RADIO & ELECTRONICS CONSTRUCTOR

IMPORTANT ANNOUNCEMENT

AUGUST 1979
50p

SQUARE WAVE TRANSISTOR TESTER

WITH AUTOMATIC POLARITY SWITCHING

BEGINNER'S MEDIUM WAVE RADIO RECEIVER

A PROJECT WITH PARTICULAR APPEAL TO THE NEWCOMER

DATABUS

PART ONE: A comprehensive jargon-free explanation of microprocessors

Also inside

ANNUAL INDEX

DIODES/ZENERS

QTY.				
	1N914	100v	10mA	.05
	1N4005	600v	1A	.08
	1N4007	1000v	1A	.15
	1N4148	75v	10mA	.05
	1N4733	5.1v	1 W Zener	.25
	1N753A	6.2v	500 mW Zener	.25
	1N758A	10v	"	.25
	1N759A	12v	"	.25
	1N5243	13v	"	.25
	1N5244B	14v	"	.25
	1N5245B	15v	"	.25

SOCKETS/BRIDGES

QTY.					
	8-pin	pcb	.20	ww	.35
	14-pin	pcb	.20	ww	.40
	16-pin	pcb	.20	ww	.40
	18-pin	pcb	.25	ww	.95
	20-pin	pcb	.35	ww	.95
	22-pin	pcb	.35	ww	.95
	24-pin	pcb	.35	ww	.95
	28-pin	pcb	.45	ww	1.25
	40-pin	pcb	.50	ww	1.25
	Molex pins	.01	To-3 Sockets		.25
	2 Amp Bridge		100-prv		.95
	25 Amp Bridge		200-prv		1.50

TRANSISTORS, LEDS, etc.

QTY.			
	2N2222	(2N2222 Plastic .10)	.15
	2N2222A		.19
	2N2907A	PNP	.19
	2N3906	PNP (Plastic Unmarked)	.10
	2N3904	NPN (Plastic Unmarked)	.10
	2N3054	NPN	.45
	2N3055	NPN 15A 60v	.60
	T1P125	PNP Darlington	1.95
	LED Green,	Red, Clear, Yellow	.15
	D.L.747	7 seg 5/8" High com-anode	1.95
	MAN72	7 seg com-anode (Red)	1.25
	MAN3610	7 seg com-anode (Orange)	1.25
	MAN82A	7 seg com-anode (Yellow)	1.25
	MAN74	7 seg com-cathode (Red)	1.50
	FND359	7 seg com-cathode (Red)	1.25

9000 SERIES

QTY.			QTY.		
	9301	.85		9322	.65
	9309	.35		9601	.20
	9316	1.10		9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS

QTY.			QTY.		
	8T13	1.50		2107B-4	4.95
	8T23	1.50		2114	9.50
	8T24	2.00		2513	6.25
	8T97	1.00		2708	10.50
	74S188	3.00		2716 D.S.	34.00
	1488	1.25		2716 (5v)	59.00
	1489	1.25		2758 (5v)	23.95
	1702A	4.50		3242	10.50
	AM 9050	4.00		4116	11.50
				6800	13.95
	MM 5314	3.00		6850	7.95
	MM 5316	3.50		8080	7.50
	MM 5387	3.50		8212	2.75
	MM 5369	2.95		8214	4.95
	TR 1602B	3.95		8216	3.50
	UPD 414	4.95		8224	3.25
	Z 80 A	22.50		8228	6.00
	Z 80	17.50		8251	7.50
	Z 80 PIO	10.50		8253	18.50
	2102	1.45		8255	8.50
	2102L	1.75		TMS 4044	9.95

C MOS

QTY.		
	4000	.15
	4001	.15
	4002	.20
	4004	3.95
	4006	.95
	4007	.20
	4008	.75
	4009	.35
	4010	.35
	4011	.20
	4012	.20
	4013	.40
	4014	.75
	4015	.75
	4016	.35
	4017	.75
	4018	.75
	4019	.35
	4020	.85
	4021	.75
	4022	.75
	4023	.20
	4024	.75
	4025	.20
	4026	1.95
	4027	.35
	4028	.75
	4029	1.15
	4030	.30
	4033	1.50
	4034	2.45
	4035	.75
	4037	1.80
	4040	.75
	4041	.69
	4042	.65
	4043	.50
	4044	.65
	4046	1.25
	4048	.95
	4049	.45
	4050	.45
	4052	.75
	4053	.75
	4066	.55
	4069/74C04	.35
	4071	.25
	4081	.30
	4082	.30
	4507	.95
	4511	.95
	4512	1.10
	4515	2.95
	4519	.85
	4522	1.10
	4526	.95
	4528	1.10
	4529	.95
	MC 14409	14.50
	MC 14419	4.85
	74C151	1.50

LINEARS, REGULATORS, etc.

QTY.			QTY.			QTY.		
	MCT2	.95		LM323K	5.95		LM380 (8-14 Pin)	1.19
	8038	3.95		LM324	1.25		LM709 (8-14 Pin)	.35
	LM201	.75		LM339	.75		LM711	.45
	LM301	.45		7805 (340T5)	.95		LM723	.40
	LM308	.65		LM340T12	.95		LM725	2.50
	LM309H	.65		LM340T15	.95		LM739	1.50
	LM309K (340K-5)	1.50		LM340T18	.95		LM741 (8-14)	.35
	LM310	.85		LM340T24	.95		LM747	1.10
	LM311D	.75		LM340K12	1.25		LM1307	1.25
	LM318	1.75		LM340K15	1.25		LM1458	.65
	LM320H6	.79		LM340K18	1.25		LM3900	.50
	LM320H15	.79		LM340K24	1.25		LM75451	.65
	LM320H24	.79		LM373	2.95		NE555	.45
	7905 (LM320K5)	1.65		LM377	3.95		NE556	.85
	LM320K12	1.65		78L05	.75		NE565	.95
	LM320K24	1.65		78L12	.75		NE566	1.25
	LM320T5	1.65		78L15	.75		NE567	.95
	LM320T12	1.65		78M05	.75			
	LM320T15	1.65						

– T T L –

QTY.			QTY.			QTY.			QTY.		
	7400	.10		7482	.75		74221	1.00		74LS02	.30
	7401	.15		7483	.75		74367	.95		74LS04	.30
	7402	.15		7485	.55		75108A	.35		74LS05	.35
	7403	.15		7486	.25		75491	.50		74LS08	.35
	7404	.10		7489	1.05		75492	.50		74LS09	.35
	7405	.25		7490	.45		74H00	.15		74LS10	.35
	7406	.25		7491	.70		74H01	.20		74LS11	.35
	7407	.55		7492	.45		74H04	.20		74LS20	.30
	7408	.15		7493	.35		74H05	.20		74LS21	.35
	7409	.15		7494	.75		74H08	.35		74LS22	.35
	7410	.15		7495	.60		74H10	.35		74LS32	.35
	7411	.25		7496	.80		74H11	.25		74LS37	.35
	7412	.25		74100	1.15		74H15	.45		74LS38	.45
	7413	.25		74107	.25		74H20	.25		74LS40	.40
	7414	.75		74121	.35		74H21	.25		74LS42	.75
	7416	.25		74122	.55		74H22	.40		74LS51	.45
	7417	.40		74123	.35		74H30	.20		74LS74	.45
	7420	.15		74125	.45		74H40	.25		74LS76	.50
	7426	.25		74126	.35		74H50	.25		74LS86	.45
	7427	.25		74132	.75		74H51	.25		74LS90	.65
	7430	.15		74141	.90		74H52	.15		74LS93	.65
	7432	.20		74150	.85		74H53	.25		74LS107	.50
	7437	.20		74151	.65		74H55	.20		74LS123	1.20
	7438	.20		74153	.75		74H72	.35		74LS151	.85
	7440	.20		74154	.95		74H74	.35		74LS153	.85
	7441	1.15		74156	.70		74H101	.75		74LS157	.85
	7442	.45		74157	.65		74H103	.55		74LS160	.95
	7443	.45		74161	.55		74H106	.95		74LS164	1.20
	7444	.45		74163	.85		74L00	.25		74LS193	1.05
	7445	.65		74164	.60		74L02	.20		74LS195	.95
	7446	.70		74165	1.10		74L03	.25		74LS244	1.70
	7447	.70		74166	1.25		74L04	.30		74LS367	.95
	7448	.50		74175	.80		74L10	.20		74LS368	.95
	7450	.25		74176	.85		74L20	.35		74S00	.35
	7451	.25		74180	.55		74L30	.45		74S02	.35
	7453	.20		74181	2.25		74L47	1.95		74S03	.25
	7454	.25		74182	.75		74L51	.45		74S04	.25
	7460	.40		74190	1.25		74L55	.65		74S05	.35
	7470	.45		74191	1.25		74L72	.45		74S08	.35
	7472	.40		74192	.75		74L73	.40		74S10	.35
	7473	.25		74193	.85		74L74	.45		74S11	.35
	7474	.30		74194	.95		74L75	.85		74S20	.25
	7475	.35		74195	.95		74L93	.55		74S40	.20
	7476	.40		74196	.95		74L123	.85		74S50	.20
	7480	.55		74197	.95		74LS00	.30		74S51	.25
	7481	.75		74198	1.45		74LS01	.30		74S64	.15
										74S74	.35
										74S112	.60
										74S114	.65
										74S133	.40
										74S140	.55
										74S151	.30
										74S153	.35
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										74S158	.30
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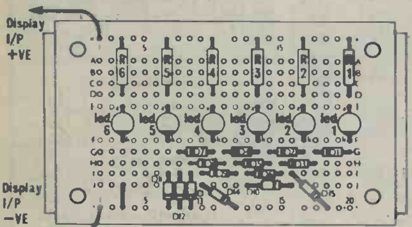
ELECTRONICS BY NUMBERS FREE PROJECTS No 1, No 2, & No 3.

ELECTRONICS BY NUMBERS

LED BAR GRAPH UNIVERSAL INDICATOR

Now using **EXPERIMENTOR BREADBOARDS** and following the instructions in "Electronics by numbers" **ANYBODY** can build electronic projects.
Look at the diagram and select R1, this is a resistor with a value between 120 to 270 ohm. Plug it into holes X20 and D20, now take LED 1 and plug it into holes E20 and F20. Do the same with the Diodes e.g. plug D7 into holes G7 and G10.



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EXP- ANY EXPERIMENTOR BREADBOARD
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LED1 to LED6 – Light emitting diodes.

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This circuit uses the forward voltage drop of diodes to determine how many LEDs light up. Any type of diode can be used but you must use all the same type. For full working details of this circuit fill in the coupon.
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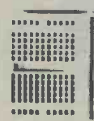
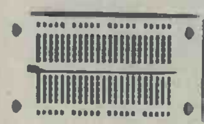


EXP.350. £3.15.
270 contact points with two 20-point bus-bars.



EXP. 300.
550 contacts with two 40-point bus-bars.
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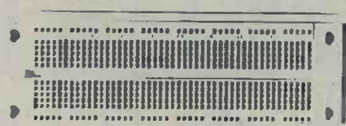

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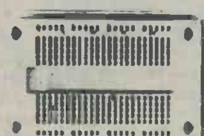

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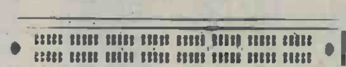
More bus-bars.
£2.30.



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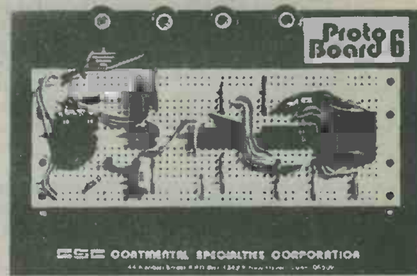
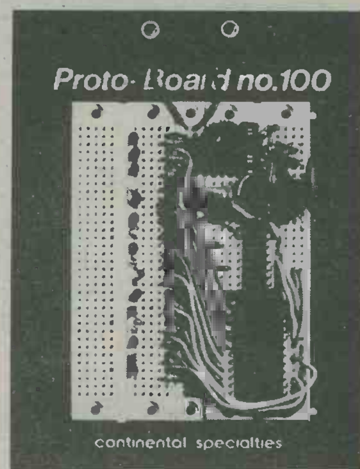


PB.6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.
PROTO-BOARD 6 KIT. £9.20.



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PC. 16-18 Dual Clip			£12.94
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16161 – 24 – 3 of each value – 100pf 120pf 150pf 180pf 220pf 270pf 330pf 390pf **£0.67**
16162 – 24 – 3 of each value – 470pf 560pf 680pf 820pf 1000pf 1500pf 2200pf 3300pf **£0.67**
16163 – 24 – 3 of each value – 4700pf 6800pf 01uf 015uf 022uf 033uf 047uf **£0.67**

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A range of paks each containing 18 first quality, mixed value miniature electrolytics.

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16219 – 40 mixed ½w 10K ohms – 82K ohms **£0.67**
16220 – 40 mixed ½w 100K ohms – 820K ohms **£0.67**
16230 – 60 mixed ⅛w 1 Meg – 10 Meg ohms **£0.67**
16231 – 40 mixed ½w 1 Meg – 10 Meg ohms **£0.67**

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16164 – 200 Resistor mixed value approx (Count by weight) **£0.67**
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16166 – 50 Precision resistors. Mixed values **£0.67**
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16193 – 6 slider potentiometers all 22K ohm 1in **£0.67**
16194 – 6 slider potentiometers all 47K ohm 1in **£0.67**
16195 – 6 slider potentiometers all 47K log **£0.67**

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Type	Price
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AC113	£0.21
AC115	£0.21
AC117	£0.32
AC117K	£0.36
AC121	£0.21
AC122	£0.16
AC125	£0.19
AC126	£0.19
AC127	£0.19
AC128	£0.17
AC128K	£0.28
AC132	£0.21
AC134	£0.21
AC137	£0.21
AC141	£0.23
AC141K	£0.32
AC142	£0.21
AC142K	£0.32
AC151	£0.21
AC153	£0.23
AC153K	£0.32
AC154	£0.21
AC155	£0.21
AC156	£0.21
AC157	£0.27
AC165	£0.21
AC166	£0.21
AC167	£0.21
AC168	£0.27
AC169	£0.21
AC171	£0.27
AC176	£0.19
AC176K	£0.28
AC178	£0.27
AC179	£0.27
AC180	£0.21
AC180K	£0.30
AC181	£0.21
AC181K	£0.30
AC187	£0.19
AC187K	£0.30
AC188	£0.18
AC188K	£0.30
ACY17	£0.37
ACY18	10.37
ACY19	£0.37
ACY20	£0.37
ACY21	£0.37
ACY22	£0.37
ACY27	£0.37
ACY28	£0.37
ACY29	£0.54
ACY30	£0.37
ACY31	£0.37
ACY34	£0.37
ACY35	£0.37
ACY36	£0.37
ACY40	£0.37
ACY41	£0.37
ACY44	£0.37
AD130	£0.75

Type	Price
AD140	£0.64
AD142	£0.91
AD143	£0.81
AD149	£0.64
AD161	£0.37
AD162	£0.37
AD161/162	£0.75
ADT140	£0.59
AF114	£0.27
AF115	£0.27
AF116	£0.27
AF117	£0.27
AF118	£0.43
AF124	£0.32
AF125	£0.32
AF126	£0.32
AF127	£0.34
AF139	£0.37
AF178	£0.64
AF179	£0.64
AF180	£0.64
AF181	£0.62
AF186	£0.54
AF239	£0.41
AL102	£1.29
AL103	£1.27
ASY26	£0.41
ASY27	£0.43
ASY28	£0.41
ASY29	£0.41
ASY50	£0.32
ASY51	£0.32
ASY52	£0.32
ASY54	£0.32
ASY55	£0.32
ASY56	£0.32
ASY57	£0.32
ASY58	£0.32
ASY73	£0.32
AU104	£1.51
AU110	£1.51
AU113	£1.51
BC107	£0.09
BC107A	£0.09
BC107B	£0.10
BC107C	£0.11
BC108	£0.09
BC108A	£0.09
BC108B	£0.10
BC108C	£0.11
BC109	£0.08
BC109B	£0.10
BC109C	£0.11
BC113	£0.18
BC114	£0.18
BC115	£0.21
BC116	£0.21
AC116A	£0.21
BC117	£0.23
BC118	£0.16
BC119	£0.27

Type	Price
BC120	£0.43
BC125	£0.19
BC126	£0.25
BC132	£0.20
BC134	£0.20
BC135	£0.17
BC136	£0.20
BC137	£0.20
BC139	£0.35
BC140	£0.32
BC141	£0.30
BC142	£0.24
BC143	£0.24
BC145	£0.52
BC147	£0.08
BC148	£0.08
BC149	£0.08
BC150	£0.23
BC151	£0.25
BC152	£0.23
BC153	£0.28
BC154	£0.21
BC157	£0.11
BC158	£0.11
BC159	£0.11
BC160	£0.28
BC161	£0.41
BC167	£0.14
BC168	£0.14
BC169	£0.10
BC169C	£0.11
BC170	£0.10
BC171	£0.10
BC172	£0.10
BC173	£0.10
BC174	£0.17
BC175	£0.39
BC177	£0.17
BC178	£0.17
BC179	£0.17
BC180	£0.27
BC181	£0.28
BC182	£0.10
BC182L	£0.10
BC183	£0.10
BC183L	£0.10
BC184	£0.10
BC184L	£0.10
BC186	£0.24
BC187	£0.24
BC207	£0.12
BC208	£0.12
BC209	£0.14
BC212	£0.10
BC212L	£0.10
BC213	£0.10
BC213L	£0.10
BC214	£0.10
BC214L	£0.10
BC225	£0.29
BC226	£0.41
BC227	£0.18

Type	Price
BC238	£0.18
BC251	£0.17
BC251A	£0.18
BC301	£0.38
BC302	£0.31
BC303	£0.30
BC304	£0.41
BC327	£0.18
BC328	£0.17
BC337	£0.17
BC338	£0.17
BC440	£0.32
BC441	£0.32
BC460	£0.41
BC461	£0.41
BC447	£0.22
BC478	£0.22
BC479	£0.22
BC547	£0.11
BX548	£0.11
BC549	£0.11
BC550	£0.16
BC556	£0.16
BC557	£0.15
BC558	£0.14
BC559	£0.16
BCY30	£0.59
BCY31	£0.59
BCY32	£0.85
BCY33	£0.59
BCY34	£0.65
BCY70	£0.16
BCY71	£0.16
BCY72	£0.15
BCZ10	£0.65
BCZ11	£0.86
BCZ12	£0.65
BD115	£0.54
BD116	£0.86
BD121	£0.70
BD123	£0.70
BD124	£0.76
BD131	£0.38
BD132	£0.38
BD131/132MP	£0.86
BD133	£0.43
BD135	£0.41
BD136	£0.38
BD137	£0.38
BD138	£0.39
BD139	£0.39
BD140	£0.39
BD139/140MP	£0.86
BF115	£0.24
BF117	£0.54
BF118	£0.84
BF119	£0.84
BF121	£0.56
BF123	£0.68
BF125	£0.56

Type	Price
BF127	£0.88
BF152	£0.28
BF153	£0.27
BF154	£0.24
BF155	£0.38
BF156	£0.32
BF157	£0.32
BF158	£0.32
BF159	£0.32
BF160	£0.34
BF162	£0.34
BF163	£0.34
BF164	£0.54
BF165	£0.54
BF167	£0.27
BF173	£0.22
BF176	£0.41
BF177	£0.28
BF178	£0.28
BF179	£0.28
BD239A/240AMP	£1.00
BF180	£0.32
BF181	£0.32
BF182	£0.32
BF183	£0.32
BF184	£0.22
BF185	£0.22
BF186	£0.29
BF187	£0.28
BF188	£0.43
BF194	£0.11
BF195	£0.11
BF196	£0.11
BF197	£0.14
BF198	£0.16
BF199	£0.16
MJE340	£0.49
MJE2955	£0.97
MJE3055	£0.65
TIP29A	£0.43
TIP29B	£0.46
TIP29C	£0.48
TIP30A	£0.43
TIP30B	£0.45
TIP30C	£0.48
TIP31A	£0.43
TIP31B	£0.45
TIP31C	£0.48
TIP32A	£0.43
TIP32B	£0.45
TIP32C	£0.48
TIP41A	£0.48
TIP41B	£0.50
TIP41C	£0.52
TIP42A	£0.48
TIP42B	£0.50
TIP42C	£0.62
TIP2955	£0.86
TIP2955	£0.65
TIP3055	£0.54

Type	Price
TIS43	£0.24
TIS90	£0.20
UT46	£0.22
2N706	£0.11
2N707	£0.52
2N708	£0.15
2N1302	£0.16
2N1303	£0.16
2N1304	£0.19
2N1305	£0.19
2N1306	£0.27
2N1307	£0.27
2N1308	£0.32
2N1309	£0.32
2N1711	£0.22
2N2219	£0.22
2N2221	£0.22
2N2222	£0.22
2N2369	£0.15
2N2711	£0.24
2N2712	£0.24
2N2714	£0.24
2N2904	£0.19
2N2905	£0.19
2N2906	£0.17
2N2907	£0.22
2N2923	£0.17
2N2924	£0.17
2N2925	£0.17
2N2926G	£0.10
2N2926Y	£0.09
2N2926O	£0.09
2N2926R	£0.09
2N2926B	£0.09
2N3053	£0.17
2N3054	£0.43
2N3055	£0.43
2N3402	£0.24
2N3403	£0.24
2N3404	£0.33
2N3405	£0.47
2N3702	£0.09
2N3703	£0.09
2N3704	£0.08
2N3705	£0.08
2N3706	£0.09
2N3707	£0.09
2N3708	£0.08
2N3709	£0.08
2N3710	£0.08
2N3711	£0.08
2N3772	£1.73
2N3773	£2.38
2N3819	£0.19
2N3820	£0.38
2N3821	£0.65
2N3823	£0.86
2N3903	£0.11
2N3904	£0.11
2N3905	£0.11
2N3906	£0.11

74 SERIES TTL IC's

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7422	£0.17	7448	£0.60	7489	£1.84	74123	£0.43	74174	£0.70
7401	£0.12	7423	£0.23	7450	£0.12	7490	£0.34	74136	£0.56	74175	£0.67
7402	£0.12	7425	£0.20	7451	£0.12	7491	£0.69	74141	£0.59	74176	£0.63
7403	£0.12	7426	£0.25	7453	£0.12	7492	£0.38	74145	£0.59	74177	£0.63
7404	£0.12	7427	£0.26	7454	£0.12	7493	£0.32	74150	£0.73	74180	£1.62
7405	£0.12	7428	£0.28	7460	£0.12	7494	£0.81	74151	£0.62	74181	£0.63
7406	£0.24	7430	£0.12	7470	£0.27	7495	£0.64	74153	£0.62	74182	£0.76
7407	£0.24	7432	£0.24	7472	£0.22	7496	£0.54	74154	£0.88	74184	£0.76
7408	£0.14	7433	£0.32	7473	£0.27	74100	£0.92	74155	£0.54	74190	£0.73
7409	£0.14	7437	£0.23	7474	£0.27	74104	£0.42	74156	£0.54	74191	£0.67
7410	£0.12	7438	£0.23	7475	£0.31	74105	£0.41	74157	£0.54	74192	£0.65
7411	£0.18	7440	£0.13	7476	£0.27	74107	£0.28	74160	£0.83	74193	£0.63
7412	£0.18	7441	£0.54	7480	£0.48	74110	£0.39	74161	£0.67	74194	£0.67
7413	£0.26	7442	£0.43	7481	£0.92	74111	£0.63	74162	£0.67	74195	£0.65
7414	£0.54	7443	£0.76	7482	£0.73	74118	£0.86	74163	£0.67	74196	£1.13
7416	£0.26	7444	£0.76	7483	£0.83	74119	£1.27	74164	£0.73	74197	£1.13
7417	£0.25	7445	£0.70	7484	£0.95	74121	£0.28	74165	£0.73	74198	£2.00
7420	£0.12	7446	£0.65	7485	£0.73	74122	£0.42	74166	£0.84	74199	£2.00
7421	£0.22	7447	£0.52	7486	£0.24						

CMOS IC's

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.16	CD4012	£0.17	CD4022	£0.87	CD4031	£2.18	CD4046	£1.40	CD4071	£0.18
CD4001	£0.18	CD4013	£0.46	CD4023	£0.16	CD4035	£1.08	CD4047	£0.94	CD4072	£0.18
CD4002	£0.17	CD4015	£0.82	CD4024	£0.70	CD4037	£1.03	CD4049	£0.45	CD4081	£0.18
CD4006	£0.99	CD4016	£0.45	CD4025	£0.16	CD4040	£0.95	CD4050	£0.46	CD4082	£0.19
CD4007	£0.18	CD4017	£0.81	CD4026	£1.30	CD4041	£0.82	CD4054	£1.19	CD4510	£1.07
CD4008	£0.99	CD4018	£0.92	CD4027	£0.54	CD4042	£0.78	CD4055	£1.08	CD4511	£1.03
CD4009	£0.49	CD4019	£0.46	CD4028	£0.73	CD4043	£0.95	CD4056	£1.46	CD4516	£1.08
CD4010	£0.52	CD4020	£0.9;	CD4029	£0.92	CD4044	£0.89	CD4069	£0.18	CD4518	£1.08
CD4011	£0.16	CD4021	£0.87	CD4030	£0.52	CD4045	£1.51	CD4070	£0.18	CD4520	£1.06

LINEAR IC's

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0.90	LM304	£1.73	MC1496	£1.01	UA741C	£0.27	TBA540	£2.36	TBA820	£0.79
CA3014	£1.52	LM308	£1.12	NE536	£2.99	72741	£0.27	TBA810S	£0.84	TBA9200	£2.81
CA3018	£0.73	LM309	£1.62	NE550	£1.03	741P	£0.22	TBA810	£1.10	TCA270S	£2.25
CA3020	£1.91	LM320-5V	£1.62	NE555	£0.26	UA747C	£0.67				
CA3028	£0.90	LM320-12V	£1.62	NE556	£0.65	72747	£0.67				
CA3035	£1.57	LM320-15V	£1.62	NE565	£1.36	UA748	£0.39				
CA3036	£1.12	LM320-24V	£1.62	NE566	£1.69	72748	£0.39				
CA3042	£1.69	LM380	£0.96	NE567	£1.91	748P	£0.39				
CA3043	£2.08	LM381	£1.63	UA702C	£0.52	SN76013N	£1.97				
CA3046	£0.79	LM3900	£0.65	72702	£0.52	SN76023	£1.97				
CA3052	£1.80	MC1303L	£0.98	UA703	£0.28	SN76110	£1.69				
CA3054	£1.24	MC1304	£2.14	UA709	£0.36	SN76115	£2.14				
CA3075	£1.69	MC1310	£1.07	72709	£0.52	SN76660	£0.84				
CA3081	£1.69	MC1312	£2.14	709P	£0.28	SL414A	£2.19				
CA3089	£2.25	MC1350	£1.35	UA710C	£0.45	TAA550B	£0.38				
CA3090	£4.05	MC1352	£1.57	72710	£0.34	TAA621A	£2.25				
CA3123	£2.14	MC1469	£3.19	UA711C	£0.36	TAA621B	£2.81				
CA3130	£1.00			72711	£0.36	TAA661	£1.69				
CA3140	£0.78			UA723C	£0.49	TAD100	£1.46				
LM301	£0.33			72723	£0.49						

IC PAKS

Manufacturers 'Fall Outs' which include functional and part functional units. These are classed as 'out-of-spec' from the makers very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

16224 – 100 Gates assorted 7400 01 04 10 50 60 etc. **£1.30**
16226 – 30 MXI assorted types 7441 47 90 154 etc. **£1.30**
16227 – 30 Assorted Linear types 709 741 747 748 710 588 etc. **£1.68**
16228 – 8 Assorted types SL403 76013 76003 etc. **£1.12**
16229 – 5 I.C.'s 76110 Eqv. to MC13130P MA767 **£1.68**

MAMMOTH I.C. PAK

16223 – Approx 200 pieces assorted fall out integrated circuits including Logic 74 series Linear Audio and DTL Mandy coded devices but some unmarked you to identify **£1.35**

UNTESTED SEMI-CONDUCTOR PAKS

16130 – 100 Germ gold bonded OA47 diodes **£0.65**
16131 – 150 Germ point contact 100mA OA78 81 diode **£0.65**
16132 – 100 Silicon diodes 200mA OA200 **£0.65**
16133 – 150 Silicon Fast switch diode 25mA IN41 18 **£0.65**
16134 – 50 Silicon rectifiers top hat 250mA **£0.65**
16135 – 20 Silicon rectifiers stud type 3 amp **£0.65**
16136 – 50 400mW zeners DO7 case **£0.65**
16137 – 30 NPN transistors BC107 8 plastic **£0.67**
16138 – 30 PNP transistors BC177 178 plastic **£0.67**
16139 – 25 NPN TO39 2N697 2N1711 silicon **£0.65**
16140 – 25 PNP TO39 2N2905 silicon **£0.65**
16141 – 30 NPN TO18 2N706 silicon switching **£0.65**
16142 – 25 NPN BFY50 51 **£0.65**
16143 – 30 NPN plastic 2N3906 silicon **£0.67**
16144 – 30 PNP plastic 2N3905 silicon **£0.67**
16145 – 30 Germ OC71 PNP **£0.65**
16146 – 15 Plastic power 2N3055 NPN TO220 case **£1.30**
16147 – 10 TO3 metal 2N3055 NPN **£1.30**
16149 – 10 1 amp SCR TO39 **£1.30**
16150 – 8 x 3 amp SCR TO66 case **£1.30**

G.P. SWITCHING TRANSISTORS

TO18 sim to 2N706 8 BSY27 28 95A. ALL usable devices. No open and shorts. ALSO available in PNP similar to 2N2906 BCY70. 20 for **54p**, 50 for **£1.08**, 100 for **£1.94**, 500 for **£8.64**, 1000 for **£15.12**. When ordering please state NPN or PNP.

