ANDREWS

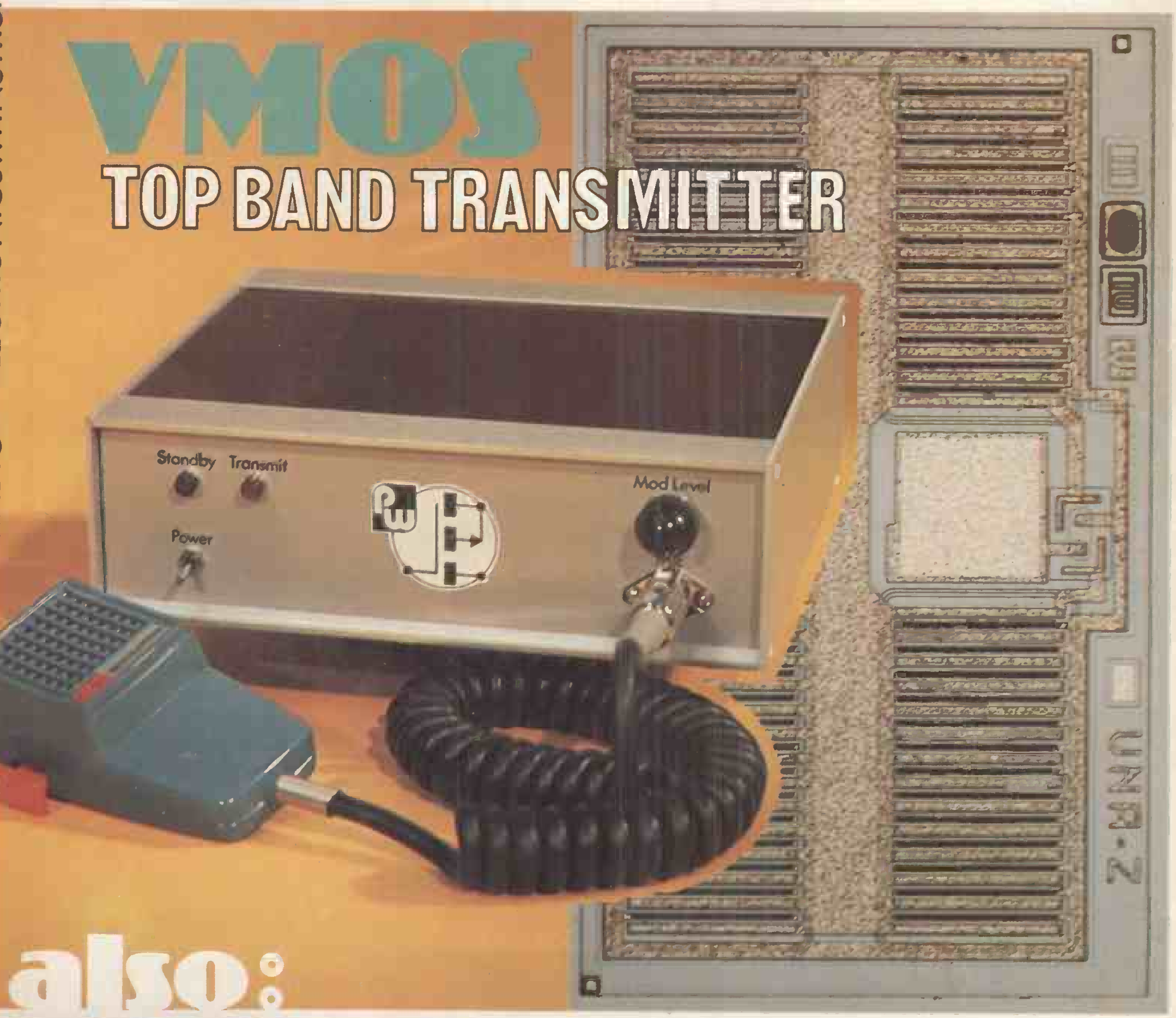
practical WIRELESS

50p

Australia	95c
New Zealand	95c
South Africa	90c
Malaysia	$2.75

JULY 1979

VMOS TOP BAND TRANSMITTER



also:

AM/FM FREQUENCY READOUT

&

THE YAESU FRG~7 RECEIVER REVIEWED

TTL ★ ★

7400	10p
7401	10p
7402	10p
7403	10p
7404	12p
7405	12p
7406	25p
7407	25p
7408	12p
7409	12p
7410	12p
7411	15p
7412	15p
7413	25p
7414	45p
7416	25p
7417	25p
7420	12p
7421	20p
7422	15p
7423	20p
7425	20p
7426	22p
7427	22p
7428	25p
7430	12p
7432	20p
7433	28p
7437	20p
7438	20p
7440	12p
7441	45p
7442	40p
7443	60p
7444	60p
7445	65p
7446	50p
7447	50p
7448	50p
7450	12p
7451	12p
7453	12p
7454	12p
7460	12p
7470	25p
7472	20p
7473	25p
7474	25p
7475	25p
7476	25p
7480	40p
7481	85p
7482	75p
7483	75p
7484	70p
7485	60p
7486	25p
7489	130p
7490	25p
7491	40p
7492	35p
7493	30p
7494	70p
7495	45p
7496	45p
7497	120p
74100	80p
74104	40p
74105	40p
74107	25p
74108	100p

74109	25p
74118	75p
74120	80p
74121	25p
74122	35p
74123	40p
74125	35p
74126	35p
74128	60p
74130	120p
74131	90p
74132	45p
74135	90p
74136	80p
74137	90p
74138	100p
74141	50p
74142	180p
74143	270p
74144	270p
74145	55p
74147	100p
74148	90p
74150	65p
74151	45p
74153	45p
74154	70p
74155	45p
74156	45p
74157	45p
74160	55p
74161	55p
74162	55p
74163	55p
74164	60p
74165	60p
74166	75p
74167	160p
74170	100p
74173	80p
74174	60p
74175	60p
74176	50p
74177	50p
74178	75p
74179	120p
74180	90p
74181	130p
74182	50p
74184	120p
74185	100p
74188	320p
74190	70p
74191	70p
74192	60p
74193	60p
74194	55p
74195	50p
74196	50p
74197	50p
74198	100p
74199	100p
74293	90p
7LS00	18p
74S112	80p

