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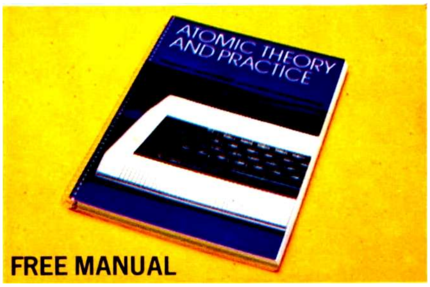
The Acorn Atom is a definitive personal computer. Simple to build, simple to operate. A powerful, full facility computer with all the features you would expect.
Just connect the assembled computer to any domestic TV and power source and you are ready to begin. (Power requirement: 8V at 800mA). There is an ATOM power unit available – see the coupon below.



FREE MANUAL

Free with every ATOM, kit or built, is a computer manual. The first section explains and teaches you BASIC, the language that most personal computers and the ATOM operate in. The instructions are simple and learning quickly becomes a pleasure. You'll soon be writing your own programs. The second section is a reference manual giving a full description of the ATOM's facilities and how to use them. Both sections are fully illustrated with example programs.

The standard ATOM includes:

HARDWARE

● Full-sized QWERTY keyboard ● 6502 Microprocessor ● Rugged injection-moulded case ● 2K RAM ● 8K HYPER-ROM ● 23 integrated circuits and sockets ● Audio cassette interface ● UHF TV output ● Full assembly instructions

SOFTWARE

● 32-bit arithmetic (±2,000,000,000) ● High speed execution ● 43 standard/extended BASIC commands ● Variable length strings (up to 256 characters) ● String manipulation functions ● 27 x 32 bit integer variables ● 27 additional arrays ● Random number function ● PUT and GET byte ● WAIT command for timing ● DO-UNTIL construction ● Logical operators (AND, OR, EX-OR) ● Link to machine – code routines ● PLOT commands, DRAW and MOVE

The ATOM modular concept

The ATOM has been designed to grow with you. As you build confidence and knowledge you can add more components. For instance the next stage might be to increase the ROM and RAM on the basic ATOM from 8K + 2K to 12K + 12K respectively. This will give you a direct printer drive, floating point mathematics, scientific and trigonometric functions, high resolution graphics.

From there you can expand indefinitely. Acorn have produced an enormous range of compatible PCB's which can be added to your original computer. For instance:
● A module to give red, green and blue colour signals ● Teletext VDU card (for Prestel and Ceefax information) ● An in-board connector for a communications loop interface – any number of ATOMs may be linked to each other or to a master system with mass storage/hard copy facility ● Floppy disk controller card. For details of these and other additions write to the address below.

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	ATOM KIT – 12K ROM + 12K RAM (MAX)	@ £255.00	
	ATOM ASSEMBLED–12K ROM+12K RAM (MAX)	@ £289.50	
	1K RAM SETS	@ £11.22	
	4K FLOATING POINT ROM (inc in 12K Version)	@ £23.30	
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PRACTICAL
ELECTRONICS
VOLUME 17 No. 7 JULY 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL 12 PAGE SUPPLEMENT

OUR AUGUST ISSUE WILL BE ON SALE FRIDAY, 10 JULY 1981
(for details of contents see page 43)

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160V: 10nF, 12n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1µF **42p**; 1µ5 **45p**; 2µ2 **48p**; 4µ7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **50p**; 470n **99p**.

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**.

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ELECTROLYTIC CAPACITORS (Values in µF). **500V**: 10 **52p**; 47 **78p**; **250V**: 100 **65p**; **63V**: 0·47, 1·0, 1·5, 2·2, 3·3, **8p**; 4·7 **9p**; 6·8, 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 100 **19p**; 1000 **70p**; **50V**: 47 **12p**; 68 **20p**; 220 **24p**; 470 **32p**; 2200 **90p**; **40V**: 4·7, 15, 22, **9p**; 330 **90p**; 4700 **120p**; **25V**: 1·5, 6·8, 10, 22 **8p**; 33 **9p**; 47 **8p**; 100 **11p**; 150 **12p**; 220 **15p**; 330 **22p**; 470 **25p**; 680, 1000 **34p**; 2200 **50p**; 3300 **76p**; 4700 **92p**; **16V**: 40, 47, 100 **9p**; 125 **12p**; 220 **13p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 3300 **74p**; 4700 **79p**.
TAG-END TYPE: **450V**: 100µF **65p**; **70V**: 4700 **245p**; **64V**: 3300 **198p**; 2200 **139p**; **50V**: 3300 **154p**; 2200 **110p**; **40V**: 4700 **160p**; **25V**: 10,000 **320p**; 15,000 **345p**.

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**; **10V**: 15, 22 **26p**; 33, 47 **35p**; 100 **55p**.

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100V: 1nF, 2n, 4n, 4n7, 10 **6p**; 15nF, 22n, 30n, 40, 47 **7p**; 56, 100n, 200 **9p**; 470n/**50V**: **12p**.

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track

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Range: 0·5pf to 10nF	**4p**
15nF, 22nF, 33nF, 47nF	**5p**
100nF/30V **7p**; 220nF/6V	**8p**

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0·25W 100Ω-3·3MΩ Horiz. larger	**10p**
0·25W 250Ω-4·7MΩ Vert.	**10p**
Precision Cermet 1W 100Ω-100K	**90p**

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1·5nF to 12nF **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**
220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF **21p**
1000, 1200, 1800 **30p**
3300, 4700 **60p**

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2-6pF, 2-10pF	**22p**
2-25pF, 5-56pF	**30p**
10-88pF	**35p**

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20-250pF	**28p**
100-580pF	**39p**
400-1250pF	**48p**

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0·5W	2Ω2-4·M7	E12	**2p**	**1p**
1W	2Ω2-10M	E12	**5p**	**3p**
2% Metal Film 10Ω-1M			**6p**	**4p**
1% 0·5W 51Ω-1M24			**8p**	**6p**

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

TRANSISTORS

AC107	35	BC547/8	14	BU208	200	TIS88A	50	2N3905	15
AC125	35	BC549C	14	E421	250	TIS90	30	2N3906	17
AC126	25	BC556/7	15	MD8001	250	TIS91	32	2N4037	46
AC127/8	25	BC558/9	15	MJ2955	90	TIS93	32	2N4058	10
AC141	30	BCY70	16	MJE340	54	UC734	65	2N4061	10
AC142	30	BCY71	18	MJE370	100	ZTX107	11	2N4062	10
AC176	28	BCY72	20	MJE371	100	ZTX108	11	2N4069	45
AC187	28	BD121	95	MJE520	95	ZTX109	12	2N4427	80
AC188	30	BD124	115	MJE2955	99	ZTX212	28	2N4859	78
ACY17	70	BD131	48	MJE3055	70	ZTX300	13	2N4871	55
ACY18	70	BD132	48	MPF102	66	ZTX301	16	2N5135/6	20
ACY19	75	BD133	60	MPF103	36	ZTX302	16	2N5138	18
ACY20	75	BD135	45	MPF104	36	ZTX303	25	2N5172	18
ACY21	75	BD136/7	40	MPF105	36	ZTX304	17	2N5179	45
ACY22	60	BD138/9	40	MPF106	40	ZTX314	25	2N5180	45
ACY28	75	BD140	40	MPSA05	25	ZTX320	30	2N5191	75
AD149	79	BD144	198	MPSA06	25	ZTX326	30	2N5194	80
AD161/2	42	BD205	110	MPSA12	32	ZTX341	30	2N5305	24
AF118	95	BD245	45	MPSA55	30	ZTX500	14	2N5457	36
AF139	40	BD378	70	MPSA56	30	ZTX501	15	2N5458	36
AF178	75	BD434	55	MPSA70	30	ZTX502	15	2N5459	36
BC107	10	BD517	75	MPSU02	58	ZTX503	18	2N5485	36
BC107B	12	BD695A	85	MPSU05	55	ZTX504	25	2N5777	45
BC108	10	BD696A	85	MPSU06	55	ZTX531	25	2N6027	32
BC108B	12	BDY56	180	MPSU52	65	ZTX550	25	2N6109	60
BC108C	12	BDY60	160	MPSU55	60	2N696	30	2N6290	70
BC109	10	BF115	35	MPSU56	60	2N697	23	2SA715	60
BC109B	12	BF167	29	OC23/26	170	2N698	40	2SC495	70
BC109C	12	BF173	27	OC28	130	2N699	48	2SC496	70
BC117/8	20	BF177	25	OC36	120	2N706A	19	2SC1096	85
BC140	30	BF178	30	OC41/42	120	2N708	19	2SC1173	125
BC142	30	BF179	35	OC44	120	2N914/5	32	2SC1306	150
BC143	30	BF180	38	OC45	40	2N918	35	2SC1307	220
BC147	9	BF194/5	12	OC70	40	2N930	20	2SC1449	85
BC147B	10	BF196/7	12	OC71	40	2N1131/2	24	2SC1678	140
BC148	9	BF198	16	OC72	40	2N1303	60	2SC1923	50
BC148B	10	BF199	18	OC76	50	2N1304	65	2SC1945	225
BC148C	10	BF200	30	OC81	50	2N1305	60	2SC1953	90
BC149	9	BF224	25	OC82	50	2N1307	65	2SC1957	90
BC149C	12	BF244A	28	OC83	40	2N1308	68	2SC1969	198
BC153/4	27	BF244B	29	OC84	40	2N1613	30	2SC2028	85
BC157/8	10	BF256B	35	OC170	85	2N1671B	160	2SC2029	180
BC159	11	BF257/8	32	OC171	85	2N2160	295	2SC2078	155
BC160	45	BF259	35	OC200	85	2N2219A	28	2SC2091	85
BC167A	10	BF274	42	TIP29A	36	2N2220A	26	2SC2314	85
BC168C	10	BF336	40	TIP29B	56	2N2221A	26	2SC2166	165
BC169C	10	BF451	35	TIP29C	60	2N2222A	25	2SC1679	190
BC170	15	BF594	30	TIP30A	48	2N2369A	18	2SD234	75
BC171/2	11	BF595	39	TIP30B	50	2N2646	45	3N128	112
BC173	11	BF910	95	TIP30C	60	2N2846	80	3N140	112
BC177/8	20	BFR39	23	TIP31A	45	2N2904	28	40250	85
BC179	20	BFR40	23	TIP31C	55	2N2905A	26	40251	97
BC181	20	BFR41	23	TIP32A	48	2N2906	26	40311	60
BC182/3	10	BFR79	23	TIP32C	60	2N2907A	26	40313	130
BC184	10	BFR80	25	TIP33A	65	2N2926G	10	40315	60
BC182L	10	BFR81	25	TIP33C	78	2N3053	26	40316	95
BC183L	10	BFR98	105	TIP34A	74	2N3054	58	40317	60
BC184L	10	BFX29	26	TIP34C	88	2N3055	48	40320	60
BC187	26	BFX84	26	TIP35A	160	2N3442	140	40360	40
BC212	10	BFX85/86	28	TIP35C	185	2N3565	15	40361	50
BC212L	10	BFX87/88	28	TIP36A	170	2N3614	199	40362	50
BC213	10	BFY50	23	TIP36C	199	2N3615	199	40406	75
BC213L	10	BFY51	23	TIP41A	55	2N3663	15	40407	60
BC214	10	BFY52	23	TIP41B	60	2N3702/3	10	40408	70
BC214L	10	BFY56	32	TIP42A	60	2N3704/5	10	40411	285
BC237/8	14	BFY64	35	TIP42B	75	2N3706/7	10	40412	65
BC307B	14	BFY81	120	TIP120	90	2N3708/9	10	40467	130
BC308B	16	BFY90	80	TIP121	99	2N3710	10	40468	85
BC327	15	BRY39	40	TIP141	120	2N3711	10	40594	105
BC328	15	BSX20	20	TIP142	120	2N3771	179	40595	110
BC337/8	15	BSX29	34	TIP147	120	2N3772	195	40603	110
BC441	34	BSY95A	25	TIP2955	60	2N3773	270	40636	175
BC461	34	BU105	170	TIP3055	60	2N3819	22	40673	95
BC477/8	40	BU108	240	TIS43	32	2N3820	45		
BC516	40	BU109	210	TIS44	45	2N3822/3	65		
BC517	40	BU205	190	TIS45	45	2N3866	90		
		BU206	200	TIS48	50	2N3903/4	18		

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709C 8 pin	35	LM10	395	NE564	435
710	67	LM301A	26	NE565A	120
741	15	LM308	95	NE566	180
747C 14 pin	78	LM311	70	NE567	170
748C 8 pin	36	LM318	200	NE570	450
753 8 pin	185	LM324	50	NE571	420
810	159	LM339	68	RC4136D	69
9400CJ	350	LM348	90	S566B	265
AY-1-0212	675	LM349	115	SAB3209	425
AY-1-1313A	660	LM358	50	SAB3210	275
AY-1-1320	225	LM379	415	SG3402	295
AY-1-5050	99	LM380	80	SN76003N	240
AY-1-5051	160	LM381N	145	SN76013N	170
AY-3-1270	840	LM382	125	SN76018	148
AY-3-8500	390	LM384	140	SN76023N	170
AY-3-8910	770	LM386	99	SN76033N	195
AY-3-8912	650	LM387	120	SN76115N	215
AY-5-1224A	235	LM389	99	SN76131	125
AY-5-1230	450	LM733	75	SN76227N	95
AY-5-1317A	630	LM2917	195	SN76477	175
AY-5-8100	775	LM3900	60	SP8629	299
CA3011	110	LM3909	70	TAA621AX1	250
CA3012	175	LM3911	125	TAA661A	155
CA3014	157	LM3914	240	TAD100	159
CA3019	70	LM3915	240	TBA120S	70
CA3020	186	LM3916	255	TBA550Q	330
CA3023	191	LM13600	135	TBA641-A12/BX1 or BX11	250
CA3028A	80	LS7220	280	TBA651	190
CA3035	235	M252AA	625	TBA800	90
CA3036	115	M253AA	1150	TBA810S	95
CA3043	275	MC1303	88	TBA820	70
CA3045	365	MC1304P	260	TBA920Q	260
CA3046	70	MC1310P	150	TCA965	120
CA3048	214	MC1445	150	TDA1004	290
CA3059	195	MC1458	45	TDA1008	310
CA3075	213	MC1494	694	TDA1022	575
CA3080E	65	MC1495	350	TDA1024	105
CA3081	190	MC1496L	92	TDA1490	290
CA3089E	215	MC1596	225	TDA2020	320
CA3090AQ	375	MC1648	290	TDA2030	300
CA3123	150	MC1709G	90	TL061	46
CA3130	90	MC1710	79	TL064CN	159
CA3140	48	MC3302	150	TL071CP	45
CA3160	95	MC3340P	120	TL072CP	70
CA3189	295	MC3360P	120	TL074CN	125
ICL7106	795	MC3401	52	TL081CP	42
ICL7107	975	MC3403	135	TL083CP	95
ICL8038CC	340	MC3405	150	TL084CP	105
ICL8211	150	MFC6040	97	UAA170	170
ICM7205	1150	MK50398	635	UAA180	170
ICM7207	475	MM5303	635	XR2206	320
ICM7215	1050	MM5307	1275	XR2211	575
ICM7216A	1950	MM57160	575	XR2266	750
ICM7216B	1950	MSM5526	820	ZN414	95
ICM7217A	790	NE529	225	ZN423	195
ICM7224	785	NE543	210	ZN424E	130
LD130	452	NE544	185	ZN425E	350
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LF351	48	NE556DB	55	ZN1034E	200
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COMPUTER IC's

2114-450	125	Z80SIO-1	£19
2114L-300n	135	Z80ASIO	£24
2114L-200n	150	Z80 DART	£12
2532-32K	£8	Z80A DART	£15
2708	250	**74S132**	138
2716-5V	300	74S138	240
2732-450n	£8	74S188	210
4116	140	74S189	158
6502	550	74S194	360
6503	850	74S241	540
6505	795	74S262	850
6520	325	74S287	325
6522	570	74S288	210
6532	795	74S470	325
6545	1450	74S472	1150
6551	785	74S475	825
6592	£27	**75150**	140
6800	375	75154	150
6802	550	75450	95
6809	1475	75451/2	70
6810	175	75454	225
6821	190	75491/2	89
6840	470		
6850	190		
6852	390		
8080A	450		
8085A	990		
81LS95	99		
81LS96	99		
81LS97	99		
8212	210		
8214	425		
8216	200		
8251	475		
8253	899		
8255	425		
8257	800		
8T26A	150		
8T28A	150		
8T31	350		
8T95N	160		
8T97N	150		
AY-3-1015	395		
AY-5-1013	375		
AY-5-2376	750		
MC1488	75		
MC1489	75		
MC14411	950		
MC14412	1100		
RO-3-2513U	600		
SFF96364E	950		
SFC71301	820		
TMS2716-3V	1050		
TMS4027	250		
TMS6011	365		
Z80CPU 2·5	525		
Z80ACPU 4M	650		
Z80 PIO	475		
Z80A PIO	550		
Z80 CTC	475		
Z80A CTC	550		

TTL 74 (TEXAS)

7400	11	7445	105	74155	75
7401	11	7446	132	74156	75
7402	11	7447	72	74157	70
7403	14	7448	75	74159	165
7404	14	7450	20	74160	99
7405	18	7451	20	74161	99
7406	36	7453	20	74162	99
7407	36	7454	20	74163	99
7408	17	7460	20	74164	120
7409	20	7470	40	74165	120
7410	17	7472	30	74166	130
7411	25	7473	35	74167	205
7412	20	7474	34	74170	205
7413	32	7475	58	74172	375
7414	38	7476	40	74173	110
7416	30	7480	52	74174	100
7417	30	7481	120	74175	82
7420	19	7482	75	74176	80
7421	38	7483	90	74177	85
7422	25	7484	99	74178	110
7423	28	7485	105	74179	150
7425	28	7486	33	74180	90
7426	43	7489	205	74181	280
7427	32	7490	42	74182	85
7428	35	7491	84	74184	130
7430	19	7492	50	74185	130
7432	27	7493	57	74188	310
7433	36	7494	85	74190	130
7437	35	7495	70	74191	120
7438	32	7496	80	74192	120
7440	20	7497	176	74193	120
7441	68	74100	130	74194	102
7442	58	74104	62	74195	75
7443	120	74105	62	74196	99
7444	116	74107	34	74197	88
		74109	60	74198	160
		74110	54	74199	150
		74111	68	74221	150
		74112	170	74246	150
		74116	170	74247	151
		74118	85	74248	189
		74119	120	74249	189
		74120	75	74251	110
		74121	35	74265	66
		74122	50	74273	267
		74123	65	74278	249
		74125	50	74279	99
		74126	45	74283	149
		74128	45	74284	350
		74132	55	74285	350
		74136	55	74290	107
		74141	75	74293	135
		74142	185	74297	236
		74143	250	74298	185
		74144	250	74365	95
		74145	90	74366	95
		74147	150	74367	95
		74148	125	74368	95
		74150	130	74390	185
		74151	70	74393	185
		74153	70	74490	185
		74154	120		

74LS

LS00	13	LS138	62	LS299	420
LS01	13	LS139	70	LS300	175
LS02	15	LS145	120	LS302	175
LS03	15	LS147	210	LS323	270
LS04	16	LS148	170	LS321	450
LS05	23	LS151	90	LS324	200
LS08	22	LS153	85	LS325	320
LS09	23	LS154	200	LS326	330
LS10	20	LS155	75	LS327	315
LS11	32	LS157	70	LS346	185
LS12	32	LS158	70	LS347	150
LS13	40	LS160	90	LS348	190
LS14	60	LS161	98	LS352	185
LS15	40	LS162	110	LS353	185
LS20	21	LS163	95	LS365	65
LS21	32	LS164	115	LS366	65
LS22	35	LS165	145	LS367	65
LS26	44	LS166	175	LS368	90
LS27	35	LS168	210	LS373	150
LS28	35	LS169	210	LS374	150
LS30	20	LS170	288	LS375	150
LS32	25	LS173	105	LS377	199
LS33	35	LS174	110	LS378	140
LS37	30	LS175	110	LS379	215
LS38	35	LS181	295	LS384	250
LS40	28	LS183	298	LS385	420
LS42	66	LS189	128	LS386	85
LS47	85	LS190	95	LS390	140
LS48	105	LS191	95	LS393	140
LS49	105	LS192	95	LS395	210
LS51	25	LS193	99	LS396	199
LS54	30	LS194	125	LS398	275
LS55	30	LS195	130	LS399	230
LS63	150	LS196	120	LS445	140
LS73	45	LS197	85	LS447	195
LS74	35	LS200	345	LS490	245
LS75	45	LS202	345	LS668	105
LS76	45	LS221	120	LS669	105
LS78	50	LS240	165	LS670	270
LS83	105	LS241	165	LS673	750
LS85	80	LS242	165	LS674	850
LS86	38	LS243	165		
LS90	50	LS244	150		
LS91	125	LS245	145		
LS92	75	LS247	135		
LS93	60	LS248	135		
LS95	115	LS249	135		
LS96	120	LS251	130		
LS107	45	LS253	95		
LS109	75	LS257	95		
LS112	40	LS258	120		
LS113	75	LS259	160		
LS114	40	LS261	450		
LS122	70	LS266	75		
LS123	75	LS273	180		
LS124	180	LS275	320		
LS125	45	LS279	88		
LS126	45	LS280	250		
LS132	60	LS283	90		
LS133	35	LS290	130		
LS136	55	LS295	215		
		LS298	130		

CMOS

4000	14	4018	76	4490	350
4001	14	4019	42	4500	750
4002	15	4020	85	4501	28
4006	86	4021	90	4502	105
4007	19	4022	85	4503	65
4008	76	4023	24	4506	75
4009	46	4024	60	4507	48
4010	50	4025	24	4508	280
4011	18	4026	170	4510	85
4012	24	4027	45	4511	98
4013	43	4028	92	4512	84
4014	80	4029	98	4513	225
4015	82	4030	55	4514	220
4016	35	4031	185	4515	250
4017	70	4032	125	4516	90
		4033	175	4517	415
		4034	213	4518	90
		4035	95	4519	80
		4036	275	4520	90
		4037	115	4521	210
		4038	110	4522	150
		4039	299	4526	98
		4040	85	4527	125
		4041	80	4528	100
		4042	70	4529	150
		4043	80	4530	90
		4044	80	4531	130
		4045	175	4532	120
		4046	96	4534	510
		4047	98	4536	310
		4048	65	4538	145
		4049	35	4539	120
		4050	38	4541	150
		4051	86	4543	150
		4052	86	4549	395
		4053	86	4553	399
		4054	130	4554	192
		4055	130	4555	85
		4056	135	4556	60
		4059	575	4557	425
		4060	110	4558	174
		4061	1225	4559	450
		4062	995	4560	199
		4063	120	4561	104
		4066	46	4562	525
		4067	430	4566	195
		4068	26	4568	299
		4069	22	4569	195
		4070	25	4572	36
		4071	25	4580	495
		4072	25	4581	320
		4073	25	4582	135
		4075	23	4583	105
		4076	85	4584	55
		4077	30	4585	99
		4078	28	4599	275
		4081	26	40097	90
		4082	25	40106	99
		4085	90	40161	99
		4086	90	40174	160
		4089	150	40193	145

CMOS (CONT.)

4093	55
4094	210
4095	95
4096	95
4097	340
4098	115
4099	150
4160	115
4161	115
4162	115
4163	115
4174	110
4175	120
4194	115
4408	790
4409	790
4410	750
4411	950
4412F	1100
4415F	480
4419	280
4422	570
4432	1050
4433	995
4435	850
4440	999
4450	350
4451	350
4452	

ZERO Insertion Force SOCKETS

24 way £6.50; 28 way £8.20; 40 way £9.75

DIODES

AA119	15
BA100	15
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
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

SCR's Thyristors

0·8A-100V	32
1A/200V	58
1A/400V	70
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

BRIDGE RECTIFIERS

(plastic case)

1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	350
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
MVAM115	158
BA102	30
BB105B	40
BB106	40

Noise Diode

Z5J 195

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	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

DIAC

ST2 25

SPEAKERS

8Ω 0·3W
2"; 2¼"; 2½"; 3" 80
40Ω 2 5" 80
64Ω 2 5" 80
80Ω 2·5" 80
8×5" 8Ω 6W HF Cone 425
Piezo Tweeters Xovers etc. available.

ALUM.BOXES

3×2×1"	65
4×2½×2"	85
4×2¾×2½"	103
5×4×2	105
5×2¾×1½"	90
5×2¾×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
7×5×3"	180
8×6×3"	210
10×7×3"	275
12×5×3"	260
12×8×3"	295

VEROBOARDS 0 1"

	Clad	Plain
2½×3¾"	73p	52p
2½×5"	83p	—
3¾×3¾"	83p	—
3¾×5"	95p	79p
3¾×17"	326p	211p
4¾×18"	426p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	118p	
Pin Insertion Tool	162p	

'VQ' Board	150p
'DIP' Board	330p
Vero Strip	144p
S100 Board	£14

PROTO-DECs

Veroblock	375p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	785p
Superstrip SS2	998p

VERO WIRING PEN and Spool 310p
Spare Wire (Spool) **75p**; Combs **6p** ea.

FERRIC CHLORIDE

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

DALO ETCH RESIST

Pen + Spare tip 90p

ALFAC TRANSFERS

Etch Resist.
Full range available:
35p a sheet

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9·5"×8·5"
6"×6"	90p	110p	95p
6"×12"	150p	196p	

SOLDERCON PINS

100 pins **60p** 500 pins **275p**

OPTO ELECTRONICS

LEDS including Clips

TIL209 Red 125"	13
TIL211 Green 125"	18
TIL212 Yellow	18
TIL220 2" Red	15
0·2" Yel, Grn, Amber	18
Red, Green and Yellow Rectangular LEDS.	29
Triangular LEDs R&G	18
0 2" Flashing LED Red	55
0·2" Red/green LED	65
0·2" Red High Bright	59
2N5777 **45**; OCP71	120
ORP12	86
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	58
SFH205 (detector)	91
TIL78 (detector)	60

7 Segment Displays

TIL321 5" C An	115
TIL322 5" C.th	115
DL704 3" C.Cth	99
DL707 3" C.Anod	99
DL747 6" C.Cathod.	180
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

Liquid Crystal Display

3½ digit **675p**; 4 digit **750p**
6 Digit LCD **850p**

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	60p	7905	65p	
12V	7812	60p	7912	65p	
15V	7815	60p	7915	65p	
18V	7818	60p	7918	65p	
24V	7824	60p			
100mA	T092 Plastic Casing				
5V	78L05	30p	79L05	65p	
6V	78L62	30p	—		
8V	78L82	30p	—		
12V	78L12	30p	79L12	65p	
15V	78L15	30p	79L15	65p	

CA3085	95	LM309K	135
LM300H	170	LM317H	240
LM304H	160	LM317K	350
LM305H	140	LM323K	625
78H05 5V/5A	550p	LM325N	240
78HG+5 to +24V 5A	650p	LM326N	240
79HG −2.25V to −24V 5A	850p	LM327N	270
		LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40

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

MINIATURE
Non Locking

Push to make	15p
Push break	25p

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 Biased	145
3 pole c/over	205

ROCKER: 5A, 250V, SPST **28p**
ROCKER: (white) 10A 250V SPDT changeover **38p**
ROCKER: With neon lights red when on. 10A 250V, DPST **85p**
ROCKER: (White) 10A/250V DPDT **72p**

ROTARY: "Make-A-Switch" Make your own multiway Switch as required. Shafting assembly has adjustable stop. 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 pole/2 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**

CRYSTALS

100KHz	300
455KHz	370
1MHz	295
1·008M	295
1·8432M	300
2·0MHz	305
2·4576M	305
3·2768M	290
3·57954M	150
4·0MHz	290
4·032M	290
4·194304M	270
4·433619M	150
5·0MHz	290
5·185M	300
5·24288M	390
6·0MHz	290
6·144M	295
6·5536M	290
7·168M	290
7·68MHz	300
8·0MHz	290
8·867237MHz	270
10·0MHz	290
10·7MHz	270
12·0MHz	290
14·31818M	320
16·0MHz	290
18·0MHz	290
18·432M	290
26·69M	290
27·648M	330
38·66667MHz	290
48·0MHz	270
100·0MHz	375

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- **PSU** 5V/3A for above **£18**
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- **Space Invaders for Superboard** (4K) **£5**
- **UK101 New Issue Compukit.** Complete kit **Only £149**
- **4K Memory** (8×2114) **£10**
- **SEIKOSHA GP80A.** Unihammer, 80 column impact matrix printer. Light weight (2·5Kgs) Now being offered at a rediculously low price of **Only £195**
- **EPSON TX80** 80 column dot matrix printer available in tractor feed or friction feed. **£235**
- **VIDEO GENIE** based on TRS80 16K RAM NEW VERSION **Only: £289**
- **SOFTY.** Intelligent EPROM Programmer Kit **£99**
  Ready-Built & Tested **£120**
  PSU for above (Built) **£20**
- **TEX UV EPROM** Eraser. Erases up to 32 ICs in 15-30 min. **£33**
- **UHF MODULATOR** 6MHz **280p**
  UHF MODULATOR 8MHz **450p**
- **KEYPADS** 4×4 matrix **350p**
- **Model 756 ASCII** Keyboard **£40**
- **10×C12 Cassettes** in stockable racks **£5.50**

p+p extra on all the above items.

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DIL PLUGS (Headers)

14 pin **44p**; 24 pin **88p**
16 pin **49p**; 40 pin **255p**
(DIL Sockets on opp. page)

'D' CONNECTORS

(Cannon type)

	Plugs	Sockets	Covers plastic
9 way	95p	125p	—
15 way	135p	198p	150p
25 way	198p	284p	170p
37 way	290p	398p	185p

AMPHENOL PLUGS
IEEE **475p**, Centronics // **575p**

DIL switches (SPST)

4 way	80p
6 way	98p
8 way	105p
10 way	175p
(SPDT) 4 way	190p

EDGE CONNECTORS

double type

	1	156
2×10 way	—	82p
2×15 way	—	98p
2×18 way	140p	120p
2×22 way	150p	125p
2×25 way	165p	160p
2×30 way	188p	—
2×36 way	197p	—
2×40 way	205p	—
2×43 way	250p	—

TRANSFORMERS

(mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA **98p**

8VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V-·25A 15V-·25A **220p**

12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2, 6V-1·2A 12V-·5A 12V-·5A **250p** (30p 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 **320p** (44p p&p)

50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A **365p** (60p p&p)

100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A **820p** (60p p&p)

JUMPER LEADS

Ribbon Cable Assembly
Single ended DIP, 24" length Cable
14 pin **145p** 16 pin **165p**;
24 pin **240p**; 40 pin **380p**.
Double ended DIP

Length	14 pin	16 pin	24 pin	40 pin
6"	185p	205p	300p	465p
12"	195p	215p	315p	490p
36"	230p	250p	375p	595p

WEMON

A 4k monitor specially designed to produce the best from your

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- True insert/delete.
- Fully programmable cursor control with meaningful symbols on screen.
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- Named tape files.
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- Cursor indication of quotes mode.
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- User controllable command vectoring for your own machine code routines.
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- Auto list on error (displays faulty line upon carriage return).
- Single command save (automatically returns "list").
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Monitor functions include:

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- Warm restart vector.
- Fill memory.
- Search memory.
- Two save and three load routines.
- Floppy disc vector.
- Break handling routine.
- Tabular display of memory.

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+ 50p P&P + VAT.

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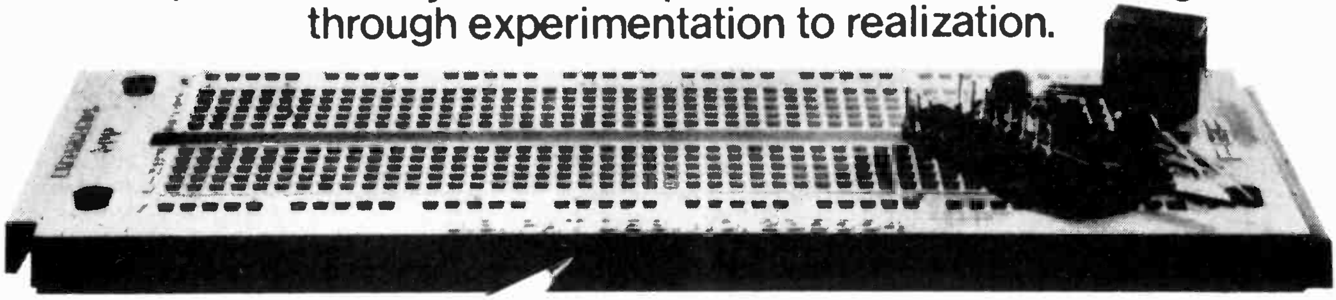
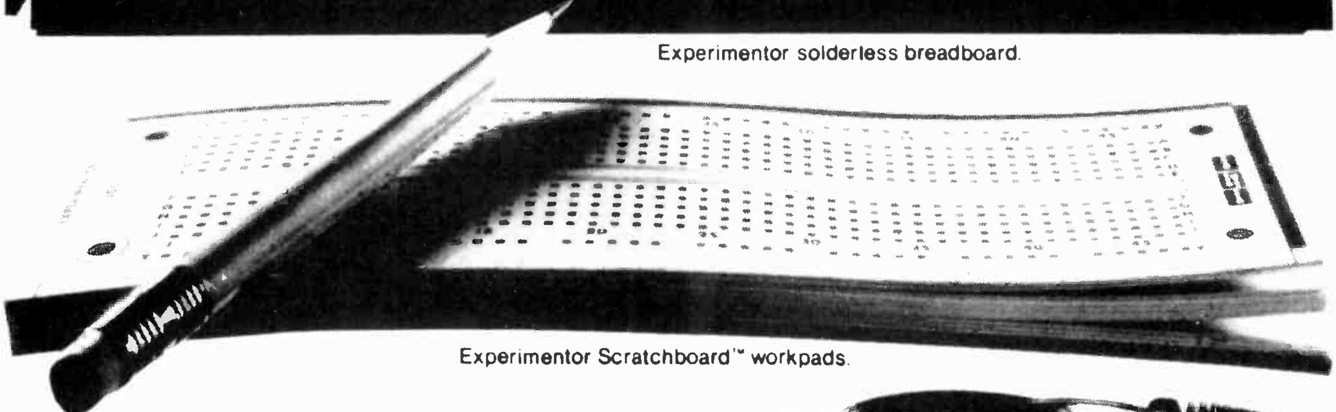
You can't beat The System.

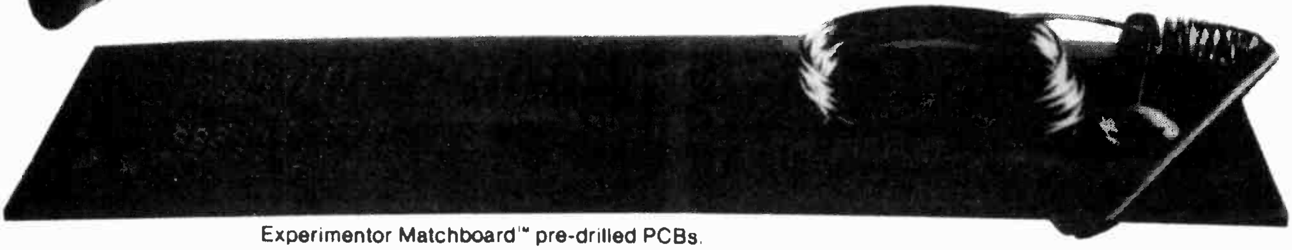
The Experimentor System™ —a quicker transition from imagination through experimentation to realization.



Experimentor solderless breadboard.



Experimentor Scratchboard™ workpads.



Experimentor Matchboard™ pre-drilled PCBs.

When you have a circuit idea that you want to make happen, we have a system to make it happen quicker and easier than ever before: The Experimentor System.

You already know how big a help our Experimentor solderless breadboards can be. Now we've taken our good idea two steps further.

We've added Experimentor Scratchboard workpads, with our breadboard hole-and-connection pattern printed in light blue ink. To let you sketch up a layout you already have working so you can reproduce it later.

With Experimentor Matchboard you can go from breadboard to the finished product nonstop! We've matched our breadboard pattern again, this time on a printed circuit board, finished and ready to build on. All for about £1.20

There's even a letter-and-number index for each hole, so you can move from breadboard (where they're moulded) to Scratchboard™ (where they're printed) to Matchboard™ (where they're silkscreened onto the component side) and always know where you are.

When you want to save time and energy, you can't beat The Experimentor System.

1. EXP-300PC, which includes one item A Matchboard pre-drilled PCB **£1.20**	**2.** EXP-302 which includes three items Three 50-sheet Scratchboard workpads **£1.50**	**3.** EXP-303 which includes three items Two Matchboards and an EXP-300 solderless breadboard **£7.60**	**4.** EXP-304 which includes four items Two Matchboards, an EXP-300 breadboard and a Scratchboard workpad **£8.70**

GLOBAL SPECIALTIES CORPORATION

GSC

G.S.C. (UK) Limited, Dept.5W
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Saffron Walden, Essex. CB11 3AQ.
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Telex: 817477

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Address ______________________

Inc P&P and 15% VAT

1.EXP 300PC **£2.25**	Qnty.Reqd.	2.EXP 302 **£2.58**	Qnty.Reqd.
3. EXP 303 **£9.40**	Qnty.Reqd.	4. EXP 304 **£11.15**	Qnty.Reqd.

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YOUR SOUNDEST CONNECTION IN THE WORLD OF COMPONENTS AND COMPUTERS

UK101

£149 IN KIT FORM
£199 READY BUILT & TESTED
£225 COMPLETE IN CASE

4K Expansion (8x2114) NOW ONLY £14.00

No extras required
- ★ Free sampler tape
- ★ Full Qwerty keyboard
- ★ 8K basic incl garbage collection routine
- ★ Ram expandable to 8K on board (4K inc)
- ★ Kansas City tape interface
- ★ NEW MONITOR ALLOWS FULL EDITING & CURSOR CONTROL **NOW INCLUDED IN KIT**

CASES

Available for U.K. 101, Superboard Nascom, Appx. DIM. 17″ x 15″ 435 x 384 mm.

PRICE £24.50
Post + Packing £1.50

VIDEO GENIE

VIDEO GENIE based on TRS80

Utilises Z80, 12K level II Basic, Integral Cassette Deck, UHF O/P, 16K RAM, all TRS80 features. Simply plugs into monitor or UHF TV with VU meter.

£289

	£
Expansion Box	185.00
Expansion Box (RS232)	215.00
16K Ram Card	94.00
32K Ram Card	129.00
Single Disk Drive (35 track)	215.00
Dual Disk Drive (40 track)	410.00
Parallel Printer Cable	17.00
Disk Drive Cable (4 drives)	32.00
Dual Disc Drive Cable	17.00
Parallel Printer Cable for Unexpanded V.G.	33.00
Sound Kit (fitting extra)	7.00
Lower Case Kit (fitting extra)	27.50
Video Genie Technical Manual	£5.00

UK101 SOUND

Sound generator and combined parallel in out port kit containing P.C.B., AY-3-8910, 6520 PIA, fully documented and demo tape.

£29.95

AY-3-8910 **£8.50**

UK101 MEMORY BOARD

★ On board power supply (uses the UK101 transformer). ★ Facility for 4K eprom expansion. ★ Fully buffered for expansion via 40 pin socket ★ 40 pin header & 8T28's included.

8K Kit (inc. 16K skts) **£79.95.** 16K Kit **£106.95**
Printed circuit board **£29.95**

PARALLEL PERIPHERAL INTERFACE

UK101 AND SUPERBOARD COMPATIBLE.
Interfaces to GP80, MX80 series, TX80, centronics P1, etc printers. Can operate relays, motors, various other peripherals. LED binary display. Plugs into ACIA socket. Fully documented.

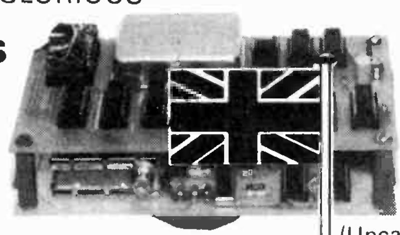
ONLY
Built and tested. **£29.95**

UK101 COLOUR BOARD

A U.K. PRODUCT AT LAST!!

Designed to simply plug into your computer and any standard colour television in

"8" GLORIOUS **COLOURS**



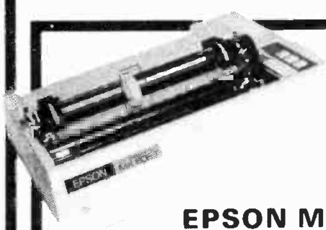
KIT (Uncased)

Includes full documentation and demonstration tape.

UK101, Superboard **£84.95**
Available for Pet **£98.95**

Send for further details.

PRINTERS



EPSON MX80 £359
9 x 9 dot matrix, 80 c.p.s. True descenders, various print densities up to 132 columns, tab controls both horizontal & vertical, bold expanded condensed printing, bidirectional.

EPSON MX80 FT/1 £399
Dual single sheet friction and continuous tractor feed, 9 wire head, true descenders.

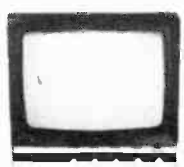
EPSON MX80 FT/2 £449
Additional feature to FT/1 is high resolution graphics.

EPSON MX70 £259
Tractor feed, 7 wire head, high resolution graphics.

SEIKOSHA GP80A £199
Dot matrix 5 x 7, 80 columns, 30 cps, graphics, double width characters.

MONITORS

EG100 12″ Black & White **£65**
Moni 9″ (illust) B&W **£82**
Hitachi Professional Monitors
9″ Black & White **£99.95**
12″ Black & White **£149**



BARCLAYCARD VISA

Please add VAT 15% to all prices. Postage on computers, printers and cassette decks charged at cost, all other items, P&P 30p. Place your order using your Access or Barclaycard (Min. tel order £5). Trade and export enquiries welcome. Official orders welcome.

Access

REMOTE CONTROL COMPONENTS AND KITS

LD271 IR Emitting diode .36
SFH205 Photodiode Detector .90
SL480 IC Pulse Amp. 1.70
SL490 32 Command Encoder/transmitter 2.40
ML922 10-channel receiver + 3 analogue outputs 4.20
ML926 16-channel receiver 4 momentary binary outputs 1.40
ML928 16-channel receiver, 4 latched binary outputs 1.40
ML929 16-channel receiver, 4 latched binary outputs 1.40
Clip-on Plastic Reflector for IR LEDs, increases range .20

ML925. A decoder designed for model/toy control, providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights, etc. 2.10

To make things EVEN EASIER, we have designed several new kits:—

MK6 – Simple Infra Red TRANSMITTER. A Pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery. 4.20

MK7 – Infra Red RECEIVER. Single channel, range approximately 20 ft. Mains powered with a triac output to switch loads up to 500W at 240V ac, but can be modified for use with 5 to 15V dc supplies and transistor or relay outputs. 9.00

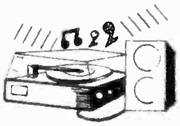
***Special Price *MK6 and MK7 together. Order as RC500K. 12.50**

MK8 – Coded Infra Red TRANSMITTER. Based on the SL490, the kit includes 2 IR LEDs, measures only 8×2×1.3 cms. and requires a 9V (PP3) battery. 5.90

MK9 – 4 Way KEYBOARD. For use with the MK8 kit, to make a 4-channel remote control transmitter. 1.90

MK10 – 16-Way KEYBOARD. For use with the MK8 kit, to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) Kit. 5.40

MK11 – 10 On-Off Channel IR RECEIVER with 3 analogue outputs 0-10V) for controlling such functions as lamp brightness, volume, tone, etc. Other functions include an on/standby output and a toggle output, which may be used for sound muting. Based on ML922 decoder IC. Includes its own mains supply. 12.00



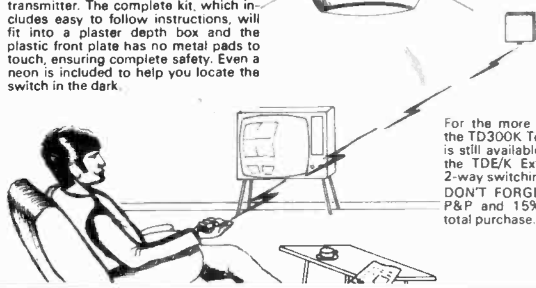
MK12 – 16 Channel IR RECEIVER. For use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary, depending on whether the ML926 or ML928 is specified. Includes its own mains supply. 11.95

MK13 – 11-Way KEYBOARD. For use with MK8 and MK11 kits. Transmits programme step + and –, analogue + and – (3), mute normalise analogue outputs, and on/standby. 4.35

ARE YOU SITTING COMFORTABLY?

Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter. The complete kit, which includes easy to follow instructions, will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.

In years to come everyone will be selling remote control dimmers, but you can have your TDR300K kit now for ONLY **£14.30** for the dimmer unit and **£4.20** for the transmitter.



For the more athletic of you the TD300K Touchdimmer kit is still available at **£6.50** and the TDE/K Extension kit, for 2-way switching etc., is **£2.**
DON'T FORGET to add 50p P&P and 15% VAT to your total purchase.

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit **£14.90**
CT1000KB with white box (56/131×71mm) **£17.40**
Ready Built **£22.50**

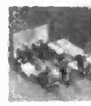
DIGITAL VOLTMETER/ THERMOMETER KIT

£19.50

Digital Voltmeter
Based on the ICL 7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery).

DISCO LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.



DL1000K
This kit features a bidirecitonal sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates meter dimming control. **£14.60**

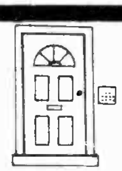
DLZ1000K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**
Optional Opto Input DLA1 **60p**

INTEGRATED CIRCUITS

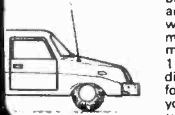
555 Timer	21p
741 Op Amp	19p
AY-5-1224 Clock	£2.60
AY-5-1230 Clock/Timer	£4.50
AY-3-1270 Thermometer	£8.20
CA3080 Transconductance Op. Amp.	72p
CA3130 CMOS Op. Amp.	75p
ICL7106 DVM (LCD Drive)	£7.00
LM377 Dual 2W Amp.	£1.45
LM379S Dual 6W Amp.	£3.50
LM380 2W Audio Amp.	80p
LM382 Dual low noise re amp.	£1.00
LM386 250mW low voltage amp.	75p
LM1830 Fluid level Detector	£1.50
LM2917 F/V Converter (14 pin)	£1.80
LM3909 LED Flasher/oscillator	60p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver (linear)	£2.10
LM3915 Dot/Bar Driver (log.)	£2.20
MM74C911 4-digit Display Controller	£6.50
MM74C926 4-digit counter with segment output	£4.50
S566B Touchdimmer	£2.50
SL440 AC Power Control	£1.75
SN76477 Complex Sound Generator	£2.52
TBA800 5W Audio Amp.	68p
TBA810AS 7W Audio Amp.	£1.00
TCM7555 CMOS 555 Timer	79p
TDA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp.	£2.85
TL081 J-FET Op. Amp.	37p
TL082 Dual J-FET Op. Amp.	60p
TMS1121 Clock/7 day timer	£8.50
ZN1034E Timer	£1.80

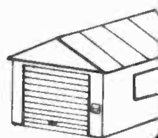
All ICs supplied with Data Sheets.
Data Sheets only – per device **10p**

EVERY DOOR SHOULD HAVE ONE



Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors. The unit, which comes complete with a 10-way keypad, requires an easily remembered four digit code to be entered before the door can be opened, while the Intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre-wired plug and a momentary or latched output version can be made. The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code. The complete kit measures 7×6×3 cms. deep and consumes a mere 40uA when not in use, and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for **ONLY £10.50** and think about all the keys you can lose or forget without ever locking yourself out. **(As featured in P.E. May '81.)**





CMOS

4000	17p	4019	42p	4069	19p
4001	18p	4023	22p	4070	19p
4002	18p	4025	21p	4071	18p
4007	17p	4026	£1.30	4077	26p
4011	19p	4027	40p	4081	20p
4012	17p	4028	50p	4093	54p
4013	38p	4040	80p	4501	24p
4015	75p	4049	38p	4511	90p
4016	35p	4050	40p	4514	£1.80
4017	70p	4060	£1.08	4516	£1.80

CAPACITORS

Polyester 250V

0.01	6p	0.22	12p
0.002	6p	0.33	12p
0.033	7p	0.47	15p
0.047	7p	0.68	18p
0.068	7p	1.0	24p
0.1	7p	1.5	27p
0.15	12p	2.2	31p

Electrolytics A Axial R Radial

63V	1.0	R	5p	16V	10	R	5p
	2.2	R	5p		22	R	5p
	4.7	R	6p		33	R	5p
	10	R	7p		47	R	6p
	47	R	12p		100	R	8p
25V	22	A	8p		220	R	11p
	47	A	10p		470	R	14p
	100	A	14p		1000	R	20p
	110	A	15p	10V	47	A	8p
	470	A	24p		100	A	8p
	1000	A	34p		220	A	12p

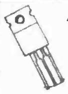
Tantalum (bead)

35V	0.1	9p	10V	22	20p
	0.22	9p	6.3V	33	20p
	0.47	9p		47	27p
	1.0	9p	3V	100	27p
25V	2.2	10p			
	4.7	14p			
	10	20p			

Ceramic 50V

		1,000pF	4p
100pF	4p	2,200pF	4p
220pF	4p	4,700pF	5p
470pF	4p	10,000pF	5p

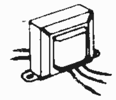
TRIACS



400V Plastic Case (Texas)

3A TIC206D	49p
8A TIC226D	58p
12A TIC236D	85p
16A TIC246D	96p
25A TIC263D	190p
6A with trigger Q4006LT	80p
8A isolated tab TXAL226B	65p
Diac	18p

MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

Opto Isolated Triac
MOC3020 0.6A/400V **£1.10**

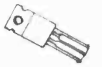
LEDs

0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red	16p
Rectangular Green	17p
Rectangular Yellow	17p

Flat Face rectangular, Triangular, Arrowhead or Square

Red	17p
Green	20p
Rec. Yellow	20p

VOLTAGE REGULATORS



Available in 5V, 12V, & 15V versions.