SILICON DIODES G.P.

300mW 40PIV (min) sum-min. FULLY TESTED. Ideal for Organ builders. 30 for **54p**, 100 for **£1.62**, 500 for **£5.40**, 1000 for **£9.72**.

VAT

All prices in this advert are VAT inclusive of 8% and 12%. Owing to increase to 15% these prices are no longer correct. Please re-calculate or alternatively the extra will be charged on receipt of orders.

P&P 35p unless otherwise marked

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DEPT. R.C.8, P.O. Box 6, Ware, Herts.

COMPONENTS SHOP, 18 BALDOCK STREET, WARE, HERTS.

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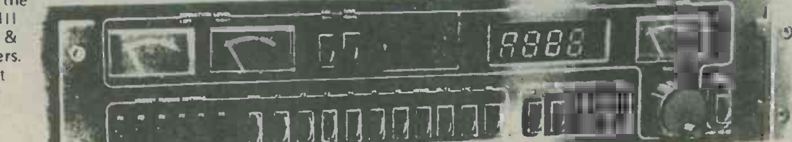
The Mark III FM Tuner

DIY Hi Fi will never seem the same again. Ambit's Mark III tuner system is electrically & visually superior to all others. Some options available, but the illustrated version with reference series modules: £149.00 + £18.62 VAT

With Hyperfi Series modules £185.00 + £23.12



Features of the system:

* Precision construction & design of all parts
* Time frequency display
* State of the art performance with facilities for updates, using modular plug in systems.
* Deviation level calibrator for recording
* All usual tuner features

ALL TUNER KITS £3 carriage

Digital Dorchester All Band Broadcast Tuner: LW/MW/SW/SW/SW/FM stereo

A multiband superhet tuner, constructed using a single IC for RF/IF processing - but with all features you would expect of designs of far greater complexity. The FM section uses a three section (air gang) tuned FET tunerhead, with ceramic IF filters and interstation mute; AM employs a double balanced mixer input stage, with mechanical IF filters - plus a BFO and MOSFET product detector for CW/SSB reception. Styled in a matching unit to the Mark III FM only tuner, employing the same degree of care in mechanical design to enable easy construction. MW/LW reception via a ferrite rod antenna.

Electronics only (PCB and all components thereon)	£33.00 + £4.12 VAT
Complete with digital frequency readout/clock-timer hardware	**£99.00 + £12.37 VAT**
Complete with MA1023 clock/timer module with dial scale	**£66.00 + £8.25 VAT**

Hardware packages are available separately if you wish to house your own designs in a professional case structure. Please deduct the cost of electronics from complete prices.

LW MW/FM LCD Digital Frequency Display - July PW feature

Update your old radio, or build this into a new design. Or use it as a servicing aid - this low power unit with LCD display reads direct frequency in kHz/MHz, or with usual AM/FM IF offsets for received frequency. Low power LCD means no RFI - 15-20mA at 9v even with the divide by 100 prescalar. FM resolution is 100kHz, AM 1kHz. Sensitivities better than 10mV

Complete kit £13.50 +*£1.56 VAT. Built and tested version £24.00 +*£1.92 VAT

Various other DFM systems described in our catalogue part 2 - including a one chip solution to providing digital display of FRG7 kHz dial, combined with clock/timers etc.

PW SANDBANKS PI METAL LOCATOR

Maintaining our professional approach to home constructor kits, we offer the pulse induction 'Sandbanks'. Now with injection molded casing for greatly improved enviromental sealing. £37.00+ *£2.96vat.

VHF MONITOR RX WITH PLESSEY IC

4/9 channel version of the PW design - but using standard 3rd OT crystals, and TOYO 8 pole crystal filter with matching transformers. Coil sets from our standard range to cover bands from 40 to 200MHz. Complete module kit £31.25 +£3.90vat .

ETI - REMCON RADIO CONTROL

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Radio and Audio Modules : The biggest range/ best specs:

EF5801/3/4 6 stage varicap tunerheads with LO feed and various levels of sophistication. New 5804 include pin AGC loop 'on board'. 5801:£17.45+£2.18vat - 5803:£19.75+£2.47vat 5804:£24.95 +£3.18vat. *Frequencies in 40-180MHz on appcn.*

EF5402 4 stage varicap with TDA1062, compound FET/Bipolar input stage, low noise, balanced mixer, pin agc, osc output. A worthy successor to the 5400. £10.75+£1.34vat

The 5402 is available centred on a wide range of frequencies from 30MHz to 180MHz. Non standard units £14.75+£1.84 - 3 weeks.

8319 4 stage varicap tunerhead from Larsholt using MOSFET RF and mixer stages. New temperature compensated oscillator for wide ranges of ambient temperature £13.45+£1.68vat

7252 Complete Larsholt FM tuner less stereo decoder. £26.50+£3.31vat

7253 Stereo FM tunerset from Larsholt with FET head. (as 7252)

944378 Hyperfi stereo decoder. The very best. £19.95+£2.19vat

911223 Pilot cancel stereo decoder, priced to make the MC1310 as obsolete as it now deserves to be.£12.50+£1.56vat

Inotec 1-A fully DC tuned and switched LW/MW/FM stereo tuner to interface with synthesiser control etc.A first! Details OA

COMPONENTS for Radio and Audio ICs, HMOS etc.

The list is too long to attempt here, but AMBIT specializes in all types of semiconductor for radio reception, including devices operating from DC to 5GHz. New low cost SBL1 diode ring mixers (equiv case MD108 etc) -first with HMOS fets, now with a PCB for DC amplifier, and offset sense and protection relay for speakers. See catalogue and updates for most info, pse send an SAE for information on anything you cannot find in catalogues.

Radio ICs	cost	+ vat	Stereo ICs	cost	+ vat
CA3089E	1.94	24	MC1310P	1.50	19
CA3189E	2.45	30	uA758	2.20	27
HA1137W	2.20	27	CA3090A	2.75	34
SN76660	0.75	9	HA1196	3.95	49
TDA1090	3.35	42	HA11223	4.35	54
TDA1083	1.95	24	KB4437	4.35	54
TDA1220	1.40	17	KB2224	2.75	34
SL6640	2.75	34	Preamp ICs/switches		
MC3357	3.12	39	TDA1028	3.50	44
HA1197W	1.40	17	TDA1029	3.50	44
MC1496	1.25	16	TDA1074	4.14	52
LM373/4	3.75	49	KB4438	2.22	28

AF power ICs	cost	+ vat
LM380N	1.00	12
TBA810AS	1.09	14
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	'N'	'LSN'
7400	13	20
7401	13	20
7402	14	20
7403	14	20
7404	14	24
7405	18	26
7406	38	
7407	38	
7408	17	24
7409	17	24
7410	15	24
7411	20	24
7412	17	
7413	30	
7414	51	
7415		24
7416	30	
7417	30	
7420	16	24
7421	29	24
7422	24	24
7423	27	
7425	27	
7426	36	27
7427	27	29
7428	35	32
7430	17	24
7432	25	24
7433	40	32
7437	40	24
7438	33	24
7440	17	24
7441	74	
7442	70	99
7443	115	
7444	112	
7445	94	
7446	94	
7447	82	89
7448	56	99
7449		99
7450	17	
7451	17	24
7453	17	
7454	17	24

	'N'	'LSN'
7455	35	24
7460	17	
7463		124
7470	28	
7472	28	
7473	32	38
7474	27	38
7475	38	40
7476	37	38
7478		38
7480	48	
7481	86	
7482	69	
7483A		110
7484	97	
7485	104	99
7486		40
7489	205	
7490	33	90
7491	76	110
7492	38	78
7493	32	99
7494	78	
7495A	65	99
7496	58	120
7497	185	
74100	119	
74104	63	
74105	62	
74107	32	38
74109	63	38
74110	54	54
74111	68	
74112		38
74113		38
74114		38
74116	198	
74118	83	
74119	119	
74120	115	
74121	25	
74122	46	57
74123	48	73
74124		137
74125	38	44

	'N'	'LSN'
74126	57	44
74128	74	
74132	73	78
74133		29
74136		40
74138		60
74139		60
74141	56	
74142	265	
74143	312	
74144	312	
74145	65	97
74147	175	
74148	109	191
74150	99	
74151	64	84
74153	64	54
74154	96	
74155	54	110
74156	80	110
74157	67	55
74158		60
74159	210	
74160	82	130
74161	92	78
74162	92	130
74163	92	78
74164	104	130
74165	105	
74166		
74167	20	
74168		
74169		200
74170	230	200
74172	625	
74173	170	
74174	87	120
74175	87	110
74176	75	
74177	78	
74180	85	
74181	165	350
74182	160	
74183		210
74184	135	

	'N'	'LSN'
74185	134	
74188	275	
74190	115	92
74191		
74192	105	180
74193	105	180
74194	105	187
74195	95	137
74196	99	110
74197	85	110
74198	150	
74199	160	
74247		90
74248		90
74249		93
74251		90
74253		105
74257		108
74258		153
74259		420
74260		153
74261		353
74266		40
74273		124
74275		312
74279		52
74283		120
74290		90
74293		95
74295		120
74298		100
74324		157
74325		242
74326		247
74327		237
74352		100
74353		100
74362		715
74365		49
74366		49
74367		43
74368		49
74373		77
74374		77
74375		150

	'LSN'
74377	124
74378	93
74379	130
74368	37
74390	140
74393	140
74395	139
74396	133
74398	180
74399	150
74445	92
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74490	140
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4017	80p
4018	80p
4019	60p
4020	93p
4021	82p
4022	90p
4023	17p
4024	76p
4025	17p
4026	180p
4027	55p
4028	72p
4029	100p
4030	58p
4031	250p
4032	100p
4033	145p
4034	200p
4035	120p
4036	250p
4037	100p
4038	105p
4039	250p
4040	83p
4041	90p
4042	85p
4043	85p
4044	80p
4045	150p
4046	130p
4047	99p
4048	60p
4049	55p
4050	55p
4051	65p
4052	65p
4053	65p
4054	120p
4055	135p

4059	563p
4060	115p
4063	109p
4066	53p
4067	400p
4068	25p
4069	20p
4070	20p
4071	20p
4072	20p
4073	20p
4075	20p
4076	90p
4077	20p
4078	20p
4081	20p
4082	20p
4085	82p
4086	82p
4089	150p
4093	50p
4094	190p
4096	105p
4097	372p
4098	110p
4099	122p
4160	90p
4161	90p
4162	90p
4163	90p
4174	104p
4175	95p
4194	95p
4501	23p
4502	91p
4503	69p
4506	51p
4507	55p
4508	248p
4510	99p
4511	149p
4512	98p
4513	206p
4514	260p
4515	300p
4516	125p
4517	382p
4518	103p
4519	57p
4520	109p
4521	236p

4522	149p
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4556	77p
4557	386p
4558	117p
4559	388p
4560	218p
4561	65p
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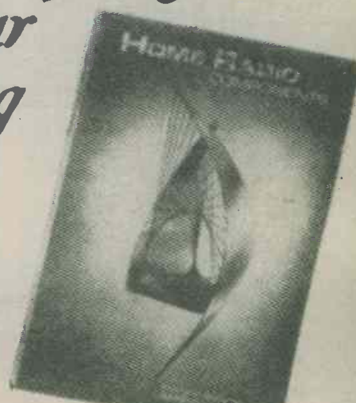

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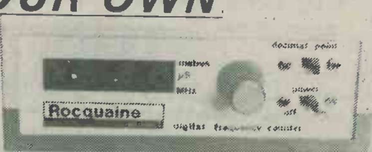

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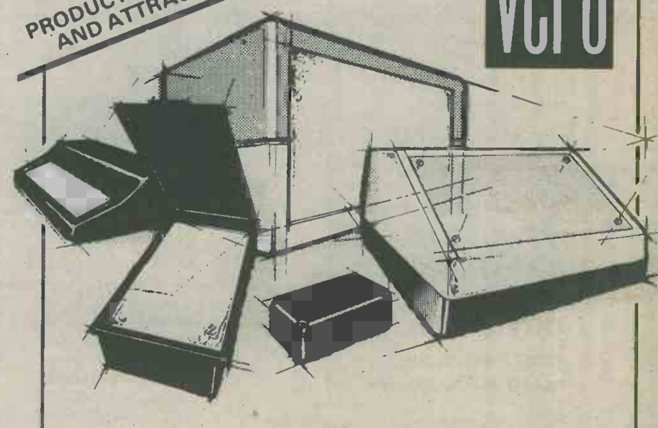

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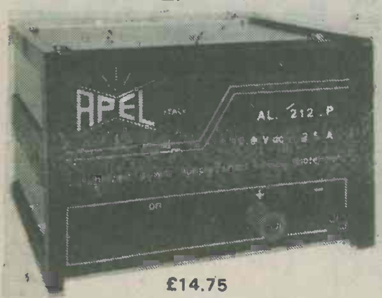

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RIPPLE	<5mV 2,2 Amp
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LOAD REGULATION	< 0,2% 0÷2,8 Amp
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RIPPLE	3mV 2,8 Amp
WEIGHT	2,330 Kg.

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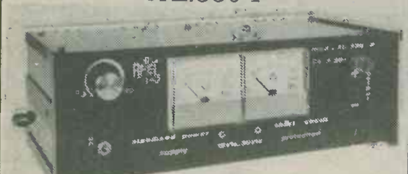

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OUTPUT VOLTAGE RANGE	1 ± 15 V. dc
OUTPUT CURRENT MAX	5 Amp
LOAD REGULATION	< 0,1% 0-45 Amp
RIPPLE	< 2mV 4.5 Amp
DIMENSIONS (mm)	W210 × H155 × D250
WEIGHT	5,100 Kg.

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OUTPUT VOLTAGE RANGE	12,6 V dc
OUTPUT CURRENT MAX	2,5 Amp
LOAD REGULATION	<0,3% 0÷2,2 Amp
RIPPLE	<5mV 2,2 Amp
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OUTPUT CURRENT RANGE MAX	3 Amp
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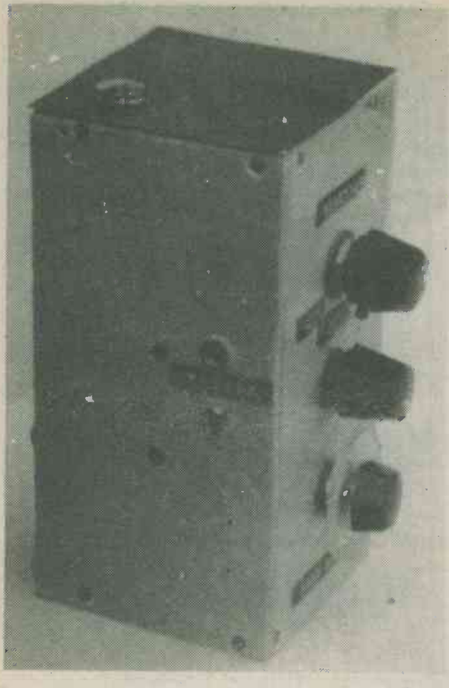


THE "DORIC" 9 WAVEBAND PORTABLE

Part 1

By Sir Douglas Hall, Bt., K.C.M.G.

This opening article describes a complete 6-waveband short wave receiver, to which can be added an amplifier and a tuner covering v.h.f., medium and long waves.

This 4 part series describes a multi-band portable receiver which offers six bandspread short wave ranges covering 13.5 to 52 metres, medium waves, long waves and v.h.f. on Band II. The design can be built in stages, each stage resulting in a complete receiver or amplifier in its own right. The first part of the series commences by dealing with the short wave section which, when assembled, consists of a receiver suitable for use on its own with headphones. The following parts of the series will describe the addition of an amplifier and speaker to this short wave receiver, and further steps which provide for the reception of medium wave, long wave and v.h.f. signals.

SHORT WAVE CIRCUIT

The circuit of the short wave headphone receiver appears in Fig.1. The aerial signal is applied via C1 and VR1 to the emitter of TR1. VR1 is a selectivity control, and can also be used as a vernier reaction control. TR1 amplifies as a common base device, the signal at its collector being passed via C3 to the base of TR2 which, at r.f., is a common collector amplifier. Detection takes place at D1, and the consequent audio signal then passes through TR2 again, working now as a common base amplifier, followed by TR1 as a common emitter amplifier with some negative feedback due to the presence of VR1.

Variable inductance tuning is used, band setting being arranged by having a ferrite rod move into coil L2, the rod movement being controlled by the six positions of rotary switch S1. This has a tuning drive drum fitted to its spindle, and a nylon cord on the drum controls the amount of insertion into the coil of the ferrite rod. At the same time, one set of the switch contacts varies the parallel capacitance across the diode, to give optimum results for each position of the ferrite rod. The associated capacitors, C5 to C8, allow reaction in the Colpitts mode to be obtained. Reaction control is given by varying the impedance of the diode, and hence the damping on the tuned circuit, by altering the direct current which passes through the diode. Panel control VR2 varies this current (which is additional to that passing through TR2) and thereby controls reaction. VR3 is adjusted to compensate for different gain levels in the transistor used in the TR2 position, and D2 and D3 provide voltage stabilization as battery voltage falls with age.

The a.f. output is built up across the large winding of the interstage transformer T1, and high resistance phones (4,000Ω magnetic or crystal) may be plugged into the lower jack socket. The upper socket is unused with the receiver in its present state of construction, and will be employed when the amplifier to be described next month is added.

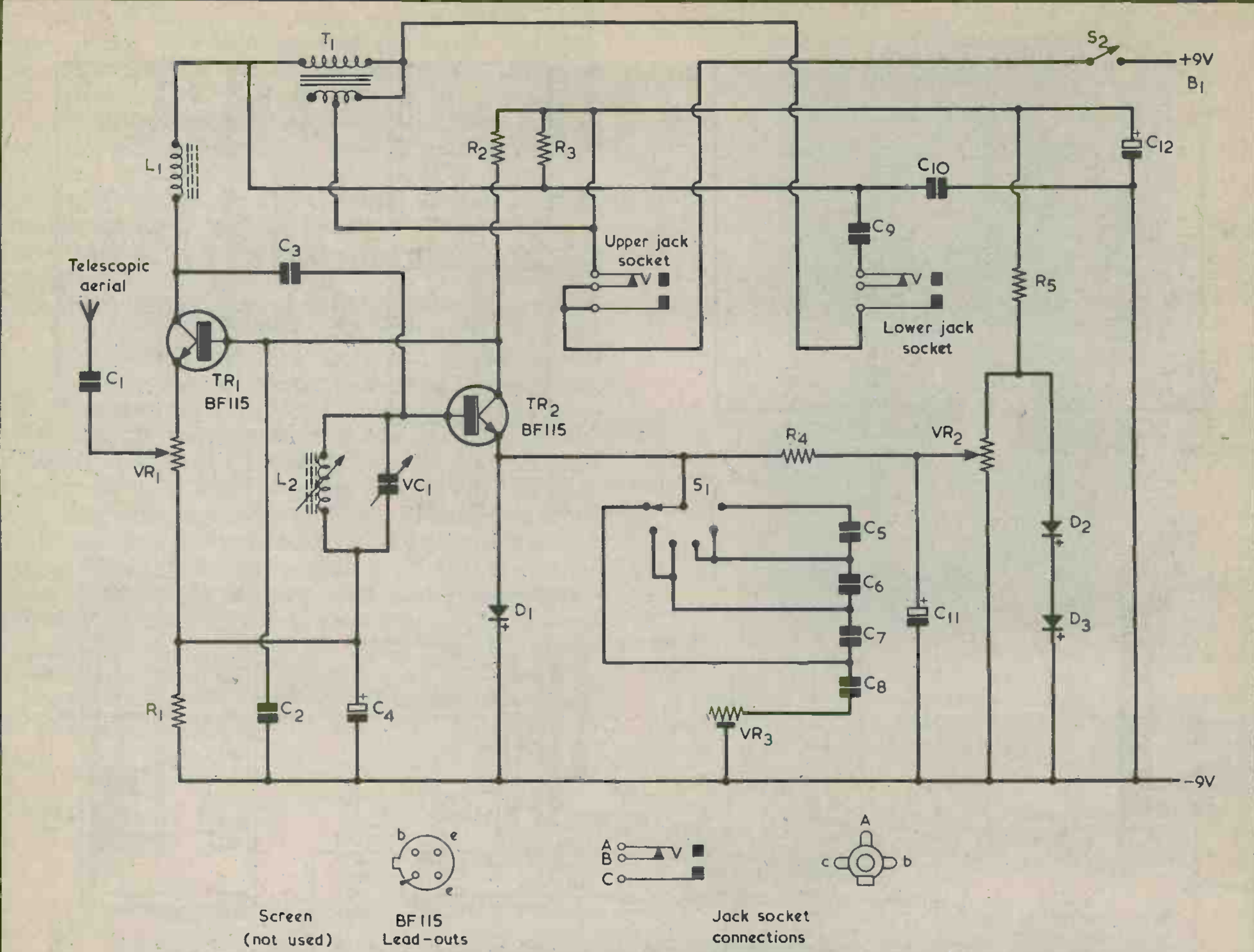


Fig. 1. The circuit of the multi-band short wave receiver. High impedance headphones are plugged into the lower jack socket, whilst the upper jack socket allows interconnection to the amplifier unit which will be described next month. L2 is permeability tuned by a ferrite rod moving to six positions inside the coil, these positions being mechanically controlled by switch S1

Resistors
(All fixed values ¼ watt 10%)
- R1 1k Ω
- R2 33k Ω
- R3 12k Ω
- R4 1.2k Ω
- R5 8.2k Ω
- VR1 470 Ω potentiometer, linear, type P20 (Electrovalue)
- VR2 4.7k Ω potentiometer, linear, with switch S2, type P20 (Electrovalue)
- VR3 470 Ω pre-set potentiometer, 0.25 or 0.3 watt, horizontal

Capacitors
- C1 100pF silvered mica or ceramic
- C2 1,000pF silvered mica or ceramic
- C3 5.6pF silvered mica or ceramic
- C4 47μF electrolytic, 3V. Wkg.
- C5 220pF silvered mica or ceramic
- C6 220pF silvered mica or ceramic
- C7 330pF silvered mica or ceramic
- C8 100pF silvered mica or ceramic
- C9 0.47μF polyester
- C10 2,200pF silvered mica or ceramic
- C11 47μF electrolytic, 3V Wkg.
- C12 1,000 μ F electrolytic, 10V.Wkg.
- VC1 15pF variable, type C804 (Jackson)

Inductors
- L1 2.5mH r.f. choke (Repanco)
- L2 see text
- T1 transformer type LT44 (Eagle)

Semiconductors

TR1	BF115
TR2	BF115
D1	OA90 or OA91
D2	1S44
D3	1S44

Switches
- S1 2-pole 6-way rotary, miniature
- S2 s.p.s.t. toggle, part of VR2

Sockets
- 2-off 3.5mm. jack sockets

Aerial
- Telescopic aerial type TA10 (Eagle-Electrovalue)

Miscellaneous
- 10-way tagstrip (see text)
- 4 control knobs
- Ferrite rod, 4 or 4½in. by 3/8in. dia (see text)
- 1½. drive drum (Home Radio)
- 9-volt battery type PP3
- Battery connector
- Nylon cord
- Materials for case and "chassis" assembly

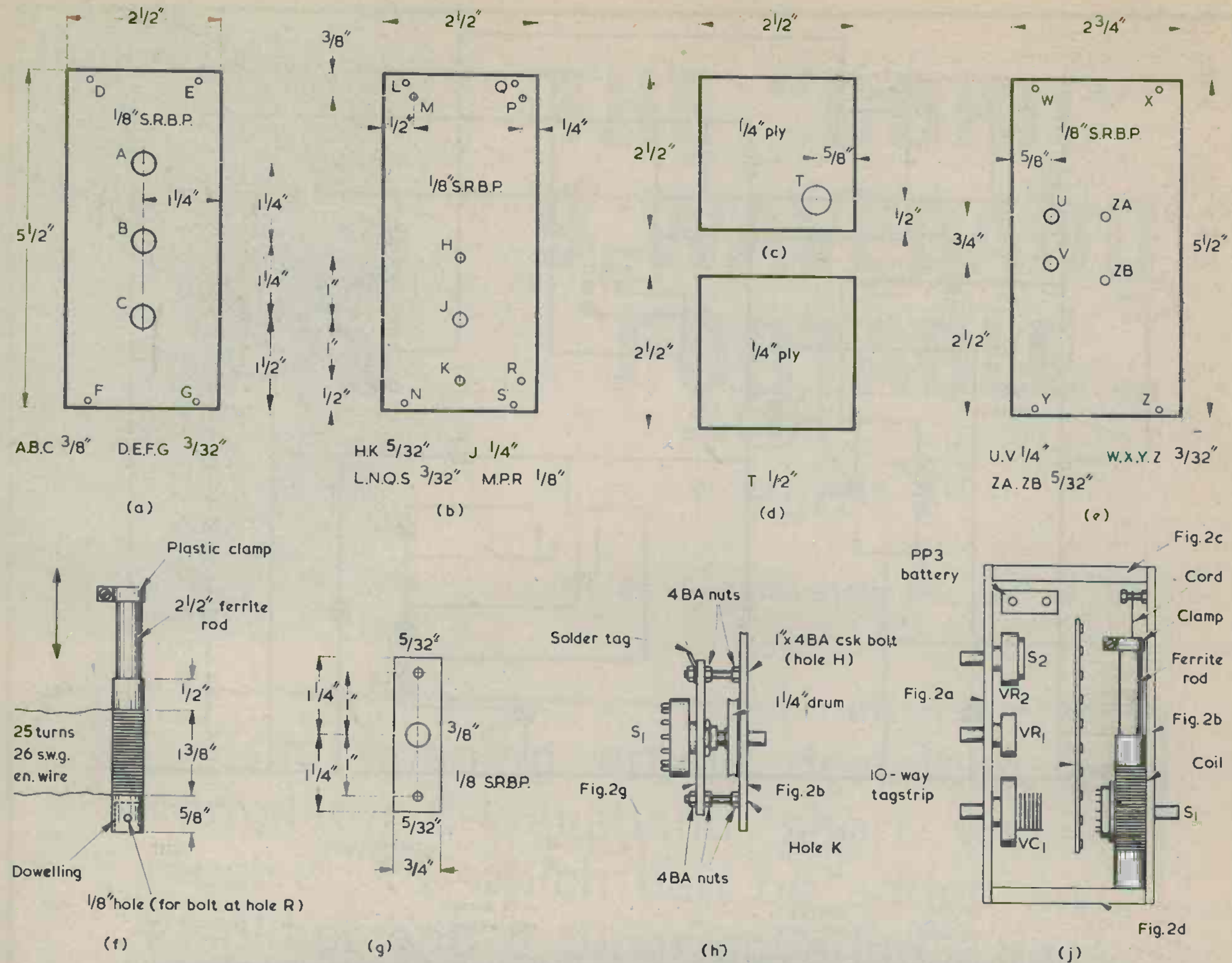
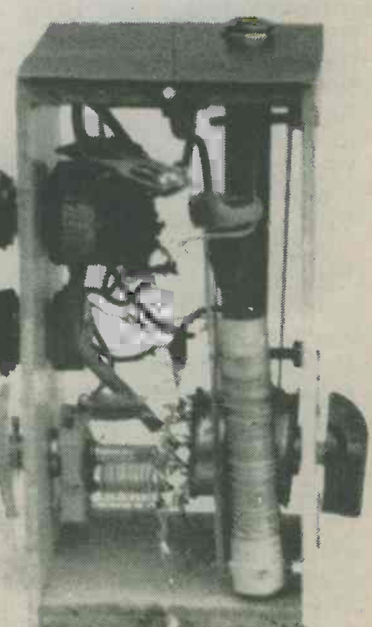


Fig. 2(a) (b) (c) (d) (e). Section of the receiver "chassis" and case (f) Details of the coil, in which the ferrite rod slides to give selection of the six waveranges (g) S.R.B.P. item onto which switch S1 is secured (h). The drive drum is fitted over the spindle of the switch, the spindle passing through hole J of Fig. 2(b) (i) Side view showing the internal assembly of the main parts of the receiver

CONSTRUCTION

Construction commences with the cutting out and drilling of the sections shown in Fig. 2(a) (b) (c) (d) and (e). These provide both the "chassis" and five sides of the case. A second piece of s.r.b.p. should be cut out identical to Fig. 2(e) but without holes U, V, ZA and ZB. This can be fitted opposite Fig. 2(e), forming the sixth side of the case, and can be the side which opens to provide access to the inside of the completed receiver. The small holes, D, E, F, G, and the corresponding four holes in Fig. 2(b) and Fig. 2(e) are for woodscrews used to assemble the parts together. Their exact positioning is not important provided that they are ⅛in. from the ends. The woodscrews then pass into the ¼in. plywood edges. The sixth opening side could, instead, be fastened by short lengths of 6BA studding cemented into the plywood, 6BA terminals then securing the side in position. Holes W, X, Y and Z in the sixth side will then need to be ⅛in. in diameter. Holes ZA and ZB are for mounting the 10-way tagstrip, the latter being used to mark out their positions.

