PRACTICAL

ELECTRONICS

JANUARY 1978

45p

Rhythm GENERATOR

...for the Musician

12 Switch Selected Rhythms

8 Percussion Voices

Also inside...

- Battery Condition Indicator
- 9v Stabilised P.S.U.

Plus... NEW SERIES ELECECTRONIC FAULT DIAGNOSIS

WATFORD ELECTRONICS

33 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 37774

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 25p* TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. SEND LARGE S.A.E. FOR OUR FREE LIST.

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

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

POLYESTER CAPACITORS: Axial lead type. (Values are in μF)
400V: 0.001, 0.0015, 0.0022, 0.0033 **8p**; 0.0047, 0.0068, 0.01, 0.015, 0.018 **9p**; 0.022, 0.033, **10p**; 0.047, 0.068 **14p**; 0.10 **15p**; 0.15, 0.22 **22p**; 0.33, 0.47 **39p**; 0.68 **45p**. **160V**: 0.039, 0.15, 0.22 **13p**; 0.33, 0.47 **22p**; 0.68, 1.0 **29p**; 1.5 **33p**; 2.2 **38p**; 4.7 **47p**. **DUBILIER**: **1000V**: 0.01, 0.015 **16p**; 0.022 **18p**; 0.047 **16p**; 0.1 **34p**; 0.47 **43p**.

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

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF)
63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22 **9p**; 47, 32, 50 **12p**; 63, 100 **27p**; **50V**: 100 **7p**; 50, 100, 220 **25p**; 470 **50p**; 1000, 2200 **68p**; **40V**: 22, 33 **9p**; 100 **12p**; 3300 **62p**; 4700 **64p**; **35V**: 10, 33 **7p**; 330, 470 **32p**; 1000 **49p**; **25V**: 10, 22, 47 **6p**; 80, 100, 160 **8p**; 220, 250 **13p**; 470, 640 **25p**; 1000 **27p**; 1500 **30p**; 2000 **34p**; 3300 **52p**; 4700 **54p**; **16V**: 10, 40, 47, 68 **7p**; 100, 125, **8p**; 470 **16p**; 1000, 1500 **20p**; 2200 **34p**; **10V**: 4, 100 **6p**; 640 **10p**; 1000 **14p**.
TAG-END TYPE: **70V**: 2000 **98p**; 4700 **121p**; **50V**: 3000 **75p**; **40V**: 4000 **70p**; 2500 **65p**; **25V**: 4700 **48p**; 2000 **37p**; **40V**: 2000 + 2000 **95p**; **325V**: 200 + 100 + 50 + 100 **190p**.

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

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

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

POLYSTYRENE CAPACITORS
10pF to 1nF **6p**; 1.5nF to 10nF **10p**.

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

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

MINIATURE TYPE TRIMMERS
2.5-6pF, 3-10pF, 10-40pF **22p**
5.25pF, 5-45pF, 60pF, 88pF **30p**

COMPRESSION TRIMMERS
3-40pF, 10-80pF, 25-190pF **25p**
100-500pF, 1250pF **38p**

POTENTIOMETERS (AB or EGEN)
Carbon Track, ¼W Log & ½W Linear values
1KΩ & 2KΩ (lin only) Single gang **26p**
5KΩ-2MΩ single gang **26p**
5KΩ-2MΩ single gang D/P switch **55p**
5KΩ-2MΩ dual gang stereo **70p**

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **20p**

PRESET POTENTIOMETERS
0-1W 50Ω—5MΩ Miniature
Vertical & Horizontal **8p**
0-25W 100Ω—3-3MΩ Horiz larger **10p**
0-25W 200Ω—4-7MΩ Vert **10p**

RESISTORS – Erie make 5% Carbon Miniature High Stability, Low noise

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

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

FREE STOCK-LIST
We stock thousands more items. Please send a large SAE for our free list.

OPTO ELECTRONICS★

LEDs + clip	
TIL209 Red	13
TIL211 Grn	24
TIL212 Yellow	27
T110	20
2" Red	17
2" Yellow Green	21
OCP70	40
ORP12	68
2N5777	54
7 Seg Displays	
TIL312 C An 3"	125
TIL313 C Cth 3"	125
TIL321 C An 5"	130
TIL322 C Cth 5"	130
DL704 C Cth	99
DL707 C A	99
DL747 C A	180
FND 357	140
DRIVERS	
75491: 75492	85

SWITCHES★

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

	JACK PLUGS Screened chrome	JACK PLUGS Plastic body	SOCKETS open metal	SOCKETS moulded with break contacts	SOCKETS in line couplers
2-5mm	12p	8p	8p		11p
3-5mm	15p	10p	8p		12p
MONO	23p	15p	13p	20p	18p
STEREO	31p	18p	15p	24p	22p

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

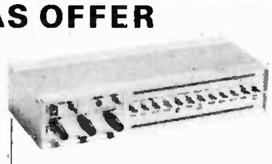
SWITCHES ★ Miniature Non-Locking
Push to Make **15p** Push to Break **25p**
ROCKER (white) 10A 250V
SP changeover centre off **28p**
ROCKER: (black) on/off 10A 250V **23p**
ROCKER: illuminated (white)
Lights when on: 3A 240V **52p**
ROTARY: (ADJUSTABLE STOP) 1 pole / 2-12 way 2p/2-6W, 3p/2 4W, 4p/2-3W **41p**
ROTARY: Mains 250V AC, 4 Amp **42p**

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

SPECIAL XMAS OFFER

TV GAMES

"Olympic Kit" **£20.80★**
"Olympic" Colour Kit **£28.50★**
(p&p insured add 95p)
EconoGame Kit **£8.99★**
COLOUR ADAPTOR for existing Black & White Games **£8.85★**
"Sure Fire Rifle" Kit for "Olympic" Game **£8.50★**
"Sure Fire Rifle" Kit for other makes **£9.25★**
(p&p insured add 48p)
"Joy Stick" **£1.95★**
IC AY-3-8500 **£4.50★**
IC AY-3-8550 **£7.50★**
IC AY-3-8600 **£9.00★**



RHYTHM GENERATOR

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

Complete Kit price incl. VAT **£49.95** only.

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

FERRIC CHLORIDE★
Anhydrous
1lb bag
65p + 30p p&p

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

COPPER BOARDS★
Fibre Glass
Single Sided
6 x 6" **75p**
6 x 12" **130p**
SRBP
8 x 10" **65p**

VOLTAGE★ REGULATORS

723C	45p
TBA625B	95p
TO3 Can	
1A 5V	170p
1A 12V	180p
1A 15V	190p
1A 18V	210p
LM323K	625p
1A—5V	220p
1A—12V	220p
Plastic	
1A 5V	115p
1A 12V	115p
1A 15V	120p
1A 18V	125p
1A 24V	130p
0.1A 5V	51p
0-1A 8V	61p

TTL 74★

7400	14	7480	50	74162	116	4021	99
7401	14	7481	97	74163	116	4022	90
7402	16	7482	82	74164	121	4023	20
7403	16	7483	95	74165	130	4024	76
7404	20	7484	95	74166	141	4025	19
7405	22	7485	110	74167	198	4026	180
7406	38	7486	36	74170	240	4027	55
7407	38	7489	320	74172	625	4028	90
7408	20	7490	36	74173	175	4029	108
7409	20	7491	80	74174	113	4030	58
7410	15	7492	53	74175	90	4033	145
7411	24	7493	35	74176	120	4034	196
7412	23	7494	85	74177	116	4040	105
7413	37	7495	70	74180	142	4042	81
7414	74	7496	82	74181	299	4043	96
7416	35	7497	262	74182	127	4044	95
7417	39	74100	125	74184	225	4045	145
7420	16	74104	62	74185	146	4046	130
7421	33	74105	62	74188	650	4047	99
7422	24	74107	33	74190	140	4048	58
7423	32	74109	54	74191	140	4049	52
7425	30	74110	54	74192	140	4050	52
7426	36	74111	70	74193	140	4054	120
7427	36	74116	198	74194	140	4055	134
7428	38	74118	90	74195	95	4056	134
7430	18	74120	115	74196	118	4060	115
7432	32	74121	28	74197	118	4067	380
7433	40	74122	48	74198	248	4068	22
7437	30	74123	70	75150	110	4069BE	22
7438	33	74125	65	75491	75	4070	32
7440	17	74126	60	75492	80	4072	21
7441	74	74128	77			4075	23
7442	68	74132	73	**CMOS★**		4076	129
7443	115	74136	73			4077	40
7444	112	74141	72	4000	15	4078	21
7445	94	74142	280	4001	17	4081	22
7446	94	74143	314	4002	17	4082	21
7447	82	74144	314	4006	105	4502	120
7448	78	74145	85	4007	18	4507	55
7450	17	74147	175	4009	58	4510	135
7451	17	74148	143	4010	58	4511	168
7453	17	74150	118	4011	19	4512	98
7454	17	74151	75	4012	18	4516	125
7460	17	74153	75	4013	55	4518	102
7470	30	74154	140	4015	93	4519	59
7472	28	74155	82	4016	52	4520	108
7473	32	74157	80	4017	99	4528	99
7474	32	74159	225	4018	99	4532	127
7475	42	74160	116	4019	60	4539	110
7476	30	74161	116	4020	102	4585	101

LINEAR IC'S

702	75	MC1303L	148
709C 14 pin	35	MC1304P	260
710★	48	MC1310P	185
741C★ 8 pin	22	MC1312PQ	195
74112	90	MC1458P★	90
74119	175	MC1496	101
747C	70	MC14433L	1250
748C	36	MC1710CG	79
753	150	MFC6040★	97
8038CC★	355	MK50253★	550
AY-1-0212	580	MK50362★	550
AY-1-1313	660	MM2101-2	210
AY-1-5051	125	MM2112-2N★	310
AY-1-6721/6	195	NE518A	210
AY-3-8500★	510	NE555★	36
AY-3-8550★	850	NE556DB★	90
AY-5-1224★	349	NE560★	325
AY-5-1230★	490	NE561★	410
CA3011★	82	NE562★	410
CA3018★	82	NE565A★	185
CA3020	170	NE566★	180
CA3023	170	NE567★	187
CA3028A★	95	NE571	450
CA3035	140	RAM2102-2★	210
CA3036	180	ROM2513★	700
CA3043	190	SG3402★	255
CA3046	80	SN72733N	125
CA3048	200	SN76003N	240
CA3075	175	SN76013N	240
CA3080E	80	SN76023N	140
CA3081	190	SN76033N	230
CA3089E	210	SN76115N	215
CA3090AQ	390	SN76227N	175
CA3123E	200	TAA621AX1	228
CA3130★	94	TAA661A	155
CA3140	95	TAA700	353
ICM7205★	1150	TAY-1-1313	660
LM300H	170	TAY-3-8550★	750
LM301A	39	TBA120S	90
LM308	140	TBA540Q	220
LM318	195	TBA550Q	355
LM324	350	TBA641BX11	250
LM339	55	TBA651	180
LM349N	120	TBA800	90
LM379	395	TBA810S	105
LM380	98	TBA820	80
LM381	170	TBA920Q	350
LM382	125	TDA2020	320
LM3909N	70	ZN414	110
LM3911	125	ZN424	130
M252AA★	195		
M253AA★	950		

TRANSISTORS p

AC117	35	BC168C	12	BF198	18	OC46★	35	ZTX504	25	2N3702	10
AC125★	19	BC169C	14	BF200	30	OC70★	30	ZTX531	28	2N3703	11
AC126★	15	BC170	14	BF224A	18	OC71★	30	ZTX550	25	2N3704	10
AC127★	18	BC171	11	BF256★	50	OC72★	30	2N526★	58	2N3705	11
AC128★	18	BC172	10	BF257★	29	OC77★	76	2N696★	35	2N3706	10
AC141★	24	BC177★	18	BF258★	29	OC79★	76	2N697★	21	2N3707	10
AC141K★	38	BC178★	16	BF259★	30	OC81★	28	2N698★	39	2N3708	11
AC142★	24	BC179★	18	BF394	22	OC82★	45	2N699★	50	2N3709	11
AC142K★	38	BC182	10	BF594	40	OC82D★	35	2N706A★	19	2N3710	16
AC176★	18	BC182L	13	BF595	38	OC83★	48	2N707★	50	2N3711	12
AC187★	20	BC183	10	BFR39	25	OC84★	44	2N708★	19	2N3715★	250
AC188★	20	BC183L	12	BFR40	28	OC123★	115	2N914★	32	2N3772★	170
ACY17	35	BC184	11	BFR79	28	OC139★	140	2N916★	27	2N3773★	288
ACY18★	40	BC184L	14	BFR80	28	OC140★	125	2N918★	30	2N3819	22
ACY19★	40	BC186	24	BFX29★	28	OC141★	157	2N920★	51	2N3820	38
ACY20★	40	BC187★	28	BFX81★	130	OC170★	40	2N930★	18	2N3823★	65
ACY21	35	BC212	11	BFX84★	24	OC171★	40	2N961★	61	2N3824★	70
ACY22★	40	BC212L	13	BFX85★	28	OC201★	125	2N1131★	22	2N3866★	90
ACY28★	40	BC213	11	BFX86★	28	OC202★	140	2N1132★	22	2N3903	20
ACY39	78	BC213L	14	BFX87★	23	OC203★	150	2N1302★	35	2N3904	18
ACY40★	48	BC214	14	BFX88★	26	OC204★	150	2N1303★	50	2N3905	18
ACY44	39	BC214L	15	BFY18	50	TIP29	43	2N1304★	50	2N3906	17
AD140	69	BC307B	20	BFY50★	17	TIP29A	44	2N1305★	28	2N4037★	52
AD149★	70	BC328	15	BFY51★	17	TIP29C	60	2N1306★	35	2N4058	17
AD161★	42	BC338★	15	BFY52★	17	TIP30	52	2N1307★	50	2N4061	17
AD162★	42	BC441★	45	BFY71	47	TIP30A	52	2N1308★	46	2N4064★	120
AF114★	20	BC461★	38	BSX20	18	TIP30B	64	2N1613★	20	2N4236★	145
AF115★	20	BC462★	45	BSX20★	18	TIP30C	70	2N1671★	190	2N4289	20
AF116★	20	BC547	12	BSY65★	30	TIP31★	50	2N1671B★	195	2N4859	65
AF117★	22	BC548	12	BSY95A★	18	TIP31A★	50	2N1893★	28	2N5135	42
AF118★	55	BC549C	13	BU105★	140	TIP31B★	58	2N1986	60	2N5136	42
AF121★	48	BC558	30	BU205★	190	TIP31C★	66	2N2160★	105	2N5138	20
AF124★	55	BCY30★	57	BU208★	225	TIP32★	55	2N2217★	48	2N5179★	60
AF125★	35	BCY34★	75	E5567	65	TIP32A★	60	2N2218A★	35	2N5180★	60
AF127★	35	BCY39★	78	MD8001★	158	TIP32B★	75	2N2219A★	22	2N5191★	65
AF139★	35	BCY40★	90	MJ400★	90	TIP32C★	77	2N2220A★	26	2N5305★	40
AF178★	70	BCY59★	90	MJ491★	160	TIP33★	85	2N2221A★	25	2N5457	35
AF180★	70	BCY70★	15	MJ2955★	120	TIP33B★	100	2N2222★	20	2N5458	36
AF186★	50	BCY71★	20	MJE340★	45	TIP33C★	110	2N2297	45	2N5459	38
AF239★	42	BCY72★	15	MJE370★	80	TIP34★	95	2N2303★	50	2N5485	38
ASY26★	45	BD115★	62	MJE371★	80	TIP34A★	95	2N2368	25	2N5777	56
ASY27★	45	BD121★	78	MJE520★	65	TIP34B★	120	2N2369★	15	2N6027	40
BC107★	9	BD123	98	MJE521★	74	TIP35★	219	2N2476	125	40311★	56
BC107B★	10	BD124★	115	MJE2955★	115	TIP35A	225	2N2483★	28	40313★	125
BC108★	9	BD131★	38	MJE3055★	80	TIP35C★	270	2N2484★	30	40316★	95
BC108B★	12	BD132★	38	MPF102	36	TIP36A★	280	2N2646★	48	40317	52
BC108C★	12	BD133★	43	MPF103	36	TIP36C★	325	2N2784	55	40326★	52
BC109★	9	BD135	38	MPF104	36	TIP41A★	66	2N2846	140	40327★	62
BC109B★	12	BD136	36	MPF105	36	TIP41B★	73	2N2894	30	40347★	99
BC109C★	12	BD137	36	MPF106	50	TIP42A★	72	2N2904A★	22	40348★	116
BC113	17	BD138	50	MPF107	50	TIP42B★	82	2N2905A★	20	40360★	43
BC114	20	BD139	36	MPSA05	32	TIP2955★	65	2N2906★	18	40361★	45
BC115	20	BD140	36	MPSA06	32	TIP3055★	52	2N2907★	20	40362★	48
BC116	20	BD142	59	MPSA55	30	TIS43	36	2N2907A★	22	40411★	289
BC117	20	BD145★	198	MPSA56	30	TIS44	45	2N2926G	10	40412★	65
BC118	20	BDY17★	195	MPSA70	34	TIS46	45	2N29260	8	40576★	190
BC119	28	BDY60★	110	MPSU02★	58	TIS50	47	2N2926R	8	40594★	98
BC134	20	BDY61★	165	MPSU05★	50	TIS74	47	2N2926Y	8	40603★	113
BC135	20	BF115★	22	MPSU06★	56	TIS91	24	2N3011★	30	40636★	165
BC136	18	BF154★	25	MPSU52★	65	ZTX107	22	2N3053★	17	40673★	87
BC137	20	BF156★	29	MPSU55★	55	ZTX108	20	2N3054★	49		
BC140★	35	BF173★	25	MPSU56★	60	ZTX109	25	2N3055★	60	**Matched Pair**	**10p extra**
BC142★	28	BF177★	24	MPU131★	39	ZTX300	16	2N3108	60		
BC143★	28	BF178★	25	OC25★	120	ZTX301	16	2N3121	40		
BC147	7	BF179★	30	OC26★	170	ZTX302	25	2N3133	43		
BC148	7	BF180★	30	OC28★	105	ZTX303	25	2N3135	33		
BC149	8	BF181★	30	OC29★	160	ZTX304	24	2N3250	30		
BC153	27	BF182★	30	OC35★	100	ZTX311	17	2N3252	36		
BC154	27	BF183★	30	OC36★	170	ZTX314	24	2N3302	35		
BC157	10	BF184★	20	OC41★	48	ZTX341	20	2N3442★	142		
BC158	11	BF194	10	OC42★	40	ZTX500	17	2N3563	32		
BC159	11	BF195	10	OC43★	65	ZTX501	15	2N3614★	169		
BC160★	42	BF196	12	OC44★	35	ZTX502	19	2N3615★	135		
BC167A	11	BF197	15	OC45★	35	ZTX503	19	2N3663	26		

CHOKES
SC60 100mH **90**

DIAC*
ST2 **25**

DIODES

AAZ15	15	OA90	6
AEY11	60	OA91	6
BA100	10	OA95	8
BY100	24	OA200	9
BY126	14	OA202	8
BY127	14	IN914	4
OA9	60	IN916	5
OA10	20	IN4001/2★	5
OA47	12	IN4003★	6
OA70	12	IN4004/5★	6
OA79	12	IN4006/7★	7
OA81	15	IN4148	4
OA85	12	3A/100V★	18
		3A/400V★	20
		3A/600V★	27
		3A/1000V★	30
		6A/600V	54

ZENERS
Range 3.3V to 33V
400mW **9**
1.3w **17**

VARICAPS

MVAM2	135
BB104	40
BB105B	40
MVAM115	95

★BRIDGE RECTIFIERS (plastic case

WO-005	20
1A100V	22
1A200V	25
1A400V	29
1A600V	34
2A50V	35
2A100V	44
2A200V	46
2A400V	53
4A100V	72
4A400V	79
4A800V	120
6A100V	73
6A400V	92
BY164	56

TRIACS★

3A 400V	113
3A 500V	140
6A 400V	140
8A 400V	100
15A 400V	200
40430	99
40528	106
40669	110

THYRISTORS* SCRs

1A50V	38
1A 100V	42
1A 200V	47
1A 400V	52
3A 100V	43
3A 400V	110
5A 400V	120
7A 200V	120
7A 400V	125
8A 400V	150
10A/700V	180
C106D	55
TIC44	25
TIC45	45
2N4444	191

PRACTICAL
ELECTRONICS

VOLUME 14 No. 5 JANUARY 1978

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our February issue will be on sale Friday, 13 January, 1978
(for details of contents see page 351)

BD 103 -The Connoisseur's Professional Choice

An exceptional transcription unit that performs to truly professional standards. Fitted with a new specially designed arm, the BD 103 will form the start, or an integral part, of a system for those who never believed they could achieve this level of quality at a reasonable price, simply compare specifications. *Low voltage DC servo controlled motor with electronic speed variation on all 3 speeds – 33⅓, 45 and 78 rpm. *Externally housed power source, thereby eliminating hum fields, convertible for 120 or 230v mains supply. *Belt drive with precision ground natural rubber moulded belt of round cross section. *Neon illuminated stroboscope underneath 12" aluminium turntable is viewed through a mirror in the platform; available with either 50 or 60Hz stroboscope. *Pick-up arm automatically raises at the end of the playing section of the record. Automatic lift-off can be overridden for non-standard records. *Low friction pick-up bearings – unipivot for horizontal motion, knife edges for vertical motion – with a unique system of magnetic stabilization on the unipivot bearings. *Playing weight adjusted by sliding weight on arm tube, which is calibrated. Additional counter weights provided for accommodation of a full range of cartridges. Adjustable magnetic bias, calibrated for varying playing weights. *Inter-changeable lightweight plug in head shell accepts cartridges with ½" mounting centres. The turntable unit is solidly mounted on to a walnut plinth, which stands on a sprung and damped anti-vibration suspension system, thereby using maximum mass to improve performance, and fitted with a hinged acrylic dust cover with lid stay. Dimensions: 15" x 18" x 5¼".

An alternative version is available without the pick-up arm and lifting device, incorporating a larger walnut/plastic cover, enabling most high quality pick-up arms to be used. Dimensions: 15" x 18" x 7".

BD 103 Alternative unit without arm and lifting device.

The BD 103 Transcription turntable and External Power unit

Connoisseur

Write for further details to:
A. R. Sugden & Co. (Engineers) Ltd.
Manufacturers of Connoisseur Sound Equipment, Connoisseur Works, Atlas Mill Road, Brighouse, West Yorkshire HD6 1ES
Telephone: Brighouse (0484) 712 142, Telex: 517144 Sugden G,
Telegrams & Cables: Connoiseur Brighouse.

TRANSFORMERS

ALL EX-STOCK—SAME DAY DESPATCH. VAT 8%

12 AND 24 VOLT OR 12-0-12V
PRIMARY 220-240 VOLTS

Ref	Amps 12V	Amps 24V	£	P & P
111	0·5	0·25	2·20	0·45
213	1·0	0·5	2·64	0·78
71	2	1	3·41	0·78
18	4	2	4·03	0·96
70	6	3	5·35	0·96
108	8	4	6·98	1·14
72	10	5	7·67	1·14
116	12	6	8·99	1·32
17	16	8	10·39	1·32
115	20	10	13·18	2·08
187	30	15	17·05	2·08
226	60	30	26·62	OA

50 VOLT RANGE
Prim 220/240V Sec 0-20-25-33-40-50V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40, 25-0-25 or 20-0-20V.

Ref	Amps	£	P & P
102	0·5	3·41	0·78
103	1·0	4·57	0·96
104	2·0	6·98	1·14
105	3·0	8·45	1·32
106	4·0	10·70	1·50
107	6·0	14·62	1·64
118	8·0	17·05	2·08
119	10·0	21·70	OA

MAINS ISOLATING (SCREENED)
PRIM 120/240 SEC 120/240 CT

Ref	VA (Watts)	£	P & P
07*	20	4·40	0·79
149	60	6·20	0·96
150	100	7·13	1·14
151	200	11·16	1·50
152	250	12·79	1·84
153	350	16·28	1·84
154	500	19·15	2·15
155	750	29·06	OA
156	1000	37·20	OA
157	1500	45·60	OA
158	2000	54·80	OA
159	3000	79·05	OA

* 115 or 240 sec

HIGH VOLTAGE MAINS ISOLATING
Prim 200/220V or 400/440V
Sec 100/120V or 200/240V

Va	Ref	£	P & P
60	243	5·89	1·32
350	247	14·11	1·84
1000	250	35·65	OA
2000	252	54·25	OA

30 VOLT RANGE
Prim 220/240V Sec 0-12-15-20-24-30V Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V 15-0-15V, 12-0-12

Ref	Amps	£	P & P
112	0·5	2·64	0·78
79	1·0	3·57	0·96
3	2·0	5·27	0·96
20	3·0	6·20	1·14
21	4·0	7·44	1·14
51	5·0	8·37	1·32
117	6·0	9·92	1·45
88	8·0	11·73	1·64
89	10·0	13·33	1·84

60 VOLT RANGE
Prim 220/240V Sec 0-24-30-40-48-60V Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V or 24-0-24V or 30-0-30V

Ref	Amps	£	P & P
124	0·5	3·88	0·96
126	1·0	5·58	0·96
127	2·0	7·60	1·14
125	3·0	10·54	1·32
123	4·0	12·23	1·84
40	5·0	13·95	1·64
120	6·0	15·66	1·84
121	8·0	20·15	OA
122	10·0	24·03	OA
189	12·0	27·13	OA

AUTO TRANSFORMERS

Ref	VA (Watts)	Volts	£	P & P
113	20	0-115-210-240	2·48	0·71
64	75	0-115-210-240	3·95	0·96
4	150	0-115-200-220-240	5·35	0·96
66	300	0-115-200-220-240	7·75	1·14
67	500	0-115-200-220-240	10·99	1·64
84	1000	0-115-200-220-240	18·76	2·08
93	1500	0-115-200-220-240	23·36	OA
95	2000	0-115-200-220-240	34·82	OA
73	3000	0-115-200-220-240	48·00	OA

CASED AUTO TRANSFORMERS
240V cable in & 115V USA 2 pin outlet

VA	£	P & P	Ref
20	4·96	0·96	113W
150	8·48	1·14	4W
200	9·92	1·45	65W
250	10·49	1·45	69W
350	12·53	1·64	53W
500	15·73	1·64	67W
750	18·55	1·76	83W
1000	22·68	OA	84W
1500VA	26·02	OA	93W
2000	37·65	OA	95W

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	1·99	0·55
212	1A, 1A	0-6, 0-6	2·85	0·78
13	100	9-0-9	2·14	0·38
235	330, 330	0-9, 0-9	1·99	0·38
207	500, 500	0-8-9-, 0-8-9	2·59	0·71
208	1A, 1A	0-8-9, 0-8-9	3·53	0·78
236	200, 200	0-15, 0-15	1·99	0·38
214	300, 300	0-2C, 0-20	2·56	0·78
221	700 (DC)	20-12-0-12-20	3·41	0·78
206	1A, 1A	0-15-20-0-15-20	4·63	0·96
203	500, 500	0-15-27-0-15-27	3·99	0·96
204	1A, 1A	0-15-27-0-15-27	5·39	0·96
S112	500	12-15-20-24-30	2·64	0·78
239	50	12-0-12	1·99	0·38

PLUS

HIGH QUALITY MODULES

10 WATT RMS AMPLIFIER	£3·66
25 WATT RMS AMPLIFIER	£4·57
35 WATT RMS AMPLIFIER	£6·95
125 WATT RMS AMPLIFIER	*£15·95
PRE-AMP for 5–10 WATT	£6·70
PRE-AMP for 25 WATT	£13·88
POWER SUPPLIES 5–10 WATT	£1·30
POWER SUPPLIES 25 WATT	£3·75
TRANSFORMER 5–10 WATT	£3·09
*TRANSFORMER 25 WATT	£4·79

P & P Modules 35p. Trans. 96p. VAT 12½%
*VAT 8%

STEREO 30 – Complete chassis in 7+7W rms amp, pre amp, power supply front panel knobs. (Need Trans.) £19·05. Trans. £3·57. Teak cab. £5·25. P & P £1·02. VAT 12½%.

BLOB BOARD (Pack of 3)

2·5" × 5·1" ·1" or 2·5" × 5·1" ·15"	£0·75
3·75" × 5" ·1" or 3·75" × 5" ·15"	£1·14
10" × 6" ·1" or 10" × 6" ·15"	£3·78

IC Range
4·8" × 3·2" £0·96. 4·75" × 7·5" £2·13
P & P 35p VAT 8%

ELECTRONIC CONSTRUCTION KIT
10 projects (including electronic organ). No soldering needed £7·29. VAT 8% P & 70p

COMPONENT PACKS
200 Mixed value resistors (count by weight)
150 Mixed value capacitors (count by weight)
30 Mixed value precision resistors ¼W 2%
15 Assorted pots
10 Reed switches
15 Wire wound resistors—mixed wattage
1 Pack wire 50 metres assorted colours
25 pre-sets assorted types and values
Please state pack required.
60p per pack. VAT 12½% P & P 40p

Prices correct 7.11.77. Please add VAT after P & P.

PE1

TEST METERS

AVO 8 MK5	£71.00
AVO 71	£29.00
AVO 73	£39.10
AVO MM5	£24·00
AVO TT169 in circuit Transistor Tester	£30.00

U4315 Budget Meter 20kΩ/VDC 2k/VAC 1000V AC/DC 2·5A AC/DC 500k res. in robust steel case & lead etc. £14·95
VAT 8% P & P £1·15
AVO cases and accessories ex-stock.

Wee Megger £58.80

OSCILLOSCOPE CL·5.
10 meg. 3 inch tube. £55·00.
Carriage £4,00, 8% VAT.

BRIDGE RECTIFIERS

			P & P
200V	2A	£0·45	0·29
400V	2A	£0·55	0·29
200V	4A	£0·65	0·29
400V	4A	£0·80	0·29
400V	6A	£1·05	0·29
500V	10A*	£2·35	0·29

VAT 12½% *VAT 8%

Audio Kit 25W + 25W. Complete with instructions £27·55. Teak cab. + mounting hardware £9·20. P & P £1·73 VAT 12½%

RECORD DECK
BSR P128R Single Player with Cartridge £16·90 P&P £1·50 VAT 12½%.

MUSIC CENTRE CHASSIS
FM (STEREO)/MW/LW 15 + 15W Music Power Inc. Tran.
Price £22·50 inc. VAT P & P £1·50 VAT 8%

POWER UNITS
Stabilised 3-6-7-9V/400mA multiplug outlet £5·95
3300 fits into 13A socket 6-7 5-9V 300mA multiplug outlet £3·30
B12-3, 4, 5, 6, 7·5, 9, 12V 500mA DC plug outlet £5·32
VAT 12½% P & P 55p

DECS SOLDERLESS BREAD-BOARDING

S Dec 70 contacts	£1·98
T Dec 208 contacts	£3·63
U Dec "A" for I.C.s etc	£3·99
U Dec "B" for I.C.s etc	£6·99

VAT 8% P & P 40p

ANTEX SOLDERING IRONS

15W	£3·75	18W	£3·75
25W	£3·40	Stand	£1·40

P & P 46p VAT 8%.

MINI-MULTIMETER
DC-1000V AC-1000V DC-100mA Res-150kΩ 1000Ω/V Bargain £5·86 P & P 62p VAT 8%

STEREO FM TUNER WITH PHASE-LOCK LOOP
4 Pre-selected stations, varicap tuning, switched AFC, LED Beacon £20·46
VAT 12½%. P & P 40p.

Magnetic to Ceramic Cartridge Convertor operating voltages 20–45V only £3.50, VAT 12½% P & P 35p.