78L series 100mA pos.	26p
79L series 100mA neg.	60p
78 series 1A pos.	52p
79 series 1A neg. 5V	75p
LM317T adjustable 1.2V-37V 1.5A	£1.80

RECTIFIERS

1N4001 1A/50V	4p
1N4004 1A/400V	6p
1N5401 3A/50V	8p
1N5404 3A/400V	10p
1A 50V Bridge	19p
1A 400V Bridge	22p
3A 50V Bridge	48p
3A 400V Bridge	58p

(Bridge rectifiers are miniature PCB mounting types)

VMOS POWER FETS

VN10KM 0.5A/60V (TO92)	52p
VN66AF 2A/60V (TO220)	88p

TRANSISTORS

BC108	8p	BFY50	20p
BC182	8p	TIP31A	40p
BC182L	8p	TIP32A	40p
BC212	9p	2N3055	45p
BC212L	9p	2N3442	90p
BC337	16p	2N3819	20p

DISPLAYS

FND504 Red 0.5" c.c. pin compatible with DL504 **75p**
DL307 Red 0.3" c.a. pin compatible with DL707 **75p**
DL727 Dual 0.5" c.a. Red **£1.50**
MP463 0.5" c.c. Red, four digit multiplexed **£2.20**
DL 34M 0.1" Bubble magnified 4 digit c.c. multiplexed 14 pin DIL package. Red **£4.50**

D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p
Soldercon Pins			50p/100

MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

MK1 TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater. 1KW **£4**

MK2 SOLID STATE RELAY
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA 1024 Zero voltage switch, this kit may be wired to form a "burst fire" power controller enabling the temperature of an enclosure to be maintained to within 0.5°C. 3KW **£5.55**

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW. **£4.50**

BOXES

Moulded in high impact ABS. Supplied with lids and screws. Black.

B1 75×56×35mm	65p
B2 95×71×35mm	85p
B3 115×95×37mm	95p

ZENER DIODES

400mW3 3V-30V	8p
1 3W 7.5-27V	15p

RESISTORS

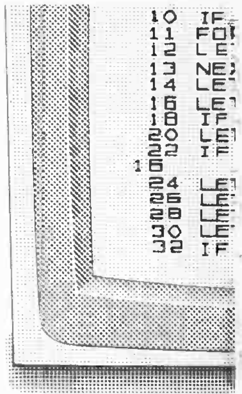
¼W 10 ohm-10M. E12 series.
Pack of 10 (one value) **10p**
10 packs (10 values) **80p**

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD 50p P&P and 15% VAT TO TOTAL. OVERSEAS CUSTOMERS ADD £1.50 (Europe). £4 (elsewhere) for P&P. Send sae for price list and with all enquiries. Callers welcome 9.30 5.00 (Mon-Fri) 10.00 4.00 (Sat.)

TK Electronics
(PE7), 11 BOSTON ROAD
LONDON W7 3SJ. 01-579 9794

VISA

New! Sinclair ZX81 Personal Computer.



Kit: £49.95 complete

Built: £69.95 complete

Reach advanced computer comprehension in a few absorbing hours

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

Lower price: higher capability
With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

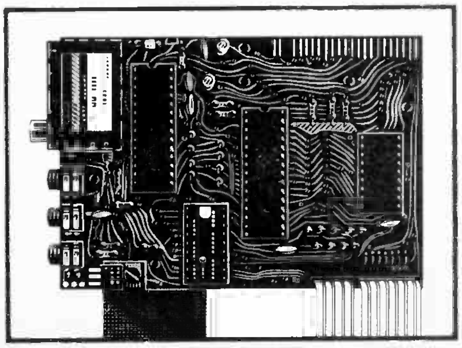
Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

Kit or built – it's up to you!

The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

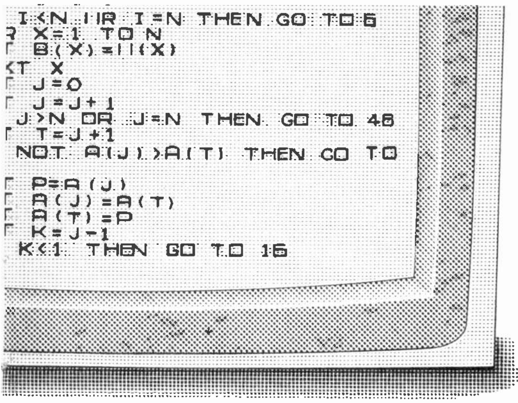
Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



Proven micro-processor, new 8K BASIC ROM, RAM – and unique new master chip.

New Sinclair teach-yourself BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.



If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

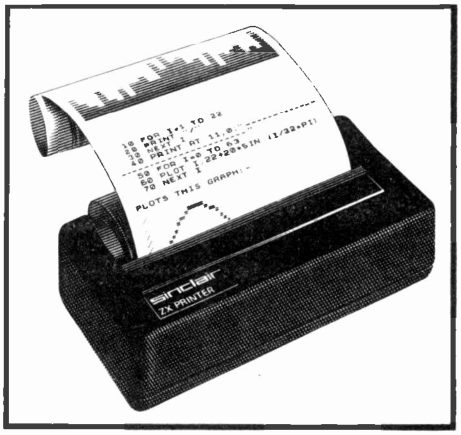
Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer (not available yet – but coming soon!)
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Coming soon – the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics across 32 columns, *and* highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 – watch this space!



How to order your ZX81

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	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
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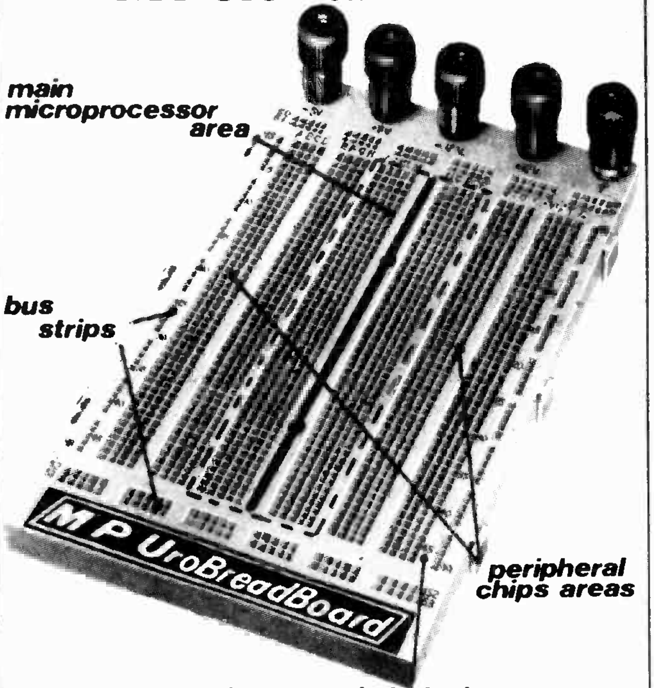

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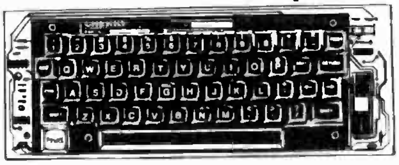

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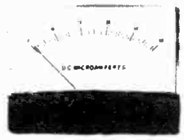

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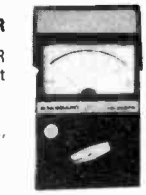

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PE VOLUME 17 No. 7 JULY 1981

THE END OF THE TUNNEL?

THERE have been one or two comments recently that the light at the end of the depression is just beginning to show and, although many component retailers are still finding the going a bit tough, there have been a couple of announcements recently that give rise to hope.

The main announcement was the draft specification on CB from the Home Office. Since its publication there has been plenty of discussion on how it meets the aspirations of the present illegal users, which of course it never could unless it allowed the American standard equipment. We believe the proposals are basically generous and the "U" turn made by HM Government in allowing the use of 27MHz is probably the best way out of the mess created by the delayed legalisation of a CB frequency. The proposals should give rise to a worthwhile system, probably giving better performance than the present a.m. CB. The Home Office announcement is covered on page 24 in this issue, PE will be publishing more on CB in the September issue and we will make our announcement next month.

Let us hope that British manufacturers will capitalize on the need for new sets, accessories and for modification of the old transceivers — though it may be expensive to get many of them to meet the Home Office requirements. We look forward to mass use of the system by a wide cross section of the community and we hope that most of the jargon now in use will not continue on the new band. One young lady (Editor's wife!) proclaimed that there was no way she was going to talk about "rubber apples and yellow ducks", when it was suggested that CB could be a great assistance in the home, car and office. This view is typical of many who are frightened off CB by all the "in talk" so let's see straightforward use by everyone, old and young.

COMPUTER PRESERVATION

The second announcement that shows problems can be overcome in these difficult times came from Lucas. They have now bought the old Nascom company which has been living "hand to mouth" under the receiver for some time. The Nascom products were basically good and their computers have always been in great demand by the hobbyist. Lucas Logic propose to improve some of the present products, introduce a "Nascom case" and are talking about the launch of a new system before too long. Although the company is now owned by Lucas the Nascom name will be retained.

This must be a triumph for all concerned with Nascom during its recent problems. It is remarkable that by careful handling and great efforts by all concerned production has continued and every new unit has been eagerly snapped up. When many companies are struggling for survival this preservation is truly noteworthy.

On another happy note Inmos have received the first Tobie award for "Research Achievement" on its 16K static RAM. The product has taken some time to appear but it looks good and should become the 16K industry standard. The Electronics Industry (or Tobie) Awards were organised in conjunction with the All Electronics/ECIF Show.

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Technical 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 Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope 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 some of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders
Binders for PE are available from the same address as back numbers at £4·30 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 £11·80 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.

...news &

Edited by David Shortland & Jasper Scott

TXs get Teletext

Thorn Consumer Electronics who recently won a Queen's Award for Technological Achievement with their Ferguson TX colour television range have now released three new Teletext models.

Both the TX 9 chassis (14 to 22in) and the TX 10 chassis (22 to 26in) were designed from the outset to incorporate remote control and Teletext functions without the need for component or circuit changes to the chassis.

Thorn now believe that many of the colour sets bought during the boom period in the early and mid seventies will be replaced with remote control sets incorporating Teletext.

Nigel Schofield, Thorn's market analyst, said recently, "Almost half of all the 22in sets now incorporate a remote control facility, while the figure for 26in sets is almost 70 per cent. The consumer desirability of remote control is evident, and full remote models, including those with Teletext, outnumber simple remotes by two to one. Towards the luxury end of the colour market, Teletext already accounts for over 20 per cent of 26in deliveries to the trade, and the current market projection is for 175,000 consumer sets this year, which entails a tripling of last year's volume, which had itself shown a 200 per cent increase on the previous year."

Another reason Thorn are confident Teletext will become a major force in TV sales is that the cost of providing a Teletext facility to a remote control TX set is about £90 and this figure is expected to drop even further as the demand for sets increases.

Three screen sizes are available in the Teletext range: a 20in model (TX 9) and two TX 10 models (22in and 26in). The sets are designed around the Mullard decoder module with full infra-red remote control for all picture adjustments, channel selection and Teletext functions.

Ferguson have also released three add-on accessories for their range of TX models, all of which can be quickly fitted by a qualified dealer. The isolated chassis of the TX 10 makes it simple to feed signals in and out without the need for isolating components.

The TA120 enables the audio signal from the TV to be connected to a hi-fi system via a DIN socket without the loss of sound quality. As an extension of the TA120 Ferguson have introduced a loud speaker which enhances the television sound and is controlled by the TV's remote control. The speaker has been designed to be placed alongside or under the television and to prevent the loss of colour purity which occurs when conventional hi-fi speakers are similarly placed the drive units incorporate low leakage field magnets.

For those who wish to use their TVs for video recording or for encoded video from a video camera then the TA124 incorporates high performance buffer amplifiers for two-way video and sound signals. The TA124 enables recorded material to be replayed via a video input socket instead of the usual aerial socket.

A battery adaptor (TA92) is also available for the TX 9 range of portable TVs which will give up to five hours' viewing with an automatic cut-out to prevent excess battery drain.

Dansette to be resurrected

J. J. Silber, who have recently been in the news having acquired the brand name of Murphy, have announced that they have also purchased the Dansette name.

Many readers will no doubt remember Dansette record players and portable radios, though the name has disappeared in recent years.

Silber, who believe that Dansette was known as a name synonomous with good quality budget equipment, feel that there is room for a 'a high volume, low priced, quality product,' and that prospective purchasers will be encouraged by the Dansette name.

There are already plans for the introduction of a new range of stereo radio/record players. They will be introduced to the market during the middle of this year and if all goes according to plan they will have a substantial price advantage over other products in this field, and, claim Silber, will incorporate refinements normally associated with products in higher priced markets.

No figures for the purchase have been disclosed, but it has been described as 'a very reasonable sum'.

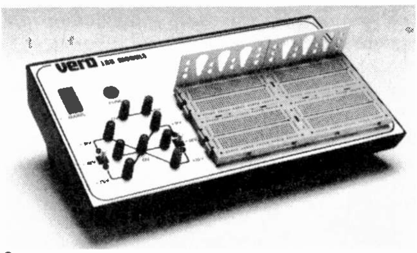
CLASSY BREADBOARD

The Verobloc laboratory module is Vero's latest solderless breadboard product and has been developed to simplify breadboard work. It features a large breadboard area and has a fully regulated three rail power supply (5V d.c. at 750mA, ±9V, ±12V, ±15V at 250mA) which is ideal for both TTL and CMOS.

The system which accepts most sizes of d.i.l. packages, diodes, resistors, capacitors, transistors and wire links comes ready assembled, complete with four Veroblocs and two pre-pierced front panels for mounting fuseholders, switches, trimpots etc. The d.c. voltage supplies may be picked up via 2mm jack sockets and toggle switches are provided for voltage selection.

The Verobloc which features tin copper nickle alloy contacts has bus strips for power distribution on both X and Y axes. All the contact positions are identified by moulded alpha numeric grid references.

The price of the Verobloc module (184–22880J) is £84·00 excluding VAT and p&p. For further details contact Vero Electronics Limited, Industrial Estate, Chandler's Ford, Hants.



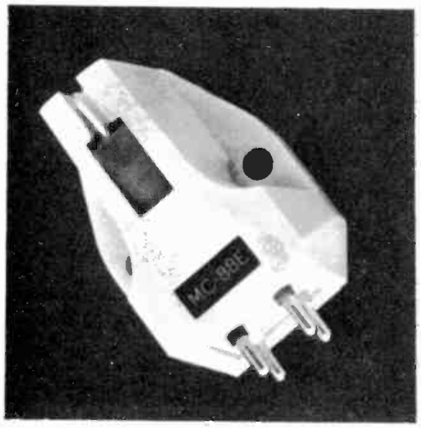
MARKET PLACE

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

MOVING COIL 'BREAKTHROUGH'

The introduction of the MC88E moving coil cartridge is the culmination of an intensive product and manufacturing development by Coral. Its high output voltage of 2·5mV does away with the need for a head amplifier or a step up device and this has been achieved by using a miniaturised armature, a unique coil winding technique and a compact magnet which generates a high magnetic flux density.

A low impedance has been obtained which is less than 1/20th of a regular moving coil cartridge weight. This ensures flat, stabilised electrical characteristics over the total audio range.

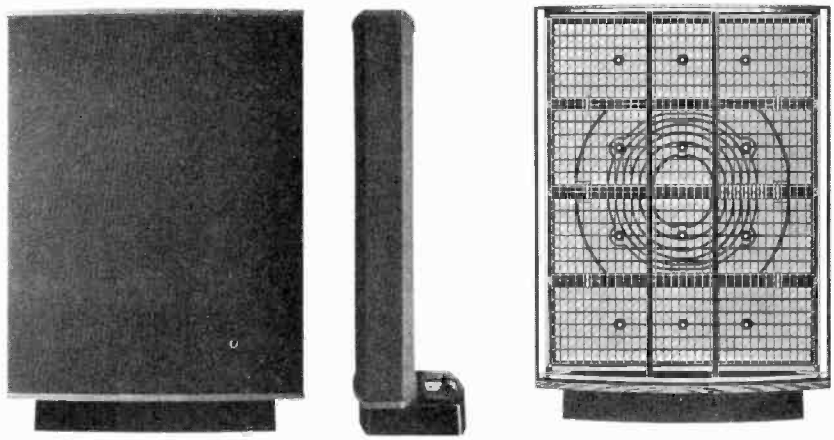


Coral's one point suspension system in which the centre of each armature is fully supported, effectively checks harmonic and intermodulation distortions and accomplishes excellent localisation for natural stereo.

The cartridge's very light weight of only 5grms will enable optimum balancing with most lightweight tone arms.

The MC88E is available for £29·95 from Videotone Ltd., 98 Crofton Park Road, London SE4 (01-690 8511).

A GRAND PAIR...



Quad have finally released a successor to their electrostatic loudspeaker which has been a standard in the hi-fi field for twenty-five years.

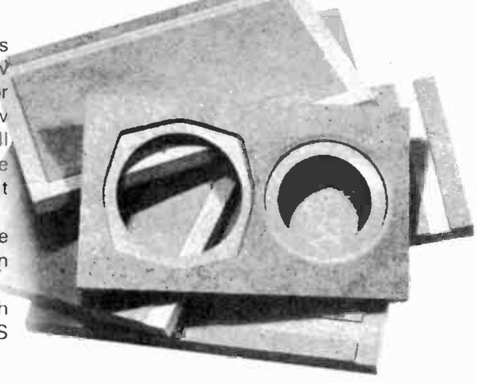
The Quad ELS63 which measures 925 × 66 ×27mm has an input impedance of 8Ω (largely resistive) and is suitable for use with amplifiers that have an output rating of 40V peak (100W into 8Ω). Amplifiers which are not short circuit protected should not be used with the ELS63.

The speaker is fitted with two protection circuits: one limits the maximum input voltage applied and the other detects fault conditions and shorts the applied signal. Although it is impossible to damage the speaker elements, the input voltage limiter can be damaged by persistent overdriving.

A small word of warning from Quad, however, to all those hi-fi buffs who *can* afford the £1000 price tag for a pair of ELS63's. Quad say that although the ELS63 will give a more realistic picture of an acoustic event than has ever before been possible, the real excellence of the speakers will only be fully realised if the very best source material is used and that ELS63's are very good at revealing any recording faults.

Quad Electroacoustics Ltd., Huntingdon, Cambs. (0480 52561).

CABINET KITS



For the loudspeaker constructor who wants a professional finish, Wilmslow Audio now stock a range of flat-pack cabinet kits for many popular designs including the new Wharfedale E50, E70 and E90 kits. All panels are accurately cut to size, and baffle boards have the necessary apertures cut and rebated if required.

When assembled, the cabinets may be painted, stained, or finished with iron-on veneer.

Wilmslow Audio Ltd., 35-39 Church Street, Wilmslow, Cheshire, SK9 1AS (0625 529599).

...NEWS &

MAIL ORDER

The latest 24 page catalogue from Rapid Electronics shows a large increase in their range of components and hardware. Rapid have also increased their stockholding so that they are able to offer a return of post service with an immediate refund made against any item out of stock.

The catalogue is available upon receipt of two 14p stamps. Rapid Electronics Ltd., Hillcroft House, Station Road, Eynsford, Kent (0322 863494).

A leaflet is available from Cotswold Electronics Ltd., describing their "budget range" of toroidal transformers in 30, 60, 100, 160, 230, 330 and 530VA sizes and at prices ranging from £4·55 to £15·80.

Cotswold will accept "freepost" cheques, P.O.'s, money orders, Access and Barclaycard, and will accept credit card orders on a 24 hour answering service. All the customer needs to do is quote a type number, mains voltage, secondary voltage, VA rating and quantity required.

All types are normally supplied with 240, 110 or 220V primary windings but special windings can be supplied on request. Dual secondary windings from 6 + 6V to 50 + 50V are available and the choice is determined by the VA rating. The secondary windings can be operated in series, parallel or independently.

Cotswold Electronics Ltd., Unit T1, Kingsville Road, Kingsditch Trading Estate, Cheltenham (0242 41313).

BASICALLY BRITISH

A British company, LSI Computers Ltd, have launched into the personal/small business computer market with the introduction of their M Three system. According to LSI, M Three, which has been developed with the help of a 25 per cent government grant, offers more ability, storage and user satisfaction than any comparable machine at present on the market.

In its basic form, M Three consists of a Zilog Z80 chip surrounded by 64K of RAM, two double-density mini-floppy disc drives, LSI's own VDU with 1920 character green phosphor display and a full functional keyboard. In addition to the normal QWERTY layout, the keyboard has editing keys, cursor control, numeric pad and fourteen programmable function keys.

It comes equipped with a CPM operating system and is programmable by users in high level languages such as BASIC, COBOL, etc. Applications software is also available from LSI including accounting, payroll, and stock control.

Prices for M Three range from £3000 to £4000. LSI can also supply suitable printers and other hardware.

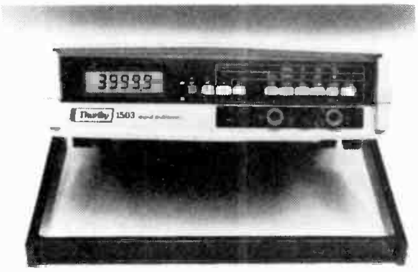
VERSATILE MULTIMETER

The latest multimeter from Thurlby is the 1503 DMM which offers the bonus of a built-in frequency meter. Frequencies up to 3999·9kHz can be measured directly with a resolution of 100Hz. Accuracy is ±1 digit over a 10°C–30°C temperature range and is defined by a 6MHz crystal timebase. A movable decimal point allows for external pre-scaling by those wishing to extend the measurement range to 40MHz or 400MHz.

In normal multimeter mode, the instrument has a high resolution $4\frac{3}{4}$ digit scale length and sensitivity figures of 10µV, 10mΩ and 1nA. There are 32 ranges provided enabling measurement of a.c. and d.c. voltage, resistance, diode test, and a.c. and d.c. current up to 25 amps.

The 1503 which is priced at £139 plus VAT has a liquid crystal display and can be powered from internal batteries or from the mains.

Thurlby Electronics Ltd., Office Suite 1, Coach Mews, The Broadway, St. Ives, Huntingdon, Cambs (0480 63570).



POINTS ARISING . . .

POSITIVE IMPEDANCE CONVERTORS (June '81)

The tables mentioned in the worked examples of filter design can be found in 'Simplified Modern Filter Design' by Philip Gaffe, published by Iliffe.

ENLARGER TIMER (March '80)

Here, switches S4, 5, 6, 11, should be push-button normally off types. ICs 14, 15, 16 shown in Fig. 1 should be decoupled, that is, have 100n capacitors connected between +5V and 0V.

MARKET PLACE

NEW DEGREE

North Cheshire College have recently announced the launching of a new Bachelor of Education degree entitled "Computers in Industrial Society", which will be validated by the University of Manchester. The first student entry will be in September this year.

The degree has been planned to suit students with an arts background as well as those with a background in science, and it covers not only the technical aspects of microelectronics, but also the implications for industry and society in general.

In addition to periods of practical experience in schools, students will spend some time with an industrial or commercial organisation. This will be of particular value to those students not wishing to become teachers.

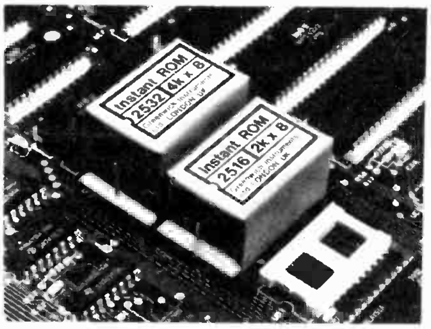
For further information, contact: Admissions (C.I.S.), North Cheshire College, Padgate Campus, Fearnhead, Warrington WA2 0DB (0925 814343 Ext. 6).

INSTANT ROM

A new programming aid for users of microcomputers (particularly the Commodore PET) has recently been announced by Greenwich Instruments Ltd.

Instant ROM is a CMOS memory package (2 or 4K) with battery back-up which plugs into any standard ROM/EPROM socket, or into the ROM expansion sockets of the PET and similar microcomputers. It can be treated as RAM, and machine code programs can be written into it. What makes Instant ROM unique is that the programs remain after the power has been switched off. It therefore behaves exactly like a ROM. Programs can be edited or altered immediately without erasure problems, yet the program is permanent.

When used with personal computers such as the PET, Instant ROM enables the user to write security and utility programs quickly, run and debug them, and then finally consign the correct program to EPROM. However, as the battery life is typically 6 years, it is also possible to ship a system with Instant ROM and to supply the ROM later.



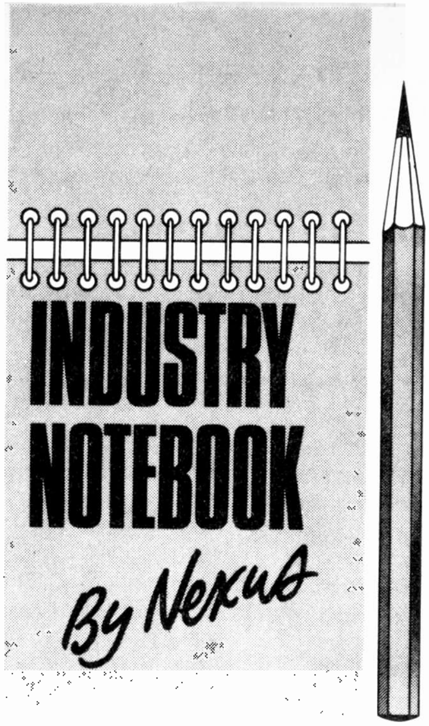
Prices, exclusive of VAT, are as follows: 2K devices: 2516 (for PET) and 2716—£39 inc. p&p; 4K devices: 2532 (for PET) and 2732—£56 inc. p&p. For further information contact Greenwich Instruments Ltd., 22 Bardsley Lane, Greenwich, London SE10 9RF (01-853 0868).

Countdown . . .

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below.

Transducer/Tempcon June 9–11. Wembley Conference Centre, London. **T**
Components June 9–12. Earls Court, London. **I**
Pet Computer Show June 18–20. West Centre Hotel, London. **B8**
Compec North June 23–25. Belle Vue Hotel, Manchester. **Z1**
International Word Processing Exhibition & Conference June 23–26. Wembley Conference Centre, London. **Z**
BEX Salisbury June 24–25. City Hall. **K**
Leeds Electronics Show June 30–July 2. University of Leeds **E**
National Education & Training (Exhibition & Conference) July 2–4. NEC, Birmingham. **B2**
BEX Portsmouth July 15–16. Centre Hotel. **K**
BAEC Amateur Electronics Exhibition July 18–26. The Shelter, Penarth Esplanade, S. Glam. **B9**
Microcomputer Show (& Seminars) July 29–31. Wembley Conference Centre. **O**
Solar Energy Exhibition Aug. 23–28. Brighton. **M**
Harrogate Int. Fest. of Sound Aug. 15–18. Royal Hall Exhibition Centre & Hotels. **X**
BEX Cardiff Sept. 3–4. Centre Hotel. **K**
Business & Light Aviation Sept. 3–5. Cranfield Airport. **Z1**
Microprocessor Workshop Sept. 7–8. University of Liverpool. **D**
Laboratory Sept. 8–10. Grosvenor House, Park Lane, London. **I**
Personal Computer World Show Sept. 10–12. Cunard Hotel, London. **M**
West of England Electronics Show Sept. 15–17. Bristol Exhibition Centre. **Q**
Business Telecoms & Electronic Office Sept. 23–25. Royal Lancaster Hotel. **O**
BEX Edinburgh Sept. 30–Oct. 1. Assembly Rooms. **K**
Viewdata Oct. 6–8. Wembley Conference Centre, London. **O**
BEX Bristol Oct. 14–15. Exhibition Centre. **K**
Video Show Oct. 16–18. West Centre Hotel, London. **Z1**
International Business Show Oct. 20–29. NE Conference, Birmingham. **A2**
Testmex Oct. 27–29. Wembley Conference Centre, London. **T**
Computer Graphics (Exhibition & Conference) Oct. 27–29. **O**
BEX Southampton Nov. 4–5. Polygon Hotel. **K**
Viewdata & TV User Nov. 4–6. West Centre Hotel, London. **Z1**
IFSEC (Fire & Security) Nov. 17–19. RDS, Dublin. **V**
Compec Nov. 17–20. Olympia, London. **Z1**
BEX Plymouth Nov. 18–19. Holiday Inn. **K**
INTRON Nov. 24–26. RDS. Dublin. **V**
There are **Continuous Events and Permanent Exhibition** at the National Micro & Electronics Centre. **L1**

A1 Inst. Electronics, Rochdale, Lancs.
A2 Hart Browne & Curtis ✆ 01-439 8556
A3 Sybex, 18 Rue Planchat, F-75020 Paris
B2 Brintex ✆ 01-637 2400
B5 Robin Bradbeer, N. London Polytechnic
B7 Modmags ✆ 01-437 1002
B8 Baroness International ✆ 01-734 2907
B9 BAEC, Penarth, S. Glam. ✆ 0222 707813
C Barry College Radio Soc. ✆ 0222 565656
D Liverpool Univ., Brownlow Hill, PO Box 147
D1 Infopress, 58 Fleet St. London
E Evan Steadman, Saffron Walden ✆ 0799 22612
F1 ARS Electronica, 34 High St., Saffron Walden
I ITF, Solihull ✆ 021-705 6707
K Douglas Temple, Bournemouth ✆ 0202 20533
L1 World Trade Centre ✆ 01-488 2400
M Montbuild Exhibitions ✆ 01-486 1951
O Online, Northwood, Middx. ✆ 09274 28211
Q Exhibitions For Industry ✆ 0883 34371
T Trident, Tavistock ✆ 0822 4671
V SDL ✆ Dublin 763871
V1 Jack Tootill, Ipswich ✆ 0473 44047
X Exhibition & Conference, Harrogate ✆ 0423 62677
Z BETA Exhibitions ✆ 01-405 6233
Z1 IPC Exhibitions, Sutton ✆ 01-643 8040



Scenarios

Imagine an industry once employing 505,000 regular whole-time workers now reduced to about 185,000. A dramatic decline by any standards and unquestionably qualifying for the use of words and phrases such as decimation, massacre, crucifixion or, at the very least, an obscenity or a national scandal. I choose the words, almost at random, from the current vocabulary of political hyperbole endlessly chanted in Westminster and the media. One might also expect a scream of anguish with over 300,000 honest and hard-working citizens 'thrown on the scrap heap'.

And yet this particular industry invites not a word of criticism and is not only admired but publicly highly praised. I refer to British agriculture, often described as the envy of the world and rightly so, with this comparatively tiny workforce producing 70 per cent in value of the food consumed by the nation's 56 million people and with a good export record as well.

Of course employment in agriculture has been declining over a long period. In 1801 it employed 36 per cent of the working population. By 1901 the figure had dropped to 9 per cent. But the figures quoted in my opening sentence are recent history, the period from 1960–1980. In 1960 the average wage of the half-million workers was £10·58. In 1980 the slimmed-down workforce was averaging close on £80 a week.

A similar scenario is now being enacted in manufacturing industry. Here again, slimming down has been taking place over many years but during the last decade was artificially delayed. The present phase of catching up (the alternative to going broke) is the natural and foreseeable result, with severe dislocation compounded by the general recession in trade.

The electronics industry with but few exceptions (e.g. ICL) has not only survived but prospered during the past two difficult years. It had, and still has, everything in its favour. It is a growth industry, it is highly innovative and, above all, it is still a young industry unhampered by traditional work practices which have proved such a curse in, for example, shipbuilding and steel. There are few industrial problems in introducing new processes and methods and in fact most of them originated in the industry itself. Computer-aided design (CAD), automatic component insertion, computer-aided manufacture (CAM) and, at the end of the line, automatic test equipment (ATE). No wonder output doubles and doubles again.

Even in electronics it is not an easy ride, particularly in the depressed areas of consumer electronics struggling against the flood of imports from the Far East. But UK manufacturers are grasping the nettle with products like the Ferguson TX TV, and Fidelity's new colour TV, the design of which cuts component count by 40 per-cent. In capital goods the outlook remains buoyant and morale is high.

Will the older industries follow the example of electronics with get-up-and-go? Let's look at BSC's Llanwern steelworks in South Wales. This modern plant was plagued by industrial disputes in which one or other of 17 unions was generally involved. Both productivity and morale were low. The 14-week steel strike in the spring of 1980 was a catalyst which helped changed attitudes. The realisation came that you had to feed the cow before you could milk it.

In just one year from the strike, Llanwern has doubled productivity and has now almost reached the productivity levels of the best in Europe. Demarcation has all but disappeared, absenteeism is all but absent, inter-union squabbles are forgiven and forgotten. Manning levels have been reduced by 60 per cent and everybody at Llanwern is much happier than in the past, especially so since production is to increase beyond that in the original slimming-down programme. Success has replaced failure, optimism has replaced despair.

It is now clear that Llanwern and its sister plants are not isolated exceptions. Textiles, one of the hardest hit industries, is now showing signs of recovery. Uncertainty in recent months is turning to confidence with investors returning to buy company shares and the recession 'bottoming out'.

Inmos

Inmos is thankfully now showing positive signs of life. This is the controversial VLSI company formed with financial backing from the British taxpayer and promising to establish large production facilities (for 4,000 people) in the UK. I was reporting this news in the November 1978 issue of PE, together with news of a 50/50 GEC/Fairchild project which I forecast would be in production ahead of Inmos.

Well, I was wrong in respect of GEC/Fairchild. The idea was dropped when Fairchild was acquired by Schlumberger and GEC has since taken a different path.

Inmos, however, continued in business, first absorbing £25 million of start-up cash and then a further £25 million. A pilot production plant was set-up, not in a depressed area of the UK, but in Colorado Springs, USA. So far as extra employment in the UK has been created, there is almost a nil return except for a handful of experienced people who would have had no difficulty in finding employment anyway.

The good news is that Inmos now has some semiconductor products to sell and has started setting up a distribution chain in the UK and the rest of Europe. Dr. Richard Petritz, the American president, chief executive and co-founder of Inmos, is not promising instant success. He accepts that the coming year is full of risk with spending continuing at a high rate and sales still very small.

While wishing Inmos every success I remain sceptical that there will be any serious production in the UK, at least for a number of years. And it takes a good deal of imagination to believe that Inmos will ever employ 4,000 people in the UK in four factories. In fact only one is in construction. But Inmos has an imaginative outlook and the dream could still come true!

Shuttle

The spectacular success of NASA's Space Shuttle is wonderful news for all technologically based industries if only in re-establishing confidence and redressing the balance with the ecology and anti-nuclear lobbies. They have had considerable success in their knocking campaigns with the implication that all technology is harmful, its application shameful. Yet, these same lobbyists shamelessly use cars (responsible for more casualties than war), exploit television for propaganda, and some occasionally enjoy a hot bath by courtesy of atomic energy.

HF Radio

Twenty years ago as communication satellites started going into orbit there was much talk of the death of HF radio and submarine cables, the historical methods of long-distance communication. The 'experts' were wrong on both predictions. Submarine cables have prospered mightily, aided by new technology. And if HF radio today carries a less percentage of total traffic it still carries more than in the past.

Far from being in a terminal condition, HF radio has been honoured with two Queen's Awards: Marconi Communications for technological achievement with their fast-tuning techniques launched in 1976 and now in a second generation, and Racal Communications for export achievement with a trebling of overseas business in the past three years.

Redifon has also introduced a new professional quality HF receiver, the R500, company-funded, which adds weight to the proposition that HF radio will remain a valuable asset in the communications business to the end of the century and beyond.

CB Proposals...

27MHz and 934MHz F.M.

As most readers will by now be aware the Home Office have issued a Draft Performance Specification on CB to be operated on 27MHz and 934MHz f.m. The draft is in our view generous in its outline of 40 and 20 channel systems respectively with effective radiated powers of 2W—on 27MHz—and 3W (integral aerial!) or 25W on 934MHz.

Perhaps the only criticism that CB enthusiasts will level at it is that the selected frequencies are not compatible with those of any other country, but since there is little "legal" compatibility between most of the other systems anyway, the problems may not be too great. This would however limit the sale of UK-made equipment.

One point that the spec. does make very clear is that no equipment with the ability to transmit an a.m. signal will be permitted. Present sets will remain illegal, they may be converted to f.m. but they will have to conform to the spec. in every way, and will need to be marked with the official mark to show that they do.

At the time of writing, the Home Office expect to publish the final spec. through HMSO at or near the end of May and presumably the Control of Manufacture and Importation order 1968 will be amended soon after to enable sets to be made, etc.

We publish here the letter we received from the Home Office, the 27MHz forward (934MHz is virtually the same) and section 1 of the 27MHz draft (General) plus the differences in the 934MHz draft.

The full drafts run for 25 and 22 A4 size pages.

CITIZENS BAND RADIO SPECIFICATIONS

Thanks for your enquiry about the technical specification for authorised citizens band radio equipment.

It is hoped that a legal system of citizens band radio will be introduced later in the year. This will operate in the 27MHz band and the 934MHz band and as promised I enclose a copy of the draft specifications for each of these.

These draft specifications will be considered by a land mobile radio specification committee whose normal membership of UK manufacturing interests has been slightly augmented in this case. This committee is scheduled to hold its first meeting on the 24th April and if you have any comments on the specification I would be grateful if you would let me have them in writing prior to that date so that they may be taken into account.

The technical standards set out in the specifications will be reflected in regulations under Part II of the Wireless Telegraphy Act, 1949. These will set standards for equipment to which manufacturers, importers or assemblers will have to conform; they will also contain a requirement for conformity to be certified by the manufacturer, importer or assembler.

The Radiotelephonic Transmitters (Control of Manufacture and Importation) Order 1968 (SI 1968/61) prohibited the importation and manufacture of citizens band equipment. The Order remains in force and covers equipment capable of transmitting on any frequency between 26·1MHz and 29·7MHz, but in due course provision will be made for manufacture and importation of equipment which meets the technical requirements as they are finally established.

Citizens' band equipment operating with amplitude modulation will remain illegal under the new facility. Sets may be converted, provided that they then conform *in all respects* with the authorised technical standards.

Home Office
27.4.81

FOREWORD

1. Citizens Band Radio, a personal two-way radio system, is available for use throughout the United Kingdom. It operates in the 27MHz waveband and the 930MHz waveband.
2. The Wireless Telegraphy Act 1949 provides that no radio equipment may be installed or used except under the authority of the Secretary of State. All citizens band radio equipment, whether hand held, mobile or base station, must be covered by a licence; it is a condition of this that the apparatus fulfils, and is maintained to, certain minimum technical standards. This specification sets out these standards for 27MHz f.m. equipment; 934MHz f.m. equipment is subject to a separate specification.
3. The manufacturer, assembler, or importer of citizens band equipment is responsible for ensuring that the apparatus conforms with the specification; and any additional requirements imposed by regulations under the Wireless Telegraphy Act 1949. Conformity with the required standards may be established by tests carried out by the manufacturer, assembler or importer, or by a reputable test establishment acting on his behalf, but in either case conformity with the specification will remain the responsibility of the manufacturer, assembler or importer.

1 GENERAL

1.1 Scope of specification

This specification covers the minimum performance requirements for angle modulated radio equipments, comprising base station, mobile and hand-held transmitters and receivers or receivers only and additionally any accessories e.g. attenuators, power amplifiers, vehicle adaptors for optional use with the above for use in the Citizens Band Radio service.

For all equipments covered by this specification, the nominal separation between adjacent channel carrier frequencies is 10kHz.

1.2 Permitted effective radiated power

The output radio frequency power of the equipment is limited to 4W. With the antenna permitted for use with the equipment this gives an effective radiated power of 2W.

If an antenna is mounted at a height exceeding 10m the licence will require a reduction in transmitter power of 10dB.

To enable the user to accomplish this easily the equipment manufacturer should provide as a standard accessory an attenuator having a nominal attenuation of 10dB, which may be purchased by the licensee.

1.3 Operating frequencies

The equipment shall provide for transmission and reception only of frequency modulated emissions on one or more of the following radio frequency channels:

Channel 1	27·60125MHz	Channel 21	27·80125MHz
Channel 2	27·61125MHz	Channel 22	27·81125MHz
Channel 3	27·62125MHz	Channel 23	27·82125MHz
Channel 4	27·63125MHz	Channel 24	27·83125MHz
Channel 5	27·64125MHz	Channel 25	27·84125MHz
Channel 6	27·65125MHz	Channel 26	27·85125MHz
Channel 7	27·66125MHz	Channel 27	27·86125MHz
Channel 8	27·67125MHz	Channel 28	27·87125MHz
Channel 9	27·68125MHz	Channel 29	27·88125MHz
Channel 10	27·69125MHz	Channel 30	27·89125MHz
Channel 11	27·70125MHz	Channel 31	27·90125MHz
Channel 12	27·71123MHz	Channel 32	27·91125MHz
Channel 13	27·72125MHz	Channel 33	27·92125MHz
Channel 14	27·73125MHz	Channel 34	27·93125MHz
Channel 15	27·74125MHz	Channel 35	27·94125MHz
Channel 16	27·75125MHz	Channel 36	27·95125MHz
Channel 17	27·76125MHz	Channel 37	27·96125MHz
Channel 18	27·77125MHz	Channel 38	27·97125MHz
Channel 19	27·78125MHz	Channel 39	27·98125MHz
Channel 20	27·79125MHz	Channel 40	27·99125MHz

Citizens Band Radio equipment shall not contain facilities for transmission of radio frequencies other than those listed above, and those contained in MPT. *(this specification—Ed.)*

Single channel equipment may be tested on any one of the approved channels. Multi-channel equipment shall be equipped to operate at the centre, and the upper and lower limits of the frequency range over which channel switching is possible.

1.4 Permitted modulation

Only equipment which employs frequency or phase modulation and has no facilities for any other form of modulation will meet the requirements of this specification.

1.5 Labelling

The equipment shall be provided with a clear indication of the type number and name of the manufacturer.

1.6 Certification of compliance

Compliance with this specification shall be indicated by an authorised mark stamped or engraved on the front panel of the equipment.

The mark used to indicate compliance shall be as shown in Fig. 1.

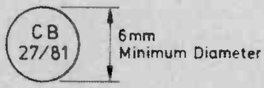


Fig. 1: Letter and figure height not less than 1 mm

1.7 Controls

Those controls, which if maladjusted might increase the interfering potentialities of the equipment, shall not be easily accessible.

934MHz VARIATIONS

1 GENERAL

1.1 Scope of specification

This specification covers the minimum performance requirements for angle modulated radio equipments, comprising base station, mobile and hand-held transmitters and receivers or receivers only and additionally any accessories, for example power amplifiers, attenuators, vehicle adaptors for optional use with the above for use in the Citizens' Band Radio service.

For all equipments covered by this specification the nominal separation between adjacent channel carrier frequencies is 25kHz.

1.2 Permitted effective radiated power

The output radio frequency power of the equipment is limited to 8W for equipments which has terminals for connexion of a separate antenna. With the antenna permitted for use with this equipment this gives a maximum effective radiated power of 25W.

For equipment with an integral antenna the effective radiated power is limited to 3W.

1.3 Operating frequencies

The equipment shall provide for transmission and reception or reception only of frequency modulated emissions on one or more of the following radio frequency channels:

Channel 1	934·025MHz	Channel 11	934·525MHz
Channel 2	934·075MHz	Channel 12	934·575MHz
Channel 3	934·125MHz	Channel 13	934·625MHz
Channel 4	934·175MHz	Channel 14	934·675MHz
Channel 5	934·225MHz	Channel 15	934·725MHz
Channel 6	934·275MHz	Channel 16	934·775MHz
Channel 7	934·325MHz	Channel 17	934·825MHz
Channel 8	934·375MHz	Channel 18	934·875MHz
Channel 9	934·425MHz	Channel 19	934·925MHz
Channel 10	934·475MHz	Channel 20	934·975MHz

(Although the specification quotes 25kHz separation the allocated channels are at 50kHz spacing—we are informed that this will be clarified at a later date—Ed.)

The separation between the "27MHz" frequencies now being used illegally and these proposals will obviously make the task of restricting any continuing illegal use that much more easy. It should also mean that, providing illegal use can be stopped, the radio control modellers should be free of interference from British CB.

It is anticipated that these proposals are realistic enough to encourage widespread use of the new service (hopefully without all the codes and jargon) and thus encourage illegal users to convert.

We do not yet know the restrictions and cost of a licence or (at the time of writing) the date of the introduction of the service—our guess is early September, but it is a guess.

ANNOUNCEMENT

PE will be publishing more on CB in the September issue. A full announcement will be made next month, when all will be revealed!

PE QUASAR
AM/FM STEREO TUNER

THE PE Quasar is an AM/FM stereo tuner which incorporates three ready-built and aligned modules: FM tuner (LP1179), r.f.-i.f. amplifier (LP1181) and a frequency multiplexed stereo decoder (LP1401). The design of the Quasar enables the completed tuner to be easily aligned using just a multimeter and a screwdriver.

CIRCUIT DESCRIPTION

The main circuit diagram of the PE Quasar is shown in Fig. 1.

The FM tuner is a ready-built and aligned VHF module (LP1179) with 75 and 300 ohms aerial inputs which has capacitance tuning for AM. Frequency drift on the FM waveband is counteracted by a built-in varicap diode across the oscillator circuit which facilitates the use of automatic frequency correction (a.f.c.) with a variation of ±0·5V (ref. zero) equalling a frequency shift of ±100kHz. The output from the tuner is connected to the i.f. circuit via a 10·7MHz ceramic filter (XLI). The output signal from the filter only becomes significant when the input signal corresponds to 10·7MHz. The filter then acts as a high Q tuned circuit.

The i.f. signal from the front end is matched to the ceramic filter and is applied to IC1 via pin 1. IC1 is a TDA1200. This i.c. integrates i.f. amplification and limiting (three stages with a level detector for each stage) with a balanced quadrature FM detector, an audio amplifier with a muting facility and a voltage regulator.

The complete system includes such features as an a.f.c. drive circuit and tuning meter drive. The a.f.c. output on pin 7 is reference to +5·6V and because the tuner module's a.f.c. is designed to operate with reference to zero volts, it is necessary to apply a stabilised voltage of approximately −4V. Providing L2 is correctly adjusted, VR1 can be set to obtain the necessary zero volts at the junction of R2 and R4.

INTERSTATION MUTING

Because of the high overall gain of the FM tuner a high level of noise can occur when tuning between stations. This noise can be reduced by interstation muting which keeps the audio stages inactive until a signal of pre-determined strength is received. The muting level in the Quasar can be altered by changing R13. A higher value reduces the muting whilst a lower value increases it.

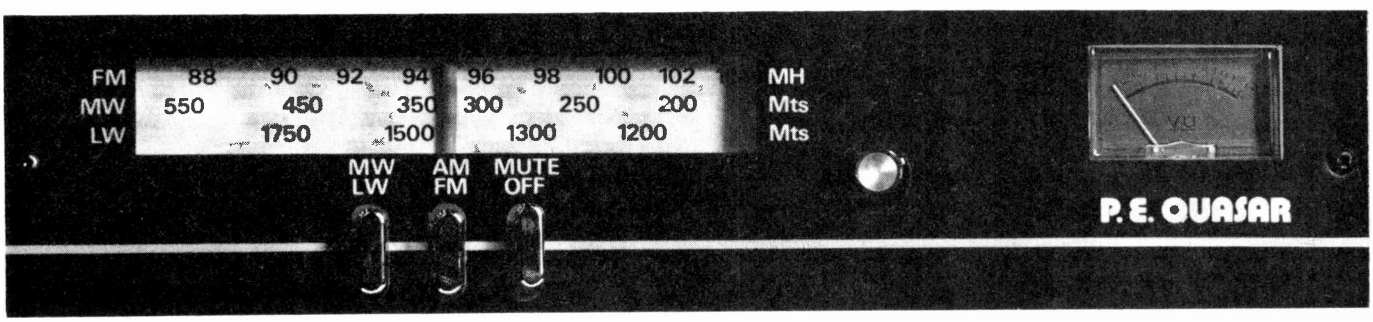
STEREO DECODER

A block diagram of the LP1401, which is a ready-built and aligned frequency multiplexed stereo decoder, is shown in Fig. 2.