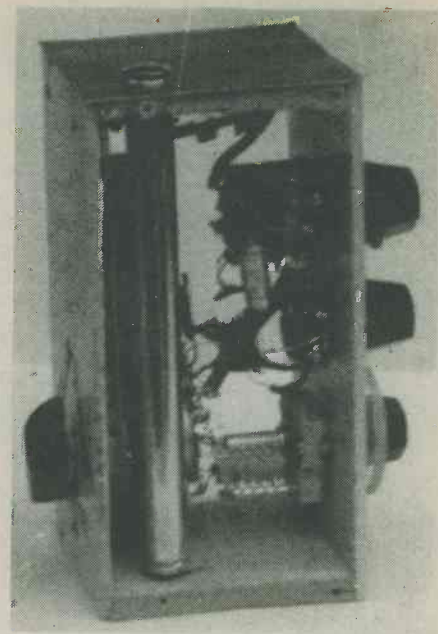
The coil is made next. Take a piece of Fablon, or Contact, 4in. by 2½in., and remove a small strip of



Looking into the receiver with coil L2 nearer the camera the backing paper, ½in. wide, at one of the 2½in. edges. Wrap the Fablon around the ferrite rod with the exposed strip last, so that it secures the tube thus formed. The rod should be able to move in the tube easily but without wobble, Cut a piece of ⅜in. wood dowelling ½in. long, wrap a turn or two of Sellotape around it to ensure that it is a tight fit and insert it at one end of the tube. Drill a ⅛in hole through the tube and the middle of the dowelling as shown in Fig. 2(f). Insert the rod into the tube to strengthen it and, starting ½in. from the end remote from the dowelling, wind onto the tube 25 turns of 26 s.w.g. enamelled wire, spacing out the turns so that the winding ends ⅝in. from the dowelling end of the tube. Use Sellotape to secure the winding ends, but not along the coil.

The ferrite rod is orange grade and can be obtained in a 4 or 4½in. length from Amatronix, 396 Selsdon Road, South Croydon, Surrey CR2 0DE. A 2½in. length is required, and this is obtained from the longer length supplied by filing round it at the appropriate point and snapping off the excess. If other grades of ferrite are used, some experimenting may be necessary to see whether the number of turns in the coil need to be altered to obtain the required wavelength range.

Mount VC1, VR1 and VR2/S2 to the item of Fig. 2(a) as shown in Fig. 2(i) and Fig. 3 A piece of



A view from the other side of the receiver. The telescopic aerial is secured to the bottom panel and passes through a hole in the top panel

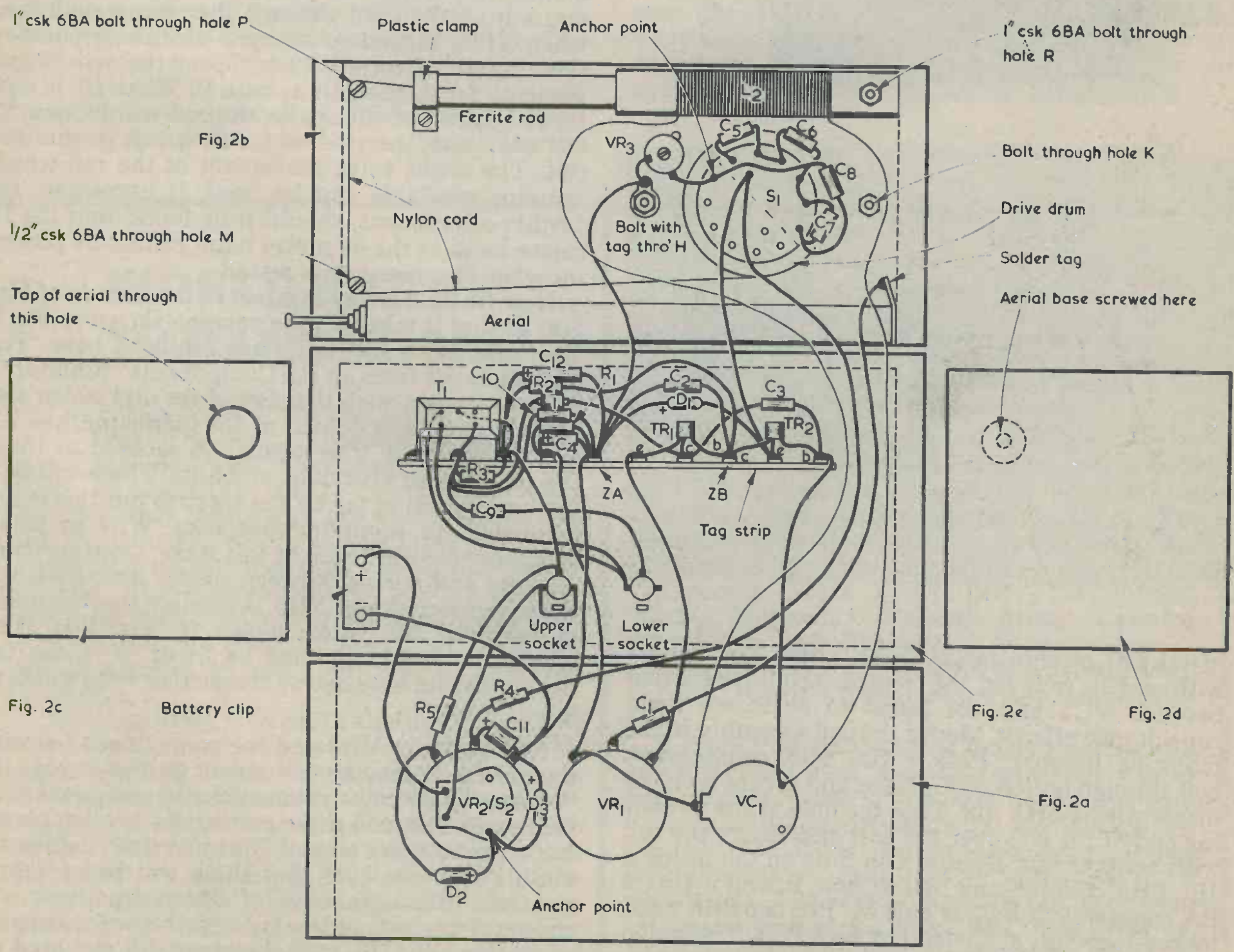
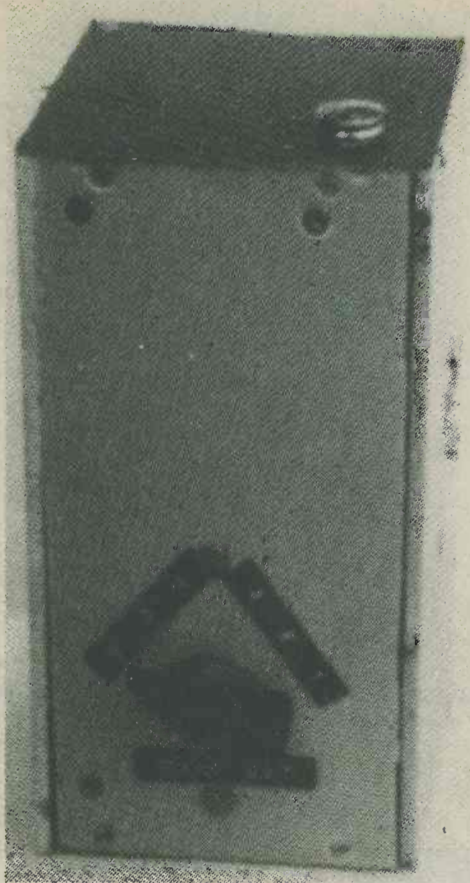
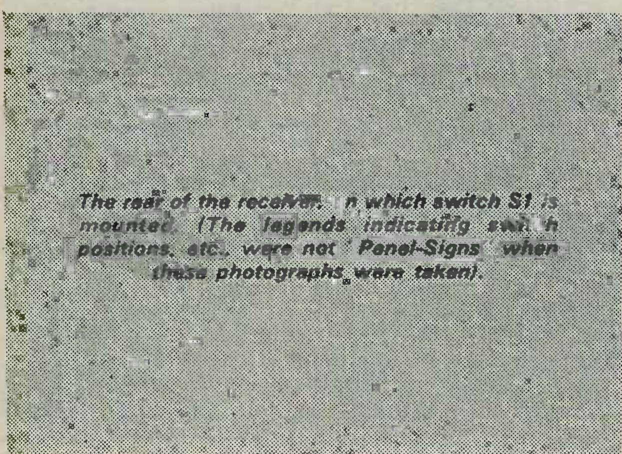


Fig. 3. Assembly and wiring of the components. The item of Fig. 2 (g) is omitted for clarity. Note how each setting of S1 allows the ferrite rod to move to a different position inside the coil. Before wiring to S1 confirm with a continuity tester the six outer tags corresponding to the inner switch arm tag. Similarly check the appropriate tags of S2 before wiring to it.





The rear of the receiver, on which switch S1 is mounted. (The legends indicating switch positions, etc., were not 'Panel-Signs' when these photographs were taken).

metal foil or thin metal sheet, about 2in. square with a ⅜in. hole at the centre, should be fitted between VC1 and the panel to overcome hand capacitance effects. Mount the coil assembly in the following manner. Pass a 1in. 6BA countersunk bolt through hole R of Fig. 2(b) and secure it on the inside with a 6BA nut. Pass the hole at the dowelling end of the coil over the bolt and secure the coil with another nut. Secure with nuts on the inside a 1in. 6BA countersunk bolt at hole P, and a ½in., 6 BA countersunk bolt at hole M. Put two 6BA nuts, locked together, at the end of each bolt. The nylon cord passes over the bolts and the locked nuts prevent it slipping over the bolt ends.

Cut out the item shown in Fig. 2(g) and secure the bush of S1 to this. Fit the 1¼in. drum to S1 spindle with the cord hook away from the switch and the drum bush well against that of the switch. Make a loop in one end of the nylon cord and pass it through the hole in the side of the drum and over the cord hook. (The cord is fitted to the drum now as it is difficult to reach the hook later). Slip the item of Fig. 2(g) over two 1in. countersunk 4BA bolts passing through holes H and K of Fig. 2(b) and adjust the spacing nuts shown in Fig. 2(h) so that the forward surface of the drum presses lightly against the item of Fig. 2(b). Fit a solder tag over the bolt passing through hole H, then add a third pair of nuts to hold the assembly firm. The pressure on the drum should be just enough to add a little stiffness to the rotation of S1 spindle. The solder tag provides an anchor point, when wiring is carried out, for one of the connections to VR3.

Next required is a plastic clamp to secure the nylon cord to the upper end of the ferrite rod. This is made with a strip of pliant plastic about ¼in. wide and 1¾in. long. This has two holes drilled at the ends such that a 6BA bolt passed through the holes and fastened with a 6BA nut can tighten the clamp so formed on the rod. Take the nylon cord, already fitted to the drum, give it a turn round the drum then lead it over the 6BA bolt in hole M and the 6BA bolt in hole P and then under the ferrite rod plastic clamp. Sufficiently tighten the clamp bolt and nut so that it is just possible to move the cord passing under it. Pass a rubber band over the bolt at hole R and the plastic clamp securing bolt, and adjust the cord through the clamp such that when S1 is turned to its most clockwise position (looking at its spindle) the top of the rod is just about to touch the bolt at hole P. When S1 is now turned fully anti-clockwise the rod will be nearly, but not quite, inserted as far as it can go into the coil. The slight extra movement of the rod which remains available can be used, if necessary, for further adjustment, should it be found that the 13 metre band or the 49 metre band cannot be picked up when the receiver is tested.

Now fit the 10-way tagstrip to the section of Fig. 2(e) so that it takes up the position shown in Fig.3. Two 4BA nuts and bolts are required here. The tagstrip is cut from an RS Components "Standard" 28-way tagstrip such that two of the tags which also provide mounting appear at the points marked ZA and ZB in Fig.3. The tagstrip is secured at these two points with 4BA bolts and nuts. There will be a further mounting tag on the tagstrip but this is not employed for mounting purposes. Wire in small components as in Fig.3, at this stage, omitting components and wiring between panels and, also, the telescopic aerial and VR3. Assemble the "chassis" to take up the form shown in Fig. 2(i). The telescopic aerial can then be fitted. A solder tag held under its base allows connection to be made to it.

Next, wire in VR3 and the connections between the panels. It may be convenient to disassemble the "chassis" and make connections to one panel first, then reassemble and make connections to other panels, but a preliminary assembly as just described is advisable to make sure that there will be no short-circuits. Although some of the components are shown to one side of the tagstrip this is for reasons of clarity only. T1 may, however, be mounted as shown, with its lugs soldered to two of the tags.

When wiring is completed, fit a PP3 battery. A simple home-made clip can be used to hold it in position, though this is not absolutely necessary.

TESTING

Extend the aerial and adjust S1 so that the ferrite rod is fully removed from the coil. Tune with VC1 and check that the 13 metre band is received when the vanes of this capacitor are nearly fully open. Greatest sensitivity is obtained when VR2 is set so that the receiver is just short of the oscillation point. Try all the switch positions and make sure that the 49 metre band is available when S1 is adjusted for the ferrite rod to be fully in the coil. If necessary, adjust the ferrite rod clamp and nylon cord as previously described. Test for overlap between the ranges; this should exist although it will be extremely small. If overlap does not appear at any switch position, this will mean that at that particular setting the turns of the coil are too close, and they should be separated with a small screwdriver. When all is well, put a little clear varnish on the winding.

While testing, use the setting of VR1 which gives the necessary selectivity. Adjustment of VR1 will have some effect on the settings for VC1 and VR2. If it is found that, with certain settings of VC1 and VR1, oscillation cannot be obtained with VR2 at maximum, adjust VR3 to insert less resistance into circuit. Conversely, if oscillation at some settings cannot be controlled, adjust VR3 to insert more resistance. A setting of VR3 to suit all wavebands should be found. So far as is possible, arrange matters so that VR2 never has to be set near its minimum position to prevent oscillation.

Wavebands can be marked, and the control functions indicated, by legends taken from "Panel Signs" Set No. 3 (white) or Set No. 4 (black), available from the publishers of this journal. When completed, the receiver case can be enclosed by the s.r.b.p. item which was cut out at the same time as that of Fig. 2(e).

EDITOR'S NOTE

The 28-way tagstrip from which the 10-way strip is cut is a "Standard" tagstrip listed by RS Components. In its 28-way form it has a length of 267mm, whereupon the 10-way strip has a length of approximately one-third of this. The tags are vertical to the mounting surface, with every third tag providing a mounting. Other tagstrips of similar dimensions could be employed. RS Components do not supply directly to individuals, and readers wishing to obtain the particular tagstrip used by the author and who do not have access to RS Components will need to obtain it through a retailer. The small radio and television shops, and their service engineers, may be helpful here. RS Components parts may also be obtained from Ace Mailtronix Limited, Tootal Street, Wakefield, West Yorkshire, WF1 5JR, subject to a minimum order of £2. A further section cut from the 28-way strip is employed in the amplifier unit to be described next month.

A second TA10 telescopic aerial is employed in the v.h.f., medium and long wave tuner which concludes the "Doric" series and readers who anticipate making this may, if they wish, obtain the second aerial at the same time as the aerial employed for the short wave receiver which has been described here. The v.h.f., medium and long wave tuner also requires a further 4 or 4½in. length of orange grade ferrite rod, and this is again available from Amatronix.

(To be continued)

WORLD RADIO TV HANDBOOK

The 33rd edition of "World Radio TV Handbook" has now become available. With 544 pages, the Handbook is crammed with information concerning radio and television transmissions throughout the world, and it lists the frequencies, schedules and other details of virtually every broadcasting station which is on the air. The edition takes in all the changes resulting from the Geneva Medium Wave Plan which came into effect in November 1978, and which applies to all countries outside the Americas.

The Handbook is of particular use to the short wave Dx listener who searches the bands for rewarding long distance reception. In addition to its frequency listings, the Handbook gives information on anticipated reception conditions in 1979, solar activity and similar subjects. Published by Billboard Publications Inc., the "World Radio TV Handbook" 33rd edition is priced at £8.50, and may be obtained from The Modern Book Company, 19-21 Praed Street (Dept. RC), London, W2 1NP. Price £9.15 inclusive of postage and packing.

WILMSLOW AUDIO CATALOGUE

Currently available from Wilmslow Audio Ltd. is their latest 40-page catalogue listing high fidelity speakers for all applications including domestic, group, public address and disco. The products of more than 30 manufacturers are presented in the catalogue, taking in such names as Celestion, Decca, E.M.I., Elac, Fane, Jordan, Watts, Motorola, Richard Allen, Tannoy, Wharfedale and Shackman. Products are illustrated by clear photographs and illustrations. Detailed product specifications are also provided.

It should be noted that Wilmslow Audio Ltd. now offer the widest range of speaker drive units and speaker construction kits in Britain, and have supplied loudspeakers to the BBC, IBA, the Forces, Rolls Royce and many other organisations in addition to individual hi-fi enthusiasts. The catalogue can be obtained from Wilmslow Audio Ltd., Dept. REC, Swan Works, Bank Square, Wilmslow, Cheshire, SK9 1HF. A charge of 15p is made to cover postage.

NEWS . . . AND

A UNIQUE COMPUTERISED SYSTEM

A unique computerised system to expedite the production and lower the costs of making animated films is now being used by the Swedish Broadcasting Corporation (SBC) for its television services.

Conventional methods of preparing animated films are enormously time-consuming. Most of the work is very repetitive since each second of finished film requires from 20 to 25 almost similar drawings.

Under the new system, utilising a SPERRY UNIVAC 1100/11 computer, SBC uses a technique developed by Alan Kitching, an animation and data processing specialist, who manages Grove Park Studios in Camberwell.

The technique, known as ANTICS, begins with a basic drawing being prepared and entered into the computer using a special light pen. By means of special command words and coded direction, speed and position specifications are also inputted into the computer. The basic drawing can then be modified in different ways, for example, it can be shrunk, enlarged, panned, skewed, shaken or reversed.

A technician with the Swedish Broadcasting Corporation uses a new computerised technique to produce an animated film for television.

It can also be induced to rotate, jump, rock, etc. The system now contains some 40 commands but Alan Kitching is working on further expansion.

PORTABLE RADIO TELEPHONE

New from Marconi Mobile Marine is the only Post Office approved radiophone which doubles as a portable. Marconi Mobile Radio, a division of Marconi Communication Systems Limited, is now an approved supplier of equipment to the Post Office Radiophone Service and the new "go-anywhere" telephone, the SV 1320A, opens up new uses for the service.

The equipment is designed to fit in the corner of a car boot with the control unit and handset installed easy-to-hand for the driver or passenger when the vehicle is on the move. By removing the control and radio units from the vehicle, an operation which takes less than a minute, the equipment becomes completely portable and is ready for use by the swimming pool, on the golf course, in the garden or on the beach.

What has hitherto been a completely impossible use for a telephone has now become feasible. The equipment can, for instance, be used as a temporary telephone on a major construction site until land lines are installed, carried across fields to a temporary remote site, or even brought along when going fishing. Any person required to keep in immediate touch with the office can have the telephone with him or her wherever located, and the system is completely secure.

The equipment operates from a 12 volt supply and is fitted with rechargeable batteries for use away from the vehicle. In normal operating conditions the batteries will last all day without recharging and, for use away from a vehicle for a long period of time, a desk-top charger is available. The SV 1320A is especially designed and manufactured for Marconi by OY Nokia AB Electronics, Finland, and is marketed exclusively in the UK by Marconi Mobile Radio.

The 9-channel set is fully approved by the Post Office and a new 55-channel set has been submitted for approval.

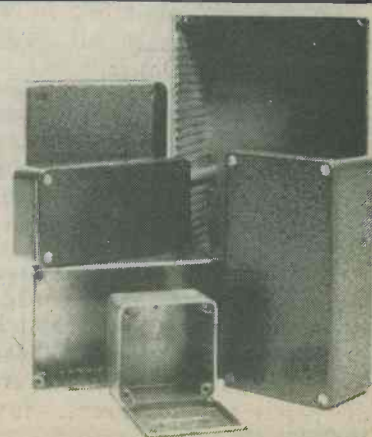
EXTENSION OF DIECAST RANGE OF BOXES

Recently introduced by BOSS Industrial Mouldings Limited, of 2 Herne Hill Road, London SE24 0AU, is another Diecast Aluminium BIMBOX which, as with all of this family of high quality boxes, is available in either natural or stove enamelled grey hammertone finish.

Measuring 50 x 50 x 31 mm (2" x 2" x 1.2") this latest addition now becomes the smallest of the BIM5000 range of 6 sizes, with the largest being 190 x 110 x 60 mm (7.5" x 4.3" x 2.4").

Being readily drilled or punched, and thereby eminently suitable for prototype and production applications, the natural and hammertone finish versions are capable of withstanding 260%C (500%F) and 90°C (375°F) respectively.

The pricing structure of this whole range is very competitive, with the various sized natural versions ranging from £0.69 each to £2.25 each and the grey hammertone finish carrying only a small additional charge.



. . . COMMENT

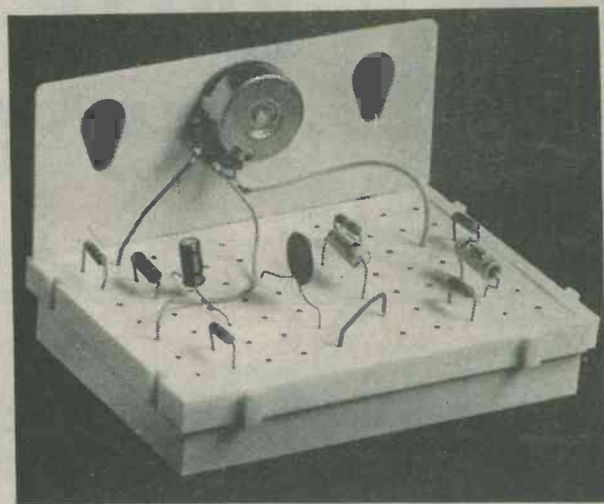
THE SILENT LISTENERS

Much interest amongst radio amateurs was produced recently by the showing of a T.V. programme by the Norwich BBC T.V. station, made by one of their team, Paul Wright, G3SEM, which dealt with the work done during World War 2, by British radio amateurs enrolled into the Radio Security Service as V.I.s as they were called, which stood for "Voluntary Interceptors".

This story has just been released from its secrecy after 40 years of silence, as all the participants in it had to sign the Official Secrets Act. The film traced the origin of radio intelligence from world War 1 to the establishment of the V.I. service in W.W. 2 and outlines much of the work done by this service in listening to secret radio communications within the enemy's territory and to their agents elsewhere. Much of this listening was done in the V.I.'s own homes using their own radio equipment and few realised just what the messages they were copying were all about!

Amongst those involved with this service were Professor Trevor Roper, Colonel Maltby, Colonel Hornsby, 'Dud' Charman, (G6Cj), Louis Varney (G5RV), Pat Hawker (G3VA), Hugo Lawley (G6ZG) and our own Director, Dr. Arthur C. Gee, (G2UK) who appears quite prominently in the programme, some of which was filmed in his radio shack.

AVAILABILITY OF S-DECS



The manufacture and distribution of S-DeCs has now been taken over by Roden Products of 5 High March, Daventry. This photograph (which does not depict the assembly described in the Double Deccer article in this issue) demonstrates the neatness and simplicity which S-DeCs impart to temporary solderless circuits.

Back numbers containing numbers 1-8 of the Double-Deccer series are all still available from the publishers of this magazine.

RADIO TRANSMITTERS AND MODULATION TECHNIQUES — I.E.E. CALL FOR PAPERS

The Institution of Electrical Engineers is seeking papers for a Conference on Radio Transmitters and Modulation Techniques" to be held at Savoy Place on 24-25 March 1980. Those wishing to have papers considered should submit a 50-word synopsis to the IEE Conference Department by 3 September 1979.

Subjects to be covered at the Conference include the following: transmitters for communication (fixed and mobile), broadcasting, television, and navigational aid; improvements in transmitting valves; impact of power semiconductors on transmitter designs; new methods of modulation; exploitation of Doherty and pulse-width modulation and other methods for the purpose of higher efficiency; transmitter control/tuning, protection and safety; common antenna working (filters and other means); linearity control; frequency and signal generation; automatic monitoring and correction; and spurious frequencies and noise radiation.

The Conference is being organised in association with the institution of Electronic and Radio Engineers and the Radio Society of Great Britain.

For further information please contact: Annemarie Cunningham-Swendell, The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.

WHO OWNS THE OLDEST RADIO?

Who owns the oldest radio that's still working? This was a competition organised by one of the BBC's local radio stations in Britain's East Midlands, Radio Leicester. And they got a bit of a surprise when the winning entry turned up.

How old do you think it was? 30 years, 40? No, more than that — there are many 40-year-old radios still in use in Britain today. This particular radio makes 40-year-old sets look like mere striplings — for the winning radio, still working, had seen service in the trenches during World War One (1914-1918) — one of the first valve radio sets ever made.

It still receives perfectly well the BBC's classical music channel and, of course, the local station that was running the competition, Radio Leicester.

It is mounted in a heavy wooden box with a leather carrying strap, and its works are completely exposed when the lid is opened. Inside the lid is a hand-drawn circuit diagram and hand-written instructions, not only telling how to use it for receiving, but also how to transmit in morse code. And the whole thing, with its batteries, is at least as heavy and big as a modern portable TV set.

BBC Radio Leicester presented the old set's proud owner, schoolmaster Gilbert King, with a prize — a new cassette recorder and radio combined.

SUGGESTED CIRCUIT

MULTIPLE 555 CIRCUITS

By G. A. French

The ubiquitous 555 timer i. c. has been employed in many home-constructor projects, featuring mainly as a one-shot timer or as an astable multivibrator. It is also possible to have applications in which one 555 switches on another 555, but these are rarely encountered. This article describes methods by means of which 555 switching of this nature can be carried out, particular emphasis being placed on techniques which result in low power supply current consumption. This last factor can be of considerable importance when the equipment incorporating the 555 is battery operated.

555 SWITCHING

The output of a 555, at its pin 3, can be either high (close to the positive supply rail voltage) or low (close to the negative rail voltage) according to the state of the voltage or voltages at its inputs. When the 555 output is high it can provide currents up to 200mA through a load connected between the output and the negative rail, and when it is low the output can cause currents up to 200mA to pass through a load returned to the positive rail.

In Fig. 1 (a) the output of ICA controls the operation of ICB, turning on the latter when ICA output is high. The operating current of ICB (and its immediate circuitry) is supplied, when it is turned on, through the output stage of ICA. In Fig. 1 (b) a similar situation is given, except that ICB is turned on this time when the output of ICA is low. Again, the operating current for ICB is provided by way of the output stage of ICA.

At first sight, there may appear to be little to choose between the two modes of operation but, when we look at the internal output stage inside the 555, we find that there are considerable differences. This output stage is shown in Fig. 2. When the 555 output is high, the high voltage is maintained by the current passing through the 6.8K Ω resistor into the input base of the Darlington pair consisting of TRA and TRB. The bottom transistor, TRC, is cut off. It will at once be apparent that, even with a negligibly low load current, the output voltage must be less than the positive supply rail voltage by the base-emitter voltage drops in TRA and TRB these drops totalling about 1.2 volts. Further, the output voltage regulation, although quite adequate for normal 555 applications, is by no means perfect, and the output voltage can fall noticeably as load current increases. If, therefore, the switching circuit of Fig. 1 (a) is employed, the supply voltage provided through ICA to turn on ICB will be at least 1.2 volts below the positive rail and can be lower again if ICB draws a high current.

