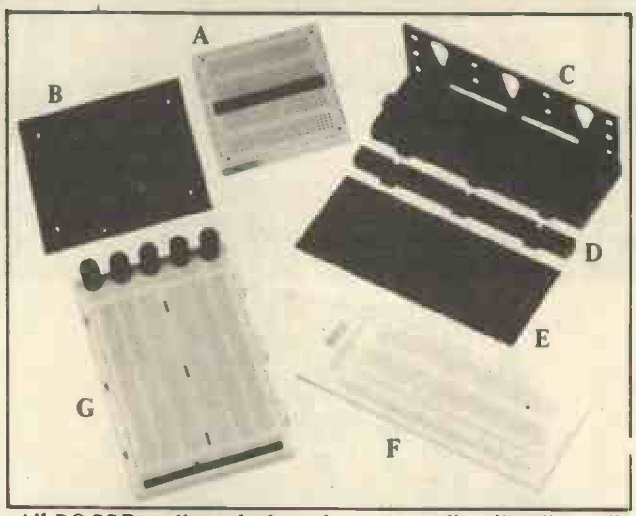

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Patents Review

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JUSTIN CASEY HOWELLS

British patent application 2 082 363 from Graham Jackson of Surrey describes in detail the electronic system for generating a noise similar to that heard by a baby in its mother's womb. According to the inventor this has a comforting effect on babies, particularly when they are new born. The sound is described as a whooshing noise which occurs cylically with the sound of the heartbeat, over a general background noise. The whooshing increases in frequency and then decreases again before the end of the cycle. The aim is to provide a unit which will produce this noise, but is cheap to make so that families can buy them for home use.

Figure 1 shows the general layout. Ramp generator 1 produces a waveform at heartbeat frequency (nominal 72 beats per minute), generator 2 modulates this waveform with white noise and voltage controlled, oscillator 3 uses the modulated waveform to produce an audio frequency of nominal 1·5kHz. The audio signal from oscillator 3 is filtered at 4 and reproduced by loudspeaker LS1.

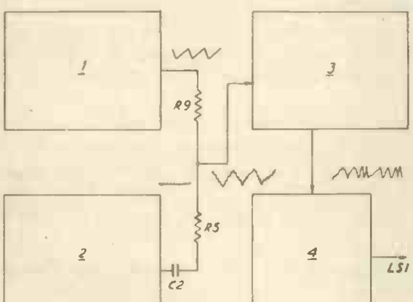


FIG 1

Figure 2 shows a pair of operational amplifiers IC1a and IC1b functioning as the ramp generator and another pair of operational amplifiers IC2a and IC2b functioning as the white noise generator. VCO3 also relies on a pair of operational amplifiers IC1c and IC1d and the filter uses a single op amp IC2c.

The heartbeat time constant for ramp generator 1 is set by the values of resistor R7, capacitor C3, feedback resistors R6, R8 and diode D1. This produces a linear positive rising voltage at the output of IC1b which rapidly falls back to its starting voltage in a cycle of 72 beats per minute.

Op amps IC2a and IC2b are connected so that they amplify their own random noise. The signal appearing at C1 is applied to the negative input of IC2a and the output of IC2a is fed through resistor R3 to negative input of IC2b. The resultant random or white noise is combined with the saw tooth waveform from IC1a and IC1b which appears at resistor R9. This produces a fuzz signal which is applied to negative input of op amp IC1d to modulate its audio output of nominal 1·5kHz value. So within each heartbeat period there is an increase in frequency followed by a decrease in frequency. This swooping signal is shaped and filtered free of high harmonics by network R14, R15 and R16, C5 and C6. The shaped signal is then amplified at IC2e to drive speaker LS1.

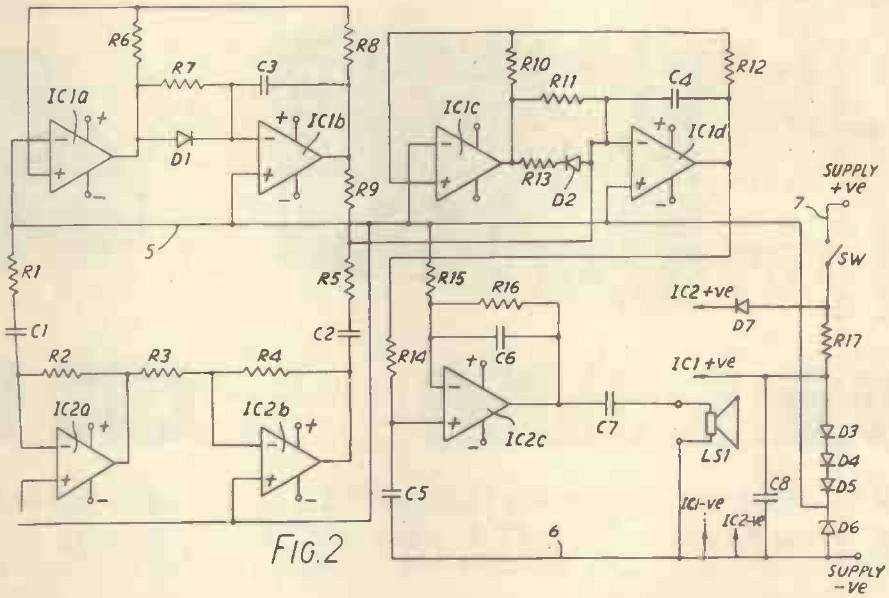


FIG.2

The patent gives full circuit diagrams with component values. The inventor suggests that the output signal can be recorded on a record or tape to make it even cheaper for parents to produce the soothing noise in their own homes.

SEIKO FLAT TV

Flat screens for small portable monochrome television sets are likely to be the next big news in consumer electronics. Sinclair and Sony have gone for a flattened cathode ray tube. Other Japanese manufacturers, such as Hitachi and Toshiba, have gone for liquid crystal displays which modify ambient light. It's impractical to use a display which produces its own light, for instance a matrix of l.e.d.s, as power consumption is too high.

The Japanese firm Kabushiki Kaisha Suwa Seikosha, in British patent application 2 081 018, claims broad protection on what could be an important step forward towards making liquid crystal display TV screeens more practical, and gives some insight into the technology employed in the Seiko "watch TV".

Figure 1 shows the circuit for a conventional display. Address line X is connected to gate of transistor 2. When it conducts a signal from data line Y is stored on capacitor 3 to drive l.c.d. segment 4. A rectangular matrix of a large number of these segments produces a small TV picture. A disadvantage of the system is that the driving electrode is made of aluminium, and does not transmit light. So the screen only

Fig.1.

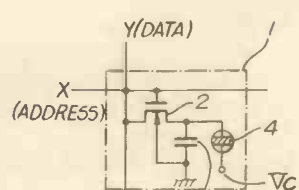
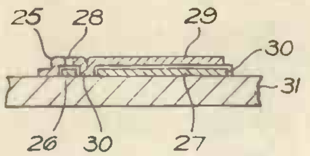


Fig. 2.



works with light reflected from the electrode. Figure 2 shows the new type of display which is being patented. A layer of polycrystalline silicon is grown on a substrate 31, which is of high melting point glass, such as quartz. p ions are then implanted to form an n-type polycrystalline silicon layer. A gate 26 and capacitor electrode 27 are formed by photo-etching a film 30 of silicon di-oxide. A second layer of silicon is then formed and p ions implanted, except over channel 28, to form source and drain electrodes, data line 25 and driving electrodes. The whole assembly is then illuminated with laser light to anneal it. The electrodes and substrate are transparent so that a TV screen made from a matrix of these elements has an increased viewing angle and gives better contrast, even when watched outdoors in sunlight.

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WANTED circuit diagram/manual Eddystone 770UM II, buy or borrow. Mr. G. E. Audas, 27 Pasture Road, Goole, Yorkshire DN14 6BP.

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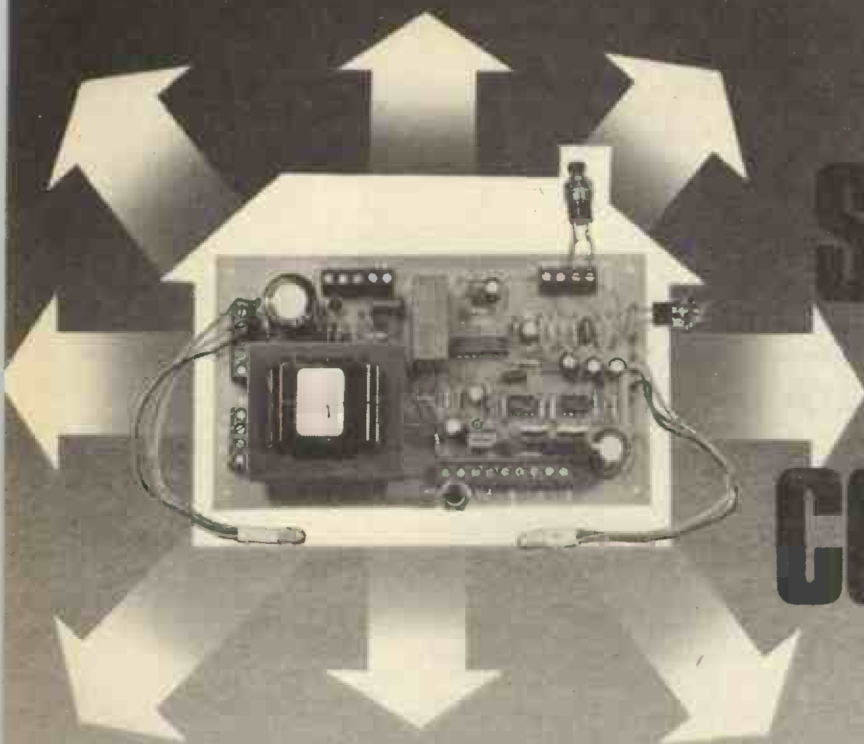

SECURITY ALARM CONTROLLER

JOHN G. LEITH

WITH the current increase in the number of reported break-ins, together with the considerable publicity given to annual crime figures, the public awareness of the need to have some form of intruder deterrent in the house is growing to the point where a burglar alarm is no longer considered a requirement of only large houses or very wealthy occupants. To meet such a need, a large number of companies are currently engaged in producing a wide range of intruder alarms. The units offered vary from simple magnetic switches and bells to highly sophisticated microprocessor controlled systems.

It is an area, however, where the enthusiast can save a considerable amount of money by fitting their own system. One requirement which the majority have in common is the need for flexible control, and it is as a result of this need that this project was originated.

CIRCUIT

In Fig. 1 the power supply for the unstabilised requirement uses the conventional full wave circuit resulting in some 18V off load falling to 14–15V in the event of an alarm. It can be seen that it is this output which is switched by S2 to the relay and CSR which is triggered by breaking the anti-tamper loops (AT1 and AT2) or pressing the panic switch which is a push to break type. With the CSR switched the relay closes and the siren is operated continuously until reset. The siren circuitry is comprised of IC2 and 3 and the output pair TR5 and TR6. Here IC3 acts as a 1kHz oscillator which is modulated by IC2 at approximately 1·5Hz. The output of IC3 is then amplified by the complementary pair.

The siren frequency slides between 1 and 2kHz with a high level output for driving a minimum load of 4 ohms. In practice this usually consists of two 8 ohm speakers in parallel with one speaker mounted in the house and the other external to draw the attention of neighbours etc.

When used with horn speakers sound pressure levels of 110dB at 2 metres can be obtained which are extremely effective.

With S2 switched to 'Alarm' the diode D3 ensures that the supply reaches the relay, CSR and the stabiliser circuitry. A discrete voltage stabiliser was adopted rather than the more usual integrated type since a low voltage drop was the prime requirement. In the circuit used only 300–400mV is dropped compared to 1·5V–2V for the integrated type. Here, TR4 limits the stabilised output current.

The stabilised supply of 11V is fed to the timing circuitry around IC1. Here IC1a and b constitute a modified monostable arrangement in that the circuit has one stable state in the true sense, but two alternative states. The duration of these are used to provide the alarm time and entrance delay with the actual value being set by R7 and C3 and R9 and C4 respectively. IC1d detects when the output from b and c is low (this occurs during the alarm time) thus switching TR1 and energising the relay. R11 and C6 comprise a filter to reduce unwanted transients.

IC1a provides the exit delay since pin 1 is held high until C2 becomes fully charged. This occurs after the time constant of C2 and R5 which is approximately 30 seconds.

R25 and D10, if fitted, provide for a delay following an alarm period. Such a null might be required in order to allow an alarm siren etc., to die down before resetting the system.

The 11V supply will also supply external units such as ultrasonic or infra-red transducers. The maximum current which can be drawn from this line is 100ma and it is short circuit protected. The choice of 11V as against a more normal 12V allows the stabilised output to be maintained even when used with batteries which are not fully charged, since the stabilisers used drops only some 300–400mV. The battery back-up facility provides a trickle charge of some 2ma, chosen to be the maximum safe continuous current permitted for small nicad cells. For other types of battery it may be possible to increase the charge rate.

The unstabilised output supplies the relay and siren requirements.

MAIN SWITCH POSITIONS

In position 3 of S2, the alarm becomes active after a delay of approximately 30 seconds. This delay allows the individual to leave the premises, close the door etc. without setting off the alarm. A further delay of some 20 seconds following an entrance to the premises allows authorised individuals time to switch off the alarm before the siren sounds, preferably by some means of security switch. If this is not switched off it will sound for a period of approximately

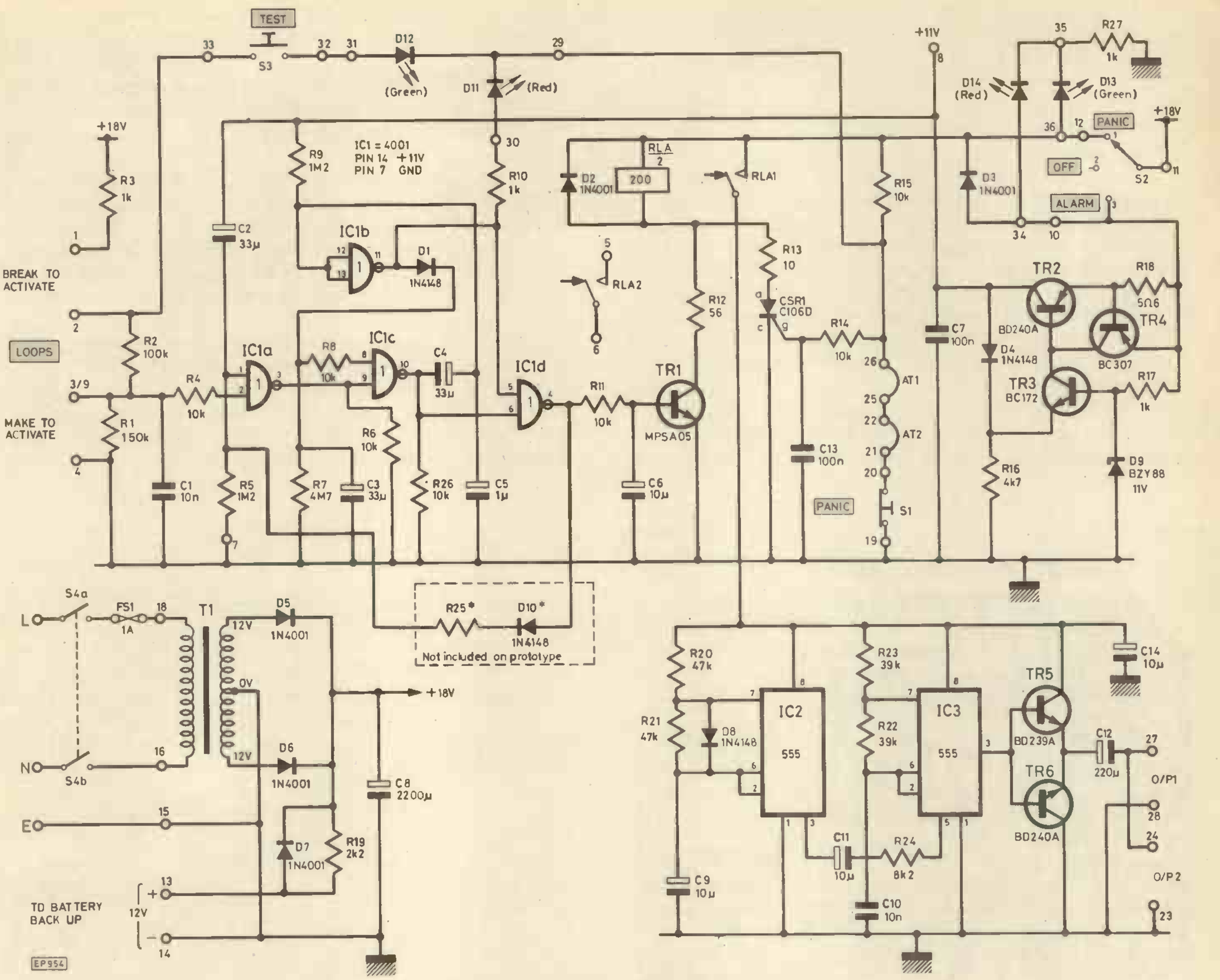

Fig. 1. Circuit of Security Alarm Controller

1·5 minutes before resetting itself, providing the original cause of the triggering has been removed.