7805	100p
7812	100p
7815	100p
7818	100p
7824	100p

POWER SUPPLY CAPACITORS

2200/16	35p	4700/63	120p
2200/63	80p	4700/70	135p
2200/100	150p	10000/10	100p
3300/30	50p	10000/25	150p
3300/63	90p	15000/15	150p
4700/25	50p	22000/25	200p
4700/40	65p		

ENQUIRIES FOR ANY OTHER TYPES

CMOS

4000	12p	4047	80p
4001	12p	4048	50p
4002	12p	4049	25p
4006	80p	4050	25p
4007	14p	4054	100p
4009	30p	4055	130p
4011	12p	4056	120p
4012	12p	4060	100p
4013	30p	4066	35p
4015	50p	4069	12p
4016	30p	4070	12p
4017	50p	4071	12p
4018	55p	4072	12p
4019	40p	4081	12p
4020	50p	4082	12p
4022	50p	4093	70p
4023	12p	4510	60p
4024	40p	4511	70p
4025	12p	4516	65p
4026	80p	4518	65p
4027	30p	4520	65p
4028	45p	4528	80p
4029	50p	4583	70p
4030	30p		
4032	80p		
4033	100p		
4040	60p		
4043	60p		
4046	90p		

★ ★ ★ ★ ★

FX1593 FERRITE RINGS
O/D 12mm, I/D 6mm
10 for 70p

TOGGLE SWITCHES SUB MIN
Single Pole C.D. 65p
Single Pole C.O. Biased 85p

RESISTORS 1/3RDW
100 of 1 type £1·00p E12 only

LINEAR

AY38500	450p	NE556	90p
CA3039	70p	NE562B	400p
CA3046	60p	SAD1024	1500p
CA3060	225p	SL917B	650p
CA3065	200p	SN76003N	150p
CA3076	250p	SN76013N	110p
CA3080	75p	SN76013ND	125p
CA3084	250p	SN76023N	110p
CA3085	85p	SN76023ND	125p
CA3086	60p	SN76033N	150p
CA3088	190p	SN76227N	160p
CA3089	160p	SN766228N	180p
CA3090AQ	360p	SN7666DN	75p
CA3123E	130p	TAA300	100p
CA3130	100p	TAA350	190p
CA3140	60p	TAA550	35p
LF356	80p	TAA570	220p
LF357	80p	TAA661B	140p
LM211H	250p	TAA700	350p
LM300TR5	170p	TAA790	350p
LM301AN	30p	TAD100	150p
LM304	200p	TAD110	130p
LM307N	65p	TBA120S	60p
LM308TO5	100p	TBA120T	85p
LM308DIL	100p	TBA480Q	200p
LM309K	100p	TBA520Q	200p
LM310TO5	150p	TBA530Q	200p
LM311TO5	150p	TBA540	200p
LM317K	325p	TBA550Q	250p
LM324	70p	TBA560C	250p
LM339	60p	TBA641A12	250p
LM348N	90p		
LM380	60p	TBA700	180p
LM381N	90p	TBA720Q	225p
LM382	90p	TBA750Q	200p
LM391	180p	TBA800	80p
LM555	25p	TBA810	100p
LM709C	40p	TBA820	100p
LM710TO5	69p	TBA920Q	280p
LM710DIL	65p	TCA270Q	220p
LM723TO5	40p	TCA270S	220p
LM723DIL	40p	TCA760	300p
LM733	120p	TCA4500A	450p
LM741	20p	TDA1008	300p
LM748	40p	TDA1034	450p
LM1303N	100p	TDA2002	300p
LM1458	100p	TDA2020	300p
LM3080	75p	TL084	120p
LM3900	55p	XR320	250p
LM3909N	65p	XR2206	450p
MC1310P	140p	XR2207	450p
MC1312P	150p	XR2208	600p
MC1314P	190p	XR2216	650p
MC1315P	230p	XR2567	250p
MK50398	650p	XR4136	150p
MM5314	380p	XR4202	150p
MM5316	480p	XR4212	150p
NE529K	150p	XR4739	150p
NE555	25p	ZN414	100p
		95H90	700p

ELEC CAPACITORS

0·47/25	7p	47/10	8p
1/16	7p	47/16	8p
1/25	7p	47/25	8p
1/50	7p	47/35	8p
2·2/25	7p	47/50	9p
2·2/35	7p	100/10	8p
3·3/25	7p	100/16	8p
4·7/10	7p	100/25	8p
4·7/16	7p	100/50	8p
4·7/25	7p	100/63	16p
4·7/50	7p	220/16	12p
6·8/25	7p	220/25	14p
10/10	7p	220/50	22p
10/16	7p	330/25	17p
10/25	7p	330/35	18p
10/50	7p	330/50	20p
22/6V3	7p	470/10	14p
22/10	7p	470/25	19p
22/16	7p	470/35	20p
22/25	7p	470/50	24p
22/35	7p	1000/16	27p
22/50	8p	1000/25	30p
33/6V3	7p	1000/35	35p
33/16	8p	1000/40	40p
33/25	8p	1000/63	50p
33/40	8p	1200/63	60p
33/50	9p	2200/10	30p

POLY CAPS

1000 PF	5p	0·1 uF	6p
2200	5p	0·22 uF	7p
3300	5p	0·33 uF	9p
4700	5p	0·47 uF	12p
6800	5p	1·0 uF	20p
0·01 uF	5p	2·2 uF	25p
0·022 uF	5p	4·7 uF	35p
0·033 uF	5p	6·8 uF	40p
0·047 uF	5p	10 uF	60p