TRANSFORMERS
SPECIAL OFFER
(Limited Stocks)

BE1 Prim 0-120, 0-120V (120 or 240V) Sec 24V 10A **£5·50 P & P £1·66**

BE2 Prim 0-90-110-200-220-240V Sec 0-110V 0-20-24V. 2·5A **£2·25** P & P 95p. VAT 8%

BE3 100V line to 4Ω 7/10W **£2·05** P & P 66p

BE4 0-120 x 0-120, 9-0·9 1A £2·40 P & P 71p

BE5 15W matching trans. sec 15Ω suit EL89 £1·50 P & P 30p

Ref 30 240-240 Isolators 200VA £4·20 P & P 96p
Ref 62 240-240 Isolators 250VA £5·20 P & P 96p

Our wide range of transformers are too numerous to list, please call (open 9am-5pm Mon-Fri) or send your requirements. Electrosil & semiconductor stockists. Panel, Multi Meters, Audio accessories, send 15p stamps for lists.

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TELEPHONE: 01–488 3316/7/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST

TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO. LTD.
PHONE 01-672 3137/672 9080
MANUFACTURERS OF QUALITY AMPLIFICATION AND LIGHTING CONTROL SYSTEMS

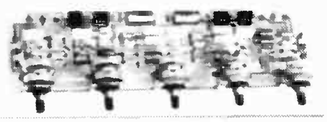
PRICES INCLUDE VAT. P & P FREE
correct at 1/9/77

TO ORDER BY POST

Make cheques/P.O.s payable to TUAC LTD. (PE127) or quote Access/Barclaycard No. and post to TUAC LTD. (PE127) 119 Charlmont Road, London SW17 9AB. We accept phone orders from Access/Barclaycard Holders. Phone 01-672 9080.

PRE AMPLIFIERS

Designed for use with TUAC power amplifier modules.

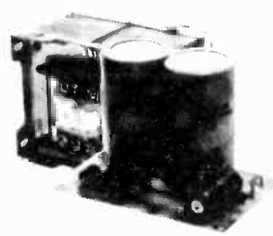


VA08
Vol. Treb. Mid. and Bass controls. HI. IMP. FET. I/P suitable Mid. Guitar, Radio Crystal/Ceramic P.U. Sensitivity 4mV. Treble+ 35dB at 16kHz. Mid + 20 -15dB at 1kHz. Bass + 20 - 10dB at 40Hz. **£9.00**

VA06
Vol Treb. and Bass controls. Sensitivity 8mV. Treb + 28 -15dB at 12kHz. Bass ± 18dB and 40Hz. **£7.75**

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

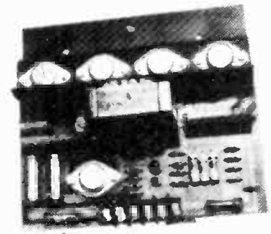
POWER SUPPLIES



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

PS250 for supplying 2 TP125s	£28.50
PS200 for supplying 2 TP100s	£28.50
PS60/60 for supplying 2 TL60s	£25.00
PS125 ±45 volts for TP125	£17.75
PS100 ±43 volts for TL100	£16.25
PS60 ±38 volts for TL60	£15.25
PS30 ±25 volts for TL30	£11.75
PSU 2 for supplying disco mixer	£7.50

AMPLIFIER MODULES



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

£12.75

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

£18.25

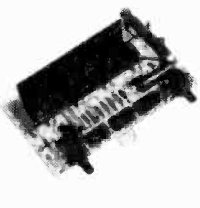
TL100
- 100 watt R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£20.75

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

£25.75

4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER - 4LSMI

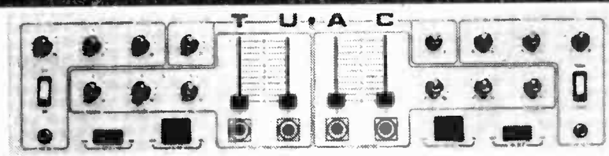


- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully supressed and fused
- Switched master control for sound operation from ½W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£20.75

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

STEREO DISCO MIXER



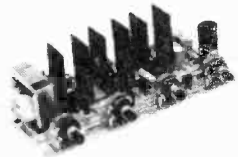
With touch sensitive switching and auto fade

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

£129.00

Mono Disco Mixer with autofade **£45.00**

3 CHANNEL LIGHT MODULATOR SILMB



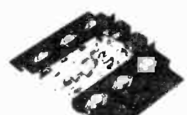
- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

£20.25

Single Channel Version 1500 Watts **£9.75**

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

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



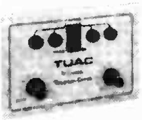
7" × 9" × 1¾" **£45**

PIEZO SUPER HORN £10.95

FRONT PANEL FOR LIGHTING EFFECT MODULES

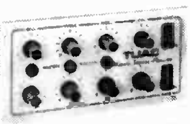
(complete with switches, neons and knobs) as illustrated

For S1LMB **£6.50**
Size 8" × 4½"



4LSM1 **£5.50**
Size 6½" × 4½"

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



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

STOCKISTS - CALLERS ONLY

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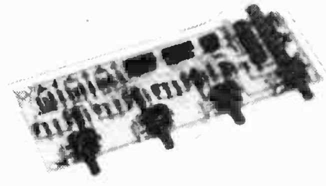
Geo Mathews, 85/87 Hurst Street, Birmingham (Tel. 021-622 1941)
Bristol Disco Centre, 25 The Promenade, Gloucester Road (Tel. Bristol 41666)
Soccodi, 9 The Friars (Tel. Canterbury 60948)
Cookies Disco Centre, 132 West Street (Tel. Crewe 4739).
Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
Luton Disco Centre, 88 Wellington Street, Luton (Tel. Luton 411733)
Mitchell Electronics, 7 Queen Street (Tel. Salisbury 23689).

Session Music, 163 Mitcham Road, Tooting (Tel. 01-672 3413).
Mon-Sat 10 a.m. - 6 p.m. Closed Wed.

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



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

3SDMI **£14.50**

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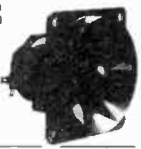

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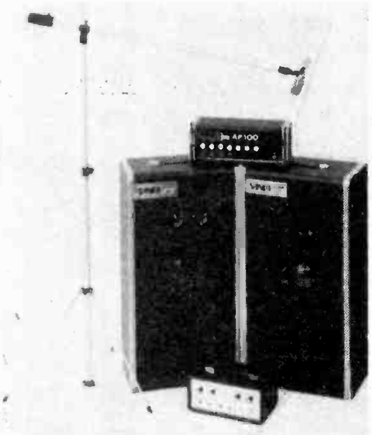

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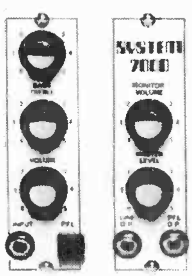

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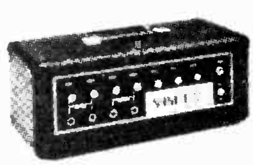

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BC171	*£0·10
BC172	*£0·10
BC173	*£0·12
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BC178	£0·16
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2N4062	*£0·12
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7401	£0·14	7410	£0·14	7442	£0·64	7483	£0·95	7494	£0·88	74123	£0·70
7402	£0·15	7411	£0·23	7445	£0·90	7484	£0·98	7495	£0·75	74141	£0·80
7403	£0·15	7412	£0·23	7446	£0·90	7485	£1·20	7496	£0·80	74154	£1·30
7404	£0·15	7413	£0·27	7447	£0·78	7486	£0·30	74100	£1·00	74180	£1·10
7405	£0·15	7414	£0·58	7448	£0·80	7489	£2·90	74110	£0·50	74181	£2·00
7406	£0·30	7416	£0·28	7475	£0·48	7490	£0·42	74118	£0·90	74190	£1·50
7407	£0·30	7417	£0·28	7480	£0·50	7491	£0·75	74119	£1·85	74198	£2·00
7408	£0·15	7440	£0·15	7481	£0·95	7492	£0·45	74121	£0·30	74199	£1·90

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·20	CD4012	£0·20	CD4022	£0·98	CD4031	£2·20	CD4046	£1·30	CD4071	£0·23
CD4001	£0·20	CD4013	£0·52	CD4023	£0·20	CD4035	£1·60	CD4047	£1·10	CD4072	£0·23
CD4002	£0·20	CD4015	£0·98	CD4024	£0·80	CD4037	£0·95	CD4049	£0·55	CD4081	£0·22
CD4006	£0·98	CD4016	£0·52	CD4025	£0·20	CD4040	£0·95	CD4050	£0·55	CD4082	£0·23
CD4007	£0·20	CD4017	£0·98	CD4026	£1·95	CD4041	£0·82	CD4054	£1·20	CD4510	£1·30
CD4008	£0·98	CD4018	£1·00	CD4027	£0·60	CD4042	£0·82	CD4055	£1·85	CD4511	£1·60
CD4009	£0·58	CD4019	£0·55	CD4028	£0·98	CD4043	£0·98	CD4056	£1·35	CD4516	£1·40
CD4010	£0·58	CD4020	£1·10	CD4029	£1·15	CD4044	£0·94	CD4069	£0·40	CD4518	£1·25
CD4011	£0·20	CD4021	£0·98	CD4030	£0·55	CD4045	£1·40	CD4070	£0·40	CD4520	£1·25

LINEAR ICs

Type	Price
CA3011	*£1·05
CA3014	*£1·70
CA3018	*£0·75
CA3020	*£1·70
CA3028	*£1·02
CA3035	*£1·70
CA3036	*£1·35
CA3042	*£1·50
CA3043	*£1·85
CA3046	*£0·80
CA3052	*£1·60
CA3054	*£1·35
CA3075	*£1·50
CA3081	*£1·50
CA3089	*£2.10
CA3090	*£4.25
CA3123	*£1·90
LM301	*£0·39
LM304	*£2.00
LM308	*£1.40
LM309K	£1·50
LM320-5V	£1·85

Type	Price
LM320-12V	£1·85
LM320-15V	£1·85
LM320-24V	£1·85
LM380-14P	*£0.98
LM381	*£1.55
LM3900N	*£0·65
MC724P	*£1·50
MC1303L	*£1·48
MC1304P	*£2.95
MC1310P	*£1·80
MC1312PQ	*£1·90
MC1330P	*£1·20
MC1350	*£1·20
MC1351P	*£1·20
MC1352P	*£1·40

Type	Price
MC1456G	*£1·40
MC1466L	£4·50
MC1469R	£2·95
MC1496G	*£0·98
NE536	*£3·50
NE515A	*£3.50
NE540	*£1·50
NE550	£0·95
NE550D	*NLA
NE555	£0·40
NE556	£0·82
NE561	*£3·95
NE562B	*£3·95
NE565A	*£1·75
NE566	*£1.70
NE567	*£2·50
UA702C	*£0·46
72702	*£0·46
UA703A	*£0·25

Type	Price
UA709C	*£0·25
72709	*£0·46
72709P	*£0·25
UA710C	*£0·40
72710	*£0·30
UA711C	*£0·32
72711	*£0·32
UA723C	£0·50
72723	£0·50
UA741C	*£0·24
72741	*£0·24
741P	*£0·24

Type	Price
UA747C	*£0·70
72747	*£0·79
UA748	*£0·35
72748	*£0·35
72748P	*£0·35
SN76013N	*£1·40
SN76023N	*£1·40
SN76110	*£1·50
SN76115	*£1·90
SN76660	*£0·75

Type	Price
SL414A	*£1·95
TAA550B	£0·35
TAA621A	*£2·00
TAA661A	*£1·65
TAD100	*£1·30
TBA540Q	*£2·20
TBA641B	*£2·25
TBA800	*£0·80
TBA810S	*£1.05
TBA820	£0·90
TBA920Q	£3·40
TCA270S	*£3·90

NEWNES TECHNICAL BOOKS

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Price **£2·25†**

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Price **£2·25†**

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No. 233 Beginners Guide to Radio
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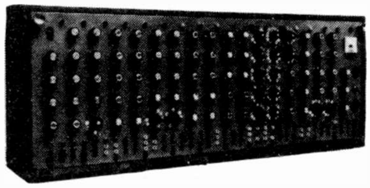
KITS FOR SYNTHESISERS, SOUND EFFECTS



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

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by Phonosonics.

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

PHONOSONICS

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

P.E. MINISONIC Mk. 2 SYNTHESISER
A portable mains-operated Miniature Sound Synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, output amp and mixer, power supply.
- Set of basic component kits — from £64·25
- Set of printed circuit boards — £9·71

P.E. SYNTHESISER (P.E. Feb. 73 to Feb. 74)
The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage, notably P.E. Minisonic, Phasing Unit, Wind and Rain, Rhythm Generator, Sound Bender, Voltage Controlled Filter, Guitar Effects Pedal and Overdrive, Fuzz, Tremolo and Wah-Wah units.
The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists.
- Set of basic component kits — £83·03
- Set of printed circuit boards — £13·20

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument): 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in our lists.
- Set of basic component kits — £48·18
- Set of printed circuit boards — £7·68

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.
- Component set with special foot operated switches — £7·59
- Alternative component set with panel mounting switches — £4·96
- Printed circuit board — £1·43

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.
- Component set for above functions (excl. SWs) — £7·84
- Printed circuit board — £1·81

Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.
- Component set (incl. PCB) — £2·88

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.
- Component set (incl. PCB) — £2·87

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.
- Component set (incl. PCB) — £4·48

SOPHISTICATED PHASING AND VIBRATO UNIT
A slightly modified version of the circuit published in "Elektor", December 1976, and includes manual and automatic control over the rate of phasing and vibrato.
- Component set — £17·69
- Printed circuit board — £2·33

WAH-WAH UNIT (P.E. Apr. 76)
The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.
- Component set (incl. PCB) — £3·55

AUTOWAH UNIT (P.E. Mar. 77)
Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.
- Component set, PCB, special foot switches — £7·27
- Component set and PCB, with panel switches — £4·83

P.E. JOANNA (P.E. May/Sept. 75)
A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.
Main power supply, tone generator, 61 envelope shapers, voicing and pre-amp circuits.
- Set of basic component kits for above — £75·29
- Set of printed circuit boards for above — £20·35
- Power amplifier — £15·97
- Printed circuit board for power amp — 95p

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

ORGAN CONVERSION KIT
Converts the P.E. Joanna electronic piano to also provide most of the facilities offered by the above electronic organ.
- Basic component set and PCB — £12·34

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.
- Component and PCB (but excl sw.) — £7·45

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

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

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds.
- Component set (incl. PCB) — £3·72

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.
- Component set using dual slider pot — £6·86
- Component set using dual rotary pot — £6·20
- Printed circuit board — £1·62

FUZZ UNIT
Simple Fuzz unit based upon P.E. "Sound Design" circuit.
- Component set (incl. PCB) — £2·03

TREMOLO UNIT
Based upon P.E. "Sound Design" circuit.
- Component set (incl. PCB) — £3·64

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.
- Component set (incl. PCB) — £2·40

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike.
- Main component set (incl. PCB) — £15·59
- Power supply set (incl. PCB) — £7·03

P.E. SYNCHRONOME (P.E. Mar. 76)
An accented-beat electronic metronome, providing duple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply.
- Component set (incl. loudspeaker) — £11·62
- Printed circuit board — £2·04

TAPE NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs
- Standard tolerance set of components — £2·96
- Superior tolerance set of components — £3·76
- Regulated power supply (will drive 2 sets) — £4·69

ENVELOPE SHAPER WITHOUT VCA (P.E. Oct. 75)
Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier.
- Component set (incl. PCB) — £4·66

ENVELOPE SHAPER WITH VCA (P.E. Apr. 76)
This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.
- Component set (incl. PCB) — £6·68

TRANSIENT GENERATOR (P.E. Apr. 77)
An envelope shaper, without VCA, having the usual attack, decay, sustain and release functions, and in addition it also provides a "Repeat Effect" enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo.
- Component set — £4·52
- Printed circuit board — £1·82

WAVEFORM CONVERTER
Slightly modified from a circuit published in a German edition of "Elektor". Converts a saw-tooth waveform into four different waveforms, sine-wave, mark-space saw-tooth, regular triangle form, and squarewave with an externally variable mark-space ratio.
- Component set (incl. PCB but excl. sw's) — £8·19

VOLTAGE CONTROLLED FILTER (P.E. Dec. 74)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.
- Component set (incl. PCB) (Order as Kit 65-1) — £8·22

RING MODULATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.
- Component set (incl. PCB) (Order as Kit 59-1) — £5·50

NOISE GENERATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.
- Component set (incl. PCB) (Order as Kit 60-1) — £3·35

SOPHISTICATED POWER SUPPLIES
A wide range of highly stabilised low noise power supply kits is available—details in our lists.

MICROPHONE PRE-AMP (P.E. Apr. 77)
- Component set (incl. PCB) — £3·78

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "talk-over"—particularly useful for Disco work or for home-movie shows.
- Component set (incl. PCB) — £3·97

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.
- Component set (incl. PCB) — £4·58

POST AND HANDLING
U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £2·00 plus VAT.
Optional insurance for compensation against loss or damage in post, add 35p in addition to above post and handling.
Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

DON'T FORGET VAT!
Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders).

EXPORT ORDERS are welcome, though we advise that a current copy of our list should be obtained before ordering as it also shows Export postage rates. All payments must be cash-with-order, in Sterling and preferably by International Money Order or through an English Bank. To obtain list send 40p.

PHONOSONICS · DEPT. PE5N · 22 HIGH STREET · SIDCUP · KENT DA14 6EH
MAIL ORDER AND C.W.O. ONLY
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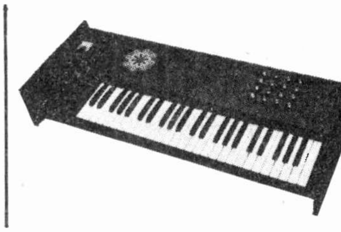
AND OTHER PROJECTS



PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list Europe—send 20p, other countries—send 40p.

KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits, including the **P.E. Joanna, P.E. Minisonic,** and **P.E. Synthesiser.** The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C. The keys are plastic, spring-loaded and mounted on a robust aluminium frame
3 Octave (37 notes) **£25·50.** 4 Oct (49 notes) **£32·25.** 5 Oct (61 notes) **£39·75.**
Contact Assemblies for use with above keyboards. Single-pole change-over (type SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally-open make-break (type DP) as for P.E. Synthesiser. Special contact assembly (type 4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables THE SAME KEYBOARD to be used with the P.E. Synthesiser, P.E. Minisonic and the P.E. Joanna simultaneously thus avoiding the cost of more than one keyboard. See our list for other contacts.

Contact	*Each*	*3 Octave Set*	*4 Octave Set*	*5 Octave Set*
SP	24p	£ 8·88	£11·76	£14·64
2P	27p	£ 9·99	£13·23	£16·47
4PS	53p	£19·61	£25·97	£32·33

PRINTED CIRCUIT BOARDS for use with the above contacts and thus eliminating most of the inter-wiring required, are available. Details in our lists.

MORE NEW KITS!

NEW RHYTHM GENERATOR
Redesigned, improved and extended version of the PE 1974 design and including new automatic rhythm programme selector.

TUNE-PROGRAMMABLE SEQUENCER
(PE Nov. 77) The new music unit currently being published.

FORMANT SYNTHESISER
(Elektor Magazine 1977). Very sophisticated music synthesiser for the advanced constructor and for whom cost is secondary to performance.

GUITAR SUSTAIN UNIT
(PE Oct. 77).
Details in lists. Please send S.A.E.

SOUND-TO-LIGHT (P.E. Aurora) (P.E. Apr.-Aug. 71)
Four channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities.

Basic component set (excl. thyristors)	£15·92
Printed circuit board for above	£3·90
Power supply	£5·78
PCB for power supply	£1·79

3-CHANNEL SOUND-TO-LIGHT (P.E. Apr. 76)
A simple but effective sound-to-light controller capable of operating 3 lamps each of approximately 700 watts. Includes power supply, thyristors, and by-pass switches
Component set (incl. PCB) £11·95

DISCOSTROBE (P.E. Nov. 76)
4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation

Basic component set	£18·19
Printed circuit board	£3·45

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)
Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Component set (incl. PCB)	£4·22
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits	£6·59
Audio Amplifier Module Type PC7	£7·35

SEMI CONDUCTOR TESTER (P.E. Oct. 73)
Essential test equipment for the enterprising home constructor. While stocks last.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB	£9·63
Panel meter (500µA)	£5·70

TRANSISTORS	
AC128	26p
AC176	26p
BC107	14p
BC108	14p
BC109	14p
BC147	12p
BC148	12p
BC149	12p
BC157	13p
BC158	13p
BC159	13p
BC182L	12p
BC184	12p
BC187	25p
BC204	14p
BC209C	14p
BC212L	15p
BC213	15p
BC478	29p
BCY71	22p
BD131	44p
BD132	54p
BFY50	22p
BFY51	22p
BFY52	24p
BSY95A	22p
MD8001	172p
OC28	60p
OC71	20p
OC72	25p
OC84	25p
ORP12	70p
ZTX107	12p
ZTX108	9p
ZTX501	13p
ZTX503	15p
ZTX531	23p
2N706	13p
2N914	22p
2N1304	22p
2N2219	27p
2N2905	35p
2N2905A	36p
2N2907	22p
2N3053	18p
2N3054	66p
2N3055	48p
2N3702	12p
2N3703	12p
2N3704	12p
2N3819	35p
2N3820	64p
2N3823E	39p
2N4060	12p
2N5245	51p
2N5459	33p
2N5777	45p

INTEGRATED CIRTS.	
318	230p
709 TO5	40p
709 8-pin DIL	48p
723 TO5	105p
741 8-pin DIL	32p
748 TO5	63p
748 8-pin DIL	63p
µA7805 TO220	205p
µA7808 TO220	205p
µA7812 TO220	205p
µA7815 TO220	205p
µA7818 TO220	205p
AY-1-0212	650p
AY-1-6721/6	195p
CA3046	90p
MC3340	150p
SG3402N	282p

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BARGAIN PARCELS SAVE POUNDS

Huge quantities of electronic components must be cleared as space required. 1000's of capacitors, resistors, transistors. Ex equipment panels etc. covered in valuable components. No time to sort. Must sell by weight 7 lbs – £4.95; 14lbs – £7.95; 28 lbs – £12.00; 56lbs – £20.00; 112 lbs – £30.00.

BARGAIN PACKS

Handy Packs
4 aluminium boxes 128 x 44 x 38 mm ideal for signal injectors, etc. £1.00
Self fluxing enamelled copper wire 18 & 22 swg on 2 oz reels. 2 for £1.10
100 miniature reed switches ideal for burglar alarms, model railways, etc. £2.20
15 x 2-pole reed relays on board operate at 12 volts £2.45.
6 x 6-pole 12 volt reed relays on board £2.45
High quality computer panels smothered in top grade components: 5 lbs £4.75; 10 lbs £8.95

New U.H.F. transistor TV tuners 4 pushbutton type £2.50
Rotary type with slow motion drive £2.50
Aluminium TV coax plugs. 10 for £1.00
Miniature 5K log pots with s/p switch. 4 for £1.
Hardware Packs each containing 100's of items including: BA nuts and bolts, Nylon, Self-tapping, Posidrive, "P" clips, Cable clamps, Fuse holders, Spire nuts etc, etc. £1 per pound. 100 assorted "P" clips £1.
Belling Lee outdoor Triplexers, U.H.F., Band 1, Band 2, 50p each, 3 for £1.

DE LUXE FIBRE GLASS PRINTED CIRCUIT ETCHING KITS

Includes 150 sq. ins. copper clad f/g board, 1 lb ferric chloride, 1 dolo etch resist pen, abrasive cleaner, 2 mini drill bits, etch tray and instructions / only £5.30

REFILL PACKS FOR ABOVE

150 sq. in fibre glass board	£2
Dalo pen	90p
1 lb ferric chloride to mil spec	£1.25

Bridge rectifier 100v 2.5 amp. 4 for £1.
5 lbs ferric chloride to mil spec £4.00
Instruction sheet 20p

TV SURPLUS
Brand New ITT C.T.V. Triplers, fit Decca "Bradford" chassis £2.50 each. 5 for £10.
Pye and Philips "GB" C.T.V. panels, various types. All incomplete but invaluable for spares or completing. 6 assorted panels for £7.50.
Thorn B & W T.V. bottom panel "950" series, manufacturers surplus £1.50 each.
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PE(A)1/78

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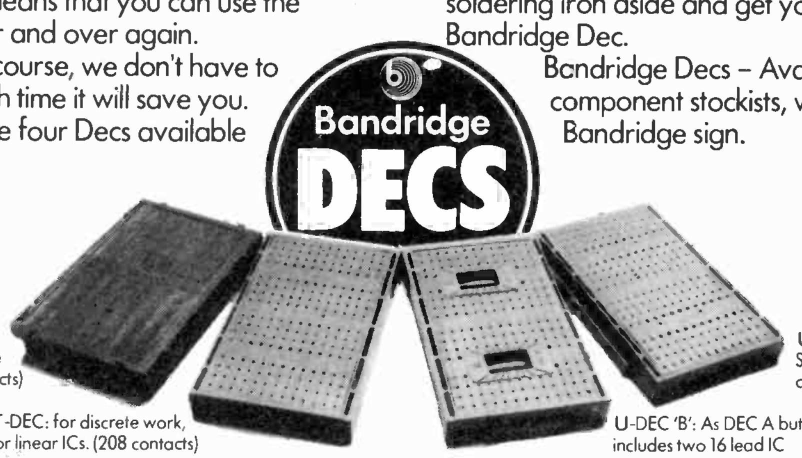

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PE VOLUME 14 No. 5 JANUARY 1978

SIGNING OFF

As MANY readers will have noted, Fred Bennett signed off as Editor of P.E. in his editorial last month. Regular readers—and P.E. has many who have been loyal from the first issue—will know that Fred Bennett was the driving force behind this magazine from the word go.

Having personally worked under him for nearly nine years I can safely say that his professionalism, foresight and planning have put the magazine where it is today—*the highest selling electronic hobby magazine in Britain*—that alone is testimony to his abilities.

Being the man he is, Fred Bennett would give credit to the staff of P.E. for their part in this achievement. With the move to Poole the magazine has also lost other staff. One ex-member who has been "in the thick of it" was the Production Editor, Dave Barrington; a loyal employee since the word go. The magazine will miss them.

SIGNING ON

Having said my piece about departing colleagues—continued, as Fred Bennett left off, in the first person—I suppose the next logical step is to introduce myself before continuing in the normal way.

Perhaps some readers will have seen the name Mike Kenward in past issues of P.E.; in fact I started my career as a journalist with P.E. in 1968, having previously been employed by the then Ministry of Aviation. Later, after being involved in the launch of *Everyday Electronics*, I moved on to become Assistant Editor of that publication. More recently I have been the Editor of a similar hobbyist publication in Canada and now find myself in the position of taking on P.E. as a result of the move to Poole.

NEW

A new year, a new editor, a new address and some new subjects for your magazine! One topic that we are continually being asked about is fault finding and this month sees the start of an important series which takes a look at ways and means of getting things going again.

Perhaps one of the most difficult tasks of the editorial team of P.E. is answering readers' queries regarding equipment built, or even part built, that has a strange fault or is missing a few parts. Some carefully chosen words may help.

We say "carefully chosen" because, as we would be the first to acknowledge, we, as a team, play an important role in feeding you "the truth, the whole truth and nothing but the truth" and though this is our continual aim we are only human and sometimes things can go awry! It has always been the policy of this magazine to keep readers fully informed of any corrections, corrigenda, general developments or improvements on all the constructional articles we publish, and that will continue to be our policy.

Having explained our "carefully chosen words" we had better choose them: Our fault finding series is, we feel, excellent material for hobbyist and technician alike, it does however leave some of the more obvious statements unsaid. This is simply because it *is* a fault finding series rather than a guide to the successful completion of equipment.

We are often asked to provide additional information on components or test and setting up procedures for equipment when, in fact, the information is contained in the article; please read carefully. So often we can only ask constructors to check their unit carefully as we know of no corrections or additions.

We feel this illustrates our point perfectly—it's not easy to diagnose faults if part of your equipment is not there in the first place!

Good fault finding is a peculiar skill, usually practised better by the humble repairman than by the honours-degree-engineer. It is a skill that can be learnt and one that can be improved with practice. A good TV repairman can find the "impossible" in a few minutes; however, even for him, miracles take a little longer!

Mike Kenward.

EDITORIAL

EDITOR
Mike Kenward

Gordon Godbold ASSISTANT EDITOR
Mike Abbott TECHNICAL EDITOR

Jack Pountney ART EDITOR
Keith Woodruff GENERAL ARTIST
D. J. Gooding TECHNICAL ILLUSTRATOR
R. J. Goodman TECHNICAL ILLUSTRATOR

Editorial Offices:
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West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 71191

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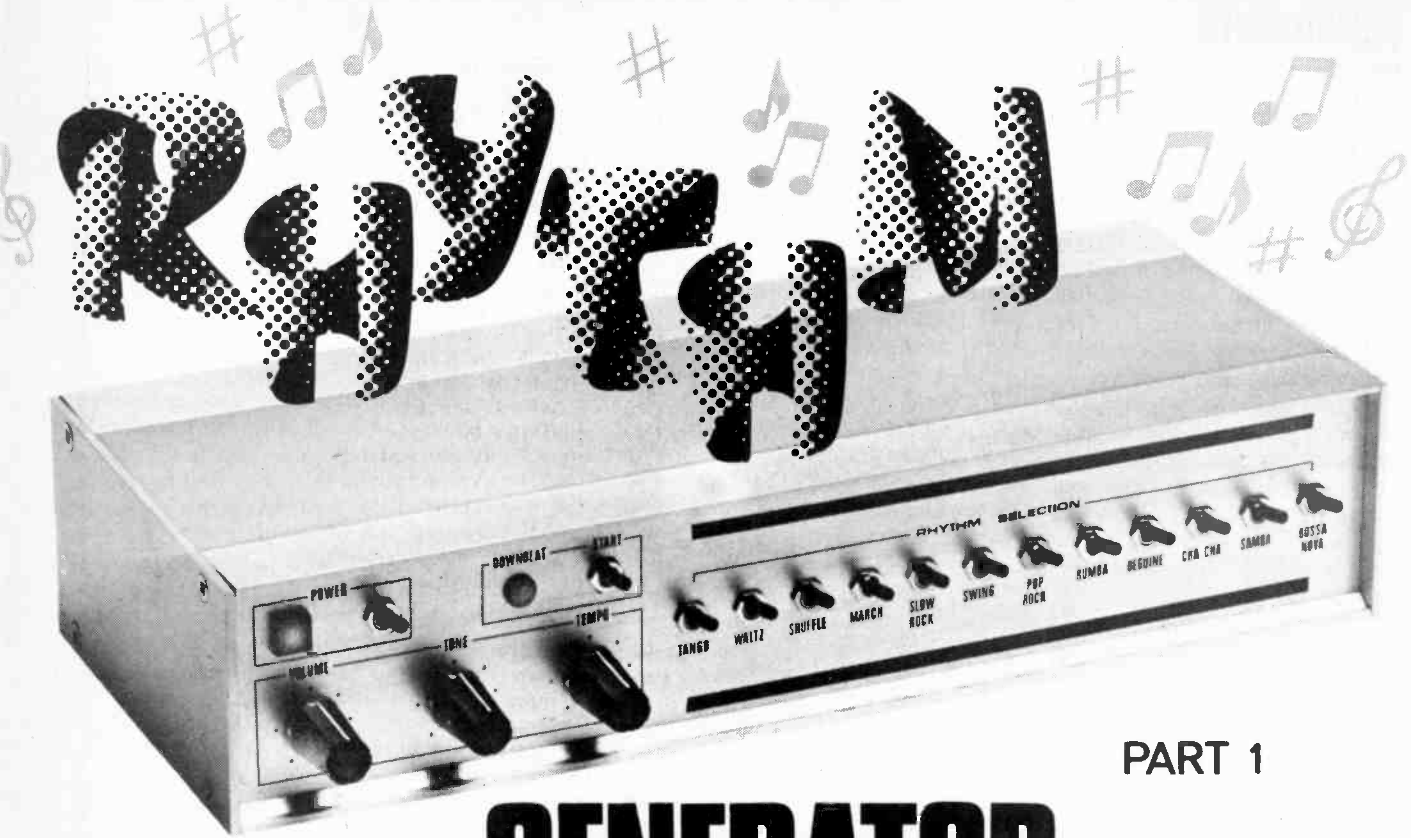
Copies of our June 1977 and subsequent issues are available from: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 65p each including Inland/Overseas p & p.