The multiplexed stereo output from pin 6 of IC1 is fed via R5 and C6 to the decoder where a splitter circuit extracts the stereo and mono signals. De-emphasis is applied to both

SPECIFICATION

MW520 to 1640kHz sensitivity 400µVm for 15dB s/n ratio
LW150 to 265kHz sensitivity 900µVm for 15dB s/n ratio
IF470kHz
VHF88 to 104MHz sensitivity 8µV for 30dB s/n ratio
Limiting 10mV or better
AFC ±100kHz
IF 10·7MHz
IF rejection 40dB min
Image rejection 40dB min
Stereo separation 38dB at 1kHz



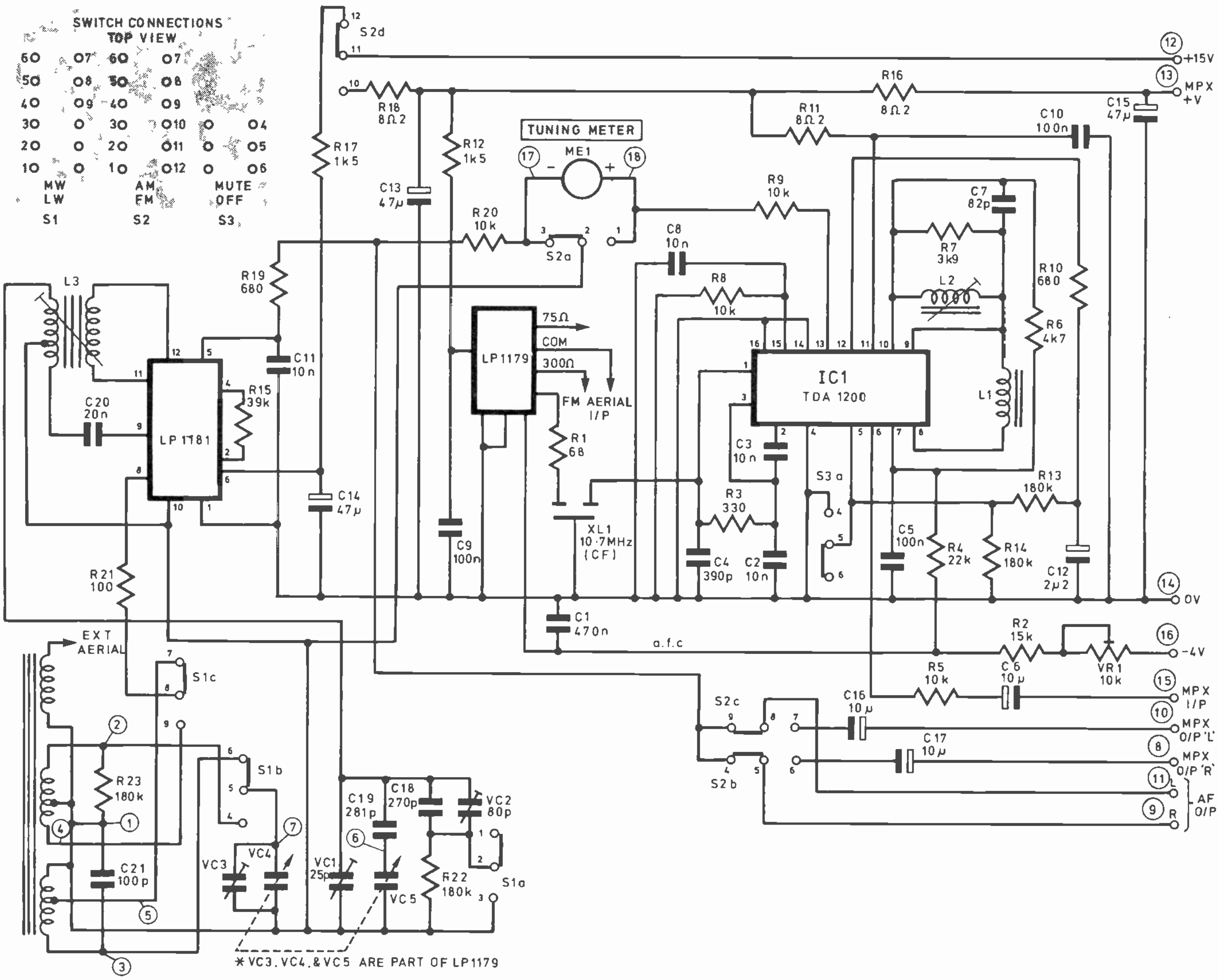
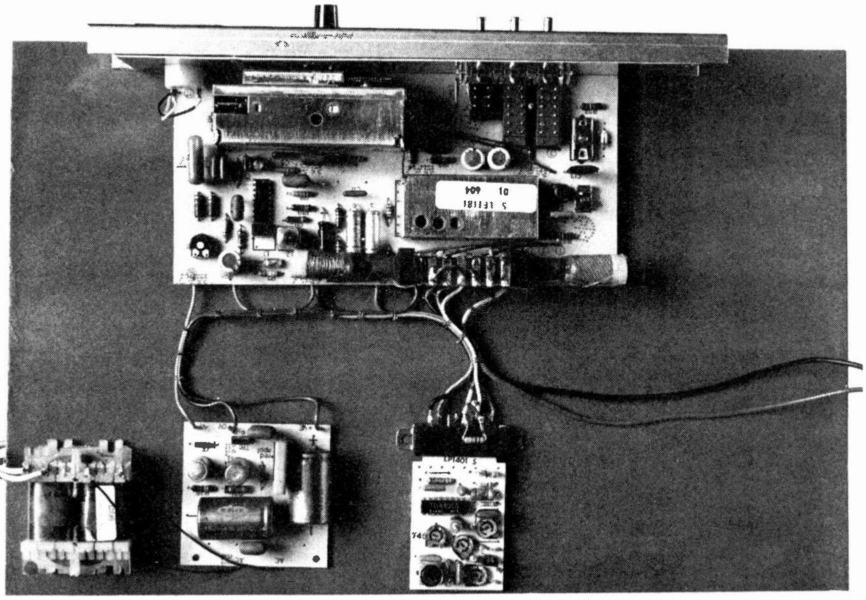
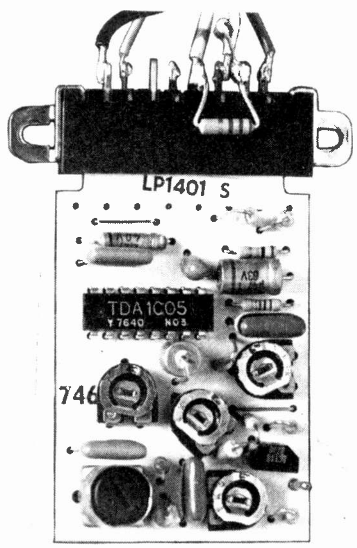


Fig. 1. Main circuit diagram of the PE Quasar



Photograph of the Quasar system



Stereo decoder and SK1

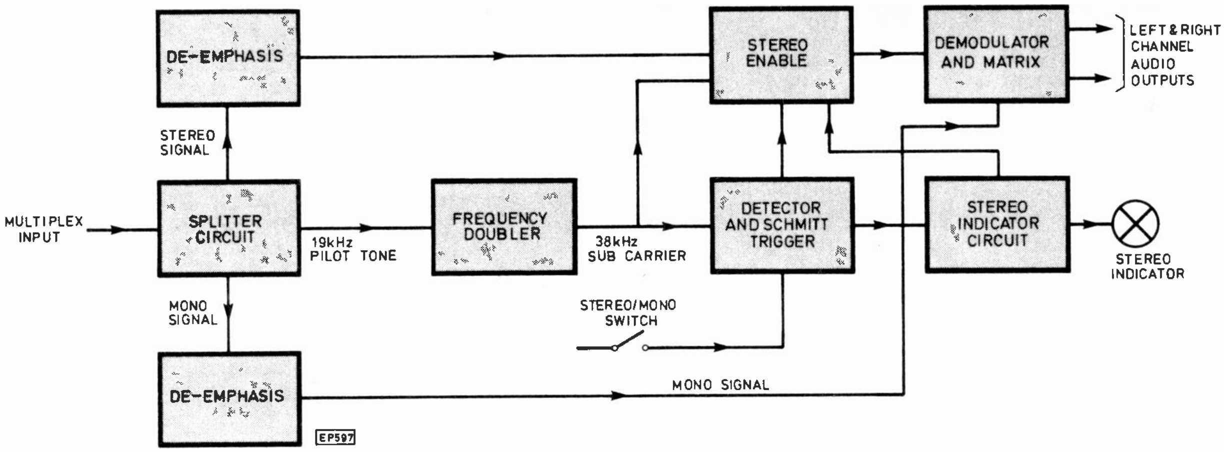


Fig. 2. Block diagram of the LP1401 stereo decoder

signals to improve the signal to noise ratio by attenuating the background noise whilst equalising the signal. The 19kHz pilot tone is also extracted and the 38kHz sub carrier, which was suppressed in the transmitted signal, is regenerated by a frequency doubler which is also amplitude limited to reduce noise. The sub carrier is then added in correct phase to the stereo signal and fed to the matrix where the original left and right channel signals are retrieved.

In the mono state the Schmitt trigger, stereo indicator lamp and the stereo on/off gate are all inactive. Only the mono signal is passed through the matrix to each channel.

The stereo enable switch is triggered by the 19kHz pilot tone. For good reception the strength of the stereo signal has to be high; a poor stereo signal would sound better in mono. The level of the pilot tone is monitored and for the Quasar to switch to the stereo mode the pilot tone signal must be higher than 15mV r.m.s.

When the stereo switch is operated a d.c. output from the detector circuit operates the Schmitt trigger which switches on the stereo indicator lamp and the demodulator.

The use of a manual mono/stereo switch enables the mono mode to be selected when a stereo signal is being received.

AM I.F. MIXER

The MW/LW ferrite rod aerial affords adequate sensitivity to all but the weaker signals. However, an extra winding is provided for an external aerial. Signals from the ferrite aerial are fed to the input of the LP1181. This module, which is pre-aligned, performs the functions of a local oscillator/mixer, i.f. amplification, detection and a.g.c. Resistor R20 acts as the "diode load" and tuning meter drive.

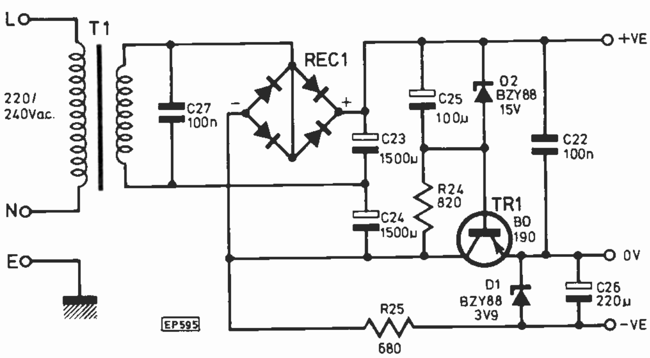


Fig. 3. Circuit diagram of the power supply unit

POWER SUPPLY

The circuit diagram of the power supply is shown in Fig. 3. The power supply is a voltage doubler circuit. The unregulated supply appears across the positive terminal of C23 and the negative terminal of C24. The design is unconventional only as far as the negative line is regulated and designated as 0V with the −4V negative supply rail derived via R25. This voltage which is Zener stabilised and decoupled by C26 is used for a.f.c. offset.

CONSTRUCTION

The p.c.b. design for the main board of the Quasar is shown in Fig. 4 with the component layout shown in Fig. 5. Before fitting the FM tuner (LP1179) the AM oscillator trimmer screw on the tuner should be removed (Fig. 6). Carefully

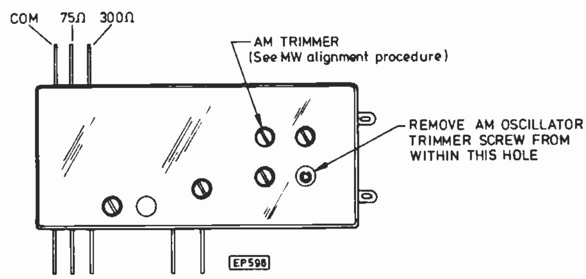


Fig. 6. AM oscillator modification for the FM tuner

check the orientation of IC1 and the AM module (LP1181) before soldering. Also note the position of the fixed coil L1 which is used in place of a variable inductor. The MW/LW aerial assembly should be soldered last as shown in Fig. 7. After soldering the aerial assembly should be glued to the p.c.b.

The power supply p.c.b. design is shown in Fig. 8 with the component layout shown in Fig. 9. After these two p.c.b.s have been soldered, carefully check the orientation of all the components and that none of the tracks are shorted out by slivers of solder.

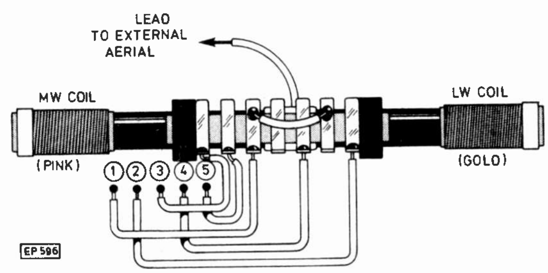


Fig. 7. Wiring details for the aerial assembly

COMPONENTS . . .

Resistors

R1	68
R2	15k
R3	330
R4	22k
R5,R8,R9,R20	10k (4 off)
R6	4k7
R7	3k9
R10,R19,R25	680 (3 off)
R11,R16,R18	8Ω2 (3 off)
R12,R17	1k5 (2 off)
R13,R14,R22,R23	180k (4 off)
R15	39k
R21	100
R24	820
*R26,R27	2k2 (2 off)

All resistors $\frac{1}{4}$ to $\frac{1}{2}$W 10%

Potentiometers

VR1	10k preset

Capacitors

C1	470n
C2,C3,C8,C11	10n (4 off) polyester
C4	390p polystyrene
C5,C9,C10,C22,C27	100n (5 off)
C6,C16,C17	10µ 25V (3 off) elect.
C7	82p polystyrene
C12	2µ2 63V elect
C13,C14,C15	47µ 25V elect (3 off)
C18	270p polystyrene
C19	281p 2%
C20	20n polyester
C21	100p 5% polystyrene
C23,C24	1500µ to 3300µ 16V elect (2 off)
C25	100µ 16V elect
C26	220µ 16V elect
VC1	25p (max) trimmer
VC2	80p (max) trimmer

Semiconductors

D1	3·9V 300mW Zener
D2	15V 300mW Zener
REC1	
TR1	BD190
IC1	TDA 1200

Inductors

L1	220 KE (22µH)
L2	L101 (2·2µH)
L3	AM Osc coil (42276)

Miscellaneous

10·7 MHz filter
LP1181
LP1401
FM Tuner front end LP1179
VU meter
Ferrite rod assembly
Mains transformer
Chassis
p.c.b.s.
Drive cord and guides. S1, S2, S3.
*See Fig. 10.
Note the p.c.b.s supplied in the kit are not drilled.

Constructor's Note

A kit of parts for the Quasar (minus the stereo enable and stereo indicator modifications) is available from **RT&VC, 21B High Street, Acton W3 6NG.** (Price £17·95 plus £2·50 p&p.)

The front panel should be assembled next. If a stereo indicator and an enable switch (Fig. 10) are to be fitted, then the mounting holes for these should be drilled first. The front panel legend can then be fixed using either double sided tape or non plastic solvent glue. The mounting holes can then be cut out in the legend using a sharp knife. The tuning meter can then be fitted to the back plate using double sided tape. Before the back plate is fitted to the main p.c.b. the three grommets should be fitted into the mounting holes for the LP1179 tuner. The three tuning drive cord guides should be inserted into the back plate and peened over using a hammer.

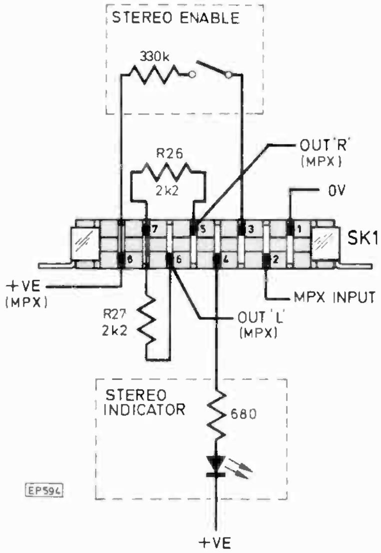


Fig. 10. Connection diagram for SK1

The two wires for the tuning meter should be soldered before the back plate is fitted. After mounting the back plate onto the p.c.b. the drive tuning cord should be fitted following the diagram in Fig. 11. The tuning indicator was formed using a piece of copper wire and length of p.v.c. sleeve. To improve the definition of the tuning needle a piece of white p.v.c. tape was fitted behind the tuning display. Do not fit the front panel into position until after the tuner has been aligned.

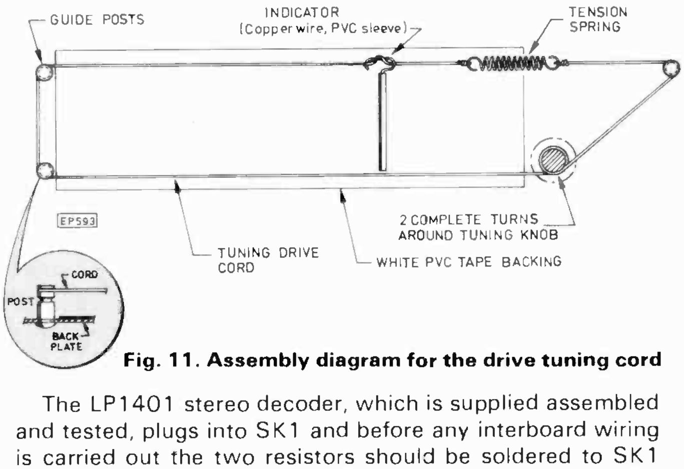


Fig. 11. Assembly diagram for the drive tuning cord

The LP1401 stereo decoder, which is supplied assembled and tested, plugs into SK1 and before any interboard wiring is carried out the two resistors should be soldered to SK1 (Fig. 10). With all the boards and SK1 assembled the interboard wiring should be carried out as shown in Fig. 12.

FM ALIGNMENT

After the Quasar has been assembled and wired it can be switched on and the voltage supplies checked. It should then be connected to a suitable amplifier and speaker system. To

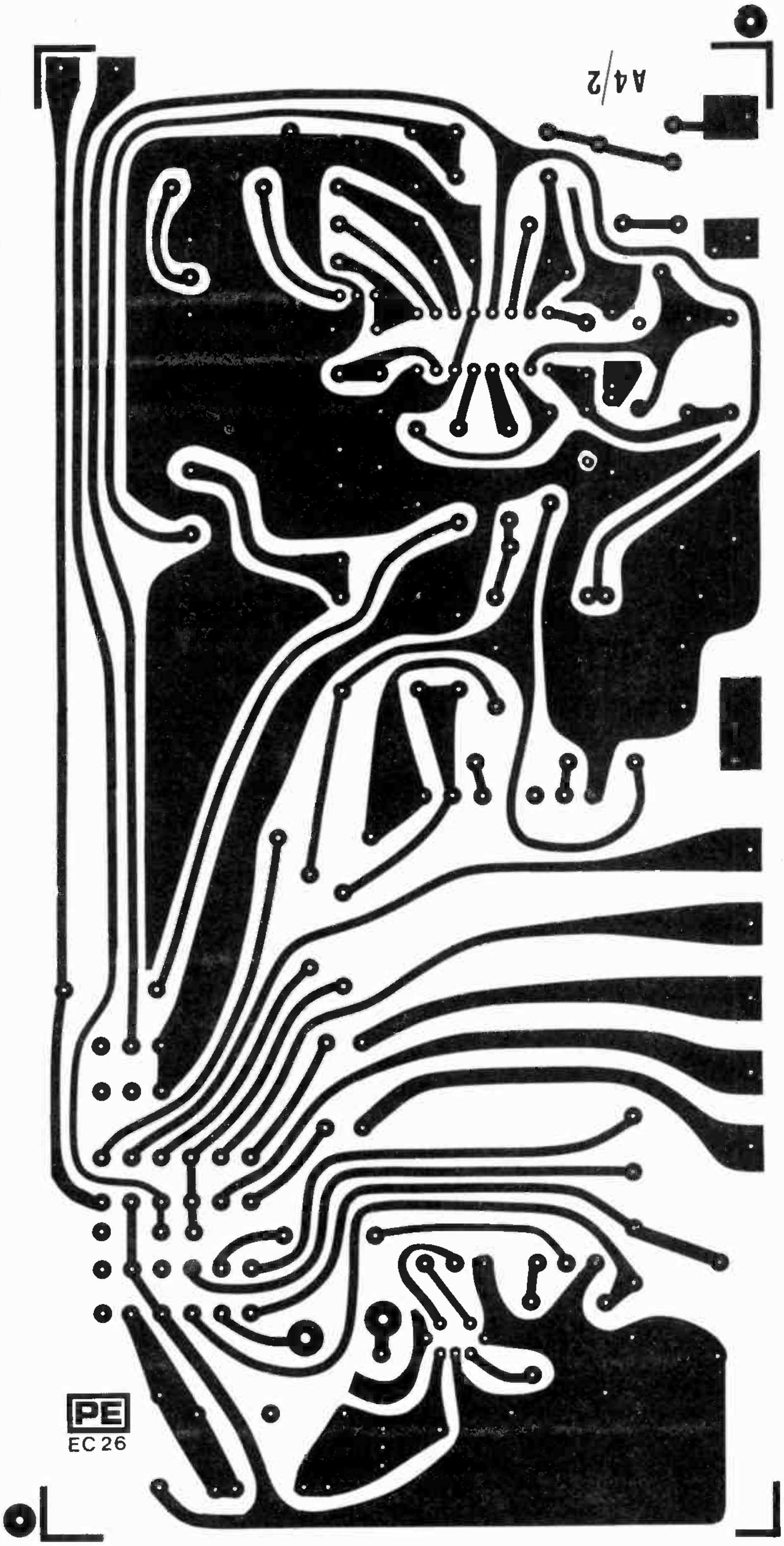


Fig. 4. P.c.b. design for the main board

Fig. 8. P.c.b. design for the p.s.u.

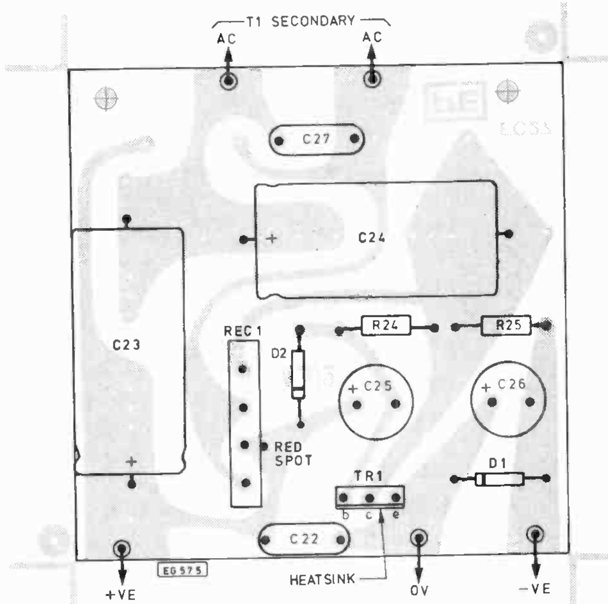
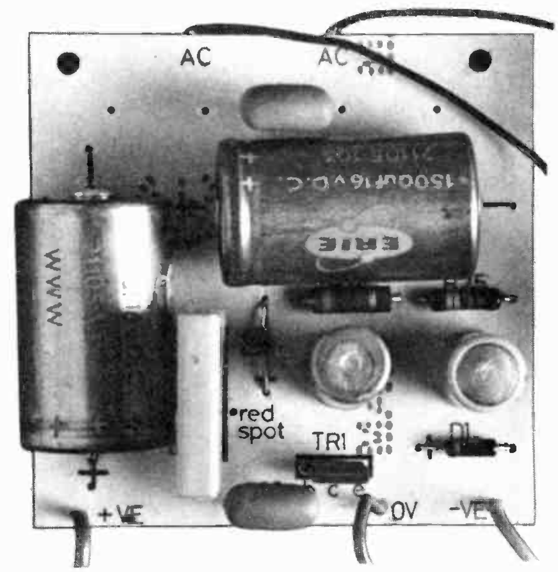


Fig. 9. Component layout for the p.s.u.



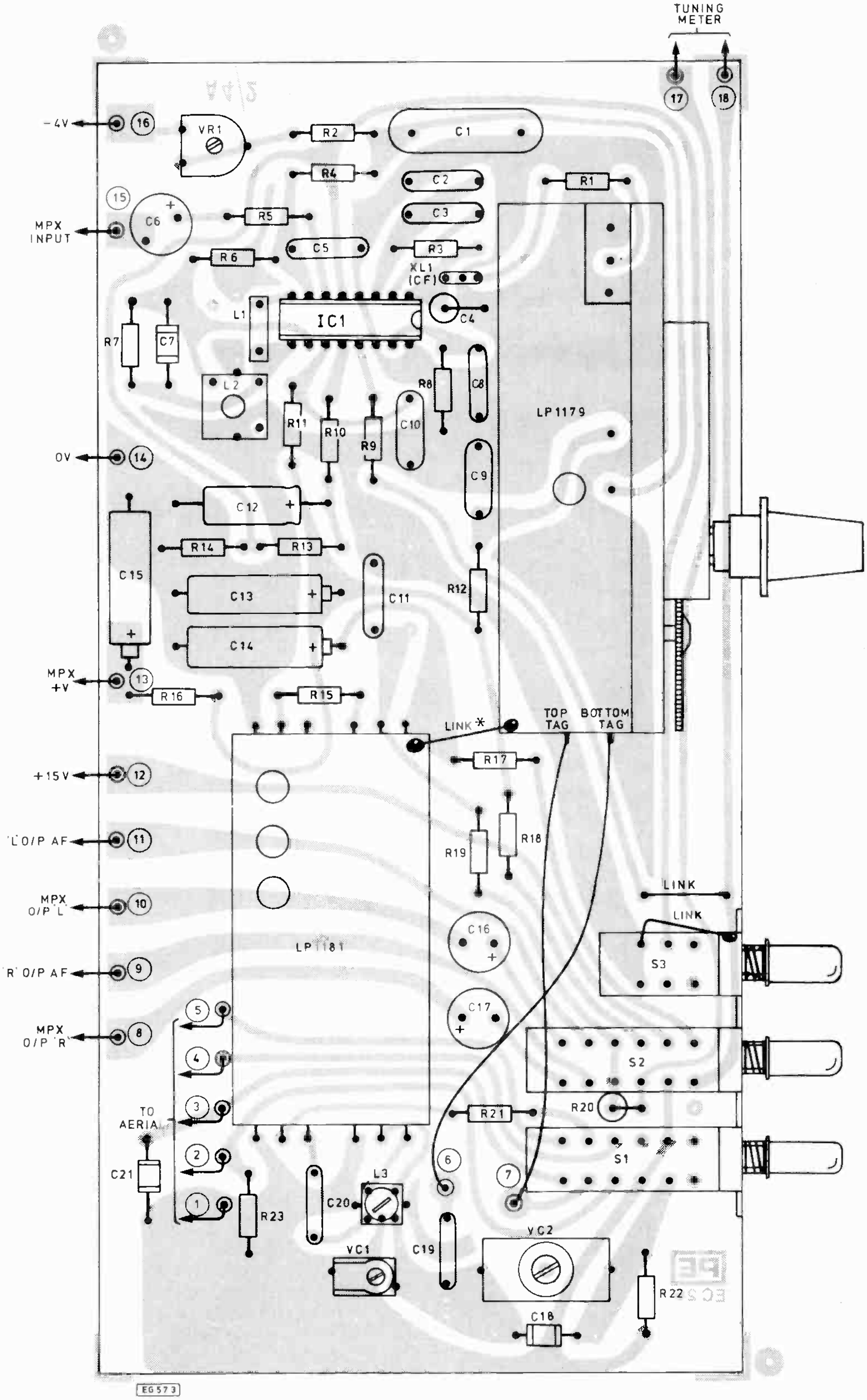


Fig. 5. Component layout for the main board. *Note this link is soldered to the case of each module

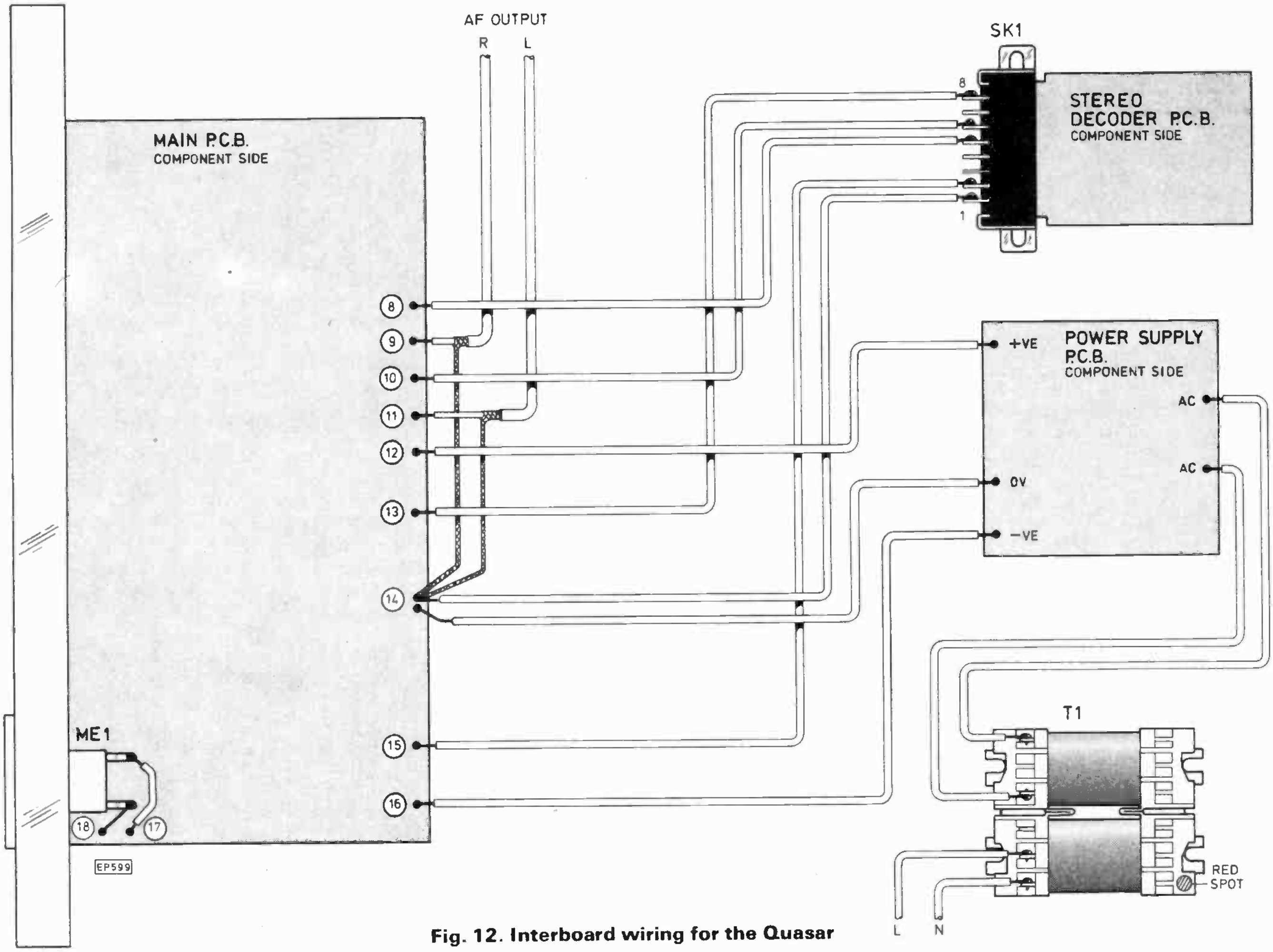


Fig. 12. Interboard wiring for the Quasar

align the FM band the following procedure should be carried out: a) Cancel the AFC by shorting C1.

b) Press the AM/FM and Mute/Off switches in.

c) Connect an aerial to tuner (75 or 300Ω).

d) Unscrew the core of L2 so that it is approximately 4 to 6mm proud of the can. If the construction is correct the Quasar will operate.

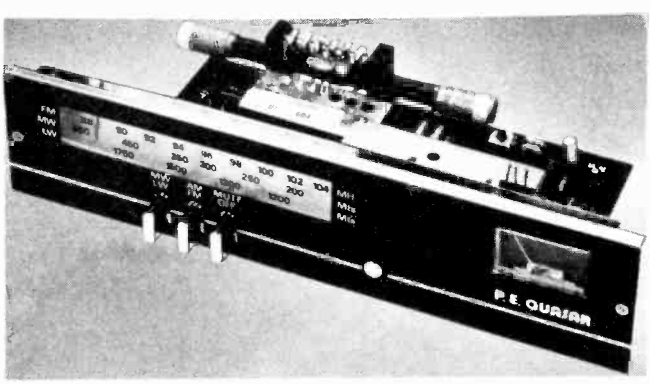
e) Adjust L2 for maximum undistorted audio output and maximum meter deflection.

f) Remove the link across C1.

g) Short the junction of R1 and XL1 to earth.

h) Adjust VR1 for zero volts across C1 and remove the link between R1/XL1 and earth.

This completes the FM alignment and the core of L2 should be sealed with candle wax.



AM MEDIUM WAVE

The medium wave band can be aligned using the following procedure:

a) Put the AM/FM and the MW/LW buttons in the out position and place the aerial coils flush with the end of the ferrite rod.

b) Tune the set to approximately 433M and adjust L3 to receive Radio 2. If this is not available set the tuner to any other known wavelength at the extreme LF end and tune L3 to receive that station.

c) Set the tuner to 247M and adjust VC1 to receive Radio 3.

d) Repeat steps (b) and (c) until the two extreme stations correspond to the scale.

e) Tune the set to a weak station at the extreme LF end and adjust the medium wave coil L3 for maximum output.

f) Tune the set to a weak station on the HF end and adjust the AM trimmer on the tuner for maximum output.

g) Repeat steps (d) and (f) for best results.

AM LONGWAVE

The longwave band can be aligned using the following procedure:

a) Press the MW/LW button in and set the pointer to 1500M.

b) Adjust VC2 to receive Radio 4.

c) Set the LW ferrite coil for maximum output. Both the aerial coils can now be sealed with candle wax. ★

Capacitance METER

MARTIN KENT

FREE CASE PROJECT

DP600 Capacitance Meter

CAPACITANCE measurement is a frequent requirement of professional engineers and hobbyists alike. In these times of rising prices, hobbyists are obliged to keep a store of used components which may be useful in future circuits. Component markings gradually disappear with time and capacitor markings seem to disappear most quickly. How frustrating it can be to be faced with a box of unmarked capacitors and a circuit requiring completion.

Matching of capacitor values is often required and apart from its primary function of testing components, a capacitance meter may also be used for a wide variety of tests including cable length, cable capacitance, p.c.b. track capacitance and it is a very useful development tool.

The DP600 Capacitance Meter provides quick and accurate capacitance measurement between 1p and 19·99µ at low cost.

CAPACITANCE MEASUREMENT

There are a large number of methods in use for the measurement of capacitance and the cost of embodying many of these techniques is out of all proportion to the accuracy and usefulness of the instrument. Among the aims in the design of the meter has been the provision of a low cost instrument, with good accuracy, covering a wide range of measurement, with low power consumption and ease of use.

The traditional method of measurement is to use a bridge arrangement with a.c. energisation, and adjusting for null indication. This method can be expensive and requires careful adjustment by the operator.

Rate of charge can be useful for capacitor measurements but is exponential, although, if a constant current source is used instead of a voltage source, good linearity can be achieved. If the constant current source is turned on for an accurately defined time, then the charge on the capacitor at the end of this time will be proportional to the capacitance. A considerable amount of circuitry is required to use such a technique in a repetitive mode, rather than a single-shot mode.

Ideally, once the capacitor to be measured is connected to the instrument, the measurement should be updated automatically as it enables circuit adjustments to be carried out simultaneously and changes in capacitance to be monitored.

The heart of the DP600 is a CMOS monostable which requires very little supply current and operates at low supply voltages; the block diagram of the instrument is shown in Fig. 1.

When triggered by an input pulse, the monostable produces an output pulse of duration proportional to R and C; accurate decade resistors are therefore suitable for setting the range of measurement, and C is the capacitor to be measured. A system suited to use of standard resistors for range switching results in much lower cost than instruments requiring standard capacitors. The monostable is triggered by a constant frequency source and the constant amplitude pulses are averaged by an RC integrator. The output voltage is now proportional to the applied capacitor and provides a direct readout on the LE DPM200 panel meter. Measurements are automatically updated by the frequency source.

An ideal capacitor is composed of two parallel plates with a dielectric of infinite resistance between the plates. However, practical capacitors have a parallel loss resistance which will shunt the capacitor and reduce the monostable pulse width slightly. The effect will only be noticeable for capacitors with very low parallel resistance, or high leakage.

SPECIFICATION

RANGE	RESOLUTION	ACCURACY
2000pF	1pF	0·75% ±3 digits
200nF	0·1nF	
20µF	0·01µF	

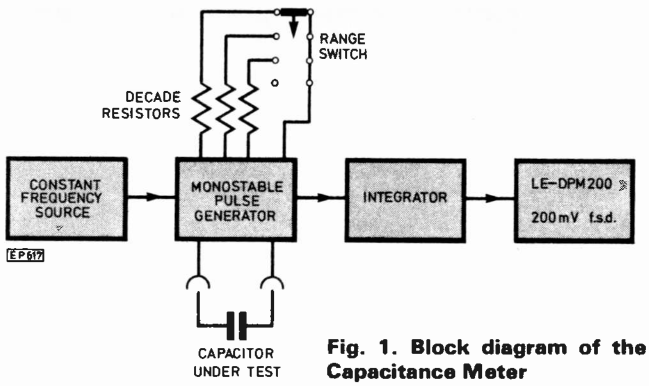


Fig. 1. Block diagram of the Capacitance Meter

CIRCUIT DESCRIPTION

The circuit diagram of the Capacitance Meter is shown in Fig. 2. Panel Meter ME1 provides a complete analogue-to-digital convertor with ultra-low power consumption and calibrated 200mV full scale.

CMOS timer IC1 operates between V+ and COM, which is typically 2·8V. Switch S1d selects the appropriate decade resistor for the range of measurement. Accuracy of measurement is dependent upon the monostable output pulses being of constant amplitude. The COM pin of ME1 has good stability with temperature but the change in current drawn through it by the lower value resistor, R8, on the top range can reduce the Common voltage by about 2%, which would be directly indicated in range accuracy. Each range could be individually calibrated, but it is desirable to use only one adjustment. To provide good amplitude stability R9 and IC2 are used, which is a bandgap reference integrated circuit with typically 1·2V output. Resistors R6–R8 should be high stability metal film types as they directly influence measurement accuracy. Pulse averaging is carried out by R10 and C3 with calibration by VR1.

To optimise measurement accuracy, an offset control is incorporated. Before the capacitor to be measured is connected to the instrument, the effects of stray capacitance may be eliminated by adjusting VR2. Provision of the offset control also enables measurements to be made of capacitors situated at the end of long cables by eliminating the cable capacitance.

The LE DPM200 panel meter includes a dual-slope integration A to D convertor which contains an RC oscillator for control of the integrator timing cycle. To reduce the cost of the instrument, the frequency source required to trigger the CMOS monostable may be derived from the panel meter. The oscillator has a nominal frequency of 48kHz which is divided down to perform the various timing functions. The backplane signal for the LCD is set at a frequency of *clock divided by 800*, or nominally 60Hz. The maximum pulse width output from IC1 is 1k × 20µ or 20ms. The period of the triggering waveform must be greater than the monostable period otherwise the monostable would be retriggered during a measurement cycle, instead of at the end of the cycle, resulting in erroneous readings. To slow down the internal clock frequency slightly C4 is added between CLK (oscillator) and TEST (digital ground).

The backplane signal is a nominal 5V amplitude with respect to TEST, but is +2·5V/−2·5V with respect to Analogue Common. Level shifting is provided by TR1.

IC1 requires a narrow trigger pulse which should return to the high state before the end of the output pulse. TR2 and associated circuitry produces a narrow negative-going pulse, of typically 50µs, for each positive-going edge of the backplane signal.

The timing waveforms of the circuit are shown in Fig. 3.

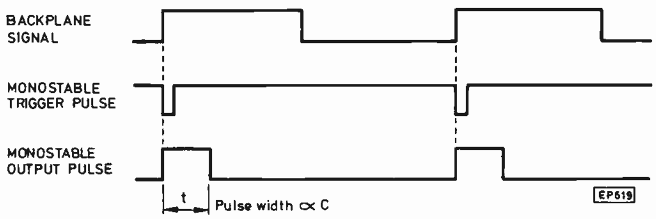


Fig. 3. Timing waveforms

Another advantage of using the internal oscillator is that the system is synchronised to the measurement cycle of the A to D convertor to reduce the display jitter which would otherwise result from the charging and discharging of C3. The R10/C3 time constant could be lengthened but this would reduce the response time of the instrument to change in applied capacitance. The display drive circuitry within ME1 is switched to the required decimal point by S1b.

ASSEMBLY AND TESTING

Assembly of the p.c.b. is very straightforward as the use of the self-contained panel meter greatly reduces the component count. The panel meter is connected to the p.c.b. via ribbon cable and the assembly should be tested before fixing into the case.

When the unit is switched on, the display should be able to be adjusted for zero reading by VR2 on each range. To calibrate the instrument it is preferable to use a standard capacitor, alternatively comparison may be made with another capacitance meter. Calibration should be carried out at mid-range, using either a 1000p, 100n, or 10µ standard capacitor. With VR1 adjusted accordingly on one range, the metal film resistors R6–R8 will ensure accurate measurement on the other ranges.

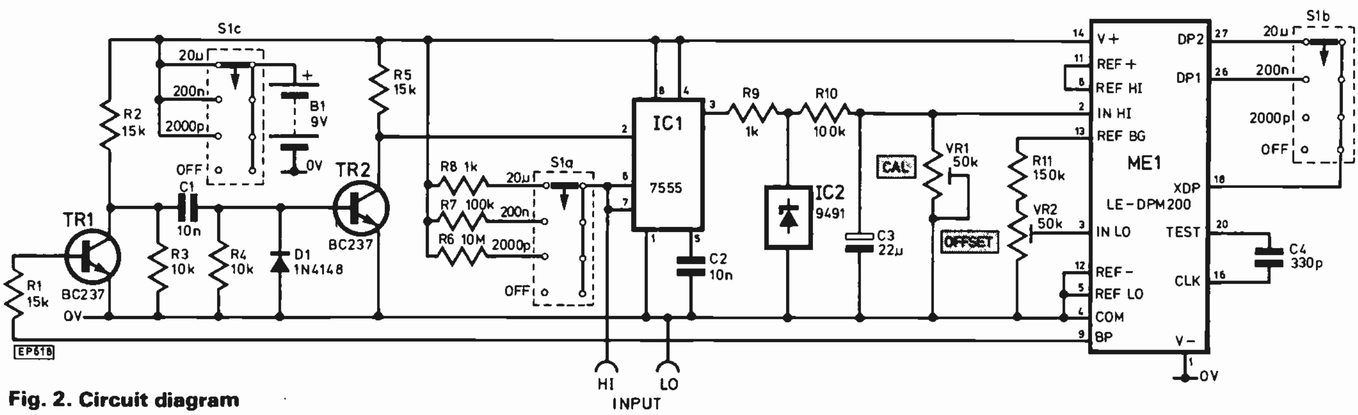


Fig. 2. Circuit diagram

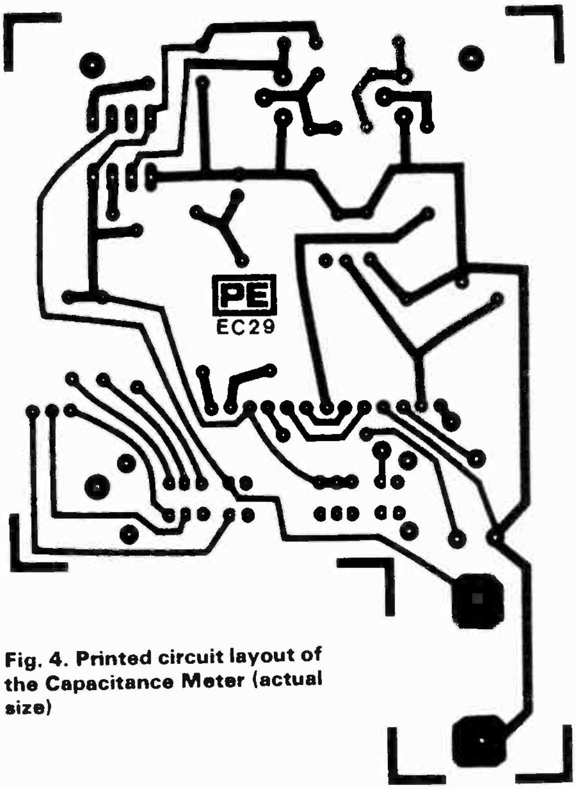


Fig. 4. Printed circuit layout of the Capacitance Meter (actual size)

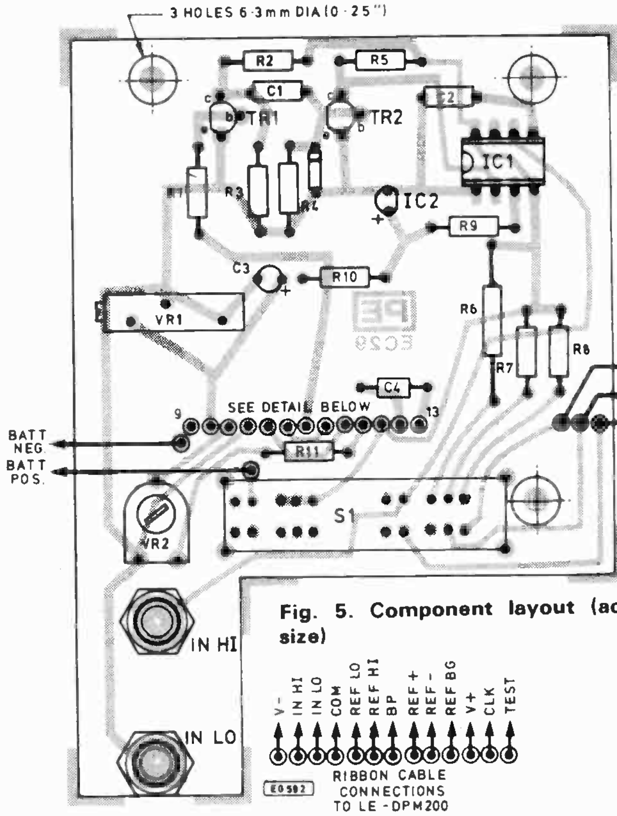


Fig. 5. Component layout (actual size)

If a capacitor of over-range value is connected to the instrument, the standard over-range warning should be indicated whereby a 1 will show in the leading digit with the other digits blanked.

APPLICATIONS

The Capacitance Meter may be used to measure a wide range of capacitors including electrolytic types.

Cable capacitance can be an important factor in signal distribution systems and this may easily be measured with the instrument. Total capacitance may be measured, alternatively the capacitance per unit length is often required and may be established using a one foot or one metre length.

If the capacitance per unit length is known or can be measured, then the length of cables may be measured using the DP600.

COMPONENTS . . .