TANT. BEADS

0·1/35V	14p	3·3/16V	14p
0·15/35V	14p	4·7/16V	14p
0·22/35V	14p	4·7/25V	14p
0·33/35V	14p	4·7/35V	14p
0·47/10V	14p	6·8/6V3	14p
0·47/35V	14p	6·8/35V	14p
0·68/35V	14p	1·0/35V	14p
1·00/10V	14p	22/15V	21p
1·00/35V	14p	33/16	25p
1·5/35V	14p	47/3V	20p
2·2/25V	14p	47/16V	25p
2·2/35V	14p	100/3V	25p

★ SPECIAL OFFER ★

2000uF 35v 40p 100/£30

REED INSERTS One Price
26MM Long 10 for
50MM Long £1·00p

TRANSISTORS

AA113	10p
AA217	30p
AC121	30p
AC126	20p
AC127	20p
AC127/01	25p
AC128	20p
AC151	25p
AC153	30p
AC153K	40p
AC154	30p
AC187	20p
AC188	20p
ACY17	35p
ACY19	35p
ACY20	35p
ACY22	40p
ACY40	50p
ACY41	50p
ACY42	50p
AD130	150p
AD143	150p
AD149	80p
AD161	30p
AD162	30p
AD161/2MP	70p
AF114	25p
AF115	25p
AF116	25p
AF118	80p
AF178	95p
AF139	35p
AF239	45p
AF279	50p
AU110	180p
BA114	12p
BA121	12p
BA154	12p
BA157	15p
BA173	15p
BAX13	5p
BAX16	5p
BAW21	20p
BB105	35p
BB110	35p
BC107	10p
BC108	10p
BC108C	15p
BC109	10p
BC109C	15p
BC113	12p
BC114	15p
BC115	15p
BC116	15p
BC117	18p
BC118	12p
BC119	25p
BC125	16p
BC125B	20p
BC126	20p
BC134	15p
BC136	16p
BC137	16p
BC138	30p
BC140	30p
BC141	30p
BC142	30p
BC143	30p
BC147	10p
BC148	10p
BC148C	14p
BC149	10p
BC153	16p
BC154	18p
BC157	10p
BC158	10p
BC159	10p
BC167A	12p
BC168	14p
BC169	15p

BC171	12p
BC172	12p
BC177	15p
BC178	15p
BC182	10p
BC182L	12p
BC183	10p
BC183L	12p
BC184	10p
BC184L	12p
BC186	20p
BC204	12p
BC205	12p
BC207	12p
BC212	11p
BC212L	12p
BC213	12p
BC213L	15p
BC214	15p
BC214L	18p
BC237	10p
BC237B	15p
BC268	16p
BC294	30p
BC300	25p
BC301	25p
BC303	30p
BC307	15p
BC308	15p
BC317	12p
BC318	12p
BC323	30p
BC328	18p
BC337	20p
BC338	18p
BC348	20p
BC461	35p
BC516	35p
BC517	35p
BC547	12p
BC547B	13p
BC548	12p
BC548C	14p
BC549B	13p
BC549C	14p
BC557	13p
BC557B	15p
BCY34	80p
BCY38	100p
BCY42	25p
BCY43	25p
BCY58	18p
BCY59	25p
BCY70	15p
BCY71	20p
BCY72	15p
BD115	45p
BD121	85p
BD131	35p
BD132	35p
BD133	45p
BD135	35p
BD136	35p
BD137	40p
BD139	40p
BD140	40p
BD144	160p
BD181	100p
BD182	100p
BD188	130p
BD207	70p
BD220	65p
BD222	65p
BD233	50p
BD238	50p
BD252	50p
BD263	65p
BD607	80p
BD608	80p
BD609	80p
BD610	80p
BDX32	200p

BDX42	50p
BDY10	100p
BF115	20p
BF120	50p
BF121	45p
BF123	45p
BF125	45p
BF127	50p
BF137	35p
BF154	18p
BF160	18p
BF161	18p
BF173	20p
BF178	25p
BF179	25p
BF180	30p
BF181	30p
BF182	30p
BF183	25p
BF184	20p
BF186	25p
BF194	10p
BF195	10p
BF196	10p
BF197	10p
BF198	25p
BF199	25p
BF200	30p
BF224	20p
BF225	20p
BF241	16p
BF244B	35p
BF255	25p
BF257	25p
BF258	25p
BF259	25p
BF271	25p
BF274	30p
BF324	30p
BF336	35p
BF337	35p
BF451	25p
BF367	20p
BF394	35p
BF458	50p
BF594	50p
BF596	50p
BF597	50p
BFR40	30p
BFR80	30p
BFW58	20p
BFW60	25p
BFW88	30p
BFW89	30p
BFW91	30p
BFX29	25p
BFX34	25p
BFX38	25p
BFX44	35p
BFX48	45p
BFX81	100p
BFX85	30p
BFX87	25p
BFX88	25p
BFY10	30p
BFY18	100p
BFY19	100p
BFY50	20p
BFY51	20p
BFY52	20p
BFY53	25p
BFY90	125p
BR101	35p
BRY39	35p
BRY56	35p
BSX20	20p
BSY40	25p
BSY95	20p
BT100A	80p
BU105	200p
BU133	180p