Binders for PE are available from the same address at £2·10 each to UK addresses, £2·70 overseas, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

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

Letters

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



PART 1

GENERATOR

N.A. COOKE

With twelve rhythms that can be superimposed and eight sound generators

THIS Rhythm Generator design compacts eight percussion instruments and a percussionist into a neat professionally styled case measuring some 300 × 130 × 60mm.

The advantage of this unit over many others is that rhythms are selected directly and can be superimposed to create new and musically more interesting patterns. There are 12 basic rhythms and these are as follows:—Tango, Waltz, Shuffle, March, Slow Rock, Swing, Pop Rock, Rumba, Beguine, Cha Cha, Samba and Bossa Nova. By simply selecting two or more, their patterns will be superimposed and a blend of the selected rhythms will result.

CIRCUIT BREAKDOWN

The block diagram (Fig. 1) shows the complete Rhythm Generator. The various circuits can be placed within four main groups:

1. Rhythm pattern generation.
2. Musical instrument simulators.
3. Pre-amplification.
4. Power supply.

To assist in understanding the complete circuit it is best to deal with each of the above groups in turn.

RHYTHM PATTERN GENERATION

The object of this circuit is to provide the instrument simulators with rhythmically pulsed information which in turn is transformed into recognisable percussion sounds.

The heart is the M253AA chip which contains a read only memory matrix pre-programmed with the 12 basic rhythm patterns. All that is required to obtain this information is to provide the chip with a square wave at the clock input, pin 24. By varying the frequency of this square wave the tempo of the rhythm may be controlled.

Fig. 2 shows the circuit diagram of the Rhythm Generator with rhythm selection stop and reset switches and downbeat indicator.

To select a rhythm the desired input must be clamped to the 0V rail (logic 0) with the other inputs tied to 4·7V (logic 1). Change-over switches S1-12 are required for this function. Here the other change over section of the switches is used to select Claves or Snare Drum as appropriate for the particular rhythm.

The square wave for the clock input is generated by a simple astable multivibrator using two CMOS NAND gates together with the associated timing components C2, R2 and VR1 which control the operational frequency. This frequency may be adjusted from approximately 5 to 50Hz

COMPONENTS . . .

Resistors

R1	22kΩ	R31	150kΩ
R2	100kΩ	R32	68kΩ
R3	22kΩ	R33	68kΩ
R4	10kΩ	R34	27kΩ
R5	22kΩ	R35	12kΩ
R6	2·2MΩ	R36	47kΩ
R7	510kΩ	R37	10kΩ
R8	2·7kΩ	R38	470kΩ
R9	220kΩ	R39	390kΩ
R10	150kΩ	R40	390kΩ
R11	68kΩ	R41	390kΩ
R12	68kΩ	R42	10kΩ
R13	27kΩ	R43	22kΩ
R14	12kΩ	R44	1MΩ
R15	47kΩ	R45	100kΩ
R16	10kΩ	R46	470kΩ
R17	150kΩ	R47	1MΩ
R18	68kΩ	R48	22kΩ
R19	68kΩ	R49	2·2kΩ
R20	27kΩ	R50	1MΩ
R21	12kΩ	R51	1MΩ
R22	47kΩ	R52	1MΩ
R23	10kΩ	R53	4·7kΩ
R24	150kΩ	R54	4·7kΩ
R25	68kΩ	R55	22kΩ
R26	68kΩ	R56	10kΩ
R27	27kΩ	R57	390kΩ
R28	12kΩ	R58	10kΩ
R29	47kΩ	R59	2·2kΩ
R30	10kΩ	R60	22kΩ
		R61	33kΩ

All ¼W 5% Carbon Film

Potentiometers

VR1	1MΩ lin	
VR2	25kΩ lin	
VR3	10kΩ log	
VR4	470kΩ	All 0·1W sub min. horizontal preset
VR5	470kΩ	All 0·1W sub min. horizontal preset
VR6	470kΩ	All 0·1W sub min. horizontal preset
VR7	470kΩ	All 0·1W sub min. horizontal preset
VR8	100kΩ	All 0·1W sub min. horizontal preset
VR9	220kΩ	All 0·1W sub min. horizontal preset
VR10	10kΩ	All 0·1W sub min. horizontal preset

Capacitors

C1	0·01μF mylar
C2	0·1μF polyrad
C3	0·22μF polyrad
C4	0·1μF polyrad
C5	0·15μF polyrad
C6	0·047μF polyrad
C7	0·047μF polyrad
C8	0·15μF polyrad
C9	0·033μF mylar
C10	0·01μF mylar
C11	0·01μF polyrad
C12	0·033μF mylar
C13	0·047μF polyester axial
C14	0·015μF polyester axial
C15	0·015μF polyester axial
C16	0·047μF mylar
C17	4·7nF ceramic
C18	1·5nF ceramic
C19	1·5nF ceramic
C20	4·7nF polyrad
C21	0·22μF polyrad
C22	0·1μF polyrad
C23	0·33μF polyrad
C24	0·068μF polyrad
C25	0·22μF polyrad
C26	0·1μF polyrad
C27	0·05μF ceramic
C28	4·7nF ceramic
C29	4·7nF ceramic
C30	0·02μF mylar
C31	0·1μF 16V radial electrolytic
C32	0·1μF polyrad
C33	0·22μF polyrad
C34	2500μF 25V electrolytic
C35	100μF 25V electrolytic
C36	470μF 16V electrolytic
C37	10μF 16V electrolytic
C38	1000μF 16V electrolytic
C39	1000μF 16V electrolytic
C40	100μF 16V electrolytic

All Electrolytics are vertical p.c.b. mounting types
Note: polyrad means polyester radial lead capacitors Mullard C280 Range

Semiconductors

TR1	BC108B	D11	12V 400mW Zener
TR2	BC108B	D12–D15	Bridge Rectifier 50V, 1A, type W0–005
TR3	BC108B		
TR4	BC108B	D16	0·15in l.e.d.
TR5	BC108B	IC1	M523AA
TR6	2N1132	IC2–IC4	CD4011AE
D1–10	1N4148 (10 off)	IC5	741 Op Amp
		IC6	78L12 AWC Regulator +12 Volt Bridge Rectifier 100V 1 amp
		IC7	78L05 AWC Regulator +5V

Miscellaneous

1	8 pin d.i.l. socket
3	14 pin d.i.l. socket
1	24 pin d.i.l. socket
13	D.p.d.t. sub min toggle (S1–S13)
1	S.p.s.t. sub min toggle (S14)
1	Neon indicator (LP1)
T1	12–0–12V 100ma transformer
L1, L2	SC60 100mH min choke
SK1	3·5mm jack socket
SK2	5 pin DIN socket
FS1	20mm panel fuse—holder and 250mA "quick blow" fuse
1	¼in rubber grommets
1	Earth tag; ¼in fixing lug
10	6BA nuts and bolts
7	6BA clearance spaces ⅜in
1	Wire clamp ("P" Clip)
	1 metre 22 s.w.g. tinned copper wire
	2 metres 3 core mains cable
	2 metres single screen cable
35	Veropins 0·1in pitch
2	Printed circuit boards
3	K15 knobs
1	"AWAB" case 12in × 5in × 2½in. 1½ metres stranded connecting wire
1	Foot switch press-to-break fitted with 3·5mm jack plug (optional extra)

Note: The inside cover page for Watford Electronics shows i.c.s. M252AA and MC253AA incorrectly priced. These should be 750p and 795p respectively

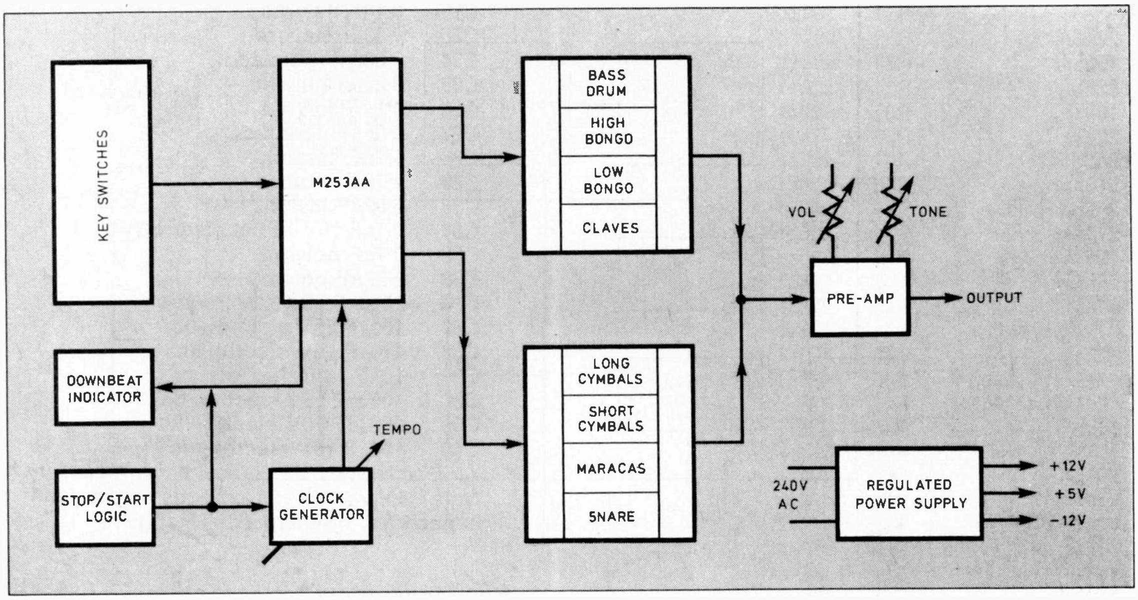


Fig. 1. Block diagram of Rhythm Generator

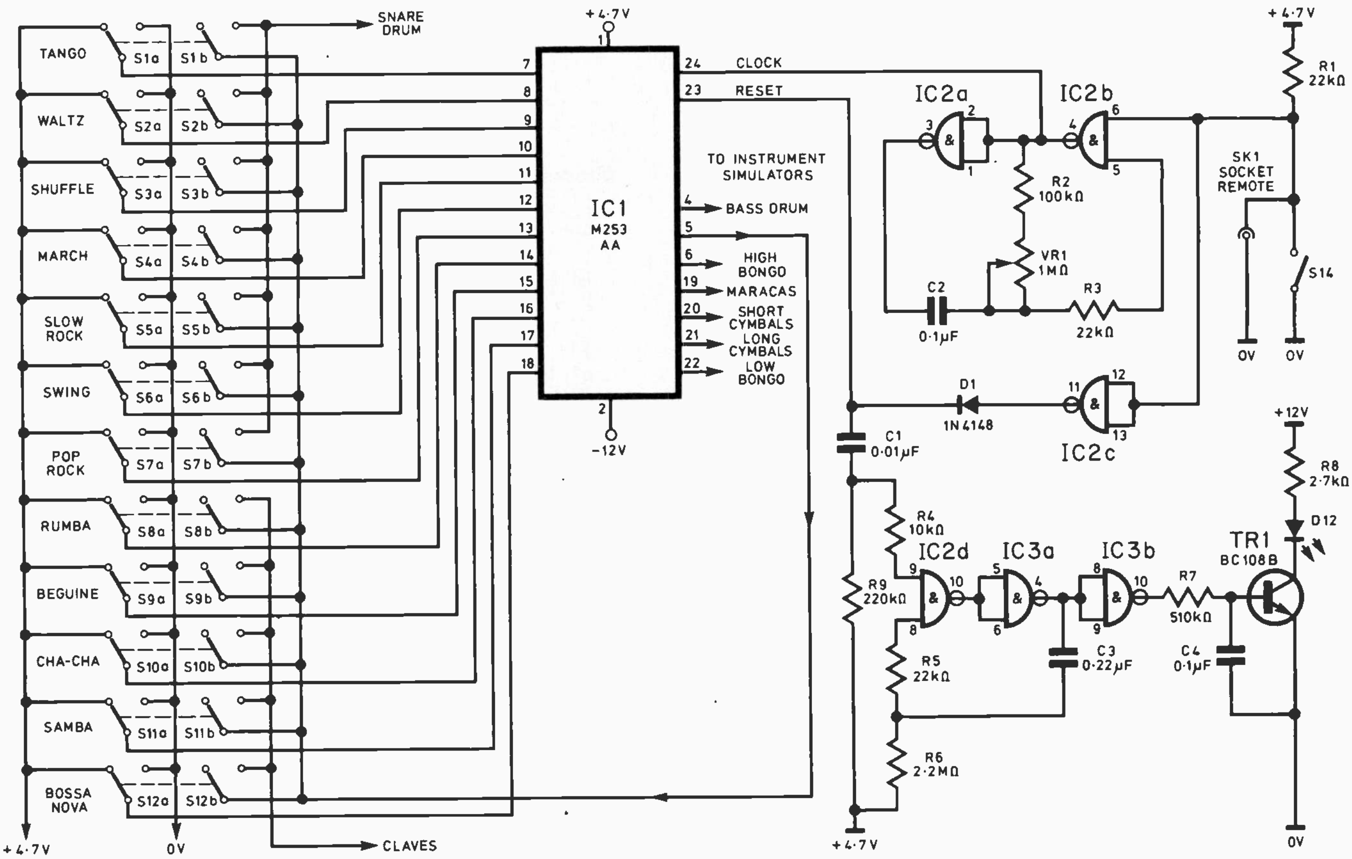


Fig. 2. Rhythm generation circuit

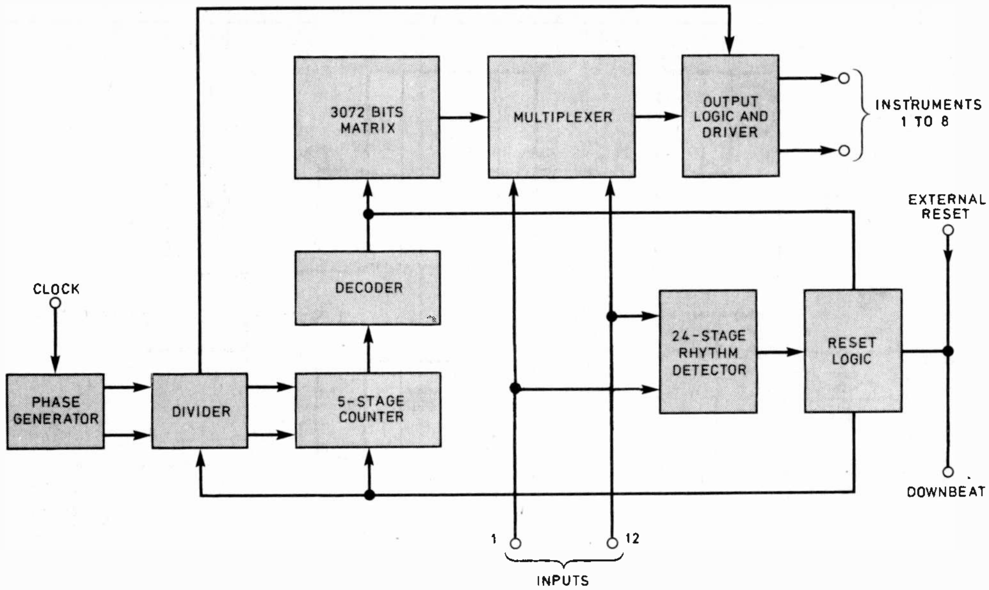


Fig. 3. Block diagram of M253AA

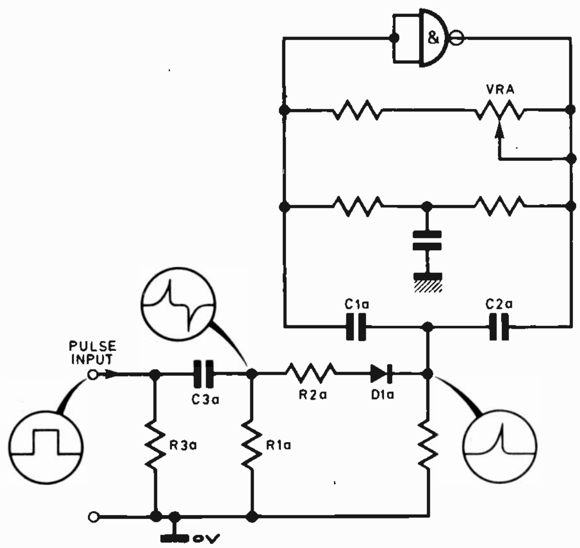


Fig. 4. The basic sinusoidal oscillator

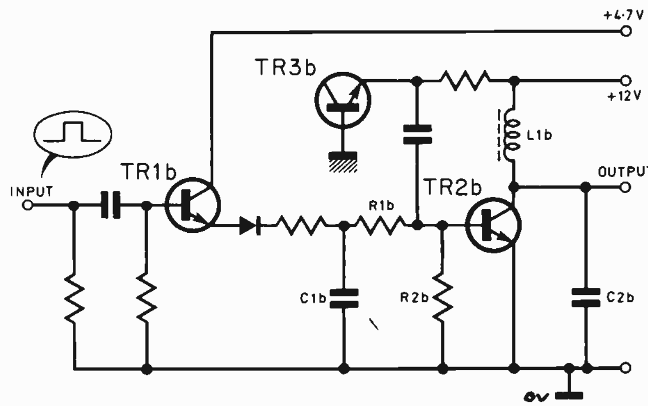


Fig. 5. Fundamental white noise circuit

by the tempo control VR1. The output of the clock generator is fed to the clock input pin 24 of the M253AA.

The rhythm stop/start switch S14 is connected through a NAND gate, operating as an inverter, to the external reset pin 23. When this switch is closed the clock generator is inhibited with its output remaining at logic 1. A pulse is also supplied via the inverter through the blocking diode D1 to reset the rhythm pattern to the beginning of the bar.

On opening the switch the output of the oscillator will immediately go to logic 0 generating the first command pulse which is the first beat in the bar.

DOWNBEAT START

The rhythm pattern always begins on the downbeat, it then lights the l.e.d. with successive downbeats until S14 is closed.

A short pulse is present at the external reset/downbeat pin of the M253AA when the internal logic resets at the end of the rhythm pattern. This pulse is of very short duration only about 2 to 3μs which is obviously too short to light the l.e.d. The lamp must also light at the beginning of the beat and not at the end of a bar which is when the downbeat pulse is present.

Two NAND gates together with R5, R6 and C3 operate as a monostable and extend this pulse to some 350ms. The third NAND gate inverts the output of the monostable in order that TR1 is switched on and this lights the l.e.d. during the set state of the monostable.

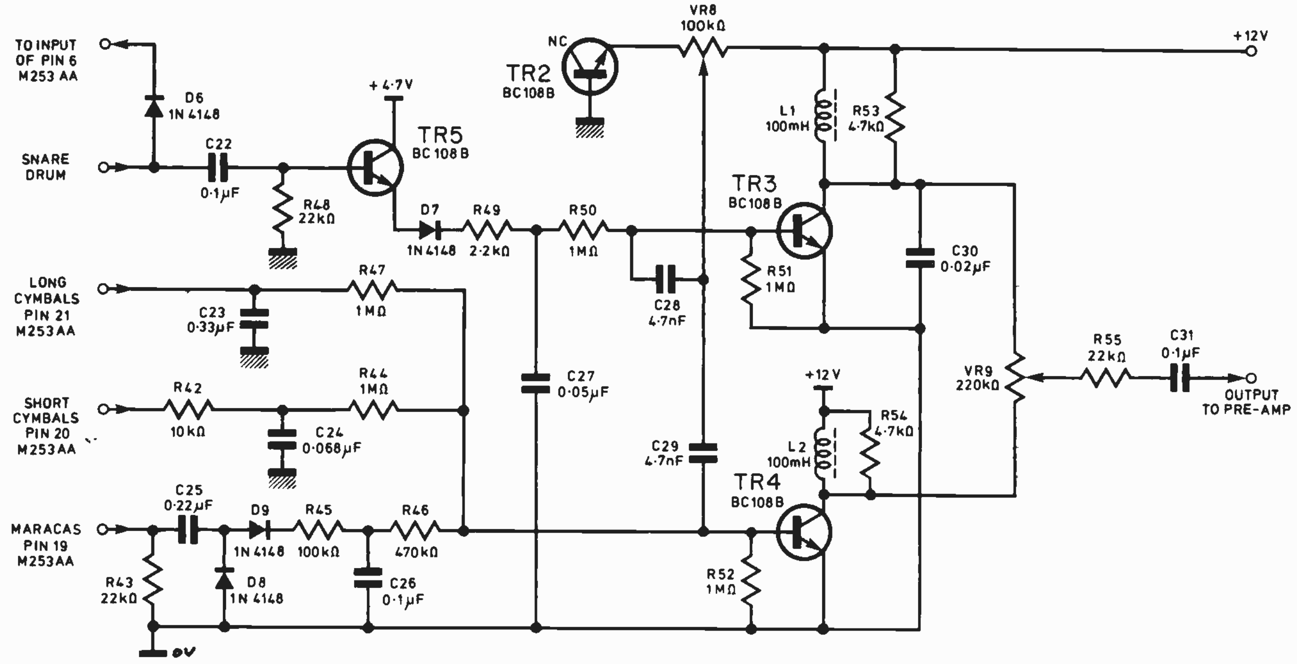


Fig. 6. The four white noise instrument simulators

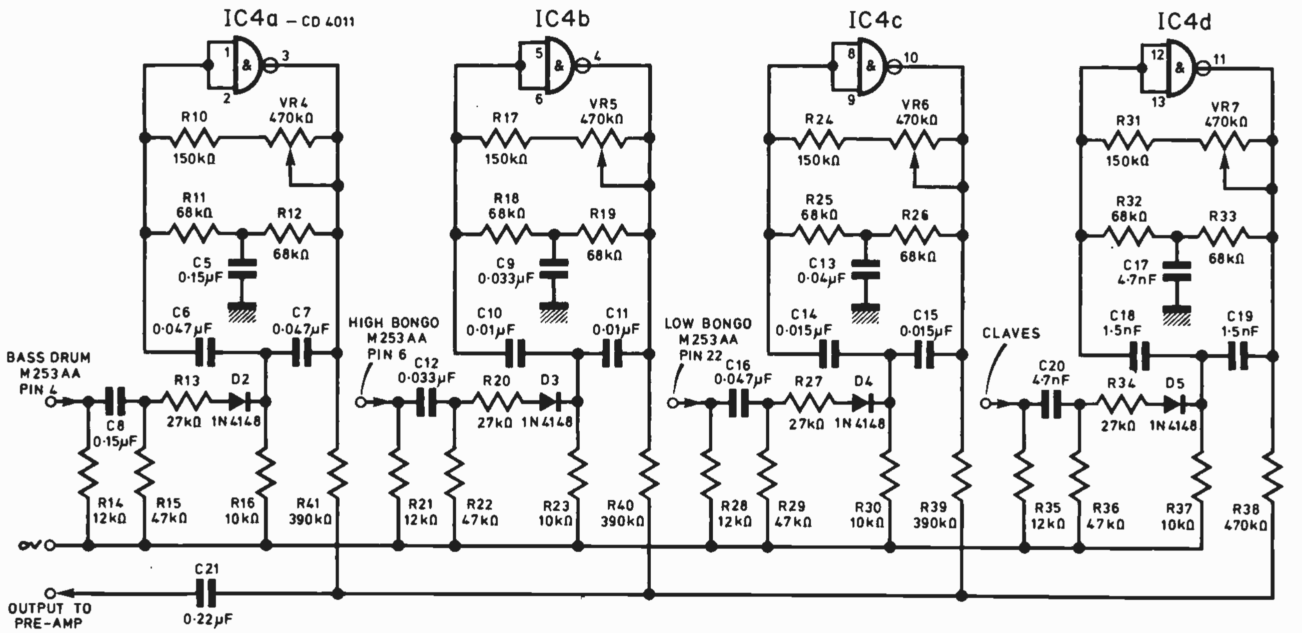


Fig. 7. The four sinusoidal oscillators

THE M253AA IC

Internal operation of the M253AA is shown in Fig. 3. Here the clock input is first divided by two and the output fed to a five-stage counter. The counter resets after 32 pulses for 4/4 time and after 24 pulses for 3/4 time. The counter states are then decoded to drive the ROM (read only memory) matrix which has been pre-programmed with the 12 different rhythm patterns. These, of course, are defined at manufacture but customer options do exist at a price!

The rhythm selection input is decoded to determine the reset point of the counter and to programme the multiplexer to read the memory matrix. Its outputs are then modified to become suitable to drive the eight instrument simulators by means of a driver stage. This driver stage also includes the logic to reset the memory output after each reading in order that successive readings occur on the correct triggering edge of the following beat.

The internal reset pulse is fed to the external pin 23 to provide downbeat indication and to allow external resetting when the generator is stopped.

PERCUSSION VOICES

The Bass Drum, High Bongos, Low Bongos and Claves are created by the use of damped sinusoidal oscillators. The long and short Cymbals and Maracas are simulated by the use of damped filtered white noise.

An example of the simple twin T oscillator used is shown in Fig. 4. The NAND gate is held just below continuous oscillation by the use of VRA.

All four oscillators in this group are identical with the exception of the values of the timing capacitors which set the frequency of oscillation (Fig. 7). The values of the capacitors are chosen to suit the instrument being simulated.

VRA regulates the decay of the oscillation and should be adjusted to give the most realistic effect. The pulsing output of the M253AA is a square wave and this is differentiated by C3a and R1a into two opposite spikes which are attenuated by R2a and rectified to a single positive spike by D1a. Resistor R3a is necessary to tie the input to earth when no pulse is present as the outputs of the M253AA are open drain types.

Fig. 5 shows the basic circuit of the white noise generators. Transistor TR1b turns on during a command pulse from the M253AA. This charges capacitor C1b which then discharges through R1b to the base of transistor TR2b.

White noise is produced by the reverse biased Zener effect of TR3b which is selectively filtered by C2b and L1b. The level of the white noise at the output of the transistor follows the decaying voltage at the base until the potential across C1b has fallen to a level which causes the transistor to switch off.

The metallic timbre of the Snare Drum is produced on a real instrument by a set of steel springs—the snares which run across the diameter of the underside of the drum. It is the snares vibrating against the skin of the drum that give it its characteristic sound.

This sound is recreated in this unit by combining filtered white noise with the damped oscillation of the High Bongo. The two separate simulators are combined via a diode which prevents the Snare Drum from sounding when the High Bongo is activated.

The Maracas simulator is unusual in that it is the only instrument in which the sound increases gradually and then decreases. This effect is produced by means of the integrator/differentiator circuit C25, D8, D9, R45, R46 and C26 (Fig. 6).

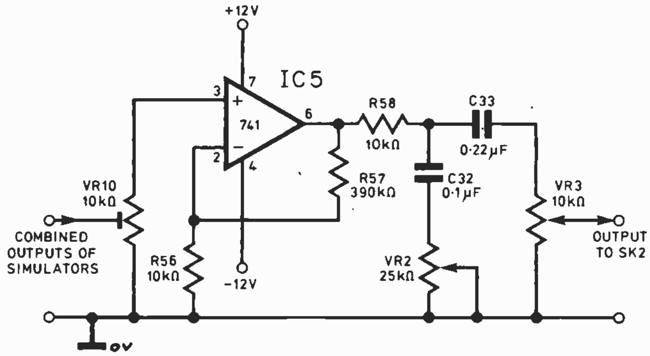


Fig. 8. Pre-amplifier circuit

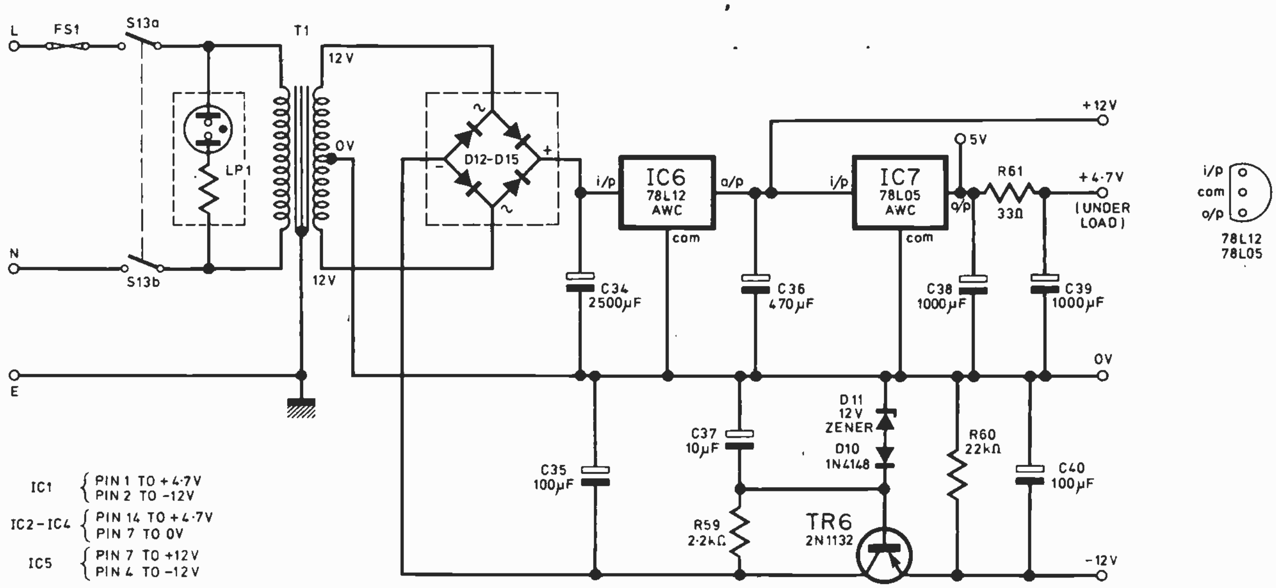


Fig. 9. Circuit of p.s.u.

PRE-AMPLIFICATION AND P.S.U.

Fig. 8 shows the circuit of the pre-amplifier. All eight instruments are combined by means of a resistor, capacitor network. This composite signal is applied through a potential divider VR10 to the non-inverting input of a 741. Feedback resistors R57 and R56 set the gain and a simple high cut filter, adjusted by means of VR2, acts as a tone control. The output to the external amplifier may be varied by the potentiometer VR3.

Fig. 9 shows the complete power supply unit. A 12-0-12V miniature transformer is used, its output being rectified by the bridge rectifier D12-15. The centre tap is at 0 volts providing a dual supply. Three regulators, two of which are cascaded, are used to provide the output voltages of +12, +5 and −12 volts. The supplies must be stable and ripple free to prevent spontaneous oscillation from the sensitive instrument simulators. To prevent an earth loop, which might cause hum, the case and transformer are earthed to the mains supply and the 0V circuit line is left floating.

Next month: Construction and setting up.

Strictly

by K. Lenton-Smith

The British Musical Instrument Trade Fair is held at three London centres simultaneously each year. One of these concentrates on keyboard instruments and, as these interest me primarily, my visit to the Fair mainly consisted of re-exploring the veritable warren of hotel rooms to see what the Electronic Organ Distributors Association (E.O.D.A.) had been hatching over the past year.