The two operating modes are indicated by l.e.d.s.

In position 2, the 'Off' position, neither the alarm or panic facility are operating, however, the test loop facility may be used in order to determine that it is safe to switch on the alarm without it being immediately activated (i.e. a door or window has not been left open). In position 1 the alarm is not activated by detection systems, in other words, doors may be opened or movements, made within the covered space. The unit will however, respond to wires being cut (AT1/AT2—the anti-tamper loops) and also to S1, this being a switch normally fitted close to the front door or the bedside used for summoning assistance. In this mode the alarm when sounded is continuous until the unit is reset by the switch set to position 2 for 5 seconds or more.

RELAY SWITCHING

As mentioned, the relay is switched by either CSR1 or TR1 enabling the siren circuit via RLA1.

The second set of contacts RLA2 are available for the switching of external loads up to 5A such as room or spot lights etc.

CONSTRUCTION

With a unit of this nature reliability is of paramount importance so the p.c.b. assembly should be carefully constructed.

The assembly procedure should start by inserting the resistors, followed by diodes, taking care to observe correct polarity. The three i.c.s should next be fitted, then small signal transistors, capacitors, power transistors and CSR, the overall aim being to build up the unit commencing with the lowest profits components, ending with the largest and most bulky. This means that the relay and C8 should be among the last to be attached to the board.

Although it is possible to install the finished board by soldering flying leads it is recommended that the screw type printed circuit terminals are used as seen in the photograph.

Before the final part of the assembly, i.e. fitting of the transformer, the location of the components should be thoroughly checked, together with the quality of the soldered joints. The transformer should now be firmly pushed into the p.c.b. and held in place whilst the tags are soldered.

TESTING

Wire links should be fitted between terminals 10–11, 19–20 and 1–2. A suitable 8 ohm speaker with a 100 ohm series resistor (in order to attenuate the output) should then be connected to O/P1 and a mains lead attached to the appropriate 240V terminals.

Finally, an l.e.d. should be fitted to the p.c.b. at locations 29–30 with the anode connected to 30.

It must be emphasised that before applying mains voltage to the unit, it should be either placed on a non-conducting surface or mounted on pillars at the four mounting points.

With the supply connected the relay should not energise, nor the l.e.d. be illuminated. The link 19–20 across the panic switch terminals should be temporarily broken. When this happens the CSR should trigger energising the relay which in turn should switch on the siren. A sliding tone between 1–2kHz should be heard from the speaker.

If this is not the case it should first be ascertained that the relay has energised switching the supply to the siren circuitry. Assuming all is well, the link on the panic switch should be restored and the supply switched off in order to reset the unit. Before reconnecting the supply the link 1–2 should be removed and the supply restored. After approximately 30 seconds (the exit delay) the l.e.d. should glow indicating that the alarm has been triggered. When a further 30 seconds have elapsed, the relay should energise and the alarm sound. This will continue for about 90 seconds if the link 1–2 has been restored. If not the siren will sound continuously.

If the results achieved deviate to any extent the component locations should be re-checked and the board examined for previously undiscovered solder slicks.

When all is working well the unit may be installed in a suitable enclosure and wired to the appropriate mode switch which should take the form of a three position security or key switch.

The outputs from the siren may also be taken direct to a single or pair of speakers dependent upon the installation.

Finally, do not forget to remove the small links on the copper side of the board when fitting the anti-tamper loops. The other facilities may be used or not dependant upon the requirements of the particular installation. ★

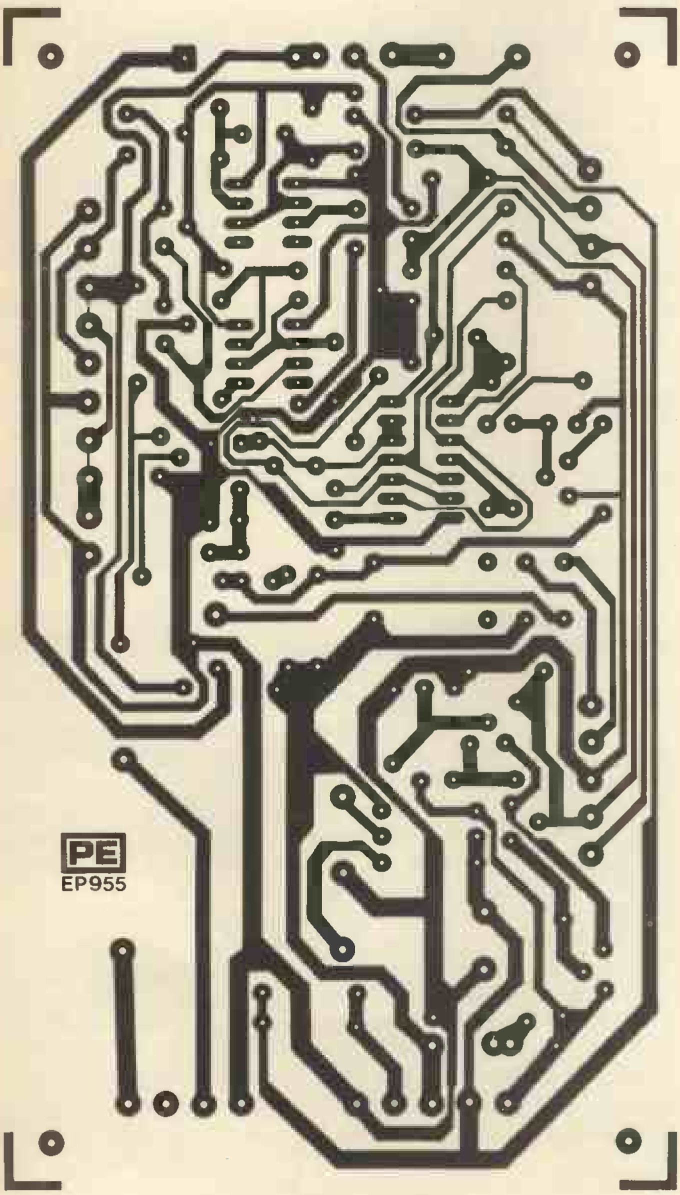

Fig. 2. Printed circuit

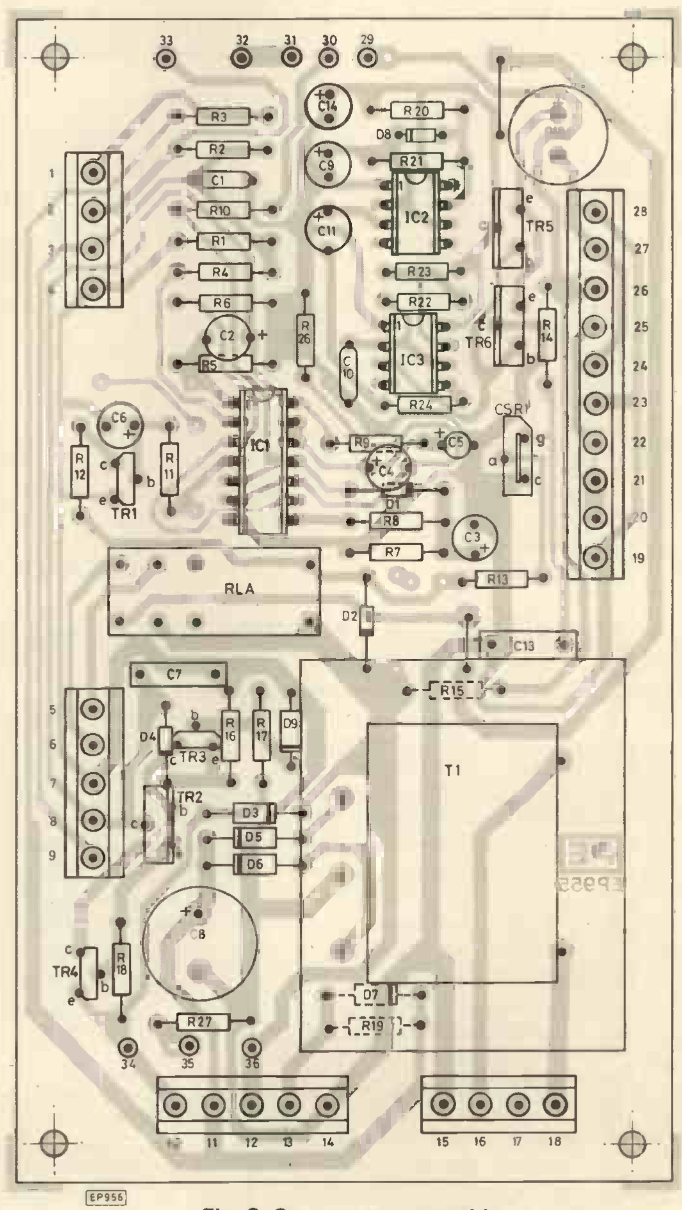

Fig. 3. Component assembly

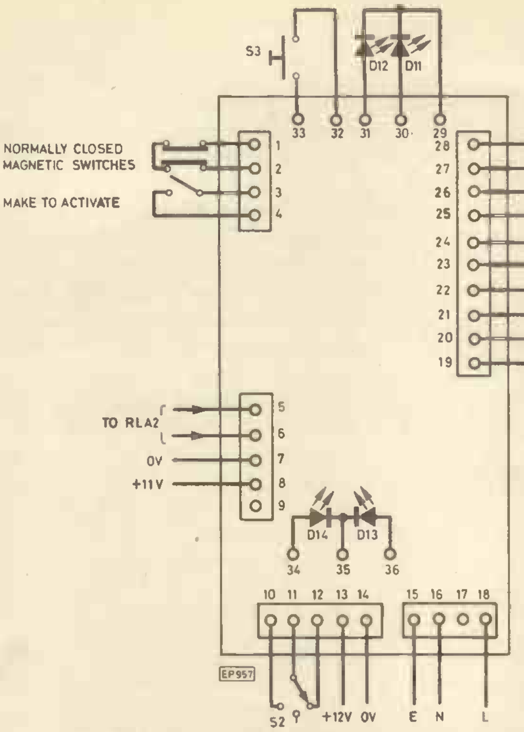

Fig. 4. External board connections

COMPONENTS

Resistors

R1	150k	R11	10k	R21	47k
R2	100k	R12	56	R22	39k
R3	1k	R13	10	R23	39k
R4	10k	R14	10k	R24	8k2
R5	1M2	R15	10k	R25*	see text
R6	10k	R16	4k7	R26	10k
R7	4M7	R17	1k	R27	1k
R8	10k	R18	5R6	All 5% ¼W	
R9	1M2	R19	2k2		
R10	1k	R20	47k		

Capacitors

C1	0·01µ	
C2	33µ	16V elect tantalum
C3	33µ	16V elect tantalum
C4	33µ	16V elect tantalum
C5	1µ	25V elect
C6	10µ	25V elect
C7	0·1µ	
C8	2200µ	25V elect
C9	10µ	25V elect
C10	0·01	
C11	10µ	25V elect
C12	220µ	25V elect

Transistors

TR1	MPSA05
TR2	BD240A
TR3	BC172
TR4	BC307
TR5	BD239A
TR6	BD240A

Diodes

D1	1N4148
D2–D3	1N4001
D4	1N4148
D5–D7	1N4001
D8	1N4148
D9	BZY88 11V Zener
CSR1	C106D
D10	(if fitted) 1N4148

Integrated Circuits

IC1	4001
IC2–IC3	555

Relay

RLA1 2 pole changeover, 12V 200Ω

Transformer

T1 12-0-12V 12VA

A complete kit of parts is available from **Riscomp Limited, 21 Duke Street, Princess Risborough, Bucks, HP17 0AT,** price £16.95 + £2.54 VAT + 50p postage and packing.

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BAZAAR

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ZX81 1K, Sinclair built, manual, p.s.u., leads. Good condition. Bargain! £45. E. Pearson, 142 Kenilworth Road, Coventry. Tel: 0203 418028.

UK101 8K 300, 600, 1200 Baud. 1/2 MHz Mon 02, uncased games tapes includes Asteroids £90. Dave Rose, Combe, Collingwood Rise, Heathfield, Sussex. Tel: Heathfield 2505.

ACORN Atom 12K RAM + 12K ROM all leads, literature and p.s.u. included £200. David Houghton, 2 Western Villas, Church Road, Kennington, Ashford, Kent. Tel: Ashford 23077.

DUMONT Oscilloscope 241, Vintage, £20. Wanted, medical type ultrasonic transducer. J. Glover, Wormley 4649, Surrey.

ZX81 (16K) manual, M/C book, keyboard, Technomatics I/O port, compatible t/recorder flexi-disc r/player, software library, tapes etc. £160 o.n.o. Mr. D. McRiner, 15 Henderson Drive, Kintore, Aberdeenshire AB5 0F8. Tel: Kintore 2768.

MULTIMETER for electrical work incl. case £12. No offers. 01-554 2913 evenings.

MEMORY board (UK101/SB) 8K RAM + 8K/16K EPROM, 40 pin header, no RAM, used for EPROM upgrade only. £40 o.n.o. R. C. Scales, Mill Farm, Hambrook, Chichester, Sussex PO18 8UJ. Bosham 572666 (after 6p.m.).

UK101 wanted, any condition, swap for World War Two German D.F. receiver, collectors item. K. Walkinshaw, 108 Shorncliffe Road, Folkestone, Kent.

UK101 8K, cased, Cegmon fitted, p.s.u. cased, RS 232 printer interface, £150 o.n.o. Tel: 061 799 9912 after 6 p.m. for information.

TANDY TRS80 12 inch green screen monitor, perfect working order, v.g.c., with mains plug, £65 o.n.o. P. Hickinson, 45 Netheredge Road, Sheffield S7 1RW. Tel: 581917 (after 4p.m.).

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MARCONI valve milli voltmeter T.F. 899 good condition £10. Stereo phones IC50 £2. Holdway, Flat 9, 10 Westwood Road, Portswood, Southampton.

LOUDSPEAKERS wanted. Pair of 8 inch 15 ohm high fidelity, high flux drive units, single cone preferred. T. A. Richmond, 78 Broadway North, Walsall WS1 2QF.