BU208	220p
BY100	25p
BY126	15p
BY127	15p
BY133	25p
BY164	50p
BYX94	8p
C1120	30p
C1164	20p
E100	42p
E300	47p
E310	60p
E420	180p
E430	120p
MJE340	45p
MPSA05	30p
MPSA06	32p
MPSA56	32p
TIP29	35p
TIP29A	40p
TIP29C	40p
TIP30	35p
TIP30A	40p
TIP30B	40p
TIP30C	45p
TIP31	40p
TIP31A	45p
TIP31B	50p
TIP31C	55p
TIP32	40p
TIP33	60p
TIP34	70p
TIP35	200p
TIP35C	225p
TIP41A	70p
TIP41B	75p
TIP41C	80p
TIP42A	80p
TIP42B	85p
TIP42C	90p
TIP2955	70p
TIP3055	50p
TIS90	25p
TIS91	25p
IN914	5p
IN3754	20p
IN4001	5p
IN4002	5p
IN4003	5p
IN4004	5p
IN4005	5p
IN4006	6p
IN4007	7p
IN4148	4p
2N456A	90p
2N929	20p
2N930	20p
2N1302	25p
2N1303	30p
2N1305	30p
2N1306	38p
2N1308	50p
2N1711	22p
2N2219A	25p
2N2483	30p
2N2906	16p
2N2907	20p
2N3053	20p
2N3054	50p
2N3055	60p
2N3702	11p
2N3703	12p
2N3704	12p
2N3705	12p
2N3706	12p
2N3708	12p
2N3715	300p
2N3819	25p
2N3866	95p
2N3904	15p
2N6027	50p
2SD234	50p
2N5777	60p

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★ ★
IN4148 DIODES BY ITT/TEXAS
100 for £1·50. Please note, these are full spec devices.

Texas TIS 88A V.H.F.
F.E.T. 10 for £2·30
100 for £20·00
555 TIMER
10 for £2·50
741 O.P. Amp ★
10 for £2·00

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LP1152	100p
LP1153	400p
LP1165	400p
LP1166	400p
LP1168	400p
LP1169	400p
LP1173	400p
LP1181	400p
LP1400	400p
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High quality Trimmer Caps
Min-Max
2·5pF–6pF All
3·5pF–13pF one
7·0pF–35pF price ★

FERRITE BEADS
6MM long OD
3MM ID 1MM
3p each 100 for £2·00

POTENTIOMETERS

1K LIN	5K LOG
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10K LIN	25K LOG
25K LIN	50K LOG
50K LIN	100K LOG
100K LIN	250K LOG
250K LIN	500K LOG
500K LIN	1M LOG
1M LIN	2M LOG

2M LIN **All at 30p Each**

GANGED POTS
5K+5K LIN or LOG
10K+10K LIN or LOG
25K+25K LIN or LOG
50K+50K LIN or LOG
100K+100K LIN or LOG
250K+250K LIN or LOG
500K+500K LIN or LOG
1M+1M LIN or LOG
2M+2M LIN or LOG
All at 80p Each.

DIL SOCKETS

8 PIN	13p
14 PIN	14p
16 PIN	15p

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BC237 100/ £5·00
BF257 100/ £12·00

BC147
BC148
BC149
BC157 100
BC158 Assor-
BC159 ted
BF194 £6·50p
BF195
BF196
BF197

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5853S	75p
B5092	125p
CD43	125p
CV4523	100p
GN4A	125p
GN9A	125p
VX918t	70p
XC25	50p
XE3P	70p
XFW47	50p
XFW50	50p
XNP12	125p
XNP28	125p

MURATA ULTRASONIC TRANSDUCERS 40kHz

Type MA40 LIS Transmit. Type MA40 LIR Receive. £2·00 each, £3·50 pair. Data 10p.

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1 POLE 12 WAY. 2 POLE 6 WAY. 3 POLE 4 WAY. 4 POLE 3 WAY. All at 40p Each.

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SPECIAL SCOOP OFFER
0·125 or 0·2 inch RED LEDS 15p each. 10 for £1·00, 100 for £7·50, 1000 for £60·00.
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FND500 Seven Segment Common Cathode Displays. Character Height 0·5" £1·30 each. 4 for £5·00.
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DECODER BOARD CONTAINING

18 × 74156 2 × 74155 2 × 7409
1 × 74180 1 × 74150 1 × TIP32
2 × 60 WAY
EDGE CONNECTORS
Few only left of this unrepeatable bargain £3·50 each

XTAL MIC Inserts 75p each.
5" Scopetubes SE5J (for callers only) £15·00 each.
Bias Rejector coils 50-100KHZ 65p each

1MHz Crystals £3·00
Push to Make Switches 20p each.
Chokes 10uH 35p each
100uH 65p each
Futaba 5LT02 Non-Multiplexed 4 Digit Phosphor Diode Display With A.M./P.M./Colon £5·00

PRE SET POTS
100mw Horiz/Vertical 50R-IM Ohm 8p Each

MULLARD POT. CORES
LA3 100-500KHZ 75p
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LA5 30-100KHZ 100p
LA7 <10KHZ 100p
LA13 200p

BZY88 ZENER DIODES
400mw
OV7-33V 10p each

BRIDGE RECTIFIERS

1 AMP 50V	30p
1 AMP 100V	30p
1 AMP 200V	35p
1 AMP 400V	35p
1 AMP 600V	40p
1 AMP 1000V	55p
2 AMP 50V	40p
2 AMP 100V	50p
2 AMP 200V	55p

R.C.A. TRIACS
400V 8 AMP £1·20
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2102 250 Nano-Sec Static RAM (1024 x 1 BIT) £2·20 each
4 for £8·40
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2112 450 Nano-Sec Static RAM (256 x 4 BIT) £2·50 each ★
2513 Character Generator. Upper Case £7·00 each ★
2513 Character Generator lower case £7·00 each ★
MM5204 E. Rom £8·00 each ★
8212 8 Bit In/out Port £3·00 each ★
8080 AN MPU (CPU) £12·00 each ★
8831 TriState Line Driver £2·00 each
8833 Tri State Trans Transceiver £2·00 each
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AY5-1013 U/ART £6·00

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LONDON N1 01-226 1489

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SAT 9 - 4.30pm
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WIRELESS
BRITAINS LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

JULY 1979
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NUMBER 7
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QUERIES
While we will always try to assist readers in difficulties with a *Practical Wireless* project, we cannot offer advice on modifications to our designs, nor on commercial radio, TV or electronic equipment. Please address your letters to the Editor, Practical Wireless, at the above address, giving a clear description of the problem and enclosing a stamped self-addressed envelope. Only one project per letter please.