AIDE MÉMOIRE

When the programmable calculator started to become commonplace, I wondered how long it would be before certain of its principles were applied to electronic music. The Trade Fair produced one example—the EKO Tivoli Elite Automatic Chord Organ, distributed by John Hornby Skewes of Leeds.

In many respects, this chord organ is conventional, with rhythm unit able to trigger fundamental basses and chords. For the raw beginner finding difficulty in coping with playing both keyboard and chord buttons, the Tivoli Elite provides three memory controls: Program/Play, Reset and Clear.

The sequence of chords is loaded into the memory bank by pressing Major or Minor chord buttons (but not Fundamentals) in the same order that the sheet music suggests, this being a silent operation. Once the sequence has been banked, it can be recalled by use of "Memory Play" control. Each time this control is operated, the next chord is released.

The tiro, thus armed with a memorised chord sequence, can concentrate on reading the right hand part, using "Memory Play" as a master chord button.

SALES

The E.O.D.A. is in business to sell musical instruments and, perhaps surprisingly, the majority of organs are sold to private individuals, rather than groups or clubs. Any demonstrator will confirm that he can sell an instrument if it sounds good in the hands of a prospective purchaser, however inexperienced. Today's instruments are bristling with gadgets to this end and it is difficult to find a "straight" organ on sale anywhere; attempting to buy such an organ inevitably will mean taking a number of non-optional extras.

BAFFLED

Rotating-baffle speaker systems and the name of Leslie are synonymous, their addition on an organ system giving a new and exciting dimension. These cabinets are a difficult proposition for the home-constructor, who usually ends up buying the commercial article.

If considering a purchase, I suggest the Sharma range of speakers is studied. These are manufactured in England despite the Japanese-sounding name (derived from Sharon and Mark, children of the company's owner) and represent very good value.

Two ranges of cabinet are available, for professional and home use, with power outputs ranging between 30W and 300W.

All but the least expensive model in each range is fitted with a treble pressure driver, revolving horns and bass rotor giving tremolo, chorale or straight signals. The technical details are less important than the end result, which is excellent throughout the range.

THE LEADER

The Allen RMI Keyboard Computer has been mentioned previously in this column, but has since been re-designed in some respects. It is neither piano, synthesiser nor organ and contains no oscillators, dividers or filters. It is a musical digital computer and unique in its field.

The present model includes presets for instant changes of contrasting sounds through its stereo system, though a single manual instrument, left and right channel volume pedals allow delicate answering between "Alto Recorder" and "Harpsichord", for example. "Organ" and "Bells" or "Jazz Flute" and "Clavichord" can also be obtained by use of the stereo presets.

This highly expressive instrument has eight foot-controls and, apart from volume, are used for percussion length, sustain, attack/decay, pitch bending, staccato and vibrato. One of the new presets, "Electric Organ", imitates to perfection the drawbars, third harmonic percussion and two-speed doppler speakers of a well known competitor company! All told, this is the perfect keyboard for modern jazz group with money no object.

The Allen organs use digital techniques for tone generation in their instruments. Musical waveshapes, often those of wind-blown pipes, are stored in digital form and can be re-created at any frequency by a high-speed signal processor. Scaling is even across the keyboards and, though complex, the microcircuits are extremely reliable and never need adjustment or tuning. The Digital Theatre Compact organ has its complete generator on a single plug-in board about 25 × 50cm in size.

In addition to the usual tabs round the horseshoe console, most Allen models (including the RMI) have card readers; inserting punched cards will give an endless variety of extra tone colours. The transposer, through five semitones upward and seven downward, provides brilliant key changes without involvement in double flats! This facility might be useful for accompanying singers with a poor sense of pitch.

A feature of the Theatre Compact is the reality of its 16′ solo voices, usually a weak point with electronic organs. Pipe organ realism is enhanced by the "Chiff" stoptab. This makes upper harmonic pitch components speak slightly in advance of the fundamental.

Though expensive by most standards owing to the complexity of the digital generator, the Allen organ is the leader in its field both for serious music or the theatre organ enthusiast.

SYNTHESISERS

The small performance keyboard is now commonplace and selling at a price within reach, often being part of an organ's circuitry. A tab found on many organs this year is "Auto Wah" implying that a v.c.f. is included in the tone forming department even if the specification does not include a complete synthesiser.

The complexity of arpeggiators and automatic chord systems seems to have grown over the past year. Used sparingly and with good taste, these can be a definite performance asset. The Yamaha D Series of organs have an interesting "walking bass", where the pedal notes go through a sequence. This is useful for twelve bar blues and, linked to the rhythm unit, can be made to follow any dance pattern.

Electronic vibrato of the "motorphaser" type appears to be popular in certain quarters, giving a good imitation of the run-up and run-down of a mechanical rotor. However, the high-frequency modulation is never as deep as could be wished for and is more characteristic of a v.c.o. modulated phase-shift system according to my experiments with such circuitry.

The E.O.D.A. might like to consider a gimmick for the 1978 show—a straightforward organ! They may be assured that there is a market for a realistic instrument at a sensible price, as there are plenty of musicians who can already read fluently and are prepared to take up organ-playing as a new venture.

A NYONE who has experienced the discovery of a flat car battery, particularly at the *wrong* end of a journey in the pouring rain, will appreciate the value of being able to watch the battery voltage. Since most modern cars do not have a voltmeter fitted as standard, it was decided to "dream up" a small indicator unit. The circuit arrived at gives the tri-state indication of HIGH, NORMAL, and LOW voltage condition; the two presets providing a wide range of possible settings.

BATTERY CONDITION INDICATOR

P. SCARGILL

PRINCIPLE OF OPERATION

The circuit works by comparing a stable reference voltage level to a fixed ratio of the battery's actual supply level. The reference chosen was about half the theoretical battery voltage, which for most modern cars will be 6V. Zener diodes of around this value do not create too much trouble with temperature variations, although in the final analysis the Zener voltage will not be entirely critical anyway.

As the battery voltage fluctuates due to loading, charging, and its general state of health, it will be compared to the relatively stable reference voltage, and the difference between the two levels magnified by the comparitor to drive the l.e.d.s. These will not indicate by how much the reference voltage has been exceeded or fallen short of, only that one of the preset limits either side of it has been crossed over. Crossing the upper limit will indicate overcharging, and crossing the lower limit will indicate undercharging or overloading.

CIRCUIT DESCRIPTION

Referring to Fig. 1, the reference voltage is generated by R4 and D1, and is fed to the non-inverting input of IC1; the current through R4 being just under 2·4mA. This is compared to (or amplified with reference to) a fixed proportion of the car battery voltage, the ratio being determined by VR1.

Sensitivity to change is controlled by VR2 and R1. This is simply the gain control of the amplifier, and is used to determine how little voltage difference at the input, is needed to reach the l.e.d. threshold levels after amplification.

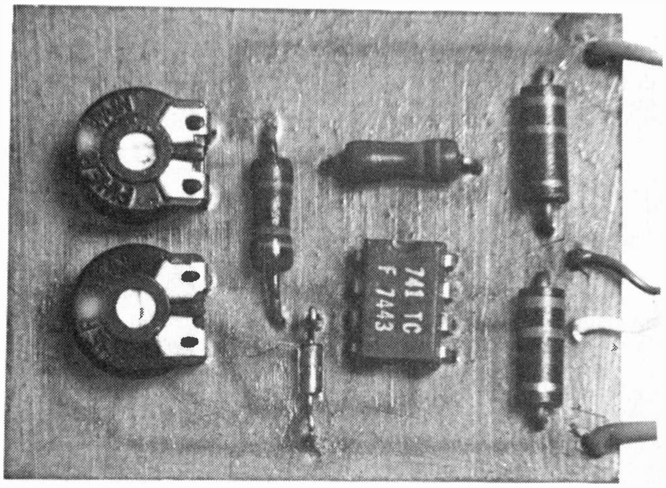
COMPONENTS . . .

Resistors
R1 1·5kΩ
R2, R3 330Ω
R4 2·7kΩ
All 10% ½W carbon

Potentiometers
VR1 10kΩ lin preset
VR2 4·7MΩ lin preset
All miniature horizontal

Semiconductors
IC1 741 d.i.l.
D1 5·6V 400mW Zener
D2 TIL209 red (or similar)
D3 TIL209 green (or similar)

Miscellaneous
FS1 200mA
Flying fuse holder for FS1
Printed circuit board, etc.



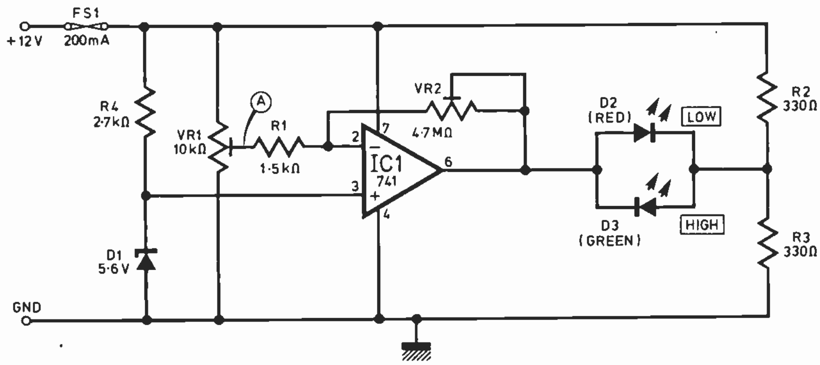


Fig. 1. **Circuit diagram of Battery Condition Indicator. (For positive earth vehicles, simply connect the input supply wires the opposite way around, so that the line through FS1 connects to chassis instead)**

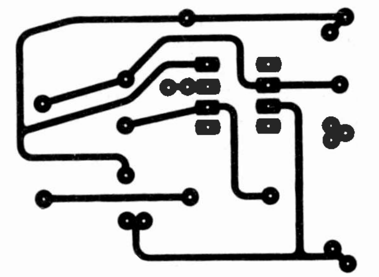


Fig. 2. Printed circuit layout. (Full size)

Since the reference is approximately half the supply voltage, then it follows that the switching mid-point will be roughly correct when VR1 is set halfway. If the battery voltage *increases*, the voltage at point "A" will also increase, and eventually exceed the reference voltage. When this happens, the output of IC1 swings low and illuminates D3. Conversely, if the battery voltage *falls* D2 will light up; and of course the nominal battery voltage will leave both l.e.d.s off. Resistors R2 and R3 limit the current in D3 and D2 respectively, and the maximum current, as a result of these will be around 20mA. Therefore the unit can be wired independently of the ignition switch, since this would take months to drain the average car battery.

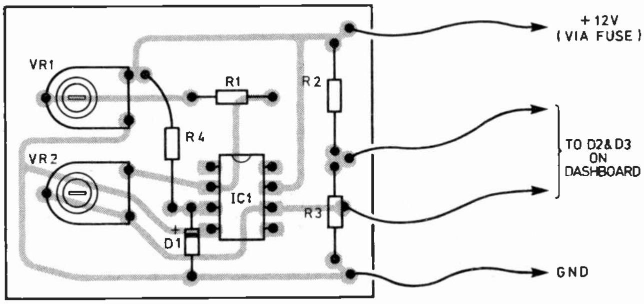
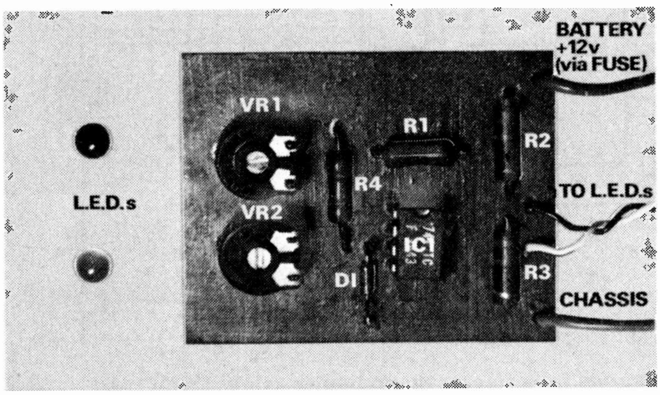


Fig. 3. Component layout for Battery Condition Indicator. A fuse (FS1) should be inserted into the +ve supply wire using a flying lead type fuse holder

CONSTRUCTION

A full size p.c.b. layout is shown in Fig. 2, the component layout of which is shown in Fig. 3. Care should be taken over the correct orientation of IC1 and D1. The l.e.d.s are mounted on the vehicle dashboard in an eye-catching position, and only two leads are necessary for the connection of these. The type of l.e.d.s used is completely a matter of choice, but larger ones will be noticed more readily. It would be a good policy to mount these l.e.d.s away from too much ambient light.

Note that in the photograph the posture of R4 is slightly different to that in Fig. 3. This is of no significance. If the component board is to be mounted behind the fascia panel, there is ample space on the p.c.b. to drill fixing holes.



Tri-state l.e.d.s are now available which will illuminate either red, green, or remain off. These are merely two back to back l.e.d.s in one package, and although one of these is "made for the job", they are considerably more expensive than using two discrete diodes.

The circuit board can be mounted in a box, or simply screwed behind the fascia panel, but it is a good idea to lacquer the component board to protect it against moisture.

SETTING UP

Both presets should be set to midway position, and the unit connected to the car battery *ensuring that the correct polarity is applied*, otherwise IC1 will be damaged.

Assuming that the car battery is at the correct voltage to start with, adjust VR1 until both l.e.d.s are off. If this cannot be achieved, set VR2 for less sensitivity (clockwise) and try again. VR1 should be adjusted to the centre of the "dead zone", and then VR2 re-adjusted to give a dead zone supply variation of ±1V either side of nominal (13V) before a l.e.d. lights up. A wider range than this can be adjusted for, if other applications are envisaged. ★

Semiconductor UPDATE...

FEATURING : LM144 MC14433 ISP-8A/650

R. W. Coles

A SHOCKER

One tends to get a bit blasé about the giant strides made recently in the operational amplifier field; mention of four amplifiers in one d.i.l. pack, or input impedances measured in giga-ohms, stirs hardly more than a bored yawn in these days of rapid microcircuit progress. It was therefore rather nice to be shaken out of this complacency by a warning footnote in the data sheet of a newly available National device, the **LM144** operational amplifier, which refers to the possible *electric shock* hazard to users!

Well, you could have knocked me down with a feedback resistor, electric shocks indeed! While I do admit to cutting my teeth on a beam tetrode, and was at one time well used to the hazards surrounding valve circuits, I really thought that I had put all that behind me when I traded in my ECL82's for the harmless delights of a 741!

Closer examination of the LM144 data sheet revealed that this intriguing device, described as a high voltage, high slew rate operational amplifier, will run from plus and minus 40V supplies, and of course, 80V across a set of well brought up fingers can impart quite a tingle! The LM144 is an externally compensated op. amp available in either a 14 pin d.i.l., an 8 pin metal can or even a 10 pin flat-pack, and it sports a nimble 30V per microsecond slew rate which makes it a very useful addition to the existing range of low voltage devices in applications which demand that something extra.

As an example, an LM144 with a voltage gain of ten can provide a plus and minus 30V swing with a 120kHZ full power bandwidth in applications such as audio power amplifiers or line drivers, so get your rubber gloves on, and start breadboarding!

COLD COMFORT

Available now from Motorola is the **MC14433** CMOS analogue to $3\frac{1}{2}$ digit b.c.d. converter chip. This chip has upstaged most of the competition by offering a full $3\frac{1}{2}$ digit resolution along with auto polarity, auto zero, minimum external component requirement, and of course, all the well known advantages of the CMOS technology, at a very low cost.

The MC14433 coding given to this sophisticated chip makes it "just another member" of the complex function CMOS family produced by Motorola, and not a one-off prima-donna as you might expect. To go along with this "standard function" image, the MC14433 comes in a common-or-garden 24 pin plastics package and costs less than £8 in hundreds, so that you can order it along with your CMOS gates, counters and monostables and treat it like just another building block!

To realise its full potential, you could build it into a sophisticated $3\frac{1}{2}$ digit multimeter with an l.e.d. or l.c.d. display, but because of its low unit cost you can consider using it in much humbler applications too, perhaps to open up whole new areas to the power and convenience of digital measurement and display.

To emphasise the wider application horizons of the MC14433, Motorola have published a design for a 2 digit thermometer for use on domestic refrigerators or freezers which uses very few components and offers high accuracy and low cost. Anyone who owns a home freezer will no doubt appreciate the comforting presence of such a gadget which could put an end to peering at glass thermometers (or even just hoping for the best!). A casual glance at a pair of l.e.d. digits would tell you whether your assets are being kept properly frozen!

SHAPING UP

I recently mentioned the new *n*-channel version of the SC/MP microprocessor, and the increased attractiveness of this low cost device as a result. SC/MP rises even further in my estimation this month thanks to the announcement by National of the **ISP-8A/650** peripheral chip.

The SC/MP systems to date have generally had to rely on standard CMOS or t.t.l. peripheral circuitry, and have not had the benefit of special programmable I/O devices such as those available in the Intel 4040 and 8080, or the Motorola 6800 families. The ISP-8A/650 changes all this by bringing together in one low cost 40 pin plastics package a 128-word by 8 bit RAM array and two multifunction 8 bit input/output ports.

The new chip is made using *n*-channel technology and runs from the SC/MPII 5V supply. Putting it together with an SC/MP MPU chip and a program ROM or PROM gives you a full function microcomputer using just *three* chips. In most systems the new RAM I/O chip could replace around a dozen standard components!

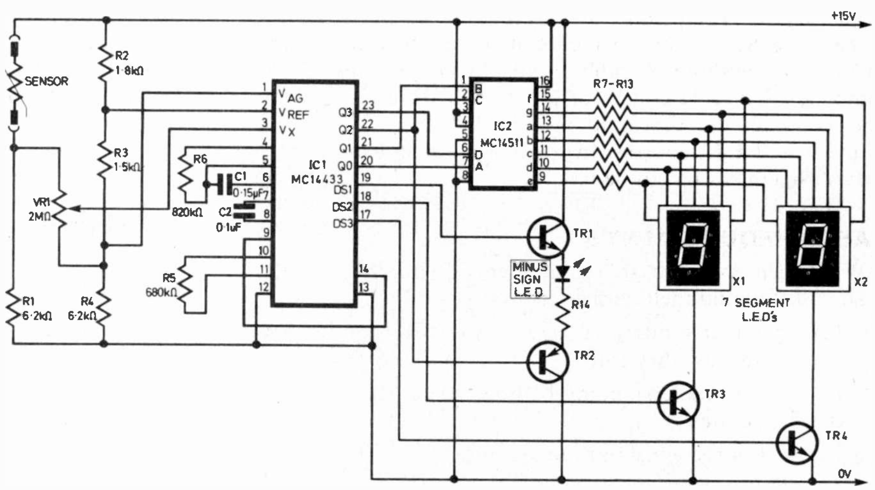


Fig. 1. Circuit diagram for a freezer thermometer using the MC14433

FAULT FINDING PART 1

G. LOVEDAY

A vital new series on the rudiments of faults diagnosis

PROBABLY every experimenter or constructor has experienced the frustration of finding that the circuit he has just built fails to work correctly at switch on, or after a short time in use. Assuming that the circuit has been designed and built correctly, the failure is generally caused by some component fault.

For the newcomer to electronics this can be very discouraging and the causes of failures can seem baffling. However, there are some basic rules to follow in diagnosing faults, and one learns more about electronics in the process.

The skill of rapid fault diagnosis is also very important in Test and Service Departments of the electronic industry, and anyone wishing to enter the profession usually has to complete a suitable course of study at a technical college. For example, the City and Guilds 272 and 222, or one of the new T.E.C. courses. In the final year an examination in fault diagnosis has to be passed.

BASIC REQUIREMENTS

What then are the basic requirements for fault diagnosis? A short list would include the following:

(a) An understanding of the way in which components work and how they fail.

(b) A good understanding of how the circuit or instrument operates.

(c) Skill in recognising fault symptoms.

(d) A systematic common sense approach to the problem.

When, for example, a faulty instrument is returned to a service department the engineer's first job is to define the fault. To do this he has to check the functional performance of the instrument and then list the symptoms associated with the fault. For a complex instrument he then has to narrow down the search for the faulty component by dividing the unit into functional blocks: power supply, oscillator, amplifier, etc. The various methods used for this are dealt with next month.

Let's first of all consider how to diagnose faults in a single electronic circuit such as the simple oscillator shown in Fig. 1.1. Like most oscillators it is made up of an amplifier, a tuned circuit, and a positive feedback loop. R1 and R2 provide forward bias for the transistor amplifier, L1, C1 and C2 determine the operating frequency and a portion of the output is fed back to the emitter in order to maintain the oscillations. All the components are vital for correct operation and should any one of them fail the circuit would stop producing oscillations.

HOW AND WHY DO COMPONENTS FAIL?

Just like everything else an electronic component has a finite operating life. Stresses are acting continuously on all components. These stresses are of two kinds, operating and environmental. The operating conditions of current, voltage, and power are determined by the design and naturally the life can be extended by operating the component well within its maximum rating. Environmental stresses are those caused by the surrounding conditions.

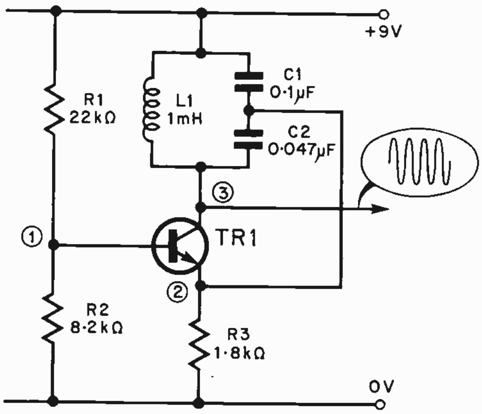


Fig. 1.1. Sinewave oscillator

High humidity, extremes of temperature and mechanical shock and vibration being three that will, if excessive, rapidly reduce the life of a component.

Take for example a resistor. It is subjected to continuous cycles of heating and cooling; this causes it to expand and contract and very slowly its chemical properties change. It becomes brittle and one day it will suddenly fail open circuit. Of course, not all failures are sudden and complete; a component may gradually drift out of specification causing a gradual loss of circuit performance.

Another common cause of component failure is where high voltage pulses or "spikes", generated from switched reactive loads, are transmitted along the mains lines and appear on internal power supply leads. These "spikes" can easily lead to the breakdown of semiconductors.

Table 1 shows the most likely type of failure for different types of components which would appear as follows:

Table 1

Component	Common type of fault
Resistors	high in value or open circuit
Variable resistors (pots)	open circuit or intermittent contact resulting from mechanical wear
Capacitors	short or open circuit
Wound components (inductors and transformers)	open circuit or shorted turns or short circuit coil to frame
Semiconductor devices, diodes, transistors, thyristors, etc.	open or short circuit at any junction

DIAGNOSING FAULTS IN THE CIRCUIT

One component failure usually gives a unique set of symptoms. These being changes in the output signals and changes in d.c. bias levels. Returning to the oscillator, let us imagine that L1 becomes open circuit. A possible fault since the coil is made of relatively thin wire. The signal output would be zero and the d.c. bias voltages, measured with a standard (20kΩ/volt) multimeter at the three test points with respect to zero volts will be:

Test Point	1	2	3
Voltage	1·2V	0·6V	0·7

(meter readings with L1 open circuit)

Whereas the expected readings should be:

Test Point	1	2	3
Voltage	2·4V	1·8V	+9V

(normal readings)

How can we use the first set of voltages to guide us to the faulty component? When L1 is open circuit an equivalent circuit of the fault conditions is as shown in Fig. 1.2. There is no d.c. path for collector current, so the base emitter junction acts as a forward biased diode passing base current only. The voltage at TP2 will be low because current through R3 has fallen. Given the values and the equivalent circuit for the fault you can readily calculate that the voltage on the emitter will be approximately 0·7V and the voltage on TP1 will be about 0·6V above that at 1·25V.

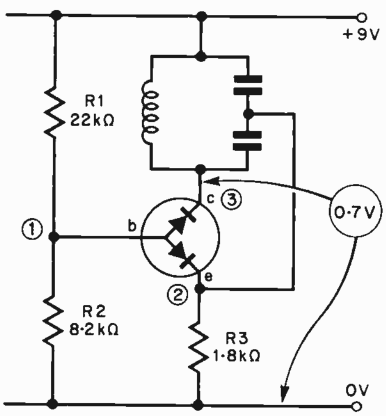


Fig. 1.2. Fault conditions for L1 open circuit

Most readers might assume that TP3 would read zero volts but when a meter is connected from the collector to the 0V rail, the base collector junction acts as a forward biased diode and so a small voltage is indicated.

When you have a set of symptoms for a particular fault try and fit the effects of the component you suspect with these results. Take for example a fault with the following symptoms:

TP	1	2	3
Voltage	0·7V	0·7V	9V

(Fault readings)

Note that the voltage on TP1 is the same as that of TP2 and this indicates a possible short circuit between those points. This would mean a short circuit between the base and emitter of the transistor. If this happens all transistor action ceases, since no emitter current is going to flow across the base into the collector, and the collector voltage should rise. This then is the correct fault, since it fits the symptoms.

Now try your hand at diagnosing the following oscillator fault conditions. The answers are given at the end of the article (Answer (1)). The symptom is no oscillations.

TP	1	2	3
Fault A	0V	0V	+9V
Fault B	2·5V	0V	+9V
Fault C	1·2V	0·6V	+9V
Fault D	2·5V	2V	+9V

FAULTS IN A MORE DIFFICULT CIRCUIT

Many circuits contain d.c. negative feedback loops which tend to complicate diagnosis since a change in bias level at one point usually effects all voltages. A simple series regulator is a good example of this. The circuit shown in Fig. 1.3 is designed to give a relative stable output of 10 volts at 200mA from an unstabilised 15 volt supply. A larger output current can be obtained by mounting TR1 on a heat sink. Remember, if you build the circuit for fault diagnosis, the circuit is not short circuit proof.

Most readers will have a good understanding of the operation but it's worth going over it briefly. TR1, the so called series control transistor, acts like an emitter follower so that an output voltage is provided across the potential divider R3, VR1 and R4.

A portion of the output voltage selected by VR1 appears on the base of TR2, the error amplifier, and this voltage is compared with the reference voltage from the Zener diode. Since the Zener has a fairly constant voltage across it any change in output voltage causes more or less current to flow through TR2. The output of TR2 is used to control the base of the series element TR1. Thus, if the output voltage falls, caused by an increase in load, TR2 conducts less, its collector voltage rises and TR1 is turned on more to correct the original fall in output.

When the circuit is working correctly and supply a 200mA load current the voltages at the test points are:

Test Point	1	2	3	4
Voltage	10·7V	6·05V	5·2V	19V

normal readings

Let us start by imagining a fault caused by an open circuit Zener diode. We should expect an unstabilised output with higher ripple, and this in fact would happen. Since the emitter voltage of TR2 rises towards the unstabilised input (+15V) the output must also rise because TR2 is cut off. However, the output voltage will not rise much above +12V because the load current requires that TR1 be supplied with base current resulting in a volt drop across R2. If the load is disconnected the output voltage will increase.

The fault conditions are:

Test Point	1	2	3	4
Voltage	13V	12·3V	15·2V	12·3V

D1 open circuit.

Naturally other faults will cause the output voltage to rise and for stabilisation to be lost. For example R3, VR1 or TR2 base emitter open circuit would do this. The particular symptom that points to D1 open circuit is of course

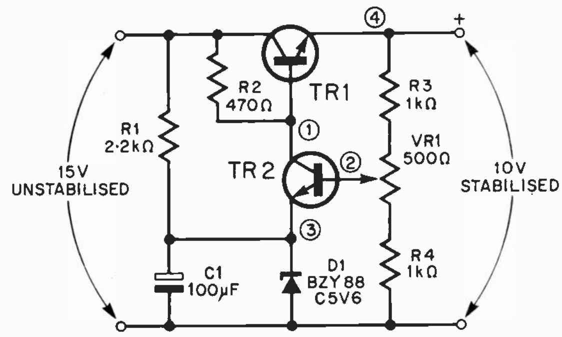


Fig. 1.3. Representative series regulator

that TP3 has risen to +15·3V. What then would be the symptons for R3 open circuit? (See Answer (2) at end of article.)

Electrolytic capacitor C1 is included to reduce the amount of ripple on the reference voltage. Consider the effect of this becoming short circuit. The emitter of TR2 becomes zero volts, and this causes TR2 to conduct hard. TP2 falls to about 0·7V setting up a voltage of about 1·3V at the output (TP4). This means that TP3 must be at about 2V, that is 0·7V greater than TP4. The output voltage must be about twice V_{be} of TR2 because of the potential divider R3, VR1 and R4.

Voltages for C1 short circuit:

Test Point	1	2	3	4
Voltage	2V	0·7V	0V	1·3V

Finally, try and diagnose faults from these symptoms. Voltages measured with 200mA load. (Answer below)

Test Point	1	2	3	4
Fault A	0V	0V	5·2V	0V
Fault B	14·8V	0V	5·2V	0V
Fault C	7V	5·9V	5·3V	6·2V
Fault D	1·5V	0·67V	5·2V	1·5V
Fault E	13V	7V	5·2V	12·3V

ANSWERS

(1) **Fault A** R1 open circuit.
Fault B Base-emitter open circuit.
Fault C Collector open circuit.
Fault D R3 open circuit.

(2)

TP	1	2	3	4
Voltage	13V	12·3V	5·2V	0V

(3) **Fault A** R2 open circuit.
Fault B Base/emitter open circuit.
Fault C R4 open circuit.
Fault D TR1 b/e short circuit.
Fault E TR2 b/e open circuit.

Next Month: Fault finding on systems

FRANK W. HYDE

SOYUS/SALYUT

The failure of the Soyus 25–Salyut 6 mission was the eighth time of disappointment for the Soviet space commission. Thirteen launches of spacecraft had been made during the year, so it would appear that there is some special reason for such a high rate of loss. In proportion this failure was the second for 1977 in the Soyus/Salyut programme, and the sixth mission in which procedural errors or the malfunction of equipment was involved during docking or in the rendezvous area.

There is a standard procedure in the Soyus/Salyut docking missions for the Soyus to be automatically guided through the rendezvous stage until it closes within 300 feet of the Salyut space station. At this point control is taken over by the commander who executes the remaining manœuvres and docking. This is done by manual control of the thrusters. The vehicle had reached this point when the trouble became such that the mission could not be completed normally. It seems that during the manual sequence it was not possible to reach a safe closing-in speed for the Soyus. One thing that seems to have had some place in the failure, was that the final positioning of the spacecraft took somewhat longer than usual. Normally the actual link up would take place at the 17th orbit. In this case it was necessary to go to 18 orbits.

Some direct information on the activities of the cosmonauts has been given by the Observer Group at Kettering School, who have become very expert under the guidance of Mr. Cooper in plotting Soviet space activities. Several conversations between the cosmonauts and the ground station were recorded at this time. This indicated that there had been an attempt at orbit 17 to initiate the preliminary techniques. However on the 18th revolution Kettering heard none of the usual discussion about the equalising of pressures which takes place after a docking. On revolution 19, Kettering heard a systems check which was normal and suggested that no problems seemed to be involved. American observations revealed that the two spacecraft were close together, and seen as one object up to at least orbit 25.

The inability of the Soyus to dock certainly meant an immediate return to earth of the vehicle and crew. Soyus missions have the facility to operate on batteries for at least two days. This enables the solar sails to be jettisoned to allow for speedier manœuvring. The return to earth of a vehicle means in any case that the docking section cannot be examined, because it is jettisoned before re-entry.

SOVIET METEOR 2

On June 29, 1977, the Soviet Space Agency launched their first vehicle into a 98 degree sun-synchronous orbit. This is a multispectral equipped vehicle, and two scanners are involved. One is two-band and the other is four-band.

The two-band unit is designated the MSUS, and this instrument operates in the 0·5 to 0·7, and the 0·7 to 1·1 micron bands. The resolution in these bands is 250m, with a swath of 2,000km at a height of 900km. The four-band unit operates on the same band as the USA Landsat spacecraft. The resolution on these bands is 1,000 × 1,600km, with a swath of 2,800km at a height of 900km.