Resistors

R1	15k	Carbon film 5%
R2	15k	" " "
R3	10k	" " "
R4	10k	" " "
R5	15k	" " "
R6	10M	Metal film 0·5%
R7	100k	" " "
R8	1k	" " "
R9	1k	Carbon film 5%
R10	100k	" " "
R11	150k	" " "

Variable Resistors

VR1	50k	Multiturn preset
VR2	50k	

Capacitors

C1	10n	Polyester
C2	10n	"
C3	22µF	Tantalum bead 16V
C4	330pF	Polystyrene

Semiconductors

D1	IN4148
TR1	BC237
TR2	BC237
IC1	ICM7555
IC2	Teledyne 9491/Intersil 8069

Miscellaneous

ME1 LE DPM200 (see special offer)
Instrument case
P.c.b.
Ribbon cable
4P4T Slide switch
PP3 Battery connector
4mm p.c.b. mounting terminals (2 off)

A kit of components (excluding the DPM200 and case) is available at £12.95 inc. VAT from **Lascar Electronics Ltd., Unit 1, Thomasin Road, Basildon, Essex SS13 1LH.**

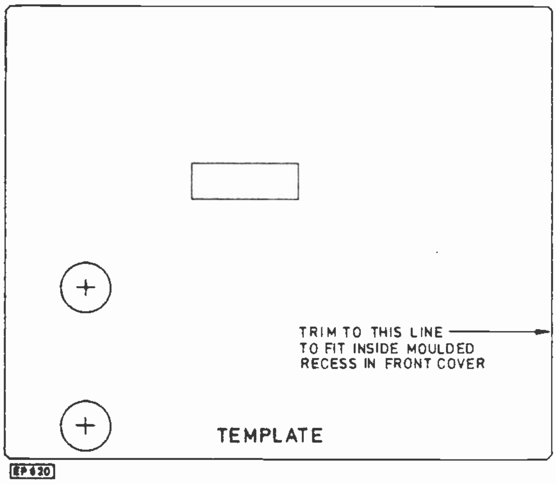
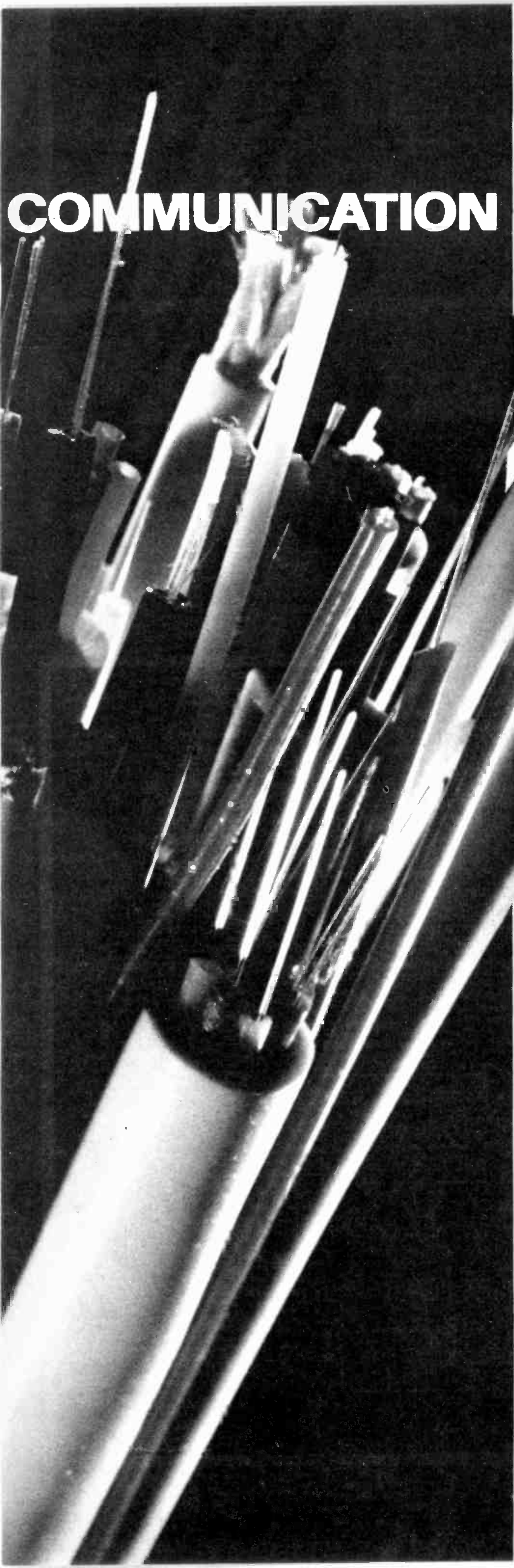


Fig. 6. Template for front panel drillings

High frequency circuits require careful attention to be paid to p.c.b. layouts when siting components and interconnecting tracks. Parallel p.c.b. tracks act as capacitors which can induce spurious oscillation and noise voltages and the instrument may be used to detect unwanted capacitance before fault-finding in systems is required.

The capacitance of components such as switches and relays may be measured, also crystal capacitance may be measured to enable the conditions for resonance in a particular oscillator circuit to be established. ★



COMMUNICATION by FIBRE OPTICS

Gary Gardner

Fibre optics are now in use as communications links. This article describes what they are and how they are made and used.

MOST of us are by now familiar with decorative fibre optic lamps on coffee tables. The use of fibre optics for seeing inside the body has been shown on TV on more than one occasion, and one may have good cause to marvel at this wonder of modern science.

An optical fibre consists of a fine strand of glass made from two chemically dissimilar glasses, one inside the other. These two glasses are referred to as the core and the cladding. The fibre has the ability to act as a wave guide to electro-magnetic radiation, such as ordinary visible light, or infra red. Thus the fibre has the unique ability to bend light, and direct it along its length. It is this property that makes the use of optical fibres so interesting.

The transmission of visible light or infra red down an optical fibre is analogous to an electrical current passing down a wire. Thus a "signal" introduced at one end should ideally emerge at the other end unchanged in shape and amplitude. Why then is it necessary for us to advocate the use of an optical fibre for the transmission of signal, if an ordinary coaxial cable will accomplish the same result? To convert electrical signals into a light beam, pass this down the optical fibre, detect it at the other end, and then convert the light back again into an electrical signal is a little like using a sledge-hammer to crack a nut, isn't it?

PLEASE TRY AGAIN LATER . . .

As demand for telecommunications services increases, so the pressure on our telephone system grows. The advent of PRESTEL, viewphone, and computer data through conventional telephone cables can and will crowd out the ordinary telephone conversations that also have to be carried. By the use of optical fibre communication systems the capacity for carrying signals is increased by tens of thousands. The reason for this is quite simple; the capacity of a carrier wave is related to its frequency. The frequency of light is many thousand times that of ordinary radio waves.

With optical fibres, the possibility of "crossed lines" will be reduced, because of the total lack of crosstalk between adjacent fibres. For military applications, such as onboard ship, communication cannot be jammed or interfered with, which is a major benefit for military use. Because of their smaller physical size, the existing underground trunking system used for the interconnection of telephone subscribers to the exchanges needs little if any modification to accommodate the new cable.

To the motorist, if nothing else, the lack of the familiar road-up signs will bring a sigh of relief. In oil refineries and other petrochemical plants, the risks of sparks causing fire or explosion are almost completely eliminated by use of fibre optic data links. The basic raw materials are commercially available today and, although the prices are high at present, these will fall dramatically when volume production gets under way.

MANUFACTURE

There are two major processes used for the manufacture of optical fibres. The British Post Office (now renamed British Telecom) have developed a glass-making process called the Double Crucible process. In this process, glasses of dissimilar composition are produced by melting extremely pure ingredients in a coaxial crucible. Once molten, the two glasses are drawn simultaneously from the bottom of the crucible to form a glass rod. As previously described, this rod consists of a central core encased in another glass, which forms the cladding.

The reason the ingredients have to be so pure, is that any impurities cut down the transmission properties of the glass. Looking at an ordinary glass shelf edge on, shows the glass to be green in colour; an optical fibre exhibiting similar properties would be useless as a transmission medium. An optical fibre has to appear as transparent as an open window, yet is equivalent to a pane of glass about a mile in thickness. To achieve this, the basic chemicals have to be purified to an extraordinary high level, and must only contain a total metal impurity of a few parts in a thousand million!

The glass rod so formed (called the preform) is then reheated until plastic, and carefully drawn into a fibre of a thickness which is comparable to that of a human hair. The fibre is protected by applying a silicone resin and polypropylene, which adds mechanical strength. A number of these conductors are then positioned around a steel strength member, and sheathed in polythene. Fibres of this type are now being manufacturered by British Telecom licencees, both in this country and abroad. GEC will shortly be producing fibres for the telephone network in this country, and Erricson likewise in Sweden.

The alternative method of production, which makes fibres of a different type, is called the Chemical Vapour Deposition method, and relies upon a glass-like layer (usually a phosphosilicate) being deposited on the inside of a quartz tube. After such a layer has been deposited, the tube is heated strongly, whilst it is rotated in a special lathe. This has the effect of collapsing the walls of the tube, resulting in the formation of a solid glass rod, which can then be reheated and drawn into a fibre, consisting of a narrow core—the deposited layer—surrounded by the cladding—the quartz tube. Again, British Telecom have a development programme for this type of fibre, and volume production is being carried out in this country by such companies as STC and GEC.

BICC and Pirelli also have small development production of fibres of this type, which will in all probability expand in the not too distant future when the demand justifies. Pilkington Ltd has two production sites producing fibres called "Hytran". One method is a modification of the double crucible, the other is by a process called "phase separable" glass.

LIGHT SOURCE

All the signals carried along optical fibres are in the form of light waves in the infra red part of the electromagnetic spectrum. These can be generated either by using a miniature laser or by using a light emitting diode. The high radiance l.e.d. is unfortunately restricted to low bandwidth short distance operations. By low bandwidth we mean a data rate of about 35Mbit/s. The alternative approach is to use a Gallium Arsenide laser which has a higher output, and is more suitable for operation over longer distances. It also has the ability to handle much higher data rate which are typically 140Mbit/s. Unfortunately, these tiny lasers are expensive (about £500 each), but it is confidently predicted that the price will dramatically fall in the future.

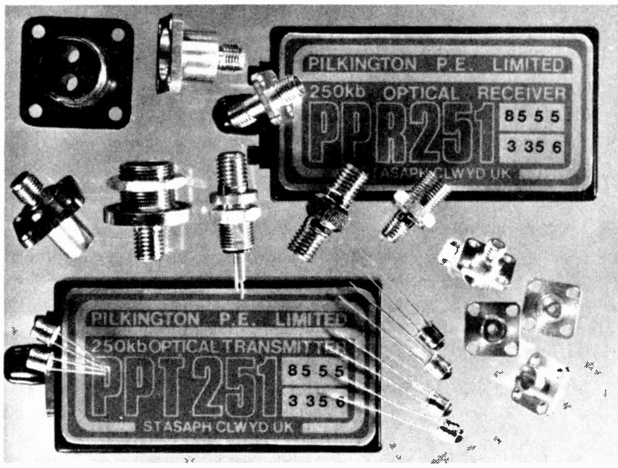
On the other end of the optical fibre, we have the light detector, which can be either a PIN diode or an avalanche diode. Unfortunately, the received infra red signal is very low (often less than 100nW), and it is important that the detector gathers most of the received power, and efficiently converts it. The silicon PIN diode meets these criteria at an economic cost. The alternative use of the avalanche photodiode provides a higher sensitivity than the PIN diode, but is only superior at higher data rates above 1Mbit/s.

WHEN?

We already use, albeit in a limited way, fibre optic systems for the transmission of telephone conversations. By the end of 1977, several of the British interested parties had demonstrated the feasibility of optical fibres in operating systems, and the Post Office had run its systems operating at both 8Mbit/s and 140Mbit/s. After the initial demonstration systems, it was found necessary to follow these up with production systems. The main reasons for this was for the Post Office to gain manufacturing and installation and operational experience.

In practice, 18 possible routes were chosen, and put out to tender. In April 1979 orders were placed to the value of £6M for a total of 34 systems on 15 routes located throughout the British Isles. The total length of the routes is 450km, giving a total fibre requirement of 3,600km. Thus orders have been awarded to STC, GEC and Plessey for the supply and installation of optical fibre transmission systems—both cables and equipment—for the expansion of the telecommunications network.

Optical fibre receivers, transmitters, l.e.d.s and avalanche photodiodes (*Pilkington Ltd*).



TRANSMISSION SYSTEMS

The transmission system is categorised by the data transmission rate, which can be 2–8–34–140Mbit/s. These, with the exception of 2Mbit/s, will all be used in the digital network being developed by British Telecom, and together with the system exchanges, lead to the Integrated Services Digital Network. The 140Mbit/s (equivalent to 1,920 telephone channels) systems will be used in the trunk network. The typical route length will be 60km and will require repeaters located at 8km intervals. Six systems will be used on three routes.

The 34Mbit/s (equivalent to 480 telephone channels) will also be used in the trunk network. In this case the repeater spacings need only be at 10–11km spacings. Four systems of this type have been ordered for installation on two routes.

The 8Mbit/s (equivalent to 120 telephone channels) will be used for both the trunk and junction networks. In the former, the route length is typically 50km ("long haul") and for the latter the lengths are typically 10–20km. In all, 24 short haul systems of this type will be installed on nine routes. Because of their shorter lengths, they are usually located in urban areas. In practice, only a few of the systems will require repeaters, but where required, these will be housed in surface buildings with spacings of up to 12km.

STC and Plessey each intend to complete at least on 8Mbit/s by this time (Croydon—Vauxhall and Brownhills—Walsall, respectively). In addition, GEC expects to install part of a 140Mbit/s route (Chiswick—Faraday). The remaining systems will follow over the next two years, with all of them becoming operational by Autumn 1982. In addition to these inland routes, a 5 nautical mile loop of optical cable will be laid by a cableship in Lough Fyne. Later, two repeaters will be inserted, to provide an operational submarine system.

THE FUTURE?

In the immediate future, it is anticipated that optical fibres will be used extensively in the trunk (or main) network, as opposed to the junction or local networks. The use of optical fibre in the trunk network offers an economic alternative to coaxial cables currently in use.

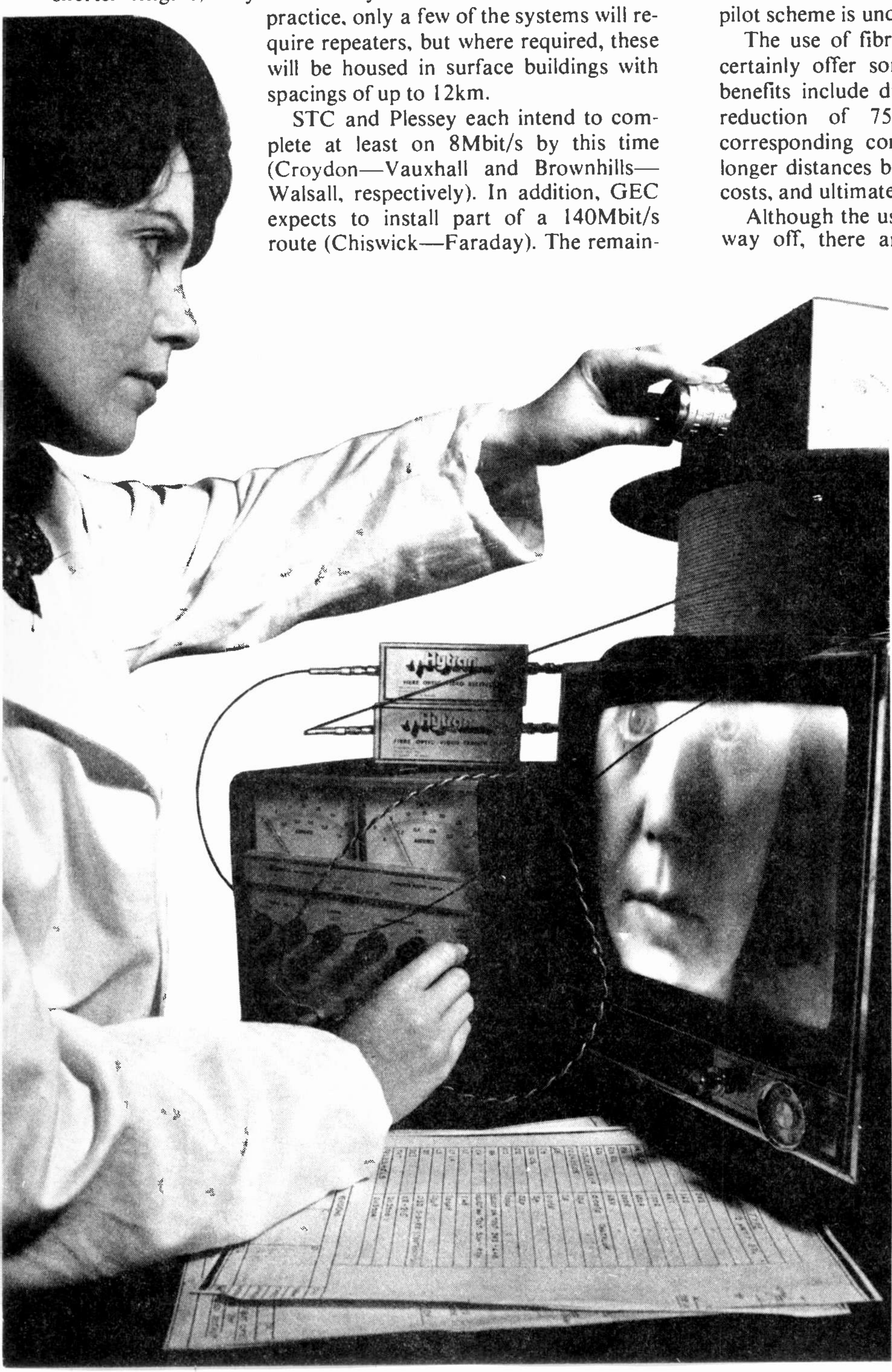
Unfortunately, the situation is somewhat different when one considers the junction network, as the use of pulse code modulation on existing systems reduces the economic advantages of optical fibres. What is certain, however, is that the cost of fibres will ultimately fall and thus encourage their use and adoption in this network. With the local network, ultimately the use of optical fibre will permit the transmission of television, and to this end, British Telecom are actively considering its introduction—a pilot scheme is under way in Milton Keynes.

The use of fibre optical systems in submarine cables could certainly offer some benefits over the existing system. These benefits include dramatic cost savings (some sources quote a reduction of 75 per cent), smaller physical size (with corresponding comparative ease of handling), and of course, longer distances between repeaters, further reducing installation costs, and ultimately providing higher reliability.

Although the use of optical fibres for this application is some way off, there are many other lines of development taking place, which will enable cheaper fibre with lower signal attenuation to be manufactured reliably. The transmitters and receivers will be fabricated in a single chip, rather than from discrete components as at present.

Potentially, these developments could transform the cost effectiveness and practical application of optical fibres over a period of a few years. The prospect for optical fibre is that it could carry the programmes of all eleven Television Companies broadcasting in the UK, and future developments such as 3D television, videophones, personal computers all *down a single fibre!*

However, this *is* some way in the future, but nevertheless implications on how the new technology will ultimately change our lives are well established. All that remains is for these systems to be introduced on a national basis. Let the light shine on. ★



A video camera connected via a fibre optic link to a monitor. The reel holding the fibre optic element and the modems can be clearly seen. (*Pilkington Ltd.*)

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Semiconductor UPDATE...

FEATURING iAPX 432 U410B

R.W. Coles

THE SHAPE OF THINGS TO COME . . .

No doubt people who read this column regularly have become numbed by the endless stream of new microprocessor wonder-chips I keep raving on about. It wouldn't surprise me, I have become numbed myself by the relentless, almost boring, march of microprocessor technology towards the ever bigger ever faster and ever more capable digital processor. Well, relentless progress is one thing and a quantum jump is quite another, and this month I am glad to report a spectacular quantum jump in microprocessor technology, from Intel, who else?

The name tag "microprocessor" is rather inadequate to describe this new concept in silicon. Intel themselves call it a "micro-mainframe", and they aren't joking or shooting a line—the iAPX 432 will outperform many familiar mainframe processors such as the IBM 370—but it's not just a super souped up 8080, it's a whole new concept in digital processing on silicon which bears little relation to any of its microprocessor antecedents.

Yes, it's a 32-bit processor alright, and it has the party tricks you might expect. 32-bit integer multiply in 6·25 microseconds, 80 bit floating point multiply in 26·125 microseconds, address range of 2^{32} (over 4 billion bytes!), an 8 Megahertz clock rate, etc., etc. Amazing enough in themselves but they're not the most important features of the iAPX 432.

ADA

The new processor has been designed with the computer programmer and high level languages firmly in mind. No more electronics engineers with logic analysers trying to discover what is wrong with the software, no more tortuous assembly language programs, this machine will *always* be programmed in a high level language with all the increased programmer productivity that that brings, even for high speed "real-time" applications. If, for you, "high level language" means BASIC, forget it. The language to learn for the future is ADA, sponsored by the American Department of Defense and designed to incorporate all the best features of PASCAL but with enhancements to suit it for the real time applications which have traditionally had to be programmed in assembler.

ADA was developed quite separately to the iAPX 432, but the new processor grew from the same body of experience and academic research and it fits the new language exactly, to the extent that many ADA statements compile directly into 432 instructions. Even system programmers will use ADA, and recourse to assembly language will rarely, if ever, be needed.

The new processor was also designed from the start for multi-tasking and multi-processor operation. Extra processing power can be added to a 432 system in the form of "attached processors" and, even better, the presence or absence of these extra processors can be transparent to the programmer!

Finally, the 432 has extensive hardware checking facilities to detect any software errors (such as trying to access instructions as data) which manage to slip through the formidable checking process already carried out by an ADA compiler.

Descending from those dizzy heights to good old fashioned hardware, the iAPX 432 is actually a three chip set of unprecedented complexity. Two of the chips, the iAPX 43201 and the iAPX 43202, act as the CPU or "General Data Processor (GDP)" as Intel call it. Together these chips house no fewer than 160,000 separate transistors, and they each have so many interconnections that a special 64-pin QUIP (Quad Inline Package) has had to be designed for them. The third device, the iAPX 43203, is called an "Interface Processor (IP)" and is used as a post-box for all GDP peripheral data transfers to attached processors, bulk storage devices, high speed printers and so on. There can be several 43203s in a system.

Believe it or not the GDP pair dissipates less than 5 watts and all three devices will run from a single 5 volt supply. With this sort of power just around the corner, the home computers of today will soon appear to be as quaint as the cats whisker wireless!

DIDDY AMP

Being an electronics person of great antiquity, the term "audio-amplifier" still stirs within me memories of the marvellous Mullard 5-10 and the other warm and glowing "bottle-jobs" of my youth. All you newcomers to the gentle art of audio amplification have missed the best bit without a doubt, because now all you need to perform this trifling function is a tiny square of plastic with eight puny legs, like the U410B from AEG-TELEFUNKEN, a "diddy-amp" if ever I saw one. Within this ridiculously inexpensive mini-dip package lives an amplifier which has a 40dB closed loop gain and a 1W maximum output power. You would normally use these uninteresting objects in, say, toys, doorbells, CB radios, intercoms and so on, where you would be well advised to keep the power down to a quite adequate 50mW, because at this level the total harmonic distortion reaches 1 per cent. A companion device, the U411B, does the same job but condescendingly allows you to alter the gain by means of a single external resistor.

They're good—but they'll *never* replace the 5-10!

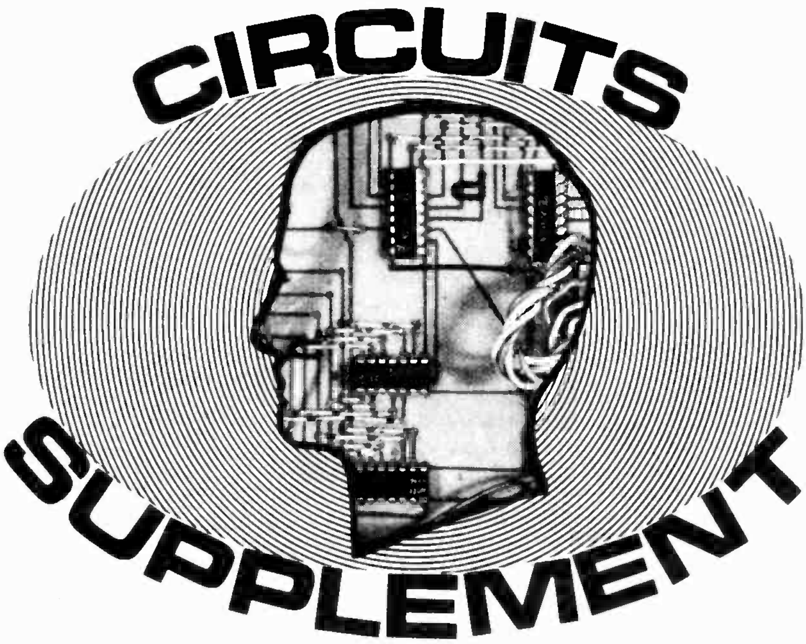
LED WARNING

Perhaps as a response to the Three Mile Island "incident", Siemens have produced a novel variation on the theme of seven segment l.e.d. numerical displays. When all is peaceful with the reactor, those in the control room will be reassured by rows of *green* numbers, indicating coolant temperature, reactor flux, and knocking-off time etc. If things start to get a bit hairy, those reassuring green digits will turn to a panic stricken *red* colour, and all concerned will be quickly informed of the impending melt-down so that they can finish the crossword or wave their colleagues goodbye or something.

"It can't be serious . . . the display's still green!"

The quick change act is made possible by constructing each segment from two l.e.d. chips of different colours wired in anti-parallel. When an external circuit senses that a reading is becoming dangerous, a quick change of drive polarity is all that's required to scare the hell out of everyone in eyeshot.

I don't have a part number for these saviours of the world, but they are part of the Siemens HD series of 10mm digits, and they could no doubt be used in many less worrying circumstances.



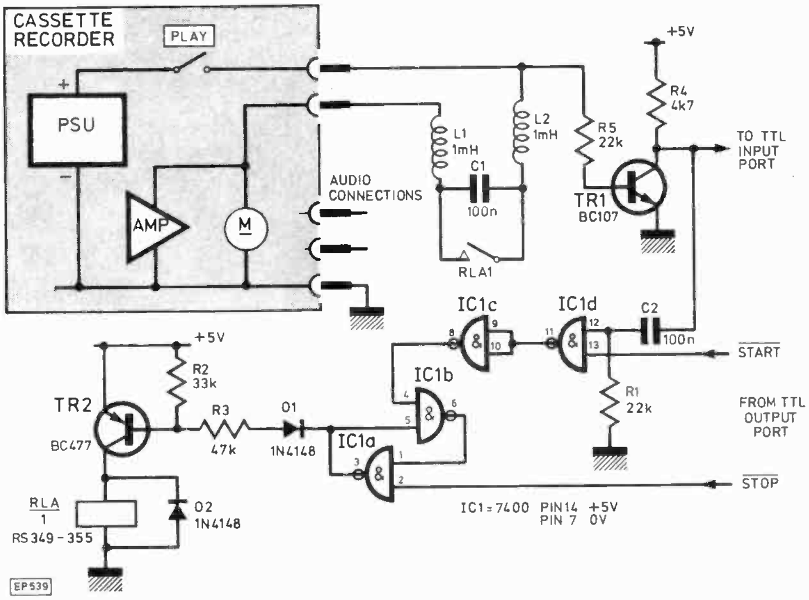
A selection of readers' original circuit ideas.

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

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

COMPUTER CASSETTE MOTOR CONTROL



THE circuit shown is a motor control system for an unmodified domestic cassette recorder, as commonly used for program and data storage with a small computer. It is necessary for the computer to be able to start and stop the cassette motor as required. This is achieved with control pulses, taken from two spare bits of an output port. One bit, when strobed low, will stop the motor, the other will start it, provided that the 'Play' switch on the cassette recorder is depressed. The computer can optionally sense the status of this switch on a one bit input port, thus providing for helpful messages to the operator, such as 'Press play on the cassette recorder'. This input can also be used to commence the timing for a record operation, insuring that the data is not written when the tape is stationary.

The circuit also overcomes the annoying disadvantage inherent in most systems, whereby it is not possible to rewind a tape without some unplugging, because the motor does not start when the buttons are pressed.

IC1a and IC1b form a bistable, whose output is connected via TR2 to the reed relay RL1. The relay interrupts the motor current via the socket provided on most cassette recorders. L1 and L2 are small chokes incorporated to reduce the current surges near computer circuitry, but they could be omitted for simplicity. R1 and C2 detect switch closures, and automatically start the motor, unless the computer is permanently holding $\overline{\text{STOP}}$ low, thus overriding the operator's control. Should a cassette recorder not be wired as shown, it obviously does no harm to change the recorder's internal wiring for this system.

D. Greaves,
Romsey,
Hants.

ELECTRONIC AIR FRESHENER

YOU have no doubt noticed how muggy the air is before a storm and how fresh it can be when the storm is over, even if the temperature has not changed. Have you ever wondered what caused the difference? No, not humidity, but the balance between two types of charged particles in the air; charges due to the electrical discharges we call lightning. These particles are called ions, and come in two versions, positive and negative. When the balance between these two is not equalised, the air can feel heavy and humid, or fresh and light. With an excess of positive ions the air is oppressive; with an excess of negative ions it is invigorating. This same effect causes the difference between vitality-lowering jungle air, and invigorating Swiss mountain air. No one as yet can explain why we are effected in this way, but negative ions have been used experimentally with great temporary success to treat disorders such as asthma.

Your first step is to cut an aluminium cover for the machine and bend it as shown in the diagram. Drill three holes on each side to screw it to the wooden base. Now screw the ignition coil to the base so that it is central. If you intend to mount the dimmer on the base as I did it will be necessary to mount the coil at a third the distance from one edge to allow for the box. However, it would probably be neater to mount your control on the wall direct.

Now wire up according to the circuit. If you have the dimmer on the wall, connect the combination to a terminal block on the base board to anchor the wires as shown.

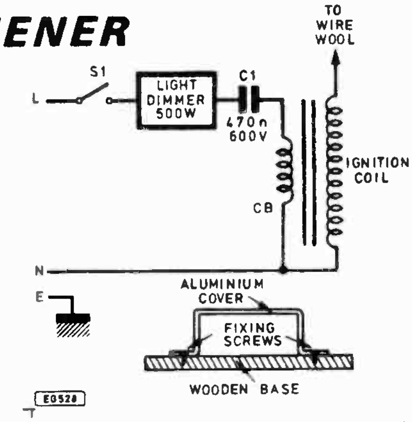
Now make a wick of wire wool and insert into the h.t. outlet at the top of the coil. Put on the aluminium cover you have made, connecting it to earth, and screw it down. You have now completed the working end of the negative ion generator.

A useful addition, for the sake of safety, is to fix a piece of zinc gauze across the top and bottom of the cover to allow free access of air, but which will keep inquisitive fingers away.

Now wire your terminal block to the light dimmer and switch on. If the dimmer has no mains switch, you will need to add one, but most now incorporate their own on/off switch. However, an extra switch in the line will add to safety as only you will now be able to switch the device on.

Having switched on you will be able to hear a high voltage discharge coming from the ignition coil. Now turn the dimmer *up* slowly till this discharge just ceases, and the air in your room will become like the Swiss Alps.

To understand the operation it is enough to know that a light dimmer contains a triac which is switched on part the way through each half cycle of the mains. The earlier during each half cycle it is switched on the more power it will pass.



The capacitor in our circuit passes this rapid switching charge through to the ignition coil at 100 times per second for 50Hz mains, rather like the contact breaker on the car opening 100 times per second, while at the same time isolating the mains from being directly connected to the ignition coil. Therefore 100 high voltage pulses are produced per second, the amplitude of which are controlled by the dimmer setting.

To convert this high voltage to negative ions, a silent discharge of electrons is required from a pointed object. I first tried a bunch of needles, but later found that wire wool provided thousands of minute sharp points for the purpose.

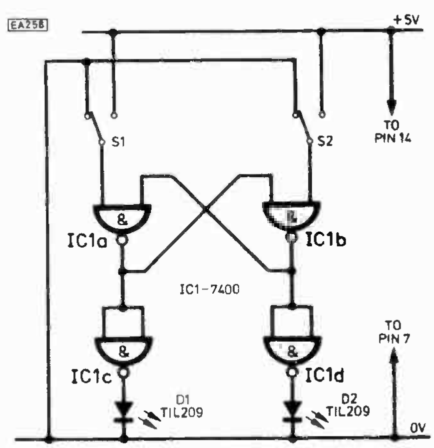
Michael Farrington
Tunbridge Wells,
Kent.

SNAP

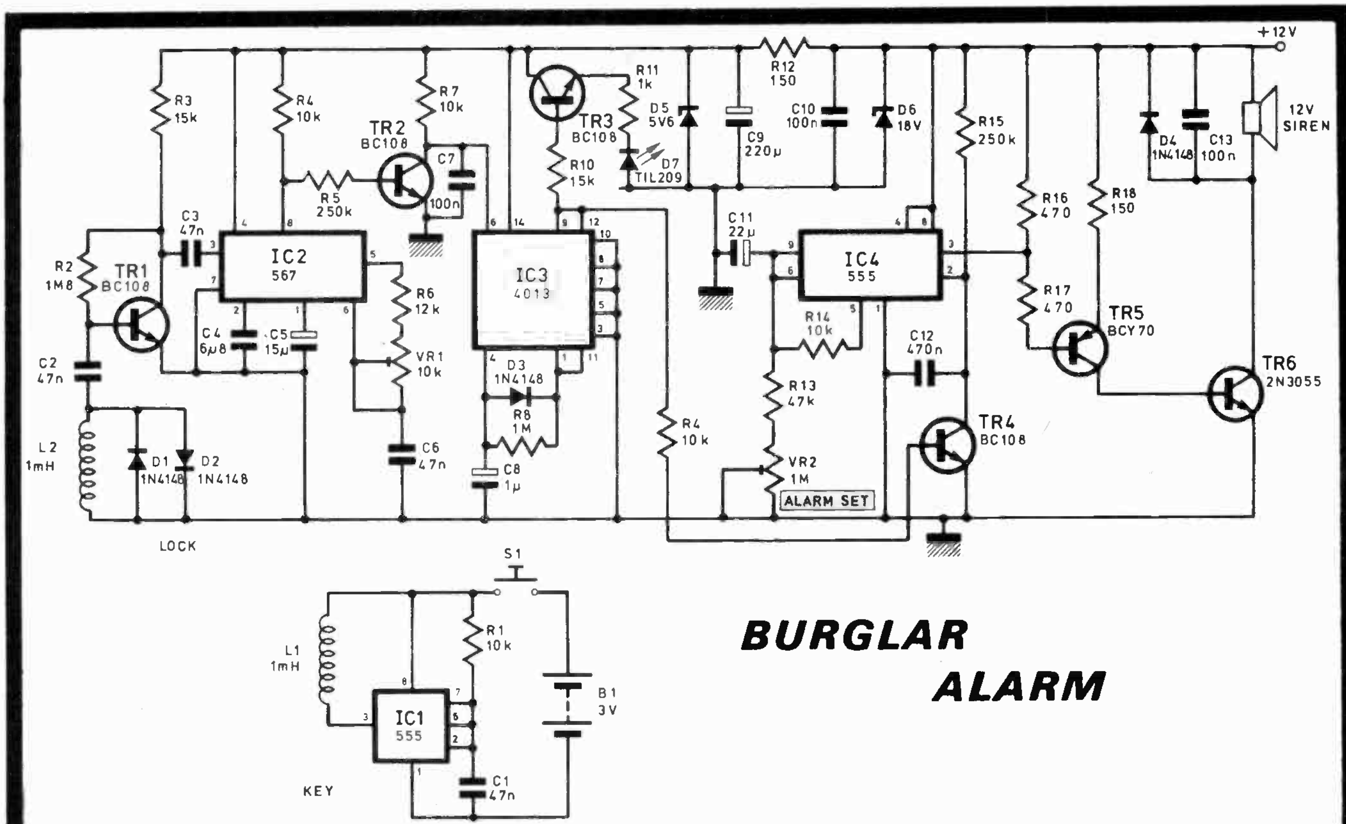
THIS simple 'Snap' circuit is built around one 7400 (Quad NAND) which makes it very simple and cheap to build. The first two gates are in an R.S. flip-flop configuration, but both their outputs are held at '1' by connecting both switched inputs to '0'.

As soon as one of the switches is thrown then the gate has two '1' inputs and so gives a '0' output, which is put into the other gate, and thus prevents it from giving anything but a '1' output. Thus, while the switch is held the other switch cannot affect the state of the flip-flop. When the first switch is set back to '0', then the circuit is reset to its original stable state. The two other NAND gates are wired to invert the outputs from the flip-flop. Thus, when the switches are at '0' the l.e.d.s are not lit, but the appropriate l.e.d. is lit by the first switch to be set at '1'.

If s.p.d.t. push-to-make switches are used then the circuit will provide a sensisitive 'who pushed first' snap indicator which resets itself when both buttons are released.



J. Hobson,
Minister,
Sheppey,
Kent.



BURGLAR ALARM

THIS consists of an astable multivibrator used as a key, and a lock circuit. This operates at a frequency of 3·2kHz and uses a 1mH choke as the load which acts as a primary of a transformer, when brought into close proximity to the lock.

The lock uses a r.f.c. (which has two diodes to prevent large voltages being induced onto it) to act as the secondary of a transformer picking up impulses from the key. These are amplified via TR1 to a large enough level to operate IC1, which is a phase locked loop tone decoder. The decoder output at pin 8 is high until the correct frequency is introduced to the i.c. This frequency is set by C6 and VR1 and R8 and adjusted to match the frequency of the key.

The output from the NE567 is buffered and inverted by TR2, the collector of which operates one half of a CD4013, which is wired as a monostable and used to make sure only one operation of the NE567 at a time is accepted before switching the other half of the CD4013 which is connected as a bistable.

The Q output of the bistable switches TR3 which lights the l.e.d. indicates when the lock has been operated to arm the alarm.

The alarm function uses a NE555 timer as a voltage sensing device. The trigger on pin 2 of the i.c. sets the internal RS bistable when the voltage across C12 is low before it is charged via R15. A voltage is tapped off pin 5 (the control voltage pin) and fed to the threshold pin 6 via a voltage divider. When the supply voltage falls due to an instantaneous drain on the battery (operation of the lights or courtesy light etc.) the voltage at pin 5 falls as well. If this level drops below the threshold voltage which is held there via C11, then the output resets and falls to a low state and stays there.

When this happens IC4 output switches on TR5 allowing TR6 to switch on and operate the siren. The internal bistable of the NE555 is not set if the Q output of the CD4013 bistable is high. If it is low, then the alarm is armed and TR4 is off and allows C12 to charge.

A stabilised supply is needed for the NE567 and CD4013 and is derived via R12 and D5 giving 5·1V. To suppress transients arriving from the car electrics a 18V. Zener and a 0·1μ capacitor are connected across the supply.

Peter Robinson
Tyldesley,
Manchester.

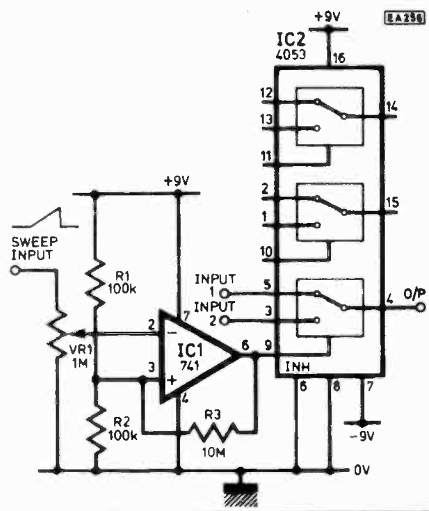
OSCILLOSCOPE TRACE DOUBLER

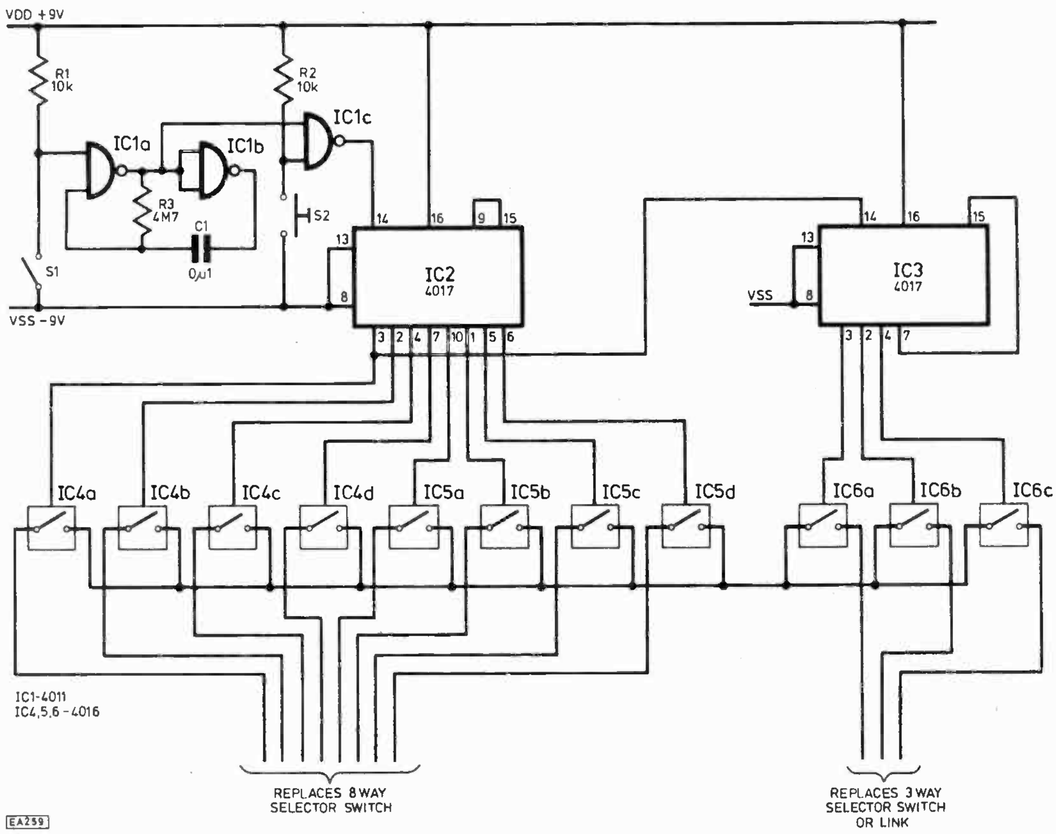
MOST designs for trace doublers work on the principle of switching, at some preset frequency, between two or more inputs and applying a d.c. level shift to separate the traces. This chopped effect can be most annoying especially when viewing digital waveforms. This circuit switches between inputs midway along each sweep and has the advantage that d.c. levels between inputs can be instantly compared.

The sweep or X output of the oscilloscope is applied to VR1 so that the input level can be adjusted to centralise the switching point. IC1 is arranged as a voltage comparator such that when the input voltage from VR1 exceeds the value set on the +ve input by R1 and R2 then the output goes low. This output is applied to the control input of IC2 which is a triple two input analogue gate.

The first half of the trace therefore contains information from input 1 and the second half from input 2. Pin 7 of IC2 is taken to a -ve supply in order to accommodate negative input signals.

R. Macfarlane,
Aberdeen,
Scotland.





RANDOM TUNE SELECTOR UNIT

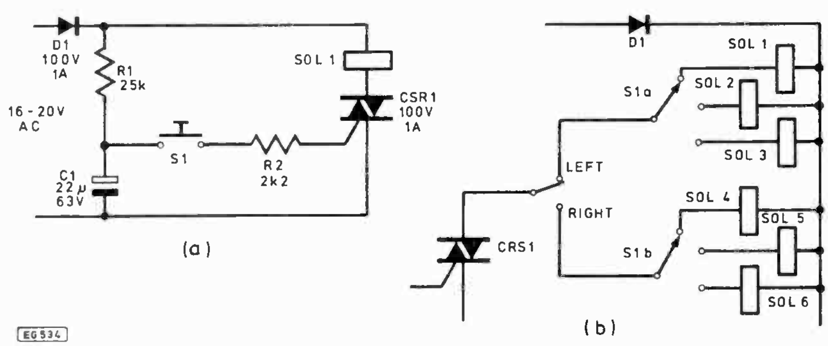
THIS simple add-on device converts these 24 tune doorbells to give a random selected tune each time the doorbell is pressed. The tune selection switches are replaced with CMOS switches.

In the random tune select mode S1 open circuit, the oscillator IC1 a,b continuously clocks the decade counters through the 24 switch positions. When the doorbell is pressed a tune is selected and plays through, regardless of the following changes in switch positions.

To select a particular tune S1 is closed and S2 pressed to clock through the decade counters until the desired tune is found.

The unit shares the doorbell's 18V power supply. This is the maximum voltage recommended for CMOS devices. The prototype worked on this, but some diodes in series with the supply lines could be used to reduce the supply to about 15V.

J.R. Scarborough,
Skellingthorpe,
Lincoln.



(a)

(b)

POINTS MOTOR CONTROL

THIS circuit was designed as a points motor control for use in model railway layouts. Normally 16–20V a.c. are applied directly to a coil, the resultant magnetic field attracting a solenoid with a brass pin attached to it. The brass pin in turn fits directly into the operating mechanism of the railway points. The disadvantage of such a simple system is that the solenoid may be burnt out if power is applied for too long, e.g. in the hands of a youngster.

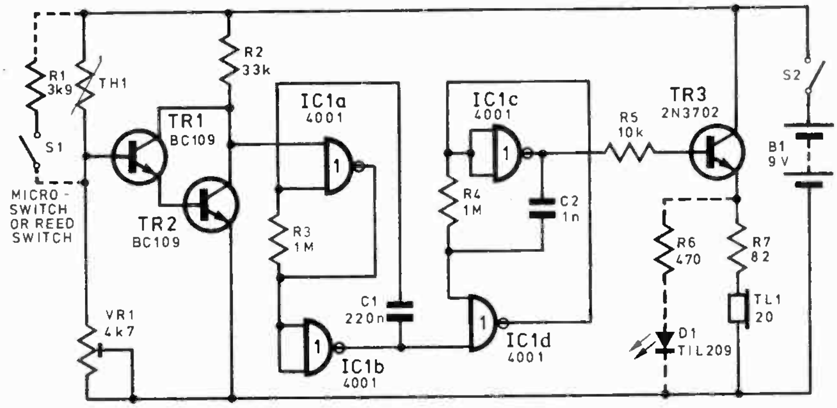
Capacitor C1 charges via R1 from the half wave rectified output of D1. When switch S1 is closed, the voltage present on C1 is sufficient to fire thyristor CSR1. Resistor R2 limits the gate current to somewhere in the region 7–10mA. The thyristor now conducts and operates the points motor. Because C1 is now discharged and R1 is too large to maintain an adequate level of gate current, the thyristor will turn off when the half wave rectified voltage waveform falls to zero, thus preventing any excess current flowing through the coil, even if S1 is kept closed.

By suitable switching, the output of the unit can be routed to various parts of the model layout.

The unit should be fed from an a.c. source in order for the thyristor to turn off. A single pole two way switch is used to select left or right, then the appropriate points are selected on a 2 pole multiway rotary switch (maximum twelve ways with two single pole, twelve way wafers) and S1 is activated.

T. J. S. Mowat,
Kincardine o'Neil,
Aberdeenshire.

FREEZER ALARM



EG536

THE unit was designed for low cost of construction and to be unobtrustive when in use. Current consumption in the quiescent state is around 0·5 mA.

The temperature sensor is a rod thermistor whose resistance at −25°C is around 14k. Perhaps a bead type would be more sensitive (and more expensive) but hysteresis introduced by the relatively large thermal inertia of the rod allows the freezer to be open for several minutes for loading without triggering the alarm.

Super alpha pair, TR1 and TR2 provide a sharp trigger for IC1a. IC1a and 1b form a gated astable with a duty cycle between 2 and 4 seconds. The output pulses of IC1a and 1b gate a second astable formed by IC1c and 1d. This astable generates a pulsed output of several hundred hertz.

TR3 is driven via a 10k resistor by the output from IC1. The transducer is a telephone earpiece which is just as effective but much cheaper than a miniature loudspeaker.

The thermistor is located at the top of the freezing compartment and left to cool for an hour. VR1 is then adjusted so that the alarm is triggered by heat from a finger on TH1 for about 10 seconds.

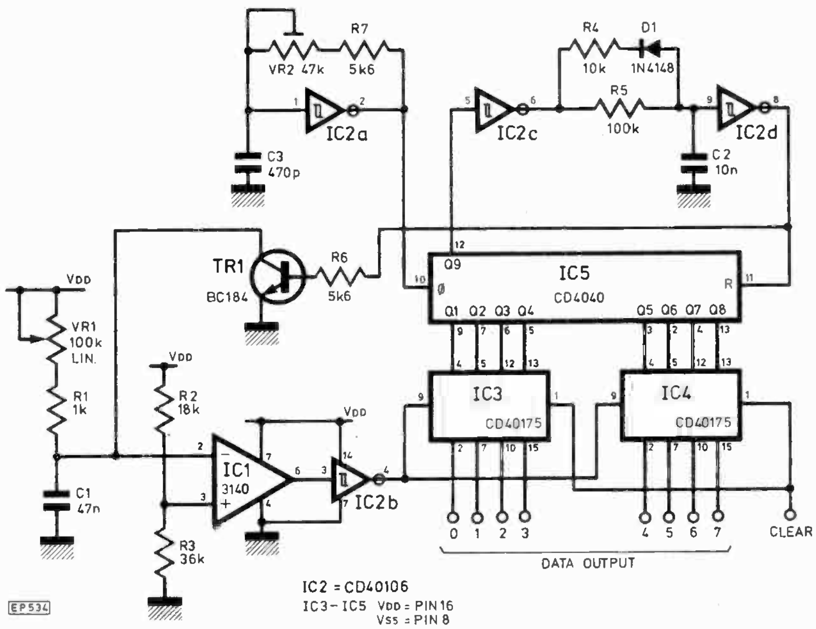
If the freezer is in a remote location such as a garage the transducer may be connected by twin flex to the house. The alarm unit should be located beside the freezer.