Components are usually available from advertisers. A source will be suggested for difficult items.

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Binders are available (Price £2·85 to UK addresses or £3·45 overseas, including post and packing) each accommodating one volume of *PW*. Please state year and volume number for which the binder is required.

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We regret that Part 2 of the PW "Trent" has had to be held over, due to production difficulties

OUR COVER
The object looking rather like a ventilation grille is in fact a much-enlarged view of the "works" of a power f.e.t. Photograph courtesy Siliconix Ltd.

Our August issue will be published on 6 July
(for details see page 43)

NEWS... NEWS... NEWS...

Marshall's Bristol move

Subsequent to the recent publishing of Marshall's 1979 product range catalogue their Bristol retail shop has moved.

From 24 April 1979, the new shop will be in larger premises at 108A Stoke's Croft, Bristol. This new location is approximately 5 minutes walk from the main shopping centre of Bristol.

At the same time they announce that they have been appointed sole specialist distributors to the constructor market for the new Mullard 'Teletext' chips—SAA 5000, 5010, 5012, 5020, 5030, 5040 and 5050. These will be available shortly.

Further information from: *Mardata, Kingsgate House, Kingsgate Place, London NW6 4TA. Tel: 01-624 0805.*

Conferences

An IERE/RSGB colloquium is to be held on Tuesday, 5 June 1979 starting at 2 pm at The Royal Institution, Albemarle Street, London W1.

The subject for discussion will be amateur work on microwave propogation and techniques over the last five years, which have made the professionals look hard.

There has been some fascinating work, particularly in the UK, e.g. "s.s.b. at 10GHz" and the colloquium will describe these great developments which are currently going on.

Further details from: *The Conference Secretariat, IERE, 99 Gower Street, London WC1. Tel: 01-388 3071.*

The programme for the Consumer Electronics Symposium, announced by the Society of Electronic and Radio Technicians (SERT) last autumn, has now been finalised, and is to be held at the University of Essex between 8 and 10 July 1979.

Copies of the programme/registration form are being widely distributed and applications from nearly 100 potential delegates have already been received.

As can be seen from the programme, there is a wide representation of authors from industry, broadcasting authorities and servicing organisations who are providing an extremely varied programme of lectures and discussion covering all aspects of electronics in the consumer field.

Further details from: *SERT, Faraday House, 8–10 Charing Cross Road, London WC2H 0HP. Tel: 01-240 1152.*

Club News

The North England Radio Club has a national and European membership, with the heart of the club on Merseyside.

They publish a monthly magazine called 'Spectrum' and meet monthly, usually at The Sports Centre, Grange Road West, Birkenhead.

New members from anywhere in the world would be very welcome. A copy of 'Spectrum' and club information may be obtained for two 9½p stamps, in the UK, or two IRC's from abroad.

The man to contact is: *Norman Monti, 66 Chesnut Grove, Birkenhead, Merseyside L42 0MZ.*

TI 9900 data book

A self-teaching microprocessor design manual—written for beginners and experts alike—is now available from Texas Instruments.

The soft-cover "9900 Family Systems Design and Data Book", will offer in more than 1000 pages a comprehensive selection of educational and applications information that can help users develop a deeper understanding of the complex technology and tremendous potential available in microprocessors.

Combining hardware and software information, the data book should assist both the engineer doing advanced m.p.u. design work and "interested" people who simply want to know more about the subject. It is a complete reference book containing the basic knowledge and data a novice might need to become better acquainted with m.p.u.s—and it carries that knowledge through into complete technical and systems design data needed to use TI's 9900 family of 16-bit microprocessor and microcomputer circuit boards.

The "9900 Family Systems Design and Data Book" costs £8.00 plus P&P, and is available from: *The Modern Book Co., 19–21 Praed Street, London.*

SERT

The Society of Electronics and Radio Technicians is pleased to announce that Mr T. Bryce McCrirrick has become a Vice-President of the Society.

Mr McCrirrick has recently been appointed Director of Engineering to the British Broadcasting Corporation in succession to Sir James Redmond.

The current President of SERT is Air Vice Marshal Alec Morris and the other Vice-Presidents are Mr Michael Clark (Deputy Group Chairman of the Plessey Company) and Sir Edward Fennessey.

Rally Dates

The Royal Naval Amateur Radio Society's Mobile Rally, will take place at HMS Mercury, Petersfield, Hampshire, on Sunday, 17 June 1979. It will be open to the general public between 1000 and 1700 hours.

The rally is intended as an outing for the whole family, with stands, arena events and displays of interest to all ages. There will also be the usual trade stands.

Further details from: *Wally Walker G4DIU, 9 Woodstock Road, Bedhampton, Havant, Hants PO9 3HX.*

The "East Suffolk Wireless Revival" Amateur Radio Mobile Rally will take place on Sunday, 3 June, 1979, at the I.A.C.S.S.A. Sports ground, Bucklesham, near Ipswich. Commencing at 1100hrs and admission will be 40p, which includes a free raffle ticket.

In addition to talk-in stations on 2m, 70cm f.m. and 80m s.s.b., there will be trade stands, technical displays (featuring Prestel, RTTY and m.p.u.s), refreshments and a licensed bar.

Further details from: *C. P. Ranson G8LBS, 67 Tranmere Grove, Ipswich, Suffolk IP1 6DU.*

"Nunsfield House Community Association Amateur Radio Group" of Derby, hold their 10th Rally, at Elvaston Castle Country Park, on Sunday, 10 June 1979.

It is expected to be their largest rally yet, with over 50 trade stands, along with many other attractions of interest to all the family.

Talk-in stations will be available on callsign GB2ECR, on 2m f.m. Ch. 22, and 70cm f.m. Ch.s SU8, SU20.