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BOX of 10 5¼ inch flexible discs. D.S.D.D. brand new. £12. K. Y. Chang, 70, 1-up, Ashley Street, Glasgow G3 6HW.

3BP1 scope tube, Pristine with base, info., £10, 100 polyester capacitors £2, 400 c.f. resistors £2. Charles Bowden, 7 Parc Eglos, Helston, Cornwall TR13 8UP.

MAPLIN 3800 Synth. needs final setting up, offers. B. Aulton, 34A Newcombe Park, Mill Hill, London NW7 3QL. Tel: 01-906 2355.

COMPONENTS, IC's, transistors, caps, resistors, misc. hardware. Tel: 0244 28095 or write for a list of types. J. P. Jones, 111 Hoole Road, Chester CH2 3NW.

WANTED PE 1974 March to July for Aurora project loan or purchase. P. Atkins, HMS Kingfisher, BFPO Ships, London.

WANTED — manual spares plug-ins components etc. for Dynamco D7100 Oscilloscope with 1Y2 and 1X2 plug-ins. Joseph Lydiate, 16 Robinia Close, Peel Green, Eccles, Lancs. M30 7QE. Tel: 061 707 4591.

HELP! Beginner wishes someone to construct P.E. Microsynth p.c.b. — will pay well, write with offers. P. Green, 179 Church Rd., Kessingland, Suffolk NR33 7SG.

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

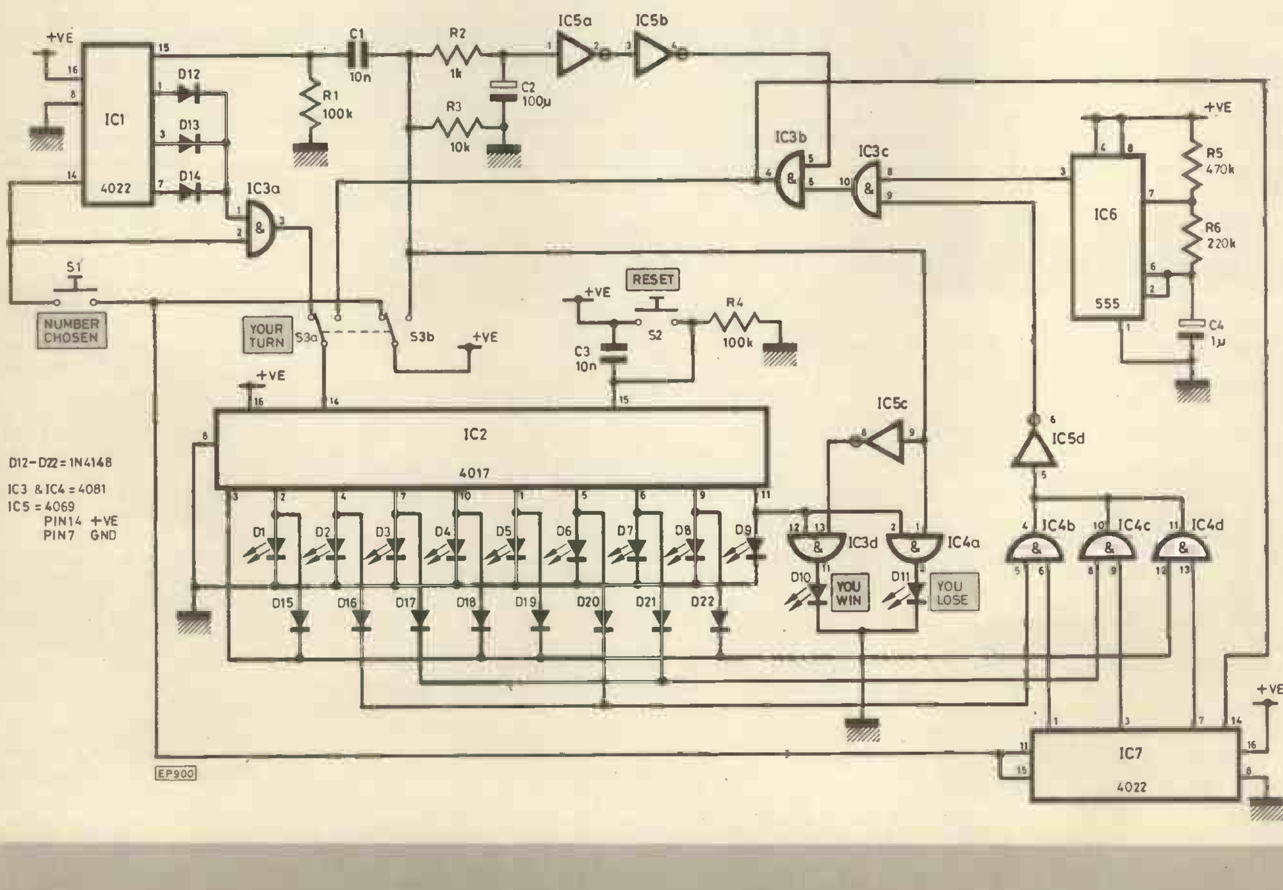
'CHALLENGE'—A GAME

THIS game is similar to an old game using matchsticks. Here nine matches are placed in a line. Two opponents can take either one, two, or three starting from the left. The player who takes the last stick is the winner. 'Challenge' takes this one a stage further and allows a single player to pit his wits against the circuit.

You choose who is going first using S3. This is shown in the 'Your Turn' position. If you go first, your chosen number is fed to the circuit using the 'Number Chosen' push button. IC1 and IC3a make sure that you do not take more than three. Your chosen number is fed to IC2 where it is counted and displayed on a row of nine l.e.d.s, which are analogous to the matches. After your turn, or if the circuit went first S3 is moved to its other position. This disconnects the 'Number Chosen' push button and resets IC1 ready for your next turn. So that the circuit's chosen number is not displayed immediately a small delay of a couple of seconds is introduced by the charging of a 100µ capacitor feeding IC5a and b. After this delay, the number is displayed. The optimum number is programmed by a diode matrix on the outputs of IC2 and depends on your last turn. Imagine that you had had first turn and chose three. It is now the circuit's turn. IC7 is in its reset state and as the AND gates, IC4b, c, and d are connected to its '1', '2', and '3' outputs, their outputs will all be low and IC5d will have a high output. This enables IC6, a 1Hz clock via IC3c after the delay caused by the 100µ capacitor. Thus a 1Hz clock signal is fed to both IC2 and IC7. Now if you had chosen three last time, the optimum number for the circuit to choose is two and this is implemented by the diode on pin 7 of IC2 (i.e. the pin which is high at the time) which will make one of the inputs of IC4c high. When two clock signals have occurred and IC7 has counted two, the output of IC4c goes high, and disables the clock viá IC5d and IC3c. Thus the display has moved on two places and it is now your turn again.

As stated before, the winner is the one who lights the last l.e.d. and this is determined by IC3d, IC4a and IC5c. The appropriate win l.e.d. is then illuminated.

G. Durant,
Brayton, Selby.



CMOS ON/OFF TOUCH SWITCH

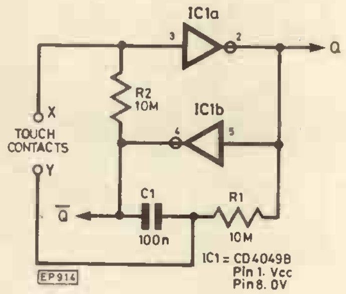


Fig. 1

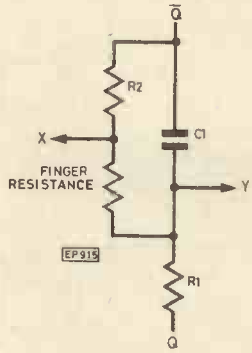


Fig. 2

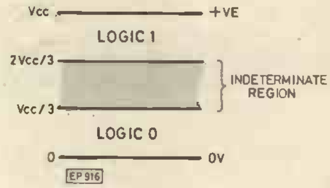


Fig. 3

THIS is yet another resistive touch switch but with some new features. The usual type is momentary action and requires a Schmitt trigger at the input for reliable operation. To get a latching on/off action a flip-flop is used, sometimes using one set of contacts for 'on' and another set for 'off'. This simple little circuit provides a latching on/off action using only one pair of contacts. It also gives complementary (Q and $\overline{Q}$) outputs (Fig. 1).

The two inverters are linked into a positive feedback loop via R2. On their own they form a bistable latch; once set in either logic state the positive feedback keeps the circuit in this state. The usual purpose of R2 is to allow a new logic level to be fed into IC1a, without short circuiting the output of IC1b. In this case it also prevents the rapid discharge of C1.

Before the contacts are touched, X is at $\overline{Q}$ and Y is at Q. When the contacts are bridged by a low resistance, X is forced to the new state Q (Fig. 2). This propagates very rapidly around the loop to reinforce itself. Working at a very much slower rate, the potential at X heads for its new steady state value. It should not be allowed to get too close to this value, however, because X will then enter the indeterminate region of the inverter input. (Fig. 3).

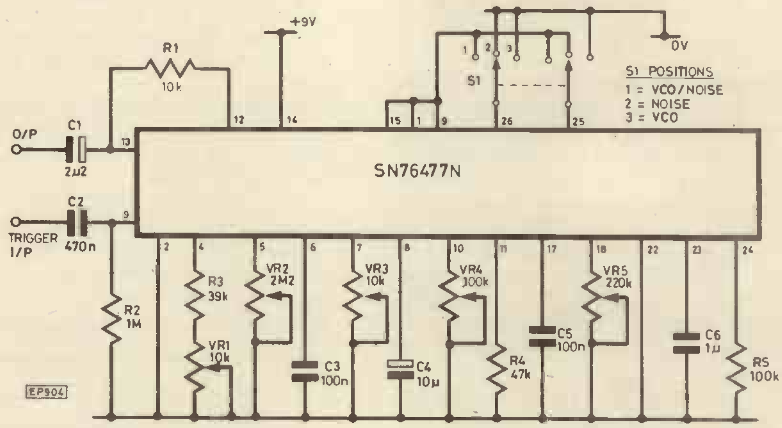
In the prototype unit the output changed from 0 to 1 then reverted to 0 if the contact was made for more than 1 second. To make sure that this does not happen the level on X must be kept within the guaranteed input levels shown in Fig. 3. This can be achieved by touching the contacts for less than 1 second, which is not at all difficult.

When the power is switched on the bistable can adopt either state. The state which is actually adopted depends on the circuitry connected to the Q and $\overline{Q}$ outputs. As a test, an l.e.d. in series with a resistor was connected from one of the outputs to ground. It was found that the bistable always came on in such a state that the l.e.d. was not lit.

The touch contacts used on the prototype were made from 14 s.w.g. silver plated copper wire. The exposed lengths were $\frac{1}{2}$in long and these were placed $\frac{1}{16}$ in apart in a piece of wood. None of this is critical though. The most important point to consider, as with any resistive touch switch, is the danger of getting an electric shock due to faulty components or wiring.

L. O. Green,
New Costessey,
Norwich.

PERCUSSION SYNTHESISER



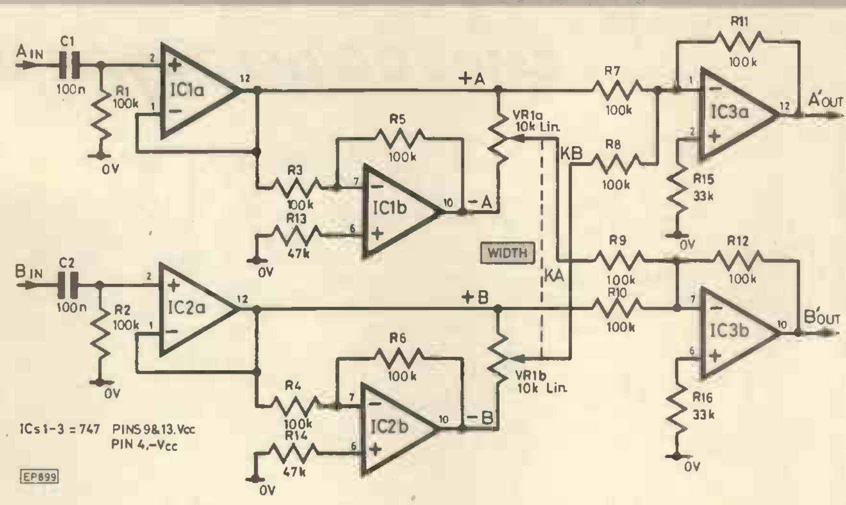
MANY rhythm generator i.c.s are limited in the amount of control over the actual instrument voices that they offer the operator. Shown is a percussion synthesiser designed to add special effects to such an i.c. The circuit is based around the popular SN76477N sound generator chip. All that this chip requires to function correctly are a few discrete components. The chip can be triggered directly from the rhythm generator chip itself via a suitable capacitor to provide a falling edge. The output from the i.c. is available at pin 13, via a 2µ2/6V capacitor.

S1 selects the mode of the internal mixer, and hence the audio source (i.e. VCO and/or Noise). VR1 sets the frequency of the internal noise clock and hence the overall tone colour of the signal. VR2 sets the upper cut off frequency of the noise filter. VR3 and VR4 set the attack and decay times of the envelope shaper, 0-100ms and 0-1000ms respectively, and VR5 sets the pitch of the VCO. With experience a wide range of complicated and interesting effects can be created (several units all working in VCO mode, set to different pitches and controlled by different outputs of a RG chip could produce some unusual sequences).

The unit can be powered from a single 9V battery.

R.A. Jagger,
Hambleton,
Yorkshire.

STEREO WIDTH CONTROL



THIS simple circuit was designed to allow the width of a stereo image to be adjusted, and as such is useful for headphones and systems with unduly large or small spacing between speakers.

A stereo channel signal is far more complex than is commonly appreciated and is not pure "left" and "right". The actual left channel signal has a percentage of the right channel added and vice versa at the recording stage. If we devote pure left and right by L and R, and the left channel by A, the right channel by B we can (with some simplification) write:

$$A = L + nR$$
$$B = R + nL$$

where n is the mixing proportion, determining the image width. If we produce the signals (A + KB) and (B + KA) where K is a variable gain whose sign (as well as gain) can be changed, the proportion of L and R in each channel can be increased or decreased. In this way the stereo width can also be increased or decreased.

This is achieved by the circuit shown where the necessary arithmetic is performed by three dual op. amps. A and B denote the two channels, which are buffered by IC1a and IC2a. IC1b and IC2b invert the signals to give −A and −B.

The ganged potentiometer VR1 is connected between +A and −A, +B and −B. In the centre position there will be no signal, but as the slider is moved towards either end, a signal of either polarity can be obtained. The sliders thus give KA and KB where the sign and value of K is determined by the potentiometer position.

The signals KB and KA are added to A and B respectively by the simple summing amplifiers IC3a and b to give the required adjusted output.

The circuit works on a dual supply in the range ±5 volts to ±15 volts, best provided by an i.c. regulator. It could be made to work with a single split rail supply, but care would have to be taken to prevent crosstalk.

With VR1 in the centre position the stereo signal is unaffected by the circuit. Moving VR1 to one side or the other will reduce or increase the stereo image. At the limits a monophonic signal results, or the stereo signal will fall apart into two separate sounds. The optimum setting will depend on the listener's preference.

E. A. Parr,
Carluke, Lanarkshire.

INSTANT DIODE TESTER

THIS is an add-on feature, for mains powered test equipment, which gives an instant indication of the condition of the diode under test and identifies its anode. It is so simple to make that it could easily be added to a workshop power supply, for instance.