Although this degree of resolution does not approach that of the US spacecraft, there is the advantage that repetitive plots are made every two–three days as against the US nine day intervals. The level of resolution is, however, *not* sufficiently high to merit computer enhancement. In the Soviet Union the data obtained is being put to use in a number of environmental and economic spheres. These are:

Atmospheric Research. The effect of air pollution was being studied by monitoring the amount of snow melting due to increased absorption of solar energy caused by pollution laden air. Dust storm boundaries were being monitored by the four-band instrument.

Snow Surveys. Snow cover registered over Siberia was to within 5% of the total area by the two-band equipment, and within 15% of the total by the four-band equipment.

Geology. Continental and regional structural units have been monitored, and geotectonic maps have been produced, on a scale of 1 : 5 million for 50 million kilometres. The extremely wide field of view has been used to define extra large fault lines and massive circular structures which would have required image mosaics to observe by any other method.

Agriculture. Both the two- and four-band instruments have been used to examine vegetation stress conditions. The grazing grass over an area of 50 million hectares has been assessed to within 100kg.

INTELSTAT 5

This satellite, to be launched in late 1979 will be provided with flight tested instrumentation which has been emphasised as a prerequisite for efficient missions in the future. This design will have an improved capacity over the Intelstats 4A. There will be 12,000 two-way circuits which will double the capacity compared to the 4A design. There will, however, be a number of departures from the previous designs. Intelstat 5 will be the first to use the 14/11gHz (K band) region of the radio frequency spectrum as well as the traditional 6/4gHz (C band) region. The total band width will therefore be 1gHz. The uplink is at the higher frequency and the down link is at the lower frequency. Frequency re-use is by both spacial and polarisation diversity. Three axis stabilisation of the vehicle is installed, and is to be launched by shuttle.

New technology is going to be introduced. Although the tried and tested travelling wave guide systems are being retained, the introduction of graphite fibre reinforced plastics for antennas will be a great advantage. The structures too will benefit from these techniques. In some cases the solid state technology will be fully exploited in order to reduce weight. But since the innovation of new techniques is largely governed by ministries, it may be some time before the field effect transistor replaces the tunnel diode in spite of superior performance.

There are six communications antennas which link the spacecraft with the Earth. The down link operates on 4gHz having an 88 element feed array. Each feed horn produces a small spot beam whose phase and amplitude are controlled by an associated feed network. The individual beams merge to form a composite beam of the proper shape and offset to serve the desired area of the Earth's surface.

There is a 6gHz hemizone receive uplink antenna, a 4gHz global coverage transmit horn, a 6gHz global coverage receive horn, and two identical 14/11gHz spot beam antennas. Each of these spot beams generate uplink and downlink beams.

The spacecraft is to be kept to within ±0·1 deg. of its assigned longitude, and ±0·1 deg. of its equatorial plane. Other limits for pitch, roll and yaw are not yet given, but it is expected that they may be in the region of ±0·2 deg. in roll and pitch, with a limit of ±0·4 in yaw. The power supply is by solar cell, and cadmium batteries which will operate during eclipse periods. The total power available will be 1,205 watts.

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Input Impedance	100,000 Ohms
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Maximum Current Drain	200 mA @ 10 volts
Maximum Input Frequency*	10,000 Hz 50% duty cycle
Operating Temperature Range	0°C to 50°C
Weight	3 ounces (85 grams)
Maximum Dimensions	4.0 x 2.0 x 1.8" 102 x 51 x 45 mm

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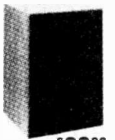

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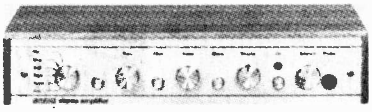

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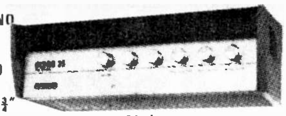

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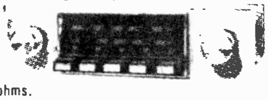

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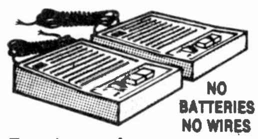

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4 7	04½p	05p	05½p	06p
6 8	05p	05½p	06p	07p
10	05p	06p	07p	09p
22	06p	07p	09p	13p
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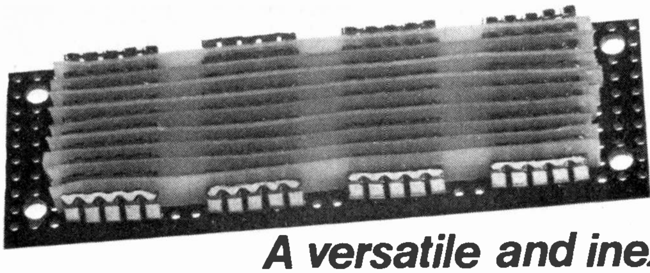


Build it yourself... BREADBOARD SYSTEM

A versatile and inexpensive experimenters breadboard

By D.F.McGINLEY B.Sc.

THIS breadboard system is designed to facilitate developing, or experimenting with circuits without the need for continual soldering and desoldering. It not only saves time, but also reduces the risk of burning components and/or fingers.

The board can accommodate i.c. packages with up to 20 pins, as well as discrete components, but the concept is capable of being expanded to any desired size. It is constructed from Veroboard and i.c. socket strip (200 sockets).

CONSTRUCTION

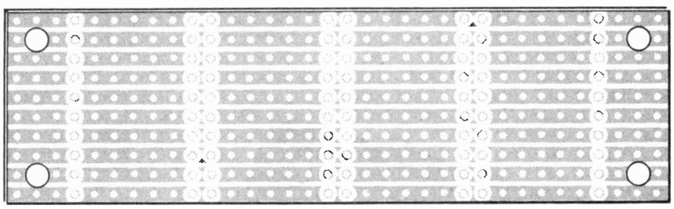
The Veroboard is cut according to Fig. 1 which gives four groups of 10 electrically separate modes, each mode having sockets. The i.c. socket strip is cut and trimmed as in Fig. 2, and the sharp edges are removed with a file. The socket strips are then inserted in the Veroboard.

SOLDERING

Each group of ten strips is retained in the Veroboard using a spare finger, and one end of each strip is soldered. When all strips are secure, each joint is resoldered while its respective strip is positioned perpendicular to the board. The other end pins of the strips are then soldered. The three inside pins of each strip are not soldered.

INSULATION

Because of the close proximity of the stocket strips on the board, it is necessary to provide insulation between



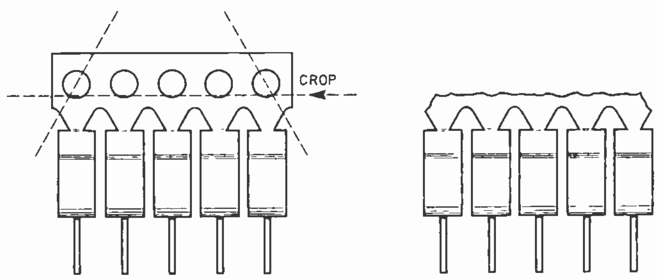
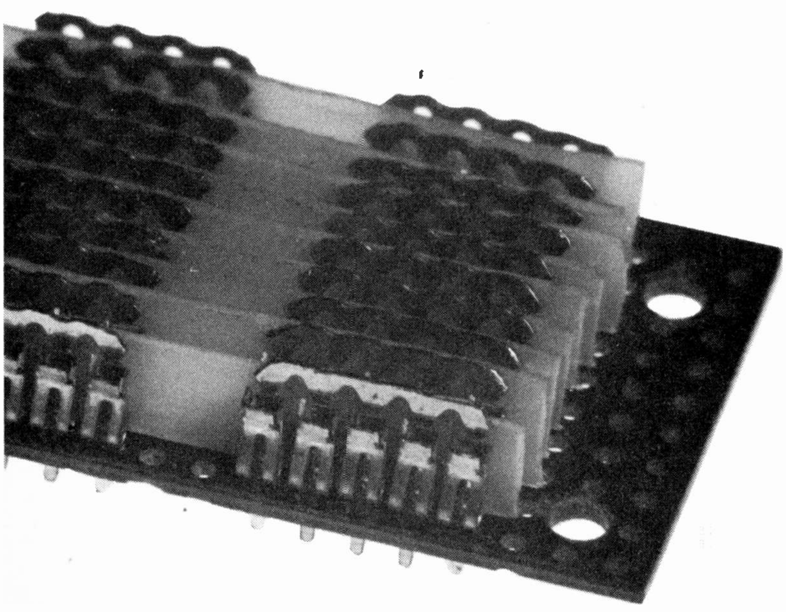


Fig. 1 (above) Veroboard cutting arrangement

Fig. 2 (above right) Modification to the i.c. socket strips



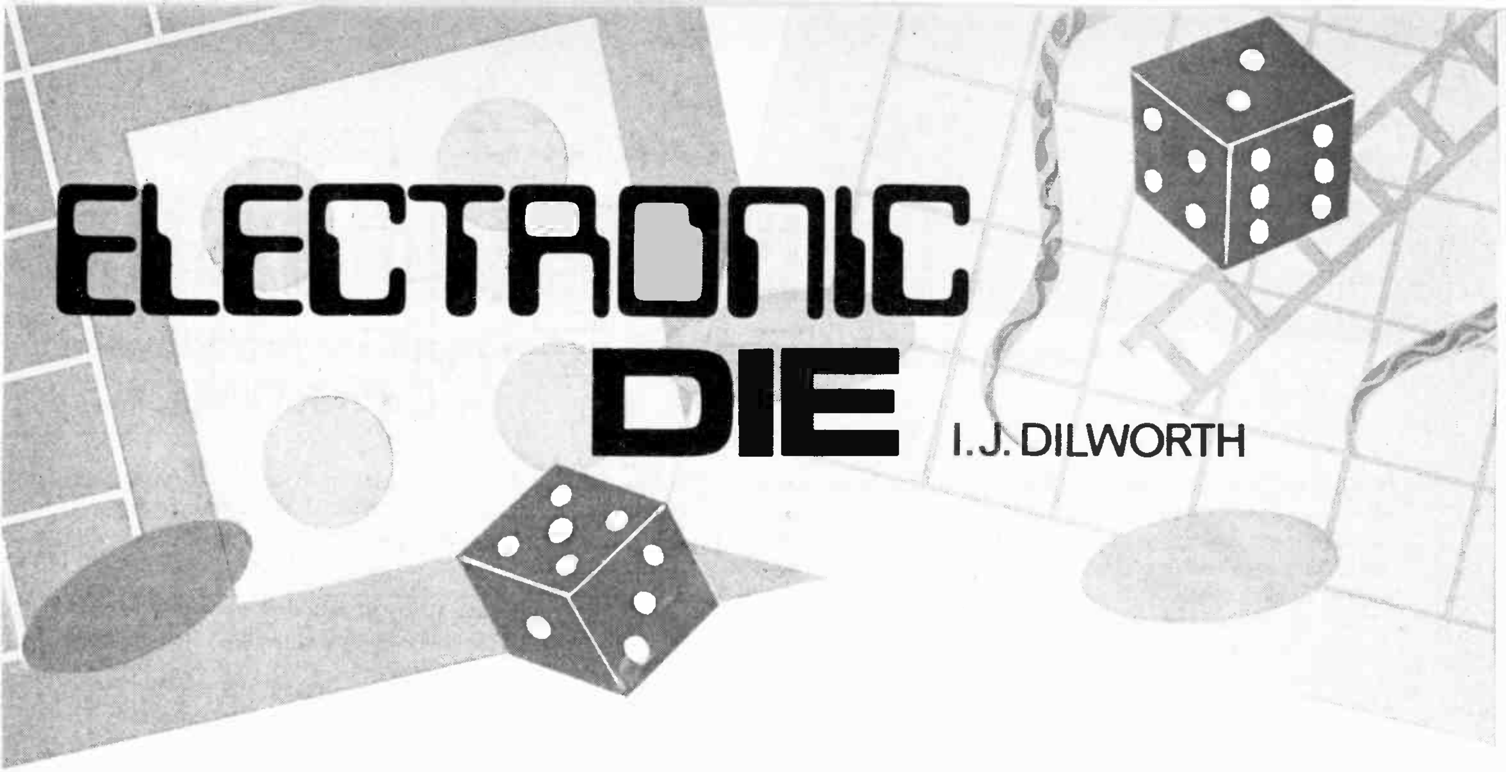
adjacent rows of sockets, to avoid accidental shorts between rows. Any insulating material will be sufficient, but 6mm strips of thin plastics material, 110mm long, cut from an ice cream container proved to be very suitable. These are inserted between the socket strips and also help to maintain the alignment of the four groups of sockets.

MOUNTING

The board is mounted on a small block of wood, being held just clear by spacers on the screws. A piece of hardboard, with several suitably sized holes drilled in it, may be screwed to the block to serve as a panel for holding switches, pots and sockets.

USE

External connections to the board, and jumper leads between strips should be made from single core bell wire. The board as designed is capable of accommodating a wide variety of circuits, and with reasonable care, should give long and trouble free service. Should any of the sockets become deformed after prolonged or over enthusiastic use, it is an easy and inexpensive matter to remove the offending strip, and replace it with a new one. ★



ELECTRONIC DIE

I. J. DILWORTH

Ideal for many board games

THE basic idea for this electronic die developed with the idea of having a hand-held unit that would be small and have a long battery life. Because of the latter it was desirable to display a number from the die by simply switching the unit on by depressing a pushbutton; releasing the push-switch isolates the battery and switches the unit off.

The display, in the H format, consists of seven light emitting diodes gated in such a way to produce the six required numbers.

To obtain a random number from the die a high frequency multivibrator is gated on and off by a much slower read rate oscillator. By making the mark to space ratio of this read rate oscillator large and the frequency of the other multivibrator high. sufficient difference in the number of cycles allowed through into the display each read rate pulse is assured and the randomness in the decoded number does not appear weighted toward any number.

DESCRIPTION

To decode in binary the required number of states, three JK flip-flops are required. In this design DTL 9093 devices are used, two being contained in one 14 pin dual-in-line package.

To fully decode the seven diode matrix of l.e.d.s the minimum gating required is two, two input NAND gates and one three input NAND. Conveniently one can use three, three input NAND gates contained in one package, i.e. SN7410 strapping the inputs on two of the gates.

Reference to Fig. 1 the circuit diagram, will show that the three JK flip-flops are connected in series, the decoding takes place as indicated in Fig. 2 which shows total display.

On binary seven Q2 and Q3 are reset leaving inverse Q1 output high and hence D1 on since this is connected to Q1.

Author's prototype, although any box can be used

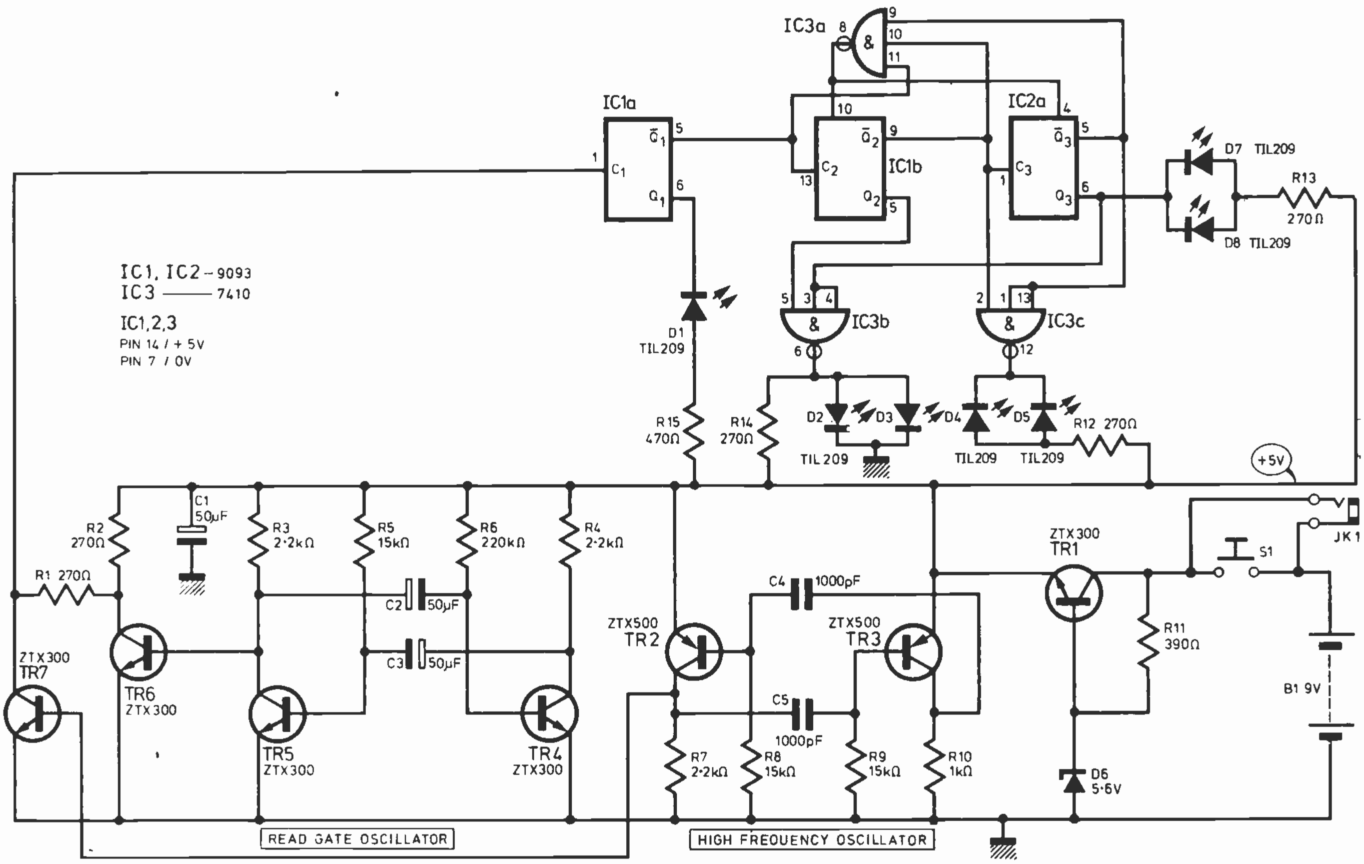


Fig. 1. Circuit of die

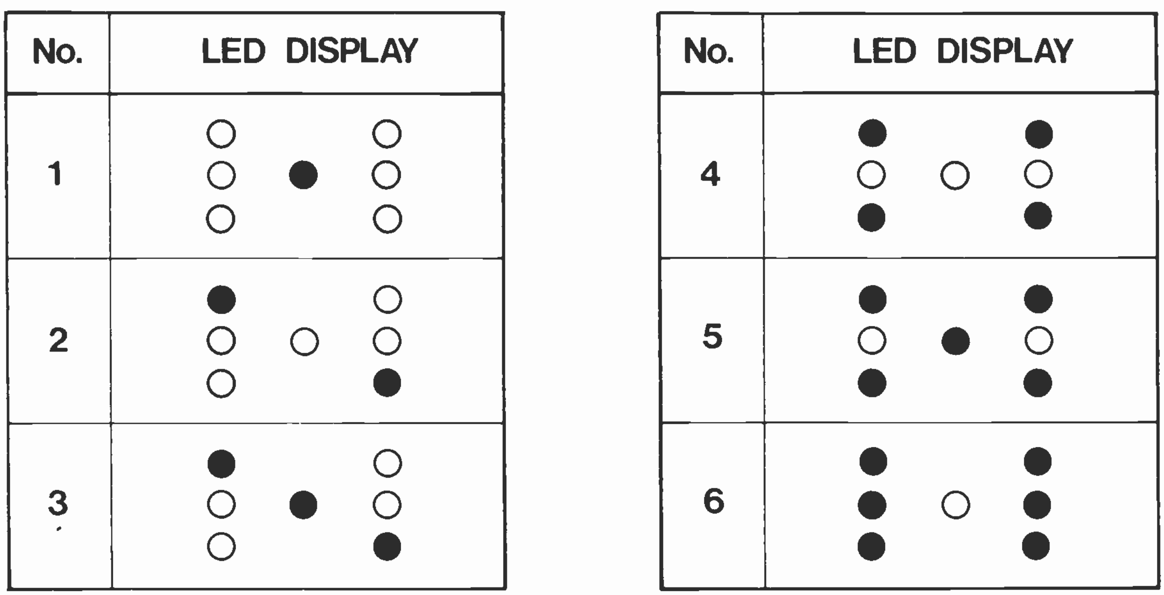


Fig. 2. Showing the l.e.d. display for a count up to six

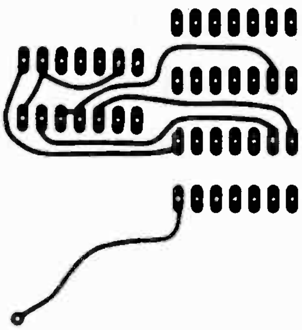


Fig. 3. Upper side pattern of the main p.c.b. shown full size

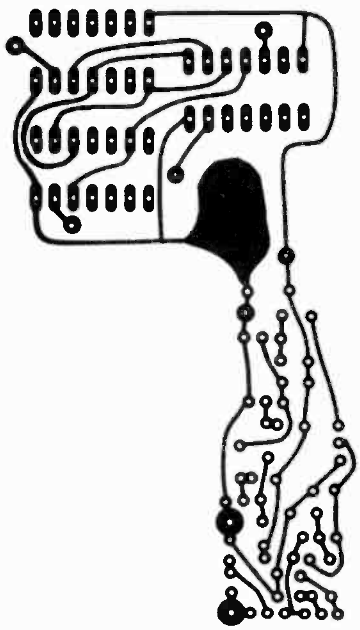


Fig. 4. Lower side pattern of the main board shown full size

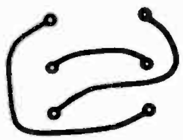


Fig. 5. Upper side pattern of the display board shown full size

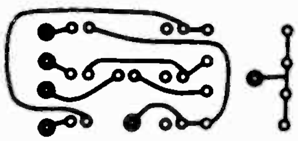


Fig. 6. Lower side pattern of the display board shown full size

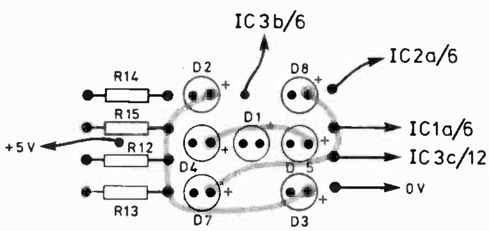


Fig. 7. Component layout of the display p.c.b. (upper side) note that the print pattern shown is of the upper side with underside connections shown with blobs

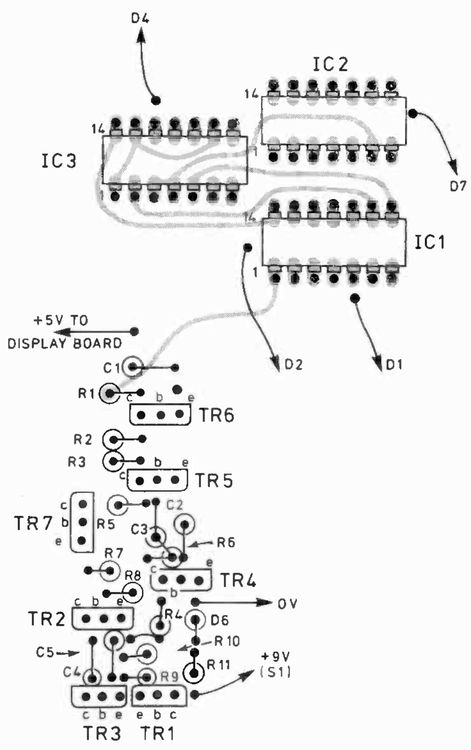
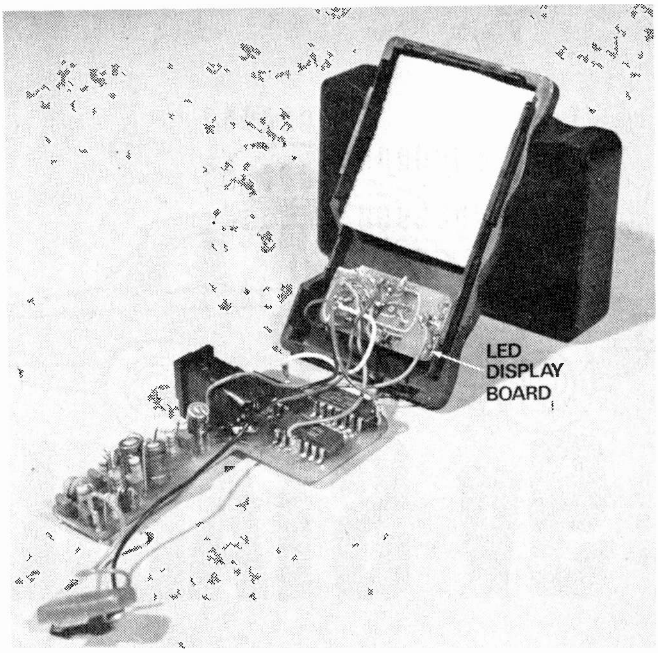


Fig. 8. Component layout of the main board (upper side). Print pattern shown is of the upper side with all underside connections shown with blobs

Table 1

No.	$\bar{Q}1$	$\bar{Q}2$	$\bar{Q}3$
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

Table showing the binary decoding necessary to drive the l.e.d. display



Interior view of die

As can be seen gate IC3a resets the two flip-flops when the three input lines correspond to 111. Similarly gate IC3c decodes two l.e.d.s concerned only with displaying six. By considering the various states indicated in Table 1 one can follow how the decoding works.

Transistor TR7 feeds 0–5 volt pulses into IC1a on the first JK flip-flop input. TR3 and TR2 constitute a multivibrator oscillating at approximately 50kHz. This square wave is fed into the base of TR7 continuously but only appears at the output on collector TR7 when TR6 is off. TR6 is gated on and off by the multivibrator TR5, TR4.

TR1 drops the 9 volt battery to 5 volts while providing good regulation until the battery is finished. C1 is included to avoid the 50kHz being modulated with multivibrator pulses from TR4, TR5 so avoiding any possible synchronisation.

CONSTRUCTION

A double sided printed circuit board is shown in Figs. 3 through to 8. Construction whether on the printed circuit board or other means is straightforward but it is very necessary to ensure the l.e.d.s are the correct way round before soldering them in.

THE DIE IN USE

Once S1 is depressed pulses are immediately fed into C_1 because TR6 should be hard off in this initial condition. The first number to be displayed will thus appear almost simultaneously, keeping the button down; the display will be seen to gate again after a display period of approximately 1–2 seconds. This will be recognisable because all the l.e.d.s will glow softly for a very short period, another number will then be displayed; this process continues as long as the die is left on.

Games such as Monopoly require two throws of the die and conveniently by leaving the die on, two numbers are displayed then the die is passed around. Unfortunately in the heat of play distrust does sometimes creep in when getting say two sixes. To avoid this a jack socket with a plug and extension lead complete with pushbutton wired in parallel with S1 facilitates leaving the die in the middle of the board where everyone can seen the number thrown, merely passing the pushswitch round when one has had a go. The PP3 battery when used in this way proves economical, consequently a larger battery is not needed making miniaturisation of the whole unit easy. ★

COMPONENTS . . .

Resistors

R1, R2, R12, R13, R14	270Ω (5 off)
R11	390Ω
R15	470Ω
R10	1kΩ
R3, R4, R7	2·2kΩ
R5, R8, R9	15kΩ
R6	220kΩ
⅛ watt (carbon)	

Capacitors

C1, C2, C3	50μF 6 volt electrolytic
C4, C5	0·001μF disc ceramic

Semiconductors

TR2, TR3	ZTX500
TR1, TR4, 5, 6, 7	ZTX300
IC1, IC2	9093 (Bi-Pak)
IC3	SN7410
D1–5, D7–8	TIL209
D6	5·6V 200mW Zener

Miscellaneous

PP3 battery snap and 9V battery
Pushbutton switch
Miniature jack socket

9v STABILISED P.S.U.

C.H. BANTHORPE

ALTHOUGH car radios and tape players are fitted into some cars, many less endowed motorists would like to use their domestic battery-operated radios, radio/recorders or recorders in their cars at times such as during holidays, long journeys or more permanently and would prefer to use the car battery supply instead of the internal costly dry batteries. This article describes a unit which can be used for such a purpose.

Measurements have shown that under normal operating conditions the nominal 12V available from the car battery can vary from 10V to 14·5V, a tremendous variation, and means must therefore be provided to obtain from such a varying input voltage an output voltage which varies very little from the one required, such as 6V, 7·5V or 9V.

It is a highly desirable feature of any circuit but particularly one for constructors that excellent performance is designed in and no adjustments or tailoring of component values is necessary when it is made up. This circuit has this feature.

CURRENT LIMITING

The energy available from a car battery is very considerable indeed and it is not impossible for wiring damage to result from breakdowns or accidental short circuits in equipment connected to a car battery system unless safety measures are taken. This unit includes such measures and its outputs can be short-circuited indefinitely without any ill effects. Under such conditions the output current falls to a low value and remains almost cut off until the short circuit is cleared.

The components used are not critical and similar alternatives should be quite satisfactory. Silicon transistors and diodes should be used, however, because they operate satisfactorily at higher temperatures than germanium types.

THE CIRCUIT

The circuit is shown in Fig. 1 and may first of all be considered with D3 omitted and D2 short-circuited. It will then be seen to consist of a stabilised voltage provided by the Zener diode D1 fed from the unstabilised input via R1.

To this stabilised voltage point is connected a complementary emitter follower TR1 and TR2, the output being taken from the emitter of TR1 which is also connected to the collector of TR2. If the circuit was used in this form it would provide a stabilised output voltage of about 0·5V lower than that of the Zener diode, but if the output was overloaded, particularly if it was short-circuited, the transistors would be destroyed.

The inclusion of D2 prevents the output current rising beyond a chosen limit. For a given set of other components the maximum current is determined by the value of R2 and when this current is reached D2 becomes reverse biased and ceases to conduct. Even if the output is short-circuited the output current will not increase beyond the chosen value. However, under such conditions TR2 would have the full input voltage applied across it and as it would also be passing maximum current it would be dissipating maximum wattage. Unless means were provided to dissipate the heat generated by this wattage, TR2 would become overheated and damage result. Much more cooling would therefore have to be provided than necessary

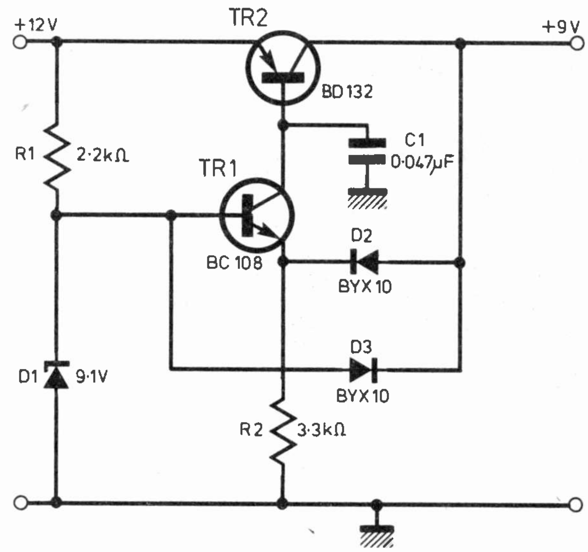


Fig. 1. Circuit of stabilised p.s.u.