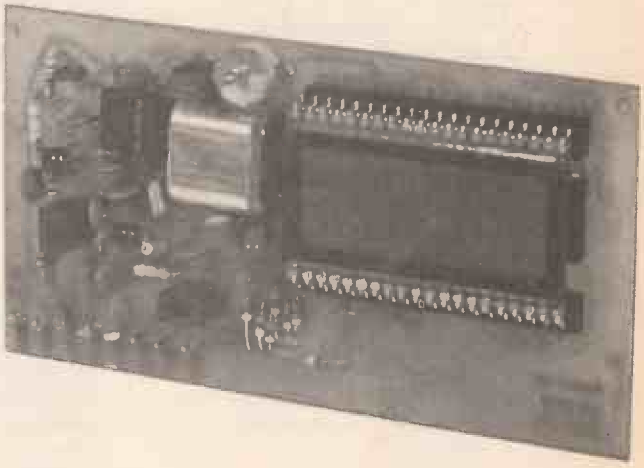
Further details from: *Chris Wallace G8PTW, QTHR. Tel: Derby 752358.*

"Bangor & District Amateur Radio Society" hold their mobile rally on 24 June 1979, at the Castlewellan Forest Park. There will be all the usual events including trade stands and a "bring and buy" stall.

Further details from: *W. H. Langtry GI4AMM, QTHR. Tel: Bangor 65394.*

a.m./f.m. Frequency readout

William POEL



If you can think of an application for an arrangement of c.m.o.s. logic with a potential sale of a million plus, then the chances are that some enterprising manufacturer of l.s.i. has got a dedicated chip either on the drawing board, or in the market place. The application described here is an ideal candidate, since it is yet another instance of age-old analogue technology being swept aside with digital technology. For a long time past, an accurate readout of a radio receiver's tuned frequency has only been available with large amounts of logic, and large amounts of patience to work out the various i.f. offset programming steps. Such systems have also cost considerably more than the best analogue arrangements, and have consequently been restricted to the very expensive exotica in both consumer and communications applications.

Just as Intersil have revolutionised the concept of the instrument type counter with their ICM7216, OKI Electric of Japan have introduced a family of c.m.o.s. for consumer and communications digital frequency readouts which render all other approaches now quite simply obsolete. For in a 40-pin l.s.i. the counter gives both a.m. and f.m. frequency readout, plus straight kHz frequency count (no offset); drives an l.c.d. directly with no r.f.i. to the radio in question and all this with a current consumption of 4mA with the prescaler off, or 15mA with it on. The unit described here is conceived and designed as a universal readout for long wave through medium wave to a maximum a.m. count of 2·999MHz, including the popular marine DF band where digital readout is almost essential for reasonable operation in congested waters. The f.m. range operates from about 20MHz to 200MHz (with SP8629 prescaler) with a resolution of 100kHz—e.g. a typical readout is 88·1MHz. In the direct mode, the display shows kHz from the a.m. input, and 100s of kHz from the prescaled input.

Purists will complain that 100kHz is insufficient for f.m. resolution—but the display flicker brought about by further resolution is very tedious, and the small number of stations not on 100kHz channels makes the exercise rather pointless for the nuisance involved. And not many f.m. receivers would show up too well from the point of view of oscillator drift.

The Circuit

The full circuit (Fig. 1) reveals a remarkably simple overall approach compared to previous endeavours to produce this type of unit. Nearly all functions are carried on within the MSM5526 i.c.—and the few remaining peripheral components are included as an extra for maximum flexibility. On f.m. the divide-by-100 prescaler is an obvious essential, but the input sensitivity of both the SP8629 and the MSM5526 is such that, if the unit is wired into many receivers directly, the pre-amps are not required. However, with these pre-amps using the high f_t BF274 type of transistor, typical sensitivities of 800µV on a.m. and 10–15mV on f.m. can be achieved—thus permitting connection of the digital display with the barest minimum of coupling. In the case of one portable radio tried by the author, it is sufficient simply to couple in via a single-ended wire loosely draped around the relevant oscillator section for either a.m. or f.m. So, even if your set doesn't possess specific local oscillator drive, a small piece of wire poked into the oscillator section will work in almost all applications.

The SP8629 has a very useful 6·3V Zener on-chip, permitting a simple but adequate 5·5V stabiliser stage to be built with an external pass transistor. The National Semiconductor equivalent DS8629 does not incorporate this facility, and a separate external Zener must be used. The stabiliser stage has an 82Ω resistor in the output—and this is the result of a mistake when assembling the prototype, since 8·2Ω should have been used. However, the whole circuit worked perfectly when switched on—and it was only when a check was made on the current drain, that this error was discovered, since the unit took a sur-