The operation of the circuit is very simple. If the diode under test is working correctly then an l.e.d. will indicate the anode. Otherwise, neither or both l.e.d.s will light, showing which type of fault is present.

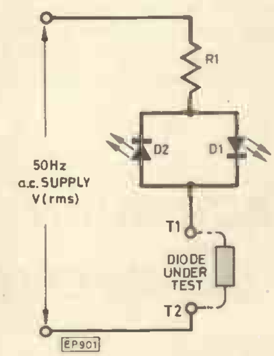
The l.e.d.s protect each other by limiting the reverse voltages to 2V. Consequently, if one is wired in reverse or fails then the other could be destroyed. Although a diode could be put in series with each l.e.d. for protection, this was not considered to be worthwhile.

It is quite safe to connect this unit directly across a transformer that is being used for other purposes, e.g. a stabilised power supply.

The calculation of R1 for various supply voltages and l.e.d. currents is an interesting use of integral calculus but a table of values has been given for convenience. Note that the power rating of R1 has been based on the worst case condition of a continuous short circuit across the test terminals. To calculate the worst power dissipation in R1, the rough approximation that

$V\sqrt{2}\sin wt - 2 = (V\sqrt{2} - 2)\sin wt$ has been used. Thus the r.m.s. voltage across R1 is $(V - \sqrt{2})$ and the power dissipation is $\frac{(V - \sqrt{2})^2}{R1}$ watts.

Note that the l.e.d. currents are mean values because l.e.d.s are constant voltage devices and the instantaneous power dissipation is therefore proportional to the instantaneous current. Consequently, the power dissipation in R1 cannot be found from I^2R, using the l.e.d. supply current for I.



L. Green,
New Costessey,
Norwich.

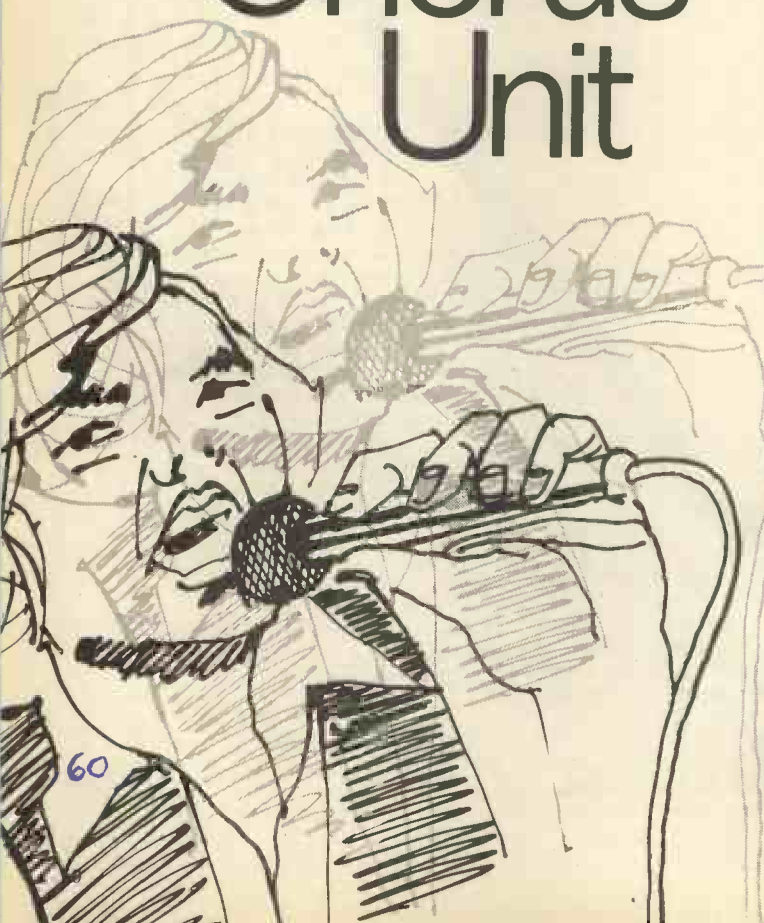
A.C. Supply Voltage (RMS)	R1 (Ohms) For various l.e.d. currents		
	10mA	15mA	20mA
6	120, $\frac{1}{4}$W	82, $\frac{1}{4}$W	56, $\frac{1}{2}$W
9	240, $\frac{1}{4}$W	160, $\frac{1}{2}$W	120, $\frac{1}{2}$W
12	390, $\frac{1}{2}$W	240, $\frac{1}{2}$W	180, 1W
15	510, $\frac{1}{2}$W	330, 1W	270, 1W
20	750, $\frac{1}{2}$W	470, 1W	360, 1W
25	910, 1W	620, 1W	470, 2W
30	1100, 1W	750, 2W	560, 2W

THE mini chorus effect is one that receives a great deal of use these days, and it is probably used most by vocalists although it is also perfectly suitable for use with electronic instruments. The effect is basically very simple, and is produced by mixing a delayed signal with an undelayed signal, and the length of the delay is usually varied at a low frequency. Apart from varying the degree to which the two signals are out of synchronisation, this varying of the delay also gives a degree of vibrato to the delayed signal. The resultant audio output gives the impression that there are two instruments or vocalists singing or playing in unison, and this normally gives a much richer and more interesting sound. This effect should not be confused with the more complex chorus effect which uses more than one delay circuit and gives the impression of many vocalists or instruments using a single source.

BLOCK DIAGRAM

The block diagram Fig. 1 shows the various stages of which the Mini Chorus unit is comprised. The delay line is of the usual charge coupled (bucket brigade) type, and this provides a delay that is governed by the frequency of a two phase clock oscillator. A delay of 10ms or more is needed in order to give the desired double output effect, and in practice a delay which is varied from about 10ms to 20ms or so is perfectly satisfactory. A low frequency sweep oscillator is used to frequency modulate the clock oscillator and give the required variation in the delay time.

Mini Chorus Unit



60

The delay required in this application can be obtained using a 512 stage delay line, but as the delay time is equal to the number of delaying stages divided by twice the clock frequency (in Hertz), this would give a clock frequency range of approximately 12 to 25kHz. This would give a rather restricted bandwidth since the maximum input frequency should be no more than half the clock frequency, and should preferably be no more than a third of the clock frequency. In order to obtain reasonable output quality this would give a maximum bandwidth of only about 4kHz. Filters are used at the input and output of the delay line to remove input signals at frequencies above the acceptable maximum input frequency, and to remove the clock signal (which effectively modulates the output signal) at the output. With a minimum clock frequency of about 12kHz both filters would need to have a very high level of performance in order to give satisfactory results.

It was therefore decided to use a 1024 stage delay line which is admittedly a little more expensive than a 512 stage type, but gives a more respectable bandwidth of about 8kHz, and with a clock frequency range of about 24 to 50kHz puts less stringent requirements on the input and output filters.

CIRCUIT

Fig. 2 shows the circuit diagram of the filter, delay line, and mixer stages of the unit.

The input filter is an active type which is based on TR1 and has a nominal roll-off rate of 12dB per octave and a cut-off frequency of approximately 9kHz. The output filter is essentially the same, but the emitter follower transistor is a *pnp* type instead of an *npn* device, and it is biased from the output of the delay line rather than from a potential divider.

The delay line integrated circuit is an SAD1024A which actually contains two 512 stage delay lines which are independent apart from common supply pins. R8 and R9 are used to bias the input of the first section of IC1 and C4 couples the output from TR1 to the input of this section. One output of the first delay line section (pin 11) is connected to the positive supply rail in accordance with the i.c. manufacturers' recommendations, and the other output (pin 12) is coupled to the input of the second section of IC1 by R10 and C5. C5 is needed as there is a small but significant d.c. shift through each delay line, and the second section of IC1 is biased by R6 and R7. R10 provides a small amount of attenuation that counteracts the small voltage gain through the delay line.

VR1 forms a simple mixer circuit which combines the outputs of the last two stages of IC1, and this component is adjusted to produce maximum cancelling of the clock signal. C6 provides a certain amount of filtering at the output in addition to that produced by the main filter circuit.

The mixer stage is a conventional operational amplifier summing mode circuit which utilises IC2. C12 rolls off the high frequency response of the mixer stage slightly and gives a small amount of additional output filtering. The effect can be switched out by opening S2 to cut the delayed signal to the mixer.

OSCILLATORS

Fig. 3 shows the circuit diagram of the sweep and clock oscillators, together with the supply and regulator circuitry.

The clock oscillator uses the four two input NOR gates of a 4001 CMOS device, and all four gates have their two inputs connected together so that they act as four inverters.

R.A.Penfold

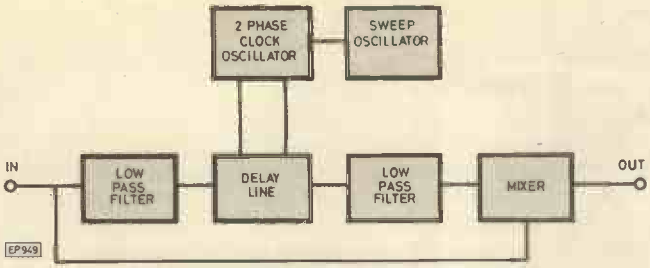


Fig. 1. Block diagram of Mini Chorus Unit

IC4a and IC4b are used in a conventional CMOS astable circuit, and IC4c is used as a buffer stage at the output of the oscillator. IC4d is used as an inverter which gives an output signal which is complementary to that at the output of IC4c, and thus gives the required two phase clock signal.

The frequency of this type of astable can be varied by applying a control voltage to the input of the first inverter via a series resistor (R24). TR3 is used as a buffer stage between the sweep and clock oscillators and is needed in order to present a suitably high load impedance to the sweep oscillator.

The sweep oscillator uses operational amplifier IC3 in a well known configuration, and this oscillator operates by charging and discharging C14 through VR2, R22, and the output stage of IC3. C14 charges and discharges exponentially and a non-linear triangular waveform is therefore produced across C14, and this signal is used to sweep the clock oscillator up and down in frequency. VR2 gives an adjustable frequency range of approximately 0·1Hz to nearly 10Hz.

The circuit requires a reasonably stable 15 volt supply, and this is derived from two 9 volt batteries in series using a simple series regulator circuit which consists of TR4, R26, D1, D2, and C17. This uses a well known configuration with the Zener stabiliser formed by R26, D1, and D2 being used to drive emitter follower transistor TR4. D2 is used to boost the input voltage to TR4 by about 0·65 volts to compensate for the voltage drop of approximately the same amount between the base and emitter of TR4.

The current consumption of the circuit is about 11ma and this gives a reasonable battery life using PP3s or equivalents, but if the unit is likely to receive a great deal of use it would probably be more economic to use larger batteries or rechargeable nickel-cadmium types.

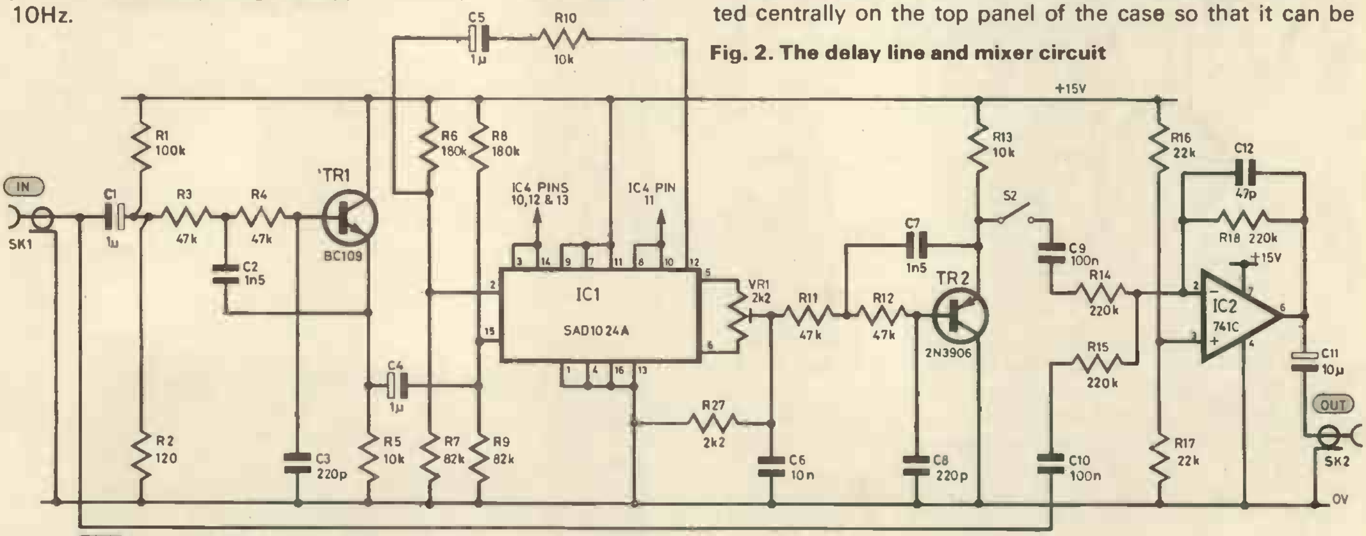
CONSTRUCTION

The printed circuit board design is shown in Fig. 4 and the wiring of the unit is illustrated in Fig. 5.

IC1 and IC4 are both MOS devices, and while the 4001 integrated circuit costs only a few pence, the SAD1024A is quite expensive and should be treated with respect. Use a socket for this component and do not fit it into place until the printed circuit board is in other respects complete. Leave it in its protective packaging until it is to be plugged into circuit, and try to avoid touching the pins.