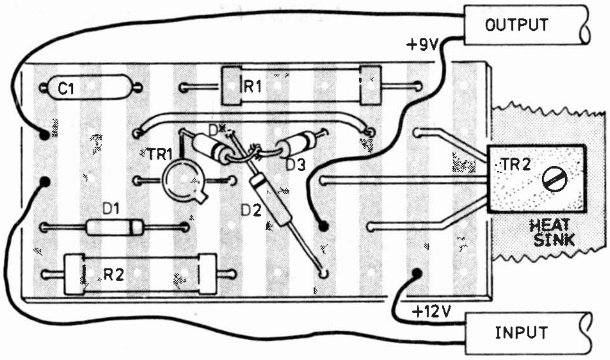


Fig. 2. Veroboard layout and track cutting details

under all conditions except severe overload such as a short circuit.

If D3 is included such a severe overload causes the diode to conduct, the Zener diode is almost shorted out, TR1 and TR2 become almost non-conducting and the short circuit output current is determined mainly by R1 in series with D3 and the output load or short circuit all across the battery circuit. This current is very small so under severe overload conditions the power dissipated in TR2 is negligibly small and cooling arrangements for normal output only need be provided.

CHANGING THE OUTPUT

In this circuit the output voltage is almost exactly that of the Zener diode used and an output of 6V, 7·5V or 9V may be obtained by merely fitting a Zener of the appropriate voltage. No meter is needed for setting-up purposes. The normal current required by the sort of load for which this unit was designed is up to 150mA and a current of at least 250mA has therefore been made available to provide an adequate margin.

There is a possible problem of starting current which in the case of brush type recorder motors is very much higher than the run current. It is this characteristic which makes them attain their running speed very quickly and is why they are so suitable for cassette recorders. However, the starting current can be up to ten times the run current and it is possible that with some recorders the unit as shown will not start up if the recorder is switched on before power is applied to the input of the stabiliser.

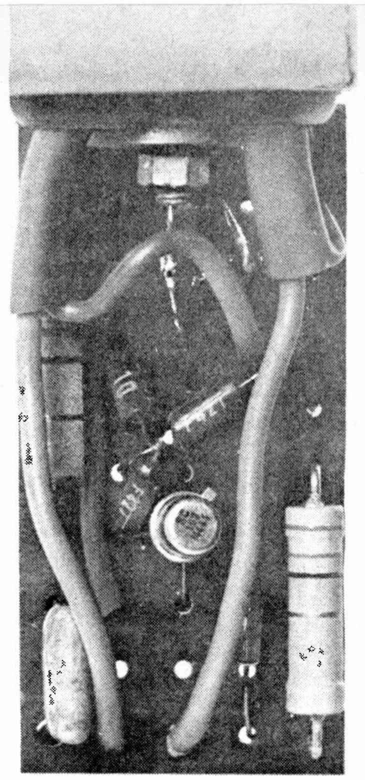
COMPONENTS...

Resistors
R1 2·2kΩ
R2 3·3kΩ
½W 10% carbon

Capacitor
C1 0·047μF polyester film

Semiconductors
TR1 BD132
TR2 BC108
D1 BZY88C9V1 9·1V 400mW Zener
D2, D3 BYX10 (2 off)

Miscellaneous
Veroboard, heat sink, nuts, bolts and lock washers.



If this is regarded as a drawback it can be overcome by putting another similar diode in series with D3. Although the short circuit current is then somewhat higher than when one diode is used it is very much less than with no diode and no starting problem will arise.

Capacitor C1 is included to eliminate any possibility of the circuit oscillating at high frequencies.

PERFORMANCE

The unit described has been used in a typical family car to operate a cassette recorder and has given no trouble. At an output of 100mA the voltage varies from 9·08V to 9·13V if the input voltage varies from 10V to 15V.

At a steady 12V input the output voltage varies from 9·1V to 9·05V if the output current varies from 100mA to 250mA.

The output current into a short circuit is 10mA.

CONSTRUCTION

The layout of this unit is not critical as indicated in Fig. 2.

It is not always realised just how difficult are the conditions in which the "electrics" in cars operate. Vibration and temperature variations are two of the real environmental hazards. Anything which can vibrate loose or break loose will do so. Leads, components and screws must be very secure, particularly with any sub-assemblies constructed.

The temperature in a car can vary from below freezing to 55°C or above during a year and due regard of this must be taken when choosing components.

Where no convenient connection, such as a cigarette lighter socket, is available it is quite simple to run a separate lead or leads to the car battery or fuse box, but a fuse should be incorporated somewhere in the "live" lead.

The easiest way of doing this is by means of a lead mounted fuse if a lead is taken directly to the battery. If the lead is taken to the fuse box it is best to choose the position, often marked "AUX", which connects to such things as the clock, roof lamp, heater, etc. Failure of wiring will not then put the car out of action. ★

MARKET PLACE

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

GOOD STYLING

Futuristic designs is the aim of a newly formed design and fabrication house, **Viglen Acrylics Ltd.,** who offer a full range of services in the supply of acrylic parts and components. The company's particular skills are in the forming and blending of nitricate shapes to customers' designs or even undertaking the complete design themselves.

A team of artists and designers work closely with the formers and "blowers" to produce new and novel combinations. Thus customers seeking to update existing products can place the project with them even if the original object was made, for example, in wood or metal.

A typical example of their work is shown in our photograph of a hi fi console. This complete system consists of a cassette player/recorder, transcription turntable, amplifier and tuner installed and tested in a plastics pod. The complete system would retail for less than £500.

The console comprises a pair of 750mm acrylic hemispheres, the lower opaque and the upper translucent. Standard colours are white base and bronze lid, but other combinations can be supplied to customers' choice. Provision of cut-outs and apertures, upper deck and internal shelving, and, if required, the angled mounting or operating controls.

Final parameters are material and application dependent, but in general bubbles can be supplied to 812mm (32in) diameter and beyond. Other shapes are available but this is dependent on sheet dimensions. In-house facilities include normal engineering functions such as turning, drilling and bending.

Further particulars of this design service can be obtained from **Viglen Acrylics Ltd., Dept. P.E., 2 Madrid Road, London, SW13.**

DISPLAY CABINET

With so much happening recently in the field of microprocessors and t.v. games, particularly in the constructor magazines, it is interesting to see that **Mentor Electronics** have just introduced a universal cabinet for V.D.U's.

Ideal for such applications as computer terminals, t.v. games, audio equipment and test gear, the Jubilee cabinet is injection moulded from Noryl high-impact thermoplastic material. It has a moulded-in blower opening, which could be used for a small speaker grille, ventilation grilles and component mounting pillars and bosses.

The front keyboard plate is held in place by an acrylic screen. The cabinet is available unpainted or painted in a textured black and light grey.

The Jubilee housing measures 533mm × 493mm × 387mm, costs £79 and is available from **Mentor Electronics Ltd., Dept P.E., Ryefield Crescent, Northwood, Middlesex, HA6 1NN.**

ADJUSTABLE VICE

A precision made bench vice which should interest both the model making and electronic constructor enthusiast is now available from **Greenwood Electronics,** manufacturers of professional soldering irons and equipment.

The Oryx Model 1B vice is a versatile tool with 89mm jaws and is fully adjustable to rotate through 360 degrees and can be locked in any position. The vice is equipped with nylon jaw linings giving a firm grip with no damage to the work piece. Jaw linings are replaceable. The main components of the vice are cast in high tensile strength lightweight alloy and finished in stove enamelled green.

Cost of the Oryx 1B bench vice is £19·95 plus VAT at 8 per cent and is available from **Greenwood Electronics, Dept P.E., Portman Road, Reading, Berks, RG3 1NE.**

NEW TURN

Coinciding with their move to new trading premises, **Trueturn Electronics** have regraded their popular standard TT wirewound potentiometer series into three classes. Grade "A" devices are guaranteed to have a ±1 per cent linearity and resistance tolerance. Grade "B" are guaranteed to ±3 per cent and grade "C" ±5 per cent, but nearer to 3 per cent linearity in practice.

The overall resistance range has been extended to 47 ohms and 47 kilohms.

The grade "A" range is more suited to applications in telecommunications and instrumentation. While grade "C" range is more suited to commercial and constructors less stringent requirements.

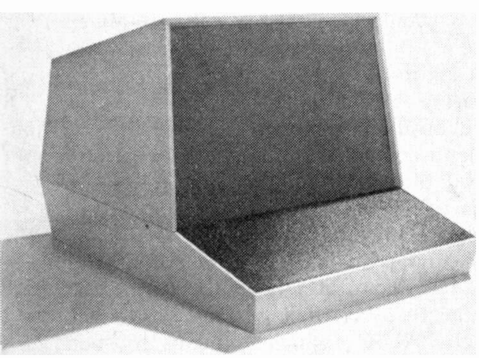
Further details, prices and nearest stockists can be obtained from **Trueturn Electronics Ltd., Dept. P.E., 2/3 Golden Square, London, W1R 3AD.**

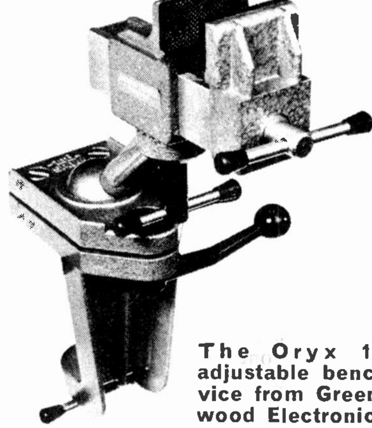
NOTE

We have been asked by **Semiconductor Specialists** to point out that they are not able to deal with individual enquiries or orders for the kit of piano i.c.s mentioned on page 7 of our Supplement in the November 1977 issue.

All enquiries and orders for these chips should be placed with **Maplin Electronic Supplies, P.O. Box 3, Rayleigh, Essex SS6 8LR.**

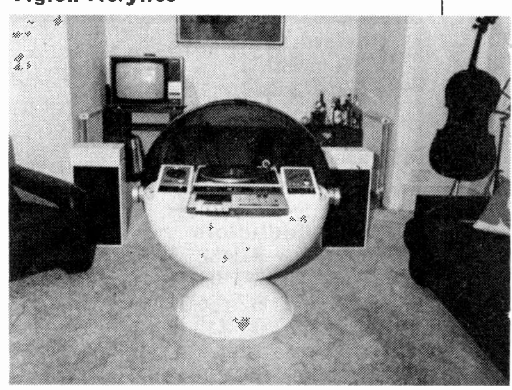
Jubilee universal cabinet from Mentor Electronics

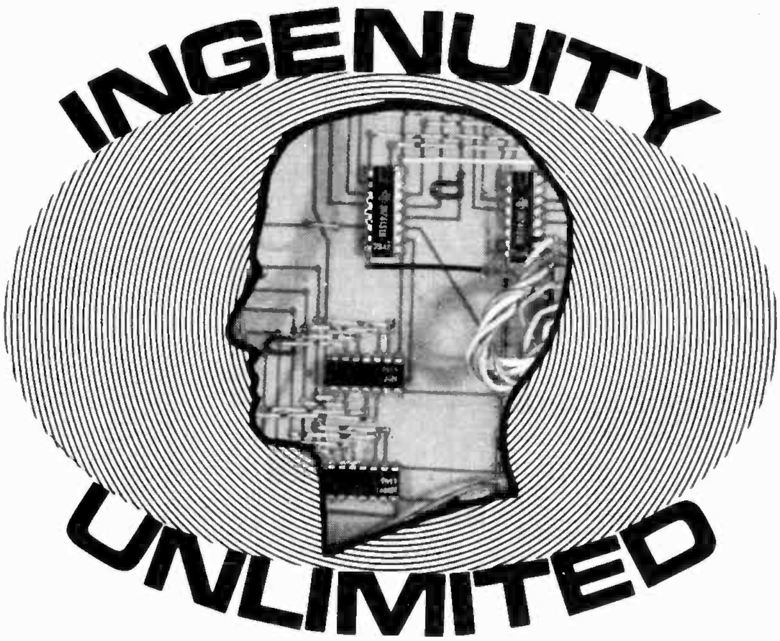




The Oryx 1B adjustable bench vice from Greenwood Electronics

Futuristic plastics hi fi console by Viglen Acrylics





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

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

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

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

TOUCH ACTUATED GENERATOR

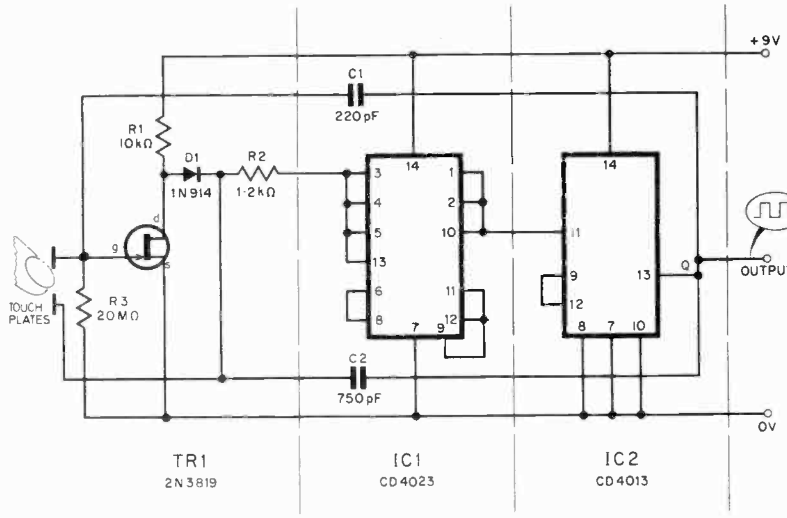


Fig. 1

THIS pulse generator provides extended pulses and is controlled by finger contact. It has the added advantage of the output being able to be held in a low or a high state.

The NAND gates of IC1 (Fig. 1), form a Schmitt trigger fed from the series diode/resistor combination D1-R2, connected to the gate of the f.e.t. The output from the Schmitt is fed to the clock of a D-type flip-flop (IC2) connected in the divide by two mode. Two capacitors provide feedback from the output of the flip-flop.

Capacitor C1, feeds the gate of the f.e.t., which, in turn controls the current flowing through R1, D1, and R2. Hence the potential at the input to the Schmitt will rise and fall according to the state of charge of C1. The rate at which this potential changes is governed by the value of C2. With this absent the highest pulse frequency attained is 25Hz.

When the gate is low less current will flow through D1 and vice versa. Thus, the input at IC1/pin 3 is alternately low and high, giving a low and high output at Q, which is at one half the frequency.

It is interesting to note that if C2 is very much greater than C1, then it is C2 that controls the pulse width. For example when C2 is 4,700pF, the pulse width is about 10s.

The values of capacitors shown in the diagram, give a pulse frequency of about 0·5Hz.

The generator is initiated, merely by finger contact on the lower plate. If it is desired to hold the output at one level or another, finger contact on the upper plate will hold the output until released. Both the touch plates should be situated close to mains wiring.

P. R. G. Reynolds,
Benfleet,
Essex

SIMPLE TIMESETTING FOR THE MK50250/253

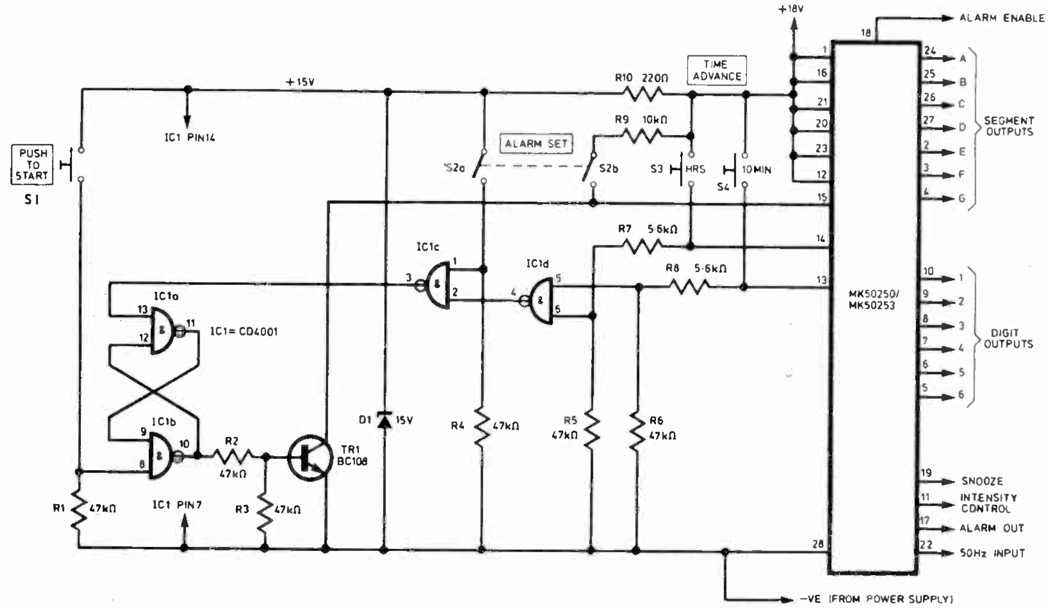


Fig. 1

Having recently built an alarm clock using the MK50250/253 range of digital clock i.c.s it was found that the less technical members of the family had some difficulty in understanding the correct procedure for setting the clock accurately, so it was decided to simplify the time setting procedure, the new arrangement being as follows:

(1). On altering the time, i.e. depressing one or more of the time advance buttons S3 and S4, the clock will automatically be stopped from counting.

(2). A single push switch (S1) should be used to re-start the clock.

(3). The clock will not stop on altering the alarm time.

The circuit shown in Fig. 1 uses a CD4001 CMOS quad NOR gate to perform the required logic functions, and is shown with connections to the MK50250/253 clock i.c. The 18V clock supply is dropped to the 15V required by the CMOS. The required level interfacing is achieved using R5, R7 and R6, R8.

It should be noted that with this particular i.c. in this arrangement the alarm time cannot be set unless the clock time is set and running. The circuit can be adapted to suit other clock i.c.s that have similar time setting arrangements to the MK50250/253.

F. Dart,
Glasgow

NOVEL STABILISER CIRCUIT

If an *n*-channel field effect transistor is used to drive an *n.p.n.* bipolar device, benefit can be derived from the fact that, for normal operation within the characteristics of both devices, the gate of a low- or medium-tolerance f.e.t. will lie some volts negative to the bipolar emitter.

One useful application of such a combination is an adaptation of the familiar source-resistor-biased f.e.t. constant current device, when more current is required than the f.e.t. alone would provide.

A conventional *n.p.n.* series voltage stabiliser suffers the disadvantage that its base must be positive to the stabilised output and must therefore be fed either from the crude d.c. at the reservoir capacitor or from a separately controlled supply. An f.e.t. driving the series element overcomes this disadvantage and enables a novel circuit (Fig. 1) to be constructed with both the gate and the reference diode fed from the output.

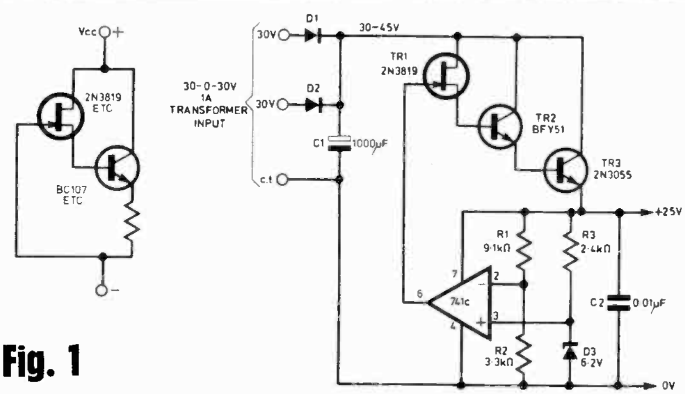


Fig. 1

The simple arrangement shown will provide 1A at an output impedance of 50 milliohms.

P. Smith,
Burnley,
Lancs

SIMPLE LIE DETECTOR

IN this skin resistance indicator the output from a 741 operational amplifier is used to control the frequency of a CMOS voltage controlled oscillator. The base frequency, with the components shown is 300Hz with a control voltage V_c at zero rising to 5kHz at a control voltage of 10V.

The 741 is operated in the differential mode. Here, the voltage applied to the non-inverting terminal (pin 3) via the probes, is compared to the voltage at the inverting terminal (pin 2). This latter voltage will be held at one half of the supply voltage by the two 100kΩ resistors. Thus, as the skin resistance decreases, the voltage at pin 3 increases to become more positive than that at pin 2. The point at which this occurs is set by means of VR2.

The increase in the output voltage, causes an increase in the output frequency from the v.c.o. Potentiometers VR1/2 are interactive and are adjusted to give a suitable starting frequency at the v.c.o. output.

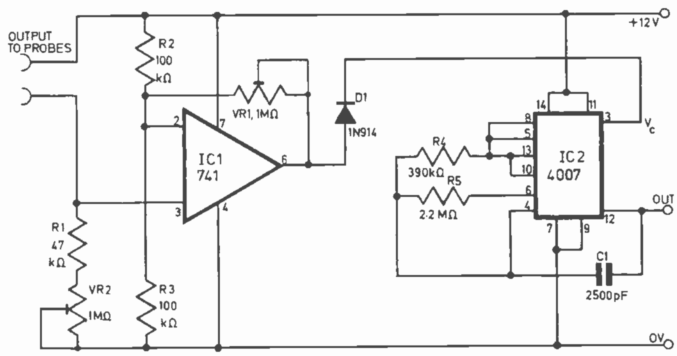


Fig. 1

The circuit may be used to monitor changes in skin resistance under stress (or relaxation!) for biofeedback or other purposes. Supply rails down to 6V may be used without any real degradation in performance.

The output may be quite easily detected using a crystal earpiece.

For the greatest sensitivity the probes should be connected to alternate strips of copper if the circuit is made up on Veroboard.

P. R. G. Reynolds,
Benfleet,
Essex

BURN ELIMINATOR FOR AUDIO XY OSCILLOSCOPE

AN XY oscilloscope is used in audio systems basically for two purposes. One is to plot the two stereo channel waveforms against each other, thus providing a measure of the separation achieved, and the other is to plot the output from the FM tuner against the a.g.c. output (before filtering) as a check against multipath reception. However, if the apparatus is left switched on for any length of time with no signal applied, or at any rate with a very low signal applied, the spot on the c.r.t. is bright enough to leave a burn mark on the screen. The circuit shown in Fig. 1 was devised to eliminate this.

Connection was made to one output of each of the deflection amplifiers by a 10MΩ resistor, the high value being to prevent any disturbance of the amplifiers. An emitter follower drives a voltage doubling rectifier whose output causes the other transistor to conduct should any signal sufficient to deflect the c.r.t. beam be present. If no signal is present the 8·2V Zener conducts and the l.e.d. lights up, its current being limited by the collector resistor of the second transistor.

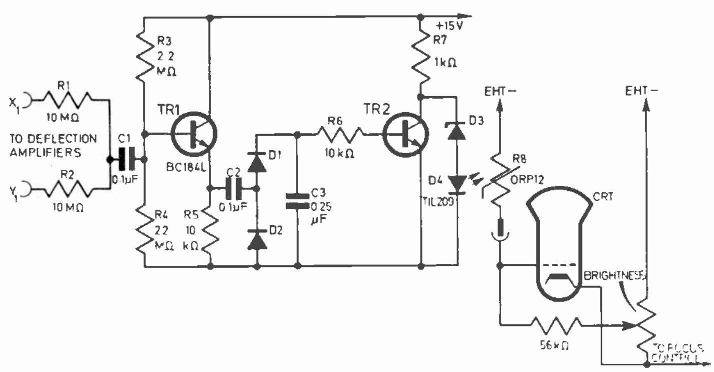


Fig. 1

When the l.e.d. is illuminated, the l.d.r. goes low and drives the c.r.t. grid negative cutting off the beam. The circuit can be overriden with the brilliance control if required.

When experimenting with c.r.t. circuits extreme care should be taken, switching off and discharging the e.h.t. circuit each time before touching the circuit. The shaft of the brightness and focus controls should either be earthed (if the insulation of the pot can stand it) or be of non conducting material.

John de Rivaz,
Harlow,
Essex

TAPE RECORDER PEAK LEVEL INDICATOR

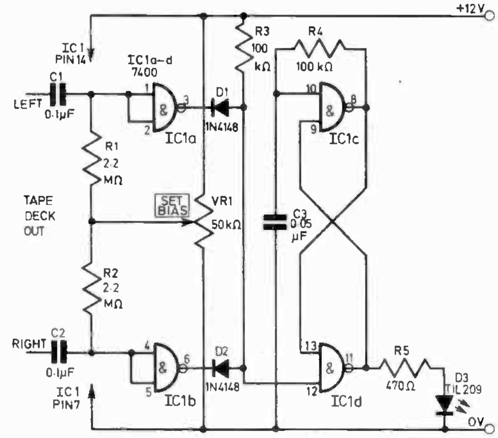


Fig. 1

Many of the high quality tape decks presently available utilise VU meters to monitor the recording levels in each stereo channel. Unfortunately, only the most sophisticated and expensive models provide any indication of the peak level rather than the average level. Because of this, it is possible for overloads to go unnoticed, especially in percussive music.

The purpose of this circuit is to form an add-on unit to perform this function. The input level is sensed for each channel by gates acting as Schmitt triggers (Fig. 1). They have present a d.c. bias which sets the input level at which triggering occurs. Their outputs are fed to a monostable type circuit which lights the l.e.d. in a short pulse for each input peak.

I have found the best setting for the bias pot. to be at the point where the l.e.d. is just turning on with a two-tone sine wave input to the deck which gives a level of about +2VU.

R. J. Crowther,
Stourbridge

MODEL TRAIN SPEED CONTROLLER

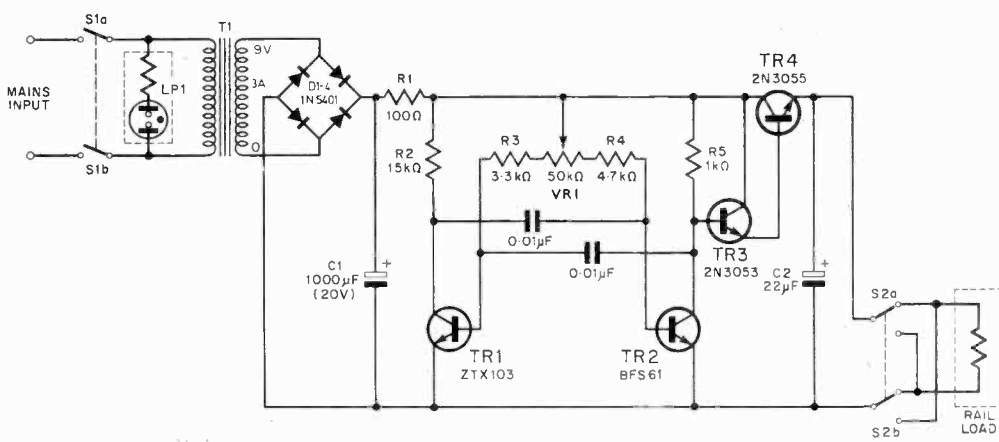


Fig. 1

The main disadvantage with many model train controllers is that they do not give a linear control of train speed. The following circuit gives a linear control enabling the train's speed to be set anywhere between a very slow pace and full speed (Fig. 1).

Mark-space variation in oscillator output is used to change the power output to the motor. Circuit operation is as follows: T1, the bridge rectifier and C1 provide a smooth d.c. supply of about 12V to the motor. S2 reverses the train's direction of travel. TR1 and TR2 form an astable multivibrator whose frequency of operation is about 200Hz and whose mark-space ratio is variable from about 1 : 11 to about 18 : 1.

The output from TR2 is current amplified by the Darlington pair TR3 and TR4 and applied to C2 and the motor. S2 reverses the train's direction of travel.

R1 serves as a current limiting resistor in the event that the rails are shorted together.

Transistor types and component values are not too critical and the circuit can probably be built up from near value components. Component layout is not critical and the circuit can easily be built on a small piece of Veroboard.

G. Hughes,
Bristol

TWO WIRE/TWO WAY BELL SYSTEM

IN the home the use of an intercom is seldom necessary as the most usual "calls" are to come in for meals, to answer the door/telephone or even to watch a particular television programme. I think that it is also fair to say that a bell is louder than an intercom so if communication with a shed, garage or workshop is required a bell is the best bet to be heard above the noise of the drilling, filing, sawing and hammering that can often be present.

Having decided to use a bell system for two way communication, there are two existing ways. The first (Fig. 1a) uses one battery/transformer with three connecting wires. The second (Fig. 1b) uses two batteries/transformers and only two connecting wires. Batteries are very expensive and decay with time, even without use, so a transformer is cheaper in the long-run.

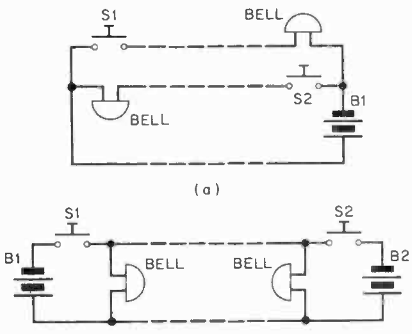
This leaves the choice of using an extra transformer or an extra core in the connecting cable. These can easily work out at the same cost, so how about using neither?

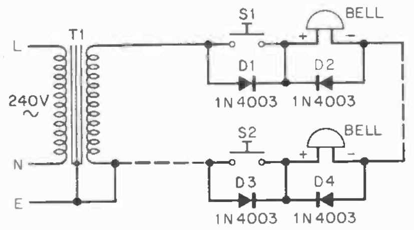
This is the object of my circuit in Fig. 1c. Here the direction of the current determines which bell rings, the direction being set by the push switches. Since each bell runs on alternate mains half cycles, it is run on d.c. so if your bell has terminals marked positive and negative, connect it up as shown. When both switches are pushed at the same time both bells will ring without damage to anything.

If you have to run a long length of cable it will be much cheaper to use one conductor with the earth as the common. This is shown in Fig. 1d.

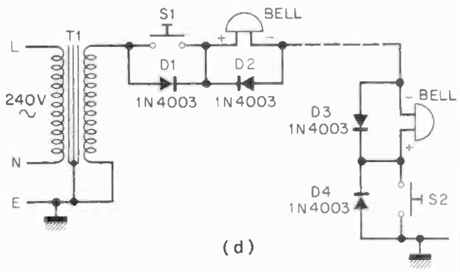
No details about the bells/buzzers or transformer have been given as they do not have to be matched precisely at all. Transformers which could not supply the necessary current continuously, because of the heating effect of the current, can be used as the bells will only be on for a very short time. In the same way the transformer voltage can be in excess of the rated value for the bells. In fact it is desirable to run the bells from a higher voltage transformer than recommended by the manufacturers as it is being run from a half wave rectified supply.