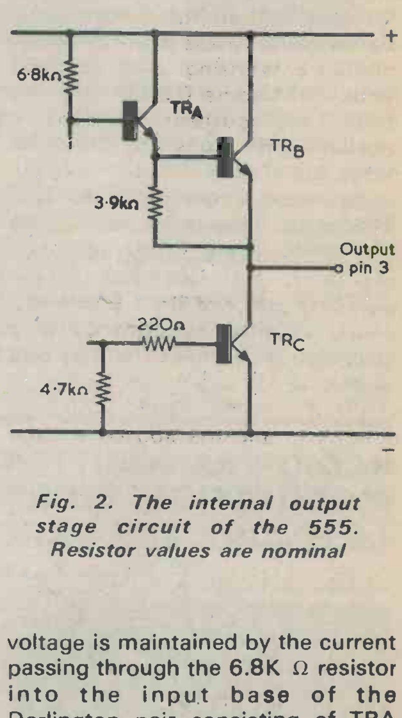


Fig. 2. The internal output stage circuit of the 555. Resistor values are nominal

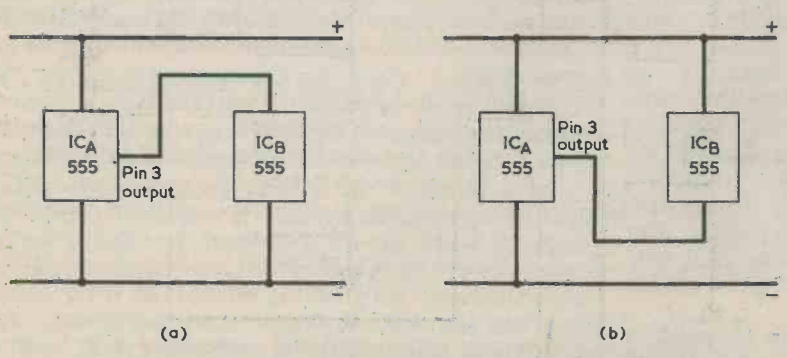


Fig. 1(a). One way of using a 555 i.c. to switch another 555. The second i.c. is turned on when the output of the first goes high
(b). With this alternative method the second i.c. is switched on when the output of the first is in the low state

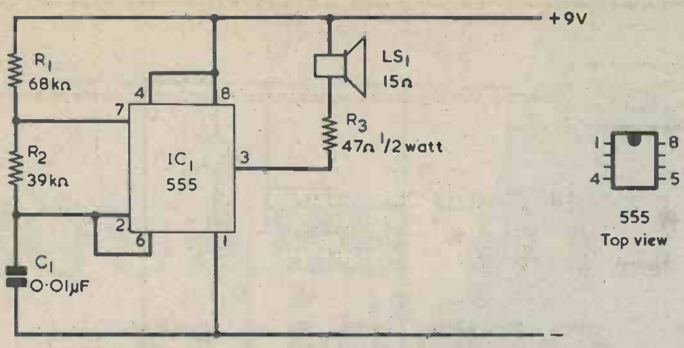


Fig. 3. A typical 555 multivibrator. This produces an a.f. tone with a frequency of 1kHz

Returning to Fig. 2 the output state given when the 555 output is low is provided by having TRA and TRB cut off, and TRC turned hard on. In this case the voltage drop between TRC emitter and collector will be typically less than 0.1 volt at low currents, rising to only slightly higher than some 0.2 volt at quite high load currents. Currently available 555 i.c.'s appear to be particularly good in this respect, those checked by the author exhibiting less than 0.2 volt drop at load currents of the order of 25mA and more. In consequence, the switching circuit of Fig. 1 (b) offers a better potential performance than does that of Fig. 1 (a): it allows very nearly the full supply voltage to be applied to the 555 which is controlled, and the applied voltage has good regulation. A further point not yet considered is that an unwanted amplification loop could be set up between the two i.c.'s when they share a common impedance. In Fig. 1 (b) the common impedance is a transistor which is turned hard on, and this can be almost completely relied on to break such a loop. As we shall see shortly, there can be another reason for preferring the approach shown in Fig. 1 (b).

MULTIVIBRATOR

Fig. 3 shows a standard 555 a. f. multivibrator driving a loudspeaker. The values of the timing components R1, R2 and C1 give a calculated running frequency (using Signetics data) of precisely 1kHz. The 555, when used as an audio oscillator, does not always perform satisfactorily if connected directly to a loudspeaker, and for this reason the 47Ω resistor is inserted in series. The a. f. tone produced is readily audible in normal circumstances. If the speaker is disconnected so that the i. c. oscillates without a load, the current drawn from the 9 volt supply is around 4mA.

The output at pin 3 is high during that part of the cycle when C1 charges via R1 and R2, and is low when C1 discharges through R2 on its own. With the component values shown, the output is high for about 75% of the cycle and is low for about 25% of the cycle. If we were to return the speaker to the negative rail, current would flow through it and through R3 for 75% of the cycle, whereas if we return the speaker to the positive supply, as is done in Fig. 3, the current flows for only 25% of the cycle. The average current drawn from the 9 volt supply will obviously be lower for the second mode of connection, and it is that which is to be preferred. In practice the total current drawn is about 25mA, this being the sum of the 4mA standing current in the i. c. and the average of the intermittent current passed by the speaker and R3.

In Fig. 4 we add a second 555, IC2, to form a 1-second bleeper. The value of C2 is 100 times that of C1, whilst the value of R4 is 10 times that of R1. R5 and R6 in series can be set up to have 10 times the value of R2. With the capacitance value multiplied by 100 and the resistance values multiplied by 10, the frequency is divided by 1,000, whereupon the running frequency of IC2 is 1Hz. As with IC1, the output at pin 3 is high for about 75% of the cycle and low for about 25% of the cycle. If we used the switching circuit of Fig. 1(a), apart from any other difficulties the oscillator would be running for 75% of the time and the average current drawn from the 9 volt supply would be high. The arrangement of Fig. 4 employs the circuit of Fig. 1(b), with the result that the oscillator runs for only 25% of the time. Note that the ***whole*** of the oscillator circuit, including C1, is fed from the output of IC2. When pin 3 of IC2 is low the 1kHz oscillator draws its 25mA through the output transistor of IC2, and when pin 3 of IC2 is high the 1kHz oscillator draws no current at all.

The total current consumption of the circuit of Fig. 4 is the standing current of about 4mA in IC2 plus the 1kHz oscillator current of 25mA in IC1 for 25% of the time. These currents average out at slightly more than 10mA. So, by using the switching circuit of Fig. 4 we have obtained a bleeper whose average current consumption is two and a half times lower than the actual current drawn by the bleeper audio oscillator on its own! This large saving in current is almost entirely due to the technique of switching on the

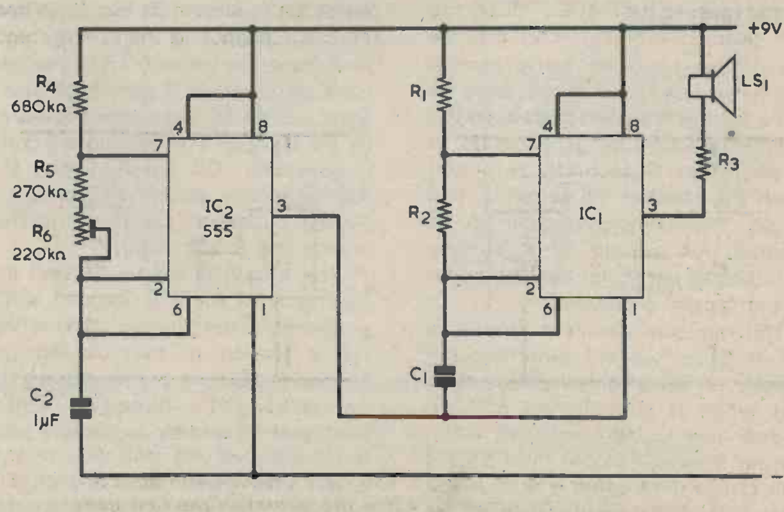


Fig. 4. Here, IC2 switches IC1 of Fig. 3 to form a 1-second bleeper. The average current consumption is considerably lower than that of the multivibrator on its own

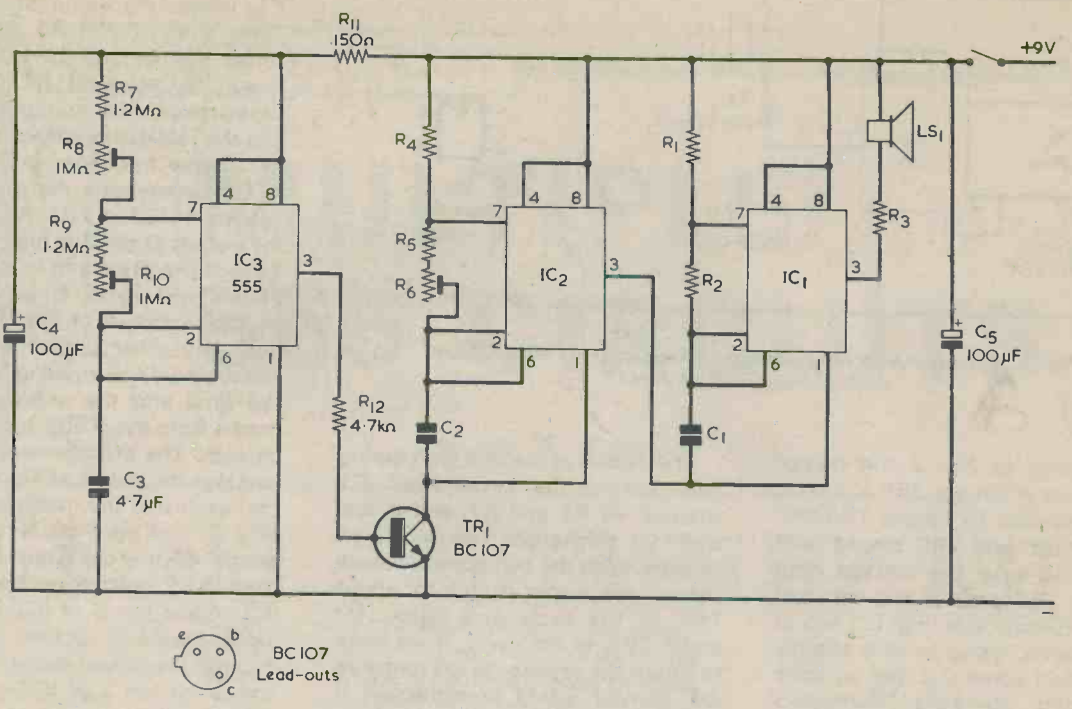


Fig. 5. Yet another 555, IC3, is added to the circuit of Fig. 4. The bleeper is turned off for 5 seconds and is then turned on for 10 seconds, giving a total cycle length of 15 seconds

oscillator from the output of IC2 when that output is in the low state.

In practice, the tolerances in the timing components of IC2 are taken up by adjusting R6 so that the bleeper runs as near to 1Hz as can be arranged. The bleeper can then function as a photographer's metronome or for timing other operations which are carried out in fixed numbers of seconds.

A THIRD 555

The metronome performance would be enhanced if we were to add a further 555 which caused the bleeper to sound for 10 seconds, to be silent for 5 seconds, to sound again for another 10 seconds, and so on. The complete cycle of 15 seconds, or quarter of a minute, would be of particular assistance for timing longer processes.

The requisite circuit is shown in Fig. 5. Since we are switching the bleeper on for a longer period than that when it is switched off, the bleeper has to be turned on when the pin 3 output of the third 555 is high rather than when it is low. The difficulties mentioned earlier will be present if we attempt to supply the bleeper directly from the pin 3 output when it is high, and there is another problem in the present instance which is due to the switched pulses already present on the positive supply rail. These make it necessary to decouple the positive supply to the third 555 to prevent false triggering. If the bleeper were to draw current from its pin 3 that current would also flow through the decoupling resistor.

In Fig. 5 IC3 turns the bleeper on and off by way of the inverting transistor TR1. When IC3 output is low, TR1 is cut off and the bleeper section draws no current. TR1 is turned hard on when pin 3 goes high and it then passes all the current required by the bleeper. The decoupling components for IC3 are R11 and C4. Although not entirely essential, a bypass capacitor, C5, is also added across the 9 volt supply.

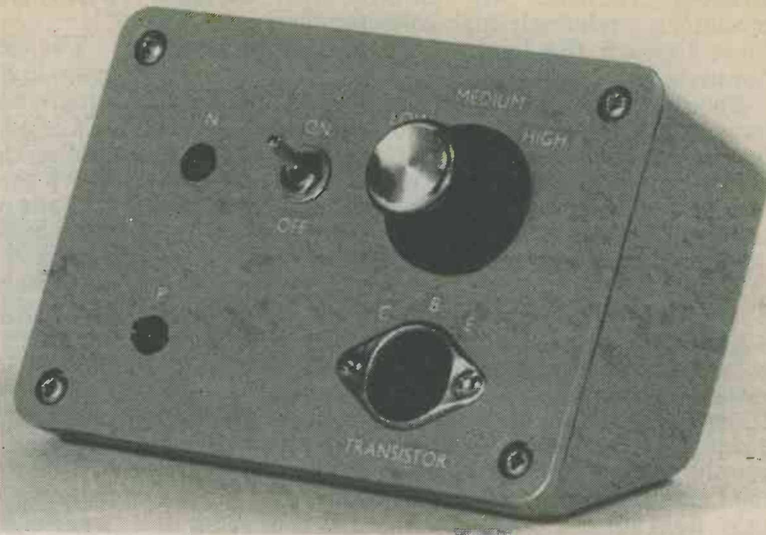
The circuit is set up by first adjusting R10 for a 5 second silent period from the bleeper, after which R8 is set up so that the bleeper produces 10 tone pulses during the period when it is turned on. It may be found necessary to slightly alter the values of R9 and R7. If it is found that the 5 second period is outside the range of R10 the value of R9 may be slightly increased or decreased as necessary. Similarly, the value of R7 may be slightly increased or decreased if the requisite series of 10 bleeps is outside the range of R8. With the prototype, the final settings in R8 and R10 were fairly close to the centres of their slider travel.

The total current from the 9 volt supply is now 4mA in IC3 when the bleeper is silent plus the current drawn by the bleeper and that flowing through R12 when the bleeper is turned on. The average current is therefore about 12mA, a slight increase on the average current of the continually running bleeper on its own.

Apart from R3, all the resistors in the circuits shown are $\frac{1}{4}$ watt, with a tolerance of 5% below 1M Ω and 10% above 1MΩ. Both C2 and C3 should be polyester capacitors. 4.7µF polyester capacitors are available from Greenweld, 443 Millbrook Road, Southampton. The three pre-set potentiometers can be 0.1 watt skeleton types.

A final point is that, after switching on the circuit of Fig. 5, the bleeper will produce more than 10 tone pulses before the circuit settles into its cycles of 5 seconds silence followed by 10 bleeps. The extra bleeps immediately after switch-on are given as C3 charges initially from its fully discharged state. ■

SQUARE WAVE TRANSISTOR TESTER



By R. A. Penfold

N.P.N. AND P.N.P. TESTS WITHOUT POLARITY SWITCHING.

This very simple and handy device is not intended to give accurate measurements of current gain and leakage in transistors, but is meant to give a quick check of whether or not a transistor is serviceable, together with a rough indication of its gain. In most instances this is all that one needs to know about a transistor, and the device has the particular advantage that polarity switching for n.p.n. and p.n.p. transistors is carried out automatically. The unit can also be used to check rectifiers and diodes, and to indicate their polarity.

OPERATING PRINCIPLE

A basic test circuit for an n.p.n. transistor is shown in Fig. 1(a). When only the emitter and collector terminals of the transistor are connected into circuit the test transistor should pass only a very small leakage current. This flows through the light-emitting diode, D1, but will be too small to cause the diode to light up.

If the base terminal is next connected into circuit a small base-emitter current will flow via R1. A ser-

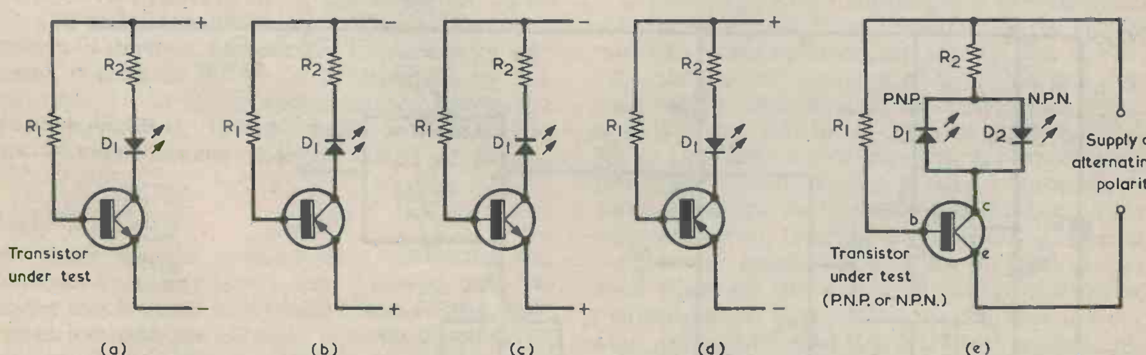


Fig. 1(a). A simple n.p.n. transistor test circuit. The l.e.d. should light when the test transistor is connected into circuit
(b). The supply and l.e.d. polarities have to be reversed for a p.n.p. test transistor
(c). Provided that the supply voltage is low, the l.e.d. will not light if an n.p.n. transistor is connected to the p.n.p. test circuit
(d). Similarly, a p.n.p. transistor will not light the l.e.d. in an n.p.n. test circuit
(e). The circuits of (a) and (b) can be combined in a single circuit powered by an alternating supply

viceable transistor will amplify this current, producing a relatively high collector current which flows through the l.e.d. and causes it to be illuminated.

Should the test transistor not be functional and have a high leakage current or a short-circuit between its collector and emitter, this will be indicated by the l.e.d. lighting up before the connection of the base terminal. An indication that the test transistor is open-circuit will be given if the l.e.d. does not light up when the base is connected to R1.

The same arrangement can be used for checking p.n.p. transistors except, of course, that the polarities of the supply and the l.e.d. have to be reversed. The required circuit is shown in Fig. 1(b). If, as in (c), an n.p.n. transistor is connected in a p.n.p. test circuit, assuming a fairly low power supply voltage, the transistor will not conduct and the l.e.d. will remain extinguished. Neither will the l.e.d. light up if a p.n.p. transistor is connected in an n.p.n. test circuit, as in Fig. 1(d).

These results enable the basic circuits of Fig. 1(a) and Fig. 1(b) to be combined into the single test circuit of Fig.1(e). Here the supply continually alternates from one polarity to the other and D1 is replaced by two l.e.d.'s connected in parallel with opposite polarities. When a serviceable n.p.n. transistor is connected to the circuit it will pass collector current on the half-cycles when the upper supply rail is positive, and D2 will light up. On the alternate half-cycles, when the upper rail is negative, no current will flow and neither l.e.d. will be alight. Thus, D2 will flash on and off at the frequency of the alternating supply to indicate that the transistor is serviceable and that it is an n.p.n. type. A short-circuited test transistor will cause D2 to flash on and off, and also cause D1 to flash on and off out of phase with D2. A transistor with high leakage current will be indicated by D2 flashing on and off before the base terminal is connected. An open-circuit transistor will result in neither l.e.d. becoming alight.

With a p.n.p. test transistor the circuit will behave in the same way as with an n.p.n. transistor, except that all indications which were previously given by D2 will now be given by D1, and vice versa.

FULL CIRCUIT

The complete circuit of the transistor checker is given in Fig. 2. The alternating voltage is given by a square wave generator comprising IC1 and TR1. IC1 is a 555 operating in the astable mode, and its timing components, R1, R2 and C2, have values which give a running frequency of about 2.3Hz. R2 is made very high in value relative to R1 so that what is virtually a 50:50 square wave is obtained. The 555 output appears at its pin 3 and this provides one of the alternating supply points. Pin 3 also connects to the base of TR1 via current limiting resistor R3, whereupon TR1 functions as an inverter, providing the second alternating supply point at its collector. When pin 3 of the 555 is positive the collector of TR1 is negative, and when pin 3 is negative the collector of TR1 is positive.

Comparing with Fig. 1(e), the supply point at the collector of TR1 connects to the emitter of the test transistor. The supply point at pin 3 of IC1 couples via R5 and the two parallel connected l.e.d.'s to the collector of the test transistor. There are slight differences with Fig. 1(e) in that the single resistor coupling to the base of the test transistor now consists of one of the three resistors selected by S1, and also that these resistors are returned to the junction of R5 and the l.e.d.'s rather than to the upper rail, as in Fig. 1(e). This connection merely means that a slightly lower voltage, of either potential, is applied to the series base resistor.

When pin 3 of the 555 is positive the voltage it provides is about 1.2 volts lower than the positive supply rail. When pin 3 is negative and the collector of TR1 is positive, the positive supply to the test circuit is made via the series resistor R4. With transistors other than open-circuit types connected to the test terminals, there will be a voltage drop of up to some 2 volts in R4. This voltage drop does not affect the basic functioning of the circuit.

Having three resistors in the base circuit enables approximate indications of test transistor gain to be given. R8 gives the highest base current and even a low gain transistor should turn hard on when this resistor is selected. A much smaller base current is provided by R7, and only medium and high gain transistors will cause the appropriate l.e.d. to flash on at full brilliance. R6 gives an even smaller base

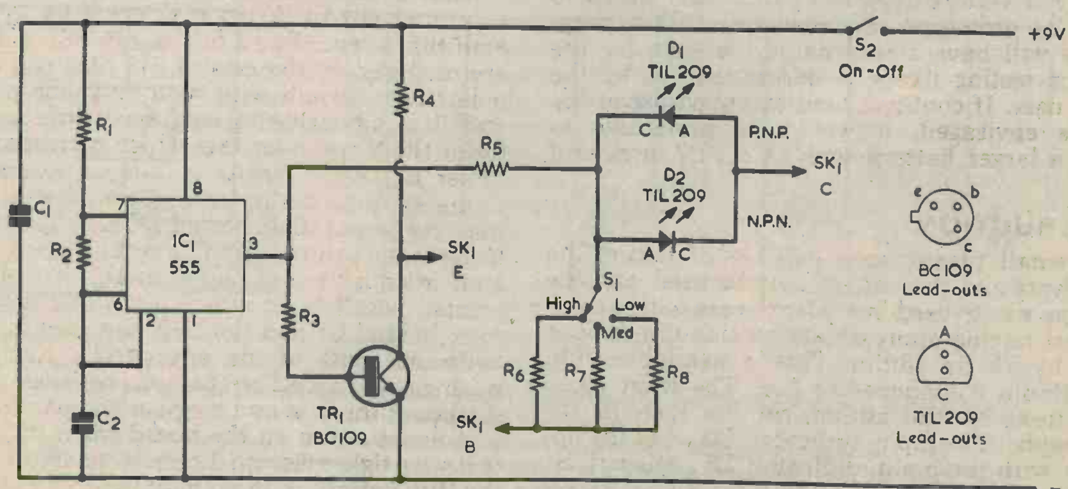


Fig. 2. Full circuit of the transistor tester. One rail of the alternating power supply appears at pin 3 of IC1, the other rail being given, after inversion, at the collector of TR1

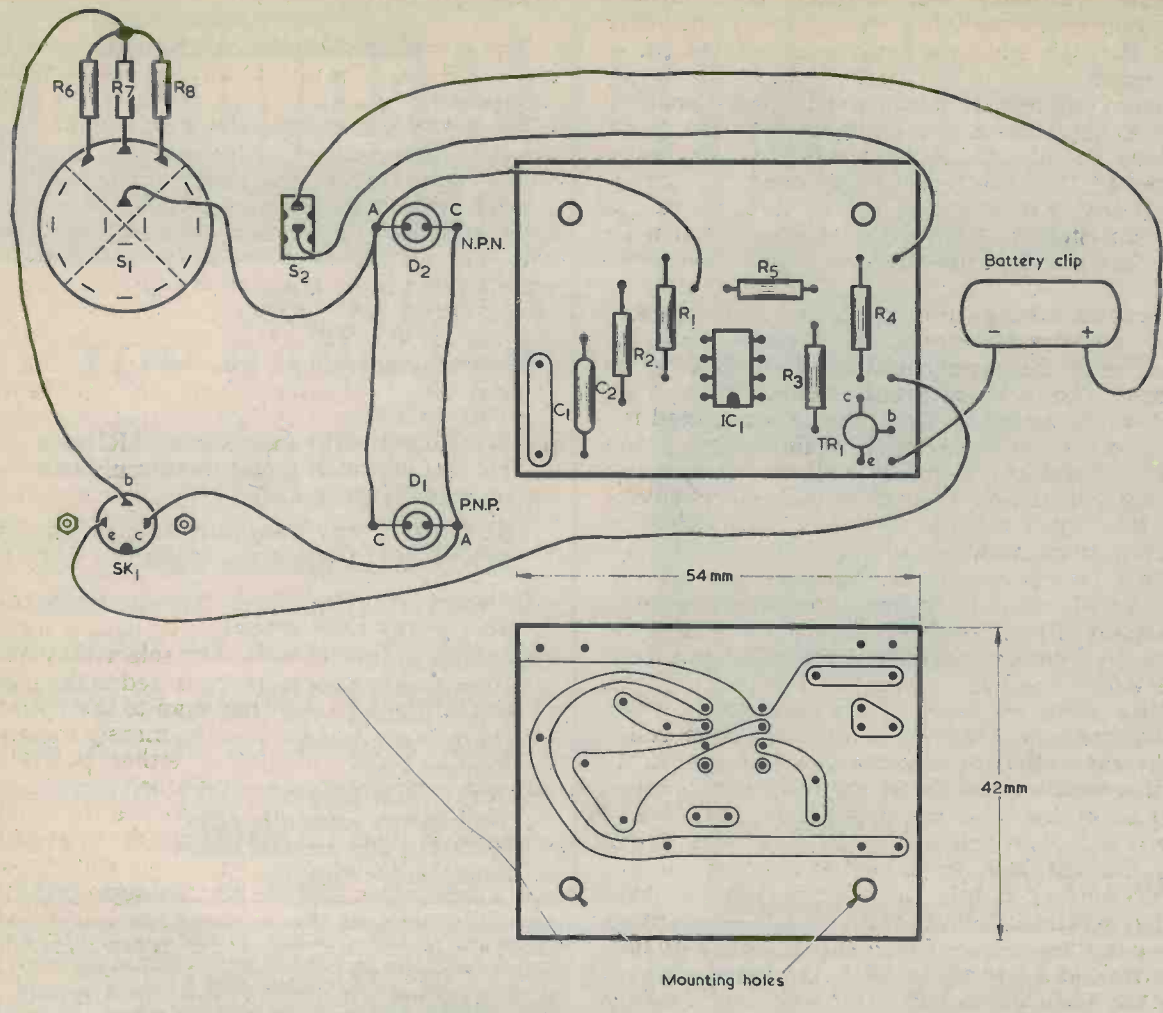


Fig. 3. Preparation of the printed circuit board and the point-to-point wiring in the transistor tester

current, and only high gain transistors will produce full brilliance from the l.e.d. when this resistor is switched in. In consequence, it is possible to obtain a reasonable idea of the test transistor gain by adjusting S1.

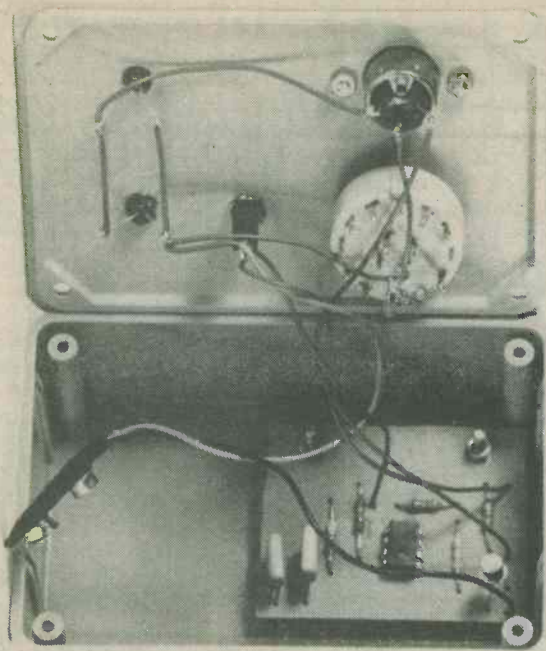
S2 is the on-off switch and C1 is a supply decoupling capacitor. The current consumption from the 9 volt battery is of the order of 16 to 18mA. The prototype unit employs a PP3 battery, and this will have a reasonable life span for the transistor testing likely to be carried out by the average user. If continual and extended use of the tester is envisaged, it would be preferable to employ a larger battery such as a PP7 or even a PP9.