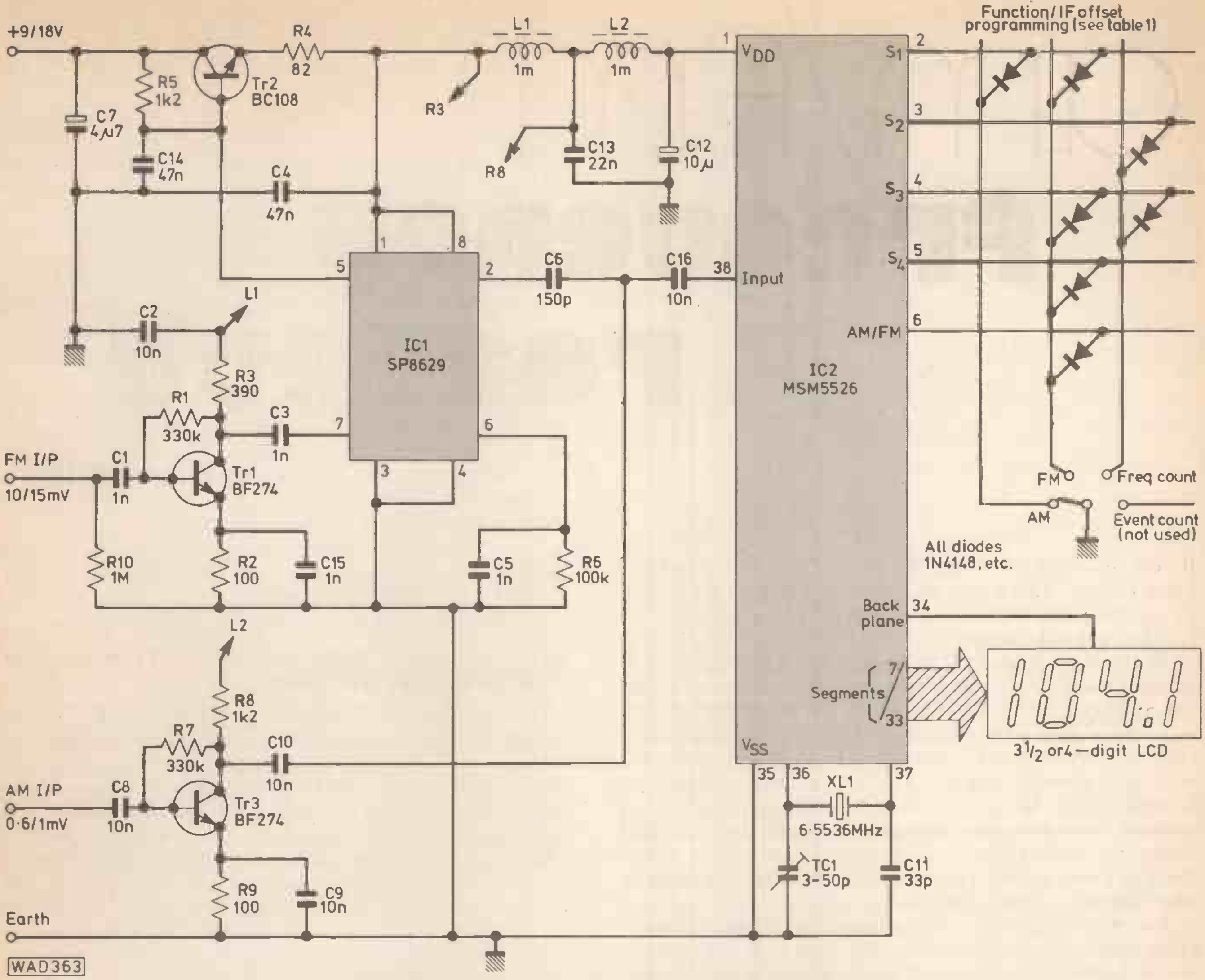


Fig. 1: Complete circuit diagram of the a.m./f.m. frequency readout based on the OKI MSM5526 i.c.

LCD 3½ Digit				LCD 4 Digit			
PIN		PIN		PIN		PIN	
1	Back Plane	40	Back Plane	1	Back Plane	40	Back Plane
2	– Bar	39	|Bar	2	nc	39	nc
3	b_4, c_4	38	Over Range	3	nc	38	nc
4	nc	37	nc	4	nc	37	g_4
5	nc	36	nc	5	e_4	36	f_4
6	nc	35	nc	6	d_4	35	a_4
7	nc	34	nc	7	c_4	34	b_4
8	DP3	33	nc	8	DP3	33	nc
9	e_3	32	g_3	9	e_3	32	g_3
10	d_3	31	f_3	10	d_3	31	f_3
11	c_3	30	a_3	11	c_3	30	a_3
12	DP2	29	b_3	12	DP2	29	b_3
13	e_2	28	DP4 (colon)	13	e_2	28	DP4 (colon)
14	d_2	27	g_2	14	d_2	27	g_2
15	c_2	26	f_2	15	c_2	26	f_2
16	DP1	25	a_2	16	DP1	25	a_2
17	e_1	24	b_2	17	e_1	24	b_2
18	d_1	23	g_1	18	d_1	23	g_1
19	c_1	22	f_1	19	c_1	22	f_1
20	b_1	21	a_1	20	b_1	21	a_1

Table 1

Display Select	Input conditions AM/FM	S1	S2	S3	S4	IF offset value
AM	H	H	H	H	X	−452·5kHz
	H	L	H	H	X	−454·5
	H	H	L	H	X	−456·5
	H	L	L	H	X	−465·5
	H	H	H	L	X	−467·5
	H	L	H	L	X	−469·5
FM	L	H	H	H	H	+10·68
	L	L	H	H	H	+10·71
	L	H	L	H	H	+10·75
	L	L	L	H	H	+10·79
	L	H	H	L	H	+10·82
	L	L	H	L	H	−10·58
	L	H	L	L	H	−10·60
	L	L	L	L	H	−10·61
	L	H	H	H	L	−10·62
	L	L	H	H	L	−10·63
	L	H	L	H	L	−10·65
	L	L	L	H	L	−10·66
	L	H	H	L	L	−10·69
	L	L	H	L	L	−10·70
	L	H	L	L	L	−10·72
	L	L	L	L	L	−10·73
direct	H	H	L	L	X	none
event counter	H	L	L	L	X	impulses

"H" = open (or Vdd)
"L" = ground (Vss)
"X" = either

prisingly low 15mA from a 9V source. The SP8629 is rated at a typical 30mA—so investigation with a voltmeter revealed that both prescaler and display i.c. were happily clocking away with only a 3·8V rail—as a result of the 82Ω mistake. A second unit was built with the same values, and worked just as well—and so it is assumed that most others will too—but if faulty counting is experienced, this 82Ω should be gradually reduced until the circuit settles.

The input to the counter i.c. is common for both a.m. and f.m. count, and the drives from the f.m. prescaler and a.m. pre-amp may be simply paralleled. The output of the SP8629 settles either high or low, depending where the last count cycle left it—and so whilst the outputs were originally paralleled via 10nF capacitors, the f.m. coupling capacitor has to be reduced to 150pF—otherwise the a.m. signal can easily be shunted through the prescaler output stage when it has settled to the low state. A value of 150pF is still quite enough to pass the very fast edges of the logic output of the prescaler, since counting of the l.s.i. occurs on edges, the actual waveform (which looks quite distorted) is immaterial.