All the components, including PP3 size batteries, can be fitted into a diecast aluminium box having approximate outside dimensions of 150 by 80 by 50mm. A diecast aluminium box is ideal for this application as it is both very strong and has excellent screening properties. S2 is mounted centrally on the top panel of the case so that it can be

Fig. 2. The delay line and mixer circuit



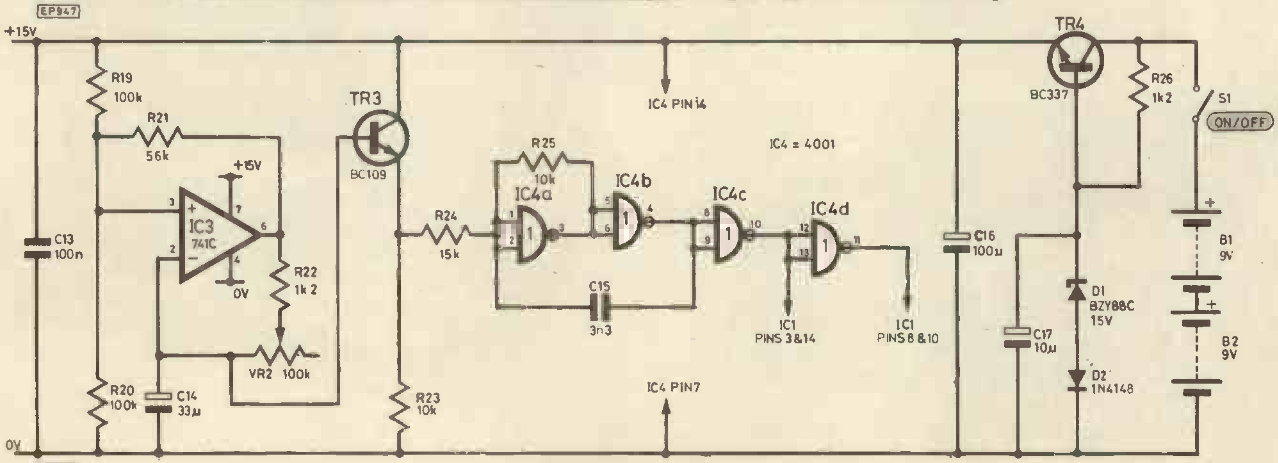


Fig. 3. The oscillator and regulator sections

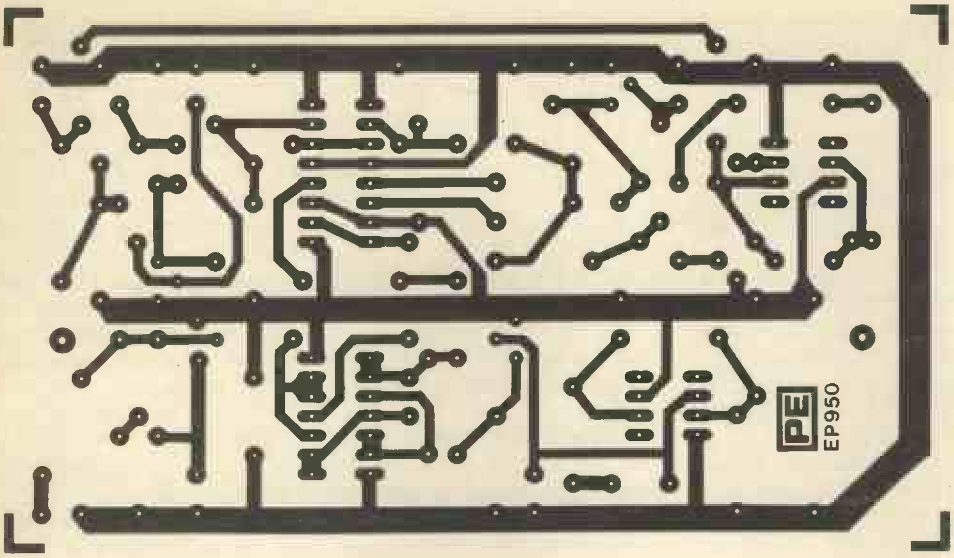


Fig. 4. Printed circuit

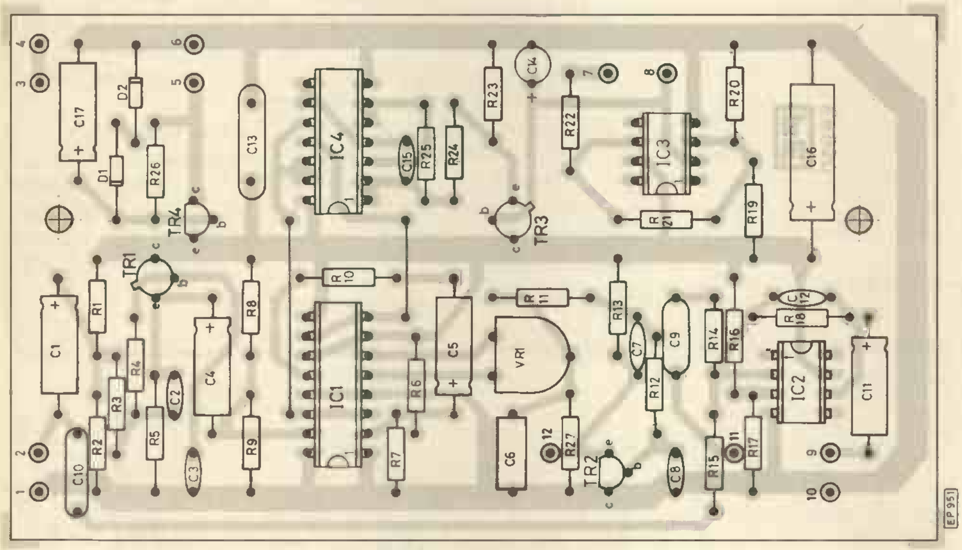
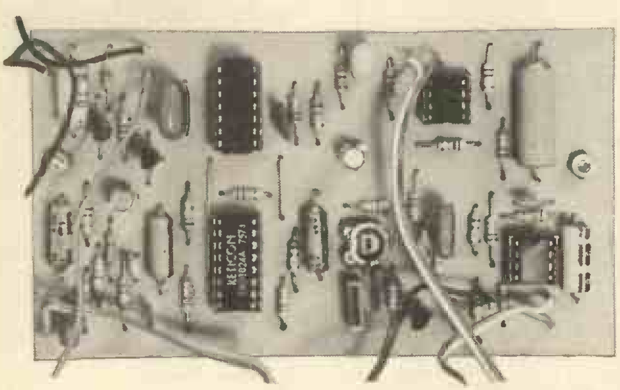


Fig. 5. Board assembly

operated by foot. SK1, SK2, and VR2 are mounted along one of the 150 by 50mm sides and must be offset slightly towards the top so that sufficient room is left for the printed circuit board. The latter is mounted on the removable base panel of the case. S2 is a pair of make contacts on the input socket SK1, so that the unit is automatically switched on and off when the input is connected to and disconnected from SK1 (which is standard practice with effects units). A separate on/off switch can obviously be employed if preferred.



COMPONENTS

Resistors

R1,19,20	100k	(3 off)
R2	120k	
R3,4,11,12	47k	(4 off)
R5,10,13,23,25	10k	(5 off)
R6,8	180k	(2 off)
R7,9	82k	(2 off)
R14,15,18	220k	(3 off)
R16,17	22k	(2 off)
R21	56k	
R22,26	1k2	(2 off)
R24	15k	
R27	2k2	

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

Capacitors

C1,4,5	1µ 63V elect (3 off)
C2,7	1n5 ceramic 10% (2 off)
C3,8	220p ceramic 10% (2 off)
C6	10n carbonate
C9,10,13	100n polyester
C11,17	10µ 25V elect (2 off)
C12	47p ceramic 10%
C14	33µ tantalum
C15	3n3 ceramic 10%
C16	100µ 25V elect

Semiconductors

D1	BZY88C15V (15V 400mW Zener)	
D2	1N4148	
IC1	SAD1024A	
IC2,3	741C	(2 off)
IC4	4001	
TR1,3	BC109	(2 off)
TR2	2N3906	
TR4	BC337	

Potentiometers

VR1	2k2 0·1W horizontal preset
VR2	100k linear carbon

Miscellaneous

SK1/S1 Standard jack with DPDT contacts (Maplin)
SK2 Standard jack
S2 Heavy duty push-to-make, push-to-break type
B1, 2 PP3 size 9 volt (2 off)
Battery connectors
Control knob
Printed circuit board
One 16 pin DIL, one 14 pin DIL, and two 8 pin DIL i.c. sockets
Veropins
6BA fixings
Diecast aluminium box about 150 x 80 x 50mm
Wire, solder, etc.

It is advisable to fix four cabinet feet to the base of the unit so that it does not tend to slip away when S2 is operated.

ADJUSTMENT

Only one preset needs to be adjusted before the unit is ready for use, and this is VR1. If an oscilloscope or a.c.

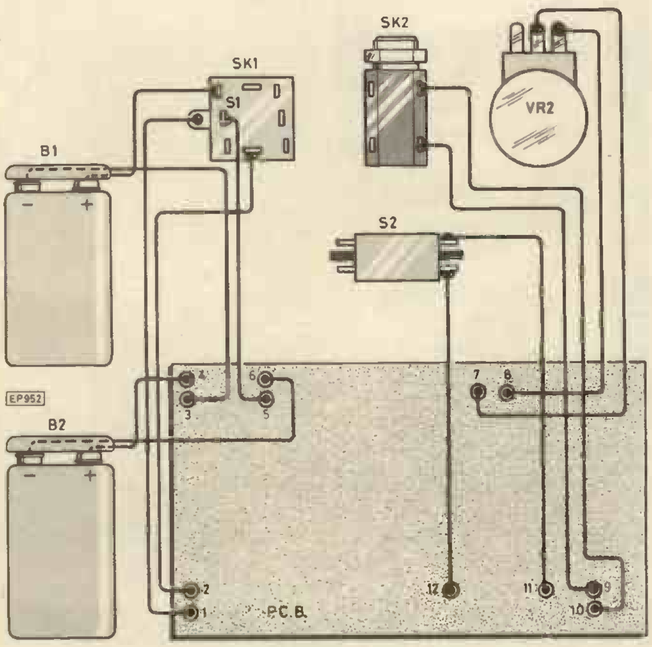


Fig. 6. External component connections to board

The completed unit

millivoltmeter is available, this can be used to monitor the signal at the wiper terminal of VR1 while this component is adjusted for minimum signal level. There should be no input signal present when making this adjustment. A simple alternative which does not require any test equipment is to add a capacitor of around 47nF in parallel with C15 so that the clock oscillator operates at an audible frequency. VR1 is then adjusted for minimum output of the clock tone.

INPUT LEVEL

The output noise level of the unit is well below 1mV r.m.s., and provided an input signal level of at least a few hundred millivolts r.m.s. is used a signal to noise ratio of about 60dB or more will be obtained. An input level of up to about 1 volt r.m.s. can be handled by the circuit without serious distortion occurring. ★

SPECIAL OFFER!

QUASAR CASSETTE DECK

£31 INCLUDING V.A.T. & CASE PLUS £2·75 P and P

In April 1982 PE, in conjunction with RT-VC, published the *PE Quasar Stereo Cassette Deck* design. The design provides some outstanding features, including variable recording bias and a gate noise reduction system. As a result of this successful design we are now pleased to be able to offer kits to PE readers at this exclusive price. The kits, including a wrap round simulated wood finish case, will be accompanied with a reprint of the PE articles which fully describe the unit and its construction.

The offer is for a limited period only and a coupon should be sent to the address shown (mail order only), callers (with a coupon) can collect kits from RT-VC at 323 Edgeware Road, London W.2. Tel: 01-723 8432. The specification of the made-up unit is given below:

SPECIFICATION

Mechanism with automatic stop and tape counter with reset button.
Tape Speed: 4·76cm/sec. ($1\frac{7}{8}$in/sec.).
Wow & Flutter: Typically 0·1%.
Drive Motor: 12V d.c. with electrical governor.
Play Torque: 40–75g/cm (DYNAMIC).
Rewind & Fast Forward Torque: 60–140g/cm (STATIC).
Rewind & Forward Time: Less than 100 sec. for C60 tapes.
Bias/Erase Oscillator: Externally variable, frequency 90–100kHz.
Output: (Adjustable) Up to 1 volt r.m.s.
Mic. Sensitivity: 1mV @ 47k.
DIN Sensitivity: 30mV @ 47k.
Frequency Response; 30Hz–12·5kHz (−3dB).
Signal to Noise Ratio.
Noise reduction OFF −50dB
Noise reduction H.F. −56dB
Noise reduction FLAT −70dB
Cross Talk: Typically −50dB.

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One deck kit costs £31 plus £2·75 p&p (£33·75)

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COMBO AMPLIFIER

PART THREE

Fred Judd
E.A. Rule

THE remaining item to complete the Combo-Amplifier is, of course, a suitable cabinet which can either be purchased ready made, providing dimensions are suitable, or constructed on the lines described. Whichever is adopted the speaker enclosure capacity must be not less than, or not very much more than 2 cubic feet, otherwise the overall frequency response will be impaired. It is also essential, for the same reason, to use the speakers and crossover network specified.

THE CABINET

The diagrams of Fig. 1 are given as a guide to the construction of a suitable cabinet made from half-inch thick ordinary chipboard. All panels must be reinforced with battens of three quarter inch square or similar, preferably both glued *and* screwed. The rear speaker panel must be very close fitting to ensure no passage of air outward from the speaker enclosure. A soft non-setting sealing compound is recommended as well as screws every few inches all round. Use a speaker front panel covering of approved material such as Tygan or Type D5 material from *Falcon Acoustics*. The crossover unit may be fixed (securely) inside the speaker enclosure.

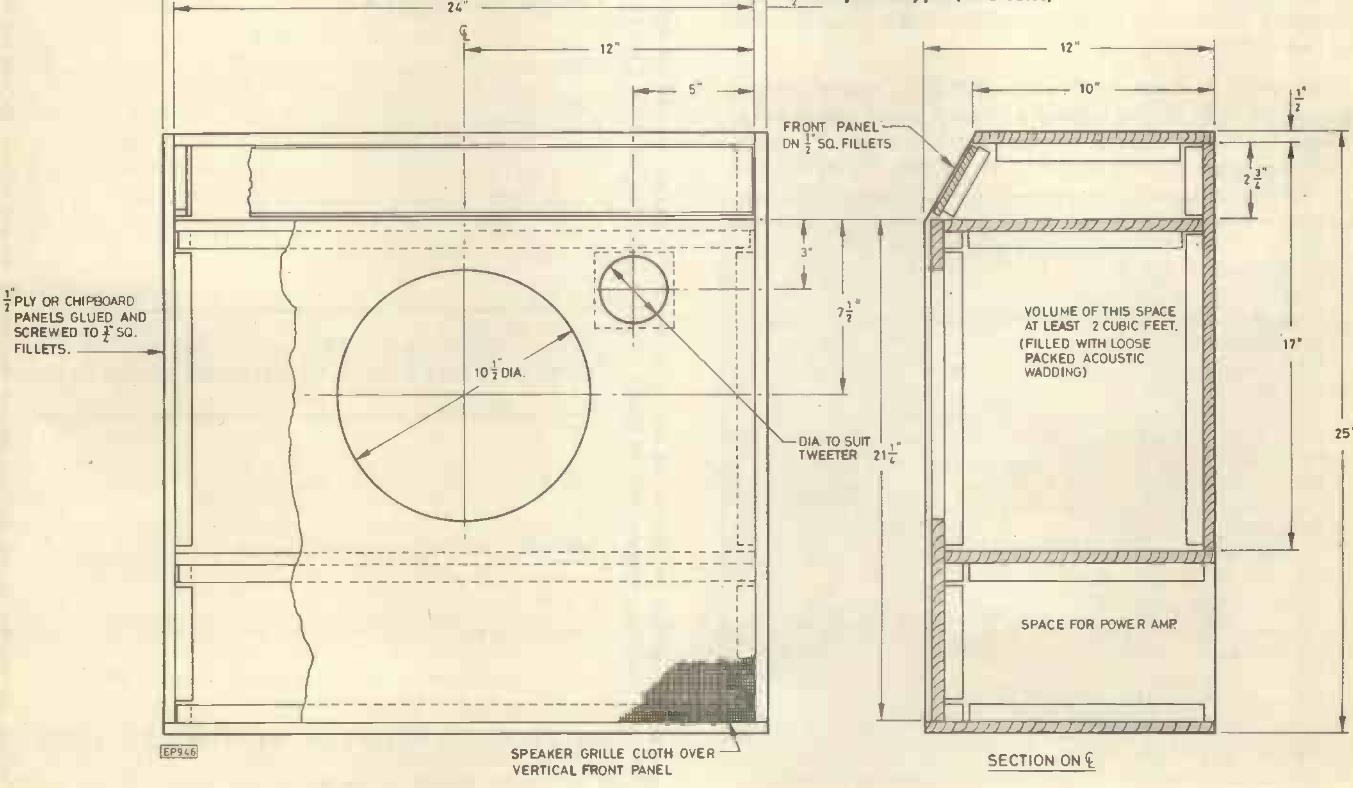
The power amplifier is housed in the lower compartment beneath the speaker enclosure and, apart from secure fixing, calls for no other special requirements, except possibly, that a punched hardboard panel (pegboard) could be used to enclose this section for protection. Some air circulation is necessary.

Finishing and covering the completed cabinet should be done before the units are fitted, and choice of covering is left to the constructor. There are plenty of strong glue-on or self-adhesive vynal and/or imitation leatherette coverings and trim material available from DIY retailers. Handles for carrying, one each side, are recommended if the Combo-amp is to be transported around. By the way, many DIY suppliers will cut chipboard panels to size, including cutting out the circular areas for the speakers. The chipboard, including cutting etc. should not cost more than £12 to £15.