CONSTRUCTION

Any small plastic case capable of taking the components and the battery may be used, and the prototype was housed in a plastic case with a sloping panel having approximate outside dimensions of 107 by 75 by 43mm. This is available from Home Radio (Components) Ltd. The front panel layout used by the author can be seen in the photographs. The n.p.n. indicator, D2, is at the upper left, with the p.n.p. indicator, D1, below it. S1 is at upper right with the test transistor socket below it, and S2 appears between D2 and S1. The l.e.d.'s are held in place by panel mounting bushes, and connections are made direct to their lead-outs.

The test transistor socket is a 3-way DIN socket, and many small transistors will plug directly into this. To cater for those which will not it is necessary to make up a test lead set. This simply consists of a 3-way DIN plug to which are connected three flexible leads of different colours terminated in miniature crocodile clips.

Most of the small components are assembled on a printed circuit board measuring 54 by 42mm., and this is reproduced full size in Fig. 3. R6 to R8 are mounted on the tags of S1. This is a 3-way 4-pole rotary switch with with only one pole used, and it is advisable to confirm with a continuity tester the three outer tags which correspond to the inner tag before wiring to this component. With some switches the relative positioning of the tags may vary from that shown in Fig. 3. The mounting holes in the printed circuit are for 6BA or M3 bolts and, when all the wiring is finally completed, the printed board is mounted on the rear panel of the case, behind S1 and the DIN test socket, by short bolts and nuts of the appropriate size. Spacing washers are needed on the bolts between the inside surface of the case and the printed board underside to prevent strain on the board when the nuts and bolts are tightened up. There is plenty of space for the PP3 battery in the remaining space on the rear panel and this can be held in place with a home-made metal bracket. Alternatively, the battery can be secured by a piece of Bostik Blue Tack.



The printed board and the battery are positioned at the rear of the case. The remaining components are mounted on the front panel

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)

R1 1.2kΩ	R5 1kΩ
R2 6.8MΩ 10%	R6 1MΩ
R3 15kΩ	R7 100kΩ
R4 560Ω	R8 10kΩ

Capacitors
C1 0.1μF type C280
C2 0.047μF type C280

Semiconductors
IC1 555
TR1 BC109
D1 TIL209 with panel-mounting bush
D2 TIL209 with panel-mounting bush

Switches
S1 1-pole 3-way miniature rotary (see text)
S2 s.p.s.t. subminiature toggle

Socket
SK1 3-way DIN socket

Miscellaneous
Plastic case (see text)
9-volt battery type PP3 (see text)
Battery connector
Control knob
3-way DIN plug
3 miniature crocodile clips
Materials for printed board
Nuts, bolts, wire, etc.

USING THE UNIT

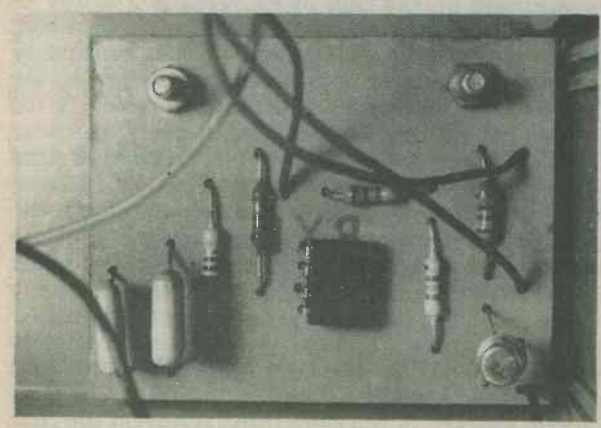
After completion the unit should be switched on with no test transistor connected. If either of the l.e.d.'s flashes even dimly there is a wiring error which has to be corrected.

When testing transistors, only the emitter and collector of the test transistor should be initially connected to the unit, whereupon neither l.e.d.'s should light up. Germanium transistors have higher leakage currents than silicon types and it is possible that a functional germanium device may cause one of the l.e.d.'s to light up rather dimly. However, the author tested a number of germanium transistors including small power output types, and none of them exhibited a sufficiently high leakage current to cause a visible glow in either l.e.d. When the base of the test transistor is connected to the checker, either D1 or D2, as appropriate to the transistor type, should flash on and off at a rate of the order of 2 times a second.

If both l.e.d.'s flash on and off when the emitter and collector terminals are connected to the checker the test transistor is short-circuited and is unusable. Should neither l.e.d. flash when all three terminals are connected then the transistor is open-circuit and is similarly unusable.

For these tests, S1 is always set to the position which brings R8 into circuit. S1 is brought into use when a medium or high gain transistor is suspected of having inadequate gain or when it is desired to select transistors in approximate terms of gain. After confirming the general serviceability of the transistor with R8 selected, S1 then switches in R7 and R6. With R7 in circuit the test transistor needs to have a gain of about 50 times or more in order to bring the appropriate l.e.d. up to about full brightness. A current gain of at least a few hundred times is required for the same indication with R6 selected. On the prototype unit, the corresponding positions of S1 are indicated on the front panel by the legends "LOW", "MEDIUM" and "HIGH". These legends are cut out from "Panel-Signs" Set No. 3, available from the publishers of this journal.

Rectifiers and diodes may also be checked. The cathode (usually marked by a coloured band around the body of the component) is connected to the emitter test point and the anode to the collector test point. This should result in D2 (n.p.n.) flashing on and off. If the connection causes D1 to flash then the cathode has been connected to the collector instead of the emitter test point. If neither l.e.d. flashes the rectifier or diode is open-circuit, and if both l.e.d.'s flash the device is short-circuited. ■



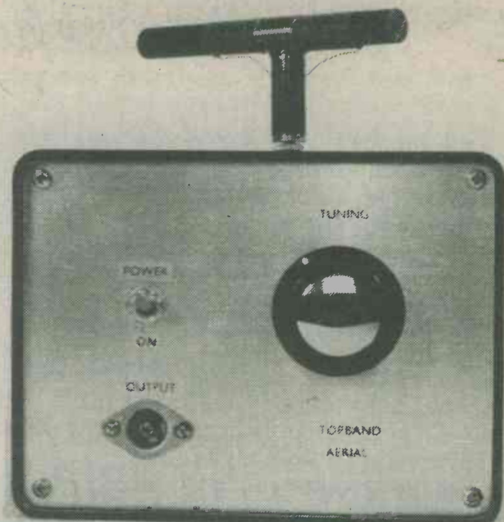
The printed circuit board is quite a simple assembly, with the components arranged as shown here

RADIO & ELECTRONICS CONSTRUCTOR

IN OUR NEXT ISSUE

TOP BAND FERRITE AERIAL UNIT

Direction reception on 160 metres



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A.M. NOISE BLANKER

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VISUAL METRONOME WITH DOWNBEAT

by **Paul M. Jessop**

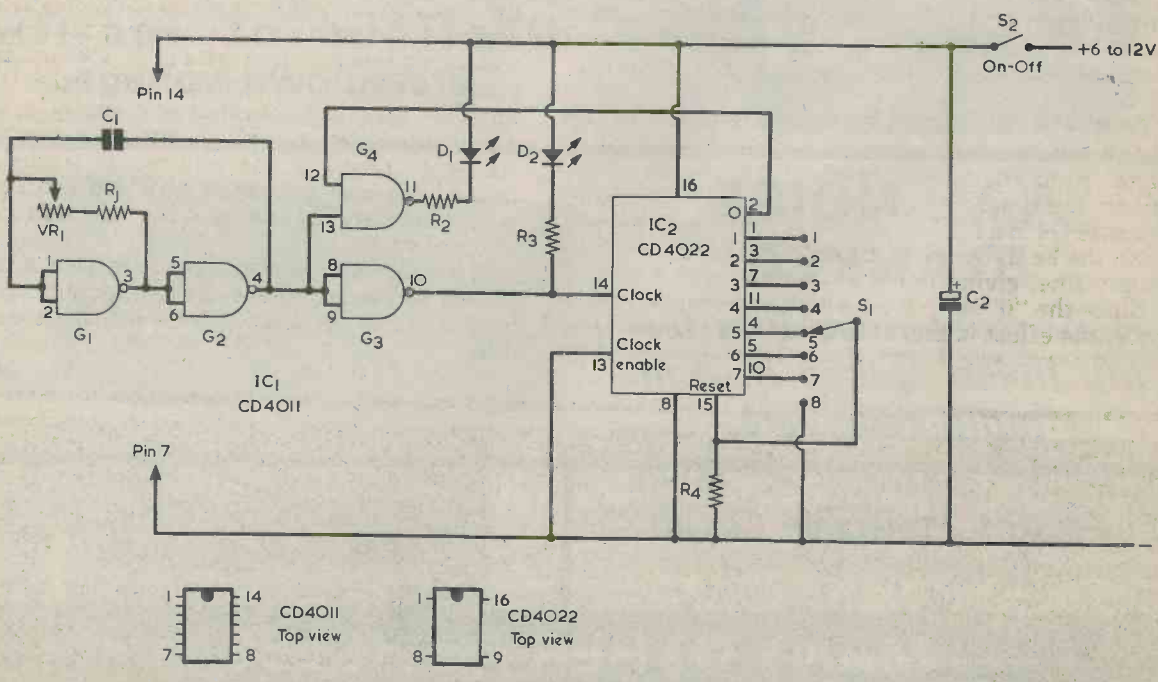
A really useful aid for the musician

The mechanical metronome was invented by Maezel around 1800 and has proved remarkably durable as an aid to musicians. Its basic principles have not been altered but for a few minor additions since its conception. One of these additions, found on some modern models, is a counter which rings a small bell on the first beat of each bar. This is known as the "downbeat" since it is the beat on which a conductor would bring his baton vertically downwards. The counting is done mechanically and the counting ratio, i.e. the number of beats per ring of the bell, can be altered by means of a knob to give varying time signatures.

The metronome is used largely by musicians when learning to play a piece so that they can accurately gauge the pace of the piece when they come to perform it. However, it would be useful if conductors could also make use of such an instrument when conducting to ensure an even pace throughout. It is not suggested that *all* music requires this, but some specifically calls for it and some would benefit from it. For this purpose the "click, click" of the mechanical metronome is clearly unacceptable, and so it was decided to use an l.e.d. to indicate the beats. It was also decided that the downbeat facility was useful and, initially, the downbeat was to have been indicated by making the l.e.d. flash more brightly. This approach was abandoned, however, because the display was not nearly clear enough. The method decided upon was to have two l.e.d's, one flashing on every beat and the other flashing only on the downbeat. The overall effect is similar to the initial method but is much more readily noticeable.

THE CIRCUIT

The circuit of the metronome is shown in the accompanying diagram, and it operates in the following manner. The NAND gates G1 and G2 form a free running astable multivibrator whose frequency is determined by VR1, R1 and C1. R1 is included to limit the upper frequency available, which would otherwise be unnecessarily high. The output



The circuit of the metronome. The downbeat is indicated by D1 flashing in unison with D2, the number of beats in each bar being selected by S1

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
R1 150kΩ
R2 390Ω
R3 390Ω
R4 12kΩ
VR1 2.2MΩ potentiometer, linear

Capacitors
C1 0.47μF type C280
C2 10μF electrolytic, 16 V. Wkg.

Semiconductors
IC1 CD4011
IC2 CD4022
D1 light-emitting diode, red
D2 light-emitting diode, red

Switch
S1 1-pole 8-way rotary
S2 s.p.s.t., toggle or slide

Miscellaneous
Circuit board
Battery, 6V, 9V or 12V
2 knobs
Case

of G2 is fed to both inputs of G3 which acts as an inverter giving an output signal with steeply rising edges. This output feeds an l.e.d., D2, through a current limiting resistor. The l.e.d. is taken to the positive supply line so that it is on when the output of G3 is low, and therefore when the output of G2 is high. The output of G3 also feeds pin 14 of IC2. IC2 is a divide-by-eight counter with eight decoded outputs and pin 14 is the clock input. To make the counter operate it is necessary to take the clock enable input (pin 13) low, and in this application the enable pin is wired permanently to the negative supply line.

On each rising edge of the clock input the counter advances by one and the corresponding output goes high. The reset pin (pin 15) is switchable between any of these outputs and this has the effect of altering the divide ratio of the counter. Consider what happens if the reset pin is connected to the "4" output. The chip counts from zero to three in the normal manner and then, on the next rising edge of the clock input, the "4" output goes high. This is of course connected to the reset input so the latter is also taken high, setting the counter to zero. Thus the counter spends practically no time with the "4" output high. In all, four pulses on the clock input cause the "0" output to go high once; this means that the counter is operating in a divide-by-four mode.

Now, the "0" output is fed to one of the inputs to G4, whose other input takes the original clock signal from the multivibrator. The output of G4 drives the l.e.d. which indicates the downbeat. Because G4 is a NAND gate, it is again necessary to drive the l.e.d. between the output and the positive supply line, giving inverted operation.

Since the "0" output goes high once per complete cycle, the effect is that D2 flashes at a regular rate, and on every, say, fourth flash D1 flashes with D2, indicating the downbeat. The fact that when D1 flashes, D2 flashes at exactly the same time gives great visual impact. Naturally, setting S1 to alternative positions controls the number of flashes in D2 for every downbeat flash in D1. With S1 at position "8" the counter itself divides by this number.

CONSTRUCTION

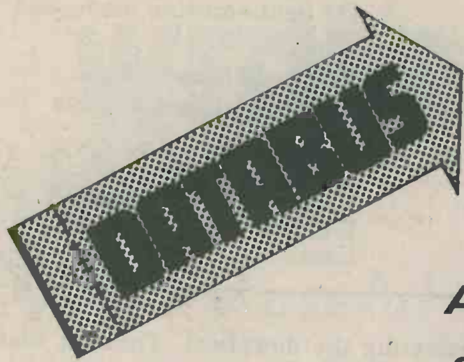
Layout is not critical and the metronome can be built in any way favoured by the constructor. The author's prototype was assembled using plain 0.1 in. perforated board and i.c. sockets, and a wiring pencil dispensing solder-through enamelled wire. Since the integrated circuits are CMOS devices, the sockets enable the wiring to be completed and checked before the i.c.'s are removed from their shorting foam or foil and inserted in their holders.

Switch S1 can be a single pole 12-way rotary type with adjustable end stop set for 8-way operation. The supply voltage may have any value between 6 and 12 volts.

The housing is very much a matter of personal taste, although if the unit is to be used for concerts the traditional pyramidal housing might best be neglected in favour of a more unobtrusive box which can rest on the conductor's podium. Both the tempo control, VR1, and the beats-per-bar switch must be clearly calibrated and easily accessible. The calibration of VR1 is an easy matter, consisting of counting the number of flashes of the faster l.e.d. in a minute at different settings of the potentiometer. This value is the number found on a musical score.

It would be unreasonable to say that a box such as this will ever replace the conductor, but it may help to make his task at least a little less demanding. ■

DATAB



At last! A comprehensive jargon-free

specifically for the electronics enthusi

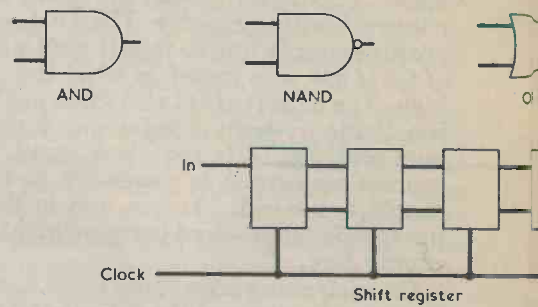


Fig. 1. Standard gate types and a shift registe... digita...

PREFACE TO THE SERIES

Have you ever had a guilty feeling that you really ought to know something about microprocessors? Have you then found that all the books and articles you looked at seemed to be written in a foreign language? If so, this series is for you. It's written in English, and the aim is to explain microprocessors from the beginning, for the beginner, rather than from halfway on for the committed micro-nut. We have to assume some starting point, and the one we've taken is that the reader has some clue about digital signals (1 or 0), knows a little about logic gates (AND, OR) and has heard of a shift register. If you're rusty or uninformed on these topics, then you'll find this series a lot easier on the aspirins if you do a little bit of homework on these topics. If you're up to date on these (and we'll remind you about them), then you're ready to start!

The three basic questions that anyone starting to take an interest in microprocessors has to ask are: what are they, what do they do, and how do they work? We can't answer these questions in one part of a series, and the last question couldn't be answered ***in detail*** even in a large book. The microprocessor has been with us for ten years now, and progress has been really fast so that catching up is a painful process.

It is not helped, either, by some of the books that are around. The genuine manufacturers' databooks are useful, and some of the texts are well put together, but it's only too easy to lash out several pounds for a few scrappily-duplicated sheets which tell you very little.

WHAT ARE THEY?

This is the easiest of the questions to answer. A microprocessor is a large scale integrated circuit (LSI circuit) which contains logic gates and shift registers arranged so that digital signals can be directed from one part to another under the control of other signal inputs. Let's compare it to something which has been around a bit longer. A telephone exchange exists to direct messages from one place to another by making connections. The connections are made automatically, by dialling a number code which causes the telephone line selectors to operate. You can imagine the microprocessor as a shrunken telephone exchange. The messages are digital signals, each consisting of eight digits or bits, and the code which decides which connections are made is called the program. If you've followed the "Tune-in to Programs" series, you'll know quite a bit about the idea of programming already.

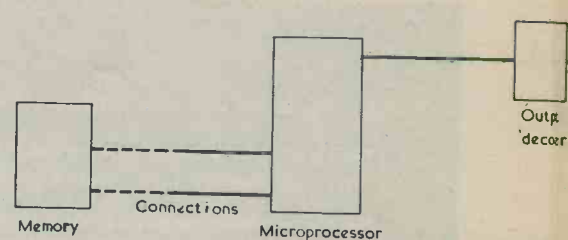


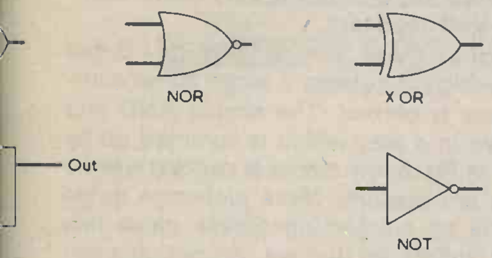
Fig. 2. The hardware surrounding a micropro... would need at le...

US No. 1

HOW MICROPROCESSORS WORK

xplanation of microprocessors written st who understands elementary logic.

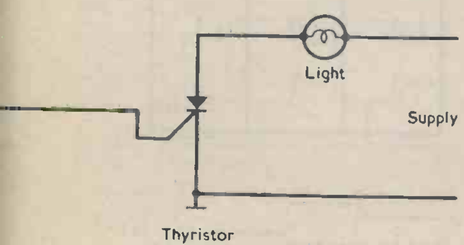
By Ian Sinclair



hese are the bread and butter components of cuits

WHAT CAN IT DO?

By itself, it can do practically nothing. A microprocessor by itself is about as useful as a car wiring loom, with no car. To be of any use, the microprocessor needs two important collections of items. One set is called hardware, and it consists of all the i.c's, relays, thyristors, motors and other gadgets that are needed to make use of the microprocessor signals. Even if the microprocessor only has to switch on a light, you still need to make the microprocessor signal operate a switch — you can't just connect a microprocessor to a lamp bulb and hope for the best. Similarly, you need i.c.'s to provide the program for the microprocessor, to store any signals that need to be kept in memory, and even to act as input or output stages. After all, you wouldn't buy a radio i.c. without expecting to have to connect an aerial and a loudspeaker!



r. Even to operate a light, a microprocessor he items shown

The other set of essentials is called software, and consists of the program instructions. These might be a set of numbers written down, a tape cassette recorded with signals, punched paper tape, or even an i.c.; but absolutely nothing can happen without these program instructions. There's an important difference here. The hardware items, once designed,

Address	Data
0200	A510
0202	A611
0204	8511
0206	8610
0208	00

Fig. 3. Software — a tiny chunk of program. This example takes a number from memory and then returns it

can be churned out by factories in huge quantities and at reasonable prices. Software, even if only a short program, takes hours of thought and effort to develop, is *always* expensive, and must be 100 per cent correct. One single program may cost more than all the hardware put together.

At this point, a small warning is needed. Lots of people are in the business of persuading you to buy microprocessor development kits. There's nothing wrong with these kits as such, they are intended to make life easier for the professional engineer who is writing programs for machine control applications and they are ideal for the job. Unless you have such

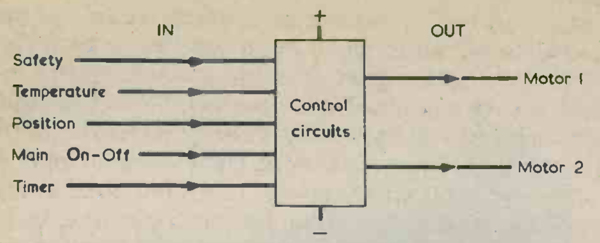


Fig. 4. Logic control. In this example various control signals fed into the controller are used to produce two output signals

a task in mind, though, they aren't so useful unless you really have an interest in programming. The capability of these devices for useful programs isn't a patch on a programmable calculator, and you'll find that even a simple program to add two fairly small numbers together takes a lot of learning.

Of course, many of these kits can be expanded into micro-computers. But do you really need a computer? If you do, then it'll be cheaper in the long run to consult IBM — at least all the snags will be ironed out, and there will be plenty of software at reasonable prices. What you save on hardware by buying or building a computer (which can still cost £400 upwards when all the necessary "extras" are bought) you lose in lashing out £50 or more for each program, or in countless hours of work writing your own. Of course, if you want to learn programming the expensive way, or if you're the only guy in the road without one . . .

When we're honest with ourselves, very few people *need* a computer, and very few will design control circuits. Nevertheless, we are going to find microprocessors cropping up in useful applications (as distinct from toys and status symbols) and we need to understand them. Just because we couldn't design a TV receiver is no cause for not understanding how it goes about its job, and the same is true for the micro. This series, then, will prepare you for the workshop manuals that will come with the next generation of washing machines, control heating systems and car electrics.

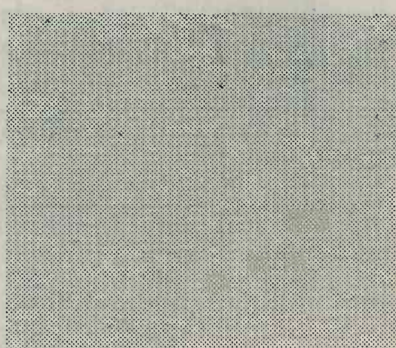
HOW DO THEY WORK?

Now we start on the answer to the third question, the one which will take up all the rest of this 12-part series. To start to understand how a microprocessor works, we really have to go back ten years in time to the events that led to the design of the first microprocessor. Visualise, if you can, the range of control applications for which t.t.l. and CMOS i.c's were being used some ten years ago. These applications included the control of machines like lathes, chemical processing plants, some air-conditioning systems and of course, computers; all large and costly machinery. In each case a large number of inputs was taken to a logic circuit, which produced outputs that turned motors or valves on or off, adjusted settings, changed temperatures. These logic circuits consisted of gates, like the familiar AND and OR gates, along with the very useful components called shift registers.

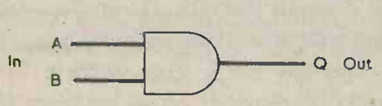
Remember what these components do. Gates give an output which is at logic 1 when some combination of inputs is correct. The simple AND and OR gates behave in a way which is summed up by the truth tables of Fig. 5; the output is decided entirely by what inputs are present. More elaborate gates can all be made by connecting simple gates like these into logic circuits, so that we can design a circuit to have any truth table we choose. For example, the truth table of Fig. 6 can be carried out (or *implemented*) by the circuit of Fig 7; the really complicated truth tables for machine control would, of course, need a large number of logic gates and would take a long time to design.

Shift registers do something quite different — they store a set of binary digits. A binary digit (or bit) is a 0 or a 1, and a set of eight is usually called a byte; these sets of eight are the groups that are used in microprocessors. When a set of bits, which may be any number but is often an 8-bit byte, is loaded into a shift register, it can be stored there. The shift register consists of flip-flops, each of which can be set to give a 1 or 0 output, and which can be clock-

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1



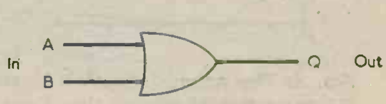


Fig. 5. Two "standard" gate types, and their truth tables. The truth table shows what the output will be for any possible combination of inputs. Two-input gates are shown

A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Fig. 6. A truth table which might be needed in a control system. The output is 1 only if at least two of the inputs are at logic 1

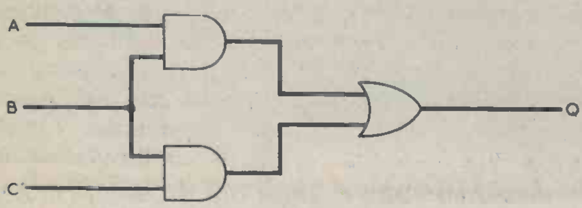


Fig. 7. An arrangement of gates which can produce the truth table of Fig. 6

Pulse No.	Q_0	Q_1	Q_2	Q_3
0	1	0	0	0
1	0	1	0	0
2	0	0	1	0
3	0	0	0	1
4	0	0	0	0

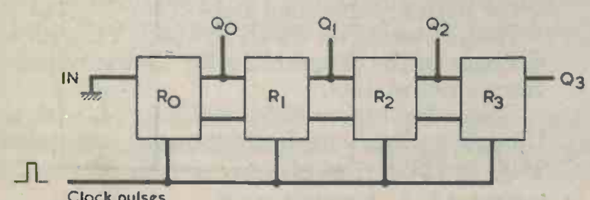


Fig. 8. The action of a shift register. Flip-flop R1 has a 1 at its output, the others have 0's. At each clock pulse, the 1 is shifted right into the next flip-flop. Any pattern of 0's and 1's stored in the flip-flops of the register would also be shifted. Left shift is also possible

ed. "Clocked" means that a clock pulse, a brief pulse repeated at intervals, is applied to each flip-flop in the shift register, causing the bits to shift one place from one flip-flop to the next in line. A direction control can decide whether this shift is to the left or to the right by altering the voltage on one pin of the i.c., perhaps 0 for left, 1 for right. Such a shift register can be filled either by sending a bit to an input pin for each flip-flop, a system called parallel entry, or by feeding a bit in at each clock pulse, a system called serial entry. Similarly, a register can transfer its bits along a set of lines (eight for a byte) in parallel, or one at a time along one line in serial form. If the output of the final flip-flop of the shift register is connected back to the input, then a complete set of clock pulses will leave the register just as it was before the clock pulses, even if each pulse has operated a gate on the way. A complete set of clock pulses means one clock pulse per flip-flop, eight for a byte. The bits can be stored unchanged therefore until a new set of inputs is loaded into the register. Now if all this is new to you, you aren't ready for reading about microprocessors yet. The aim of this very brief summary is to refresh the memory, not to teach from scratch, and to indicate where we start from.

Using shift registers along with gates, we can carry out any operation we like, providing that it can be done using binary digits. We can, for example, add binary numbers, subtract, multiply and divide them, decide when one number is equal to, greater than or less than another. We can also load numbers in, store them, and read them out; anything provided that what we operate on must be binary numbers. All of these operations can be carried out by digital circuits using gates and shift-registers.

Now the more elaborate our requirements to control machines become, the bigger the circuits get. The obvious thing to do, considering how many circuits can be built on a chip, is to make a circuit which has a huge number of gates and shift registers, and use the same chip for all control circuits. You can just imagine what a monstrosity this would be, with several inputs for each gate, and an output, each needing a pin. To use such a chip, we would need to connect the correct pins together to get the logic circuit we wanted. If we then wanted to change what the circuit did, we would need to rewire the connections between the pins.

It's just not on, and the solution to the problem is the device we call the microprocessor CPU (or MPU) chip. It contains gates and registers, but the connections ***between them*** are also made by gates under the control of a code of one or two bytes. In addition, operations are carried out one at a time rather than altogether, so that we don't need a huge number of inputs and outputs. To ensure that it can cope with really complex problems, it operates on a byte of eight bits at a time. The whole system is timed and controlled by clock pulses from a clock generator, usually running at 1MHz or more, so that a lot of operations can be carried out every second.