A burglar alarm facility (dashed) can be added by wiring a microswitch or magnet operated reed switch in parallel with the thermistor. This switch closes when the freezer top is opened.

The on/off switch is a shorting plug which is removed when the freezer is being defrosted. The plug is mounted on the top of the case to give a clear visual indication that the alarm is disabled. The plug would also be removed before loading or unloading when the freezer is located outside the house.

R. Mackay,
Grangemouth,
Scotland.

DIGITAL POTENTIOMETER



EP534

IT is useful on many occasions to be able to feed a value set on a variable resistor into a microcomputer. Examples of this include cursor and graphics control, games, servo position, and even speed control. The easiest way to do this is to feed a voltage output from the resistor to an A to D converter; but this does tend to be expensive if 8 bit resolution is required. The circuit presented here achieves 8 bit accuracy from 100k potentiometer at not very much cost.

Capacitor C1 charges up via VR1 until the threshold of the 3140 is reached. Obviously the setting of VR1 will influence the charge up time. The output of the 3140 changes and in so doing loads the two four bit latches, IC3 and 4, with the current count value on the outputs of IC5 (a 14 bit counter). This latched value will vary between 1 and 255 using the values shown, over the sweep of the potentiometer. The counter continues until Q9 goes high, corresponding to a count of 256. The output from pin 8 of the Schmitt trigger goes high very quickly after, resetting the counter and discharging C1 by means of the transistor. As the counter resets Q9 goes low, and capacitor C2 starts to charge slowly, until the threshold of the Schmitt is reached releasing the counter and stopping the discharge. This delay is necessary to ensure C1 has plenty of time to discharge. The main oscillator should be adjusted to give a count of 255 with the potentiometer fully open, this corresponds to 107kHz.

The data is continuously available at the latch outputs. If some form of Read/Clear is required the clear line should be connected to the processor port, otherwise it should be pulled up.

I. C. Lare,
Northwich,
Cheshire.

DELAYED SWITCH ON FOR SPEAKERS

THIS circuit connects the loudspeaker to a power amplifier a few seconds after the amplifier is switched on, thereby avoiding turn on 'thumps' and possible damage to the speaker.

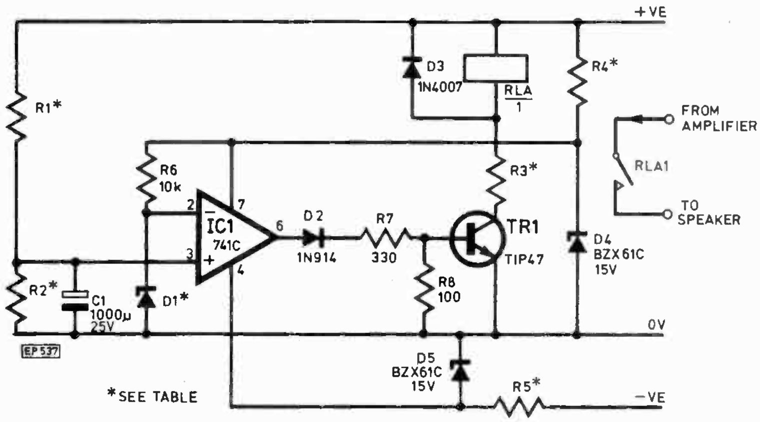
When the power is switched off, the speaker will be disconnected when the rail voltage falls by about 30%; the time taken depending on whether the amplifier is handling a signal. This disconnection protects the speaker from the d.c. offsets at the output, and oscillations that occur in many power amplifiers a few moments after being switched off.

If the amplifiers form part of a large system driven at high levels, and a power failure occurs, then the speakers will be disconnected very rapidly. Even if the power is immediately reinstated, the connection of the speakers will be delayed, thus turn on 'thumps' from preamps, mixing desks, crossovers, etc. will cause no damage.

D1 sets up a reference voltage at pin 2 on the comparator (IC1). At the moment of turn on, the voltage at pin 3 is zero and the output voltage swings negative, hence TR1 and RLA remain off. C1 charges via R1 and when the voltage on pin 3 of IC1 exceeds the reference, the output (pin 7) swings positive, turns on TR2, which in turn connects the RLA and the speaker. When the power is disconnected, the supply rail falls rapidly (provided a speaker is being driven) and the relay will 'drop out' naturally when the supply rail falls to a fraction of its nominal value. In addition, C1 discharges via R2 and when the voltage on pin 3 of IC1 falls to some 70% of its original value, the comparator output will swing negative and turn off TR1, hence RLA and the speaker.

The voltage on pin 2 of IC1 is normally some 70% of that on pin 3 to allow for variations in the rail voltage which occur in the unstabilised power supplies common to all high quality audio power amplifiers.

Ben Duncan,
Tattershall,
Lincoln.



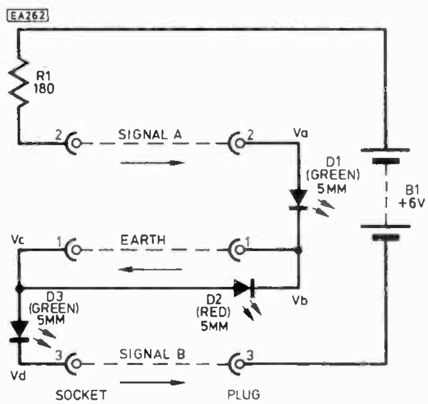
Power	Max. voltage	R1	R2	R3	R4	R5	RLA.	D1 (All BZX85 or BZX61c)
17w into 8Ω 35w into 4Ω	24V	10K	2K	Link across	47OR	1K2	24V	3V3
40w into 8Ω 80w into 4Ω	35V	10K	1K5	1 watt 220R	1 watt 1K	2K7	24V	3V3
80w into 8Ω 150w into 4Ω	47V	10K	1K	Link across	1 watt 1K6	4K3	48V	3V6
150w into 8Ω 250w into 4Ω	63V	1 watt 10K	1K	1 watt 560R	2 watt 2K2	1 watt 6K8	48V	4V7
250w into 8Ω 500w into 4Ω	85V	1 watt 10K	1K	2 watt 1K5	4 watt 3K3	1 watt 10K	48V	6V2

All Resistors ¼ watt unless otherwise indicated.

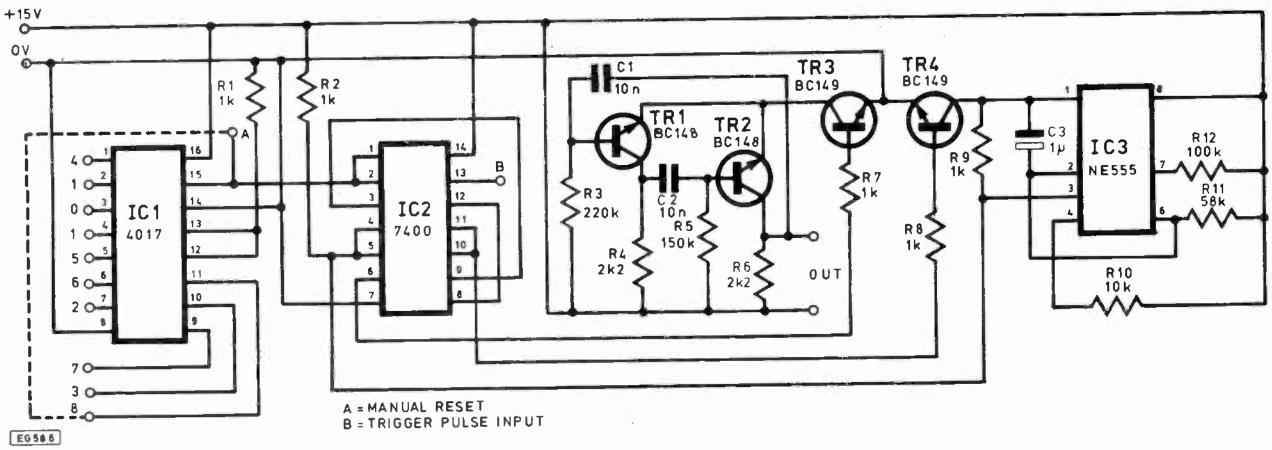
CABLE TESTER

A healthy cable is indicated by both green LEDs being lit and the red one extinguished. To give this indication, the voltages along the chain of LEDs must descend so that Va > Vb, Vb ⩾ Vc, and Vc > Vd. These voltages can only be maintained by currents flowing along each conductor as shown. Any single open or short circuit on the cable extinguishes one or both of the green LEDs. Multiple faults can result in the red LED paralleling the green ones and taking current from them.

J. A. Percival,
Clowne,
Derbyshire.



LEDS SHOULD BE OF THE SAME TYPE AND MANUFACTURE



PROGRAMMABLE PULSE GENERATOR

THIS circuit describes a device which creates a series of audible signals each of which is about 0·25 second long with a gap of about the same length between each. It was originally designed to identify a number of remote sensors. Each remote would contain one of these circuits and be connected to a small radio transmitter. When triggered it would emit a specific number of 'bleeps' and then reset itself to await the next trigger. The idea being that each remote sensor would transmit a different number of 'bleeps' and so the master on receiving the signals would be able to identify which remote was triggered.

Pins 8–13 of IC2 are wired up to create a latch, when a trigger pulse is detected at pin 13 (B), a trigger pulse being logic 0, pins 10 and 11 go high and via TR4 an oscillator IC3, operating at approximately 4Hz, is switched on providing a clock pulse for IC1. Pins 1–11 of IC1 provide outputs which are normally low and go high when the corresponding number of pulses is provided at the clock input, e.g., when five pulses are sent to the clock input, output 5 (pin 5) will go high. When a clock pulse is provided by IC3 and sent to the clock input of IC1 it is also sent through an inverter, produced by pins 4, 5 and 6 on IC2. The output of the inverter (pin 6) is used to switch on and off an audio oscillator via TR3. The audio oscillator is produced by TR1 and TR2, and is a simple multivibrator. An output can be taken from both sides of R6 and can drive a small high impedance crystal transducer. This output is the final output and it is here that I connected the transmitter mentioned earlier. Every time the clock oscillator goes low a 'beep' will be heard in the transducer. The programmable part is achieved by creating a direct link from one of the numbered outputs to the reset pin (pin 15) on IC1 thus when a wire is connected as shown by the dotted line eight 'beeps' will be heard and then the circuit will reset itself. As the latch requires a low reset the pulse is first sent through an inverter produced by pins 1, 2 and 3 of IC2.

Other uses for this circuit could include an automatic telephone dialler or a simple remote control system. The number of 'beeps' can be increased by an indefinite degree by connecting another 4017 counter into the circuit. To do this simply disconnect pin 12 on the existing counter, from the resistor R1 and take it to the clock input (pin 14) on the next counter, all other pins should be connected as they are on the first counter; the output pins on counter two can then be checked to see how many pulses they produce.

J. Chalmers,
East Grinstead,
West Sussex.

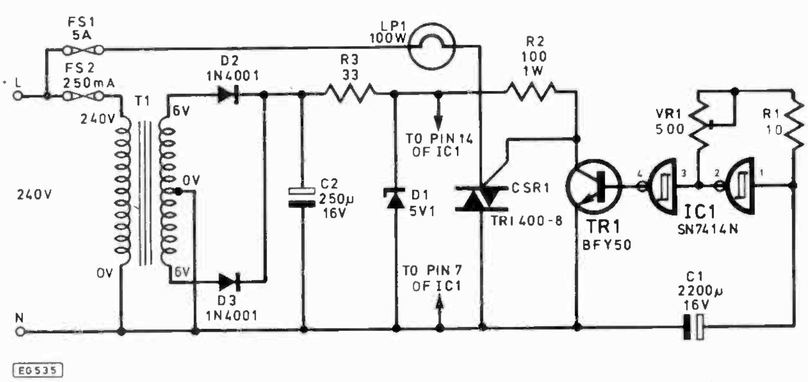
VARIABLE LIGHT FLASHER

THIS circuit is for a simple light flasher that is for both domestic and disco use. It is built around a TTL SN7414N hex inverter Schmitt used as an oscillator. To obtain full lamp brilliance a triac is used, rather than a thyristor, and is driven by a BFY50 transistor. The output of the power supply is about 9V which is dropped to 5·1V, for the i.c., using a Zener diode.

The range of frequencies that the lamp will flash over is determined by C1, VR1 and R1. The formula for calculating the frequency is $f = 1/(R_1 + VR_1)C_1$ where f is in hertz, C is in farads, R is in ohms.

With the values shown in the diagram the lamp flashes about once every second to about 45 times a second. The lamp load that the circuit will drive is determined by the handling capability of the triac.

K. Badcock,
Kettering,
Northants.



ELAPSED TIME METER

THE meter is connected across the mains supply to the device being timed, after any on/off switch or thermostat.

Because the display is only activated when a reading is required, and is not multiplexed, the circuit shows very little current consumed when counting, and a negligible amount on standby. It will run for at least a year on one PP3 battery.

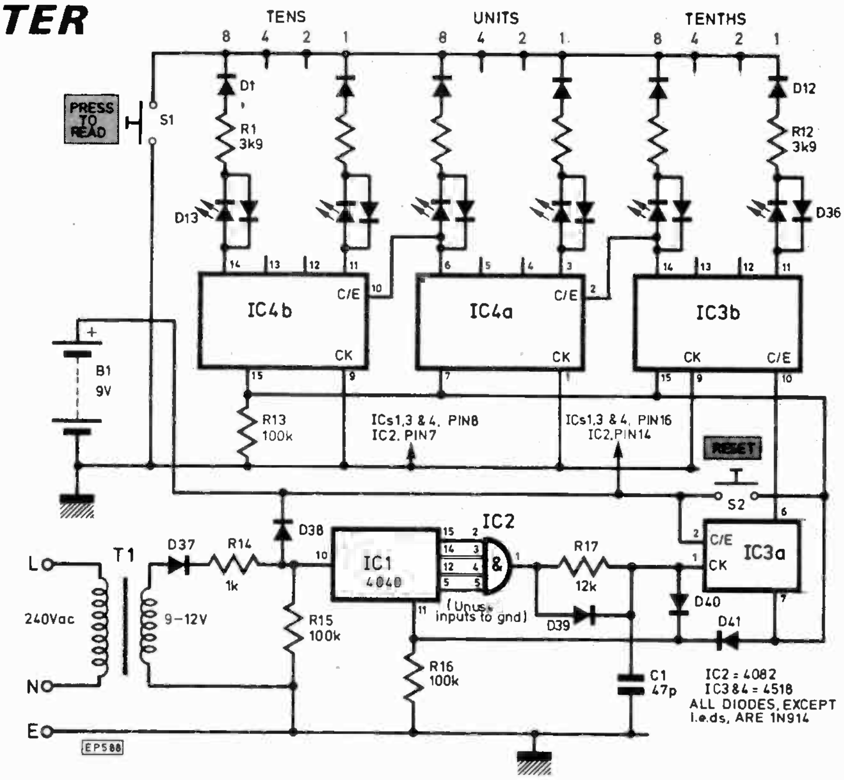
The operation is as follows: when the device being timed is operating, 50Hz pulses are fed from T1 through D37 into IC1. The pulse level is limited to 9V by D38. IC1 is gated by IC2 to divide by 1800. The output of IC2 is stretched by R17 and C1 and clocks IC3a as well as resetting IC1. IC3a gives an output pulse every 0·1 hour, and these pulses are counted by IC3b and IC4, the count being displayed in BCD format when S1 is pressed.

The display l.e.d.s are shunted by diodes, and have other diodes in series, to prevent reverse voltages being applied to the l.e.d.s. The display brightness is kept low to enable the l.e.d.s to be driven directly by the 4518 ICs, and to reduce battery drain.

S2 resets the counters, and D40/D41 ensure that the output pulse from IC2 only resets IC1.

The counter gives a maximum count of 99·9 hours. If a larger count is required, a 4017 could be inserted between IC1 and IC3a, the latter being used for the first (tenths) display. The maximum count will then be 999·9 hours.

A. M. Tucker,
Charminster,
Dorchester.



HEXADECIMAL DISPLAY UNIT

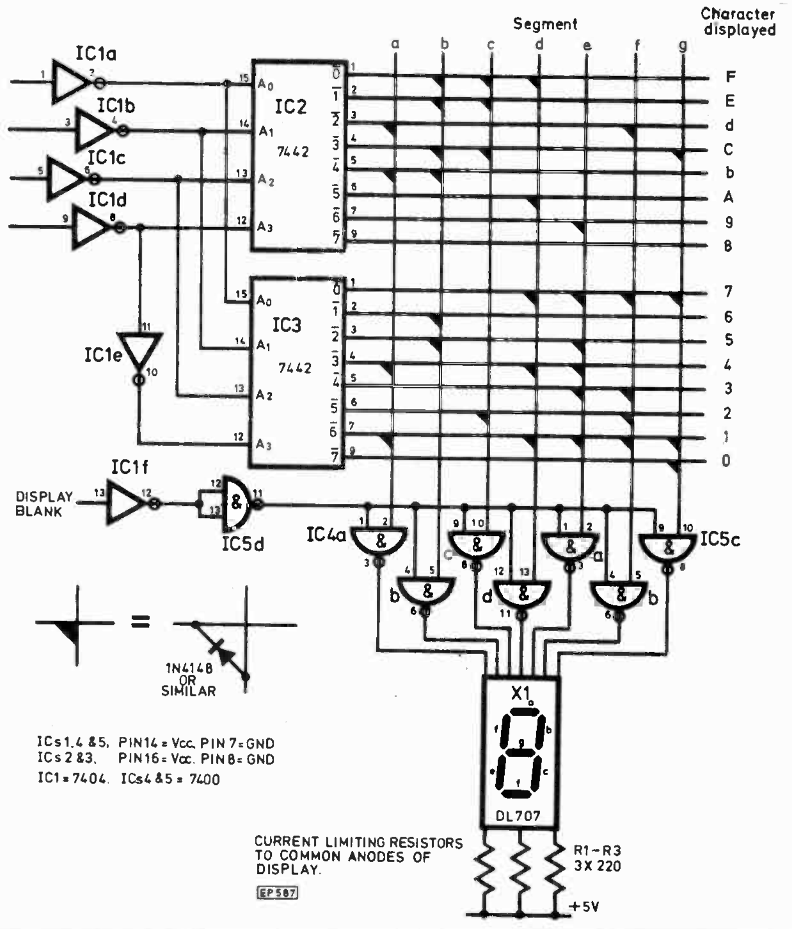
THIS circuit decodes a 4-bit binary number and displays the appropriate hexadecimal character (0–F) on a 7-segment display.

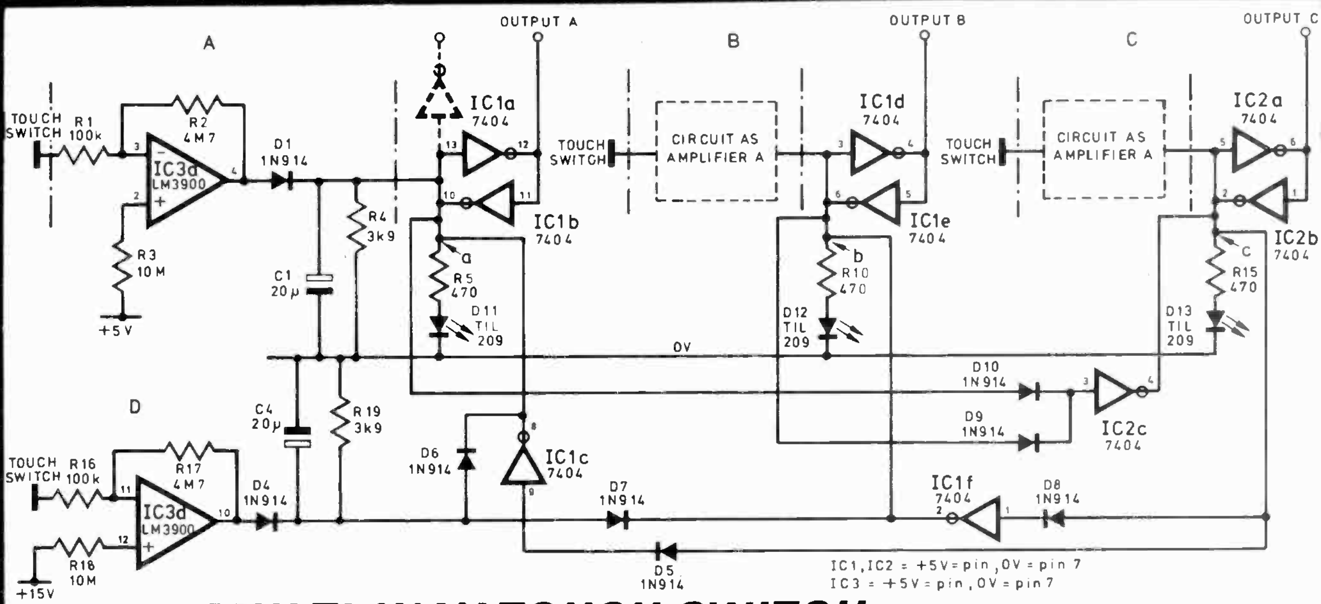
The diode matrix would normally use 78 diodes in a conventional system but this has been reduced to 34 by using diodes in the matrix to stop segments lighting. All segments light otherwise.

Two 7442s are used to produce a 1 to 16 output from the binary input because the 74154 could not pull the segment driver inputs low enough through the diode matrix.

The use of 7400s to drive the display allowed the unused input to be used for display blanking.

J. K. Semple,
Plaxted,
Kent.





EG572

MULTI-WAY TOUCH SWITCH

THIS circuit has been developed to eliminate the possibility of activating the wrong combination of switches. Switch C can never be switched 'on' when either switches A or B or both are 'on'. Circuit D enables switches A and B to be switched 'on' simultaneously.

This circuit senses the 50Hz noise our body is always picking up and uses that as the control signal. IC3a is connected as a standard amplifier with a gain of about 50. When a finger touches the touch plate, the noise voltage on the touch plate is amplified and then rectified by D1 and filtered by C1 to provide a small voltage change across R4, providing a logic 1 pulse at IC1a. IC1a and IC1b acts as a memory. When the finger is removed, point a remains at logic 1. The output of switch A goes from logic 1 to logic 0. The l.e.d. D11 goes on when point a is at logic 1 and will remain so as long as it is at logic 1.

To enable switch C to be turned 'off' when switch A is 'on', point a is connected via an inverter to point c of switch C. This will result in the memory circuit of switch C being reset, and its output will go to logic 1 if it is at logic 0.

Switch B is wired similarly to switch C. Switch D is wired to switches A and B at point a and b respectively to enable switches A and B to be switched 'on' simultaneously.

Further stages can be added to this multi-way switch and different switching combinations can also be chosen.

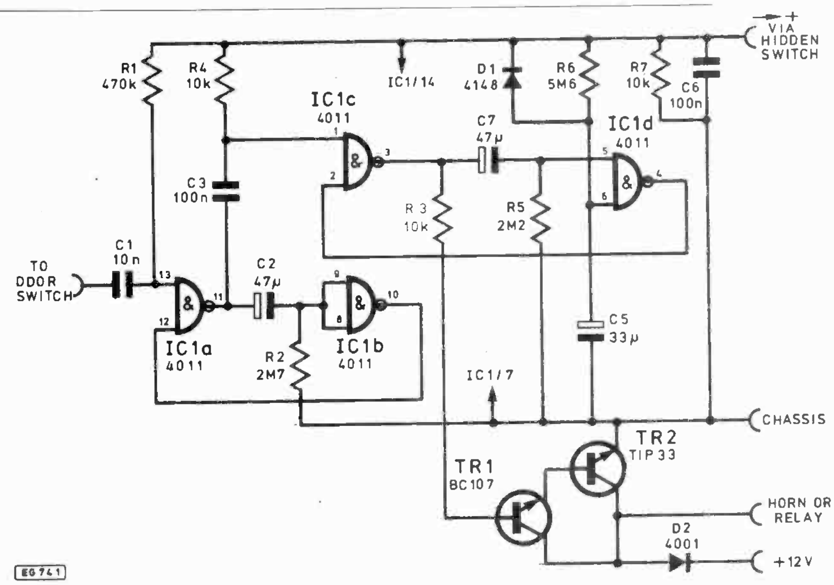
Multi-pole function can be achieved by connecting an inverter to point a or its equivalent point in the other stages.

This unit was intended for direct interface with TTL, but the output could be used to drive a relay if heavier loads are required.

The knob of a door could be used as a touch plate, thus using the unit as a burglar alarm.

Yee Yew Khuan,
Selangor,
West Malaysia.

CAR THEFT ALARM



EG741

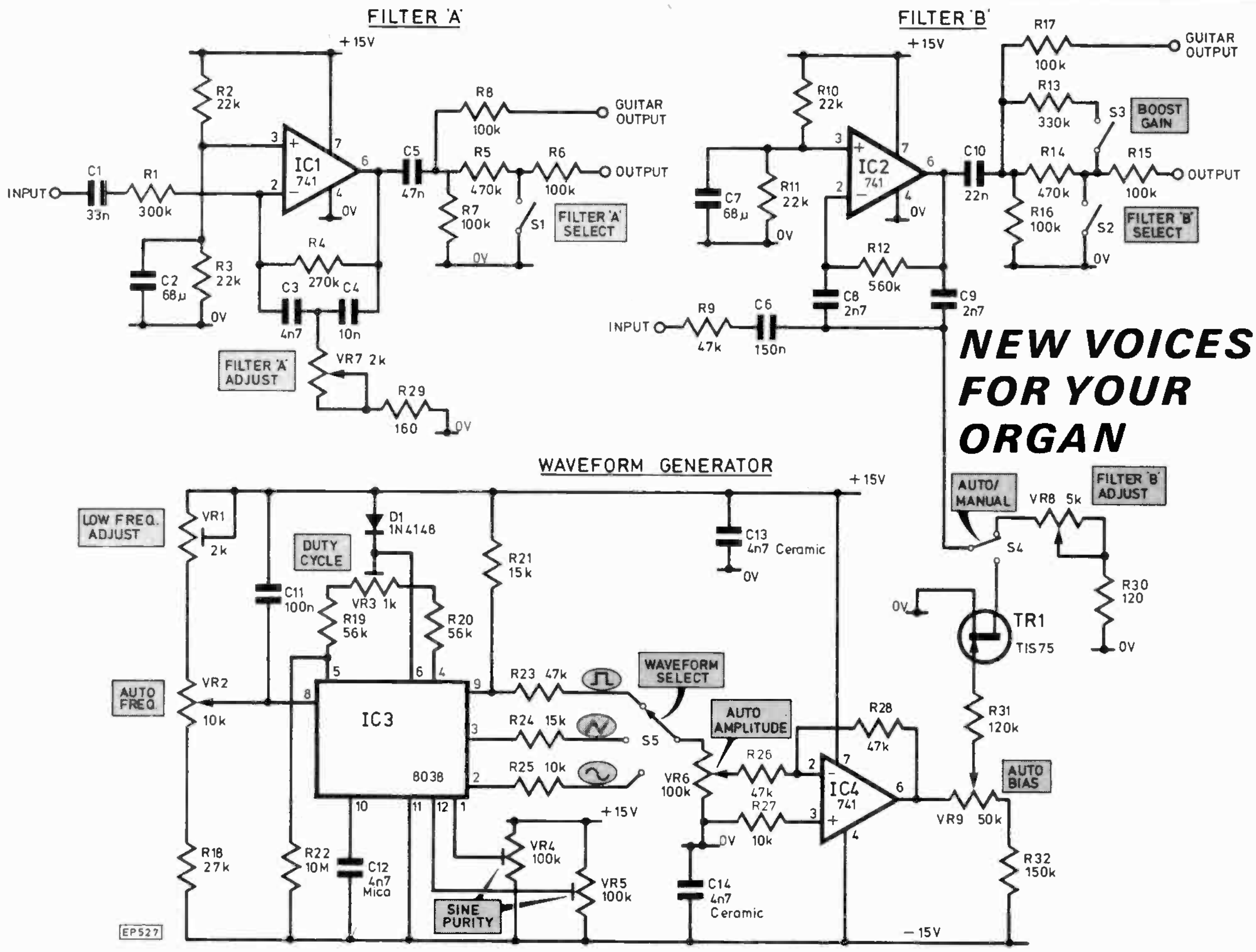
THIS alarm consists of two monostable multivibrators built around a single i.c., a two-transistor driver stage able to drive the car's horn or a relay, and a hidden switch to turn the unit on/off.

When the car's door is opened, the door contact will close and trigger the first multivibrator. If the unit isn't turned off before a certain time determined by R2 C2, the second multivibrator will be triggered, sounding the horn (or drawing the relay) for a time determined by R5 C7. To be able to leave the car without triggering the alarm, pin 6 will be held low for a time determined by R6 C5, making the second multivibrator insensitive to triggering.

When the unit is turned off, C5 will rapidly discharge through D1 R7 to make it possible to turn the unit on again immediately. With the values shown, the alarm will sound for about 2 minutes and you'll have about 20 seconds to turn the unit off after entering the car. These times can be changed by altering the RC networks. If the diode D2 is connected directly across the horn (or relay) the + connection will not be necessary.

Anders Ljungfeldt,
Gothenburg,
Sweden.

NEW VOICES FOR YOUR ORGAN



THE desirability of a large range of interesting voices is an indisputable requirement for all organists. This presents no problem when unlimited funds are available since the ubiquitous chip has provided the means to produce an almost infinite range of sounds controllable by tabs, drawbars, peddles, knee switches, etc. However, in the more modest range of organs, as few as three tabs only may be available on each manual, together with presets such as vibrato, wha, banjo, etc. This does allow a dozen or so combinations but it will soon become desirable to have more.

The new sounds are achieved by the use of two filter circuits either singly or in combination, both employing LM741 operational amplifiers to provide band pass characteristics. Both filters provide gain over a narrow band of frequencies but filter A has a gain of unity at low frequencies. By connecting adjusting resistors, the band pass frequency can be varied over a wide range whilst the band width remains constant.

Filter A will pass the fundamental frequency of the note played plus the harmonics which lie within the pass band. These harmonics being boosted by the gain in the pass band.

Filter B provides very similar boosting characteristics to the harmonics but does not pass the fundamental.

Use of filter A or both will provide a basic flute-like tone but with the addition of the selected higher harmonics. The effect will be to considerably brighten the tone and particularly to increase the attack on the leading edge of the envelope. The addition of the upper harmonics will not produce edgy string-like sounds since the width of the pass band is insufficient, the sound being more bell-like.

By setting S4 to auto, VR8 is replaced by a field effect transistor used as a variable resistor, so that voltage control of the pass band frequency can be achieved. This allows the use of a waveform generator to control the filter frequency and provide repetitive effects of almost infinite variety.

The waveform generator circuit is based on the 8038. It can provide sine, square, triangular and ramp-type waveforms over a frequency range of 0·1 to 100 Hz approximately.

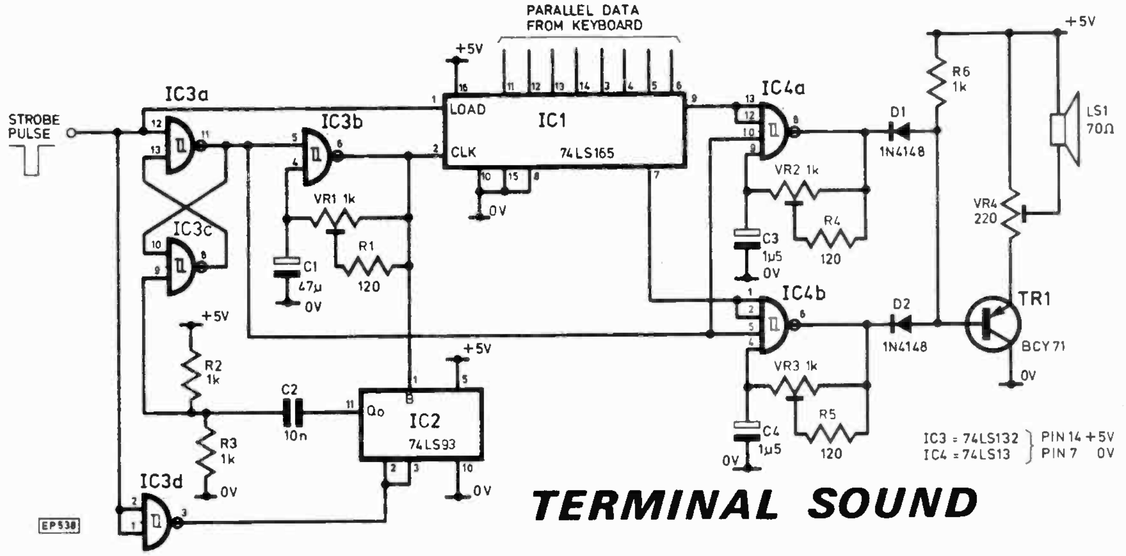
The chosen waveform is applied to filter B via the f.e.t. TR1 together with a d.c. bias which sets the nominal pass band frequency. The amplitude control sets the extent of the frequency sweep. Many combinations of pass band frequency sweep amplitude and repetition rate are possible.

Using the filters with their nominal pass band frequencies set by VR7 and VR8 will provide very bright voices when used on their own or will brighten any combination of the organs existing voices. Vibrato will enhance all the voices as desired. If the waveform generator is used with a sine wave to drive filter B an effect similar to vibrato will occur but only on the upper harmonics. With very small amplitudes this can be a very subtle and musical effect, particularly when the sweep frequency is matched to the tempo of the music being played. Many other modern effects can be produced with large amplitudes of sweep frequency, for example, when matched to the beat of the music or when very slow, allowing the pass band to sweep the whole range.

Some combinations of the controls will not be musical but many new voices and combinations of effects will enhance the performance of your organ.

The complete unit should be installed in parallel with the existing organ filters. The bus bar connections should be made to the filter inputs with the outputs going to the summing amplifiers.

B. F. Smith,
Humberstone,
Leicester.



TERMINAL SOUND

INTENDED as an addition to microprocessor or VDU keyboards, this produces a different pattern of high and low tones for each key on the keyboard. Although it is not necessary to learn these different patterns, after some use the tone generator becomes a real aid to accurate typing.

The 8-bit data from the keyboard is loaded into a shift register IC1, and latch IC3a,c is set, when a keyboard strobe pulse is produced. Pulses from the oscillator IC3b shifts the data so that the two tone oscillator IC4a,b produce a high tone for a 1 and a low tone for a 0. These tones are summed and fed to a small loudspeaker. Counter IC2 resets the latch after the last data bit is shifted out.

VR1 sets the speed of shifting, and VR2/VR3 adjust the high and low tones respectively. VR4 sets the volume. The circuit shown is for negative strobe pulses, but is easily rearranged for positive strobes.

T. P. Hopkins,
Didsbury,
Manchester.

NINE-CHIME DOOR BELL

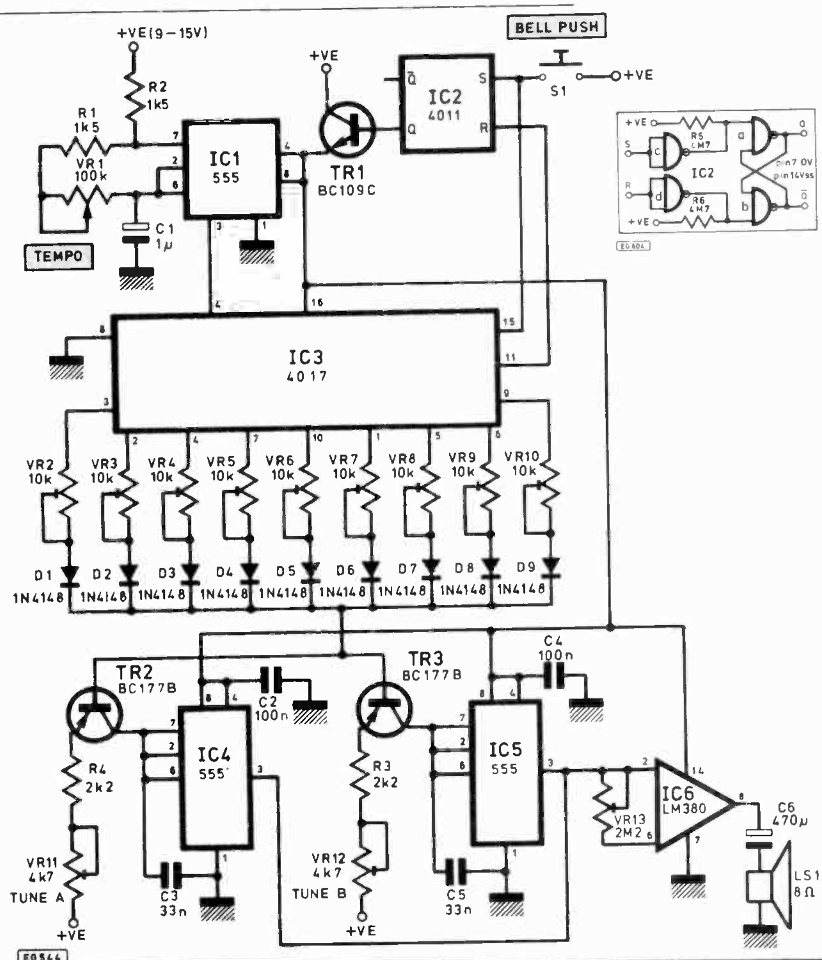
THIS bell is programmed by the user to play a tune with anything up to nine notes. Instead of one oscillator playing the tune, two oscillators are used, which are tuned so as to give a chord on every note.

When the bell push is operated, the latch formed by IC2 is triggered and the decade counter IC3 is reset. The output of the latch operates a switching transistor. This applies the supply voltage to ICs 1, 3, 4, 5, and 6. At this point, a slow oscillator formed by IC1 is started, the output of which starts the counter counting. A tempo control is provided which speeds up or slows down the tune.

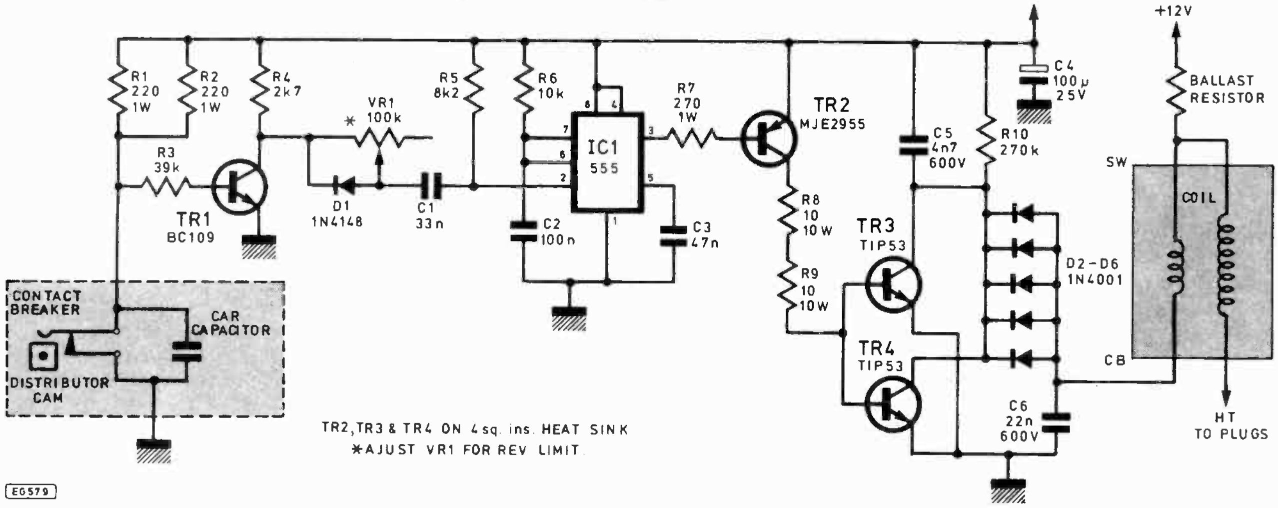
Each output of the counter goes via a preset and diode which are commoned and the output voltage from each note (which is programmed by adjusting the pre-sets), goes to two voltage controlled oscillators formed by IC4 and 5. Each VCO has its individually controllable tune preset. In practice these are set up so the notes produced form a melodic chord. The output from each VCO goes to a simple power amplifier formed by IC6. This is provided with a simple volume control which feeds a loudspeaker.

When the last note has played the counter is automatically reset and the latch also resets. The power is removed from all the i.c.s except IC2, which is always receiving power so the door chime may be triggered.

Graeme Durant,
Selby,
N. Yorkshire.



INDUCTIVE DISCHARGE IGNITION



EG579

WITHOUT going into the controversy about the advantages of capacitor or inductive discharge ignition versus normal ignition, a circuit for inductive discharge ignition is presented here. It is a points assisted unit in which the coil load of 3·5 amps is removed to a switching transistor. Other features in the circuit are: rev limit, points bounce control, long dwell time, lower RFI than a CDI system.

Most ignition coils have a resistance (including ballast) of about 3·5 ohms and an inductance of some 11mH. A time constant of 3 milliseconds results and some 10 milliseconds are needed for the coil to saturate fully after switch-on. In the circuit presented the coil is switched on for most of the time (long dwell) and is only switched off to fire the plugs for about 1 millisecond. (For very high revs this time can be reduced to 500µs.)

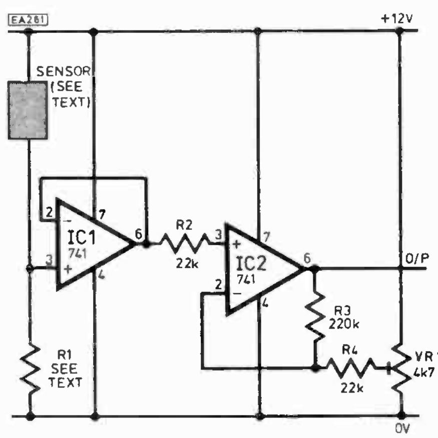
IC1 acts as a 1ms monostable and with its output normally low TR2, TR3 and TR4 are switched on. When triggered IC1 output goes high for 1ms and switches TR2, TR3 and TR4 off for this period to fire the plugs. TR1 acts as an inverter to trigger the monostable and the circuitry around VR1, C1 and D1 act as a rev limiter and point bounce control. When the points open TR1 conducts and C1 is rapidly charged bringing pin 2 of IC1 low momentarily before C1 charges up again. This triggers IC1. When the points close again TR1 stops conducting and C1 discharges slowly through VR1. Points bounce occurs on closing and should a bounce occur a retrigger cannot occur because C1 has not yet fully discharged. Should the time constant of C1, VR1 be set very long then C1 may not have discharged when the next firing pulse is required. A misfire occurs and the revs are limited to the corresponding time constant set by VR1. In practice VR1 should be set at maximum safe engine revs for effective point bounce control.

TR3 and TR4 are high voltage switching transistors. Each can handle 3 amps but gain at this current is low. Parallel operation reduces individual current to a point where gain is higher requiring less base drive.

The circuitry around D2 to D6, C5, C6 is for surge control and to prevent high reverse voltages across TR3 and TR4. Note that C6 has a much lower value than a normal car capacitor and this can be varied to tune the coil for best output using a 'scope. The value shown however is a good average value for most coils.

R. Immelman,
Somerset West,
South Africa.

SIMPLE PRESSURE SENSOR



THIS unit was originally designed as part of a burglar alarm system, although, as it is capable of giving an output which is almost linearly proportional to pressure, it may find many other uses such as a tactile sensor in a robot.

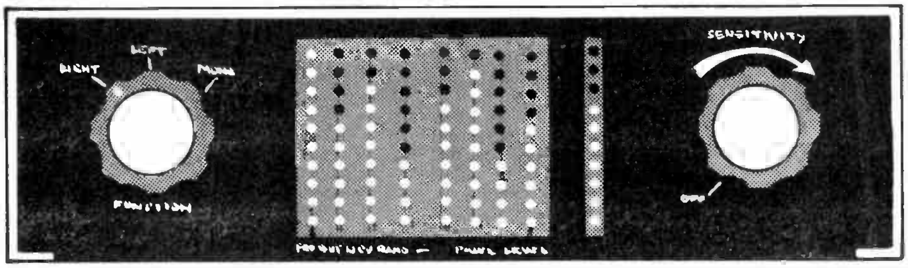
The circuit shown is a linear reading pressure sensor. The voltage at the output of the potential divider formed by the sensor and R1 (which rises with increased pressure) is buffered by IC1 and fed to the amplification stage IC2—the resulting output is directly proportional to pressure. The preset VR1 is used to set the output voltage to a convenient level in the absence of an input. This output could then be fed into an A/D converter for use in a robotic system.

The sensor is a piece of conductive foam of the type with which CMOS i.c.s are supplied. As the foam is compressed its resistance decreases. In the prototype the foam was sandwiched between a piece of p.c.b. material with a wide strip of copper removed from the middle, and a piece of plain circuit board. Built in this way the foam bridges the gap on the p.c.b. although the foam could be sandwiched between two pieces of copper backed board with one terminal of the sensor being taken from each.

The resistor R1 should be approximately $\frac{1}{4}$ the value of the uncompressed resistance of the foam.

S. Draper,
Sudbrooke,
Lincoln.

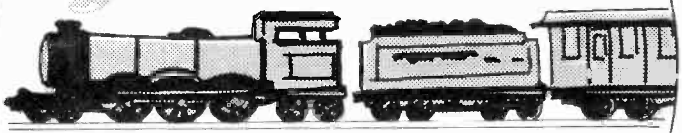
next month...



AUDIO ANALYSER

Ever wondered what effect your room furnishings have on the output of your hi-fi or if your amplifier delivers equal power over the audio spectrum? Now you can find out with our Audio Analyser. We will also describe a stereo microphone preamplifier and a noise source which can be used with it.

Model Train Controller



Adds realism to train movements by ensuring smooth starting, acceleration and gentle braking in a single control. An added feature is protection against track short circuits.

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This is a new approach to the subject which brings together theory and practice and includes many useful tips and "standard circuits" etc. It comes complete with a wide range of useful projects which complement the theory.