SPEAKER CONNECTIONS

Speaker connections, and the connections to the Falcon Acoustic type crossover network, are shown in Fig. 3. As already mentioned it is essential to use the specified

Fig. 1. Details of the cabinet used in the prototype (see text)



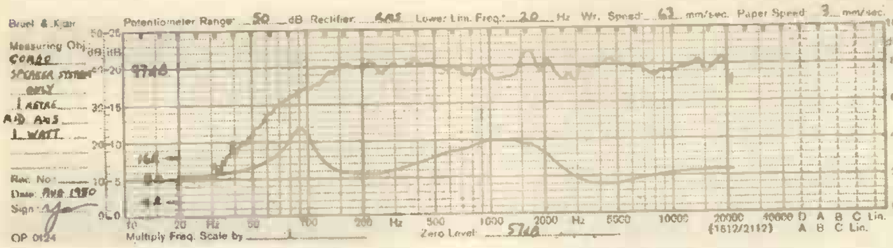


Fig. 2. Graph of speaker performance using B & K plotter

Your attention is drawn to Points Arising, on page 20 of this issue.

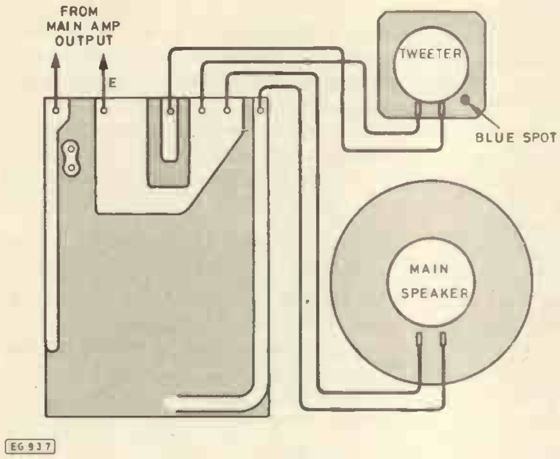


Fig. 3. Connections to the specified crossover unit

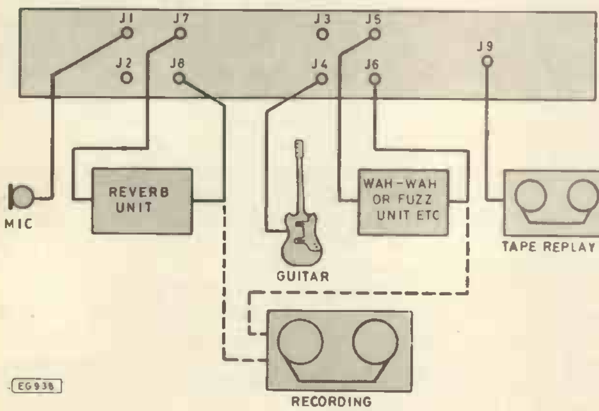
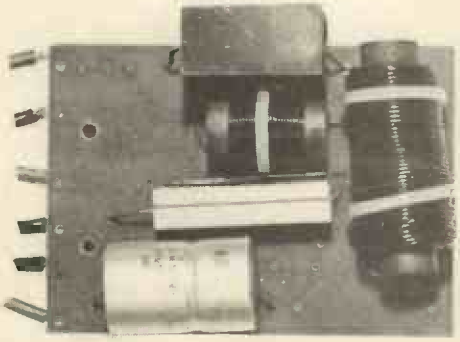


Fig. 4. Typical arrangement of connections to and from external equipment



speakers and crossover network to obtain the overall frequency and impedance response as per the B & K readout given in Fig. 2. This is the response taken from the prototype Combo-amplifier speaker system described in this article and as shown in the photographs. Use thick multi-strand cables for connections between the amplifier output and the crossover networks and speakers, otherwise power will be lost.

When the speakers and crossover network have been fitted and wired, the enclosure is filled with loosely packed acoustic wadding, the amount required being as per the components list.

Note: The power amplifier is capable of driving two of these speaker systems in parallel to a maximum audio power of 100 watts. Connection between the output of the preamplifier to the input of the power amplifier must of course be screened, i.e., a single screened cable must be used.

APPLICATIONS OF THE COMBO-AMPLIFIER

The input/output facilities on the preamplifier can be used in a number of ways, and some are shown in Fig. 4. Here, a microphone is used on one channel, together with an external reverb. unit coupled back into the amplifier via the accessory socket of that channel. The remaining channel takes in an electric guitar and an external wah or fuzz unit. Signals picked up from these channels can, as shown, be fed to a tape recorder. Tape replay can be made via the auxiliary amplifier socket (J9). Sockets J8 or J6 can also be used as individual inputs. For disc record replay a suitable RIAA response corrected preamplifier is necessary (assuming the usual magnetic pickup), the output from this being connected to the amplifier via J6, J8 or J9 depending on the output signal level from the pickup preamp.

COMPONENTS . . .

Bass loudspeaker 12" (Falcon type TL80P)
Tweeter unit (Falcon type KSN6001A)
Crossover network (Falcon type R40)
Acoustic wadding (1½yds. x 24in. wide, 1in. thick)
Speaker front material, woodscrews and glue etc.

Constructor's Note

Falcon Acoustics, Tabor House, Norwich Road, Mulbarton, Nr. Norwich.

There is no reason why the circuitry should not be adapted for disco work for example, by duplication for stereo and using two speaker systems on each amplifier thus giving a combined "stereo" output in the region of 200 watts. ★

Space Watch...

FOURTH MISSION OF COLUMBIA

One of the first tasks of Columbia's fourth mission was to test out the mechanical arm which was only partially deployed on the third mission. A very full day was spent on the 29th of June when the Canadian built robot arm with its shoulder, elbow and wrist jointed sections controlled by motors, lifted from the cargo bay the 363 kilogram Contamination Monitor. This unit, about the size of an executive desk, with the title of Induced Environment Contamination Monitor (IECM) was moved to various planned positions outside the Orbiter. The object was to discover whether the spacecraft emits dust or pollutants that might affect the equipment or the operational performance. During a first survey the sensors were used to sample areas in the cargo bay itself. Possible dangers are dust or pollutant sources from the materials within the spacecraft and well as gases from reaction jets used to change attitudes and speed.

During a second survey the thrusters were deliberately operated in order to discover whether the exhaust gases or plumes might affect satellites in future rendezvous in space. One minor difficulty arose in a circuit affecting the grappling device but the condition was overcome by a new control procedure.

The successful repeat tests were important for considerable future activities are planned, such as the lifting of spacecraft from their orbits and bringing them into the cargo bay for service. Some details of this procedure have already been described in an earlier *Spacewatch*. There must be a sense of relief for the designers because this particular piece of equipment cost more than 100 million dollars.

The Electrophoresis unit was started up. The salt water solution of human cells was subjected to the electric field and the results of weightlessness allowed the free separation that the basic theory called for. Several runs were made and the process declared satisfactory. This means that the detailed processes, as given in August *Spacewatch*, will now be a feature of the next four missions.

The "Getaway Special" however was not so successful. The first attempts to activate the package failed. At first it was decided that there would not be any point in continuing efforts to start since it was possible that the algae, Duckweed and fruit flies were not likely to survive the space conditions. However the fault was found to be a broken connection from the switch panel of the spacecraft. This was by-passed and the package activated. The experiments in the Getaway Special were set up by the students from UTAH University. There were nine experimenta and among them were the Algae and Duckweed growth project. This was designed to check the effect of weightlessness on the growth of the plants and also the effects due to changing conditions right down to the touchdown period. The effects of space were also to be examined as to the genetic growth of the fruit fly. The same study was set up for the brine shrimp.

Other activities of the crew involved the use of the television camera to observe storms in action over South America and obtain data regarding lightning effects and other cloud data. The lightning survey is important for there is much need to know more of its effects. For one thing it will help to throw some light on the birth of storms and the evolution of the energy which makes them so freakish.

The television camera was also used to transmit to Earth pictures of the Gulf Coast and Florida. Pictures were also transmitted of the flight deck and mid-decks of the Shuttle itself. The crew were excited about their own view of the Earth. Thomas Mattingly said "You can look out on the horizon and see the Earth's rim and at the same time a lot of the light cloud patterns." As the Orbiter flew over Florida, most of the peninsular was clearly visible including Cape Canaveral. It was possible to see the Orbiter's 4,500 metre runway. "That is a familiar sight," said Mattingly. The camera was also turned to take pictures of the 2 metre high Electrophoresis Unit.

Some critical tests were made on the performance of the hull of Columbia. The underside was exposed to a temperature of 93 degrees C. The doors remained in the shade and their temperature fell to minus 93 degrees C. One of the doors could not be latched due to these extremes of temperature and consequent distortion. The effects of these wide ranging differences of temperature, from the Sun side to the dark side, are reduced by "rolling". That is the spacecraft presents all its surface to the Sun in a planned sequence. In the case of this particular vehicle there was an important reason for the long period of exposure to the extreme heat.

While Columbia was on the launch pad a severe thunderstorm with torrential rain caused the protective heat shield tiles to absorb a great deal of water. If the water remained in the tiles it would freeze in the deep cold of space but on the re-entry mode would turn to steam causing tiles to crack and even fall off. While this is not necessarily a fatal hazard it could cause a measure of overheating of the spacecraft in exposed places. It is not a risk that should be taken. The "rolling" manouvre will be continued in order to keep a stable temperature over all surfaces. This mission, the fourth of the series, brings the Shuttle plan to the point of going commercial. The first of the new generation of shuttle orbiters begins with the Challenger which will be launched in full mode in January 1983.

GETAWAY SPECIALS

Before leaving the first chapter of "Shuttles Progress' there are some points worth mentioning relating to the spirit of progress: Gilbert Moore is an executive of Utah Aerospace with the old pioneer spirit and the will to take a chance. He spent 10,000 dollars *six years ago* for a "Getaway Special" package. He donated it to Utah State University to be used in a programme of student developed experiments. So confident was he in the worth of this package that he has already pledged another 40,000 dollars for four more such packages. Already he has enthusiastically declared his faith in the value of the experiments but also the importance of developing equipment for future space experiments.

More than 350 similar payloads have been booked for the future and the applicants range from school children to the major corporations. One example is that of a city high school that is hoping to fly an ant colony in space. A Japanese newspaper is hoping to make a snow-making experiment under near-zero gravity conditions of space to investigate the formation of ice crystals.

The green algae experiment calls to mind the work done by the Russian experimental space centre some years ago and detailed in an earlier *Spacewatch*. The experiment was directed to the production of oxygen by subjecting the algae to ultra-violet light. The result on earth was a great success so much so that there was a bonus of oxygen. This was part of a study for the long time manned space exploration where special growth of certain plants and primitive cell growth was used in a two month stay in a capsule for a cosmonaut. It was later extended to much longer periods successfully enough to prove the possibility of new life support.

It is surely inevitable man will not be confined to instrumental exploration, sophisticated though it is. Simulation of reality is of great value in search of a preliminary understanding, but knowing in real time is real knowing.

It is perhaps fitting that this report should end with Gilbert Moore's own words,

> "Another group of students have put up experiments to determine whether better metals, alloys and composite graphite materials can be made in space. One student is melting and solidifying smooth metallic surfaces for the possible future manufacture of telescopes in space. Another of the alloy experiments is to make alloy of two metals which cannot be combined on Earth. These are a powdered mixture of bismuth and tin . . . but the real significance of the "Getaway Special" is that it represents unfettered science, the opportunity for young individuals to try out new ideas."

Frank W. Hyde

MICRO PROMPT

The hardware and software exchange point for PE computer projects

TEXT STRING SEARCH

Sir—This editing program fits neatly into the "free" RAM between Ø222 and Ø2FA and EØ to E6, and operates as follows: The text string to be located in the program list is entered in the normal way as a BASIC statement with the line number Ø. To avoid the interpreter being confused by a meaningless BASIC line, it is necessary to enter the line thus:

Ø LIST *string*

Where string is a text string of any length.

If a Warm Start is now executed, all the program lines containing the desired text will be listed on the VDU. Should there be too many to fit on the screen at one time, holding down space bar will temporarily stop the listing.

At the end of the listing, the machine is again ready for normal BASIC operations or another Ø LIST command. If a line number Ø does not exist then the Warm Start operates in the normal way.

When entering BASIC words (eg. IF, GOSUB, THEN etc.) into the zero line, they must be entered in full. For example Ø LISTGOTO5 will work but Ø LISTGO will not. This is because BASIC words are stored in a single codeword. The program then compares these codewords looking for a match. For the same reason any BASIC words or symbols used in the program between quotes must be specified within quotes in the Ø LIST line too. Non BASIC words and characters do not need to be specified in full however.

The machine code program is loaded into RAM by executing the BASIC program below. The USR function is used to jump to the initialisation point Ø222.

P. Becket,
Blackpool.

```
Ø222 LDA #S22
Ø224 STA SØ1
Ø226 LDA #SØ2
Ø228 STA SØ2
Ø22A LDA SØ3Ø3
Ø22D BNE SØ234
Ø22F LDA SØ3Ø4
Ø232 BEQ SØ23A
Ø234 JSR SA86C
Ø237 JMP SA274
Ø23A JSR SA86C
Ø23D LDY #SØØ
Ø23F LDA #SØ6
Ø241 STA SEØ
Ø243 LDA #SØ3
Ø245 STA SE1
Ø247 LDA (SEØ),Y
Ø249 BEQ SØ251
Ø24B JSR SØ2B6
Ø24E JMP SØ247
Ø251 LDA (SEØ),Y
Ø253 BEQ SØ28D
Ø255 LDA #SØ6
Ø257 STA SE2
Ø259 LDA #SØ3
Ø25B STA SE3
Ø25D LDA SEØ
Ø25F STA SE4
Ø261 LDA SE1
Ø263 STA SE5
Ø265 LDA (SE2),Y
Ø267 BNE SØ26C
Ø269 JMP SØ2C2
Ø26C STA SE6
Ø26E LDA (SE4),Y
Ø27Ø CMP SE6
Ø272 BNE SØ2A5
Ø274 CLC
Ø275 LDA SE2
Ø277 ADC #SØ1
Ø279 STA SE2
Ø27B BCC SØ27F
Ø27D INC SE3
Ø27F CLC
Ø28Ø LDA SE4
Ø282 ADC #SØ1
Ø284 STA SE4
Ø286 BCC SØ28A
Ø288 INC SE5
Ø28A JMP SØ265
Ø28D JSR SØ2B6
Ø29Ø LDA (SEØ),Y
Ø292 BEQ SØ2E8
Ø294 JSR SØ?B6
Ø297 JSR SØ2Ə6
Ø29A LDA (SEØ),Y
Ø29C STA $11
Ø29E JSR SØ2B6
Ø2A1 LDA (SEØ),Y
Ø2A3 STA $12
Ø2A5 JSR SØ2B6
Ø2A8 JMP SØ251
Ø2AB LDA #SØØ
Ø2AD STA $11
Ø2AF STA $12
Ø2B1 STA $13
Ø2B3 JMP SA29B
Ø2B6 CLC
Ø2B7 LDA SEØ
Ø2B9 ADC #SØ1
Ø2BB STA SEØ
Ø2BD BCC SØ2C1
Ø2BF INC SE1
Ø2C1 RTS
Ø2C2 LDA #SCD
Ø2C4 STA SØ4
Ø2C6 LDA #SØ2
Ø2C8 STA SØ5
Ø2CA JMP SA4CØ
Ø2CD LDY #SØØ
Ø2CF LDA #SC3
Ø2D1 STA SØ4
Ø2D3 LDA #SA9
Ø2D5 STA SØ5
Ø2D7 PLA
Ø2D8 PLA
Ø2D9 LDA #SFD
Ø2DB STA SDFØØ
Ø2DE LDA SDFØØ
Ø2E1 CMP #SFF
Ø2E3 BNE SØ2D9
Ø2E5 JMP SØ247
Ø2E8 JSR SØ2B6
Ø2EB LDA (SEØ),Y
Ø2ED BNE SØ2F2
Ø2EF JMP SØ2AB
Ø2F2 JMP SØ297
```

```
5    REM  ZEROLIST ** P.BECKETT ** JUL 8Ø
1Ø   DATA 169,34,133,1,169,2,133,2,173,3,3,2Ø8,5
2Ø   DATA 173,4,3,24Ø,6,32,1Ø8,168,76,116,162,32
3Ø   DATA 1Ø8,168,16Ø,Ø,169,6,133,224,169,3,133
4Ø   DATA 225,177,224,24Ø,6,32,182,2,76,71,2,177
5Ø   DATA 224,24Ø,56,169,6,133,226,169,3,133,227
6Ø   DATA 165,224,133,228,165.225,133,229,177,226
7Ø   DATA 2Ø8,3,76,194,2,133,23Ø,177,228,197,23Ø
8Ø   DATA 2Ø6,49,24,165,226,1Ø5,1,133,226,144,2
9Ø   DATA 23Ø,227,24,165,228,1Ø5,1,133,228,144
1ØØ  DATA 2,23Ø,229,76,1Ø1,2,32,182,2,177,224
11Ø  DATA 24Ø,84,32,182,2,32,182,2,177,224,133
12Ø  DATA 17,32,182,2,177,224,133,18,32,182,2
13Ø  DATA 76,81,2,169,Ø,133.17,133,18,133,19,76
14Ø  DATA 155,162,24,165,224,1Ø5,1,133,224,144
15Ø  DATA 2,23Ø,225,96,169,2Ø5,133,4,169,2,133
16Ø  DATA 5,76,192,164,16Ø.Ø,169,195.133,4,169
17Ø  DATA 168,133,5,1Ø4,1Ø4,169,253,141,Ø,223
18Ø  DATA 173,Ø.223,2Ø1,255,2Ø8,244.76,71,2,32
19Ø  DATA 182,2,177,224,2Ø8,3,76,171,2,76,151,2
2ØØ  FOR I = 546 TO 756
21Ø  READ X : POKE I,X
22Ø  NEXT
23Ø  POKE 11,34 : POKE 12,2 : X=USR(X)
```