What are the advantages? Well, one is that the same component can be put to an incredible variety of uses. If we want to change the action, we don't have to lift a soldering iron or a pair of cutters, we simply change the program instructions. Working with a complete byte at a time lets it cope with a lot of signal information — if we need larger numbers we can spread it over 2 or more bytes. Incidentally, pocket calculators use only 4 bit units for working with numbers up to 9.9999999 x 10^{99} — working with large numbers just takes longer.

The sequence of operating means that we can have practically as many inputs and outputs as we like, providing we don't expect them to be absolutely simultaneous.

The important points about the microprocessor therfore are how we connect it up to other devices (to pass signals in and out) and how we program it to carry out the sequences of operations we want. We'll start next month by looking at some of the chips which are needed to make the microprocessor work, and the first and most important of these is memory.

(To be continued)

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

●NEWSCASTS FROM INDIA

All India Radio, Delhi, operate a News Broadcasts Service in their Domestic Services, these programmes being in English, English/Hindi or in Urdu. The newscasts last from 5 to 15 minutes at various time periods from 0030 through to 1740 on many differing channels. Reception of some of these broadcasts here in the U.K. would represent quite a feat of Dxing for beginners — 'chasing' these transmissions can provide quite a lot of 'fun and games' — try it and find out!

Listed here are the afternoon transmissions (correct at the time of writing) which are most likely to be heard here in the U.K..

From 1230 to 1240 in English/Hindi on **3235, 3355, 6120, 9575, 9590, 11620, 11735** and on **15430.**

From 1430 to 1435 in English on **3255, 3925, 4860, 6145, 7135, 7195, 7280, 7412, 9950** and on **10335.**

From 1530 to 1545 in English on **3235, 3255, 3315, 3355, 3925, 4860, 6145, 7135, 7195, 7280, 7415, 9950** and on **10335.**

From 1730 to 1740 in English/Hindi on **3255, 3925, 4860, 6145, 7195, 7412** and on **9950.**

AROUND THE DIAL

In which are listed some of the transmissions recently logged which we hope will be of interest to many readers.

●LIBYA

Tripoli on **11700** at 1120, OM with Arabic chants in the Domestic Service, scheduled here from 1000 (variable) to 1615. The Foreign Service operates here from 1700 to 2200.

●CLANDESTINE

"Radio Freedom from South Yemen" on a measured **9953** at 1928, OM with songs in Arabic, local-type music. The schedule is from 1130 to 1430 and from 1630 to 2000 at the time of writing this article.

"Voice of the Malayan Revolution" on **15790** at 1520, childrens choir plus piano, YL with identification at the end of the English programme at 1530. Schedule of the English transmission is from 1450 to 1530 daily.

"Voice of Lebanon" on **6550** at 1932, OM with songs in Arabic, Arabic music. The schedule is from 1900 to 2105 in Arabic (English newscast at 1745).

●CHINA

Radio Peking on **9860** at 1940, YL with Chinese songs in the Portuguese programme to Europe and Africa, scheduled from 1900 to 2000.

Radio Peking on **9880** at 1945, OM with the English programme to North and West Africa, scheduled from 1930 to 2030.

Radio Peking on **9900** at 1900, chimes 'East is Red', identification in the Hausa programme to West Africa, scheduled here from 1900 to 1930.

Radio Peking on **9945** at 1530, YL with song in Chinese in the programme for Vietnam, scheduled from 1500 to 1600.

Radio Peking on 9965 at 1520, YL with song in Chinese in the Bengali programme, scheduled from 1500 to 1600.

●CHINA — REGIONAL

Nanning on **4905** at 2012, YL in Chinese with a relay of Peking 1. The schedule is from 2000 to 2200 (May to October from 2000 to 2300 and 1100 to 1735).

●TAIWAN

BCC Taipeh on **9765** at 1940, YL with the French programme for Europe, the Middle East and Africa, scheduled from 1930 to 2020. Newscast until 1942 then YL with a song in Chinese.

●NORTH KOREA

Radio Pyongyang on **6600** at 2054, light music Euro-style, 4 low plus 1 high pitched 'pips' time-check at 2100 followed by identification and news in the Korean Domestic Service, also logged in parallel on **11350.** The schedule is from 2000 to 0830 and from 1500 to 1800.

●JAPAN

Tokyo on **9585** at 2104, OM with a newscast in English after station identification, schedule (in English and Japanese) is from 2100 to 2130.

●VATICAN

Vatican City on **9625** at 2001, YL with Rosary to Europe and Africa, scheduled here from 1945 to 2005 and also in parallel on **9645.**

●ISRAEL

Jerusalem on **9815** at 2018, OM with the English programme to Europe, the Middle East, North America and South West Africa, scheduled from 2000 to 2030.

●SEYCHELLES

Mahe (FEBA) on **11860** at 1750, OM with the Arabic programme to North East Africa and the Middle East, YL with identification in this Far East Broadcasting Association transmission scheduled from 1700 to 1800.

●MADAGASCAR

Radio Netherlands Relay on **11730** at 1835, OM with a newscast in the English programme for Africa, scheduled here from 1830 to 1920.

●GREECE

Athens on **11730** at 1546, YL with songs, typical Greek music in the Greek programme to North America, scheduled from 1500 to 1550.

●SPAIN

Madrid on **11840** at 2039, OM with news of local events — including maximum and minimum temperatures at many Spanish resorts — in the English programme for Europe, scheduled from 2030 to 2130.

Madrid on **11880** at 0550, YL with a newscast in the English programme to North America, scheduled from 0515 to 0615.

Madrid on **11920** at 1130, YL with identification and a newscast in the Spanish programme for Latin America, North Africa and the Middle East, scheduled from 1100 to 1235.

●ITALY

Rome on **11800** at 1940, YL with the local news in the English programme for the U.K., scheduled here from 1935 to 1955.

●FINLAND

Helsinki on **11755** at 1930, OM with news of the Nordic Countries in the English programme to Europe and Africa, scheduled from 1930 to 2000.

●KUWAIT

Radio Kuwait on **11990** at 1917, local-type music in the Arabic Domestic Service, scheduled here from 1830 to 2110.

●ROMANIA

Bucharest on **11720** at 0540, YL with the news in the English programme to Africa, scheduled from 0530 to 0600. Also logged in parallel on **11830.**

Bucharest on **15335** at 0650, OM and YL alternate with news items in the English programme for the Pacific, scheduled from 0645 to 0715.

●BURUNDI

Bujumbura on **3300** at 1809, OM with the local news in French. This is the Home Service 1 in French and vernaculars, being scheduled here from 0330 to 0600 (Sundays through to 2100) and from 1500 to 2100 weekdays. The power is 25kW but the channel is anything but a good one!

●RWANDA

Kigali on **3330** at 1813, OM with a newscast in French in the Home Service, scheduled here from 0300 to 0600 (Sunday until 0900), 0900 to 1200 (Saturday and Sunday until 2100) and from 1330 to 2100. The power is 5kW.

●ANGOLA

Luanda (R.Nacional) on **3355** at 1919, OM and YL alternate with announcements in Portuguese. The schedule is from 1530 to 2400 and the power is 10kW.

●VENEZUELA

Radio Occidente, Tovar, on **3225** at 0220, religious service in Spanish, extended schedule — which is normally from 1030 to 0200. The power is 1kW.

Radio Universidad, Merida, on **3395** at 0230, OM with identification, jingles, LA music. The schedule is from 1000 to 0400 and the power is 1kW.

●COLOMBIA

Ecos del Combeima, Ibague, on **4875** at 0653, OM with identification as "Radio Super" followed by Sambas etc. The schedule is on a 24-hour basis and the power is 5kW.

Radio Cinco, Villavicencio on **5040** at 0659, OM with a lullaby in Spanish, OM with identification at 0701. The schedule is around the clock and the power is 3kW.

Emisora Nuevo Mundo, Bogata, on **4755** at 0500, OM with full identification followed by a newscast in Spanish. The schedule is around the clock and the power is 1kW.

Ondas del Meta, Villavicencio, on **4885** at 0453, OM with commercials, identification and Sambas etc. The schedule is from 0900 to 0500 and the power is 1kW.

●ECUADOR

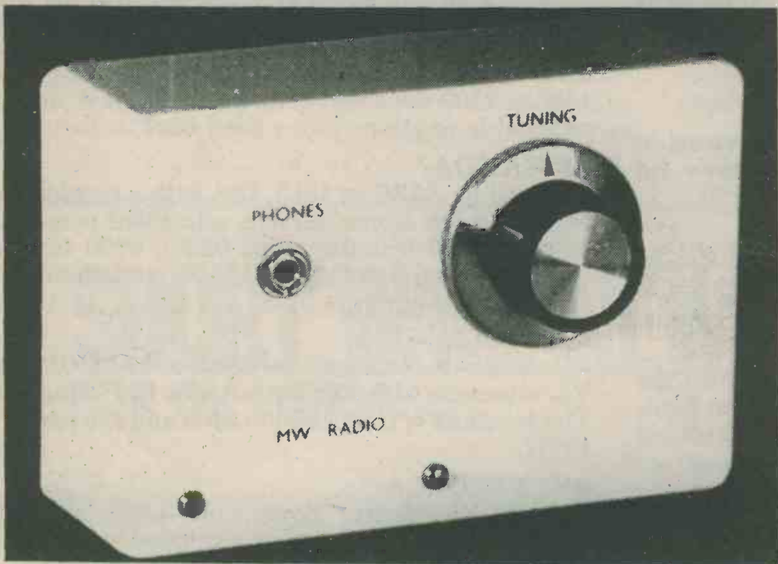
Radio Popular, Cuenca, on a measured **4801** at 0507, OM with identification as "Radio Popular" (sometimes identifies as "Radio Amiga Popular de Cuenca"). The schedule is around the clock and the power is 2kW. This one is best received after Radio Lara, Barquisimeto, Venezuela, on **4800** closes at 0400.

Radio Splendit, Cuenca, on **5025** at 0242, OM with a love song in Spanish, OM with announcements and identification at 0245. The schedule of this one is from 0900 to 0500 (variable 0430-0530) and sometimes around the clock. The power is 5kW.

●BRAZIL

Radio Aparecida, Aparicida, on **5035** at 0249, OM with announcements in Portuguese, local-style dance music. The schedule is from 0900 to 0300 and the power is 1kW.

BEGINNER'S MEDIUM



The receiver has only one control, this being for tuning. It switches on automatically when the crystal earpiece plug is inserted in the jack socket

By

I. M. Attrill

This simple receiver is easy to construct and uses readily available components. It is a t.r.f. (tuned radio frequency) design having a single transistor regenerative detector followed by a high gain i.c. audio amplifier stage, and the completed set requires no alignment. The radio is powered by an internal 9 volt battery of PP3 size, which provides many hours of use as the current consumption is only about 3mA. A ferrite rod aerial is employed and gives sufficient sensitivity to receive the local BBC medium wave stations as well as Luxembourg and a few other Continental signals during the hours of darkness. The output is suitable for a crystal earpiece. Magnetic phones or a magnetic earpiece cannot be used.

CIRCUIT DIAGRAM

The full circuit of the "Beginner's Medium Wave Radio" appears in Fig. 1. L1 is the tuned winding of the ferrite aerial, and it can be tuned over slightly more than the medium wave band by means of variable capacitor VC1. The low impedance coupling winding, L2, passes the signal picked up by the tuned winding to the base of the high gain common emitter amplifier, TR1, via C2. R2 provides base bias.

The r.f. collector load for TR1 is R4, which couples to the positive rail via R3 with C3 acting as a bypass capacitor at radio frequencies. TR1 offers greater gain to positive signal half-cycles than it does to negative half-cycles because the positive half-cycles cause it to draw a higher collector current. The result is that the average collector current of TR1 varies with the amplitude of the received signal. Since that amplitude itself varies with the modulating broadcast a.f. signal, it follows that the a.f. modulation is recovered at TR1 collector. The r.f. carrier is present also at TR1 collector and is prevented from passing further by the filter consisting of R4 and C3. This capacitor has a relatively high reactance at audio frequencies, whereupon a proportion of the recovered a.f. at TR1 collector is passed to the receiver a.f. amplifier via C4.

The collector of TR1 is coupled back to the ferrite aerial tuned circuit by way of R1, the connection being phased so as to give positive feedback. This regeneration considerably improves the sensitivity of the receiver, since it increases the efficiency of TR1 as a detector by enhancing its ability to give increased gain on positive half-cycles. The feedback also improves the selectivity of the set, enabling it to pick out just one of several closely spaced transmissions.

The a.f. output from the detector is still not very great, being typically in the region of 1 millivolt. A large amount of audio amplification must therefore be used to bring the signal up to a sufficiently high level for the crystal earpiece. This amplification is provided by IC1, which is an operational amplifier used in the inverting mode. The non-inverting input (marked with a plus sign) is biased to half the supply voltage by the equal value resistors, R6 and R7. R8 causes the inverting input (marked with the minus sign) to take up the same potential as the non-inverting input and also, with R5, provides a negative feedback network. The two resistors limit the gain of IC1 to a level which is approximately equal to the value of R8 divided by the value of R5. The consequent a.f. gain is 1,000 times, and this high level of amplification ensures that a good volume level is obtained from any signal of reasonable strength.

The earpiece is driven direct from the output of IC1, and as it is a crystal type there is no need for an output d.c. blocking capacitor. The earphone

WAVE RADIO

A PROJECT WITH PARTICULAR APPEAL FOR THE NEWCOMER.

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)
R1 680kΩ (see text)
R2 2.2MΩ 10%
R3 3.3kΩ
R4 1.2kΩ
R5 10kΩ
R6 22kΩ
R7 22kΩ
R8 10MΩ 10%

Capacitors
C1 100μF electrolytic, 10V Wkg.
C2 0.1μF type C280
C3 0.047μF type C280
C4 0.22μF type C280
VC1 300pF variable, "Dilecon" (Jackson)

Inductors
L1, L2 medium wave aerial coil type MWC2 (see text)

Semiconductors
TR1 BC109C
IC1 CA3140E (8-pin d.i.l.)

Socket
JK1 3.5mm. jack socket (see text)

Miscellaneous
Plastic case (see text)
Veroboard, 0.1in. matrix
Ferrite rod, 9.5mm. diameter (see text)
2 ferrite rod mounting clips (see text)
9-volt battery type PP3
Battery connector
Control knob
Crystal earpiece with 3.5mm. jack plug
8-way d.i.l. i.c. holder (see text)
Wire, solder, etc.

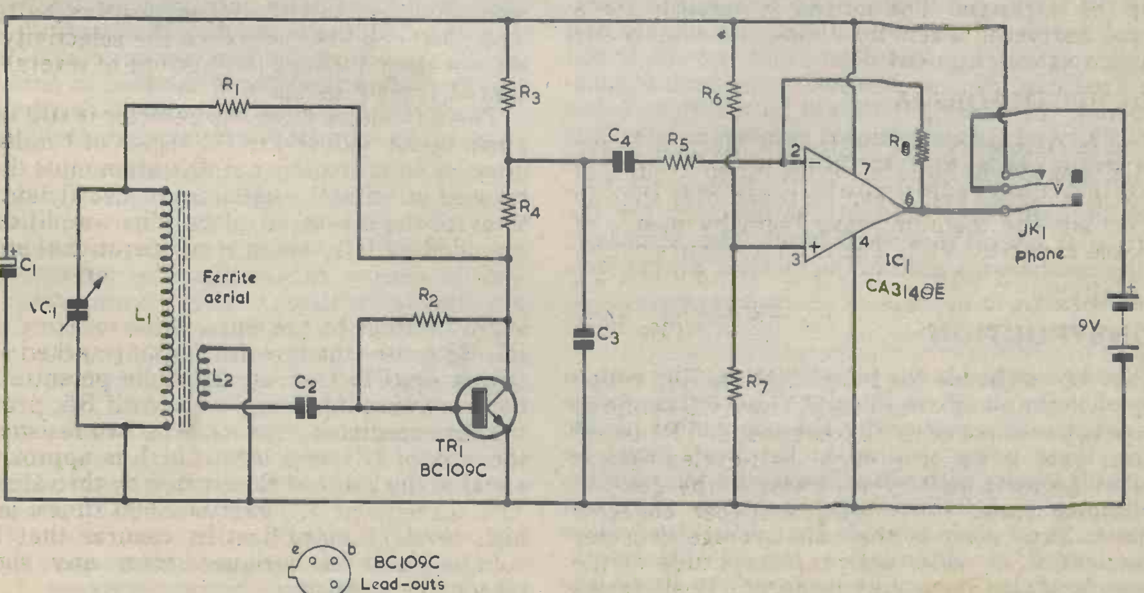
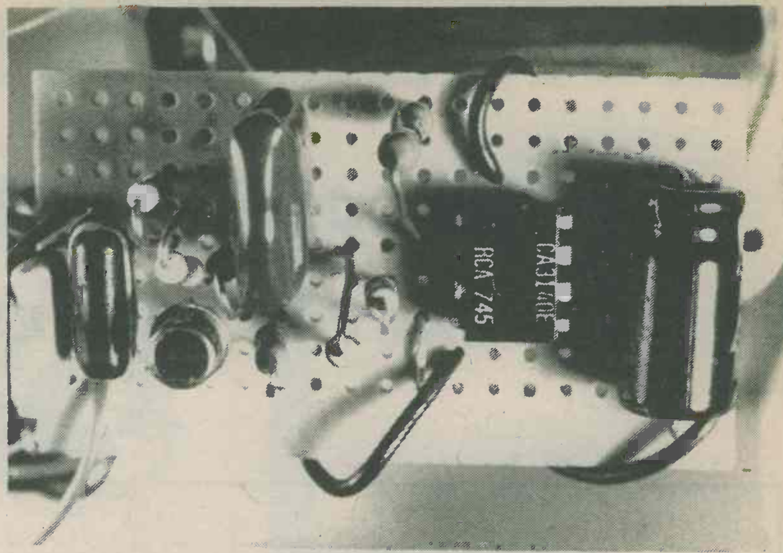


Fig. 1. The circuit of the Beginner's Medium Wave Radio. This drives a crystal earpiece

The parts which are assembled on the Veroboard component panel. If desired, an i.c. holder may be employed for the CA3140E



jack socket has a "make" contact which automatically switches the set on when the earphone is plugged in, and switches it off again when the plug is removed. There is in consequence no need for an on-off switch.

COMPONENTS

The receiver is housed in a plastic box type PB1, having dimensions of 114 by 76 by 38mm., which is available from Maplin Electronic Supplies. A metal case cannot be used because this would screen the ferrite rod and prevent the reception of signals. It is necessary, also, for VC1 and the phone jack socket to be mounted on an insulated panel because the modification to the phone jack results in its mounting bush having a different potential to that at the mounting bush of VC1. The phone jack should be a type having an "open" construction, i.e. it should not have an insulated body.

The ferrite aerial coil and the CA3140E used for IC1 are both available from Ambit International, who can also supply the two plastic clips which hold the ferrite rod in place. As is described shortly, the ferrite rod will in most instances have to be a longer rod which is cut down, and the longer rod required can also be obtained from Ambit International. (In passing it should be mentioned that the 1978 Ambit International catalogue states that the ferrite aerial coil specified is "not suited to bipolar descrete inputs." However, its characteristics are perfectly satisfactory for the particular circuit described here). The remainder of the components used in the receiver are generally available.

CONSTRUCTION

The layout inside the plastic case can be seen in the photograph of its interior. The ferrite rod is mounted at the bottom by the two Ambit plastic clips, these being secured to the front panel by short 6BA bolts with nuts. The ferrite rod requires a diameter of 9.5mm. and a length of about 100mm., and it is probable that difficulty will be experienced in obtaining a rod of this length. Because of this it may be necessary to obtain the length from a longer rod. The procedure here is to file a fairly deep V-shaped groove all round the rod at the point where it is to be broken and to then lightly tap the required length of the rod against the edge of a wooden table or bench. It does not matter if there is a rough finish to the rod at the point of the break. Rods with lengths of 140, 160 and 175mm. can be obtained from Ambit International. Since it is not easy to shorten a rod which is only slightly over the required final length, it would be preferable to start off with the 160mm. or 175mm. rod.

The variable tuning capacitor is mounted on the right hand side of the front panel, as viewed from the front, and this requires a mounting hole of 10mm. diameter. The jack socket is fitted to the left of the tuning capacitor and requires a hole with a diameter of about 6.5mm.

The jack socket will normally have contacts which break a circuit when the plug is inserted, these usually being employed to mute a speaker when an earphone is connected. The appearance of the contacts is as shown in Fig. 2(a). It is merely necessary to carefully bend back the thicker fixed contact and then bend it downwards so that it is below the springy moving contact. The fixed contact should be finally positioned so that, without a plug inserted, the moving contact does not touch it. At the same time the two contacts should connect together when the plug is inserted in the socket.

Apart from the battery and its connector, the remaining components are assembled on a

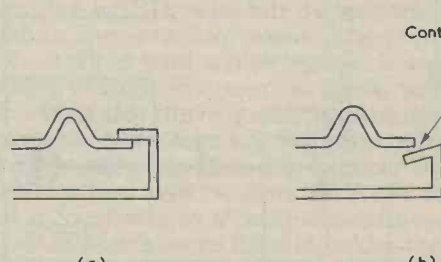


Fig. 2(a). The rear ends of the contacts of the jack socket before modification
(b). One of the contacts is bent so that the two contacts only make when the jack plug is inserted

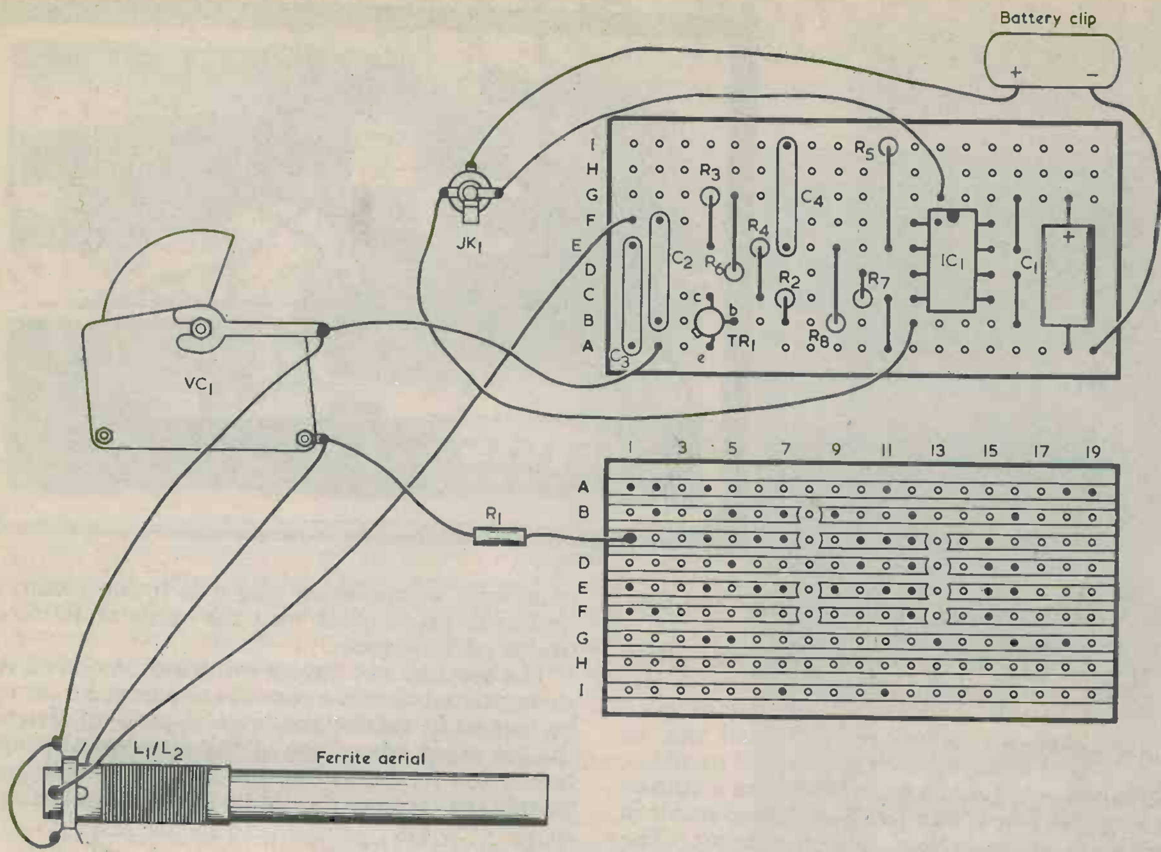


Fig. 3. Component layout on the Veroboard panel and the general wiring of the receiver

Veroboard of 0.1in. matrix having 19 holes by 9 copper strips. Details of this panel are given in Fig. 3, which also illustrates all the point-to-point wiring of the receiver.

Start by cutting out the Veroboard to the correct size using a hacksaw, and then make the eight breaks in the copper strips. The breaks can be made with a Vero spot face cutter or a small twist drill held in the hand. The three link wires and the components should then be soldered to the board at the positions indicated in Fig. 3.

IC1 should be the last component to be soldered to the board. This device has a PMOS input stage and it can be damaged by high static voltages if these should appear at the inputs. The i.c. will almost certainly be supplied with its pins imbedded in a piece of metal foil or conductive foam, and it should not be removed from this until it is time for it to be connected into circuit. All soldering should be carried out with an iron having a reliably earthed bit. Chances of accidental damage are much reduced if an 8-pin i.c. holder is employed. This holder is soldered to the board in place of the i.c., and the latter is then inserted in the holder at a late stage of the construction.

The point-to-point wiring is next carried out, and it should be noted that one lead of R1 is soldered to strip "C" on the copper side of the board. Its other lead connects to the fixed vanes tag of VC1, as shown. The leads to the jack socket, to VC1 and to the aerial coil employ single strand p.v.c. covered wire, and they should be kept short and direct. It will then be found that they are sufficient to hold the component board in position, making any further mounting unnecessary. The board fits into the space between the jack socket and the ferrite aerial, with the component side towards the aerial and C3 nearest VC1. Its position is clearly shown in the photograph of the inside of the receiver case. The battery is fitted above the phone jack and may be held in place by means of Bostik Blue Tack.

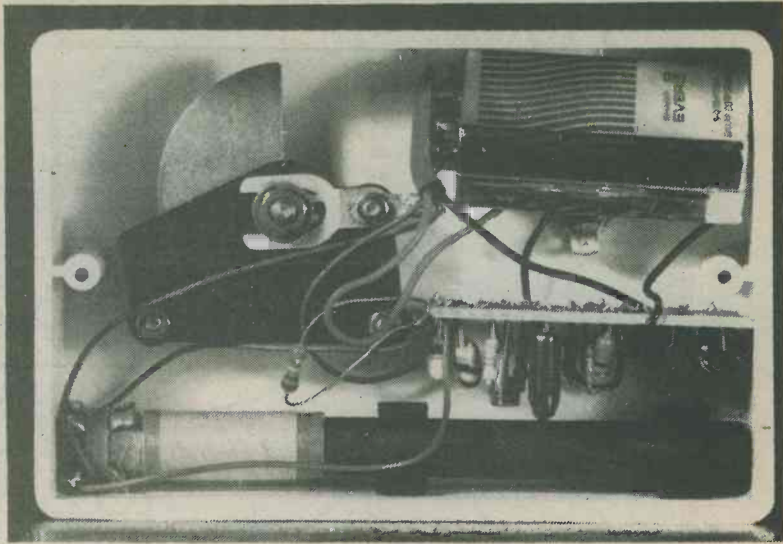
If any difficulty is experienced in identifying the tags of L1 and L2, this should be cleared up by visually inspecting the coil and comparing it with the circuit diagram of Fig. 1. It should then be apparent which two tags connect to the negative supply rail and which connect to VC1 and C2.

ADJUSTMENT

Provided that the aerial coil is positioned right at the end of the ferrite rod the set should work correctly without any alignment. If it does not, switch off at once and check the wiring thoroughly for errors.

It is just possible that the regeneration provided by R1 is too great, causing the detector to oscillate and resulting in a whistle of varying pitch as the set is tuned across a station. This is unlikely but, should it occur, the trouble can be cured by experimentally increasing the value of R1 until satisfactory results are obtained.

It is more likely that the level of regeneration will be below optimum, but this will not prevent the



The internal layout inside the receiver case. The ferrite rod is secured by two plastic clips, one slightly left of its centre, as shown here, and one near its right-hand end

receiver from exhibiting good selectivity and sensitivity.