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NE565N	1.00
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uA747CN	0.70
uA748CN	0.36
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TDA1054	1.45
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TDA1072	2.69
TDA1074A	5.04
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TDA1090	3.05
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TDA1220	1.40
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SL1610P	1.60
SL1611P	1.60
SL1612P	1.60
SL1613P	1.89
SL1620P	2.17
SL1621P	2.17
SL1623P	2.44
SL624C	3.28
SL1625P	2.17
SL1626P	2.44
SL1630P	1.62
SL1640P	1.89
SL1641P	1.89
TDA2002	1.25
ULN2242A	3.05
ULN2283B	1.00
CA3080E	0.70
CA3089E	1.84
CA3090AQ	3.35
CA3123E	1.40
CA3130E	0.80
CA3130T	0.90
CA3140E	0.46
CA3189E	2.20
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LM3900N	0.60
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TDA4420	2.65
KB4423	2.30
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KB4432	1.95
KB4433	1.52
KB4436	2.53
KB4437	1.75
KB4438	2.22
KB4441	1.35
KB4445	1.29
KB4446	2.75
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NE5044N	2.26
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CRYSTALS

32.768kHz	2.70
100kHz	3.85
455kHz	5.00
1.000MHz	2.95
3.2768	2.70
4.000	2.00
4.1934	2.00
4.096	2.00
4.032	2.00
4.433619	2.00
4.800	2.00
5.000	2.00
6.5536	2.00
7.000	2.00
7.68	2.00
8.000	2.00
9.000	2.00
10.000	2.00
10.240	2.00

CRYSTALS

10.245	2.00
10.6985	2.50
10.700	2.00
10.7015	2.50
11.00	2.00
11.115	2.00
11.520	2.00
8.9985	2.00
9.0015	2.00
21.000	2.00
24.000	2.00
25.000	2.00
26.000	2.00
18.000	2.50

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CHANNELLING:
27MHz: 50kHz
35MHz: 20kHz

4000 series

4000	0.13
4001	0.13
4002	0.14
4007	0.19
4008	0.70
4009	0.30
4010	0.30
4011	0.24
4011	0.15
4012	0.20
4013	0.35
4015	0.70
4016	0.30
4017	0.65
4019	0.38
4020	0.68
4021	0.75
4022	0.68
4023	0.19
4024	0.45
4025	0.18
4026	1.05
4028	0.60
4029	0.75
4030	0.35
4035	0.75
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4043	0.68
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4053	0.69
4054	1.30
4055	1.30
4056	1.35

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4063	1.15
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4082	0.25
4093	0.45
4099	0.99
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4506	0.75
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4510	0.70
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40194	0.69
40195	0.69

TTL 'N'

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7401	0.10
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7403	0.11
7404	0.12
7405	0.12
7406	0.22
7407	0.22
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7451	0.14
7453	0.14
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7470	0.28
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7473	0.28
7474	0.28
7475	0.35
7476	0.30
7480	0.26
7481	0.20
7482	0.75
7483	0.60
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7496	0.45
7497	1.40
74100	1.10
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74105	0.62
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74109	0.35
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74111	0.68
74112	1.70
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74118	0.85
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74120	0.95
74121	0.35
74122	0.34
74123	0.40

74125	0.40
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74132	0.50
74136	0.65
74141	0.45
74142	1.85
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74182	0.70
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74190	0.55
74191	0.55
74192	0.55
74193	0.55
74194	0.55
74195	0.55
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74284	3.50
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74298	1.85
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74490	1.85

'LPSN'

7400	0.11
7401	0.11
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7403	0.12
7404	0.13

7405	0.14
7408	0.14
7409	0.14
7410	0.13
7411	0.14
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7447	0.42
7448	0.65
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7451	0.14
7454	0.15
7455	0.15
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7473	0.21
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7475	0.28
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7496	1.20
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74165	1.20
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74175	0.55
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74197	0.65
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74202	3.45
74221	0.60
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74241	0.99
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74393	0.61
74395	2.10
74396	1.99
74398	2.75
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74447	1.95
74490	1.10
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74C CMOS

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7408	0.20
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7476	0.48
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74154	2.26
74157	1.52
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74161	0.80
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74193	0.80
74195	0.80
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74221	1.06
74901	0.38
74902	0.38
74903	0.38
74904	0.38
74905	5.64
74906	0.38
74907	0.38
74908	0.84
74909	1.52
74910	3.62
74914	0.86
74918	0.98
74925	4.32
74926	4.32
74927	4.32

E&OE

Subject to availability

TRANSISTORS

BF194	18p
BF195	18p
BF224	22p
BF241	18p
BF274	18p
BF440	21p
BF441	21p
BF362	49p
BF395	18p
BF479	66p
BF679S	55p
BFR91	1.33
BFW92	60p
BFT95	99p
BFY90	90p
40238	85p
BF256	38p
2SK55	28p
2SK168	35p
J310	69p
J176	65p
40823	65p
40673	3SK51
3SK45	49p
3SK51	54p
3SK60	58p
3SK88	1.24
MEM680	75p
BF961	70p
BC237	8p
BC238	8p
BC239	8p
BC307	8p
BC308	8p
BC309	8p
BC413	10p
BC414	11p
BC415	10p
BC416	11p
BC546	12p
BC556	12p
BC550	12p
BC560	12p
BC639	22p
BC640	22p
2SC1775	18p
2SA872A	14p
2SD666A	30p
2SB646A	30p
2SD668A	40p
2SB648A	40p
2SD760	45p
2SB720	45p
2SC2547	19p
2SA1085	20p
2SB753	2.34
2SB723	2.34
2SK134	3.10
2SK135	4.25
2SJ49	3.10
2SJ50	4.25
2SK227	3.55
2SJ83	3.55

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12/24V RANGE PRI 220/240V
SEC: 0 12V 0V 12V

TYPE	amps 12v	amps 24v	price £	p-p £
242	0.3	0.15	1.70	0.40
213	1	0.50	2.32	0.70
71	2	1	2.51	0.90
18	4	2	3.24	1.43
68	3	1.5	3.15	1.43
85	5	2.5	5.52	1.43
70	6	3	6.26	1.43
108	8	4	7.36	1.73
72	10	5	8.05	1.65
116	12	6	8.57	1.90
17	16	8	10.53	2.05
115	20	10	13.69	2.05
187	30	15	17.62	2.45
232	40	20	25.16	3.50
226	60	30	35.35	4.00

15/30V RANGE PRI 220/240V
SEC: 0V 12V 15V 0V 5V 9V 15V
VOLTS AVAILABLE 3 ⟹ 15 — 0 — 15

TYPE	amps 15v	amps 30v	price £	p-p £
112	1	0.50	2.47	0.95
79	2	1.0	3.16	0.95
3	4	2	5.64	1.43
20	6	3	6.59	1.73
21	8	4	7.80	1.73
51	10	5	9.68	1.90
117	12	6	10.97	2.05
88	16	8	14.65	2.20
89	20	10	16.93	2.35
90	24	12	18.84	2.55
91	30	15	21.56	2.65
92	40	20	30.08	3.50

25/50V RANGE PRI 120/220/240V
SEC: 0V 20V 25V 0V 8V 15V 25V
VOLTS OUT 5 ⟹ 25 — 0 — 25

TYPE	amps 25v	amps 50v	price £	p-p £
102	1	0.50	2.88	1.43
103	2	1.0	3.60	1.43
104	4	2	7.04	1.73
105	6	3	8.33	1.90
106	8	4	11.18	1.90
107	12	6	14.79	2.20
118	16	8	20.49	2.55
119	20	10	24.52	2.55
109	24	12	29.39	3.50

30/60V RANGE PRI 120/220/240V
SEC: 0V 24V 30V 0V 10v 18V 30V
VOLTS 6 ⟹ 30 — 0 — 30

TYPE	amps 30v	amps 60v	price £	p-p £
124	1	0.5	2.92	1.43
126	2	1	5.78	1.43
127	4	2	7.13	1.73
125	6	3	10.73	1.90
123	8	4	12.28	2.20
40	10	5	15.55	2.20
120	12	6	17.72	2.35
121	16	8	25.09	2.65
122	20	10	29.07	4.00
189	24	12	33.51	4.60

48/96V RANGE PRI 120/220/240V
SEC: 0V 36V 48V 0V 36V 48V
VOLTS 12 ⟹ 48 — 0 — 48

TYPE	amps 48v	amps 96v	price £	p-p £
430	1	0.5	4.14	1.43
431	2	1	7.22	1.73
432	4	2	11.87	2.05
433	6	3	14.47	2.20
434	8	4	18.43	2.45
435	10	5	26.16	2.65
436	12	6	32.75	4.00
437	16	6	35.77	4.60

AUTOTRANSFORMERS 240/220 — 115V
65VA — 10 KVA
0V 115V 220V 240V

TYPE	va	price £	p-p £
25	65	3.82	1.10
64	80	4.40	1.10
4	150	5.64	1.43
69	250	7.13	1.73
53	350	8.97	1.90
67	500	11.09	2.20
83	750	12.42	2.20
84	1000	16.88	2.65
95	2KVA	31.26	4.00
73	3	61.27	4.75
57	5	87.42	6.60
101	10	159.45	13.00

CASED AUTOTRANSFORMERS
240V LEAD IN 115V 2 PIN SOCKET OUT

TYPE	va	price £	p-p £
56W	20	5.52	0.58
64W	80	7.63	1.43
4W	150	9.63	1.73
69W	250	11.98	1.90
67W	500	18.67	2.20
84W	1000	26.90	2.65
95W	2000	48.45	7.00
73W	3000	69.18	8.00

LINE ADJUSTMENT AUTOTRANSFORMERS
0 200 210 220 230 240 250

TYPE	va	price £	p-p £
415C	50	2.13	0.58
416C	100	3.13	1.10
417C	200	3.65	1.43
418F	350	5.63	1.43
419F	500	6.13	1.73
420E	750	7.60	1.90
421F	1000	10.55	2.05

MAINS ISOLATORS (SAFETY SCREEN)
PRI 120/220/240V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

TYPE	va	price £	p-p £
149F	60	7.35	1.73
150F	100	8.61	1.73
151F	200	12.15	2.05
152F	250	14.75	2.20
153F	350	18.22	2.55
154F	500	22.70	2.65
155F	750	32.08	7.00
156F	1000	41.26	7.00

MAINS ISOLATORS (SAFETY SCREEN)
PRI 380/415/440V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

TYPE	va	price £	p-p £
243F	60	7.35	1.43
244F	100	8.61	1.73
245F	200	12.15	2.05
246F	250	14.75	2.20
247F	350	18.22	2.55
248F	500	27.70	2.65
249F	750	32.08	7.00
250F	1000	41.26	8.00

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13 amp plug in type. Reversible spider jack lead.

TYPE	va	mA	price	p-p
100	6-7.5-9v	250	3.85	0.58
101	Regulated 6-7.5-9v	300	4.70	0.58

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Our offer price including VAT and postage etc., saves £3 on the normal 1 off price from Lascar.

SPECIFICATION

Input impedance:	>100M
Full scale reading:	199·9mV
Accuracy:	0·05% of reading ±1 digit
Power supply:	5–15V d.c.
Power consumption:	50μA (in low power mode), typically 8,000 hours PP3 life
Sample rate:	3 readings per sec.
Auto-zero:	No necessity to adjust for offsets
Auto-polarity:	Automatic polarity indication eliminates the need to reverse input leads to obtain correct reading.
Over-range warning:	1 in leading digit with other digits suppressed
Bandgap reference (50ppm/°C typ.)	incorporated for excellent stability of reading
Digit height:	15mm (0·6") can be read at distances up to 10 metres
Low battery warning:	direct display, voltage threshold easily adjusted
Operating temperature:	0°C to 50°C
Overall dimensions:	72×36×12mm
Panel cut-out:	68×33mm
Display annunciators:	many useful legends are built into the custom l.c.d. which may be activated as required

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LIGHT METER

MARTIN KENT

FREE CASE PROJECT

THE measurement of light intensity is required in many applications areas, including photographic exposure meters, dust density meters for environmental control, fog density meters, flame monitoring in heating engineering, in addition to general photometry experiments.

The DP800 Lightmeter may be easily assembled using the LE DPM200 Panel Meter and very few additional components. Extensions of the basic circuit are also described to widen the possible applications.

OPTICAL SPECTRUM

The optical spectrum is characterised by radiation having wavelengths between 10nm and 1mm and may be divided into two invisible sections (infrared and ultraviolet) separated by a central visible section. Parameters defining the visible section are generally termed photometric units and the radiant energy is characterised by wavelengths of about 380nm to 780mm. The term 'light' only relates to that part of the optical spectrum capable of being detected by the human eye.

The rate of flow of visible radiant energy with respect to time is the luminous flux which is measured in lumens. For light measurements the standard unit is the lux which is a measure of the luminous flux density incident upon a surface or illuminance (Ev) and is defined as 1 lumen/m^2.

One of the traditional components used in light measurement is the cadmium sulphide light dependent resistor. The device is easy to apply but produces non-linear variations of resistance with respect to incident light. Phototransistors were a later development whereby light falling upon the exposed base causes variations in collector current. Operation of phototransistors is usually linear over small ranges.

Luminous fluxes should be measured with photodetectors which produce a linear output with special correction to the spectral sensitivity of the eye. Silicon photodiodes are available which act as variable current sources with output proportional to luminous flux and which also provide faster switching than phototransistors.

Fig. 1 shows the relative spectral response of the human eye and of the photodiode used in the DP800. When a photodiode is reverse-biased the leakage current is independent of the applied voltage but a condition is reached when the current cannot be further reduced by shielding from irradiation; the current then flowing is known as the dark current which is typically 1·4μA for the photodiode used (Fig. 2). The true photocurrent generated is the difference between the light current, when exposed to radiant energy, and the dark current.

PE Digital Precision Lightmeter DP800

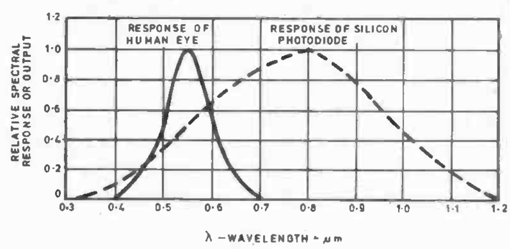

Fig. 1. Relative spectral characteristics

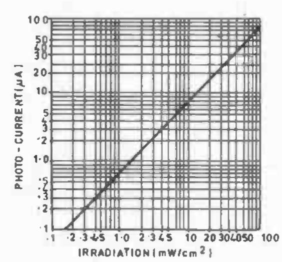

Fig. 2. (Left) Graph showing photocurrent vs irradiation for the photodiode used

CIRCUIT

The circuit diagram of the basic luxmeter is shown in Fig. 3. Photodiode D1 is reverse-biased by the stable 1·2V bandgap reference within the LE DPM200. The panel meter

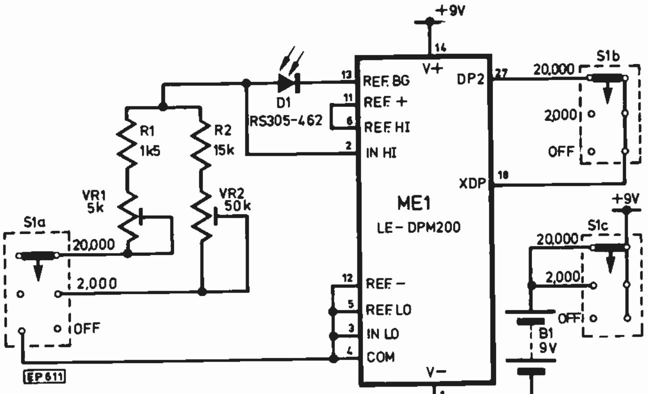

Fig. 3. Circuit of Lightmeter

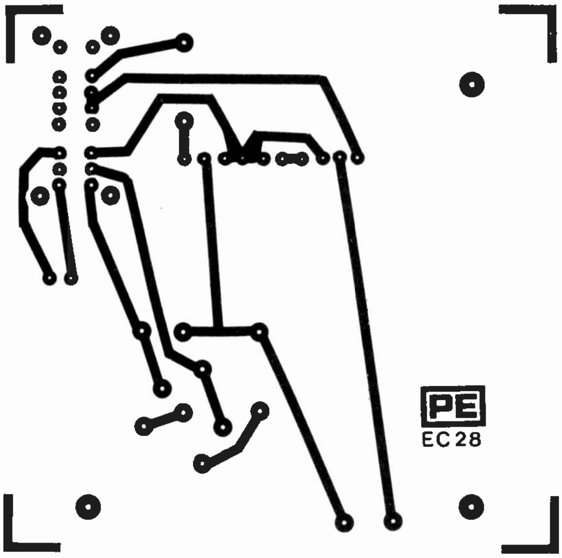

Fig. 4. Printed circuit board

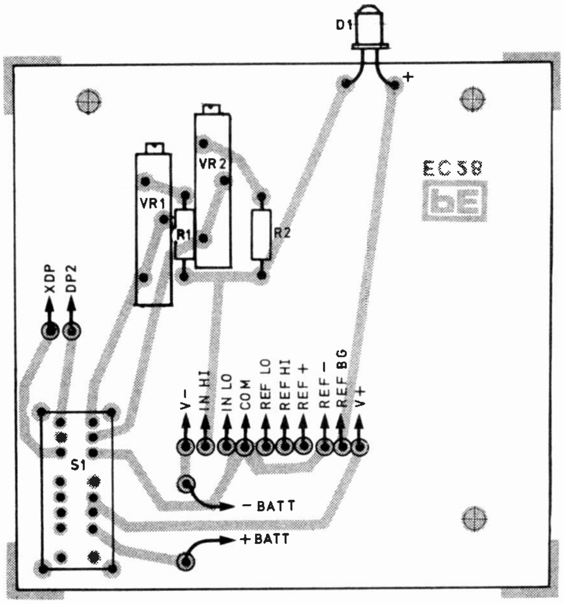

Fig. 5. Component layout

operates with 200mV f.s.d. and the photocurrent is scaled to the correct voltage by R1 and VR1.

Typical responsivity of the photodiode is 0·7 μA/mW/cm². It is possible to obtain a direct reading of lux by using the fact that 1mW/cm² is equivalent to 200 lux, therefore 1 lux is equal to a photocurrent of typically 3·5nA.

The instrument may be easily scaled to provide ranges of varying sensitivity. For example, 2000 lux would produce 7μA photocurrent and to produce 200mV f.s.d. requires a resistance of approximately 28kΩ, similarly 20,000 lux requires a scaling resistor of 2·8kΩ. As a guide, the light energy in the UK on a sunny day can be in excess of 500W/m² or 10,000 lux. The wide tolerance in manufacturers' specification for the responsivity of the photodiode necessitates a wide range of adjustment on VR1. Devices with closer tolerance are available but are a great deal more expensive.

The p.c.b. track is shown in Fig. 4 and the component layout in Fig. 5. Ribbon cable is used to connect the p.c.b. to the panel meter.

APPLICATIONS

The circuit can be calibrated by comparison with another luxmeter and is capable of measuring light intensity over a very wide range, making it useful in photographic and general photometry applications. Lux readings may be converted to specific photographic values to enable the instrument to be used as an exposure meter. In the human eye the pupil of the iris adapts the area of the aperture, according to the effective luminance in the field of vision. The aperture area of the pupil acts like a variable stop, so that the solid angle for the incident luminous flux on the individual points of the retina is variable in the ratio of about 1:16. In photography, for a film of given sensitivity (ASA/DIN rating), the exposure required for a specific lux reading is dependent upon the camera aperture setting (f stop) and the shutter speed (since a fast shutter speed reduces the amount of light energy striking the film).

Shutter speeds on cameras are usually in steps of 2:1 (1/500 s, 1/250 s, 1/125 s etc.) and the aperture f stop numbers are also chosen to provide changes of aperture area in the range of 2:1 between adjacent f stop numbers, with higher numbers indicating smaller apertures. For a given lux reading, various combinations of shutter speed and aperture setting will produce the same overall exposure and the shutter speed may be selected according to subject movement etc. Examples of camera settings for ASA100/DIN21 type film are shown over.

Bright Sunlight	f stop	22	16	11	8
	shutter speed	60	125	250	500

For reduced lux readings, combinations should be chosen to provide greater exposure.

Cloudy Conditions	f stop	8	5·6	4	2·8
	shutter speed	60	125	250	500

ALTERNATIVE CALIBRATION

An alternative method of calibrating the Lightmeter is to use an 18% grey scale test card which is used widely for calibration of photographic exposure meters. These meters are calibrated to read correctly when directed at the standard grey scale which is of density such that 18% of the incident light is reflected.

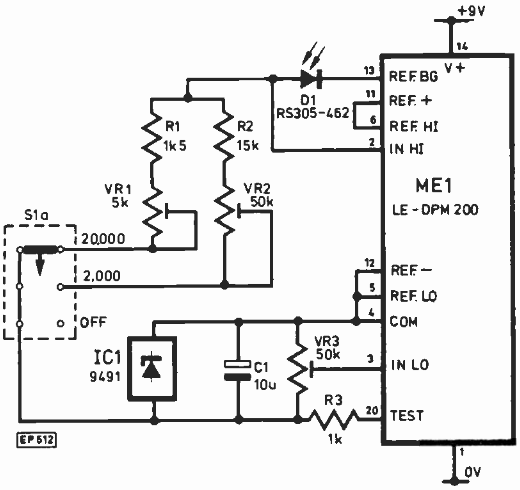

Fig. 6. Method of incorporating offset adjustment

OTHER CIRCUITS

When making low level lux measurements of luminous objects an adjustable offset control may be added to the basic circuit to remove the effects of ambient lighting or of the photodiode dark current at very low levels. Fig. 6 shows the method of incorporating an offset adjustment using a voltage divider across a bandgap reference integrated circuit.

For darkroom use the photodiode may be mounted remotely from the instrument, via screened cable, and used to measure the exposure required. The enlarger projects an image of the negative on to the photosensitive paper and the photodiode should be positioned to receive the radiation reflected from the paper. The photodiode should only evaluate the central picture content.

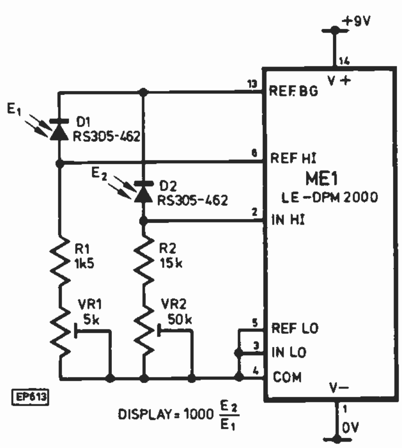

Fig. 7. Ratiometric method of measurement

RATIOMETRIC MEASUREMENTS

The versatile nature of the LE DPM200 may also be harnessed to provide ratiometric measurements, enabling the ratio of the most exposed to least exposed areas of negatives to be indicated, as shown in Fig. 7.

Ratiometric measurements are also useful in absorption experiments. Critical properties of materials, which are of particular interest in the fields of chemistry, medicine and pollution control, are characterised by absorbence. The general arrangement for absorbence measurements is

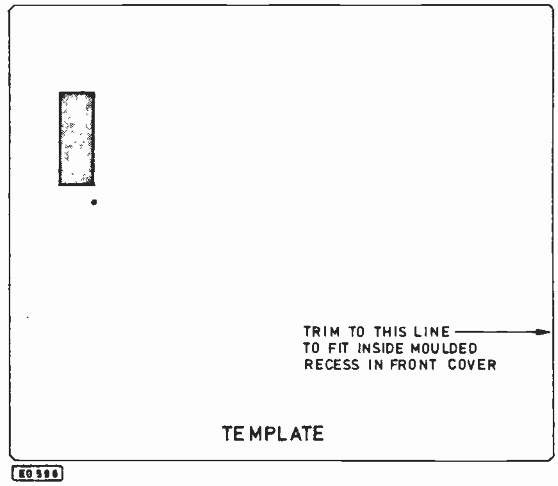

Fig. 8. Front panel template

shown in Fig. 9. The relationship between absorbence, A, and light intensity, E, is:

$$A = \log \frac{E_I}{E_T}$$

where E_I = intensity of incident light
E_T = intensity of transmitted light

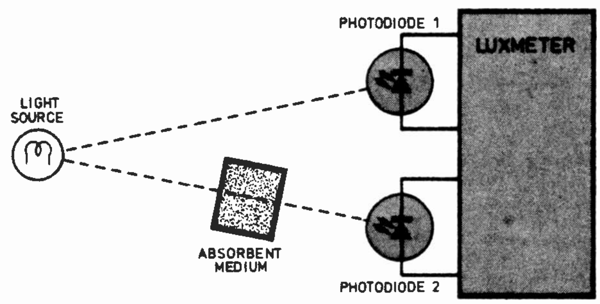

Fig. 9. Making absorbence measurement

The two photodiode inputs to the panel meter represent the intensity of light transmitted through space and through a medium that absorbs light. Relative absorption of the medium will be directly displayed and absolute absorption may be calculated if desired by taking the log of the displayed value.

COMPONENTS . . .

Resistors

R1	1k5	carbon film 5%
R2	15k	carbon film 5%
VR1	5k	multiturn preset
VR2	50k	multiturn preset

Semiconductors

D1 Photodiode RS305-462

Miscellaneous

ME1 LE DPM200 (see special offer)
Instrument case, front panel label, p.c.b., 4P3T slide switch. Ribbon cable. PP3 battery connector

A kit of components required for the Lightmeter is available at £9.95 inc. VAT (**excluding** LE DPM200 and case) from **Lascar Electronics Ltd., Unit 1, Thomasin Road, Basildon SS13 1LH.**

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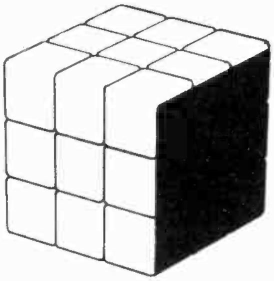

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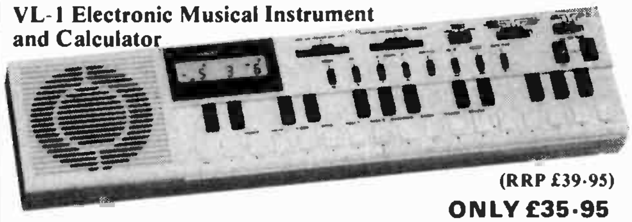

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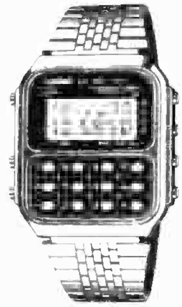

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NOISE METER

MARTIN KENT

PE Digital Precision Sound Meter DP700

SPECIFICATION

Measurement Range	60–110dB
Resolution	0·1dB
Accuracy	0·5dB

ONE of the health hazards under constant attack by environmentalists is high sound level. In factories, offices, airports and indeed most situations where men and machines are placed together, the monitoring of sound levels is very important. If sound levels are high, then work rate can be impaired, pain may be induced and even permanent damage to hearing may be caused.

The DP700 Noisemeter is an extremely compact instrument, with very low power consumption, which measures between 60 and 110dB. True r.m.s. measurements are made by a new integrated circuit to achieve good accuracy from widely varying input waveforms. The instrument is simple to operate and will be found useful in checking sound levels at work or home. Many hobbies require the participants to be aware of sound levels including model aircraft and car rallying. Audiophiles can also use the instrument for checking sound systems and room accoustics.

SOUND MEASUREMENT

A graph of typical sound levels found in different environments is shown in Fig. 1. Intensity of sound covers an extremely wide range and if measurements are made with a conventional linear meter, then very large numbers are involved. Sound measurements are normally made on the dB scale to compress the readings and make the numbers more usable; also the human ear responds to sound logarithmically rather than linearly. It can be shown that if a certain sound level is taken as the 0dB reference, then a 120dB reading corresponds to an increase of 1,000,000:1 and long scale length instruments would be required to make such measurements.

The decibel (dB), or one-tenth of a bel (B), is defined as the logarithm of an electrical power ratio of 1.259:1. The number of dB corresponding to the ratio of two powers is given by 10 log (P_2/P_1), consequently the number of dB corresponding to the ratio of two voltages is given by 20 log (V_2/V_1) since power is proportional to the square of voltage.

The DP700 is designed to operate with an electret condenser microphone which converts sound pressure acting on a capacitive element into a voltage which is amplified by an integral i.c. amplifier.

The most accurate method of measuring alternating voltages is to determine the r.m.s. value. The majority of instruments which measure a.c. inputs employ averaging circuits which are scaled to provide r.m.s. indication provided the input waveform is sinusoidal. Sound waveforms are usually anything but sinusoidal and as the peak value moves further away from the mean (increasing crest factor) so the error in measurement using averaging

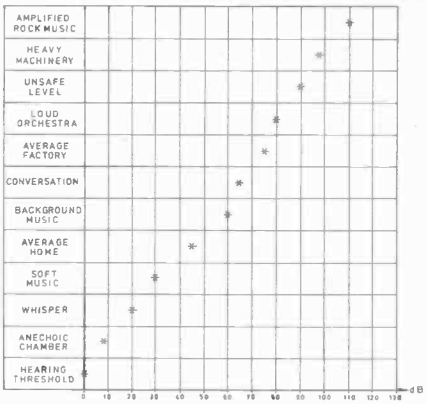


Fig. 1. Typical sound levels found in different environmental conditions.

circuits increases. Discrete r.m.s. measurement circuits are complex and difficult to set up due to the problem of requiring to calculate the square root of the mean sum of the input values squared.

The manner in which the corresponding dB scaling increases with voltage output from the microphone is shown in Table 1.

TABLE 1

Voltage Ratio	dB
1	0
10	20
100	40
1000	60
10,000	80
100,000	100
1,000,000	120

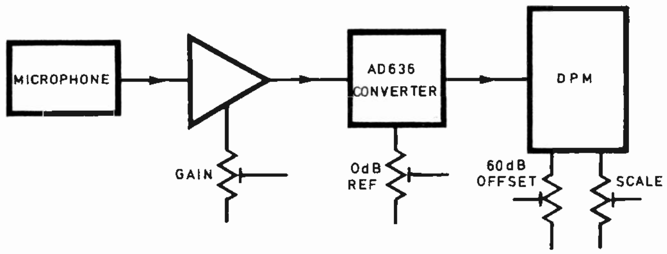
Table of dB scaling increases with output of microphone.

To achieve a wide span of readings a logarithmic amplifier is clearly required to convert the microphone voltage to a dB scaled voltage. Most sound level meters employ large numbers of ranges in order that approximations to the log value can be made over a narrow range. Such instruments normally employ centre-zero moving-pointer meters and can be awkward to use.

TRUE R.M.S. IC

The Noisemeter has been designed for ease of use and provides clear unambiguous indication from 60dB to 110dB without the need to change ranges. A new integrated circuit from Analog Devices, the AD636, is a laser-trimmed device which computes the true r.m.s. value of a complex input signal and produces a dB scaled output in addition to a linear output. The AD636 is designed specifically for interface with instruments such as the LE DPM200 panel meter and also requires low supply current to complement the ultra-low power of the panel meter.

The block diagram of the DP700 is shown in Fig. 2. A transistor amplifier interfaces the electret condenser microphone to the AD636 which converts the true r.m.s. value of the a.c. input to a d.c. value scaled in dB and is read directly by the LE DPM200.



E6594

Fig. 2. Block diagram.

CIRCUIT DESCRIPTION

The circuit diagram of the Noisemeter is shown in Fig. 3. Transistor TR1 forms an input amplifier to permit a variety of microphones to be used and the input level is adjusted by VR1. The AD636, IC1, computes the root-mean-square relationship:

$$V_{RMS} = \sqrt{V_{IN}^2}$$

where V_{IN}^2 is the average of the squared instantaneous values of the input voltage over a nominal period. High crest factors of input waveform can be accepted without loss of accuracy.

The absolute value of the input signal is taken and converted to a current which is applied to a squarer circuit. The output current drives a current mirror through a low pass filter, the time constant of which is controlled by C4. The current mirror produces a current corresponding to the r.m.s. value of the input voltage and a voltage output of −3mV/dB.

The 0dB reference point is adjusted by VR2 which controls the internal reference current of the AD636. A range of 50dB is possible with the device and the panel meter reading is offset to provide a 60dB display with zero input voltage, such that the instrument is usable from 60dB to 110dB. The offset is adjusted by VR3.

Scaling of the panel meter is adjusted by VR4 which sets the reference voltage. The AD636 produces an output of −3mV/dB and the panel meter operates with a 300mV reference voltage instead of the usual 100mV. Operation of the panel meter is ratiometric such that:

$$\text{Display} = 1000\,\frac{V_{IN}}{V_{REF}}$$

The instrument is designed around a self-contained microphone with remote on/off switch and connected via two jack plugs. Easier access to machinery etc. is therefore provided than if the microphone element was mounted in the case. The remote on/off switch minimises the already very low current consumption of the instrument due to the use of the LE DPM200 panel meter. The microphone may, of course, be detached for use in recording or other sound systems.

ASSEMBLY AND TESTING

Very few components are required in addition to the LE DPM200 to complete the instrument. To ease the calibration, four wire links LKA-LKD are provided which should be

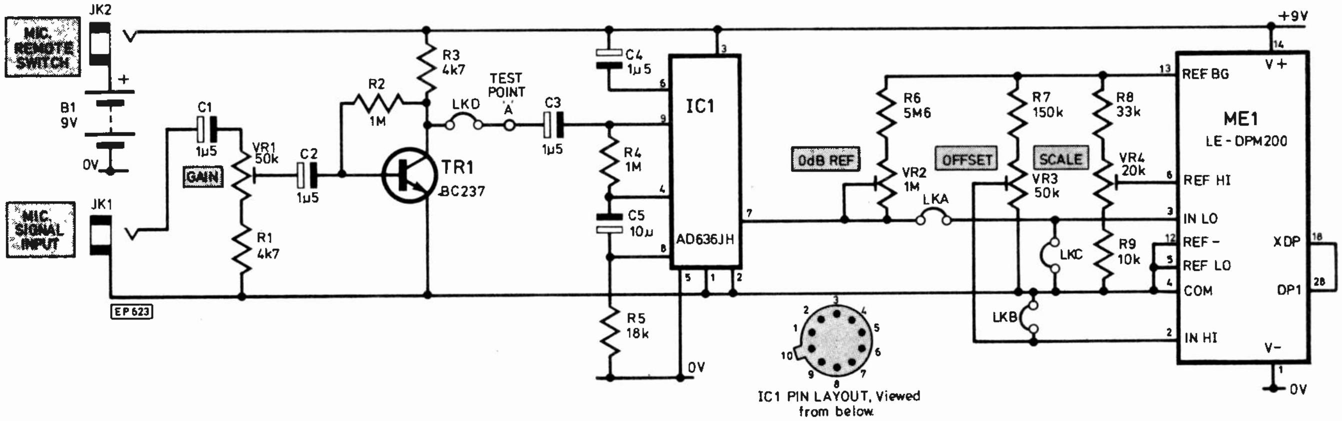
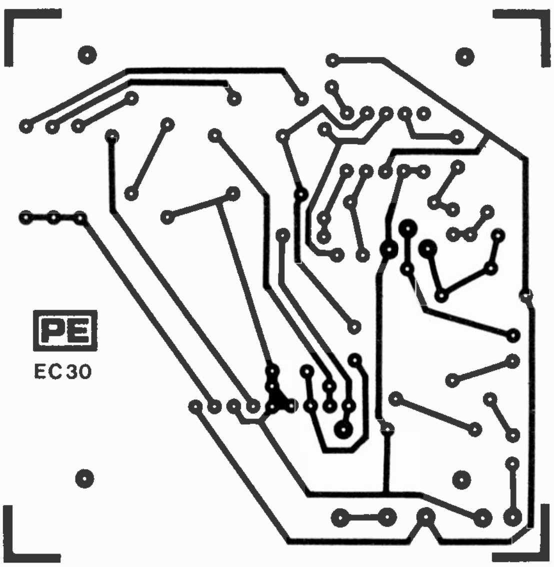


Fig. 3. Circuit of Noisemeter.



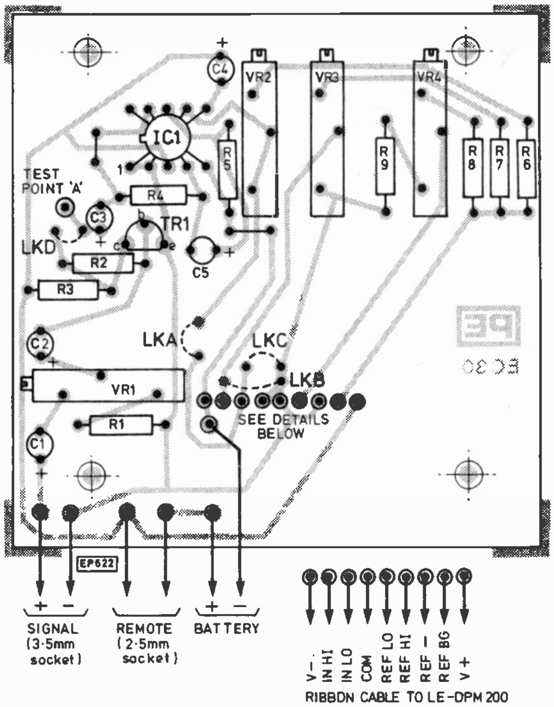


Fig. 4. P.c.b. and overlay (right).

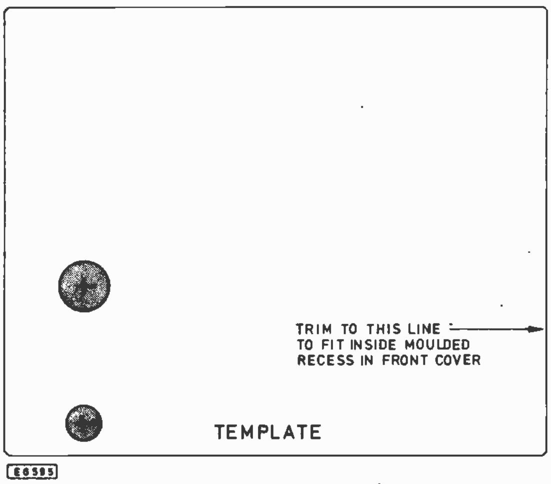


Fig. 5. Front panel template.

omitted at this stage. When complete the pcb is connected to the panel meter by ribbon cable.

A 3·5mm jack socket mounted on the front case connects the input signal from the microphone and a 2·5mm jack socket connects the remote on/off switch. Connect the microphone to the sockets and a battery to the PP3 connector.

Testing and calibration should be carried out as follows: Ensure that link LKA connecting VR2 to IN LO is removed and then insert the link LKB to short IN HI to COM. The offset controls are now overriden, a 100mV d.c. reference voltage should be connected between IN LO and COM and VR4 should be adjusted to make the display read 33·3 to accommodate the 3mV/dB output of IC1. Disconnect the reference voltage.

Remove link LKB and add link LKC. VR3 should now be adjusted to provide a display of 60·0, corresponding to 60dB reading with zero input. Remove links LKC and LKD, add link LKA. Connect a 10mV r.m.s. sinewave of typically 1kHz between Test Point A and COM. Adjust VR2 to return the display to 60·0 to establish the 0dB reference point for the AD636. Disconnect the a.c. input and add link LKD.

Using a sound reference of typically 80dB, or comparing against another calibrated meter, VR1 should be adjusted to provide the correct reading for the particular microphone used. ★

COMPONENTS . . .

Resistors

R1	4k7	Carbon film 5%
R2	1M	
R3	4k7	
R4	1M	
R5	18k	
R6	5M6	
R7	150k	
R8	33k	
R9	10k	

Variable Resistors

VR1	50k	Multiturn presets
VR2	1M	
VR3	50k	
VR4	20k	

Capacitors

C1	1μ5	Tantalum Bead 16V
C2	1μ5	
C3	1μ5	
C4	1μ5	
C5	10μ	16V elect.

Semiconductors

TR1	BC237	
IC1	AD636JH	(Lascar Electronics)

Miscellaneous

ME1 LE-DPM200 (see special offer). JK1 3·5mm jack socket. JK2 2·5mm jack socket. PP3 battery connector, instrument case, p.c.b., ribbon cable. Microphone electret condenser with remote switch type and preamp YB, 33L. A complete kit of components for the Noisemeter is available at £29.95 inc VAT (excluding LE-DPM200 and case) from **Lascar Electronics Ltd, Unit 1, Thomasin Rd, Basildon, Essex, SS13 1LH.**

MICRO PROMPT

The hardware and software exchange point for PE computer projects

IT DOES BOTH!

Sir—Without an assembler, the easiest way to store machine language programs is as a BASIC program of DATA statements, and poke them into the correct memory locations. Unfortunately this requires the conversion of hex instructions into decimal numbers and the writing of the BASIC program. The HECDEC program does both!

Simply enter the instructions as pairs of hex digits separated by Return and enter "X" to mark the end of the data. The BASIC program will then be sent to the cassette. Then LOAD the program back and add any necessary POKE instructions.

Comments on the program:
Line 30 set the dimension of B as required.
Line 40 two hex digits *must* be entered.
Line 70 X terminates the data entry.
Line 160 six DATA items per line.
Line 200 an option to retransmit the program. RETURN exits.

No check is made for illegal data entry, this could be added if thought necessary.

```
10  REM HECDEC PROGRAM
20  REM NOEL CAFFREY JAN
    1981
30  K= 1: DIM B(2ØØ)
40  INPUT "HEX DATA . . ."; A$
50  I =1: N = Ø
60  S$ = MID$ (A$,1,1) : C =
    ASC(S$)
70  IF S$ = "X" THEN GOTO 13Ø
75  IF LEN(A$)><2 THEN PRINT"
    ERROR . . . RE-ENTER":
    GOTO 40
80  IF C< = 57 THEN N = N +
    C–48
90  IF C>57 THEN N= N + C–55
100 IF I= 2 THEN GOTO 12Ø
110 I= 2: N=N*16: GOTO 6Ø
120 B(K) = N: K = K + 1: GOTO 4Ø
130 PRINT ":TURN ON TAPE
    RECORDER": SAVE
140 FOR I = 1TO 1ØØØØ: NEXT
150 L = 1ØØØ: PRINT L; "DATA"; :
    FOR I = 1 TO K–1: PRINT B(I);
160 IF I/6 <>INT(I/6)THEN GOTO
    18Ø
170 L = L + 1ØØ: PRINT: PRINT L;
    "DATA";: GOTO 19Ø
180 PRINT ",";
190 NEXT
200 PRINT: INPUT":ANOTHER
    COPY"; W$
210 GOTO 15Ø
```

Noel Caffrey,
Castleknock,
Co. Dublin.

SCROLL CONTROL

Sir—While writing a program to convert hexadecimal to decimal and vice-versa for my UK101, it became apparent that it was not possible in BASIC to prevent the screen rolling up and leaving the input message on the screen. (At least, this could not be done within a reasonable time.) As this was required, I wrote the following program which enables one to leave the input message on the lowest line of the screen and only the resulting output is rolled up. It does however require a machine code routine. The accompanying program shows how the procedure works and uses the trivial (but short!) example of finding a square-root. Some of your readers may find this useful, especially for "conversion-type" programs; the output is very neat and uncluttered.

The routine as given works on an 8k machine, memory should be restricted to 8100 bytes at start up. The machine code is stored at 1FA4 to 1FC6. For a 4K machine lines 35 and 400 should be altered to read:—

```
35 POKE 11, 210: POKE 12, 15
400 DATA 4050, 35
```

The machine code then starts at OFD2, memory should be restricted to 4050.

In passing it may be worth noting that in my hex. to dec. program I had to ensure that any input was valid by inputting it into a DIM field, this prevents any "REDO" messages being put out by the interpreter which would spoil the effect.

```
10  REM NEAT OUTPUT ROUTINE
20  REM BY S.F.J.

30  GOTO 50
35  POKE 11, 164: POKE 12, 31
40  LET X = USR(X)
45  RETURN

50  READ SP, N1
60  FOR I = 1 TO N1
70  READ RE
80  POKE SP, RE
85  LET SP = SP + 1
90  NEXT
100 FOR I = 1 TO 15: PRINT: NEXT
110 INPUT "INPUT NUMBER"; N
120 IF N < = 0 THEN 300
130 LET S = SQR(N)
140 GOSUB 35
150 PRINT TAB(10); N; TAB(25); S
160 PRINT TAB(10);
170 FOR I = 1 TO 25
180 PRINT CHR$(132);
190 NEXT
200 PRINT
210 GOTO 110
300 GOSUB 35
310 PRINT TAB(10); N; TAB(26);
    "INVALID!"
320 GOTO 160
400 DATA 8100, 35
410 DATA 169, 0, 170, 169, 64
420 DATA 168, 169, 191, 133, 225
430 DATA 169, 211, 133, 226, 161
440 DATA 225, 145, 225, 198, 225
450 DATA 169, 255, 197, 225, 208
460 DATA 244, 198, 226, 169, 207
470 DATA 197, 226, 208, 236, 96
```

Stephen Jaworski,
Walsall.

POOLS AID

On a light hearted note, here is a program which turns your UK101 into a punter's aid. Beats a blindfold and pin!

```
10  INPUT "HOW MANY
    MATCHES ARE ON THE
    COUPON"; U
20  INPUT "HOW MANY LINES DO
    YOU WISH TO ENTER"; V
30  INPUT "HOW MANY
    MATCHES TO BE CHOSEN PER
    LINE"; W
40  DIMA(W): L=INT
    (W*RND(1)+V)
50  FOR T=1TOL: PRINTTAB(19)
    "THINKS": FORX=1TOW
60  B=INT(U*RND(1)+1): FORY=
    1TOW: IFA(Y)=BTHEN60
70  NEXT: A(X)=B: NEXT: FORZ=
    1TOW: FORQ=1TOW
80  IFA(Q)<A(Q–1)THENS=
    A(Q): A(Q)=A(Q–1): A(Q–1)=S
90  NEXT: NEXT: FORY=1TOW:
    IFT>L–VTHENPRINTA(Y);
100 IFY=WTHENPRINT
110 NEXT: NEXT: PRINTTAB(30)
    "GOOD LUCK": END
```

It will be noticed that an inefficient ranking method is used at 70–80. This adds to the suspense by slowing the execution considerably, so that a typical run may take about a minute.

The writer will be happy to accept 0·01% commission from winners of half-a-million or so.

R. J. Newman,
Chesham,
Bucks.

WARM START INTERRUPT

Sir—Concerning Mr. N. Climpson's Screen Editor on tape, from the July 1980 edition of Practical Electronics, I am sure I am not the only one who becomes infuriated when POKE 536, 45:POKE537,31 has to be typed in every time the machine is warm-started, to re-activate the editor. Hence I have designed a very simple machine code routine, which will re-activate the editor automatically after a warm start:

```
5ØØ76 DATA 169, 45, 141, 24, 2, 169, 31,
      141, 25, 2, 76, 116, 162
5ØØ78 FOR I=546 TO 558:READ
      A:POKEI, A:NEXT
5ØØ8Ø POKEØ1, 34: POKE 2,2
5ØØ82 NEW
```

(This should be added on to the end of the editor, and saved as a whole.)

All this does, is point the jump to warm start (addresses 0000–0002) to a simple routine to put 45 and 31 into addresses 536 and 537, respectively and then jump to address A274 to warm-start.

This method of interrupting the warm-start can incorporate any routine (for example to re-activate the error message program of D. J. Anderson, see September PE). I hope this will be useful.

Martin Stiby,
Dunstable.

TRAÇE PROBLEM WITH CEGMON

Sir—Mr. Beckett's TRACE program works very well on the standard UK101, and promises to be very useful. With the CEGMON, however, there seems to be a problem, and I wonder if anyone can help.

When the TRACE program is loaded and X = USR(X) entered one of three things happens:

1. TRACE operates as intended. This happens rarely, maybe due to some random store contents not under control.

2. The keyboard locks up, and nothing further can be done.

3. TRACE operates only while the space bar is held down, and single stepping (a potentially useful feature) can be achieved by pressing and releasing the space bar.

Occasionally both 1 and 3 are available. Pressing any key makes the subject program run continuously with TRACE, and pressing the space bar stops it.

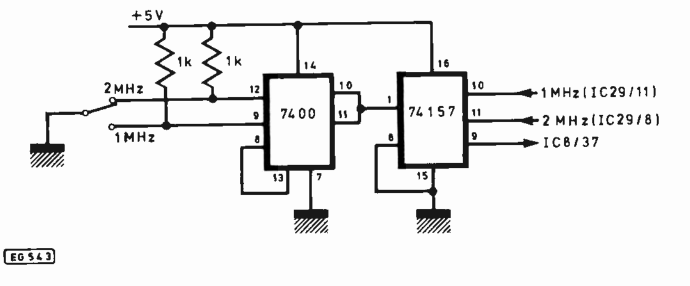
The trace program given with the CEGMON is inferior, since it destroys the printing format, and especially with graphics one cannot follow what is going on.

R. J. Newman,
Chesham,
Bucks.

DYNAMIC CHANGEOVER

Sir—I refer to the letter "2MHz Conversion" in Microprompt, Practical Electronics, September, 1980. You note that the 1MHz/2MHz changeover switch cannot be used while the machine is working. The circuit below allows this frequency change to be performed while running. It is not infallible, but if the machine does hang up, Reset followed by Warm Start will usually restore the program.

The 7400 is wired as a pair of cross-coupled NAND gates, to debounce the frequency change switch. The output is used to drive the 74157, feeding either 1 or 2MHz to pin 9, wired to Ø0 (pin 37 of IC8, 6502).



Break existing link between IC29/11 and IC8/37.

With reference to the new monitor for the UK101, I have found that programs recorded at 600 baud often show corruption when being loaded (the 50th character of a line repeats the 49th) if the machine is running at 1MHz. The problem disappears if 2MHz is used. Has anyone else noticed this? The original monitor does not show this problem.

D. P. Goulder,
Comberton,
Cambs.

PRINTER INTERFACE?

Sir—I wish to interface a Centronics printer to my UK101 and wondered if this could be done using the PE decoding module. If so, how? I would appreciate details on how to do this if it is possible.

N. Odell,
Sheffield.

PS: The printer requires seven data bits and Strobe, Acknowledge and Busy lines are provided.

REPLY

Yes there is nothing that cannot be done with the Decoding Module!

You could drive your printer from Port B of the PIA, though you may need to buffer each data line with something like 7407 gates.

To get it to print, you will need to take the strobe line low while data is on the output of the port. One way would be to connect bits Ø-6 of the PIA directly to the 7 data lines of the printer (possibly via a buffer), and to connect bit 7 of the PIA to your strobe line.

Take the busy line to CB1, of the PIA and then all you need is some software. This will be a short program which picks up the SAVE vector and:

1) Configures the PIA for output on port 1
1a) Puts bits 7 high
2) Monitors the busy line (on CB1) until it is not busy
3) Outputs the character in the Accumulator to the port.
4) Takes bit 7 low, then high again to perform the strobe
5) Loops back to the UK101 output routine

This would be a fairly short machine code routine that could be located in the spare space at Ø23Ø hex.