Comments for Disassembled Listing

Ø222–Ø228	Change warm start vector to Ø22
Ø22A–Ø232	If line Ø exists go to Ø23A
Ø234–Ø237	No line zero—normal warmstart
Ø23F–Ø245	Set EØ, E1 to Ø3Ø6 ie start of Basic text
Ø247–Ø253	Set EØ, E1 to point to line after line Ø
Ø255–Ø25B	Set E2, E3 to point to line Ø
Ø25D–Ø263	Set E4, E5 to point to current line
Ø265	Get character from line Ø
Ø267	End of line Ø?
Ø269	Yes, then a match has been found
Ø260	No, store in E6
Ø26E	Get character from current line
Ø27Ø	Compare
Ø272	Match, no
Ø274–Ø27D	Yes, then increment E2, E3 to point to next character in line Ø
Ø27F–Ø285	Increment E4, E5 to point to next character in current line
Ø28D–Ø2A3	Mismatch found so increment EØ, E1 to point to next line and try again
Ø2AB–Ø2B9	Delete line Ø and return to BASIC
Ø2B6–Ø2C1	Increment address at EØ, E1
Ø2C2–Ø2Ca	Match found; set Ø4, Ø5 to come back to this program after listing the current line. List the line who's number is in 11, 12
Ø2CD–Ø2D8	Re-entry point after listing line on VDU
Ø2D9–Ø2E5	Loop if spacer-bar pressed.

GARBAGE COLLECTION

Sir — one of the more picturesque phrases in computer jargon is 'Garbage Collection', a term which crops up occasionally in reference to a routine which had caused problems in several machines including the UK 101. In the earlier machines, this was responsible for causing hang ups when running programs involving extensive string handling. It was also responsible for the fact that the FRE(X) function didn't work properly.

Current machines have a Garbage Collector (written by myself), which works correctly but the process seems to remain a mystery to many people. Whilst it is true that the detailed operation of BASIC is extremely complex, many of the routines are quite simple in principle and these notes are intended as a non-technical guide to 'Garbage Collection', all that will be assumed is an elementary knowledge of BASIC programming.

The value of numeric variables, no matter how large or small, is contained in just four bytes. The name of the variable uses two bytes so that each numeric variable may be stored in just six memory cells. This does *not represent much of the available memory so it is perfectly efficient to set aside this space for each numeric variable mentioned in the program and this is what is done.*

String variables, however, can be anything between 1 and 255 characters long and it would be extremely inefficient to set aside 255 memory locations for each String variable just in case it happened to be needed. Instead, BASIC keeps an 'index' of all the strings referred to in the program. This index records the name of the String followed by its length and the address of the memory cell containing the first character. The string itself can be practically anywhere in memory, it doesn't matter as long as BASIC knows where it is.

If, for example, a program line contains the statement: A$ = "TITLE", then BASIC simply notes in its index the address of the initial 'T' of that word where it stands in the program line. Note how efficient this is, no extra memory is used until it becomes necessary.

Many strings, however, don't appear in the program line at all, those called for by 'INPUT' statements are an obvious example but complex strings created during the program run also fall into this category. Such strings are stored at the very top of the available memory using space downwards as they are created. By 'top of memory' we mean high numbered addresses. The program itself is stored near the bottom of memory (low numbered addresses) working upwards. A block of data following the last program line contains the values of numeric variables and our 'index' of String variables. If a new line is entered in the program this block of variables data is pushed further up the memory.

As each string is recorded in memory the gap between the end of the program/variables block and the start of the strings gets smaller and smaller. Eventually a collision is imminent and this is when the problems begin. If every string is still current at this point then nothing can be done and an 'Out of Memory' error will result.

More often than not, however, some of the strings still in memory will have been updated during the program run and the previous versions are no longer required. It is easy for BASIC to decide which strings are still current, it merely has to check down its 'index' — any string not listed there may as well not exist because BASIC no longer knows where it is. In other words it represents Garbage.

What is required is a routine to sort out which strings are still needed and pack those to the top of memory, overwriting any obselete strings in the process — a routine known as a 'Garbage Collection'. The task sounds incredibly difficult, the current strings may be of any length and stored in any order. Actually, it's quite straightforward as we shall see.

The whole index is scanned to find the string whose start is at the highest numbered address, this string is then moved to the top of memory. Any strings which get overwritten in the process must be redundant otherwise they would have been in the index and their address would have been found instead. As each string is moved it is 'ticked off' and the record kept of the 'top of available memory' is amended to take account of the space which has been used up. The index is also updated to keep track of the new position of the string.

This process is repeated until all the strings have been moved. Thus all current strings are neatly packed to the top of memory regardless of length, and no gaps are left. The space created in memory is then available for further use.

Many people seem curious to know what was wrong with the original routine. The answer, strangely enough, is nothing! It was, however, set up to handle a string index of a different structure to the one which actually exists.

The guess is that this BASIC was modified at some stage to automate the allocation of string space. Many BASICs require the user to set memory aside for strings using the CLEAR instruction and it is feasible to assume that under these conditions the structure of the string index would be simpler.

Having created a more complex arrangement, the problem arose of how to expand the Garbage Collector using no extra space. Anyone who has dug into this BASIC will be aware of the brilliant efficiency of the coding. The chances of being able to expand a routine are virtually nil.

By extraordinary good fortune, however, the Garbage Collector happened to be the exception. A calculation was performed twice within the routine using very different methods and it was possible to exploit this redundancy to gain just enough space to incorporate the necessary expansion.

The revised routine resides in the BASIC 3 ROM labelled BASUK03-2. This is now supplied as standard, re-affirming the lead of the UK 101 in terms of quality, speed and value for money. Owners of the earlier machines still fitted with the original ROM may now, of course, obtain a direct plug-in replacement from any UK 101 dealer.

Dick Stibbons,
Hayes,
Middx.

WEMONISING YOUR EXTENDED MONITOR

Sir—Owners of the UK101 interested in machine-code programming who have fitted the WEMON monitor may be a little disappointed to find that the excellent Extended Monitor supplied with the UK101 will not run.

Although the WEMON has many machine-code handling features which did not exist in the original monitor, serious programmers will find the disassembler and relocator in the Extended Monitor virtually essential.

Here are the modifications which must be made to the Extended Monitor to enable it to run under WEMON:

The original program is saved in checksum format with a 256-byte checksum loader added ahead of it. The latter is saved as a hex dump and is not compatible with the WEMON named hex file format. However, WEMON does embrace the old UK101 memory-select, modify and execute feature and uses the same key functions. Thus, it is possible to load the checksum loader—then the Extended Monitor—by adopting the following procedure:

1) *Execute a Cold Start then reset and return to machine-code monitor.*
2) *Press 'M' (Return) to enter the register-select mode.*
3) *Key in address 00E0, press '/' and change the contents of this location by pressing 'F' (this sets the monitor to receive input from cassette).*
4) *Start tape recorder.*

The checksum loader will be seen loading from the top of the screen and, when this has finished, the main program loads from the bottom as it did with the old monitor. When the load is complete, reset and return to machine-code monitor, then save the Extended Monitor in WEMON format, without the checksum loader, from 0800 to 0FFF. This is a worthwhile precaution because if the program is accidentally lost during modification, reloading in WEMON format is easier and very much faster than the original checksum load.

Program modifications are:

1) *The sub-routine call at 0855 must be changed to call the WEMON keyboard routine (KBRD) at F369.*
   Change content of 0856 to 69
   Change content of 0857 to F3
2) *The original Extended Monitor used 48 Page Zero locations from 00D0 to 00FF. The program must be modified to use a different area of Page Zero (00A0 to 00CF) in order to avoid locations used by WEMON. Fig. 1 lists a total of 222 addresses. The contents of each location must be changed to the new value shown in the table.*
3) *On the original Extended Monitor, the key '@' was used to access the 'Open*

Location NNNN' feature. The '@' character is not available from the keyboard under WEMON, therefore another key must be used. There are two choices, one is to utilise one of the spare letters—J, U, or Z. However, the author preferred to retain these as user-defined keys and chose a second option. This involves adding a short machine-code routine ahead of the Extended Monitor which interrupts the keyboard routine. The new routine looks for CTRL-A and if found prints '@' and returns with 40 (ASCII value of '@') in the accumulator. This causes the Extended Monitor to select the 'Open Location NNNN' mode and starts the first line with '@' as originally. Fig. 2 shows a disassembled listing of the new routine which is located between 07F2 and 07FF. The sub-routine call at 082F must be changed to call the new routine.

Change content of 0830 to F2
Change content of 0831 to 07

4) *After carrying out (3) above, it was found that CTRL-J and '↑' both caused the open location to increment. The author had never liked the use of these keys and, by changing a single byte, '↑' is used to increment and shift '↑' to decrement.*
Change content of 0B74 to 1A
5) *The checksum saver routine (0EC3) starts with a call to sub-routine FFF7 which, in the old monitor, was used to set the SAVE flag. The author could find no WEMON routine which only sets the SAVE flag and therefore added a short routine to do this. Fig. 3 shows a disassembled listing of the new routine which is located between 07EC and 07F1. The sub-routine call at 0EC3 must be changed to call the new routine.*
Change content of 0EC4 to EC
Change content of 0EC5 to 07

In conclusion the Extended Monitor will now run and should be saved in WEMON format from 07EC to 0FFF. So far as the author can tell, all of the functions of the Extended Monitor are preserved, but note the following changes in key function:–

CTRL-A — Opens Location NNNN
'↑' — Increments to next location
Shift '↑' — Decrements to previous location

0805	B0	0B40	AE	0C81	C1	0D95	AC	0E2F	A8	0ECC	AB
081D	B4	0B42	AD	0C86	C0	0D97	AA	0E39	A8	0ED1	AE
099F	A7	0B44	AF	0C93	A9	0D9C	AA	0E66	AC	0ED3	AC
09A7	A5	0B5C	AA	0C98	A8	0DA0	AB	0E68	AD	0ED5	B7
09A9	A6	0B7C	AA	0CA9	A8	0DAF	B7	0E6D	A8	0ED7	AF
09AB	A7	0B87	AA	0CAB	C0	0DB1	AC	0E6F	A9	0ED9	AD
09B4	A5	0B8C	AA	0CAE	AB	0DBB	AC	0E72	A8	0EDD	B7
09DC	A1	0B90	AB	0CB0	C0	0DBD	A5	0E74	AE	0EE1	B7
09E0	A2	0B96	AA	0CB3	C0	0DBF	AD	0E77	A9	0EE5	B7
09E2	A8	0B9A	AA	0CB7	C0	0DC1	A6	0E79	AF	0EFA	AD
0A01	A5	0B9E	AB	0CB9	A9	0DC3	AA	0E7D	A9	0EFF	AC
0A06	A2	0BA3	AB	0CBD	B8	0DC5	B7	0E80	A8	0F07	AC
0A1C	A3	0BA8	AA	0CC0	B4	0DC7	AB	0E84	AD	0F0C	AC
0A21	A4	0BB9	AA	0CC3	B1	0DC9	A9	0E86	AC	0F10	AD
0A27	A4	0BBE	AB	0CC5	B2	0DCC	A5	0E89	AF	0F15	AB
0A29	A3	0BC5	AA	0CC7	B6	0DCE	AE	0E8B	AE	0F1A	AA
0A40	A2	0BC8	B0	0CCA	B5	0DD0	A6	0E90	AC	0F21	B7
0A44	A3	0BD0	B0	0CCD	B3	0DD2	AF	0E92	A8	0F51	AA
0A4C	A1	0BD5	B1	0CD0	B0	0DD9	A8	0E94	A8	0F53	AB
0A50	A5	0BD7	B2	0CE1	AC	0DDE	A2	0E96	AD	0F58	A9
0A5A	A1	0BDA	B3	0CF6	AD	0DEB	AE	0E98	A9	0F5D	AD
0A83	A6	0BE1	B5	0CFB	AC	0DED	A5	0E9A	A9	0F62	AC
0A85	A5	0BE6	B6	0D08	AC	0DF0	AF	0E9C	A9	0F64	A8
0A95	A2	0BE9	B4	0D18	A5	0DF2	A5	0E9E	A8	0F69	A8
0A98	A6	0BEF	B5	0D1A	AB	0DF7	A5	0EA0	AB	0F6B	AC
0A9E	A5	0BF1	C0	0D1C	A6	0DF9	AC	0EA2	AA	0F6E	A9
0ACA	B7	0C00	B6	0D21	A8	0DFD	A5	0EA7	AB	0F75	AB
0ACF	B7	0C02	C0	0D3E	A0	0DFF	AD	0EA9	AA	0F7C	AA
0B15	AB	0C18	B6	0D56	A8	0E07	B7	0EAD	AC	0F9D	AA
0B1A	AA	0C1D	B5	0D5F	AC	0E0D	A9	0EAF	AE	0F9F	AA
0B20	AD	0C45	B0	0D61	A0	0E19	A5	0EB2	AD	0FA3	AB
0B25	AC	0C5E	A9	0D6A	A8	0E1B	AA	0EB4	AF	0FA5	B7
0B2F	AF	0C61	B8	0D72	AC	0E1D	A5	0EB9	AC	0FBE	AB
0B34	AE	0C63	A8	0D74	AA	0E21	A6	0EBB	AE	0FC3	AA
0B37	AC	0C65	C0	0D76	AD	0E23	AA	0EBE	AD	0FE3	AA
0B3B	AD	0C69	C0	0D78	AB	0E27	AB	0EC0	AF	0FEB	AA
0B3E	AC	0C6C	C0	0D8E	A0	0E2A	A9	0ECA	AA	0FEF	AB

Fig. 1. Table of Extended Monitor addresses showing new contents necessary to avoid Page Zero locations which are used by WEMON

```
07EC A9FF      LDA %$FF
07EE 8D0502    STA $0205
07F1 60        RTS
```

Fig. 3. Sub-routine to set SAVE flag

```
07F2 205308    JSR $0853
07F5 C901      CMP %$01
07F7 F001      BEQ $07FA
07F9 60        RTS
07FA A940      LDA %$40
07FC 206108    JSR $0861
07FF 60        RTS
```

Fig. 2. Sub-routine to enable CTRL-A to be used to Open Location NNNN

Regrettably, the Extended Monitor now occupies more than 2K but this is of little consequence if the program is loaded from cassette.