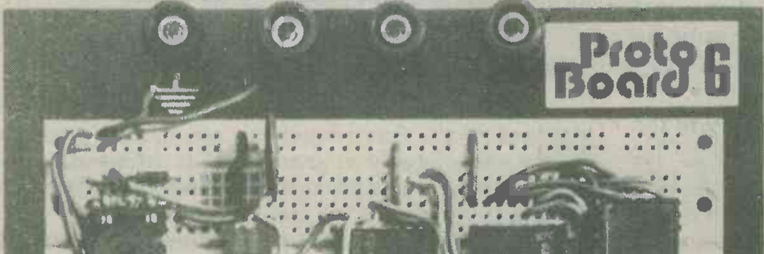
Experimentally minded constructors can, if they wish, try the effect of reducing the value of R1, whereupon it may be found that reception of weak signals is improved. However, R1 must not be made too low in value or the detector will oscillate, producing the whistle of varying pitch as a station is tuned in. Too low a value in R1 can also result in the receiver giving a low quality output. The prototype receiver gives good results with less than maximum regeneration and it is by no means essential to experiment with the value of R1 to optimise performance.

The set does not have a volume control. If a very strong signal should cause overloading the set may be turned to reduce the level of pick-up. Turning the set takes advantage of the directional properties of the ferrite rod aerial. Similarly, with weak signals the receiver should be oriented for strongest signal pick-up.

AN ENTREE TO SOLDERLESS BREAD BOARDING

For those interested in getting their feet wet in solderless breadboarding without wringing their wallets dry, Continental Specialties Corporation recommends their model PB-6 Proto-Board® Kit, low cost (£9.20) way of quickly learning and appreciating the advantages of the solderless breadboarding approach.

The PB-6 Proto-Board Kit comes complete with a pre-assembled breadboarding socket, two pre-assembled solderless bus strips, four five-way binding posts, a metal ground base plate, non-marring feet and all required hardware. When complete, its six hundred and thirty tie points permit flexible configurations of as many as six 14-pin DIP ICs.



Despite its low cost, the PB-6 provides a very confident breadboarding base. Of the four binding posts, one is grounded to the ground base plate permitting high distributed capacitance and low distributed inductance for enhanced high-speed circuit operation. The three remaining five-way binding posts can be used to interconnect the circuit on the PB-6 to power and signal lines and the outside world.

Following the easy assembly instructions enclosed, using only pliers and a screwdriver, assembly time for the PB-6 is less than ten minutes.

For further information, contact Continetal Specialties Corporation (U.K.) Ltd., Shire Hill Industrial Estate, Saffron Walden, Essex.

TUNE-IN TO PROGRAMS

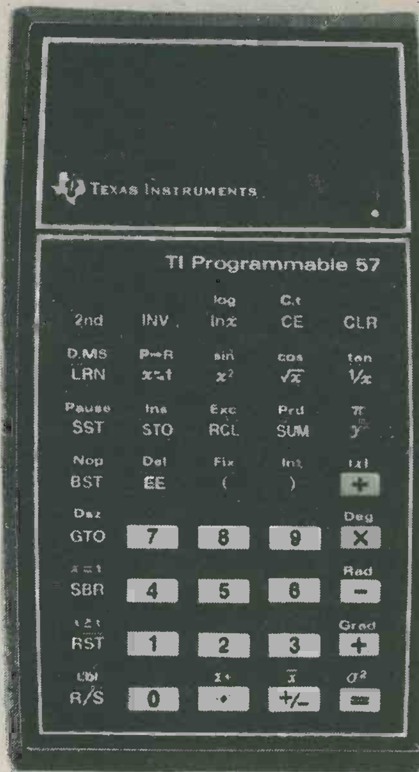
PART 7

By
Ian Sinclair

BUG HUNTING

We've all done it — we've written a program, checked it, entered it into the machine and all we get when we run it is a flashing display or a silly answer. Obviously something's wrong, but what? There are several things we can do, some with the calculator, some without, to debug a program, but before we start we should check the following:

1. Is each store loaded up with the numbers that are to be used in the calculation?
2. Is each [STO], [RCL], [GTO], [Lbl] or [SBR] instruction followed by the correct reference number?
3. Have we used an [=] or [)] to complete calculations where these are needed? Some operations, like [1/x], do not need [=], others, like [+] [-] [X] [÷], do. If in doubt, check out a sum with the calculator used simply as a calculator (not running a program).



The keyboard of the Texas Instruments TI-57 programmable calculator. Most keys have a second function, whereupon facilities are nearly double the number of keys provided

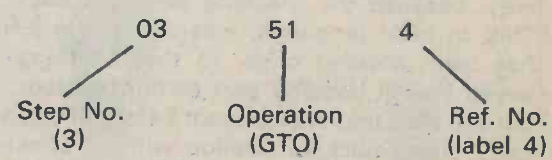
PROGRAM CHECK

A particularly good way to check a program before running it on the calculator is to imagine yourself as the calculator, writing down the effect of each instruction and acting on the number you have written down with the next instruction. This way, if we do only what the program dictates, we can often spot omitted [=] or other signs which make a calculation impossible or incorrect.

If the program seems perfectly correct (and if it has run before then it must be correct), the next step is to check that this is the program that is actually entered. We may quite easily have missed a step or even added one which was not intended. How, then, do we trace through a program?

The answer is that the TI-57, along with the PR-100, has editing facilities, enabling us to look at each step of a program which is in store. To make use of these facilities load up the memories as required by the program, set up just as you would for running the program, press [RST] so that the program is reset to the beginning, and then press the [LRN] key.

The display then splits off, as in Fig. 1, to show the program step number on the left, along with the code number for the program instruction on the right. Remember your step codings? The code is a two-digit number in which the first digit represents the key row, starting at the display end of the calculator. The second digit represents the key column, starting at the left hand side with number 1, and moving from left to right along the normal functions (the ones printed on the keys) then back again at No. 6 to number the upper functions (marked above the keys and again from left to right). Examples of these key codings are shown in Fig. 2. Any number in addition to the two-digit key code is a reference number such as a memory number, a label number, etc.



This is then the *fourth* step of the program, GTO 4. The first step is 00.

Fig. 1.

[INV] always codes as [–] before the operation code, so that [INV] [SBR] is [–61], [INV] [sin] (or arcsin) is [–28], and so on. Numbers are not coded, but entered normally.

Operation	Code	Operation	Code
Pause	36	y^x	35
GTO	51	sin	28
Dsz	56	cos	29
SBR	61	tan	20
x=t	66	(	43
RST	71	)	44
R/S	81	÷	45
Lbl	86	X	55
STO	32	–	65
RCL	33	+	75
SUM	34	=	85
x^2	23	+/–	84
$\sqrt{x}$	24	log	18
1/x	25	antilog	–18

Fig. 2. SOME IMPORTANT KEY CODINGS

In this condition, we can check the program step by step, using the [SST] key. Pressing the [SST] key advances the program by one step, showing the step number and the code for the operation that will be carried out. The [BST] key has a similar effect, but runs the program one step back on each press. Take great care not to press any other key unintentionally while a program is being checked in this way, because the machine is in the *learn* mode. This, in plain language, means that the [LRN] key has been pressed once, so that anything that is keyed in will become part of the program, wiping out the step that was present before. If you want to carry out a quick calculation without affecting the program you will have to press [LRN] again, so that the display returns to normal, showing a single zero.

You may not, of course, have to go through the whole program. When an error occurs which results in a flashing display, you can use the [R/S] and [CLR] (or [CE]) keys to freeze everything, then press [LRN]. That should get you to the place where things started to go ape, so you can backstep using [BST] until you find what went wrong. Another possibility is that you may have a hunch that the root of the trouble is around step 25. You can get there by the key sequence [GTO] [2nd] [25] [LRN], which will result in the machine showing step 25. Once there, you can [SST] and [BST] your way around until you find the trouble. Note, by the way, that this [GTO] method needs a two-digit number. If, for example, you are looking for step 7 and you press [GTO] [2nd] [7], the machine will look for *label* 7. To get program step 7, you must key in [GTO] [2nd] [07] — the use of two digits makes a great difference.

You still can't see where it's gone wrong? There's still hope for you because we can also check what the calculator does to each number. Enter in a nice easy set of numbers, like 1, 2, 3, into the memories that are to be used. Calculate what the result of each step should be. Now load up the program in the usual way, press [RST] when the machine is out of program mode (after the second press of [LRN]) and, instead of pressing [R/S], press [SST]. What will be displayed this time will be the result of the first step of the program. For example, if the program starts with [RCL] [1], and memory 1 is loaded with the number 1, then pressing [SST] at the start of this program will bring a 1 into the display. The next press of the [SST] key carries out the next instruction. If the next step is [+], [–], [X] or [÷], the display does not change. Instructions like [1/x], [$\sqrt{x}$] or [x^2] will cause the results of such steps to be displayed. This way, we can [SST] our way through the program looking at the results. Note that [BST] does not work in this mode. The results should agree with the old-fashioned artithmetic which you tried earlier. If it doesn't agree somewhere, you've found the fault.

EDITING

Both the TI-57 and the PR-100 allow a number of editing operations to be carried out on programs which are in store. These operations are insertion, replacement and deletion. Of these, the easiest edit is to write over a program step. You may find, for example, that your written program says [5] [SUM] [2], and the program in the calculator is displayed as 25 32 2, meaning that this is step 25 and that the key strokes programmed were [STO] [2] (since 32 is the code for [STO]). Note that the PR-100 shows these as separate steps since merged codes are not used.

While the calculator is in the [LRN] mode, this incorrect program step can be written over simply by keying in [SUM] [2] in place of the [STO] [2] which was there. Once this is done, the display will show the next step of the program, so that we have to use the [BST] key to go one step back to check that the program is now as we want it.

Another editing step which is sometimes useful is the [Nop] step (obtained by pressing [2nd] [BST]). When the program is being checked in the [LRN] mode, any step can be erased by using [Nop] (No-

Program Example

LRN RCL 1 SBR 0 1/x
X (RCL 2 SBR 0) X
RCL 0 = R/S
Lbl 0 X RCL 3 + 1
= INV SBR LRN

Program Listing Using SST Key

Press LRN to start, then SST:

00	33	1	11	81	
01	61	0	12	86	0
02	25		13	55	
03	55		14	33	3
04	43		15	75	
05	33	2	16	01	
06	61	0	17	85	
07	44		18	–61	
08	55		19	00 this indicates the end of the program.	
09	33	0			
10	85				

Load in the following values: 150 STO 0, 22 STO 1, 125 STO 2, 0.0036 STO 3. With the program loaded and the machine out of LRN mode, the use of SST will now run the program one step at a time, as follows:

22.	1.
22.	1.3435878
22.	1.3435878
0.0036	1.3435878
0.0792	1.3435878
1.	150.
1.0792	201.53818
1.0792	201.53818
0.9266123	201.53818
0.9266123	201.53818
0.9266123	0.0036
125.	0.7255374
125.	1.
125.	1.7255374
0.0036	1.7255374 End
0.45	0 of program.

Fig. 3. USING THE SST KEY

operation), leaving a space which will be skipped when the program runs. A No-operation space can be filled with another instruction later if one is needed.

A very useful editing step is the [Ins], meaning Insert, key, reached by [2nd] [STO]. Using this key shifts all the program steps, leaving a space into which another step can be placed. To use the [Ins] step, locate the step in the program ***after*** which you want to add another instruction, then press [Ins]. There is a short delay as all the registers shift the program down, then the display shows a set of zeros after the step number. The new step can then be keyed in. If there's another new step to add, the [Ins] key must be pressed again. Once again, the calculator must be in the [LRN] mode before these operations can be carried out. A point to watch when steps are inserted is the overall length of the program — if the program filled up the calculator previously, using the [Ins] key will cause the last step of the program to be lost.

The final key of the editing set in the TI-57 is the [Del] (Delete) key, obtained by pressing [2nd] [EE]. Pressing this key when the calculator is in the [LRN] mode removes the step which is being displayed, and closes up the gap.

DEBUGGING SUMMARY

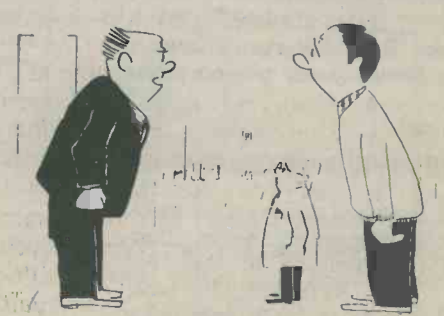
1. When a program is first entered by pressing [LRN] and programming, the key codes are ***not*** displayed.

2. To check key codes, the program must be entered and the machine kept in [LRN] mode. Alternatively, the [LRN] key must be pressed to enter [LRN] mode if the program has been run. The [RST] key must have been used out of [LRN] mode to reset the program, and then the [SST] key can be used to examine the program step by step. The [BST] key also operates in [LRN] mode to backstep the program.

3. The [SST] key works out of [LRN] mode also. Out of [LRN] mode, the [SST] key will run a program step by step, showing the result of each step on the display.

4. The edit keys, [Nop], [Ins] and [Del] can be used in [LRN] mode only.

(To be continued)



"No, Stupid! Not a micro professor I wanted a microprocessor."

In your workshop

PROBLEMS WITH SYNC

"Our darned bog-roll has gone out of sync again!"

Dick shut the Workshop door behind him noisily and stumped, scowling, over to his bench.

Smithy looked up at him.

"How d'you mean, out of sync?"

"There's something wrong with the perforations," replied Dick aggrievedly. "The perforations in the top layer are displaced by about two inches from the perforations in the bottom layer."

"I can't begin to understand what you get up to out there," remonstrated Smithy mildly. "The bog-roll always seems to be all right for me."

Dick suddenly cast a suspicious glance at the Serviceman.

"Here," he asked, "you haven't been getting in some sub-standard rolls on the cheap, have you?"

"Certainly not," retorted Smithy in a deeply shocked tone. "I would never even dream of skimping on an important item like that. I always get the finest quality two-ply toilet tissue."

"Humph!"

MORE SYNC TROUBLE

Dick slouched down on his stool, looked at his empty bench, then turned his attention to the "For Repair" rack. Resignedly he rose, walked over to the rack, selected a monochrome TV receiver and carried it back to his bench. He next plugged it into the mains, connected an aerial and switched it on. As the sound signal from one of the local channels became audible from the speaker, he waited for the picture tube to warm up.

The screen flickered into life, to reveal a picture which was completely out of horizontal lock. Dick turned the set round and located the horizontal hold control. Looking at the screen he adjusted the control carefully. He was able to find a critical setting which caused the picture to be momentarily resolved, but it very soon went out of horizontal lock again.

"Just my luck," he grumbled to himself. "I've got another problem with sync now."

Smithy, carrying a serviced cassette recorder over to the "Repaired" rack, turned round at the sound of his assistant's voice.

"Don't tell me," he said irately, "that you're ***still*** chuntering on about that sync business."

"It's this TV," stated Dick. "There's not a trace of horizontal sync in it at all."

"Let's have a look."

Smithy walked to Dick's side and, in his turn, experimentally turned the line hold control. He was similarly able to obtain a momentarily resolved picture, which soon fell out of lock once more.

"There's almost certainly a snag in the line flywheel sync circuit," he

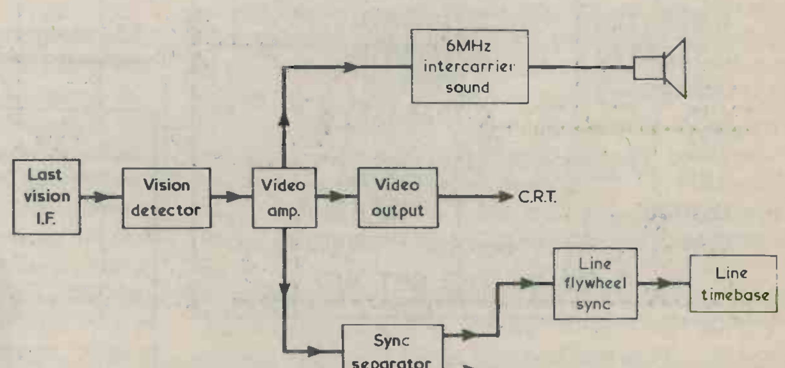


Fig. 1. Typical stage line-up for a monochrome television receiver following the last vision i.f. amplifier. The sync separator provides sync pulses which are applied to the line flywheel sync circuit

pronounced, as he switched off the set. "We're getting a picture and we can hear the intercarrier sound. So there must be a signal getting through all the way to the video output stage. Also, we're getting frame hold, which means that the sync separator circuits are at least passing frame sync pulses to the vertical timebase. Since we're able to get the line timebase on to the correct frequency, even if only momentarily, that timebase can be assumed to be all right. All that's left is the horizontal flywheel sync circuit." (Fig. 1).

"How d'you know that this set has got a flywheel sync circuit? Couldn't it have direct line sync, in which the line sync pulses trigger the horizontal timebase oscillator?" (Fig. 2).

"Direct line sync went out of use ages ago," replied Smithy. "You might come across it in some extremely old valve TV sets, but you certainly won't find it in any solid-state sets like the one you've got there. Apart from some of the most recent sets, which have got the line oscillator and sync stages packed away inside an integrated circuit, line flywheel sync arrangements have become standardised with time as an inexpensive and reliable circuit which uses two silicon diodes connected in series. These two diodes are caused to become conductive when the transmitted line sync pulses are passed to them. Let's get out the service manual for this set and I'll show you."

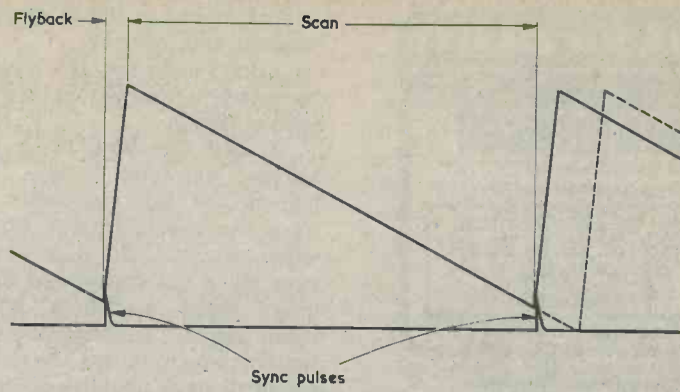


Fig. 2. Graphical presentation illustrating the action of a direct line sync system. The waveform represents a signal in the line timebase oscillator, and the sync pulse initiates the start of the flyback period before it would naturally occur. If the sync pulse were absent the waveform would continue as shown in broken line

Quickly forgetting his complaints about the Workshop's ultra-mural facilities, Dick rose with alacrity and made his way to the filing cabinet. He soon found the appropriate service manual and brought it back to his bench opening it out at its circuit diagram.

"There you are," said Smithy, pointing to a section of the circuit. "There are the two flywheel sync diodes." (Fig. 3).

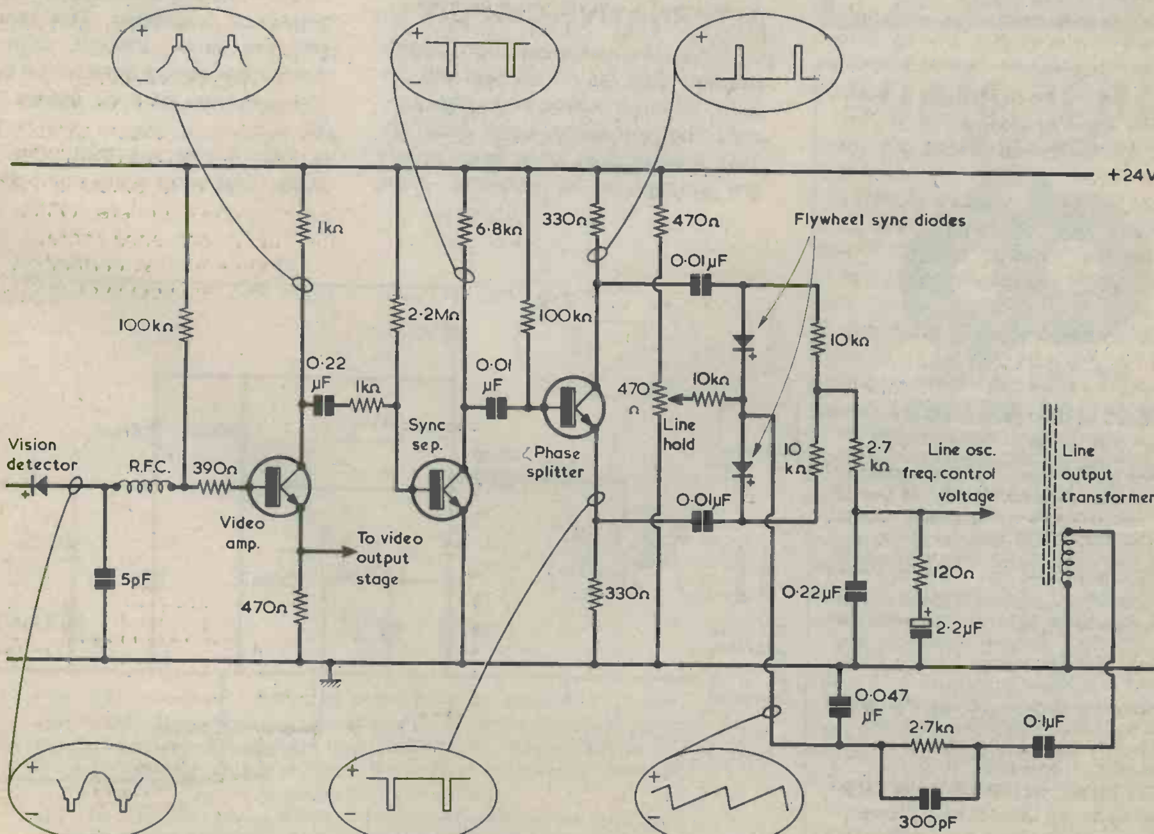


Fig. 3. Slightly simplified circuit representative of monochrome TV practice illustrating how the line sync pulses are fed to the two flywheel sync diodes to turn them on in the presence of the pulses. The components between the line output transformer winding and the sync diodes provide waveform shaping

Dick looked at the diodes in the diagram and frowned.

"I don't quite see," he remarked, "how they get turned on by the line sync pulses."

"They're coupled to a phase splitter," explained Smithy, "which follows the sync separator. Let's trace the circuit through from the video detector. On 625 lines the sync pulse tips correspond to maximum signal amplitude, and the video detector is connected with a polarity which causes the detected signal to have negative-going sync pulses. This signal is passed to the base of the video amplifier transistor, whereupon the signal at the collector of this transistor must have positive-going sync pulses. These are fed to the base of the sync separator transistor, which amplifies the sync pulses only. This it does by a very simple process. The series 0.22μ F capacitor in its base circuit becomes charged such that the more positive parts of the sync pulses turn the base-emitter junction of the transistor hard on. The transistor is then simply cut off for the remainder of the signal, which takes the base well negative of the 0.6 volt forward voltage needed to cause the junction to conduct."

ALTERNATIVE CIRCUIT

"That seems fair enough," commented Dick, as he studied the circuit. "When the sync pulses are present the transistor turns fully on. This means that only sync pulses are present at its collector. Also, they must be negative-going."

"That's right," confirmed Smithy. "These negative-going pulses are next coupled to a phase splitter. This produces negative-going pulses at its emitter and positive-going pulses at its collector, and these pulses are applied to the flywheel sync diodes via series 0.01μ F capacitors. The result is that the diodes become conductive when the sync pulses are present and are fully turned off between the sync pulses. As you can see, the two diodes are connected in series, with the anode of the lower one connecting to the cathode of the upper one."

A thought suddenly occurred to Dick.

"Just a minute," he said slowly. "I seem to remember seeing a TV circuit in which there were two diodes connected back to back. That is, their two cathodes were connected together."

"That's an alternative method of connecting the flywheel sync diodes," stated Smithy. "When the diodes are connected like that they're fed sync pulses from a single point instead of from a phase splitter. They could, for instance, be fed negative-going sync pulses direct from the collector of the sync separator transistor. The result is still the same, though, with both diodes becoming conductive only in the presence of sync pulses." (Fig. 4).

"Ah, I can see that now," said Dick, "but what's the point of mak-

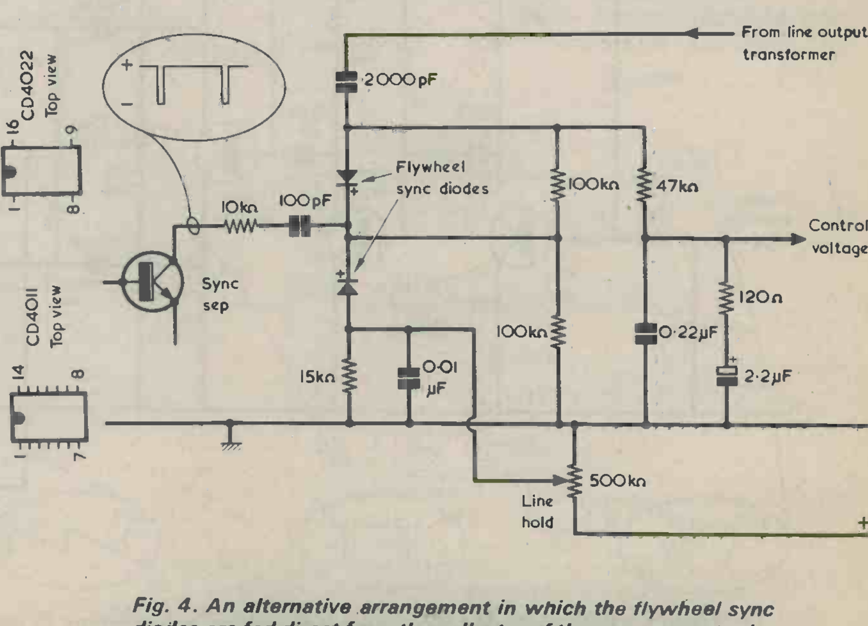


Fig. 4. An alternative arrangement in which the flywheel sync diodes are fed direct from the collector of the sync separator instead of through a phase splitter. An incidental feature is that the 100pF capacitor causes differentiated spikes to be fed to the diodes instead of the full pulses

ing the diodes conductive during sync pulses anyway?"

"When the diodes conduct," said Smithy in reply, "they pass a voltage derived from a winding on the line output transformer to the line timebase oscillator via a sort of smoothing circuit. The smoothed voltage controls the frequency of the line oscillator, which is usually of the blocking oscillator variety. This control voltage normally couples via a series resistor to the base of the blocking oscillator and it then varies the time between one flywheel period and the next."

"I don't quite get that."

"Well," said Smithy, "a blocking oscillator normally has positive feedback given by way of a transformer with a small soft iron core or iron-dust core in it. During the scan period of the oscillation cycle, the collector or emitter current in one of the windings on the transformer continually increases until the core becomes saturated. The line oscillator then goes into the quick flyback part of the cycle, after which it starts the next scan period. As you can guess, the instant at which core saturation takes place will occur earlier if the control voltage applied to the oscillator base goes more positive. Got it?"

"Yes I have, now. What's this voltage which is derived from the line output transformer?"

"It's a voltage with a waveform like this," replied Smithy.

He took a ball-point pen from his pocket and sketched out the waveform in the margin of the service manual. (Fig. 5(a)).

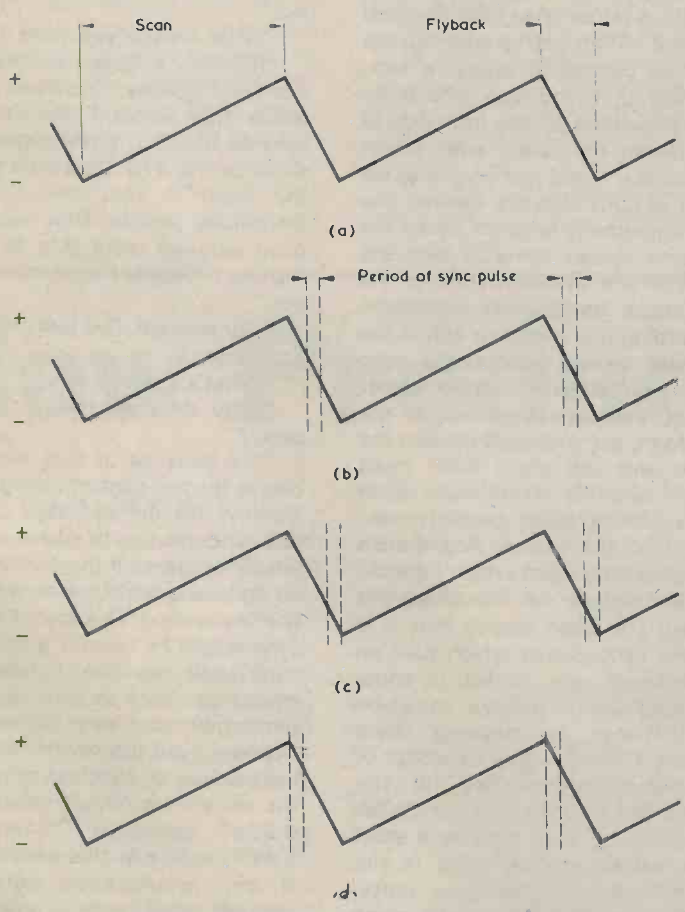


Fig. 5(a). Idealised version of the waveform applied from the line output transformer winding of Fig. 3 to the flywheel sync diodes. (In some receivers the polarity of the waveform is reversed if the line oscillator frequency decreases with a positive-going control voltage)
(b). The situation given when the sync pulse coincides with the centre of the flyback period of the waveform
(c). Condition given when the line oscillator tends to run at too high a frequency
(d). The sync pulse coincides with an early part of the flyback period if the line oscillator attempts to run too slow

"As you can see," he continued, "it has a slowly rising section during the scan period of the waveform and a sharply falling section during the flyback period. What the flywheel sync diodes do is to turn on during the flyback period and pass the voltage present on the waveform at that instant to the smoothing circuit which produces the control voltage for the line oscillator. Now, let's say for argument's sake that the desired line oscillator running conditions are given when the sync pulses coincide with the centre of the flyback period. They will then cause a voltage to be passed to the control voltage smoothing circuit which is just right to keep the line oscillator running in the desired manner."