L. O. Green,
Norwich



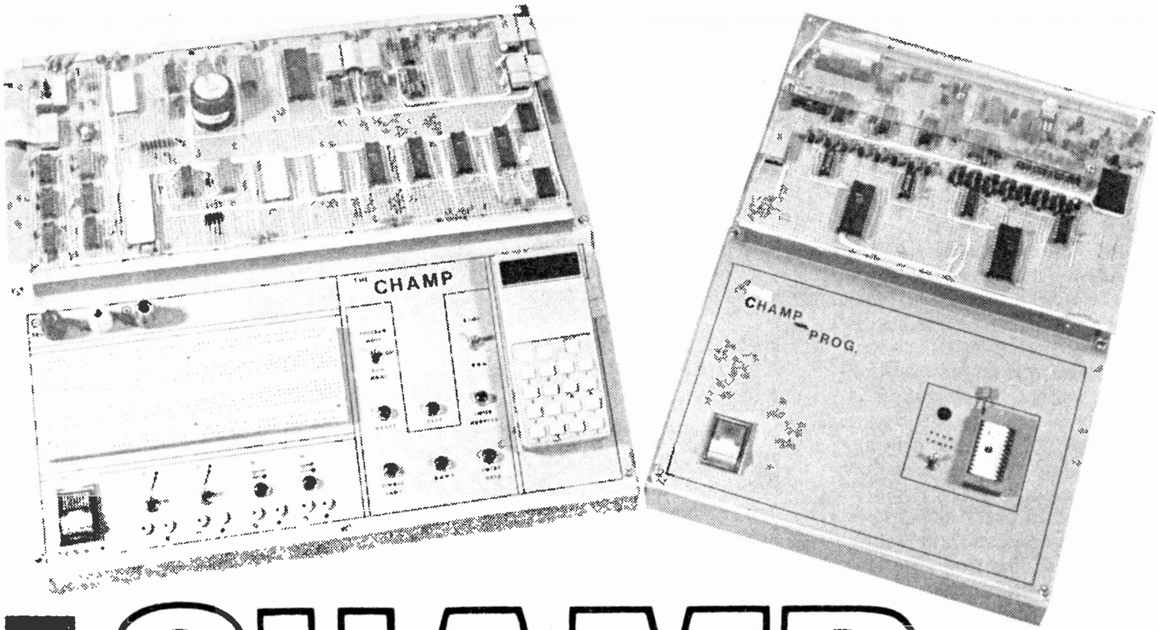


(c)



(d)

Fig. 1



PE CHAMP PART FIVE

R. W. COLES
B. CULLEN

The only language that CHAMP is programmed to understand is hexadecimal, and therefore to be able to talk to *it* a hexadecimal keyboard is required, and for it to talk *back*, a hexadecimal display is required. Hexadecimal is a base 16 number system which we human beings represent with 16 separate characters, namely 0 to 9 and A to F; and which CHAMP represents with a four bit binary word from 0000 to 1111 (0000 = 0, and 1111 = F). Every time we press a single key therefore, we enter a four bit word or "nibble" into CHAMP's internal registers, two presses being necessary to enter a single instruction word of eight bits, and three presses being necessary to enter a single address word of 12 bits.

The hexadecimal notation is useful because it enables us to enter data much quicker than would be possible with binary notation, and because codes for the various instructions in the 4040 instruction set are much easier to remember and use in this format. This makes program writing and debugging much simpler than would be possible if binary, or even octal were employed. The hexadecimal character set can also be represented on the cheap and freely available seven segment l.e.d. display devices, albeit in a stylised form.

CALCULATOR

As the basis of our hexadecimal keyboard/display unit we need 16 separate keys and several seven segment display digits, and of course, this combination is handily available in the form of any cheap four function calculator, making the use of such a unit the natural choice. The advantages of using a calculator rather than building from scratch are that firstly, all the case and hardware construction has been done already, and secondly, it is unlikely that you can buy a 16 digit keyboard and an eight digit display, with drivers, for the price! Cheap "throw away" calculators can now be found for less than five pounds, and there are numerous first generation machines no longer in use, and left lying around gathering dust. For CHAMP we chose to use one of the early Sinclair Cambridge machines which were produced in very large numbers, and the result was a very compact and economical keyboard/display unit at very low cost.

We realise that you may not be able to lay your hands on such a machine, and if this is the case it should be possible, using the design and notes presented in CHAMP-5, to adapt most cheap four function calculators to suit, or even to build from scratch if you prefer.

HOW THE DISPLAY WORKS

Referring back to Fig. 2.3, you will see that there are two 75491 i.c.s (top right,) and these drive the segments of the seven segment display in the calculator. The eight inputs for the 75491 (seven segments plus decimal point) are provided by the 4265 programmable I/O chip which uses ports X and Y for this purpose. The CHAMP display is an eight digit unit and is of course driven in multiplex fashion, and this requires an additional eight control lines to select the currently active digit.

Rather than produce these digit strobes on the CHAMP board itself, a shift register controlled by only two wires from CHAMP, is used instead. The shift register, along with other circuitry, is situated inside the calculator case.

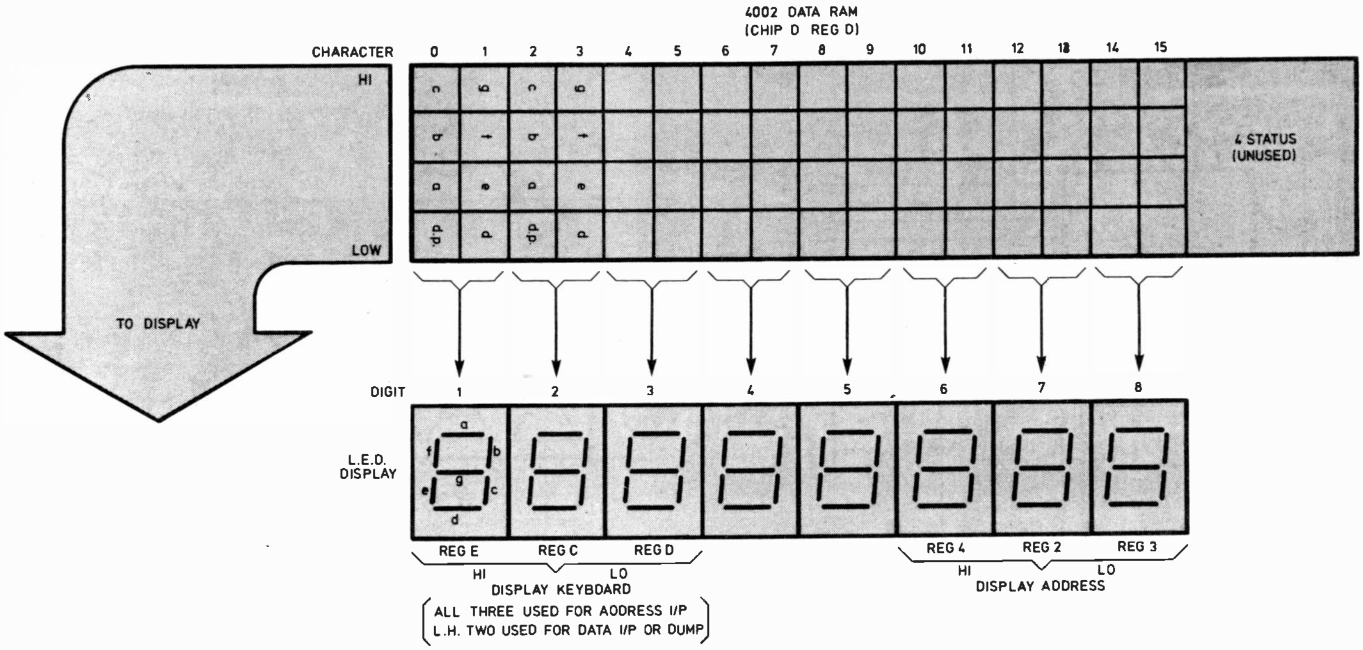


Fig. 5.1. Method of driving the display direct from RAM. A "replica" of the energised segments is stored, so that no decoding i.c.s. are necessary. Logic 1 in 4002 = Lo'. Logic 1 on 4265 o/p = Hi' = segment "on"

The CHOMP display/driver software loads a single logic 1 into the shift register, and then clocks it along to enable each digit in turn. When the logic 1 "drops off the end" of the shift register it is replaced, at the correct time, by a new one at the data input to the register.

The display driver software is responsible for making sure that the correct segment information is presented to the display at the correct digit time. It achieves this by keeping a replica code for the required display in the 4002 data RAM; reading out the data for each segment in turn to the 4265, and then going back to do it again when digit eight has been displayed, and a fresh logic 1 has been presented to the register.

The display replica is held in 4002 chip zero, register zero, where the available 16 four bit characters are used in pairs to hold the complete eight digit by eight segment display readout. This can be seen more clearly by referring to Fig. 5.1, which shows how the RAM characters map onto the display digits. Notice that the replica is already in seven segment code when stored in the RAM by CHOMP. Because the replica is not in binary, no external decoder chips are necessary to drive the display. The decoding is executed using software by means of a "look-up" table, and this will be examined in detail next month.

One advantage of driving the display in this fashion is that user programmes can drive the segments in any way they please. For example, as decimal digits only, as a full alphabet of characters (which can just about be done with some improvisation), or simply as a "0" and "1" binary display.

When CHOMP is running, only six of the possible eight display digits are used, the left-most three being used for address or data entries and dumps, and the three right-most digits being used to show the current value of the address pointer maintained by CHOMP. User programmes can of course employ all eight digits, and there is no need to write any display driver software because the CHOMP subroutine DDRV handles all eight digits, and can be called by a user programme when required.

HOW THE KEYBOARD WORKS

By using a four bit output port, a four bit input port, and some software, the 4040 chip can easily encode and debounce a 16 key keyboard, and even has a special instruction, KBP (keyboard process), available to make the job simple. Despite this, CHAMP does not use software for this purpose, and uses instead a hardware keyboard encoder and debounce circuit; so perhaps a word of explanation is called for. During the CHAMP design process it was realised that the addition of software for keyboard purposes would make the use of *two* 4702A chips necessary to house CHAMP, and for economy reasons this was not desirable. In addition, the two four bit ports required would not be available on the 4265 and so some extra port hardware would be necessary, which could either be an extra 4265 or some TTL to do the same job. These two things together made the apparently simple software solution untenable in this *particular* case, and this constitutes, we think, an interesting example of the hardware/software trade off which is necessary in any microprocessor system design.

The hardware encoder/debouncer is in fact quite simple, and requires just four TTL packages, three of which are housed in the calculator case itself. Two 74148 eight input priority encoders with their active-low outputs NORed together by a 7400 gate provide the 16 key to four bit binary encoding function, and the debouncing is achieved with the aid of a 74123 dual monostable.

KEYBOARD/DISPLAY CIRCUIT

Figure 5.2 shows the internal circuitry of the keyboard and display and also covers the interface of this unit to the CHAMP main board. This circuit is intended for direct use by those who have a Sinclair Cambridge calculator of the correct type, but can also be used by those with a similar calculator, and by those who intend to build a unit from scratch. All that is in fact required from the calculator is the eight digit seven segment display

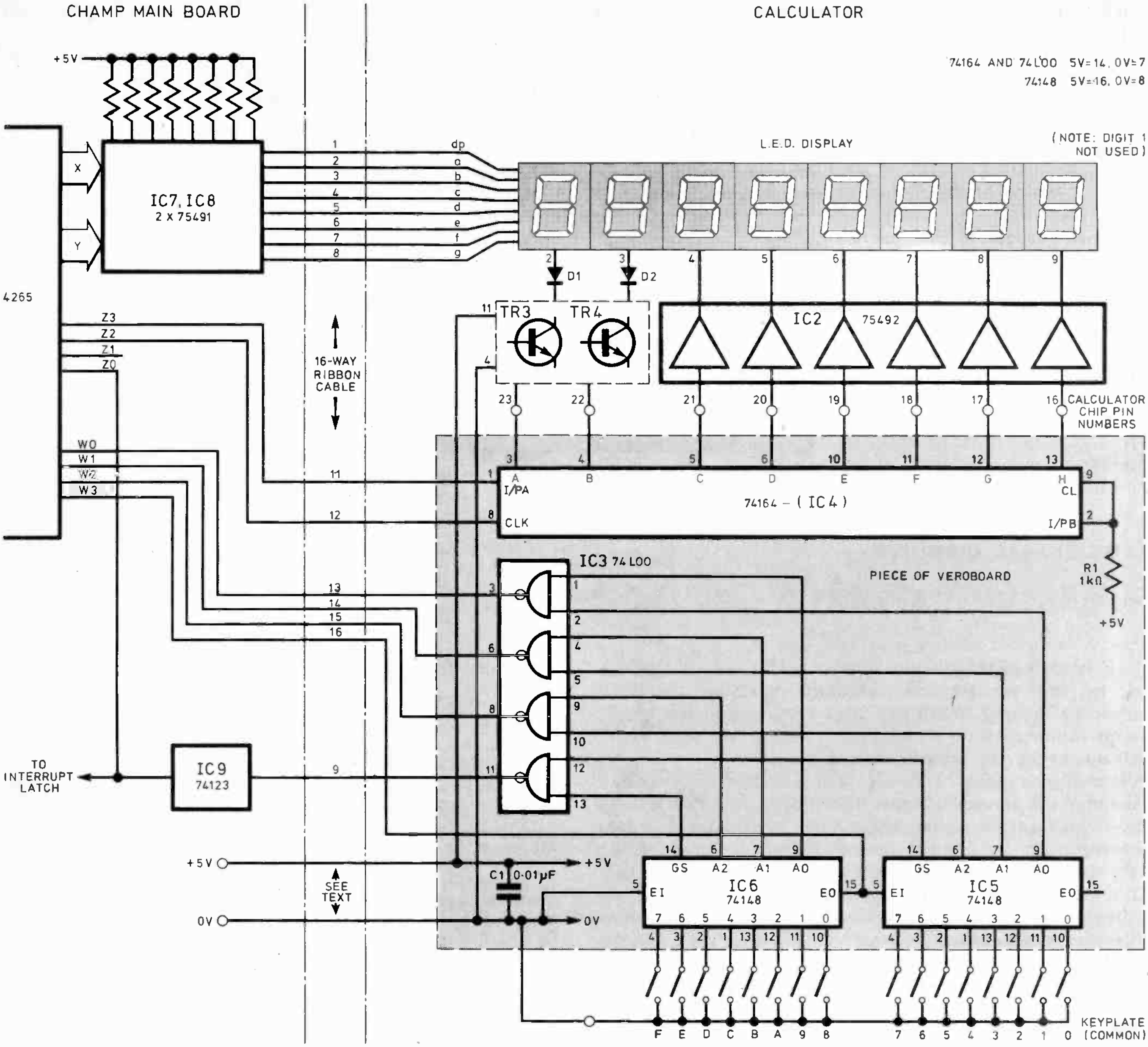


Fig. 5.2. Complete keyboard/display system showing the interconnections to CHAMP board. The shaded area shows which components are mounted on the Veroboard within the calculator case

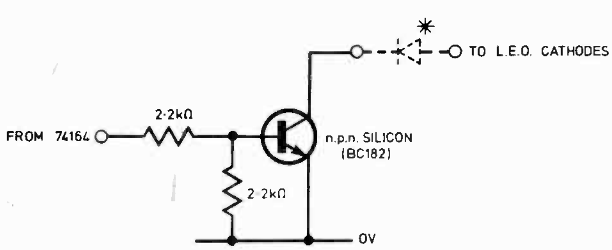


Fig. 5.2a. Driver circuitry for 0·125 inch l.e.d. display digits. The diode (1N4148) is only required when some of the cathodes are driven by a 75492 i.c.

unit (which must be a small common cathode l.e.d. unit), the digit drive circuitry (which may be discrete transistors or a 75492 chip), and the keyboard array itself (which must be capable of being rewired as 16 single keys with one common connection). The calculator MOS chip and all other circuitry is not required and can be removed. Some more recent calculator designs drive the digit lines directly from the LSI chip without separate digit drivers, and if you have one of these, then the required drivers can be added by using either a pair of 75492s or eight silicon n.p.n. transistor stages of the type shown in Fig. 5.2a. Anyone building from scratch (why not build it on the breadboard?) can use the Fig. 5.2a driver circuitry, and must add their own l.e.d. display. In this case it is important *not* to use the 0·3in or 0·6in type of discrete l.e.d. because these have a voltage drop which is "too high for comfort" on the 5V supply scheme employed here. *Only small 0·125in common cathode arrays are suitable.*

Those using other calculators, or building from scratch, may also find it necessary to alter the value of the current limiting resistors R51 to R58 on the main board to achieve a satisfactory display intensity.

ADDITIONAL CIRCUITRY

Returning to Fig. 5.2, display, drivers, and keyboard components can be identified which form part of the original calculator, and also the additional components which must be mounted inside the calculator case.

Four integrated circuits are added to the calculator, as we shall see later, and these are mounted on a small piece of Veroboard which may be housed in the battery compartment of the Sinclair Cambridge. The digit drive shift register is formed by IC4, with its A data input driven by output Z3 of the 4265, and its clock input driven by output Z2, under the control of the CHOMP software. The eight outputs of the 74164, are the digit strobes and are applied to the display via digit drivers which in the case of the Sinclair unit, are already available on the calculator p.c.b. The 75492 driver has only six stages, and to make this up to eight, Sinclair have added two discrete transistor stages, but this poses a small problem when working from 5V supplies because the difference in voltage drops between the two types of driver causes a difference in l.e.d. digit brightness. This was easily cured in our keyboard unit by adding silicon diodes in series with the *discrete* driver outputs. Anyone who used all 75492 drivers, or all transistor drivers, should of course omit these diodes.

Integrated circuits IC3, IC5 and IC6 form the keyboard encoder, where IC5 and IC6 are 74148 eight input priority encoders, which give a three bit binary output code corresponding to the active input line with the highest numerical weighting. To get a full 16 line encoder, two 74148 devices are cascaded using the OUTPUT ENABLE and INPUT ENABLE facility provided on these chips. Chip IC3 provides the final three low order BCD bits and the common "group strobe" which is present when any key is pressed, the high order BCD bit being taken directly from the ENABLE output of the 8 to F encoder. This encoder scheme is simple and very effective, having the advantage of requiring a very simple switching array of 16 s.p.s.t. keys with one side of all of these wired common to 0V. This overcomes a major obstacle when using a cheap calculator keyboard, because almost any design can be rewired into this configuration from the "row and column" matrix usually employed. The type of matrix used in a calculator design varies a great deal, but a little careful thought should be enough to enable a CHAMP builder to adapt any design to suit this simple new requirement.

As you can see, a total of 17 connections are required between the keyboard unit and the CHAMP main board, which poses a bit of a problem because 16-way sockets have been chosen as Standard. The solution was to carry the 15 logic signals using the standard 16-way ribbon cable connection system, and to add two extra wires for the 0V and +5V power supply to the keyboard. As you can see in the photographs, these two extra wires were the two "outers" of an 18-way ribbon cable connection, and were terminated at the CHAMP end by means of sleeved Soldercon pins which can be pushed on to terminal pins adjacent to SK3 on the main board. This arrangement has worked well in practice, and allows the keyboard to be disconnected easily when required.

KEYBOARD CONSTRUCTION

From now on, we will be considering the keyboard design used with the CHAMP prototype, and this means that details which follow relate *only* to a particular version of the Sinclair Cambridge which uses the Texas Instruments' TMS0801 calculator chip. This type of Cambridge can be recognised by the fact that it has a CE button between the C button and the ON/OFF switch, whereas some others have a K button.

Start by dismantling the case. This is achieved by locating a screwdriver in the slot around the side of the case and twisting. The buttons and keyplates are held in position by means of a plastics retaining frame which has three studs protruding through the circuit board which are welded on the component side. Lay the calculator circuit board face down on a flat surface and snip the welded studs away, then lift the circuit board off and you should be left with the key buttons and their retaining frame. The stainless steel keyplate will be left attached to the circuit board by means of the ON/OFF switch, and this should be removed, together with its thin plastics insulating spacer. Put these parts aside for later use. If you have any trouble with this part of the modification, refer to Fig. 5.3.

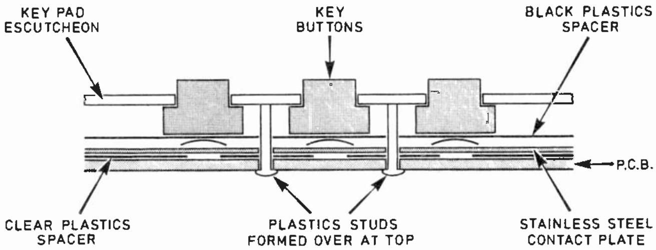


Fig. 5.3. A guide to the basic construction of the Sinclair 0801 keyboard assembly

COMPONENT REMOVAL

Using Fig. 5.4, identify and remove the following unwanted components:

C1, C2, C3, C4.
D1, D2, D3, D4.
R1, R2, R3, R4, R6.
TR1, TR2.
L1.
IC1.

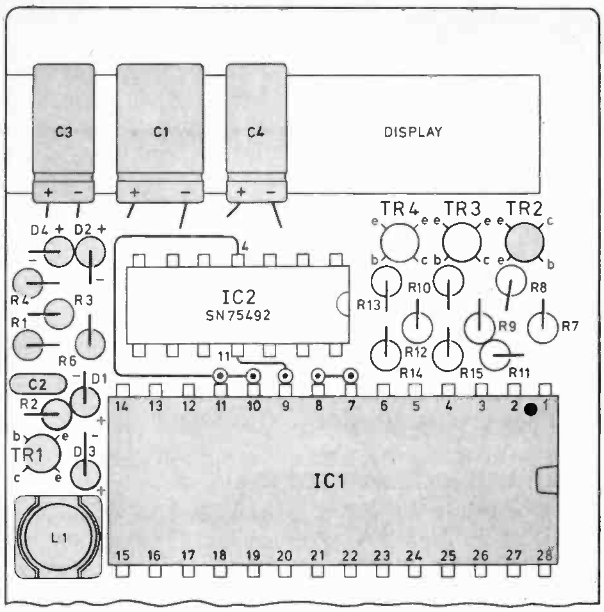


Fig. 5.4. Component layout of the Sinclair calculator. The shaded components should be removed (see text)

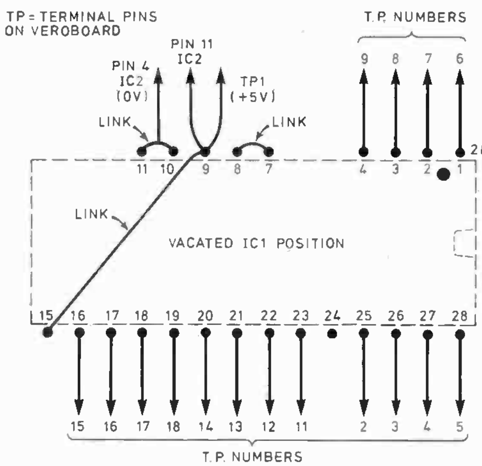


Fig. 5.5. After the calculator chip (IC1) has been removed from the Cambridge, terminal pins should be inserted through the lead holes. The vacated i.c. pad can then be wired as shown in the diagram

The removal of IC1 in particular should be carried out with great care, since the board is double sided and uses plated-through holes. A "Solder Sucker" or de-solder braid *must* be used.

With IC1 removed, refer to Fig. 5.5, insert the terminal pins and make the links (except those to PL1 and the Veroboard) as indicated.

Using Fig. 5.6, identify the Bowmar l.e.d. display and then, working from left to right, break the tracks connecting display digits 2 and 3 to the circuit board proper, and bridge the gaps with two IN4148 Silicon diodes as shown. Next, add a flying lead from the hole location shown, to act as a 0V connection to the Veroboard, to be added later. Using Fig. 5.7, which shows the component side of the calculator circuit board, make the 16 track breaks required with a sharp modelling knife or similar implement, and be sure to get rid of any swarf which may cause shorts later. The flying leads from individual keypads can now be added, and these should be of Kynar wire (or similar) left long at first, and trimmed to size when the Veroboard is added. To avoid disaster, these wires should be soldered very carefully to *avoid solder running through the plated hole to the keyplate side* where it will cause trouble.

THE VEROBOARD

The Veroboard layout is shown in Fig. 5.8, and this board can now be cut to size and assembled in the usual way. Soldercon pins were used for all four i.c.s in the prototype although this is not essential. Make sure that all track breaks, terminal pins, wire and fixing holes are correctly located, and then wire up the board with the fine wire in accordance with Fig. 5.2. Notice that PL1 does not mate with a socket, but is soldered directly to the board.

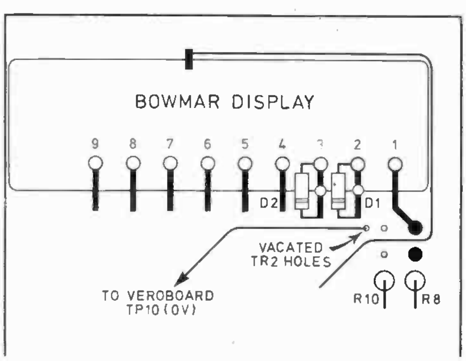


Fig. 5.6. Modifications to be made around the calculator display

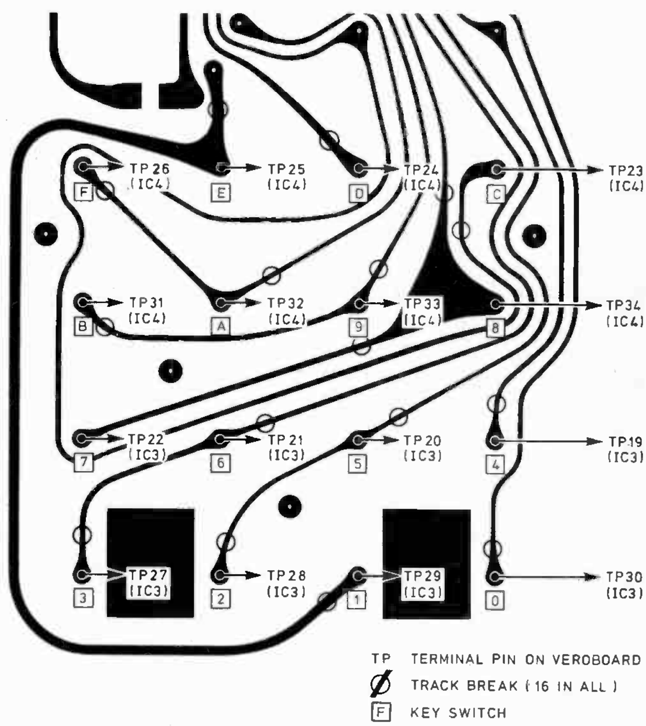


Fig. 5.7. Proprietary p.c.b. inside the Sinclair Cambridge, showing the keyboard end where track cuts are necessary

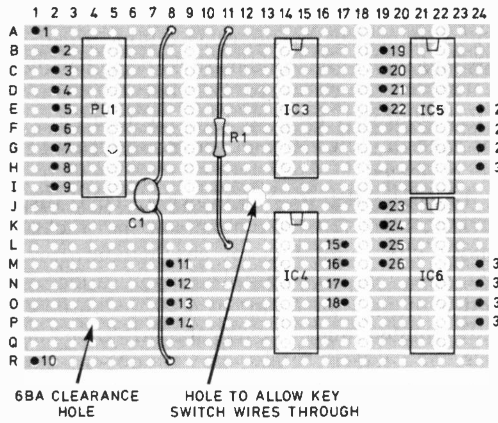


Fig. 5.8. Component layout for Veroboard to be mounted inside the calculator case

Terminal pins could be used for this termination instead of the 16-way plug, but in this case some kind of "strain relief" should be provided for the loom to prevent wires breaking during everyday use of the keyboard.

Using the circuit diagrams the Veroboard can now be connected up to the rest of the calculator circuitry. This involves:

16 connections to keypads
17 connections to IC1 (now removed)
one connection to the hole left by the emitter of TR2 (now removed).

KEYBOARD ASSEMBLY

In the prototype, the Veroboard was attached to the calculator p.c.b. by means of a countersunk 6BA screw, which made it necessary to drill and countersink a hole in the main circuit board. This had the advantage of easy dismantling should it be required, and the addition of two insulating strips act as spacers. Perhaps a better solution would be the use of double sided sticky pads.

Reassembly of the calculator can be achieved fairly easily by reversing the dismantling procedure, the separate parts of the keyboard assembly being adequately retained by the case when it is snapped together.

POINTS ARISING

BURGLAR ALARM *(May 1977)*

Constructors may find that in the GUARD condition, sufficient current can leak through LP1 and LP2 to energise WD1, (see Fig. 1). This can be overcome either by replacing these bulbs with l.e.d.s (in series with 560Ω resistors), or placing a OA47 diode in series with LP2 *only*, wired in forward bias.

In order that the TAMPER SWITCH (S3) will operate at *any* time, it should be wired between points "12" and "1" via a 330Ω resistor, and *not* points "12" and "11" as shown in Fig. 1.

FREQUENCY COUNTER/TIMER *(September 1977)*

Some readers have found that the crystal XL1, in Fig. 4, does not control the oscillator frequency as it should do. Anyone experiencing this difficulty should try reducing the value of C6 to around 330pF.

COMPONENTS . . .

KEYBOARD/DISPLAY UNIT

Resistors
1 off 1kΩ R1

Capacitors
1 off 0·01µF ceramic C1

Semiconductors

2 off 1N4148	D1, D2
1 off 74L00	IC3
1 off 74164	IC4
2 off 74148	IC5, IC6

Miscellaneous
Sinclair Cambridge calculator (type using TMS0801 chip)
Stripboard, 0·1 inch matrix
Terminal pins
16-way d.i.l. plug (PL1) and ribbon cable
Kynar, or similar wire

CONSTRUCTOR'S NOTE

The keyboard/display unit, as with other system parts extraneous to the CHAMP board, can be linked using ribbon cable and d.i.l. plugs and sockets. The sockets are readily available, but the plugs may be obtained from: **P.S.P. Electronics, 228 Preston Road, Wembley, Middlesex, HA9 8PB.** The plugs are made by T & B Ansley, part No. 609-M165 (16-way).

TESTING

The keyboard encoder can be checked in isolation by wiring four l.e.d. lamps with 1kΩ resistors in series to pins 13, 14, 15 and 16 of the 16-way d.i.l. plug on the end of the flat cable. The anodes of the l.e.d.s should be connected to +5V, and the supplies should be connected to the keyboard as if for normal use. Pressing any key should generate the correct binary code on the four l.e.d.s, though in inverted form (light off equals logic 1). The strobe output on pin 9 should always be generated regardless of which key is pressed, and this can be checked with a fifth l.e.d. or by means of a voltmeter. Checking the display is more difficult, although if trouble is experienced, ohmmeter checks between the segment drive lines and the outputs of the digit drives can be carried out as a starting point.

WIDE USE

The CHAMP keyboard/display described this month is by no means dedicated only to the CHAMP system, and could, if required, be interfaced to almost any microprocessor system where its ready encoded keyboard output and flexible display format would be an advantage.

NEXT MONTH: CHOMP Firmware

PATENTS REVIEW...

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

TOUCH SWITCH BP 1 477 252

An outline of the various techniques adopted to-date to provide stray field capacitor switching is given in BP 1 477 252 by Robert Bosch GmbH, Stuttgart.

Essentially, such switches incorporate two flat electrodes, spaced apart, so that one transmits and the other receives a signal, in a manner responsive to any change in the signal path, for instance by the approach of a finger. The new patented circuit is intended to overcome disadvantages of this basic type, for instance sensitivity to moisture and humidity.

In Fig. 1 a transmitting electrode is connected to a high frequency generator and capacitively coupled to the receiving electrode by the stray field. The receiver is connected to a compensating amplifier, which also directly receives the output of the generator for comparison with the received signal. Between the two electrodes there is a further central electrode which is earthed.

Under a normal condition, the compensating amplifier senses the presence of a reasonable signal from the receiver and holds the relay (operative on a load such as a horn) open. When the tip of a finger is moved towards the surface of a metal screen covering the three electrodes, some of the field is diverted upwards by capacitive coupling and this attenuates the signal received. Accordingly, the difference between inputs to the compensating amplifier increases, as does the output. This triggers the changeover of the relay contacts.

It is claimed that the comparison technique overcomes the difficulties caused to conventional trigger circuits when they become dirty or wet.