D. E. Graham.

IMMEDIATE ERROR BANISHED

Sir—One minor irritation on the UK101 Superboard is the OM error message after the first command in immediate mode having just returned to BASIC from the monitor. This is especially annoying whenever a long instruction has been used, such as

```
FOR X = 7000 TO 8191 : PRINT
    CHR$(PEEK (X) ); : NEXT
```

Here is a patch of six bytes to avoid the OM error. The stack pointer is set to 255 (FF in hex) before the warm start.

```
0000  4C  FA    20JMP $02FA ;
                  TO THE PATCH
02FA  A2  FF      LDX # $FF
02FC  9A        A2TSX
02FD  4C  74      JMP $A274
```

The BASIC program pokes the patch into place.

```
5 REM TO AVOID OM ERROR MESSAGE
10 FOR X = 762 TO 767 : READ Z :
   POKE X,Z : NEXT
15 POKE 1,250 : POKE 2,2
20 DATA 162, 255, 154, 76, 116, 162
25 END
```

Robin H. Tracy,
Coventry.

STRING ANSWER

Sir—In response to R. J. Newman's query in the May 'Microprompt' the function STR$(X) is so designed that a leading blank (ASCII=32) will be inserted into the string from STR$(X) unless the number to be converted is negative—in which case the leading blank will be replaced by a minus sign (ASCII=45).

Eg.

```
100  X = –8 : X$ = STR$(X)
110  PRINT X$; ":" ;
120  PRINT ASC(X$) ; ASC (MID$(X$, 2,
       1))
RUN
–8 : 45 56
```

Christopher Davies,
Hove,
East Sussex.

TAPE VIEWER

Sir—Mr. Derry's letter (PE November 1980) was most welcome to one who has been making clumsy attempts to add auto-run to Basic programs. It would be useful to add that POKE 515,0 should be the first executable instruction in any auto-run program, so that other data on tape will not load and foul up the program.

His section on RAMless messages sent me to Edward H. Carlson's book "All About OSI BASIC in ROM" (Edward H. Carlson, 3872 Raleigh Dr, Okemos, Michigan 48864, USA) which inspired the following program for reading messages and programs without loading them into memory.

```
1 A=61440 : B=A+1
2 WAIT A,1 : ?CHR$ (PEEK(B)); :
GOTO 2
```

RUN the program, use CTRL/C to exit. (It may be necessary to stop the tape if unmodulated tone is playing through.) No error messages, no use of RAM (other than VDU RAM), and no waiting for ten minutes while EXMON loads! Any desired program line or message can be taken from the screen using one of the screen editors now available.

Mitch Park,
New Zealand.

E/MONITOR RELOCATED

Sir—In response to Mr. Walton's enquiry in the January 81 issue in Micro Prompt, I have successfully relocated the Extended Monitor to run at $1800–$1FFF leaving 6K below it.

The Extended Monitor uses an address table to select the function required. The ASCII value of the letter typed in is converted into an index which points to an address within the table. The 2 bytes of the address are fetched and pushed onto the stack, followed by the Processor Status Word. Control is then passed to the subroutine by executing an RTI (Return from Interrupt) instruction. The return address for the subroutine has been pushed onto the stack prior to this.

The address table is located at $0960–$0999 and is shown in Fig. 1. The procedure for successful relocation is as follows:

(1) Make a new copy of the program at the required location using the relocation facility.

(2) Determine the relocation constant (the amount by which the starting address has been increased), e.g. to locate at $1800, the relocation constant is $1000.

(3) Add the relocation constant to $0960 to give the base address of the new address table. Also, add the relocation constant to the addresses stored within the table.

(4) Step through the table starting at the base address you have calculated and change all the incorrect table entries (this will be most of them).

Character	*Table Address*	*Contents*
@	0960	0B53
A	0962	0BB3
B	0964	0C9A
C	0966	0CBF
D	0968	0CD2
E	096A	0C57
F	096C	0DA3
G	096E	0BC1
H	0970	0E33
I	0972	0C12
J	0974	0809
K	0976	0BAF
L	0978	0F43
M	097A	0D91
N	097C	0D35
O	097E	0F29
P	0980	0BB0
Q	0982	0D14
R	0984	0DB7
S	0986	0EC3
T	0988	0C6E
U	098A	084C
V	098C	0F3B
W	098E	0D7E
X	0990	0BB2
Y	0992	0BB1
Z	0994	0FB7
Return Address	0996	081E
Brkpt. Routine	0998	0BC7

Fig. 1 Extended Monitor Address Table

The new version of the Extended Monitor is now ready to run. If after jumping into the new version, all seems well, make sure by erasing the old version using "Fill".

Fig. 2 shows the table values required to run at $1800 and incorporates the following changes:

J transfers control to $0300
U Jumps to Cold Start Basic ($BD11)
Z jumps to the old monitor at $FE00

Having relocated the Extended Monitor, you now need to either burn it into EPROM or else make a new self-executing tape. As the procedure for making a new tape is rather long, I suggest that anyone wishing to know how to do this should write to me (via PE—Ed).

John Riley, B.Sc.,
Coventry.

Character	*Table Address*	*Contents*
@	1960	1B53
A	1962	1BB3
B	1964	1C9A
C	1966	1CBF
D	1968	1CD2
E	196A	1C57
F	196C	1DA3
G	196E	1BC1
H	1970	1E33
I	1972	1C12
J	1974	0300
K	1976	1BAF
L	1978	1F43
M	197A	1D91
N	197C	1D35
O	197E	1F29
P	1980	1BB0
Q	1982	1D14
R	1984	1DB7
S	1986	1EC3
T	1988	1C6E
U	198A	BD11
V	198C	1F3B
W	198E	1D7E
X	1990	1BB2
Y	1992	1BB1
Z	1994	FE00
Return Address	1996	181E
Brkpt. Routine	1998	1BC7

Fig. 2 Address Table for Extended Monitor at $1800

M/C FOR PSG

Sir—When using the programmable sound generator, it soon becomes apparent that machine code is much faster and more efficient on memory than BASIC. But even here, with several more complex sound effects, some sort of loader is required. The following program takes data from a table and loads it into the PSG registers. Put the starting address of the table in $E0, $E1 (lo byte first). The table should follow the format:

REGISTER
CONTENT
REGISTER
CONTENT
REGISTER
CONTENT
$FF

To execute .GO222

```
0222  A000      LDY#$00
0224  B1E0      LDA($E0),Y
0226  C9FF      CMP#$FF
0228  D001      BNE$022B
022A  60        RTS
022B  8DF0F1    STA$F1F0
022E  C8        INY
022F  B1E0      LDA($E0),Y
0231  8DF1F1    STA$F1F1
0234  C8        INY
0235  18        CLC
0236  90EC      BCC $0224
```

The addresses at $022C-D and $0232-3 will need altering for PSGs not located at $F1F0 and $F1F1.

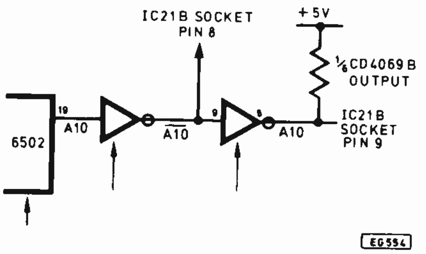
T. D. Allen,
Poole.

OVERLOADED BUS

Sir—There is a fault in the UK101 circuit which may well have put a number of computers into cupboards gathering dust. It concerns the loading on the address bus line A10. This processor line is very heavily loaded with LSI integrated circuits (16 RAM inputs and 5 ROM inputs). It is also expected to drive one full t.t.l. load, namely IC21b – $\frac{1}{16}$ of a 7404.

I had rather a lot of problems getting my UK101 to work – 5 or 6 faulty t.t.l. circuits and a solder bridge which destroyed two 74123s. Since getting it working, one ROM and three RAMs have failed. My own preference for a Buffer, after giving considerable thought to the subject, is to use a 74LS output with a pull up resistor to the +5V line. This resistor should ideally be a constant current resistor and I've realised that $\frac{1}{16}$ of a CD40698 with input shorted to earth is the ideal sort of resistor – the gate output, of course.

The circuit I propose to use is shown below left, and I welcome comments on this.



On further consideration of the UK101 circuit I realize that the processor R/W line needs similar treatment. A8 and A9 also look poor, but I would guess that IC171, a 74LS139, has inputs which cause fewer problems.

There are some spare t.t.l. inverters available in IC18 so all one really needs is a CD40698 to make these changes, though I will have to open the case of my UK101 to check this.

J. D. Owen,
Pendine, Dyfed.

VARIABLE INTENSITY

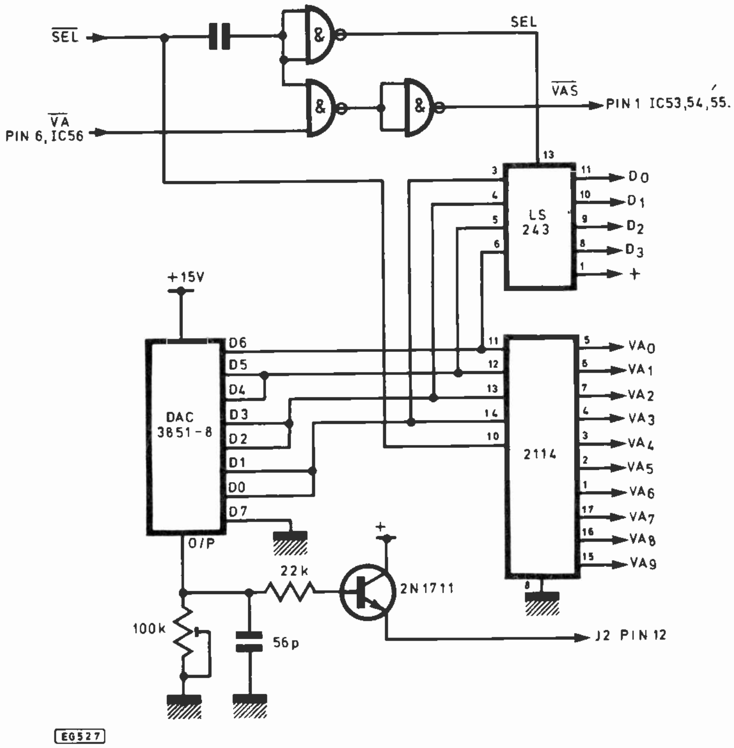
The tone control occupies 1K of memory between D4ØØ and D8ØØ (just after the video refresh memory). To save space and money the unit uses the address decoding of the UK101. A $\overline{SEL}$ signal is derived from pin 9, IC20, which decodes A10, A11 and A12, A13, A14, and A15 (via IC23). The unit also uses the video address bus (VA0>VA9) and is therefore wired to the compukit board and not taken via the expansion sockets.

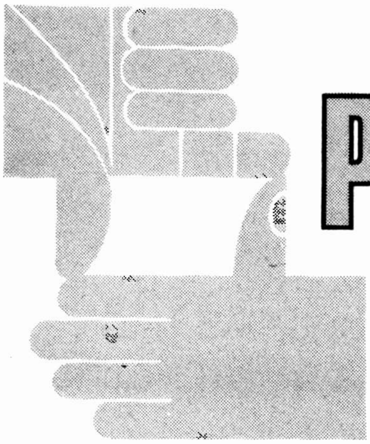
$\overline{SEL}$ takes the 2114s $\overline{WR}$ low, enabling data to be written into the 2114 through an LS243 (tristate buffer) which is enabled by SEL. $\overline{SEL}$ is also required to take control of the VA bus from the binary counters. This is also the function of $\overline{VA}$ (pin 6, IC56) for the video refresh memory. $\overline{VA}$ and $\overline{SEL}$ are therefore decoded and a new signal $\overline{VAS}$ (video address select) is formed. The p.c.b. track to pin 6, IC56 must be cut for this function.

In normal operation the binary counters address the 2114 through the VA bus. The data corresponding to the location's intensity then appear on the 2114's data bus. This bus is directly connected to the D-to-A converter (non latching). NB: The DAC 3851 used gives a current output, and so a trimpot is used to obtain the correct voltage. Some modification may be required for D/A converters with voltage outputs.

A point worth noting about the Compukit's video circuitry is that reverse characters, i.e. black on white, is available from pins 4 and 5 of IC70; this is much clearer for test than the standard white on black display. It is well worth having this feature switch-selectable or even programmable by 'POKEing'.

R. Mark Charles.





PATENTS REVIEW...

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1·45 each.

SONIC HOLOGRAPHY

The second patent application from Robert Carver of the USA (WO 80/02219), filed under the Worldwide Patent Cooperation Treaty, gives hitherto undisclosed details of what the Carver Corporation sells in the USA as the "Sonic Hologram Generator". This exotic description has irritated some reviewers. But those who have heard the Carver sonic holography pre-amplifier in action confirm that it is capable of producing a surprising surround of sound from ordinary stereo recordings and just two loudspeakers fed from a stereo amplifier. The sonic holography patent, like the Carver amplifier patent referred to last month, is lengthy (nearly 150 pages including drawings) so also like the amplifier patent can cost up to £20 to buy. But it is, like all patents referred to in this column, available for free inspection at those libraries in the United Kingdom (e.g. the Science Library at the London Patent Office) which offer the public access to a full collection of British and foreign patent applications.

The holography patent postulates theories on audio reproduction which will not be accepted by all engineers. Essentially Carver argues that stereo reproduction through a pair of loudspeakers can be improved if the natural cross talk between loudspeakers is eliminated. It is of course inevitable that both ears of the listener will pick up sound from both loudspeakers, whereas anyone listening through headphones will hear the left channel only through the left ear and so on. It has previously been shown by various workers that binaural recordings made with a dummy head system (microphones set in the ears of a dummy head) and intended for replay through headphones, can be successfully reproduced through loudspeakers if there is electronic compensation for acoustic cross talk. Carver is in effect proposing a similar, but refined, technique to enhance the loudspeaker reproduction of recordings intended for *loudspeaker* reproduction. But it is clear that his thinking centres on recordings made in a typically transatlantic fashion.

Figure 1 shows how instruments 12a–g of an orchestra are recorded using a spaced pair of microphones M1, M2. Figure 2 shows how the recording is then replayed to a listener P through spaced loudspeakers LS, RS. It is here important to note that the use of the widely spaced pair of omnidirectional microphones is much less common in Europe than in the USA.

Here it is more normal to use a closely spaced or "coincident" pair of directional microphones. In the Carver example, sound from instrument of the orchestra 12f is picked up by microphone M2 and then, after a short delay and at reduced level, by microphone M1. When the recording is reproduced through loudspeakers LS, RS that sound is produced first by loudspeaker LS and then, after a short delay and at reduced level, by loudspeaker RS. Due to acoustic cross talk, when speaker LS reproduces the sound of instrument 12f it is heard first by the listener's left ear along the path Le and then, slightly later, by the listener's right ear, along slightly longer path Lr. When, soon after, the sound of instrument 12f is reproduced by speaker RS, it is heard first by the listener's right ear along path Rr and then, slightly later, by the left ear along slightly longer path Rl. Carver argues that stereo reproduction can be enhanced, to produce a nearly total dimensionalized effect whereby it appears that the music is in a sense surrounding the listener, if acoustic cross talk is cancelled so that the left ear hears only the left loudspeaker and so on. Instrument 12f is now heard first from the left loudspeaker by the left ear, and then, shortly afterwards, from the right loudspeaker by the right ear. In other words a spurious image of the sound follows the real image. This understandably confuses the ears and brain into believing that, as Carver puts it "the hearer somehow appears to be within the sound or in some manner surrounded by the various sources of the sound".

Figure 3 shows the basic circuit. The right channel input R(IN) is split and one signal fraction sent via frequency equalizer A(R) to a summing junction C(R). The remaining signal fraction is fed via phase inverter B(RL) to an array of four time delay frequency analysers b1(RL), b2(RL), b3(RL) and b4(RL). The phase inverter shifts the signal by 180° and splits it into four parts which are each delayed by a different period of time in the four delay devices. These devices also all modify the signal level as a function of frequency. The four, differently delayed, outputs are summed at C(L) with a fraction of the left channel input L(IN). This has been frequency equalized A(L) in mirror image circuitry which also feeds the summing junction C(R) with a left channel signal fraction processed at B(LR) and b1(LR) etc. So each of the two output channels contains an anti-phase, multiple-delay signal crossed over from the other channel. The crossover signals compensate for acoustic cross talk between

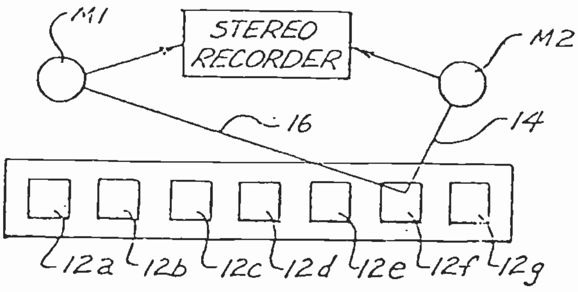


Fig. 1

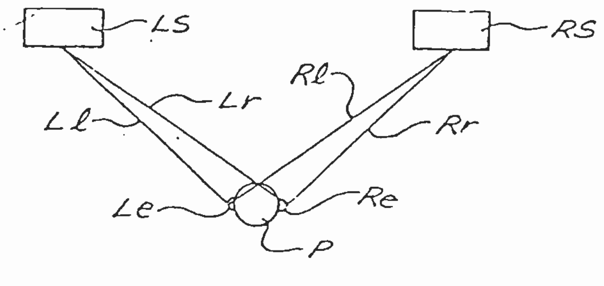
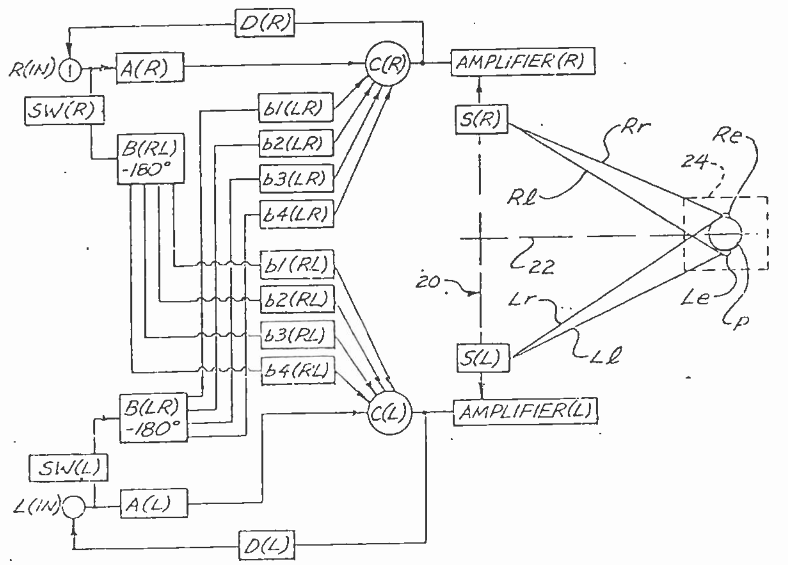


Fig. 2



loudspeakers in the following manner. The listener's left ear first hears a sound direct from speaker LS along path Le. At the slightly later time when the listener's right ear would hear the same sound from loudspeaker LS along slightly longer path Lr, it also receives the delayed replica of that signal in anti-phase from speaker RS. There is thus cancellation at the right ear so the left ear hears only the left speaker.

An array of four different delay devices is used in each channel cross over to compensate for listener head movement. As the head and ears move to a different position so a different time delay in the compensating signal comes into play. So a compensating sound superimposed on one channel will still arrive at the same time as the main sound from the other channel. Carver suggests that in practice delay periods of 110, 180, 370 and 690 microseconds are suitable to create a comfortably large listening window.

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

CB: Learn from US mistakes

Sir—I've followed, as an observer, some of the developments in the UK concerning CB Radio, and I'm frankly amazed at the ridiculous claims being made for it.

As background, I witnessed the institution of CB on 27MHz in the US in 1958, and its various stages and problems through to the present (at least to October of 1979, when we came to Saudi Arabia for a two-year contract).

The basic errors made in the US (and I see the arguments being made to repeat the errors in Britain) were many. First, the band chosen was poorly suited for the stated objectives. Second, because the temptations for illegal operation were so great, and the controls so lax, even the stated objectives were forgotten to the point that those people who had a "legitimate" use according to the regulations were pushed out. The Federal Communications Commission has been notably incapable of doing more than putting a finger in the dike (part-time). Your policing agency will have the same problems, because the situation is identical.

Now, CB has some good points and good uses. But they are almost entirely related to individual use of the medium. Group activities and uses tend to be a waste of time and effort, because of the massive illegal use.

In the US at least (and the situation may be quite different in the UK), almost all the uses to which CB is put are duplications of things which are already available in other services; however, the use of CB is so easy that the other solutions are ignored. In short, 99% of what goes on on Stateside CB shouldn't even exist!

Let me list situations:

1. Emergency communications are quite often worthless on CB. Hoaxes are perpetrated daily. In Houston, Texas (our home), a "command centre" was set up in one of the downtown tall buildings to handle accident reports to the police from commuters on CB. Within a matter of months, the police began to ignore reports from even this well-planned and well-staffed operation, because of the numerous false calls. Additionally, legitimate emergency communications are deliberately disrupted a large majority of the time.
2. Profanity is rife on CB, and I don't mean "Hells" and "Damns". No subject of anatomy is too delicate to discuss in detail, no vulgar terms are taboo, and there is *no* way to protect your family. Anonymity works strange changes in the human animal.
3. After a short while, the frustrations of the whole thing cause the individual to either give up, or he decides to fight it. If he gives up, the remaining users gain (less interference) and he loses (he doesn't have the usage he desired). If he decides to fight it, everyone loses. First, he tries higher power. When that loses its splendour, or he finds that there are those who have more power than he does, he looks for something further. So he figures out a way to get away from the crowd (in the US they're called "Sliders"). Now he's got high power *and* he can move out of the band. Next facet: Most of the manufacturers of illegal equipment don't come anywhere near producing anything with any quality. The result is usually (and this can be documented) a 200 watt amplifier, for instance, that dumps 20 watts on channel 19, and the remaining 180 watts somewhere between 30 and 500MHz (Murphy's law says most of that will be on discrete TV channels).
4. Now, what happens next? Well, since he's illegal, there are few things in which he can legitimately engage, and eventually he decides that there's no fun in it, so he looks for new worlds to conquer. What's left? Well, he can move out and bootleg on the ham bands. This is a common occurrence is the US. He can have all sorts of fun creating havoc, and really disrupting things.
5. Many of the CB'ers in the US finally get disgusted and move up to legitimate Ham Radio via the licence route. Ham Radio is where they should have been in the first place.

Okay, for those who get disgusted and quit, and those who get disgusted and upgrade to ham radio, what purpose has CB served? With the illegality that is rampant (at least in the US), CB serves no purpose which justifies its existence, even for those who stay in it. And, Great Britain appears not to have learned the lessons from observing the mistakes of the other countries.

One last observation: I see in several of the magazines advertisements that suspiciously look like offers by UK commercial establishments to sell illegal equipment. CB is getting off to a *great* start! Why, some magazines print articles on how to build equipment that's illegal to use, and even tell you it's illegal to use it! Sounds slightly hypocritical to me.

I enjoy your magazine. The layout's good, the articles are interesting and it's easy to follow. Keep up the good work, and watch CB grow. I predict you'll find that the only winners will be the purveyors of equipment.

Kent Marshall,
Dhahran.

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0.22/250	£0.14		
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.22/250v	£0.16	47/250v	£0.26
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47/63	20	47/100	24
100/25	20	100/40	19
100/63	21	100/100	44
220/16	19	220/25	22
220/40	24	220/63	45
220/100	67	470/16	23
470/40	47	470/63	72
470/100	1 16	1000/16	45
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* LM 301-8	0.26	SAA 5012	7.11
LM 308N	0.48	SAA 5020	5.33
LM 348	0.90	SAA 5030	8.26
* LM 380 N14	0.50	SAA 5040	15.14
LM 383	1.56	SAA 5050	8.51
* LM 386N	0.75	SAS 560	1.60
LM 389N	0.92	SAS 570	1.60
LM 340T5	0.50	SAS 580	1.80
LM 710-14	0.42	SAS 590	1.80
LM 723 CH	0.60	* SFF 96800A	6.25
LM 723 C14	0.40	SFF 96810A	4.28
LM 741 C14	0.58	SFF 96821A	5.19
LM 923	0.44	* SN 76115	0.70
LM 1303	1.00	* SN 76228	1.00
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* LM 3915	2.20	TBA 120	0.75
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NE 543K	1.55	TBA 570Q	2.20
NE 544	1.60	* TBA 810S	1.00
* NE 555	0.21	TBA 920	2.75
* NE 556	0.73	* TBA 990Q	2.65
NE 558	3.12	TCA 270S	3.15
NE 562	3.12	TDA 2540	3.85
NE 565	1.05	TDA 2611	1.58
NE 566	1.53	* TLO 81CP	0.32
NE 567	1.10	* TLO 82CP	0.56
NE 570	3.50	* TLO 84CN	1.00

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" "	DM350	£72.50	£1.30
" "	DM450	£119.00	£1.30
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2N 3133	.10	AF 126	.10	BC 213L	.05	BSY 28	.10
2N 3566	.50	BC 115	.05	BC 214	.05	MJE 371	.30
2N 3638	.05	BC 118	.05	BC 214B	.05	MPSA 05	.05
2N 3642	.10	BC 154	.10	BC 214L	.05	ZTX 500	.05
2N 3708	.05	BC 157A	.05	BC 238B	.05	AA 119	.05
2N 3711	.05	BC 157B	.05	BC 239C	.05	BA 102	.05
2N 3794	.05	BC 158	.05	BC 251B	.05	BA 142	.05
2N 3771	.75	BC 159	.05	BC 253	.08	BA 144	.05
2N 3905	.08	BC 167B	.05	BC 308B	.08	BA 154	.05
2N 3962	.10	BC 168B	.05	BC 350	.05	BA 316	.05
2N 4286	.05	BC 169B	.05	BC 347	.05	BA 317	.05
2N 4400	.05	BC 170B	.05	BC 414	.05	BA 318	.05
2N 5220	.05	BC 171B	.05	BC 415A	.05	BAW 49	.05
2N 5222	.10	BC 172	.06	BC 416A	.05	BAX 13	.05
AC 126	.15	BC 172C	.06	BC 517	.12	BAY 93	.02
AC 127	.15	BC 173	.05	BCY 71	.05	BB 105B	.10
AC 132	.05	BC 174B	.05	BCY 72	.09	BY 126	.14
AC 152	.15	BC 178B	.14	BD 138	.10	CV 7641	.05
AC 188	.15	BC 182A	.05	BF 161	.08	GEX 23A	.03
AC 188K	.15	BC 183	.05	BF 177	.05	ITT 44	.05
AC 187K	.15	BC 183B	.06	BF 180	.08	ITT 921	.05
ACY 22	.05	BC 183L	.05	BF 181	.05	OA 47	.10
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SN7410	£0.19	* SN7440	£0.15	SN7450	£0.19	* SN7491	£0.35	SN74145	£0.77	* SN74190	£0.60
* SN7412	£0.15	* SN7441	£0.30	* SN7453	£0.15	* SN7492	£0.20	* SN74155	£0.50	SN74192	£0.91
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WILLIAM HERSCHEL

In 1781 on the 16th of April, William Herschel, using his telescope which he had built with his own hands, discovered the planet Uranus. This musician from Germany became one of the world's greatest astronomers. He lived at a time in British history which saw the beginning of a new surge forward in technology over wide horizons. His discovery of the planet named after him and now called Uranus, marked more than a mere observational feat, opening up new wonders and extending the solar system with the first discovery of an additional planet. It marked also a new development in technology. Herschel added to the astronomical scene an advanced technology in practical optics.

The story of his entry into the study of astronomy is interesting and instructive. During the time that he lived in Bath he was given the opportunity to use a small telescope. So struck was he by the increased richness of the number of stars which could be seen with the naked eye, that he sought to purchase a telescope of his own. Eventually he was offered one at a cost of something like £100. This he could not afford so he set about making his own. Many of these activities have been recorded, but it is worth noting that he decided to make a larger telescope on the assumption that this would enable him to see more. The materials to hand that could be used for the tube, the stand and controls were plentiful. It was the 'mirror' that posed the main difficulty. He recognised that the material, an alloy called 'speculum' metal, had limits. So expert did he become in the manipulation and polishing techniques that the 'mirror' was of such quality that it surpassed any then known.

Here then was one of startling new events of science history, for had it not been for Herschel's production of a so well figured 'mirror' Uranus might not have been discovered for a long time. This was why the planet had not been discovered previously though others had described a possible body without confirmation. The simple fact was that the telescope was so good that Herschel recognised that he was looking at a planet because it *appeared as a disc* and therefore could not be a star.

It is a fitting tribute to this man that the new 4·2m telescope being built for the observatory on the island of La Palma, was named the William Herschel Telescope by the Director of the Royal Greenwich Observatory, Professor F. Graham Smith, during the National Astronomy Week which began on April 25, 1981. The 4·2m telescope has an altazimuth mounting, the system that Herschel used for all his telescopes. The 4·2m telescope is the largest of the three telescopes to be set up at the Roque de los Muchachos, La Palma. There is a connection between Spain and Herschel because the King of Spain purchased one of his best telescopes (with a 24in. mirror) and installed it in Madrid in 1804.

THE NEW FRONTIER

The successful first flight of the shuttle Columbia marks a point in space history that must touch the hearts of even the most blasé of citizens anywhere. The vistas that open will affect every walk of life and invade every area of human endeavour. The capability of the new technology will result in the extension of benefits to the whole world. For some of the plans, already past the drawing board, there will be the requirement for the extensive use of engineering which calls for a vast amount of raw materials and the processing of millions of components of all kinds. For some of the commercial activities a number of thermo electric items such as solar cells will require an increase in the winning of items like gallium, arsenide and silicon, far beyond the present consumption. Material for the assembly of large structures is another item which will consume raw materials for platforms such as would never be contemplated on earth—structures which will be measured in hectares and miles as continuous units. Operational personnel in space could well be getting toward the 1,000 mark by the end of the century, that is to say the personnel aloft as distinct from the backup teams. The continuous servicing of the existing individual spacecraft and satellites means increased life with fewer launches. Units can be standarised as the pallets that are already operational.

It will indeed be a brave new world extension. Progress is now in a logarithmic mode and looking back over 200 years it is clear that these modes increase in frequency and there are new clichés such as 'we have learned more in the three days of this mission than in the last three years'. At a recent conference on Saturn and Uranus these were the constant remarks—and so it will go on.

A look back at the Columbia mission and the technical details of the launch is instructive. One point that emerges is that in most sections of the operations the results were beyond target so that the normal planned programme was well within the capability of the possible activities. For example the 7·5 million pounds of thrust at lift-off took the vehicle aloft at a steeper angle than was planned. This 5% steeper climb lifted the vehicle (the Americans call it 'lofting'), and this of course used more fuel than was planned, but because the greater height was attained it helped to restore the propulsion requirement and the astronauts were notified that they were ahead of time, and instructions might be advanced. However, because of the balancing of the two conditions the original timing was restored. No adverse conditions arose when it came to the time of separation of the boosters.

It was a tribute to the planning that the crew were warned that the main engine cut-off would be at 8min 34sec. This was exactly correct. At this cut-off point the velocity was 25,670ft/sec, only 2ft/sec higher than the target. Altitude and the rate of climb was exact. All moves went smoothly to the point when the 130nau.m by 130nau.m orbit was reached. More details will be available later when the official reports are released.

The re-entry part of the mission was an unqualified success and started when the speed of the vehicle was at mach 25. At mach 5 the mission commander John F. Young took manual control. The height was then 115,000 feet and Young continued control through the reversal stage till 35,000 feet. The vehicle's tile protection was safe through the 2,300 to 3,000 deg.F period of blackout. This was at a height of 188,000 feet at mach 10·3.

It may be possible in the next issue of *Spacewatch* to have more details of the moment to moment sequence, outward and return.

The Columbia will go back for refurbishing and it is expected that the next mission will be in September or early October this year. As has already been stated, the first period of shuttle operations will be used to fulfil the time already booked for scientific and defence activities. This is expected to continue on present contracts to 1985. By that time the other shuttles will be operational and open for business. The goal of the enterprise is to 'carry into space anyone who needs to operate equipment, experiments or machinery'. There will be available NASA trained pilots, engineers, doctors, physicists and other scientists. Normally healthy people from 25 to 65 will be able to go into space with safety. It is expected that the upper limit will be increased to 80 in the next decade. Each vehicle can be used 100 times and there will be four of them in the initial programme.

It is perhaps not unreal to look at the facilities of the shuttle and see a picture of a unit having attached to it all kinds of units each doing some job or other and the whole looking as though there was a fiesta with everything 'dressed overall'.

JOBLESS BUILD A GATEWAY TO THE STARS

Astronomer Patrick Moore officially opened a new visitor centre which has been created at the Royal Observatory, Blackford Hill, Edinburgh, by a team of unemployed adults and teenagers. It traces developments and the international role of the Royal Observatory and houses the nucleus of a national collection of Scottish astronomical telescopes dating from about 1710. It also gives the latest information on the exploration of space. A model of the Space Shuttle is on view.

The Manpower Services Commission paid the wages of the unemployed persons.

Interfacing COMPUKIT

Part 7 D.E.Graham

THIS MONTH we conclude the series with discussion of an Interrupt Driven Clock, and with applications of the Analogue to Digital Converter section of the *P.E.* Analogue Board. These include voltage, temperature, light and sound measurement with v.d.u. bar chart displays, plus a data logger and sampling oscilloscope. But first we continue the discussion of the use of interrupts, begun last month.

6522 INTERRUPTS

The interrupt lines of the 6821 on the Decoding Module and the 6522 on the Analogue Board have both been connected to the UK101's $\overline{IRQ}$ line so that interrupts from both these devices may be readily handled. Unfortunately space has not allowed a discussion of the use of 6821 interrupts during this series. The principles involved however are similar to those for 6522 interrupts, and for further information on the 6821 the reader is referred to the data sheets.

6522 interrupts are handled through two sets of registers, the Interrupt Flag Register or IFR (register 13 at 61357) and the Interrupt Enable Register or IER (register 14 at 61358). These are represented in Table 6.3 of part 6 of the series. From this it will be seen that one bit of the IFR and one bit of the IER are associated with each of the control lines CA1, CA2, CB1 and CB2, and one with each timer and the shift register.

The various bits of the IFR are automatically set by the 6522 when events such as the timing out of the timers, or particular transitions on the peripheral control lines occur, and these flags may be inspected periodically by the CPU. If the interrupt is used however, such continual polling is not necessary, and the CPU need only inspect the IFR once an interrupt has been sensed and accepted. The IFR will then tell the CPU which one of the 7 possible functions caused the interrupt.

To condition the 6522 to cause an interrupt request (ie by taking $\overline{IRQ}$ low) when any of its flags are set is achieved by previously setting the corresponding bit in the Interrupt Enable Register. This register uses bit 7 to indicate whether specified bits are to be set or unset. If bit 7 is a one, then writing to any other bit of the register will set that bit. Thus, placing 130 (=128+2) into the IER codes bit 7 with a one, so that the remaining data (2) will cause bit 1 to be set. No other bit positions will be affected. Unsetting bits in the IER is accomplished with bit 7 at zero, so that writing 65 to the IER will unset bits 6 and 0, again leaving the remainder unchanged. To clear the register completely the IER should be loaded with 127. Pressing the Reset button on the Decoding Module will also zero this register.

INTERRUPT DRIVEN CLOCK

As an example of the use of interrupts with the 6522 we will look at the implementation of an interrupt driven clock on the UK101.

This will employ timer T1 on the 6522 to produce an interrupt every 50ms, and the UK101 will be conditioned to respond to this by updating a series of memory locations in which it holds the current time in hours, minutes, seconds, and twentieths of a second.

Table 7.1 gives the assembler listing of a program which accomplishes this. It resides at 0230 hex in an unused area of RAM below the UK101's BASIC file space. The program falls into two parts: the interrupt service routine itself, from 0230 to 0278 hex; and the initialisation routine from 027D to 02A6 hex. This latter is executed only once at the outset, and we will look at this first.

The first five lines set a jump to 0230 instruction at the UK101's IRQ vector. Line 780 initialises the memory location TWENT that is used to count twentieths of a second. The next sequence is used to configure the 6522. Lines 790 and 800 set timer T1 in the continuous mode by placing 64 into the ACR. Lines 810 and 820 enable the T1 interrupt by loading the IER with 192 (=128+64), thus setting bit 6. The instruction CLI at line 830 clears the interrupt mask, while lines 840 to 870 load the low and high order bytes of the T1 latches with the values 78 and 195, so initiating the count. The count total is thus 195 × 256 + 78 (=49998). The 2 micro-secs delay inherent in the counter make this up to 50000, so giving a 50ms interrupt repetition rate. The final command executes a return from subroutine.

The interrupt service routine starting at 0230 first places the accumulator on the stack, and executes a read from the low byte of T1's count registers. This latter has the effect of automatically clearing the T1 interrupt flag, so taking $\overline{IRQ}$ high again in preparation for the reception of further interrupt requests. The program then decrements the location TWENT (at 022A hex), and checks to see whether it has reached zero. If not it restores the accumulator from the stack, and exits the interrupt routine. If zero has been reached on the other hand, it increments the location SECS (at 022B hex), checking to see whether 60 seconds have been counted, in which case it increments MINS, and so on.

To start the clock once the program has been entered, it is only necessary to execute the subroutine at 027D. This may be accomplished from BASIC using a USR(X) call, or from a machine code routine with a JSR command. We will access it from BASIC.

RUNNING THE INTERRUPT CLOCK FROM BASIC

The BASIC program listed in Table 7.2 consists of two parts. The first loads the clock program of Table 7.1. The second allows the current time to be inserted in the three locations SECS, MINS and HRS, and uses a USR(X) call to enter the clock initialisation routine, thus starting the clock. Lines 3000 onwards then cause the time to be POKEd to the centre of the screen. Line 2100 determines the screen position of the display, and this should be altered for Superboard use.

The clock display program may be exited by pressing the space bar at any time, and as long as the UK101 Reset is not pressed, the interrupt clock will continue to operate. Other programs may then be loaded, run and saved as required without disrupting the clock, and these may if desired access the continually updated time by PEEKing locations 555, 556 and 557 for seconds, minutes and hours respectively. There seems to be just one proviso to this: programs which use more than the simplest configuration of GOSUB commands must be avoided, since due to an error in the UK101's firmware the IRQ vector has been located within the stack. As a result, subroutine calls can corrupt the interrupt vector at 01C0, and are in turn corrupted by it. It is for this reason that the program of Table 7.2 avoids subroutine calls, and makes use of flags F and F1 to get around the problems which this creates.

Once the clock has been started, the whole program may be erased with a NEW command, if desired, so as to save memory space, again without affecting the running of the clock.

As with other applications of the 6522, the accuracy of the interrupt clock is tied to that of the UK101's 8 MHz crystal. In my machine this caused the clock to run slow by about 2 secs every hour. This could of course be corrected by using a closer tolerance crystal. But a much simpler way is to alter the value loaded into the low byte of T1's latch register—this is the last data item (78) on line 210 of the program of Table 7.2. With this method it should be possible to achieve accuracies of the order of 1 sec in 16 hours, which should be sufficient for most foreseeable applications.

MACHINE CODE TO BASIC TRANSLATOR

Lines 100 to 340 of the program on Table 7.2, which enter the interrupt clock program in 6502 code using BASIC, were themselves produced by a translator program written for the purpose. Since this program can translate the contents of any section of memory into BASIC POKE statements, it can be used for saving data or programs stored anywhere in the machine. The program is listed in Table 7.3. It first requests the start and end address of the memory block to be recorded. These may be in hex or decimal, since a hex to decimal conversion routine is included in the program. Next it requests the line number that the BASIC program which it will write is to start from, and the title of the program. It then instructs the cassette recorder to be set to record, and writes the program directly on to it. The machine may then be cleared, and the cassette loaded and run as if it were a normal program.

ANALOGUE TO DIGITAL CONVERTER

The fourth section of the Analogue Board consists of a multiplexed 8 channel analogue to digital converter. The heart of this unit is a ZN427 monolithic A/D converter i.c. See Fig. 7.1. This uses the so-called successive approximation technique to achieve conversion times of some 20μs or less. This is a far more efficient means of conversion than the other commonly used method which simply causes a D/A converter to sequence its output from zero to 255, using a comparator to stop it when the output matches the analogue signal to be measured. In this case conversion may take as long as 255 clock cycles.

Fig. 7.2 gives the circuit of the A/D section of the Analogue Board. The 8 analogue inputs are taken through SK6, whose full pinout is given in Fig. 7.3. From here they are applied to IC8, a 4051 8 way analogue switch. This selects one of the 8 channels according to the logic states of its pins 6, 9, 10 and 11. These in turn are determined by the

Table 7.1. Assembler Listing of Interrupt Clock

```
 80 0000        ;INTERRUPT CLOCK AT 022B, C & D
 90 0000        START=$0230
100 0230        *=START
110 0230        TWENT=START-6
120 0230        SECS=START-5
130 0230        MINS=START-4
140 0230        HRS=START-3
150 0230        ACR=61355
160 0230        IER=61358
170 0230        TL=61348
180 0230        TH=61349
200 0230 48     BEGIN PHA ;INTERRUPT SERVICE ROUTINE
220 0231 ADA4EF LDA TL
230 0234 CE2A02 DEC TWENT
240 0237 D03B   BNE OUT
250 0239 A914   LDA #20
260 023B 8D2A02 STA TWENT
270 023E A901   LDA #1
280 0240 18     CLC
290 0241 6D2B02 ADC SECS
300 0244 8D2B02 STA SECS
310 0247 C93C   CMP #60
320 0249 D029   BNE OUT
330 024B A900   LDA #0
340 024D 8D2B02 STA SECS
350 0250 A901   LDA #1
360 0252 18     CLC
370 0253 6D2C02 ADC MINS
380 0256 8D2C02 STA MINS
390 0259 C93C   CMP #60
400 025B D017   BNE OUT
410 025D A900   LDA #0
420 025F 8D2C02 STA MINS
430 0262 A901   LDA #1
440 0264 18     CLC
450 0265 6D2D02 ADC HRS
460 0268 8D2D02 STA HRS
470 026B C918   CMP #24
480 026D D005   BNE OUT
490 026F A900   LDA #0
500 0271 8D2D02 STA HRS
510 0274 EA     OUT NOP
520 0275 EA     NOP
530 0276 EA     NOP
540 0277 68     PLA
550 0278 40     RTI
560 0279 00     BRK
570 027A 00     BRK
580 027B 00     BRK
590 027C 00     BRK
700 027D        ;INITIALISE CLOCK
710 027D A94C   LDA #$4C
720 027F 8DC001 STA $01C0
730 0282 A930   LDA #$30
740 0284 8DC101 STA $01C1
750 0287 A902   LDA #$02
760 0289 8DC201 STA $01C2
770 028C A914   LDA #20
780 028E 8D2A02 STA TWENT
790 0291 A940   LDA #64
800 0293 8DABEF STA ACR
810 0296 A9C0   LDA #192
820 0298 8DAEEF STA IER
830 029B 58     CLI
840 029C A94E   LDA #$4E
850 029E 8DA4EF STA TL
860 02A1 A9C3   LDA #$C3
870 02A3 8DA5EF STA TH
880 02A6 60     RTS
```

Table 7.2. Interrupt Clock in BASIC

```
OK
LIST

90 REM INTERFACING UK101 PROGRAM 19
100 REM 6522 INTERRUPT CLOCK AT 0230 HEX
105 REM LOCATIONS  560  TO  678
110 DATA 72 , 173 , 164 , 239 , 206 , 42 , 2 , 208 , 59 , 169
120 DATA 20 , 141 , 42 , 2 , 169 , 1 , 24 , 109 , 43 , 2
130 DATA 141 , 43 , 2 , 201 , 60 , 208 , 41 , 169 , 0 , 141
140 DATA 43 , 2 , 169 , 1 , 24 , 109 , 44 , 2 , 141 , 44
150 DATA 2 , 201 , 60 , 208 , 23 , 169 , 0 , 141 , 44 , 2
160 DATA 169 , 1 , 24 , 109 , 45 , 2 , 141 , 45 , 2 , 201
170 DATA 24 , 208 , 5 , 169 , 0 , 141 , 45 , 2 , 234 , 234
180 DATA 234 , 104 , 64 , 0 , 0 , 0 , 0 , 169 , 76 , 141
190 DATA 192 , 1 , 169 , 48 , 141 , 193 , 1 , 169 , 2 , 141
200 DATA 194 , 1 , 169 , 20 , 141 , 42 , 2 , 169 , 64 , 141
210 DATA 171 , 239 , 169 , 192 , 141 , 174 , 239 , 88 , 169 , 78
220 DATA 141 , 164 , 239 , 169 , 195 , 141 , 165 , 239 , 96
310 FORC=0 TO  118
320 READ I
330 POKE  560 +C, I
340 NEXT
2000 PRINT:PRINT:PRINT:PRINT:PRINT
2005 PRINT:PRINT,"INTERRUPT CLOCK"
2007 PRINT:PRINT:PRINT"  ENTER PRESENT TIME"
2010 INPUT"    HOURS";H
2020 INPUT"    MINUTES";M
2030 INPUT"    SECS";S
2035 POKE557,H
2040 POKE556,M
2045 POKE555,S
2050 POKE11,125
2060 POKE12,2
2070 X=USR(X)
2100 Z=53660
2110 FORQ2=1TO16:PRINT:NEXT
2200 REM MAIN CLOCK LOOP
2230 IFF1=0THEN3000
2240 F1=0
2250 IFF=2THEN6000
2260 GOTO4000
3000 REM CLOCK DISPLAY
3020 H=PEEK(557)
3030 M=PEEK(556)
3040 S=PEEK(555)
3100 H$=STR$(H)
3120 M$=STR$(M)
3140 S$=STR$(S)
3160 T$="  "+H$+":"+M$+":"+S$+"   "
3200 REM POKE ROUTINE
3210 FORI=1TOLEN(T$)
3220 Q=ASC(MID$(T$,I,1))
3230 POKEZ+I,Q
3240 NEXT
3500 REM SPACE BAR SCAN
3510 POKE530,1
3520 POKE57088,253
3530 IFPEEK(57088)=239THENF1=1
3540 POKE530,0
3545 IFF=2THEN5550
3550 GOTO2200
4000 PRINT:PRINT:PRINT"  DISPLAY ROUTINE EXITED"
4010 PRINT"  CLOCK CONTINUES"
4020 PRINT"  TO RESUME DISPLAY, RUN 2100
4030 POKE530,0
OK
```

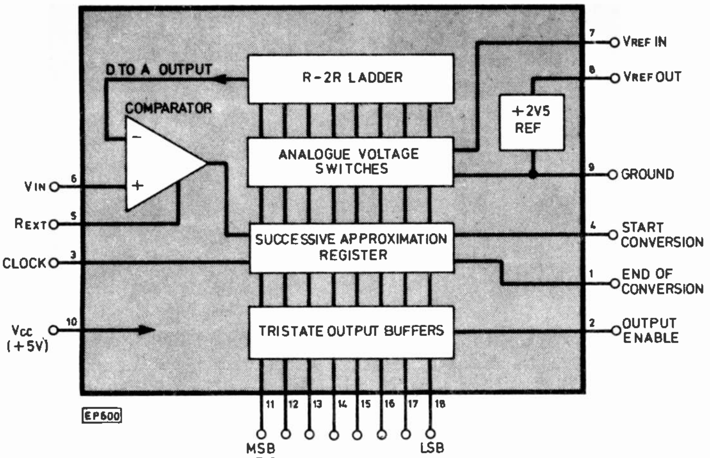


Fig. 7.1. ZN427 Block Diagram

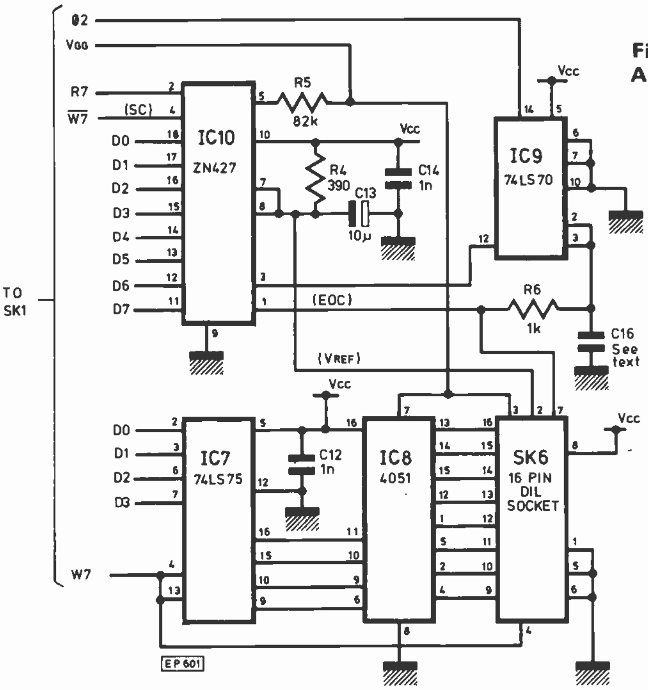


Fig. 7.2. A/D section of Analogue Board

quad latch IC7. This is enabled by line W7 from the Decoding Module. The 8 channels are selected by POKEing the channel number (0-7) to address 61319. Thus the command POKE 61319, 6 will connect channel 6 (at pin 10 of SK6) to the input of the converter.