Smithy added several broken vertical lines to his waveform to indicate the voltage sampling process. (Fig. 5(b)).

"What happens," asked Dick, "if something causes the line oscillator to try to run at a higher frequency?"

"In that case," stated Smithy, "the flyback periods will be produced earlier than they should be, and the turning on of the flywheel sync diodes will coincide with a later part of the flyback section. This will cause the control voltage, after smoothing, to go negative and counteract the tendency of the line oscillator to run at too high a frequency."

Smithy pointed his pen at the appropriate parts of the waveform. (fig. 5(c)).

"This is all making sense now," said Dick thoughtfully. "I suppose that, if the line oscillator tries to run at too low a frequency, the flywheel sync diodes turn on at an early part of the flyback period, causing the voltage applied to the control voltage smoothing circuit to go positive." (Fig. 5(d)).

"That's exactly right," concurred Smithy. "The flywheel sync circuit keeps the line oscillator running at correct frequency provided that the transmitted sync pulses coincide with any part of the flyback period in the line output transformer waveform. In the set we have here the d.c. conditions in the flywheel sync circuit can be varied by adjusting the slider of a 470Ω potentiometer, whereupon this potentiometer acts as the line hold control. It is adjusted to bring the whole circuit into the correct operating state for control to take place. In some sets the d.c. conditions are fixed and the line frequency is controlled by adjusting the position of the core in the line blocking oscillator transformer. This adjustment then becomes the line hold adjustment."

RANGE OF CONTROL

"There's something here," said Dick, "that's puzzling me a bit."

"What's that?"

"You've just shown me that you can get line synchronism when the line sync pulses coincide with either the beginning, the end or the middle of the flyback period of the line output waveform."

"Yes," said Smithy, "there's quite a wide range over which control is given."

"Well, say the sync pulses coincide with a late part of the flyback period. This could mean that the receiver will have gone into flyback before the end of the transmitted picture information has reached the set."

"That's true," agreed Smithy, "and it's a minor snag with flywheel line sync. When you've adjusted the line hold control to obtain a lock, you find that you can effectively move the whole picture from side to side within the range over which lock occurs. I said just now that we would assume that the desired line hold adjustment is given when the line sync pulses coincide with the centre of the flyback period of the line output transformer waveform. In practice, it is better to adjust the line hold control so that the sync pulses coincide with a rather earlier part of the flyback period in the waveform, say midway between the centre and the start. With most modern sets this will normally result in the picture being properly centralised on the screen. And there's one other little point which I should mention before we finish on this subject. I've been saying that it is the line sync pulses which turn on the flywheel sync diodes. In some sets the sync pulses may be differentiated by passing them through a lowish value capacitor or capacitors before they hit the diodes. The result is that the diodes are turned on each time by a short spike whose leading edge is the leading edge of the sync pulse, rather than by the full sync pulse itself. The result is the same, of course, but the short spike allows the flywheel sync circuit to have increased resolution because a smaller section of the line output transformer waveform is sampled in each cycle."

"Well," said Dick, "that certainly clears up this flywheel sync business."

He scowled as his earlier grievances rose up in his mind.

"It's a pity," he went on dismally, "that we can't clear up the bog-roll sync problem as easily."

"If you keep on about that," warned Smithy sternly, "I'll get in some of that hard single layer public loo stuff. You won't have any problems with ***that*** going out of sync."

Dick was aghast.

"You wouldn't," he said in a trembling voice, "do anything like that, would you, Smithy?"

"I will if you don't stop complaining."

"Oh, all right then," grumbled Dick. "I suppose I'd better have a go at repairing this set, then."

He disconnected the receiver from the mains and proceeded to take off its back.

"I should check the sync diodes themselves," suggested Smithy. "One of them may have shorted out."

"What makes you think that?"

"It's only a guess on my part," admitted Smithy. "However, if one diode has shorted out it would provide a circuit path between the slider of the 470Ω line hold pot and the input to the control voltage smoothing circuit. That would explain why we were able to control the line timebase frequency with the pot."

"Fair enough. I've just thought of something."

"What's that?"

"Why do they call it 'flywheel sync'?"

"It's because of that smoothing circuit for the control voltage," said Smithy. "In the old days of direct line sync, the line timebase could be falsely triggered if the receiver picked up interference pulses, and you'd get line tearing. This meant that line sync would be lost for a number of lines until the line timebase oscillator got back in step again with the transmitted sync pulses. With flywheel sync the control voltage is held steady by the first capacitor in the smoothing circuit, which is the 0.22μF capacitor following the 2.7kΩ resistor in this particular set. If any interference pulses get through they won't have much effect on the voltage across the capacitor, and that's what gives the flywheel effect." (Fig. 6).

By now, Dick had unhinged the printed board and was examining it closely. He turned his head briefly and looked at the 0.22μF capacitor in the circuit diagram.

"There's another resistor and capacitor in that circuit," he remarked. "There's a 120Ω resistor and a

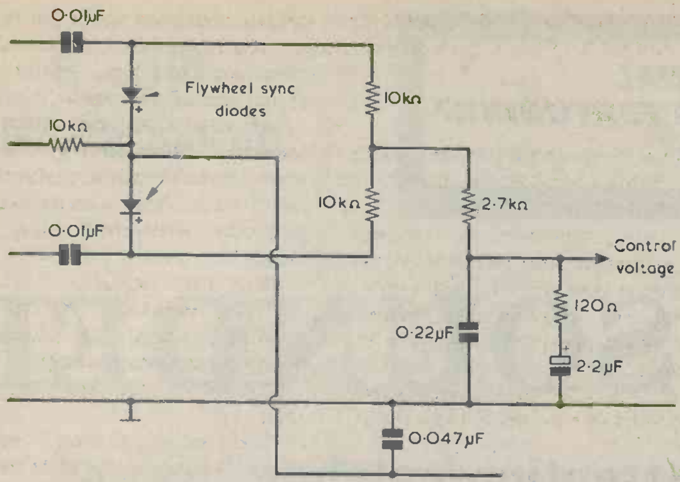


Fig. 6. Detail of the circuit of Fig. 3. The control voltage "smoothing" components are the 0.22µF capacitor, the 120 Ω resistor and the 2.2µF capacitor. The last two components also reduce any tendency towards hunting in the sync system

2.2µF electrolytic in series."

"Those are anti-hunt components," said Smithy. "If you just had the 0.22µF capacitor on its own the circuit could have a tendency to hunt around the correct line frequency. It would be the same sort of hunting effect that you get in a servomechanism. The resistor and the capacitor modify the time constant of the flywheel sync loop so that any hunting that takes place is negligibly low. Have you located those two diodes yet?"

"Yes, I've just found them."

"I should check them both ways round with an ohmmeter," said Smithy. "If my hunch is right you'll soon be able to find the short-circuited one."

And, indeed, Smithy's prediction proved to be correct, and Dick discovered that the lower diode in the circuit diagram was now conducting fully in both directions.

PROBLEM SOLVED

Smithy watched his assistant contentedly as the latter went to the spares cupboard to find a new diode and then soldered it into circuit in place of the faulty one. He waited until Dick had checked the receiver, to find that the horizontal sync circuit was now functioning properly, then quietly made his way out of the Workshop.

Over the years we have followed Smithy into many strange and out of the way places, and modesty would prevent us from accompanying him on his present mission were it not for the fact that his actions solve a minor little mystery. After he had settled himself comfortably, Smithy thoughtfully took the top ply of the paper positioned at his side and passed it once around the roll. The sets of perforations became aligned perfectly. Some time later he just as thoughtfully took the top ply once around the roll again, to give the out-of-sync characteristic which was proving so troublesome to his unsuspecting assistant. ■

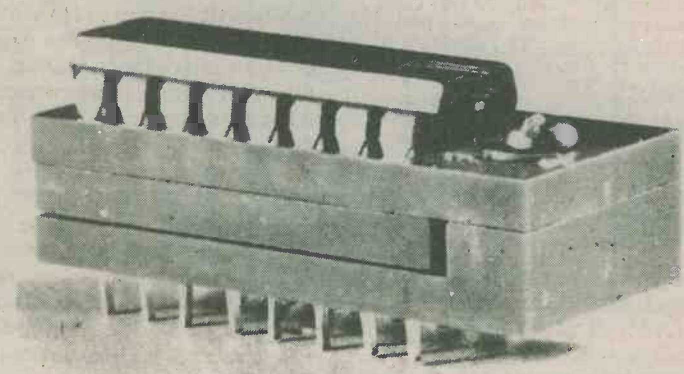
New Product

Z.I.P. D.I.P. SOCKET

The letters Z.I.P. stand for Zero Insertion Pressure and they are applicable to the dual-in-line i.c. holder shown in the accompanying photograph. The socket has been introduced by BFI Electronics Limited, 516 Walton Road, West Molesey, Surrey, KT8 0QF, and is currently available in 16-pin. 24-pin and 40-pin versions will be in production in the near future.

Using the socket is extremely easy. The dual-in-line i.c. is simply dropped into the open socket, after which the small screw at the end is given a quarter turn. This clamps all the i.c. pins inside the socket and ensures excellent mechanical and electrical contact over the life of the i.c. and the socket. The i.c. can be released by turning the screw back to its original position, which will certainly make life easy for service personnel who wish to replace or check the i.c.

Known as the Textool "ECONO ZIP" socket, the holder is designed as a low cost item with a limited number of clamping operations, but it still incorporates most of the features found in high quality "lever-arm" clamping sockets. It is moulded in a UI-approved thermoplastic and its contacts are plated to high standards for maximum life and minimum contact resistance.



The "ECONO ZIP" Zero Insertion Pressure i.c. socket, introduced by BFI Electronics Limited. The socket, which clamps the pins of integrated circuit packages after insertion, is operated by turning the screw head on its upper surface

DOUBLE DECCERS — *A SPECIAL SERIES FEATURING S-DeCs*

No. 9

By Ian Sinclair

SIREN SOUNDER

A real attention-catcher

There are simple circuits which can be built on a single S-Dec and which will give a two-tone siren note, but a more difficult proposition is the "sliding-note" siren of the type which is familiar to followers of U.S. Cops and Robbers TV, and which is extensively used in the U.S.A. for emergency vehicles of all sorts. The note from such a siren starts at a high pitch, slides down to a fairly low pitch, then returns to the high pitch again, repeating about twice per second to form a sound that simply cannot be ignored. The circuit of this project provides such a sound pattern, and has enough power output to make a most intrusive noise. It makes an ideal warning sound as well as being extremely useful as a sound effect.

SEVEN TRANSISTORS

The circuit consists of a sawtooth generator, a buffer amplifier and inverter stage, an astable oscillator and an output stage. Six n.p.n. transistors and one p.n.p. transistor are used.

TR1 and TR2 are connected to form an oscillator which simulates the action of a unijunction transistor. TR1 is n.p.n. and TR2 is p.n.p.; their emitters are connected together and there is also a resistive link between the collector of TR1 and the base of TR2. The circuit acts in the following manner. Imagine that the circuit is switched on with C1 discharged. The base of TR1 will then be at the potential of the negative rail, causing TR1 to

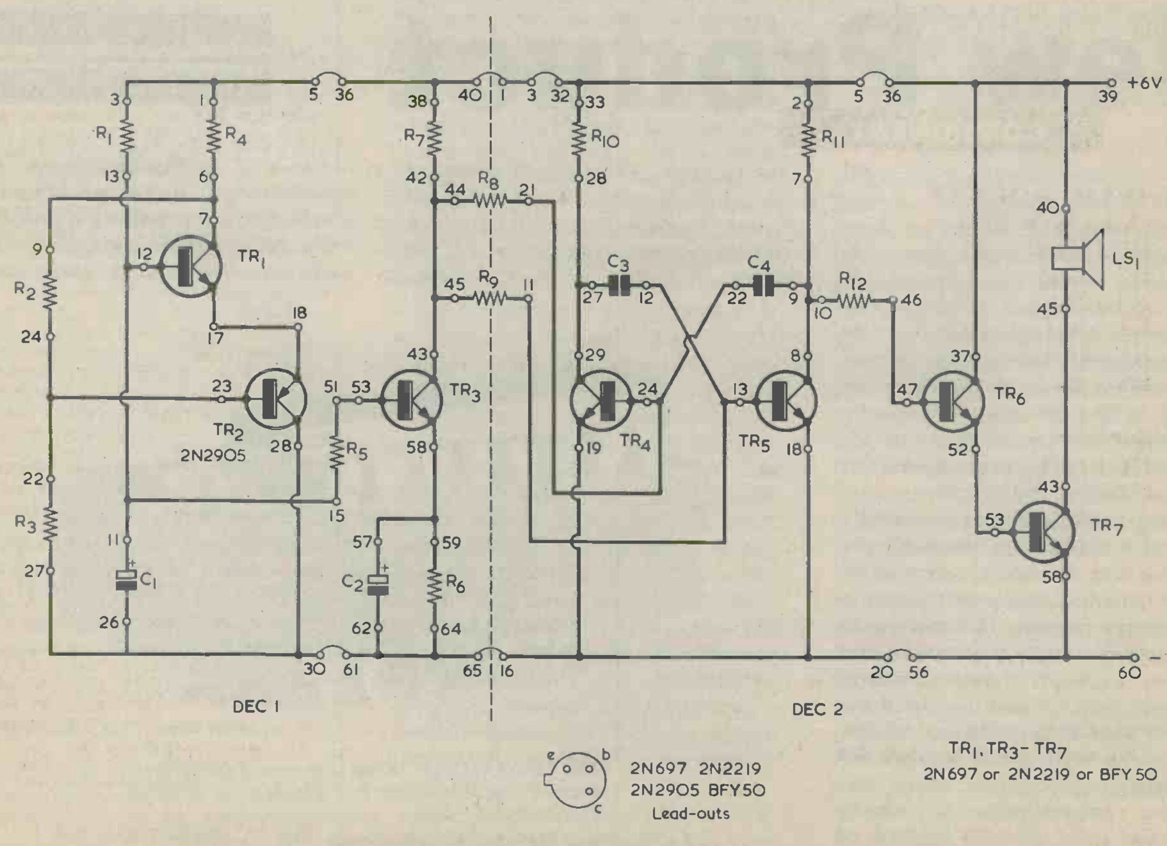


Fig. 1. The circuit of the siren sounder. Component leads and link wires are inserted in the S-DeCs at the numbered points indicated

be cut off. The junction of R2 and R3 will be at about 2 volts positive of the negative rail and TR2 will also be cut off. This is because TR2 is a p.n.p. transistor, which requires the base to be negative of the emitter if it is to conduct.

C1 charges through R1 at a rate determined by the time constant of these two components. When the voltage at point 12 of DeC 1 reaches a level of about 3.2 volts (the 2 volt bias at the base of TR2 plus two base-emitter voltage drops of 0.6 volt each) both TR1 and TR2 start to conduct. With TR1 conducting its collector voltage falls, so that the base voltage of TR2 falls also. The emitter current flowing in the transistors then turns them both hard on. C1 discharges very rapidly through the base-emitter junction of TR1 and through TR2, the voltage across it falling to about 0.8 volt (the base-emitter voltage of TR1 plus a voltage of about 0.2 volt across TR2). The two transistors then turn off, C1 commences to charge again via R1 and another cycle starts.

The waveform at point 12 of DeC 1 is a sawtooth with a positive-going ramp, but we need a negative-going ramp to generate in a multivibrator a note which descends in pitch. We also need rather more amplitude if we are to provide a realistic sound. TR3 is a buffer amplifier which amplifies and inverts the sawtooth. At point 43 of DeC 1, therefore, the waveform is a negative-going sawtooth with a peak-to-peak amplitude of about 6 volts.

ASTABLE OSCILLATOR

TR4 and TR5 form an astable oscillator with cross-coupling capacitors C3 and C4, and collector load resistors R10 and R11. This functions in the familiar multivibrator manner with the capacitors charging through R8 and R9. The rate of charging is faster if the charging resistors are returned to a high voltage, as consequently is the frequency of oscillation. R8 and R9 couple to the collector of TR3 and, at the start of each negative-going ramp of the sawtooth at this collector, the astable frequency will be high. The frequency falls as TR3 collector goes negative until, at the end of each sawtooth ramp, the frequency abruptly goes high again.

The square waves generated by the astable at the collector of TR5 are directly coupled to the output stage, which consists of emitter follower TR6 and the common emitter transistor, TR7. R12 ensures that the astable is not excessively loaded by driving the output stage, and the gain provided by TR6 ensures that TR7 is driven between the fully bottomed and cut-off conditions. The loudspeaker should preferably be a high resistance type, with an impedance of 60Ω to 80Ω. However, a 15Ω speaker can also be used if your ears can stand it!

Several circuit changes can be made if needed. The range of notes can be shifted down in frequency by replacing C3 and C6 with 0.02μ F or 0.05μ F capacitors. The rate of the sawtooth can be increased by connecting another 150kΩ resistor in parallel with R1. The added resistor can be inserted in holes 4 and 14 of DeC1. The rate can be made variable by removing R1 and connecting a 1MΩ potentiometer and a series 56kΩ resistor in its place, as indicated in Fig. 2. The 56kΩ resistor ensures that the potentiometer cannot be adjusted to a low resistance setting which would cause the sawtooth generator to "stick", with both TR1 and TR2 conducting heavily.

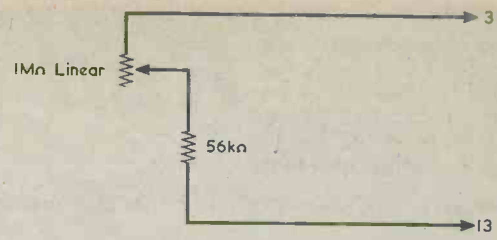


Fig. 2. A variable control of sawtooth frequency can be obtained by replacing R1 with a potentiometer and fixed resistor in series

COMPONENTS

Resistors
(All ¼ watt 5%)

R1 150kΩ	R7 4.7kΩ
R2 22kΩ	R8 56kΩ
R3 12kΩ	R9 56kΩ
R4 1.8kΩ	R10 1.8kΩ
R5 22kΩ	R11 1.8kΩ
R6 1.8kΩ	R12 56kΩ

Capacitors
C1 10μ F electrolytic, 16V Wkg.
C2 10μ F electrolytic, 16V Wkg.
C3 0.01μ F polyester or mylar
C4 0.01μ F polyester or mylar

Semiconductors
TR1 2N697 or 2N2219 or BFY50
TR2 2N2905
TR3-TR7 2N697 or 2N2219 or BFY50

Speaker
LS1 60Ω to 80Ω (see text)

Miscellaneous
2-off S-DeC
6V battery

CONSTRUCTION

Start construction by clipping two S-DeCs together to form one long DeC. Connect the loudspeaker leads using single-core wire. If stranded wire must be used twist and tin the ends to ensure that there are no loose strands. Plug in the wire links, seven in all, and also the two resistors, R8 and R9, which link the two DeCs together. Next plug in the capacitors, remembering that C1 and C2 are electrolytic and must be connected with correct polarity. The transistors can now be plugged into circuit. TR2 is a p.n.p. type, but its lead-out layout is the same as the other transistors. The assembly of the astable follows the "mirror-image" style, with both emitters connected to the central line of the DeC. Finally, plug in all the remaining resistors.

Add the 6 volt battery leads and prepare to unleash the siren-sound on an unsuspecting world.

■

Radio Topics

By Recorder

HIGH VALUE RESISTORS

Most of us look upon 10MΩ as being the highest value of resistor we're liable to use but, of course, there are applications where much higher resistance values are required. These can be met by a new range of metal glaze resistors announced by SASCO, P.O. Box 2000, Crawley, Sussex, RH10 2RU.

The resistors form the Mullard VR37 Series, and their values range from 1MΩ to 33MΩ. They are designed for applications where high resistance values, high stability and reliability are required. They are also suitable for voltages up to 2.5kV r.m.s.

In their manufacture, a metal glaze is first of all deposited on a high grade ceramic body, the ends of which are then fitted with metal caps to which are welded solder-coated electrolytic copper leads. The required resistance value is obtained by cutting a helical track through the metal glaze. The resistors are protected by multiple coats of a light-blue insulating lacquer, and are colour coded according to E24 preferred values.

Resistance tolerance is 5%, and temperature coefficient of resistance is plus or minus 200 parts per million per degree Centigrade. Maximum power dissipation at an ambient temperature of 70 degrees Centigrade is 0.5 watt and stability is typically within 0.5% over 1,000 hours' operation at 0.5 watt dissipation.

Framing the numeric display at the upper left edge of the panel is the new Vero rectangular display bezel. Simple to fit in place, the bezel not only covers unsightly tool marks but also gives an attractive frame and highlights the display

DISPLAY BEZEL

The above photograph illustrates a moulded display bezel, specifically intended for covering unsightly panel cut-out tool marks, which can now be obtained from Vero Electronics Limited. It is available in two sizes and provides an attractive frame as well as highlighting the display behind it. A choice of lenses is offered, these being neutral, red and clear, polarised or non-polarised. There is also a full range of compatible mounting boards for both l.e.d. and l.c.d. displays.

The bezel is designed to fit into a single rectangular cut-out. It is positioned in this cut-out by four removable location pegs and is then firmly secured by two moulded-in threaded studs which also hold the display mounting board. Spacers to pass over the studs are provided.

Further details are available from Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire, SO5 3ZR. Enquiries should refer to the "Display Bezel AB 064".

PETSOFT PROGRAM PACKS

If you want to pamper your Commodore Pet personal computer, Applied Computer Techniques have available a catalogue listing nearly 100 programs as well as Pet Workbooks.

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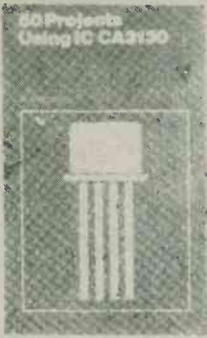

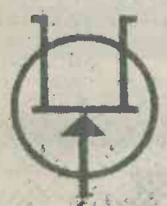

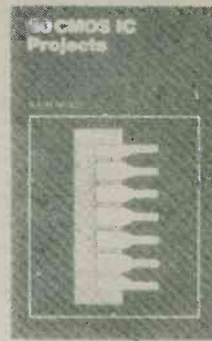

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(Continued on page 771)

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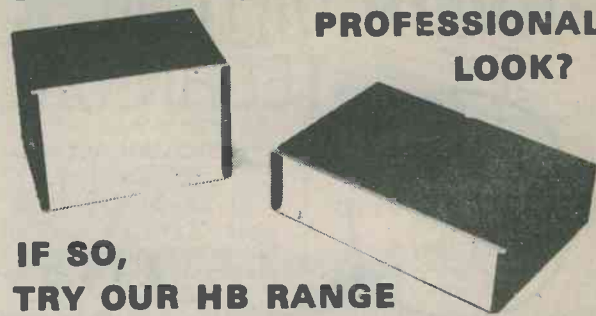

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(Continued on page 772)

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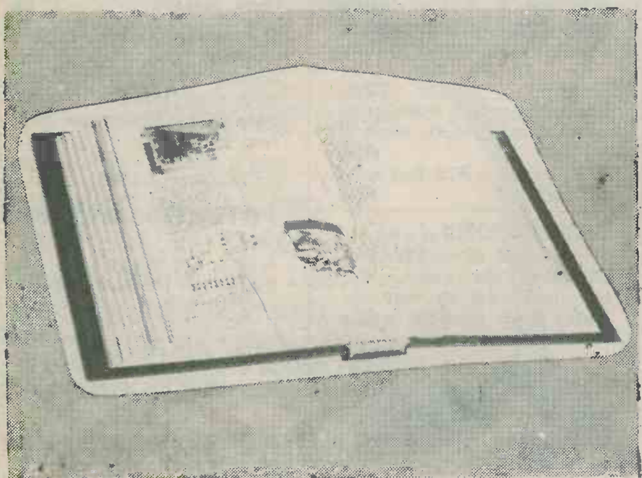

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INDEX TO VOLUME THIRTY-TWO
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BOOTSTRAPPING

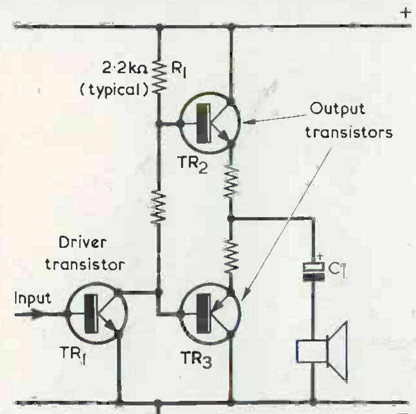
A typical emitter follower audio output stage is shown in (a). In series with the output emitters are two low value resistors which prevent thermal runaway. A further low value resistor (or resistive device) between the output bases prevents crossover distortion. All three resistors may be ignored in the present discussion.

The output emitters normally sit at half supply voltage. R1 is TR1 collector load resistor. When an input signal causes TR1 collector to go negative, so also does the base, and consequently the emitter, of TR3. When TR1 collector goes positive so, similarly, does the emitter of TR2.

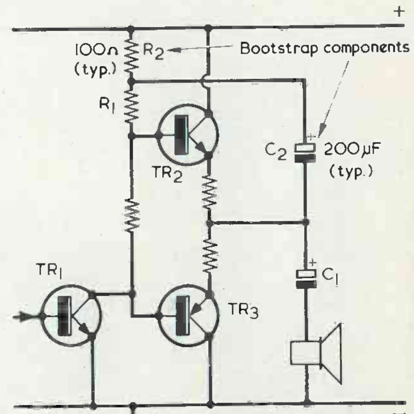
As TR1 collector goes more and more positive the voltage across R1 reduces until a level is reached where the current this resistor passes to the base of TR2 is insufficient to drive the speaker. This constrains the maximum positive excursion of TR1 collector before the onset of distortion.

Bootstrap components C2 and R2 are added in (b). C2 causes the upper end of R1 to "follow" the audio output signal so that, if TR1 collector and TR2 emitter go highly positive so also does the upper end of R1. Ample current is now available for TR2 base and the only limit to positive excursion at TR1 collector is the positive supply rail. Since the voltage across R1 remains virtually unaltered at audio frequencies the resistor offers a very high a.f. resistance and consumes negligible a.f. power, causing the circuit to be more efficient.

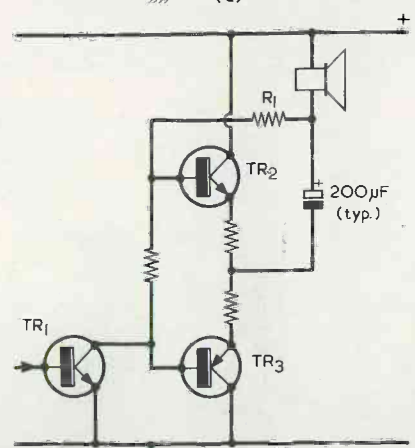
A neat version of the bootstrap circuit which saves a capacitor and a resistor is shown in (c). If the upper supply rail is negative all polarities are reversed, as in (d).



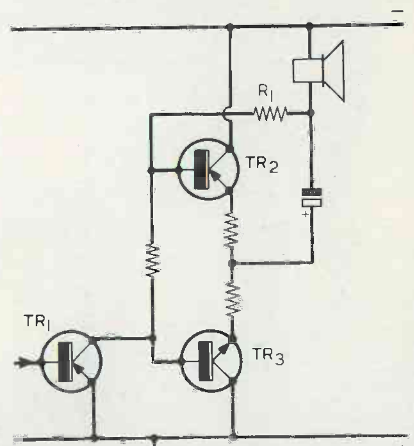
(a)



(b)



(c)



(d)

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