However, for those who want to store the modified program in EPROM, there is a way to fit it into 2K. Key 'Z' on the Extended Monitor, followed by a 2-byte address, causes a line of eight bytes to be printed. This feature is not mentioned in the sheet which accompanies the Extended Monitor and is of doubtful value anyway as WEMON 'Verify' also prints lines of eight bytes. The code for this is from 0FB7 to 0FFF and this area could be used to contain the two new sub-routines. The sub-routines are fully relocatable but the call addresses at 082F and 0EC3 would have to be changed to call the routines at their new locations.

D. G. K. Guy,
Hitchin,
Herts.

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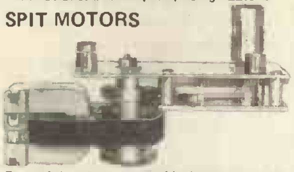

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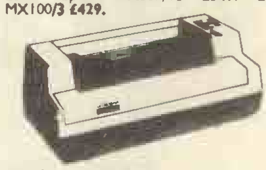

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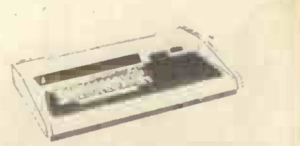

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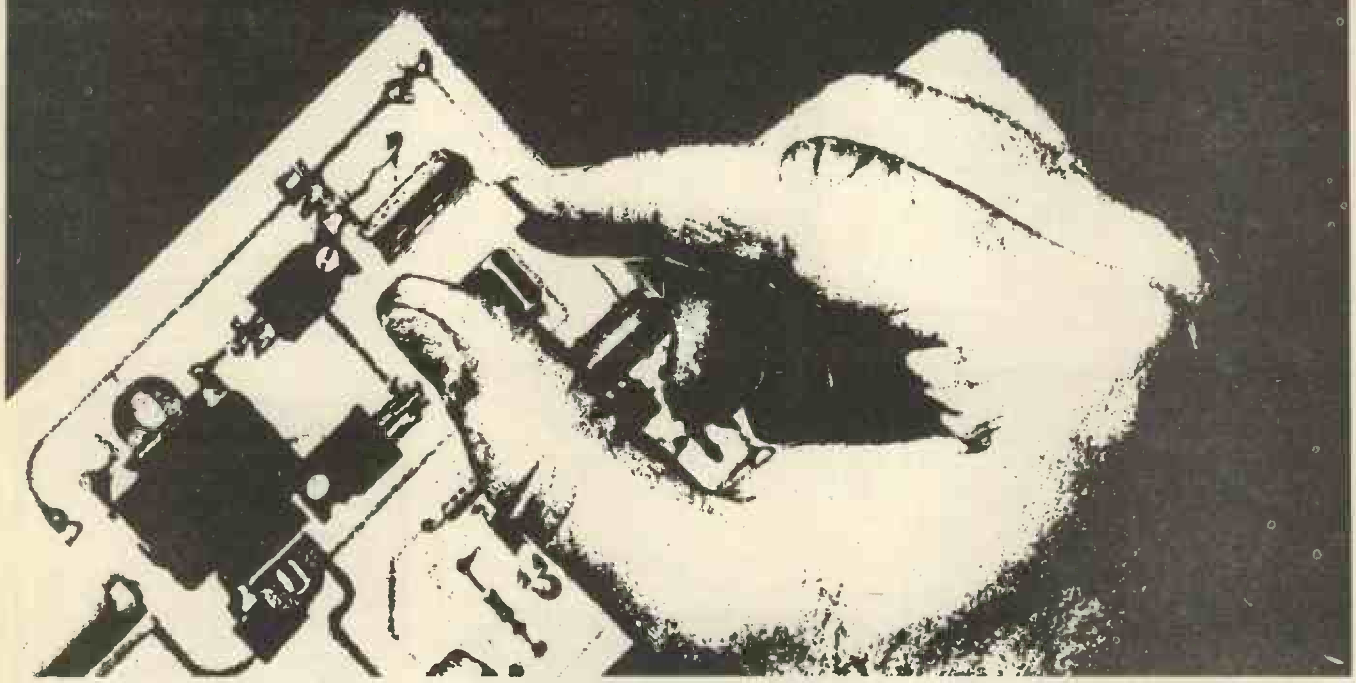

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CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No. of ways	Header Plug	Receptacle	Edge Conn
10	90p	90p	200p
20	145p	125p	240p
26	175p	150p	300p
34	200p	160p	380p
49	220p	190p	550p
50	235p	200p	600p

D-CONNECTORS

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

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

DIL HEADER PLUGS

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

RIBBON CABLE (Grey)

10 way	60p
14 way	80p
16 way	90p
20 way	105p
26 way	140p
34 way	220p
40 way	265p
50 way	330p
64 way	370p

JUMPER LEADS

24" Ribbon Cable with headers

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

24" Ribbon Cable with sockets

	20 pin	26 pin	34 pin	40 pin
1 end	160p	210p	270p	300p
2 ends	290p	385p	490p	540p

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

EURO CONNECTORS

(Indirect Edge Conn.)

DIN STD	Plug	Skt
41617 21 way	170p	170p
41617 31 way	180p	180p
41612 2 x 32 way	250p	320p
Angled 2 x 32 way	325p	375p
41612 3 x 32 way	275p	380p
Angled 3 x 32 way	–	400p
2 x 32 way IDC a+c	–	525p

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

EDGE CONNECTORS

	0.1"	0.156"
2 x 18 way	–	140p
2 x 22 way	200p	170p
2 x 23 way	210p	–
2 x 25 way	225p	220p
1 x 43 way	260p	–
2 x 43 way	395p	–
2 x 50 way	–	–
1 x 77 way	700p	–
S100 Conn	–	600p

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Dot matrix printers. Bi directional, Logic Seeking, Auto Underline, Bit Image Printing, Super & Sub-scripts. 80 col. 8 cps £330 + £8 carr. 136 col. 100 cps £430 + £10 carr.

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BASIC BUILT
8K + 2K £135
EXPANDED
12K + 12K £175
8K + 5K + COLOUR £169
(Carr. £3 unit)

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18MHz BANDWIDTH
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(25 x 40 chars.) RGB input
£240 + £6 carr.

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The complete microprocessor development system for both Engineers and Hobbyists. You can develop programs, debug, verify and commit them to EPROMs. Will accept most + 5V EPROMs. Can also be used as a ROMULATOR. Full review in September 81 PE. Built unit complete with PSU and TV lead £169.

MENTA

A sophisticated Z80 development system and trainer. Direct interface to TV & cassette recorder. Powerful keyboard assembler & program debugging facility – ideal for both engineers and students. Audible feedback on keyboard input. Menta + PSU + TV Lead £115.

RUGBY ATOMIC CLOCK

This Z-80 micro controlled clock/calendar receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided. See July/August ETI for details. Complete kit £120 + £2 p. & p.

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7442A	32p
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74LS377	60p
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LM3914	200p
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NE556	45p
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NE567	140p
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15V 1A	7815	*40p	7912	45p
18V 1A	7818	*40p	7915	45p
24V 1A	7824	*40p	7918	45p
5V 100mA	78L05	30p	7924	45p
12V 100mA	78L12	30p	79L05	65p
15V 100mA	78L15	30p	79L12	70p
			79L15	70p

OTHER REGULATORS

LM309K 1A 5V	135p	78HGKC	600p
LM317K	325p	78HO5KC	550p
LM317T 1A Adj	200p	78MGT2C	140p
LM337T	225p	78GUIC	200p
LM323K 3A 5V	500p	79GUIC	225p
LM723 150mA Adj	37p	79HGKC	700p
TL494	400p	TL497	300p
78S40	300p	LM305H	250p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	110p	TIL 111	70p
MCT26	100p	TIL 112	70p
MCS2400	190p	TIL 113	70p
ILQ74	240p	TIL 116	70p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	10p
TIL209 Red	10p	TIL222 Gr	12p
TIL211 Gr	12p	TIL228 Yel	15p
TIL212 Ye	15p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p	NSB5881	670p
		TIL311	600p

DISPLAYS

3015F	200p	TIL312/3	110p
DL704	140p	TIL321/2	130p
DL707 Red	140p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p		
FND507	90p		
MAN3640	175p		
MAN4640	200p		

DRIVERS

9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	350p
6502A	500p
6800	225p
6802	250p
68B02	700p
6809	650p
6809E	£12
68B09	£12
8035	350p
8039	£3
8080A	250p
8085A	350p
INS8060	£11
TMS9980	£20
Z8	£24
Z80	290p
Z80A	320p
Z80B	£12
8088	£18

SUPPORT DEVICES

3242	800p
3245	450p
6520	280p
6522	310p
6522A	550p
6532	600p
6551	650p
6821	100p
68B21	220p
6840	375p
68B40	£6
6850	110p
68B50	220p
6852	250p
6854	£7
6875	570p
8154	950p
8155	350p
8156	350p
8205	225p
8212	110p
8216	100p
8224	110p
8226	250p
8228	220p
8243	280p
8250	850p
8251	250p
8253	380p
8255	255p
8256	£36
8257	£4
8259	£4
8279	440p
8284	350p
8288	£11
TMS9918	£60
Z80PIO	250p
Z80APIO	280p
Z80CTC	250p
Z80ACTC	250p
Z80ADART	£7
Z80ADMA	£10
Z80SIO-0/1/2	£9

CRT CONTROLLER

CRT6545	900p
CRT5027	£18
CRT5037	£18
EF9365	£45
EF9366	£48
MC6845	650p
MC6847	650p
SFF96364	£8
TMS9918	£60
TMS9927	£18

ZIF SKTS (TEXTOOL)

24 pin	£6
28 pin	£8
40 pin	£10

MEMORIES

2101A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	100p
2147	450p
4027-3	300p
4044-45	450p
4116-15	100p
4116-20	90p
4118-3	500p
4118-4	450p
4164-2	£6
4816AP-3	280p
5101	300p
5516	950p
6116P-3	550p
6116LP	750p
6514-45	£3
6810	120p
7489	210p
74S189	325p
74S201	350p
74S289	325p
93415	600p
93425	600p

ROMs/PROMs

74S188	225p
74S287	308p
74S288	225p
74S387	325p
74S471	650p
74S473	850p
74S474	650p
74S570	650p
74S571	650p
74S573	950p

EPROMs

2516 (+5V)	250p
2532	380p
2564	£15
2708	250p
2716 (+5V)	250p
2732	450p
2716 (350ns)	500p
2732 (300ns)	750p
TMS2716	750p

UARTs

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

INTERFACE ICs

AD558CJ	775p
AD561J	£14
AM25S10	350p
AM25LS2521	£2
AM26LS31	125p
AM26LS32	125p
COM8116	800p
DAC80	£28
DM8131	275p
DP8304	250p
DS8830	140p
DS8831	140p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	675p
MC14412	750p
ULN2003A	90p
75107	90p
75110/12	90p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	80p
8T97/98	80p
81LS95	80p
81LS96	80p
81LS97	90p
81LS98	90p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p

DISC CONTROL ICs

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

CHARACTER GENERATORS

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

CRYSTALS

32·768KHz	100p
100KHz	250p
200KHz	280p
1·0MHz	290p
1·008MHz	275p
1·5MHz	450p
1·8432MHz	210p
2·00MHz	225p
2·45760MHz	210p
2·5MHz	250p
2·662MHz	250p
3·276MHz	150p
3·5795MHz	100p
3·686MHz	300p
4·00MHz	150p
4·194MHz	200p
4·43MHz	110p
4·608MHz	250p
4·9152MHz	250p
5·00MHz	175p
6·00MHz	150p
6·144MHz	150p
7·0MHz	150p
7·168MHz	175p
8·00MHz	150p
8·86MHz	175p
10·00MHz	175p
10·5MHz	250p
10·7MHz	150p
12·0MHz	150p
14·318M	175p
14·756MHz	200p
15·00MHz	200p
16·00MHz	200p
18·00MHz	200p
18·432	150p
19·968MHz	150p
20·000MHz	200p
26·690MHz	150p
27·145MHz	200p
38·6667MHz	175p
48·0MHz	175p
55·5MHz	400p
116MHz	300p
145·80MHz	250p

KEYBOARD ENCODER

AY-5-2376	700p
74C922	420p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

BAUD RATE GENERATOR

MC14411	675p
COM8116	700p
4702B	750p

TELETEXT DECODER ICs

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9

REAL TIME CLOCK

MM58174	850p

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

LOW PROFILE DIL SOCKETS BY TEXAS

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

TRANSISTORS

AD161/2	45p
BC107/8	13p
BC109C	14p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	25p
BC477/8	30p
BC516/7	40p
BC547B	14p
BC548C	12p
BC549C	16p
BC557B	14p
BC559C	16p
BCY70	18p
BCY71/2	22p
BD131/2	75p
BD135/6	45p
BD139	40p
BD140	40p
BD189	60p
BD242	60p
BD379	60p
BD380	60p
BF244B	35p
BF256B	50p
BF257/8	32p
BF259	36p
BF337	30p
BFR39	25p
BFR40/1	25p
BFR79	25p
BFR80/1	25p
BFX29	40p
BFX30	27p
BFX84/5	40p
BFX88	27p
BFX89	150p
BFY50	24p
BFY51/2	24p
BFY56	33p
BFY90	80p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
J310	50p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	60p
MJE2955	100p
MJE3055	70p
MPF102	40p
MPF103/4	30p
MPF105	30p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A/C	35p
TIP30A/C	35p
TIP31A/C	40p
TIP32A/C	40p
TIP33A/C	70p
TIP34A/C	90p
TIP35A/C	120p
TIP36A/C	140p
TIP41A/C	50p
TIP42A/C	60p
TIP54	160p
TIP120	75p
TIP122	90p
TIP142	120p
TIP147	120p
TIP2955	78p
TIP4055	70p
VN10KM	100p
VN66	80p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	18p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	25p
2N2222A	25p
2N2369A	25p
2N2484	25p
2N2646	45p
2N2904/5	25p
2N2906A	25p
2N2907A	25p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	40p
2N3823	50p
2N3866	90p
2N3902	700p
2N3903/4	16p
2N3905/6	16p
2N4037	25p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5194	90p
2N5245	40p
2N5296	65p
2N5401	50p
2N5457/8	32p
2N5459	32p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1172	150p
2SC1306	150p
2SC1307	150p
2SC1957	90p
2SC2969	198p
2SC2028	120p
2SC2029	250p
2SC2078	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES

BY127	12p
OA47	8p
OA90/91	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

ZENERS

2.7V-33V 400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	180p
2N5060	30p
2N5064	35p

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