The converter itself requires a low-enable Start Conversion pulse, and this is supplied by $\overline{W7}$ from the Decoding Module. This means that each time the multiplexer at 61319 is addressed, a new conversion sequence is initiated.

The clock input of the converter at pin 3 requires a frequency less than 600 kHz. In order to satisfy this condition, IC9 is used to divide the UK101 Ø2 clock by two, giving a clocking frequency of 500 kHz. Other timing conditions of the ZN427 are satisfied by delaying the operation of the divide by two counter until the ZN427 End of Conversion signal (EOC) goes negative. This is achieved by taking pin 1 of IC10 to pins 2 and 3 of IC9. In the prototype, this was further delayed by the insertion of C16 (50nF); and this capacitor was included in the component overlay diagram published in part 4 of the series. This extra delay time is not necessary for any of the applications described below, and it is recommended that C16 be removed from the board, so greatly enhancing conversion times.

The EOC signal produced by the ZN427 to indicate the completion of conversion has been taken to pin 7 of SK6, and may be monitored by the CPU if required, although conversion is so fast that there is barely time to monitor it in machine code (and certainly not in BASIC) before conversion is completed. Once conversion has taken place, the converter may be read at 61319. Thus the following two commands will print the value of the analogue input on channel 4.

POKE 61319, 4
PRINT PEEK(61319)

The POKE and PEEK statements may of course be put within a FOR loop to sequence through each of the 8 channels:

FOR A = 0 TO 7
POKE 61319, A
PRINT PEEK(61319)
NEXT

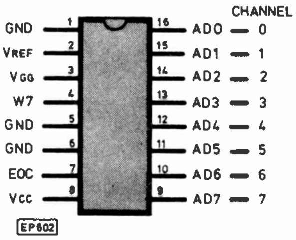


Fig. 7.3. Connections to SK6 on Analogue Board

```
50 REM INTERFACING UK101 PROGRAM 20
60 REM MACHINE CODE TO BASIC TRANSLATOR
70 PRINT:PRINT:PRINT:PRINT
72 PRINTTAB(6)"MACHINE CODE TO BASIC TRANSLATOR"
74 PRINT:PRINT
75 PRINT"     THIS PROGRAM PRODUCES A TAPED PROGRAM"
76 PRINT"     IN BASIC FOR REPRODUCING ANY BLOCK OF"
77 PRINT"     MEMORY LOCATIONS"
90 PRINT:PRINT:PRINT
92 PRINT"     ARE START AND END ADDRESSES OF MEMORY"
93 PRINT"     BLOCK IN HEX"
95 INPUTY$
96 IFLEFT$(Y$,1)="Y"THEN600
98 PRINT
100 INPUT"   START ADDRESS IN MEMORY";AS
105 PRINT
110 INPUT"   END ADDRESS IN MEMORY";AE
120 INPUT"   FIRST LINE NO OF BASIC PROG";NB
130 PRINT"   TITLE OF BASIC PROGRAM"
135 INPUTA$
140 SAVE
150 PRINT"   START RECORDER"
160 INPUT"   ENTER S TO START";B$
200 PRINTNB; "REM ";A$
205 PRINTNB+5; "REM LOCATIONS ";AS;" TO ";AE
210 FORA=0TO(AE-AS)STEP10
220 PRINTNB+10+A;" DATA";
230 FORB=0TO9
240 PRINTPEEK(AS+A+B);
250 IFAS+A+B=AETHENB=10
254 IFB<9THENPRINT",";
260 NEXT
270 PRINT
280 NEXT
400 Z=NB+100+10*INT((AE-AS)/10)
410 PRINTZ;" FORC=0 TO ";AE-AS
420 PRINTZ+10;" READ I"
430 PRINTZ+20;" POKE ";AS;"+C, I"
440 PRINTZ+30;" NEXT"
450 FORZX=1TO5000:NEXT
500 POKE517,0
510 FORA=1TO16:PRINT:NEXT
520 PRINT,"RECORDING COMPLETE"
550 END
600 PRINT"   START ADDRESS (HEX) IN MEMORY"
620 GOSUB900
630 AS=N
635 PRINT
640 PRINT"   END ADDRESS (HEX) IN MEMORY"
650 GOSUB900
660 AE=N
670 GOTO120
900 REM HEX CONVERSION
910 INPUTQ$
920 IFLEN(Q$)<>4THENPRINT:PRINT"  4 DIGIT FORMAT ONLY":GOTO900
930 N=0
940 X$="0123456789ABCDEF"
950 FORJ=1TO4
960 FORI=1TO16
970 IFMID$(Q$,J,1)=MID$(X$,I,1)THEN1010
980 NEXTI
990 PRINT:PRINT"  CHARACTER NOT IDENTIFIED - REDO"
1000 GOTO900
1010 N=N+(I-1)*16^(4-J)
1020 NEXTJ
1030 PRINT"  DECIMAL EQUIVALENT = ";N
1050 RETURN
OK
```

Table 7.3. Machine Code to Basic Translator Program

The conversion scale of the ZN427 is determined by the voltage applied to its pin 7. On the Analogue Board this is connected to the ZN427's precision 2·55 volt reference source, which results in a very convenient conversion scale of 10 mV per digit, so that an input of 2·17 volts for example will produce a digital value of 217, and so on.

EIGHT CHANNEL DISPLAY PROGRAM

The program in Table 7·4 may be used to monitor the input levels on all 8 channels of the converter. Analogue to digital conversion is carried out in lines 220 and 230, and the updated conversion result POKEd to the screen, after suitable processing. As may be seen from the photograph, a horizontal bar graph representation is also produced for each channel. This latter is only altered in subsequent passes if a change in input voltage is detected. The program may be exited by depressing the space bar.

VOLTAGE MEASURING

As it stands, the converter will measure voltages from 0 to 2·55 volts presented to the input pins of its 8 channels (ie pins 16 to 9 of SK6, corresponding to channels 0 to 7 respectively). For accurate conversion, each input should be loaded with an impedance of 10k or less. This is necessary to ensure an impedance match with the input circuitry of the ZN427, and also in order to avoid charge carry-over from one channel to the next as the multiplexer sequences through the channels. If for example a voltage is applied to channel 0, and the input of channel 1 is left floating, channel 1 will read a non-zero voltage as measured in the display program of Table 7.4. This is avoided by keeping input loads below 10k and by earthing unused inputs.

If it is required to increase the voltage range of any channel of the converter, this may be accomplished by using a resistor network. That shown in Fig. 7.4 gives a scale factor of two so that 5 volts will give a reading of 250. The resistors used should be 1% types or better, although if these are not available, lower tolerance resistors could be trimmed (by constructing series/parallel combinations) so as to give a reading of 127 or 128 when point X is connected to pin 2 of SK6. This is the ZN427's own 2·55 volt reference source. The function of C in the dropper network is to keep the input impedance low enough to match the ZN427. Similar techniques may be used to extend the range further.

ANALOGUE JOYSTICK

Each of the 8 channels of the converter may be used with a virtually infinite variety of sensors. We will give circuits for use with some of the more obvious. Fig. 7.5 gives a circuit for a two-direction joystick. Each joystick potentiometer is supplied by the 2·55 volt reference source, and 100nF capacitors are again used to keep the input impedance low. As the circuit stands the two joysticks are connected to channels 0 and 1, and very straightforward software could be used to move a cursor or other character to any point of the screen in response to the position of the joystick. With the analogue use of the joystick, as opposed to the digital applications discussed in parts 3 and 5 of the series, the cursor could immediately move to the selected spot without having to traverse all intermediate screen positions first.

LIGHT SENSOR

Fig. 7.6 gives the circuit for an l.d.r. light sensor. With R1 at 1k this produces a good range of output, from very dim conditions (a v.d.u. screen at 1 metre) to brightly lit interiors. Higher precision in dark conditions may be achieved by increasing the value of R1, while improving the range in very bright conditions will be limited by the current drawn.

Table 7.4. Eight Channel A/D Converter Display

```
100 REM INTERFACING UK101 PROGRAM 21
110 REM 8 CHANNEL A/D CONVERTER DISPLAY
120 FORA=1TO8:PRINT:NEXT
130 PRINTTAB(10)"8 CHANNEL A/D CONVERTER"
140 PRINT:PRINTTAB(13)"(SPACE BAR EXITS)"
150 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
160 FORA=1TO3000:NEXT
170 FORA=1TO16:PRINT:NEXT
180 GOSUB 470
190 Z=53335
200 B=61319
210 FORA=0TO7
220 POKEB,A
230 N=PEEK(B)
240 S=Z+A*128
250 GOSUB 300
260 GOSUB 560
270 NEXT
280 GOSUB 410
290 GOTO210
300 REM NUMERICAL DISPLAY ENTRY POINT
310 REM SCREEN POKE ROUTINE
320 N$=STR$(N)
330 L=LEN(N$):REM STRING DISPLAY ENTRY POINT
340 FORM=1TOL
350 Q=ASC(MID$(N$,M,1))
360 POKES+M,Q
370 NEXT
380 IFPEEK(S+M)=32THEN 400
390 POKES+M,32:M=M+1:GOTO 380
400 RETURN
410 REM SPACE BAR MONITOR
420 POKE530,1
430 POKE57088,253
440 IFPEEK(57088)=239THENPOKE530,0:END
450 POKE530,0
460 RETURN
470 REM TEXT HANDLING
480 B$="CHANNEL"
490 Z=53323
500 FORA=0TO7
510 N$=B$+STR$(A)
520 S=Z+A*128
530 GOSUB 330
540 NEXT
550 RETURN
560 REM BAR DISPLAY CALCULATION
570 N1=INT(N/10+.5)
580 N2=N1-N(A)
590 IFN2=0THENN(A)=N1:RETURN
600 IFN2<0THEN 650
610 FORQ1=N(A)TON1-1
620 POKES+6+Q1,161
630 NEXT
640 GOTO 680
650 FORQ1=N(A)TON1STEP-1
660 POKES+6+Q1,32
670 NEXT
680 N(A)=N1
690 RETURN
OK
```

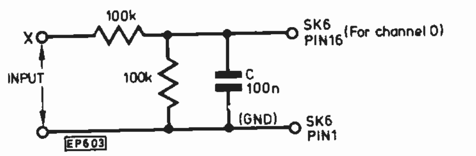


Fig. 7.4. Divide by two network

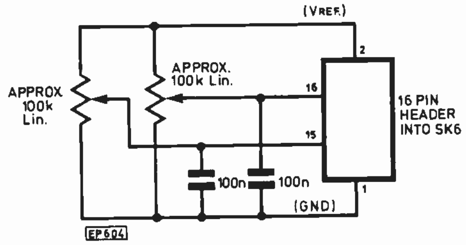


Fig. 7.5. Connection of 2 axis joystick to A/D converter

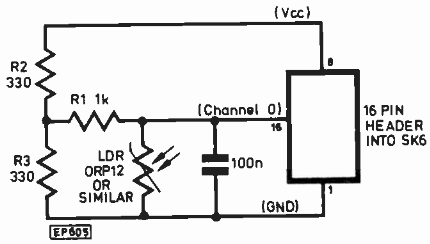


Fig. 7.6. Connection of light sensor to A/D converter

The left hand end of R1 could have been connected to the 2·55 volt reference source at pin 2 of SK6, but this is easily overloaded (maximum loading about 1k), and it is more prudent to use the pair of dropper resistors shown; or alternatively a 2·5 volt zener could be used. With the circuit of Fig. 7.6, quite small changes in light level may be discerned; and by using an l.d.r. on each channel, pattern recognition experiments may be undertaken. For such an application nine (or better still, sixteen) would be a more appropriate number of light sensors to use, in which case a second multiplexer could be added, either driven by one port of the PIA or VIA, or using a second 74LS75 latch, for which purpose the decoded line W7 has been taken out to pin 4 of SK6 on the Analogue Board. In such an application it should be noted that POKEing a one to bit 3 at 61319 renders the analogue switch IC8 open circuit.

TEMPERATURE SENSOR

Thermistors may be used for temperature measurement using a simple dropper resistor in the same manner as described for the l.d.r. application, although only fairly high resistance types are suitable, in order to avoid self-heating effects.

Far more precise measurement may be achieved for little extra outlay by using a temperature sensing diode such as the LM335Z. This is essentially a diode whose forward voltage is dependent on its temperature in a very linear manner, at the rate of 10mV per degree Kelvin. This means that its voltage increases by 10mV for every degree Centigrade above absolute zero (−273°C). Thus at 20°C its forward voltage will be 2·93. This voltage is unfortunately beyond the direct range of the A/D converter. But it is easily reduced with a resistor network such as that shown in Fig. 7.7. This will produce a reading of about 146 at 20°C.

To improve the reading precision, a d.c. amplifier with offset facility can be used between the sensor and the converter. Fig. 7.8 gives a circuit for such an arrangement. With this the voltage gain of the amplifier can be altered from unity to about 50 by adjusting VR1, and an offset of ±3 volts at maximum gain can be achieved by altering VR2. It should be noted however, that even at quite modest gain settings, the earth loop caused by using the UK101's mains transformer to drive the Decoding Module produces hum problems, and a small fluctuation appears on the reading. To avoid this, a separate 9-0-9 volt transformer should be used to power the Decoding Module.

To obtain the highest precision with the LM335Z (1°C error at room temperature) it should be used in conjunction with a 10k potentiometer as in Fig. 7.9, and the potentiometer adjusted to give an output as close to 2·982 volts as possible at 25°C.

The d.c. amplifier of Fig. 7.8 may also be used for increasing the sensitivity of the converter for use in other applications, such as d.c. voltage measurement etc.

AUDIO DETECTION

The circuit of Fig. 7.10 allows sound levels to be measured with the A/D converter. Like the temperature sensor amplifier of Fig. 7.8, it uses a 741 op. amp., but no earth loop hum problems arise in this case because no offset is required, and pin 2 can be taken down to earth. The values of R1 and C1 in the integrator following the diode detector circuit should be selected to give a time constant appropriate to the use to which the unit is to be put. Generally speaking this should be somewhat greater than the sample repetition time of the program driving the converter. In the case of the 8 channel display program of Table 7.4, a time constant of about one tenth of a second is appropriate, and may be

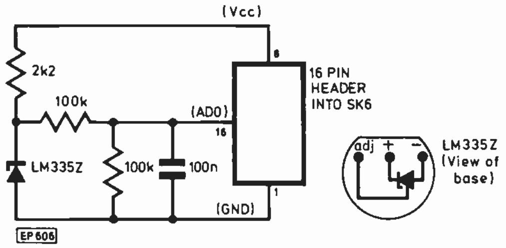


Fig. 7.7. Connection of Temperature Sensor to A/D converter

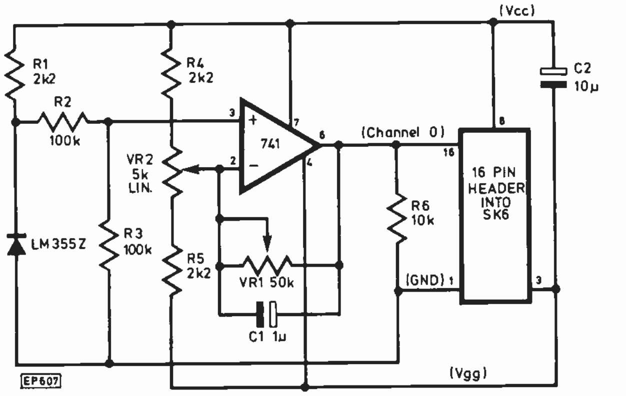


Fig. 7.8. Temperature Sensor with voltage amplifier

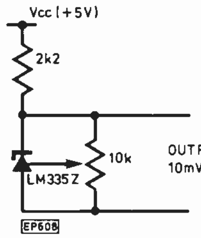


Fig. 7.9. Calibration of LM335Z temperature sensor

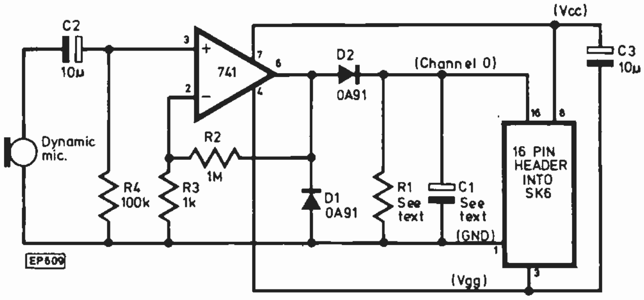


Fig. 7.10. Audio Detection using the A/D converter

achieved using 10k for R1 and 10μ for C1. For much higher sample repetition rates, such as those achievable with the sample 'scope program below, C1 may be removed completely for certain applications.

DATA LOGGER

The interrupt clock described earlier may be used in conjunction with the A/D converter to create a simple data logger. A program that accomplishes this is given in Table 7.5. To use it, load the interrupt clock program in BASIC of Table 7.2, then load the data logger supplement of Table 7.5. The latter makes use of routines in the former, including the interrupt clock itself, to implement the data logging function. When RUN is executed, the interrupt clock will operate as before, but now pressing the space bar will cause a transfer to the data logger. This requests a start time for logging in hours, minutes and seconds; then a repetition

```
4090 REM INTERFACING UK101 PROGRAM 22
4100 REM DATA LOGGER SUPPLEMENT
4110 REM TO BE LOADED ON TOP OF
4120 REM PROGRAM 19 (THE INTERRUPT
4130 REM CLOCK)
5000 REM DATA LOGGER
5020 F=2:Z=53276:NA=0
5100 FORQ2=1TO16:PRINT:NEXT
5110 PRINT,"DATA LOGGER"
5130 PRINT:PRINT:PRINT"   STAPT TIME OF RECORDING"
5140 INPUT"   HOURS";SH
5142 INPUT"   MINUTES";SM
5144 INPUT"   SECONDS";SS
5150 PRINT:PRINT"   REPETITION PERIOD OF READINGS"
5160 INPUT"   HOURS";RH
5170 INPUT"   MINUTES";RM
5180 INPUT"   SECONDS";RS
5190 PRINT:PRINT"   NUMBER OF READINGS"
5200 INPUTNR
5210 DIMA(NR,8):DIMA$(NR)
5220 FORQ4=1TO16:PRINT:NEXT
5230 PRINT"  NO";TAB(11)"TIME";TAB(33)"DATA"
5500 GOTO2200
5550 REM ENTRY POINT
5560 IFS=SSANDM=SMANDH=SHTHEN5600
5570 GOTO2200
5600 REM DATA AQUISITION
5605 PRINT" ";NA+1;"..";
5610 PRINTT$;
5620 FORQ2=0TO7
5625 IFQ2=4THENQ3=-24:PRINT
5630 POKE61319,Q2
5640 A(NA,Q2)=PEEK(61319).
5650 PRINTTAB(23+6*Q2+Q3);
5660 PRINTA(NA,Q2);
5670 NEXT
5680 Q3=0
5690 PRINT:PRINT
5695 NA=NA+1:IFNA=NRTHEN6100
5700 CS=0:CM=0
5710 SS=SS+RS
5720 IFSS>59THENSS=SS-60:CS=1
5730 SM=SM+RM+CS
5740 IFSM>59THENSM=SM-60:CM=1
5750 SH=SH+RH+CM
5760 IFSH>=24THENSH=SH-24
5800 GOTO2200
6000 PRINT,"EXIT FROM DATA LOGGER"
6010 GOTO6110
6100 PRINT,"DATA LOGGING COMPLETE"
6110 PRINT,NA;"READINGS TAKEN"
6120 PRINTTAB(15)"TIME";T$
6125 PRINT:PRINT
6130 PRINT"TO DISPLAY CLOCK, RUN 2100"
6140 PRINT"TO RESTART LOGGER, RUN 5000"
```

Table 7.5. Data Logger Supplement

```
100 0000           ;SAMPLE SCOPE
110 0000           START=$0230
120 0230           *=START
130 0230           ;INPUT ROUTINE
140 0230 AE2E02 LDX START-2
150 0233 AD2F02 BB LDA START-1
160 0236 8D87EF STA 61319
170 0239 AC2D02 LDY START-3
180 023C 88     AA DEY
190 023D EA     NOP
200 023E EA     NOP
210 023F EA     NOP
220 0240 D0FA   BNE AA
230 0242 AD87EF LDA 61319
240 0245 9D9002 STA $0290,X
250 0248 CA     DEX
260 0249 D0E8   BNE BB
270 024B 60     RTS
280 024C 00     BRK
290 024D 00     BRK
300 024E 00     BRK
310 024F 00     BRK
400 0250           ;OUTPUT ROUTINE
410 0250 AE2E02 CC LDX START-2
420 0253 BD9002 DD LDA $0290,X
430 0256 8D88EF STA 61320
440 0259 AC2C02 LDY START-4
450 025C 88     EE DEY
460 025D EA     NOP
470 025E EA     NOP
480 025F EA     NOP
490 0260 D0FA   BNE EE
500 0262 CA     DEX
510 0263 D0EE   BNE DD
520 0265 4C5002 JMP CC
```

Table 7.6. Assembler Listing of Sample 'Scope

period in hours, minutes and seconds; and lastly the number of loggings required. This latter number sets the dimension of two arrays A$(I), which records the time of each reading, and A(I,J), which contains the 8 data values recorded at each reading.

The program then initiates the continued POKEing of the time to the centre of the top line of the screen, at the same time continually checking to see whether the start time has been reached. When it has, the A/D converter sequences through its 8 channels, and the resultant data is stored in the array for later use. The number of the reading, the time and the 8 data values are also printed on to the screen. See accompanying photograph. The program then waits for the duration of the repetition period, and again stores and prints the data measured. If hard copy or cassette recording of the data is required, an appropriate routine may be added at 6200 to be executed after data logging has been completed. And as with the interrupt clock itself, the space bar may be used to exit the data logger.

The logger program is highly flexible, and can take readings at intervals as short as 1 second, or as long as 24 hours, and the number of readings allowed is limited only by the memory size of the machine. A 4k machine will allow some 15 or 16 readings, while with 8k this rises to somewhere above 110. If memory size is a problem, a considerable saving could be made by storing the measured data individually in RAM by means of POKE statements to a protected area. Alternatively the program could be modified so as to print out, but not to store, the data, in which case there is no limit to the number of readings taken.

The uses to which the data logger may be put are legion. It could for example be used to monitor the temperature, noise, light and humidity levels in a given locality; and checks could be made on the effectiveness of thermal insulation by recording inside and outside temperature over a 24 hour period. It could also be used to gather data on the temperature dependence of a resistance, or to record the voltage decay curve of a CR combination of sufficiently long time constant. Additionally, the logger could be used in conjunction with the event recorder using T2 of the VIA described last month, to log the number of events of a given kind occurring within any period. Those events could variously be counts from a Geiger-Muller tube, passages across a photocell, the occurrence of sound levels above a given threshold etc. Once the data has been collected from whatever source, the UK101 can then be used to analyse it in any appropriate manner, and to present the results graphically if so desired.

WAVEFORM SAMPLING

The very fast conversion rate attainable with the ZN427 A/D converter—around 50,000 per second—allows the sampling and digital storage of waveforms at frequencies up to a few kHz. Using the converter a series of samples may be taken in very rapid succession, and stored in RAM, from where they may be analysed at leisure. For example, Fourier analysis might be performed on the data, or the sampled waveform could be replayed continuously through the D/A converter for steady display on an oscilloscope screen. Alternatively the UK101 VDU screen could be used to display the sampled waveform.

For such applications it is obviously essential to use machine code, since using BASIC would only allow some 100 or so samples to be taken every second. Table 7.6 gives an assembler listing of a two-part program which has a sampling and replay facility. The first part, which is located at 0230 hex, causes a series of samples to be taken and stored in RAM above 0290 hex. The sampling rate, the number of samples, and the channel number from which the samples are taken are determined by the contents of locations 022D, 022E and 022F respectively, and these may be set up before the program is run. The second part of the program, which begins at 0250 hex, allows the replay of the stored data in a continuous loop to the D/A converter located at 61320 dec. The number of samples to be replayed, and the replay rate, are determined by the contents of locations 022E and 022C respectively, and again these parameters may be set up before the routine is run.

A program in BASIC is given in Table 7.7 which loads the above program, and then controls the sampling and replay parameters with a series of INPUT statements. The program sets the channel number to 0, and the number of samples to 100 in lines 280 and 290. These may be altered if required, though 100 is the maximum number of samples allowed. It then requests a sample rate from 1 (fast) to 255 (slow), and after making the sample, requests a replay rate. It then replays through the D/A converter in a continuous mode, which can only be exited through a reset and warm-start.

The accompanying photographs show a 'scope trace of a 100Hz waveform that was sampled and replayed using this program. The original waveform is also shown. As may be seen from this, fidelity of reproduction is very good, even though no sample-and-hold circuitry has been used in the A/D conversion.

Sampling with this arrangement is fast enough for the lower end of the audio spectrum, and the circuit of Fig. 7.10 may be used in conjunction with the sampler to allow sampling of parts of speech signals and other audio waveforms.

As suggested above, the 100 data samples produced by the sampler may be analysed at leisure, or modified before replaying them through the D/A converter. If it is required to work on more than one set of samples, for comparison purposes for example, the 100 bytes of data may be transferred to another location using PEEK and POKE commands. The 100 bytes from 0290 hex would then be used simply as a temporary input buffer for the incoming data.

Table 7.7. Sample Oscilloscope in BASIC

```
100 REM INTERFACING UK101 PROGRAM 23
110 REM SAMPLE SCOPE PROGRAM
120 GOSUB 360
130 REM
140 FORA=1TO16:PRINT:NEXT
150 PRINT,"SAMPLE SCOPE"
160 PRINT,"ON CHANNEL 0"
170 PRINT:PRINTQQ$
180 GOSUB270
190 POKE11,48:POKE12,2:X=USR(X)
200 PRINT:PRINT:PRINT"    SAMPLE MADE"
210 PRINT:PRINT
220 INPUT"    REPLAY RATE (1-255)";RR
230 PRINT:PRINT"    REPLAY IN PROGRESS"
240 PRINT"    USE RESET KEYS TO EXIT"
250 POKE556,RR
260 POKE11,80:POKE12,2:X=USR(X)
270 REM INITIALISATION
280 C=0:REM SET CHANNEL
290 N=100:REM SET NO OF SAMPLES (100 = MAX)
300 INPUT"    SAMPLE RATE 1 (HIGH) TO 255 (LOW)";R
310 IFR<1ORR>255THEN300
320 POKE559,C
330 POKE558,N
340 POKE557,R
350 RETURN
360 REM MACHINE CODE PROGRAM
370 REM LOCATIONS  560  TO  615
380 DATA 174 , 46 , 2 , 173 , 47 , 2 , 141 , 135 , 239 , 172
390 DATA 45 , 2 , 136 , 234 , 234 , 234 , 208 , 250 , 173 , 135
400 DATA 239 , 157 , 144 , 2 , 202 , 208 , 232 , 96 , 0 , 0
410 DATA 0 , 0 , 174 , 46 , 2 , 189 , 144 , 2 , 141 , 136
420 DATA 239 , 172 , 44 , 2 , 136 , 234 , 234 , 234 , 208 , 250
430 DATA 202 , 208 , 238 , 76 , 80 , 2
440 FORC=0 TO  55
450 READ I
460 POKE  560 +C, I
470 NEXT
480 RESTORE
490 RETURN
```

Table 7.8. Supplement to Sample Oscilloscope for Screen Display of Waveform

```
205 REM INTERFACING UK101 PROGRAM 24
206 REM GIVES SCREEN DISPLAY OF
207 REM SAMPLED WAVEFORM
208 REM LOAD ON TOP OF PROGRAM 23
210 GOTO7000
7000 REM SCREEN DISPLAY ROUTINE
7050 INPUTZZ
7060 IFZZ<0 OR ZZ>60THEN110
7070 ZZ=60-ZZ
7100 X=54222
7110 FORQ=1TO16:PRINT:NEXT
7120 S=656 +ZZ+40
7130 FORN=0TO40
7140 H=INT((PEEK(S-N))/2)
7150 H1=INT(H/8)
7160 H2=INT((H-H1*8))
7170 POKEN+X-64*H1,H2+128
7200 NEXT
7250 POKE530,1
7260 POKE57088,253
7270 IFPEEK(57088)<>239THEN7260
7280 POKE530,0
7290 GOTO7000
```

VDU SAMPLE SCOPE

If no suitable oscilloscope is available, or a larger display is required, the add-on program of Table 7.8 will allow for any 40 byte wide part of the sampled waveform to be displayed on the UK101 screen. When this program is loaded on top of the sample scope program of Table 7.7, it requests an offset factor to be entered (0-60) after the sampling routine has been executed, and POKEs up a display on the screen, using the characters 128-135 to achieve a vertical resolution of 128. The offset factor determines whereabouts along the 100-wide sample the display is taken from, and altering this moves the 40-byte wide sample window to left or right through the 100 bytes of data. If the space bar is depressed during the display, a new offset factor may be entered to change the position of the window. If a number greater than 60 is entered here, the program re-enters the sampling routine so that a new sample may be taken. The accompanying photograph shows the screen representation of the 100 Hz signal shown in the oscilloscope trace photographs referred to earlier. As may be seen, reproduction quality is quite good given the constraints imposed by the UK101's low resolution graphics.

CUSTOMISED WAVEFORM GENERATOR

The D/A section of the machine code routine referred to above may also be used on its own for the creation of customised waveforms. The 100 bytes of memory space above 0290 hex can be filled from BASIC using SIN, COS, LOG, RND, power or other functions of the user's choice. The replay routine in machine code may then be executed to generate the waveform repeatedly, and at speed, through the D/A converter at 61320.

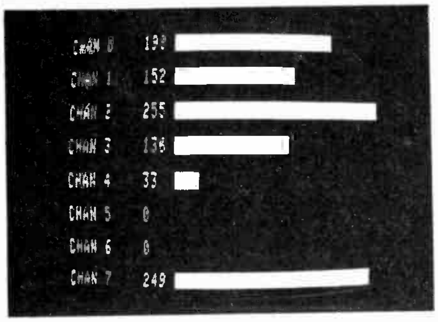
The number of bytes of digitised waveform sent to the D/A converter before the sequence is repeated is determined by the data held in location 558 dec. This may be POKEd with any value from 1 to 100 so as to achieve a smooth follow on from the end of one displayed cycle of the waveform to the next.

A NOTE ON THE USE OF NEW MONITORS

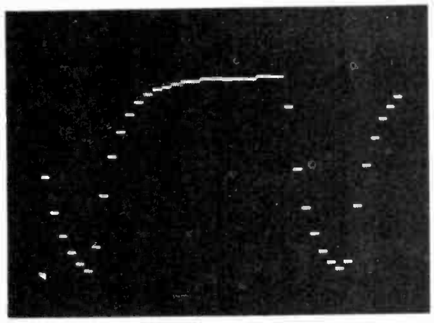
All programs in this series are fully compatible with the UK101's original monitor, and with Technomatic's CE1 monitor. But difficulties may arise with other new monitors when using the 3 or 4 programs that contain machine code routines located at 0230 hex, such as the Interrupt Clock and the Sample Scope program. The reason for this is that monitors such as Cegmon, Wemon and Compshop's new monitor use some of the space above 022A hex for scratchpad purposes. With Cegmon this space can be kept free by disabling the screen editor, and using the original screen handling routines. But to get around the problem more generally, an alternative set of programs have been prepared for the Interrupt Clock and Data Logger, and the Sample Scope, which relocate the machine code routines at the top of memory. There is no space to list these programs here, but they are included in the cassette containing the 24 numbered programs from this series, available from *Technomatic Ltd.*

On Wemon and Compshop's new monitor, but not on the CE1 or Cegmon, the IRQ vector has also been relocated, and this must be accounted for in programs such as the Interrupt Clock and Data Logger, which make use of IRQ, by modifying lines 720, 740 and 760 of the assembler listing in Table 7.1. Further details on this modification are given in the data supplied with the cassette, since the shifted version of these programs must in any case be used with these two monitors.

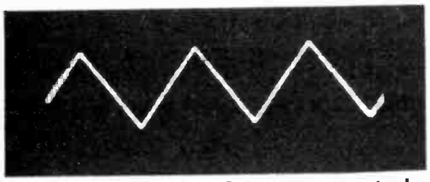
INTERFACING COMPUKIT



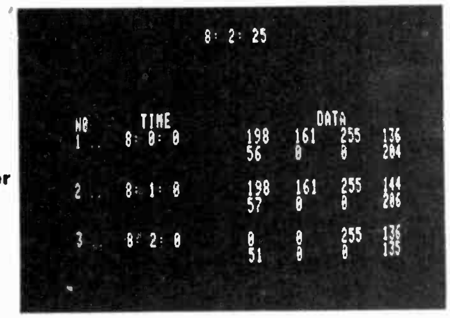
Screen Photograph of Eight Channel Display Program



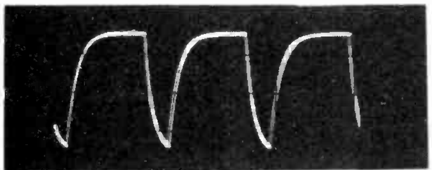
Screen display of sampled 100Hz waveform



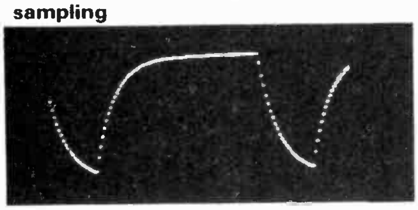
Triangular Waveform generated by the Customised Waveform Generator, and output through the D/A Converter

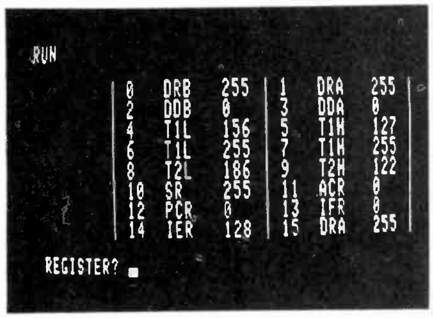


Screen Photograph of Data Logger



100Hz waveform before and after sampling





Screen photograph taken during the running of the 6522 Handling Program (Program 12) described last month

NEXT MONTH . . . we shall be publishing an **EPROM PROGRAMMER** which may be driven from this interface system.

Additionally, we will be taking a look at **Chromosonic's Colour Board** in use with the UK101

Constructor's Note

In order to improve stability in the offset adjustment on the D/A converter op amp IC11, R10 on the Analogue Board should be increased to 47k.

Filling the data space using the program below will produce an even triangular wave made up of exactly 100 samples:

```
2000 FORA=0TO99
2010 B=4×A
2020 IFA>49THENB=4×(99−A)
2030 POKE656+A,B
2040 NEXT
2050 GOTO300
```

The accompanying photograph shows the waveform produced using this program. As may be seen, its shape is good, and since it is constructed of a relatively large number of samples, its true step nature is not apparent in the photograph. It should be noted when creating other waveforms using the machine code replay sequence, that although the storage space for the waveform begins at 0290 hex, this location is the *last* rather than the *first* to be accessed, so that the *last* byte of waveforms placed into these locations for subsequent replay should be at 0290 hex, the first being at 0290+N-1, where N is the number of samples to be replayed.

CONCLUSION

Although this is the final article of the present series, it by no means exhausts the possible applications of the UK101 Decoding Module and Analogue Board. Further applications are planned for future issues of P.E., and it is hoped that ideas will also be contributed by UK101 and Superboard users through the columns of P.E.'s MicroPrompt. ★

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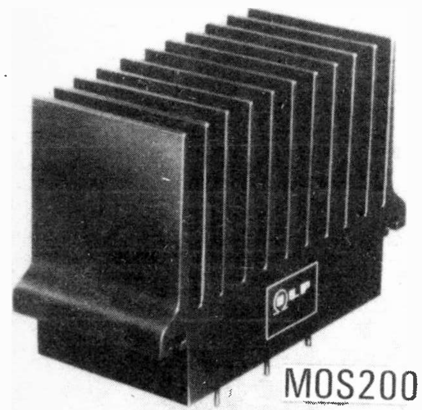
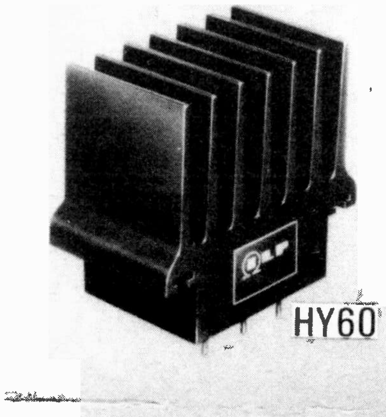


MOS200



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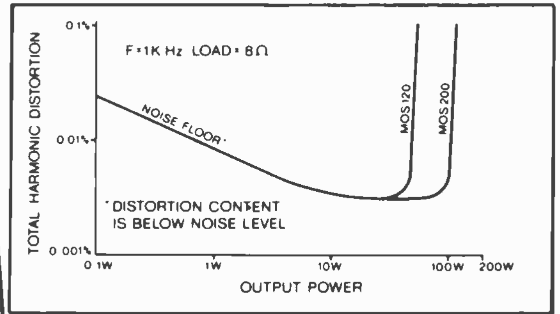
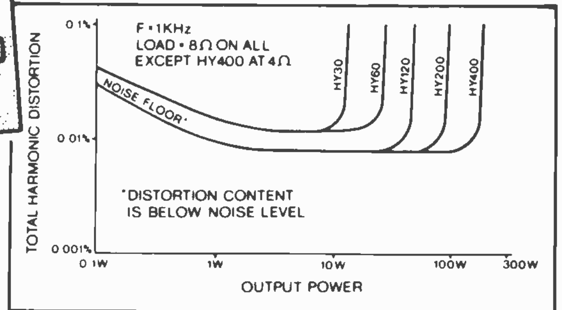


Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



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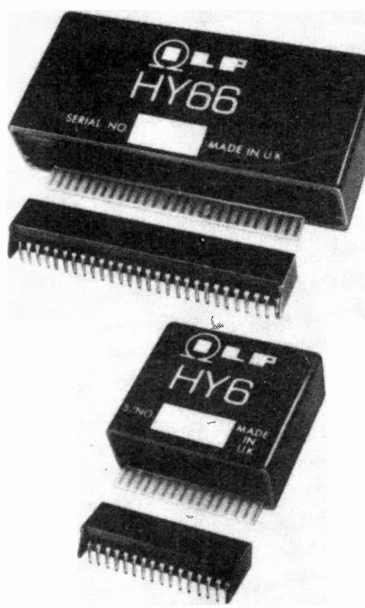

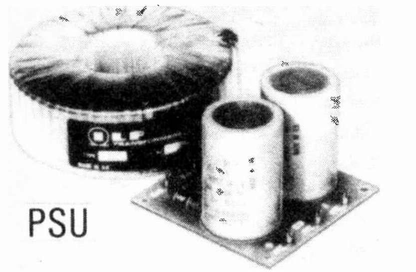

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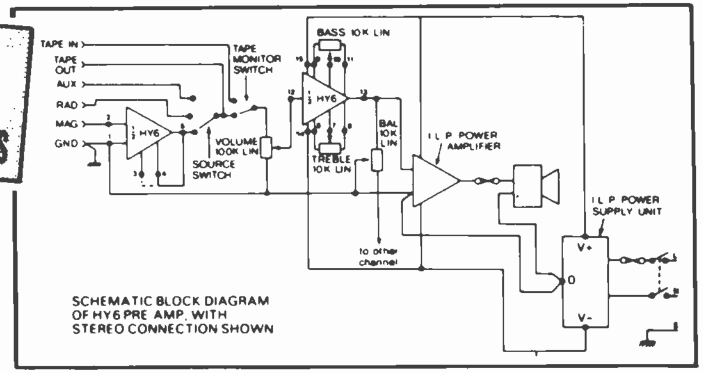

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BC108 11p
BC109 11p
BC113 8p
BC117 23p
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BC147 10p
BC148 10p
BC149 10p
BC157 12p
BC158 12p
BC170 6p
BC171 10p
BC172 6p
BC173 8p
BC177 16p
BC178 16p
BC179 16p
BC182 10p
BC182L* 10p
BC183 10p
BC184 10p
BC186 25p
BC207 13p
BC209 13p
BC212 10p
BC212L* 10p
BC213L 10p
BC214 10p
BC214L* 10p
BC261B 23p
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BC303 32p
BC328 17p
BC477 35p
BC478 20p
BC547 12p
BC548 12p
BC549 12p
BC557 14p
BC558 14p
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BCY71 18p
BD115 35p
BD131 40p
BD132 40p
BD135 25p
BD136 25p
BD137 25p
BD138 25p
BD139 40p
BD140 40p
BF181 8p
BF184 25p
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BF196 12p
BF197 12p
BF224B 14p
BF244C* 30p
BF258 28p
BF259 40p
BFR39 30p
BFR40 20p
BFR79 32p
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2N4060 10p
2N4061 10p
2N5458 40p
2N5459 40p
2N6027 30p
3N128 100p

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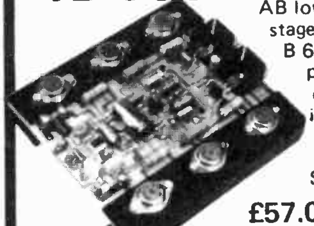
00 16p
01B* 17p
02 16p
06B 90p
07* 16p
08 85p
09 42p
10 50p
11B* 20p
12 25p
13B 45p
14 80p
15B 80p
16 44p
17 75p
18 85p
19 50p
20B 100p
21 95p
22* 95p
23 25p
24B 55p
25 20p
27 50p
28 85p
29 100p
30 55p
35 110p
41 85p
42 80p
43 95p
44 95p
47 105p
48 60p
49 40p
50B 50p
66 55p
68 25p
69* 22p
70B 30p
71 25p
72 25p
73 25p
81 28p
82 28p
86 80p

45XX
10 99p
11B 99p
16 105p
18 105p
20 105p
28 105p

TTL 74XX
00 16p
01 16p
02 16p
03 16p
04 16p
05 18p
06 35p
07 35p
08 20p
09 20p
10 16p
11 25p
12 20p
13 30p
14 44p
16 30p
17 28p
20* 15p
21 40p
22 26p
23 33p
25 33p
26 45p
27 33p
28 40p
30 18p
32 30p
33 38p
37 35p
38 32p
40 18p
41 70p
42 60p
43 115p
44 110p
45 105p
46 100p
47A 75p
48 75p
50 16p
51 16p
53 16p
54 16p
60 16p
70 35p
72 30p
73* 33p
74 33p
75 40p
76 33p
80 50p
82 88p
83 103p
85 140p
86 35p
89 240p
90* 33p
91 85p
92 50p
93 36p
94 85p
95 75p
96 66p
97 200p
100 130p
105 60p
107 35p
109 60p
110 55p
118 90p
121 35p
122 50p
123 65p
125 50p
126 48p
132 65p
141 52p
145 90p
147 170p
150 130p
151 70p
153 70p
154 120p
155 80p
156 80p
157 75p
160 100p
161 99p
162 99p
163 99p
164 120p
165 120p
166 120p
167 225p
173 110p
174 99p
175 90p
177 90p
178 150p
179 177p
180 90p
181 170p
182 90p
184 150p
185 150p
190 120p
191 120p
192 110p
193 110p
194 100p
195 80p
196 99p
197 80p
198 150p
199 160p

TTL 74LSxx
LS00 15p
LS01 15p
LS02 16p
LS03 16p
LS04 17p
LS05 26p
LS08 25p
LS10 23p
LS11 26p
LS12 28p
LS13 45p
LS14 57p
LS20 20p
LS21 26p
LS27 35p
LS30 22p
LS32 28p
LS42 75p
LS47 85p
LS48 110p
LS73 50p
LS74 30p
LS75 42p
LS76 50p
LS78 50p
LS86 40p
LS90 46p
LS92 80p
LS93 70p
LS95 130p
LS96 125p
LS109 85p
LS113 70p
LS114 46p
LS122 80p
LS123 70p
LS132 70p
LS154 194p
LS157 70p
LS163 108p
LS221 120p
LS251 150p
LS253 102p
LS279 100p

TD 500



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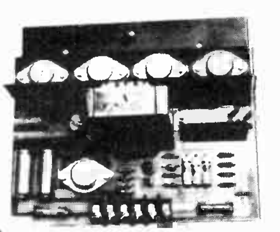

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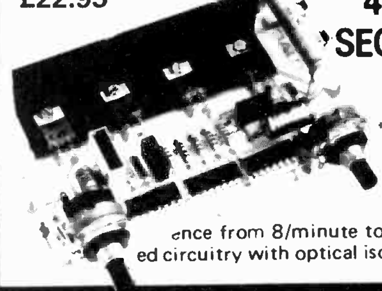

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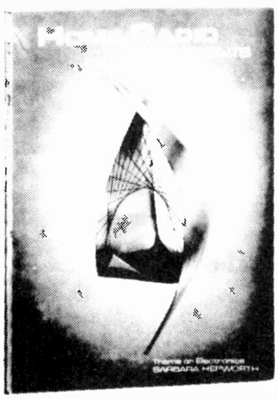

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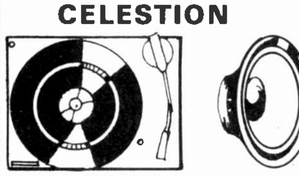

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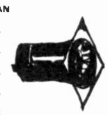

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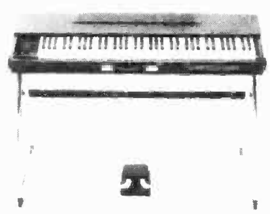

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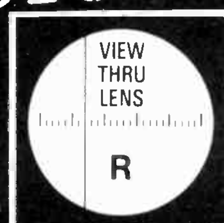

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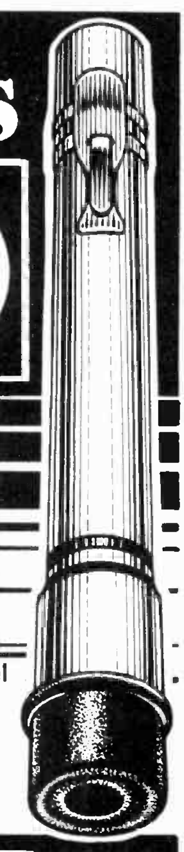

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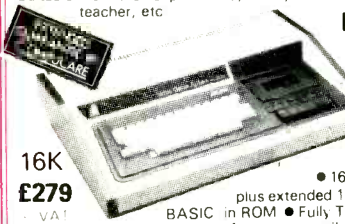

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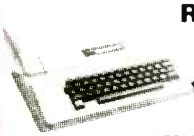

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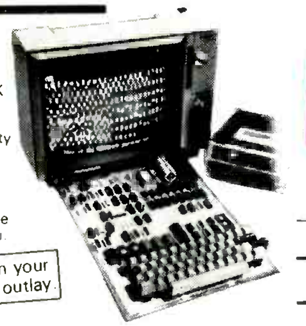

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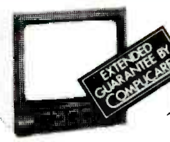

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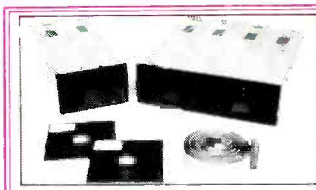

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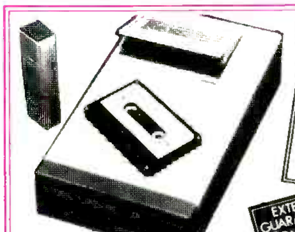

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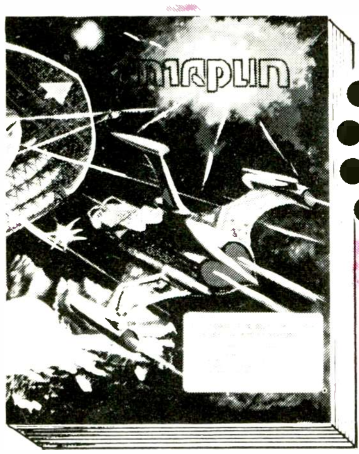

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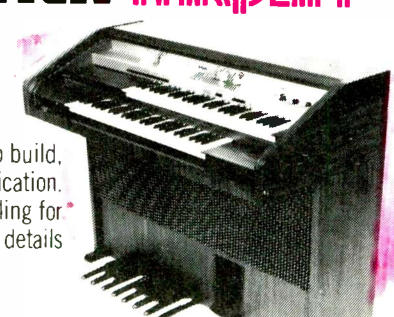

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