BP 1 477 252

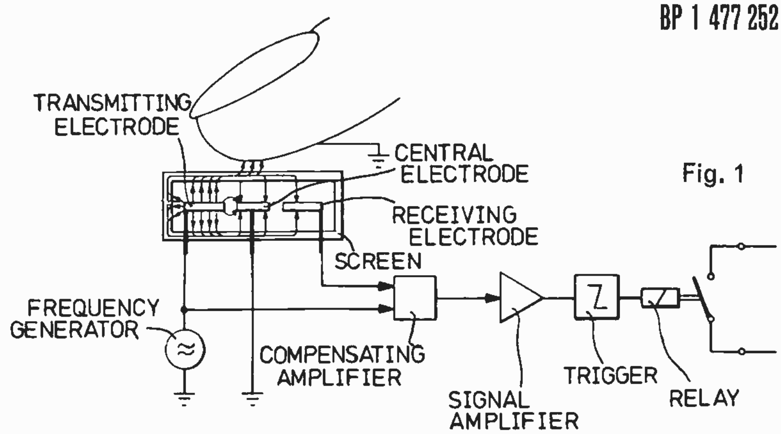


Fig. 1

IN BRIEF

BP 1 459 902—Stiefenhofer KG: *Control Switch*. Control apparatus for use by at least partially paralysed persons. A cyclically stepped switch, which can, for instance, be used to control a telex machine, is itself controlled by the logic interpretation of very basic pulses generated by a simple switch which can be controlled by a paralysed person, e.g. by light finger pressure or air pressure from the mouth.

PATENT COPIES

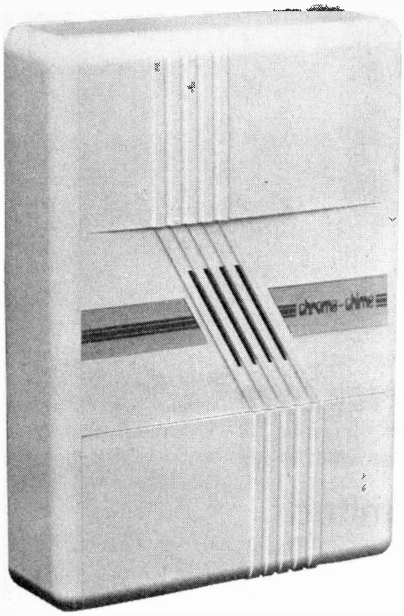
Every month we carry a note telling readers how to go about buying copies of British Patents mentioned by number. Unfortunately the British Patent Office still maintains its flat-rate pricing policy, whereby a simple patent of two or three pages costs the same (currently 95p) as a four-volume computer specification.

Inevitably this deters many people from buying copies of patents, for instance of new electronic circuits, which they would otherwise like to have for reference at home. As we have previously reminded readers, however, it is possible to economise by visiting any one of the two dozen libraries around the country which have copies of British Patents, or at least abridgements of them, on their public shelves.

This also presents a useful and quite legal way of beating the pricing system. In virtually all the British libraries with patents on their shelves (except the main patents library housed in the building of the London Patent Office in Chancery Lane) it is possible to have on-the-spot photocopies made of selected pages of a patent. Average cost is around 6p per page.

The main London library will not make selective photocopies in this way at page rate, because they very rightly fear that so many people would use the system and so many bound volumes of patents would be continually off the shelves and in the photocopying room that the library would cease to be useful for reference. But the provincial patent libraries are far less busy, and anyone wanting a copy of just a couple of pages of a patent, for instance the main circuit diagram and a list of component values, will be able to get it for just a few new pence if they go to a provincial patents library.

Most of the major cities have such libraries, but if in doubt readers can phone 01-405 8721, ask for Library Information, and check their nearest source of patents.



CHROMA-CHIME

kit review

BRAIN child of a young British engineer, Robin Palmer, the Chroma-Chime is claimed to be the world's first microprocessor-driven electronic door chime. The Chroma-Chime has been on the market for some months, and more recently has been made available in kit form for constructors.

The Chroma-Chime Kit is of particular interest since it brings the microprocessor (in a dedicated form) into the hands of the constructor in a reasonably priced project which has the great merit of being a useful and attractive item for installing in one's home. Thus the constructor can satisfy his curiosity concerning these latest devices, gain experience using them, and at the end of a five-hour building stint possess an article whose functioning will never fail to amuse and amaze friends and all callers!

THE HEART

The heart of this electronic door chime is a 4 bit microprocessor, Texas TMS1000. This 28-pin *p*-channel device incorporates a clock generator, RAM, ROM and I/O, as well as CPU and therefore is correctly described as a one-chip microcomputer.

It is of interest to note that the TMS1000 is currently in use in various dedicated applications, including taximeters, scientific calculators, a board game and, perhaps the most sophisticated use so far, as an electric cooker controller where it times the on/off periods according to recipes and fires the triacs in the power circuits.

In each of its customised forms, the TMS1000 is marked additionally with a unique code number. In the case of the Chroma-Chime, this is MP0027A.

For this particular dedicated application the original software programme written by the Chroma-Chime designer has been built into the ROM during chip manufacture by Texas Instruments.

CHROMA-CHIME DETAILS

All the notes necessary to produce the 24 tunes are generated by counting down from the master clock oscillator. Since they all have precise digital relationships they cannot go out of tune to each other.

Five transistors are included in the twenty-odd discrete components that go to make up the overall circuit. Three are used in control circuits and two form a Darlington pair driving the loudspeaker.

Twenty-four tunes are "in-store". Selection is made via two control knobs readily accessible at the front of the unit. Other controls are provided for volume, tempo (speed) and tone.

The Chroma-Chime can be operated from two separate bell-pushes. One circuit provides access to the full repertoire, the other (intended for the back door) allows a choice of two tunes only.

The jingles include Greensleeves, God Save The Queen, Oranges and Lemons, and Beethoven's "Fate Knocking".

THE KIT

The Kit was well organised. Everything in the component and material line (including solder) was provided. (With our kit was an Erratum slip: the five points covered were duly noted and the relevant parts of the Manual amended accordingly.)

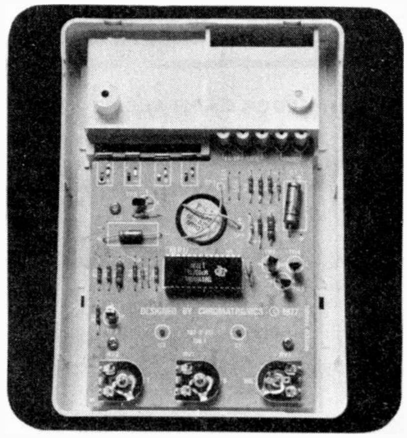
An excellent Assembly Manual explained everything very clearly, with many line diagrams and photographs illustrating different operations in the assembly. If the maker's advice to read the Manual through before starting construction, and then to follow it through paragraph by paragraph in practice is adopted, success should be achieved first time.

PREPARATION

Close examination of the parts, checking every item against the list provided, is an important first step. We discovered a bonus in our kit, in the form of a spare 39kΩ resistor.

The microprocessor chip was supplied mounted on a piece of expanded polystyrene, with a piece of tin foil sandwiched between. The chip was not removed from this packing until the time had arrived to mount the i.c.

To the tools specified for the job, we would suggest adding a bench light or torch, and a magnifying glass. It's best to have no doubts or uncertainty as to



whether a connection point has been well and truly soldered.

Do not forget to acquire the two PP3 batteries. To finish the construction work (say one evening) and then be unable immediately to test one's workmanship must be frustrating, to say the least.

ASSEMBLY

The actual assembly work on the p.c.b. is not difficult, provided one has had some experience with small-scale operations, and has a certain adroitness with a miniature soldering iron. The Manual recommends a bit less than ⅛in (3mm). We used a 1·5mm bit, which proved ideal; except for sweating the four battery contacts, when we switched on a 3mm bit. The amount of 22s.w.g. multicore solder provided was well in excess of actual requirements.

We took time over the assembly of components on the p.c.b., double-checking values and positions of every component.

The big moment was mounting the i.c. socket and fitting the i.c. in position. Having first carefully aligned the pins with the sockets, a good firm downward pressure was applied and i.c. was home, safe and secure. The i.c. socket connecting strips came away cleanly after repeated bending with pliers.

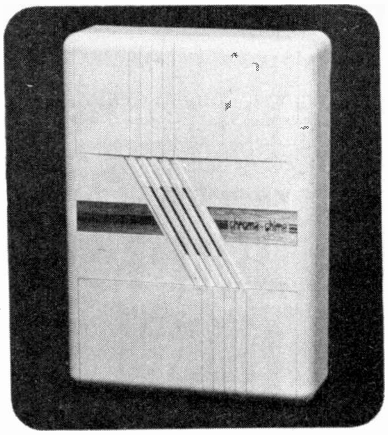
When the p.c.b. assembly work was completed there were only two further soldered connections to make—to the loudspeaker. This unit is clamped to the case with three "Starlok" washers. We adopted the Manual's advice and found that an old ball point pen case served admirably as a box spanner for this purpose.

The completed p.c.b. was then fitted into the case. The control knobs were located in the holes at the front of the case and they then engaged with their respective parts on the p.c.b. Finally, a few screws were fitted and a pair of PP3 batteries inserted into the compartment.

TESTING

Still carefully following the Manual, we set the various controls as stated, placed a screwdriver blade over terminals three and four and were almost immediately regaled with the opening theme from Beethoven's Fifth.

After carrying out the full testing procedure we fixed the labels (decorative



and informative) to their respective places on the case, and fitted the two access covers and the base cover.

INSTALLATION

Installation should present no problems. Any lamp incorporated in a bell-push must be removed before connecting up, otherwise the Chroma-Chime will sound continually. Detailed instructions concerning Installation and Operation are provided in a separate leaflet accompanying the kit.

NEWS BRIEFS

GEC Computer System for RNIB

THE Royal National Institute for the Blind has placed an order on GEC Computers Limited, valued in the region of £175,000, for the supply and maintenance of GEC 4070 computer equipment to be used in the production of braille literature. The order is part of a major expansion and modernisation exercise which will make the RNIB's work in this field the most advanced in the world.

The computer equipment will be used in the RNIB's new printing centre and will speed publication of a greatly increased range of braille books and periodicals for educational, vocational and recreational purposes.

Operators at 16 text-entry visual display terminals will key in text from English originals. The computer system will directly accept these inputs and translate the data into braille output coded onto magnetic tape cassettes. These are used to control embossing machines which automatically punch the braille characters (called cells) onto zinc plates suitable for use on a printing press. Alternatively, for single copies of a document, the computer can itself drive a paper embosser thus eliminating the need to manufacture a metal printing plate. The use of visual display units as input terminals gives the operators the facility to edit text on entry. Separate purpose-built refresh graphics display terminals are used to edit the braille cells prior to committing the output to embossed paper or zinc.

The new GEC system will replace an existing system which uses punched cards as the text input medium.

At present if edits are necessary which cannot be contained on one single source card—and this really means changes of a very minor nature indeed—then repunching and re-translating of all subsequent cards may be necessary. Editing, particularly on a large work, is thus a very laborious procedure, wasteful in time and materials. It is only then this stage is completely satisfactory that the output deck of punched cards, representing braille, can be produced.

Solar Water Heaters

A ONE day technical meeting organised by the UK Section of The International Solar Energy Society held at the Royal Institution, London, in October was devoted to Practical Aspects of Domestic Solar Water Heaters. Papers were delivered by specialists in various subjects, dealing with component parts such as collector plates, control systems and complete solar installations in houses.

Of the latter, two examples of conversions for solar energy collection and storage in existing properties were described: one was an energy saving house project sponsored by Granada TV, the other concerned experiences with a pilot domestic solar-assisted water heating system installed in a modern flat, under the auspices of a South London Consortium of Local Authorities. Finally, a lecturer from Ayr (Scotland) Technical College described progress in the house he is building himself, in which solar heating has been planned-in right from the start.

Electronics came into the picture during the discussions on control systems. Standard modules containing most of the electronics are normally used. The thermistor is the generally used and favoured sensor, and thermal-couples were not recommended because of attendant problems with pipes. There was some discussion about the position of the sensor: important that it be *within* the collector panel, and critical in placing on cylinder (about one-third up from bottom being suggested), incorrect positioning could cause feedback to occur.

International Broadcasting Convention

BECAUSE it has outgrown the facilities available at Grosvenor House, its traditional home since 1968, the next International Broadcasting Convention will be held at the Wembley Conference Centre, London, September 25–29, 1978.

The IBC is a biennial event; it provides an international forum for engineers with interests in the wide field of broadcasting to discuss technical developments, and to exhibit and demonstrate the latest equipment. Further information can be obtained from The Secretariat, International Broadcasting Convention, IEE, Savoy Place, London WC2R 0BL.

INDUSTRY NOTEBOOK

By Nexus

BERLIN SHOW

Old-timers in the UK look back with nostalgia to the great Radiolympia shows of the late '30s when thousands of the listening and looking (high-definition TV had just started) public flocked to the Olympia exhibition halls to see what was new. Attempts were made to revive the shows in the post-war years but without commercial success.

For a taste of the excitement of a huge radio show you now need to visit Berlin. The international show this year attracted over 600,000 visitors, an all-time record reflecting the many attractions and brilliant organisation laid on. There were 468 exhibitors from 27 countries so there was plenty to see.

Perhaps the most interesting statistics to emerge from the show post-mortem was the result of a special poll of private, as distinct from professionally engaged, visitors on whether they were familiar with Teletext and Viewdata. Of those questioned 69 per cent knew about Teletext and 60 per cent Viewdata. And of those polled, 33 per cent said they would be prepared to buy both systems.

One sector which is flourishing is Citizen's Band radio. German manufacturers were complaining that the Bundespost didn't give enough warning before the facility became available. Now, however, at least seven German manufacturers are making equipment to meet a demand estimated at 50,000 sets a month.

All equipment has to be submitted for approval to the Bundespost and this may hamper some of the cheaper imports from the Far East. Twelve channels have been allocated for CB in the 27MHz band and it appears there is already much channel congestion in centres of high population.

Overall the German market in entertainment electronics is expected to grow between eight and ten per cent in 1977, certainly not exciting but not unsatisfactory in the prevailing economic climate.

Meantime, back in the UK there is still considerable pressure to restrict the imports of Asian consumer electronics goods and, at the time of writing, the Hitachi affair is still unresolved. For those who haven't been following the story, the Government is anxious to encourage foreign investment and two Japanese companies have already set up TV manufacturing plants in the UK. They are National Panasonic (Matsushita) and Sony. Now Hitachi wants to come in and set up a TV plant to employ 400 people.

Mullard, Britain's largest component manufacturers and only TV tube maker is objecting, supported by Thorn, Britain's largest TV manufacturer who say that if Hitachi comes in and competes in the UK they may be forced to buy far more components from the Far East to compete in price, thus withdrawing component orders from Mullard and other UK suppliers. It is argued that to create 400 new jobs in the proposed Hitachi plant may result in the loss of 1,500 jobs or more elsewhere and lead to the eventual collapse of British component manufacturers.

Among those lobbying are the trade unions, members of Parliament, component and set manufacturers. The Department of Industry is split in its views and so, it is said, are working parties discussing the problem in the National Economic Development Council.

British companies have a production capacity of 2·4 million TV sets a year. Total output in 1977 is expected to be only 1·5 million. So clearly the nation doesn't need any more capacity for manufacturing. But, perversely perhaps, the buying public likes Japanese sets. So better to make them in the UK with British labour rather than import them. Or is it? The debate continues.

ON THE MOVE

Apart from microwave ovens and Doppler-shift type intruder detectors, neither of which are yet in the real mass-market, it is hard to see microwave devices catching on with the general public. But in the USA where they are more liberal on such matters, car-mounted radar speed-trap detectors have been making good progress. One forecast is that a million will have been sold by the end of 1977.

The only snag is that nearly all the detectors work on X-band while the American police have been moving their speed measuring equipment up to K-band. The police use hand-held equipment like a gun pointed at the suspect and momentarily press a trigger to obtain a measurement instead of the X-band method of continuous radiation. So not only are the road-hogs' detectors foiled by being in the wrong waveband but the momentary radiation on K-band will be very hard to detect in time to avoid a fine.

THE MIDDLE EAST

The £500 million extension of British Aircraft Corporation's defence contract with Saudi Arabia was heartening. BAC employs 2,000 people overseas in a massive training and equipment programme for the Royal Saudi Air Force and 750 other companies, including electronics suppliers, stand to gain through sub-contracts.

Rumours that Racal Electronics Group had set up a factory in Egypt were confirmed at the recent Racalex exhibition in London. Racal chairman, E. T. Harrison, stated that the Egyptian and other joint manufacturing agreements overseas had been worth £25 million and that the need to collaborate with overseas governments was recognised and would continue.

The contract with the Egyptian Government involves the training and supervision of a local labour force of over 200 people for manufacture of Racal-designed SSB communications equipment in a purpose-built factory.

Selling technology is good business but it also exports jobs.

The counter argument is that if companies like Racal don't step in then others will. Harrison said that Racal held off powerful competition for the Egyptian contract from leading French, American and other British firms. And it is a fact of life today that when a large contract is negotiated through overseas governments that some measure of local production is stipulated. Only in such ways can a developing country establish an indigenous electronics manufacturing capability.

Another good contract from Arab sources is for Marconi Marine equipment for the United Arab Shipping Company. Forty of the company's fleet of 60 ships are already fully equipped with Marconi radar, radio, ADF and echo sounders. The older Russian-built vessels in the fleet are now being re-equipped as necessary with Marconi equipment.

SHAKE-OUT

The South African electronics industry, dominated largely by subsidiaries of British, French and American companies, is now virtually self-sufficient and, under Government pressure, is currently moving to completely local control, especially in key areas of defence electronics and "strategic" products. The trend is for majority shareholdings to be acquired by local interests with the former principals permitted to retain a minority interest.

ITT, for example, has already relinquished control of one of their South African groups of companies, retaining some 30 per cent of the equity.

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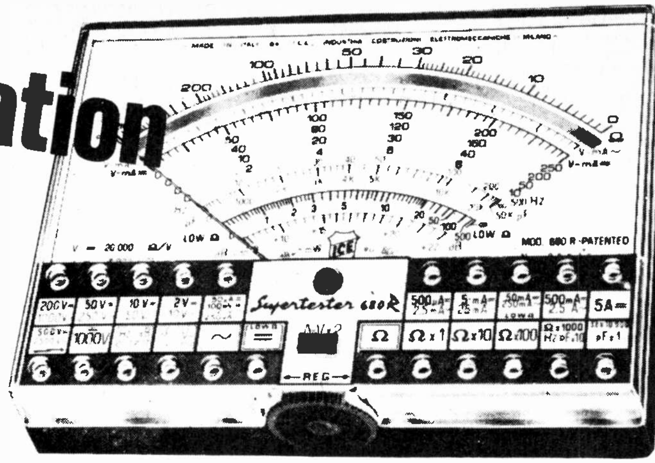

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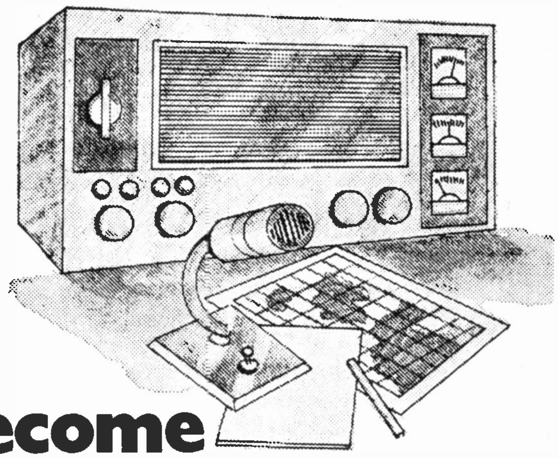

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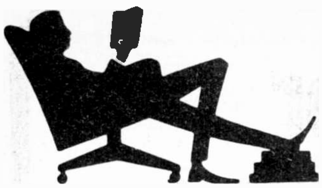

BOOK REVIEWS

HAM RADIO
By K. Ullyett
Published by David & Charles
163 pages, 145 × 225mm. Price £4.50

With no mathematics, and only simplified written theory not backed up with diagrams, this hardback really only serves as an introduction at a very general level to ham radio. It begins with a brief history of ham radio activities (worldwide), bringing you up to the present time. Various interesting black and white photographs are included. The book does, however, serve as an excellent insight into the field of interest as a whole, revealing such unexpected aspects as ham television, something which many "outsiders" do not realise exists!

If the numerous call signs and codes associated with ham radio are a complete mystery to you, then the information given in the tables at the back of this book (including international ham prefixes and abbreviations) should reveal all. There is a chapter entitled "Getting A Permit" telling you everything you need to know about this first step, and to further help you into the fraternity, should you be interested, is a list of useful international addresses for both ham radio and television organisations and societies.

Other information given under the heading "Miscellaneous Data" is various charts covering component identification marks, and frequency band allocations.

M.A.

HOW TO BUILD ADVANCED SHORT WAVE RECEIVERS
By R. A. Penfold
Published by Bernards (Publisher) Ltd
117 pages, 110 × 180mm. Price £1.20

Listening to short wave transmission holds a fascination for certain people, and if you wish to discover if this includes yourself, *How To Build Advanced Short Wave Receivers* might be a good starting point!

Proprietary receivers are not cheap, and if you *are* a constructor, why not build your own? The author proposes that sets with a performance equal to that of commercial equipment are not too difficult to put together, and are certainly a lot cheaper when home made. Also, a greater understanding of the principles involved will result from such activity.

There are no constructional details in the sense of nuts and bolts, but the component manufacturers are given, and physical layout requirements where necessary. Circuit theory is explained on everything in the four chapters, which work upwards from simple sets to those comparable with commercial receivers.

The principles of superhet', a.g.c., i.f., b.f.o. and alignment, are a few of the things you'll be wiser about after reading the book. Stages using f.e.t. devices and varicap diodes are described too.

Chapter Four is called "Add-On Circuits" and covers those extra "odds and ends" such as the "S" Meter, Crystal Calibrator, and Power Supply Unit.

M.A.

Readout—
A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

On The Air

Sir—May I comment on your mention of Citizens' Band Radio in October's Practical Electronics, see "Industry Notebook".

The Citizens' Band Association, who are the most powerful CB lobby in Britain, propose a v.h.f. f.m. Citizens' Band using 230–232MHz and having 40 to 80 25KHz channels. Such a service would cause far less spectral pollution than the 27MHz a.m. used elsewhere and would also provide a welcome boost to the British Radio Industry. Three British firms are already developing sets for use in such a CB service and if the type-approval procedure was arranged to favour domestic sets for the first two or three years we would not need to fear the Japanese.

Our studies suggest that the introduction of CB in Britain would lead to sales of over £150M in the first two years, creating 5,000 direct jobs and up to 10,000 indirect ones and yielding over £30M in VAT and licence revenue. Even if the Japanese did all the manufacturing (and, as suggested above, this could be prevented) the cost to our balance of payments would be under £70M and the 10,000 indirect jobs and £30M tax revenue would still be created.

If any of your readers would like to support our campaign may I suggest that they contact our membership secretary, Pamela Webster, at 16 Church Road, St. Marks, Cheltenham, Gloucestershire.

J. M. Bryant, President,
Cheltenham.

Instant Wipe

Sir—I noted with interest K. D. Horton's "Wiper Delay Circuit" in your *Ingenuity Unlimited*, September issue, since I have used an almost identical circuit for the past year or so.

However, I have found it an advantage to connect C1 to the 12V switched line instead of 0V (reversing the polarity of course). This gives an immediate sweep of the wipers on switching on.

C. J. Collins,
Letchworth.

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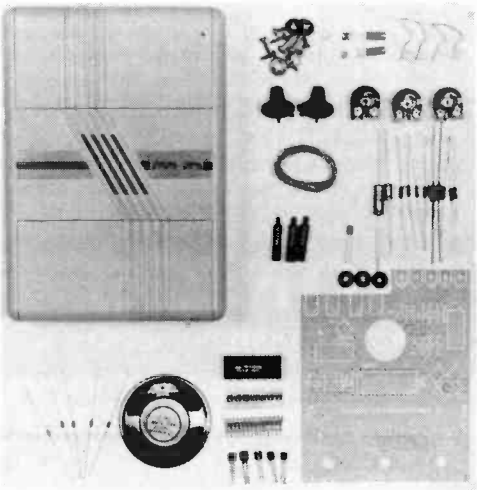

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Rule Britannia*
Land of Hope and Glory
Oh Come All Ye Faithful
Oranges and Lemons
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Sailor's Hornpipe
Beethoven's "Fate Knocking"
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Beethoven's Ode to Joy
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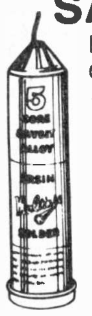

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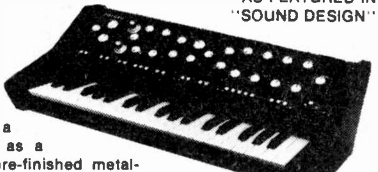

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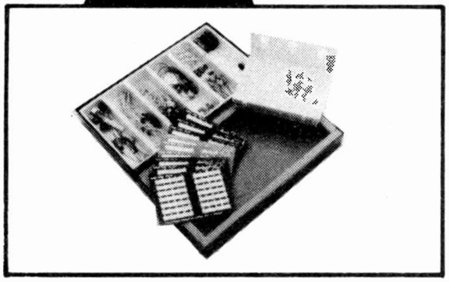

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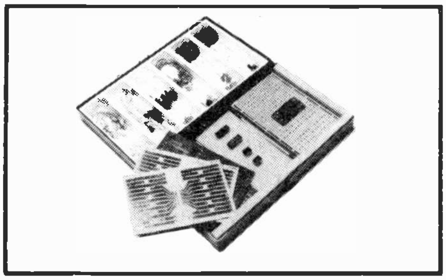

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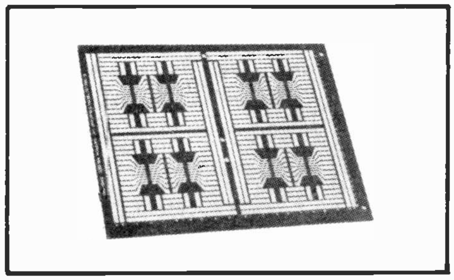

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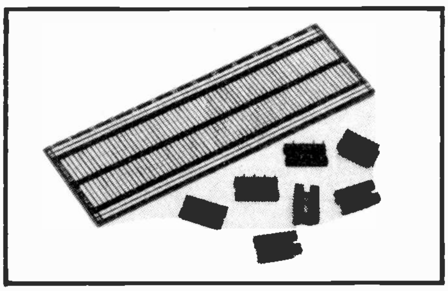

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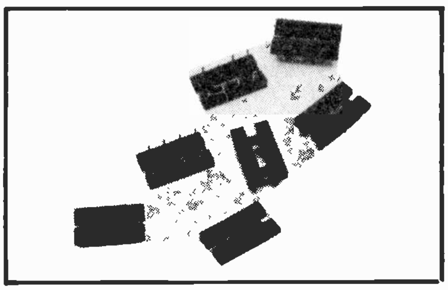

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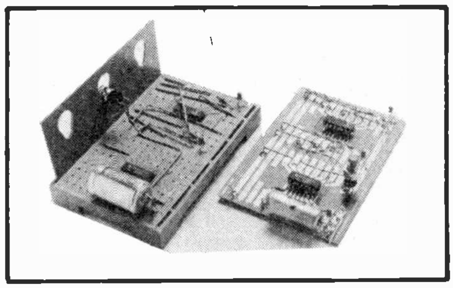

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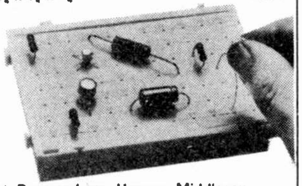

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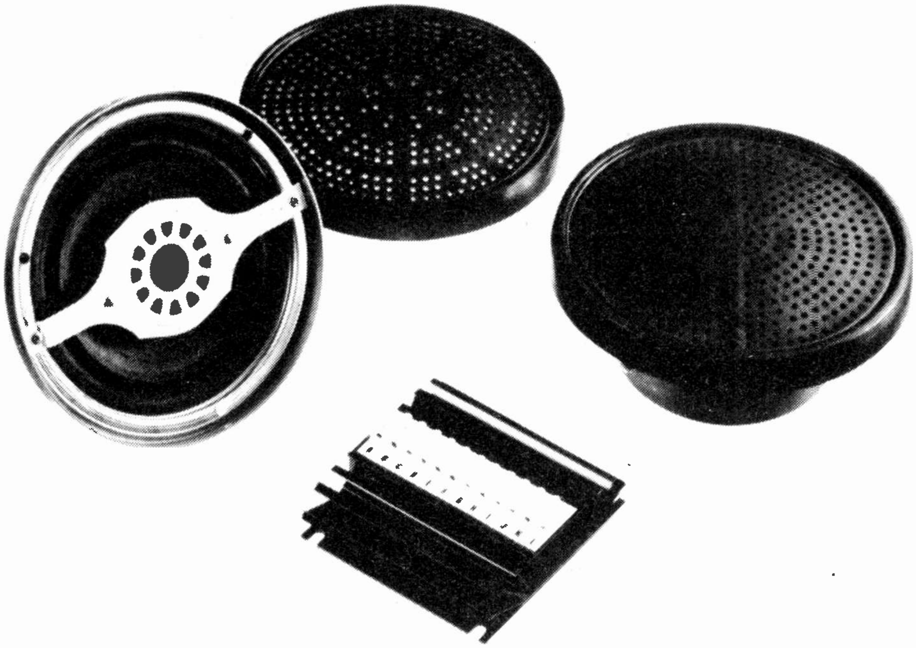

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The S15 has been specially designed for car use and produces performance equal to domestic speakers yet retaining high power handling and compact size.

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15 watts per channel into 4Ω
Distortion 0·2% at 1kHz at 15 watts
Frequency response 50Hz–30kHz
Input Impedance 8Ω nominal
Input sensitivity 2V R.M.S. for 15 watts output
Power line 10–18V
Open and Short circuit protection
Thermal protection
Size 4 × 4 × 1 inches

C15/15 Price **£17·74** + **£2·21** VAT. P. & P. free

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2in Active Tweeter
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BC108	0·12
BC109	0·13
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*BC173	0·15
BC177	0·19
BC178	0·18
BC179	0·20
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BF152	0·25
BF153	0·25
BF154	0·25
BF159	0·35
BF160	0·30
BF167	0·38
BF173	0·38
BF177	0·38
BF178	0·45
BF179	0·48
BF180	0·45
BF181	0·45
BF182	0·45
BF183	0·45
BF184	0·38
BF185	0·37
*BF194	0·12
*BF195	0·11
*BF196	0·13
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OA70	0·30
OA79	0·30
OA81	0·30
OA85	0·30
OA90	0·08
OA91	0·08
OA95	0·08
OA200	0·10
OA202	0·11
OA210	0·75
OA211	0·75
OAZ200	0·65
OAZ201	0·65
OAZ206	0·65
OAZ207	0·65
OC16	1·25
OC20	2·00
OC22	2·50
OC23	2·75
OC24	3·50
OC25	0·90
OC26	0·90
OC28	2·00
OC29	2·00
OC35	1·50
OC36	1·50
OC41	0·50
OC42	0·50
OC43	1·50
OC44	0·50
OC45	0·50
OC71	0·45
OC72	0·45
OC73	1·00
OC74	0·75
OC75	0·60
OC76	0·50
OC77	1·20
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7425	0·35
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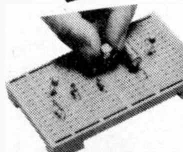

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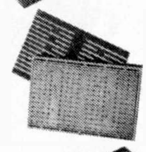

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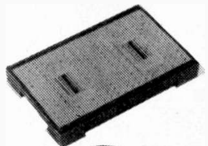

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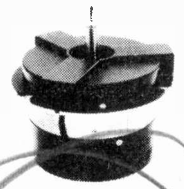

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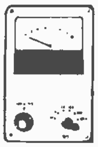

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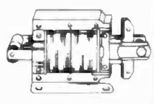

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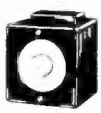

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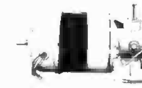

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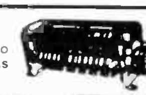

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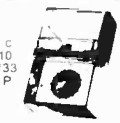

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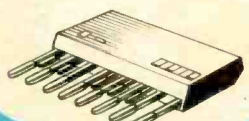

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