The input to the 8629 must be disabled when reading a.m., and it is important to follow Plessey's application advice, and tie the unused differential input down via a 100kΩ resistor to ground, to prevent spurious oscillation occurring under no-input conditions.

The i.f. offsets are all pre-programmed via a diode matrix, set according to Table 1. Just about every standard offset is available, although occasional 500Hz compromises are called for, e.g. 454·5kHz not 455kHz. With an a.m. resolution of 1kHz, and an average i.f. filter tolerance of 1kHz, this sort of error is unlikely to be at all significant.

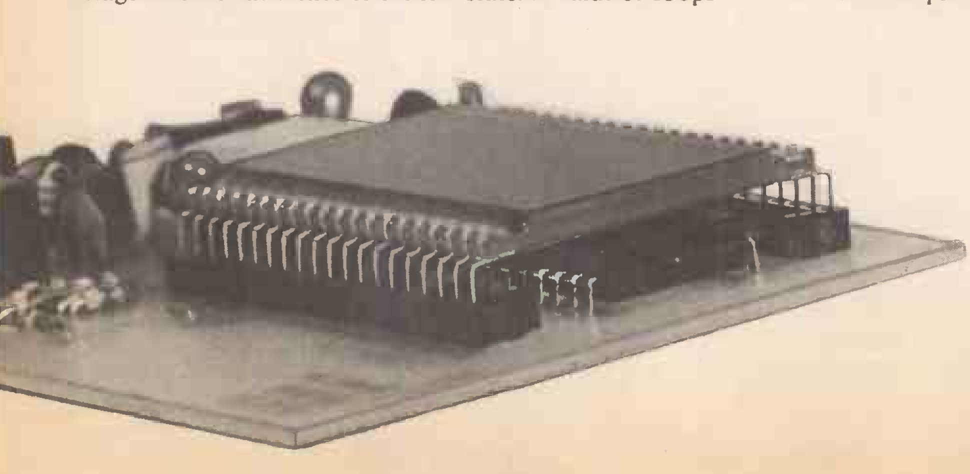
The functional setting is likewise matrix controlled, enabling selection via the simplest of all devices, a ground-to-operate switch. As well as the three modes available on this board, a straightforward event counter is also available for batch counting to a maximum of 2999 units, but this feature is not used in this instance.

Had this been a description of a "discrete" approach c.m.o.s. unit, the circuit description would have just about reached the oscillator stage, but instead, there is nothing more to say!

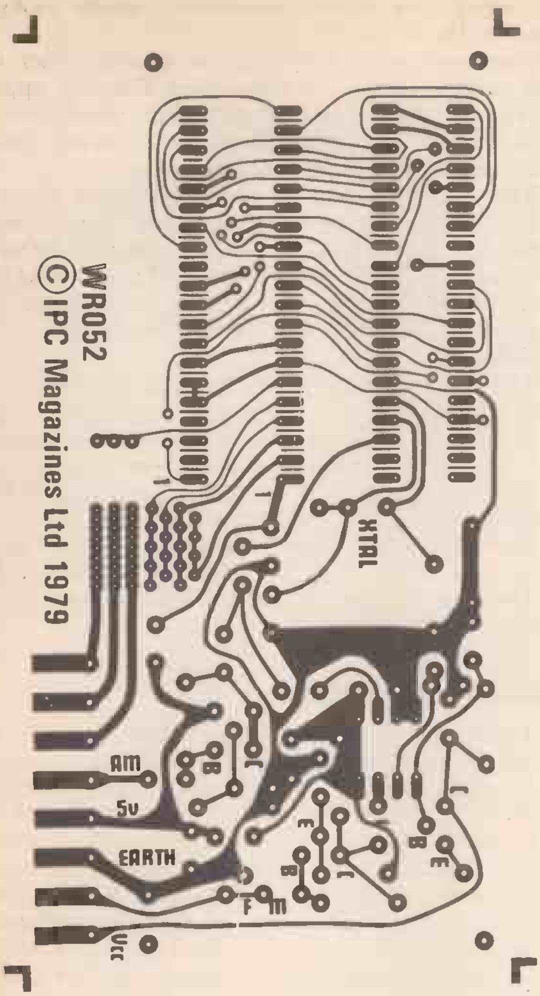
Construction method

The printed circuit board layout, Figs. 2 and 3, employs a useful technique when using direct drive to l.c.d.s from l.s.i., namely placing the i.c. under the display. This technique saves space—and cuts the only marginal area of possible interference (from the l.c.d. backplane strobe) to a bare minimum. Construction on anything but the properly made p.c.b. is not really feasible. Fixing holes for mounting are provided so that the unit may be fitted directly behind the receiver front panel. The c.m.o.s. MSM5526 is not a particularly fragile device, but the usual care should be taken when soldering, to avoid static damage, caused by poorly earthed soldering implements, or earth leakage currents. The p.c.b. is laid out for either HC13 or HC18 style crystals, and since 6·5536MHz is a standard binary frequency, the supply is not generally a problem.

Great care must be taken when mounting liquid crystal displays, since these are not only costly, but very fragile if pressure is applied unevenly. A socket must be used to raise the l.c.d. above the rest of the components, and either socket strip or a 40-pin d.i.l. socket cut in half is suitable for the purpose. Molex i.c. pins are not a good idea since in strips of 20, it is very difficult to accurately locate the pins of the display. The electrical contact is also somewhat more chancy at this sort of length, since a small displacement of one pin can cause a lot of trouble.



The MSM5526 is mounted directly on the board and the liquid crystal display is mounted over it, using i.c. sockets to space it from the p.c.b. (see text)



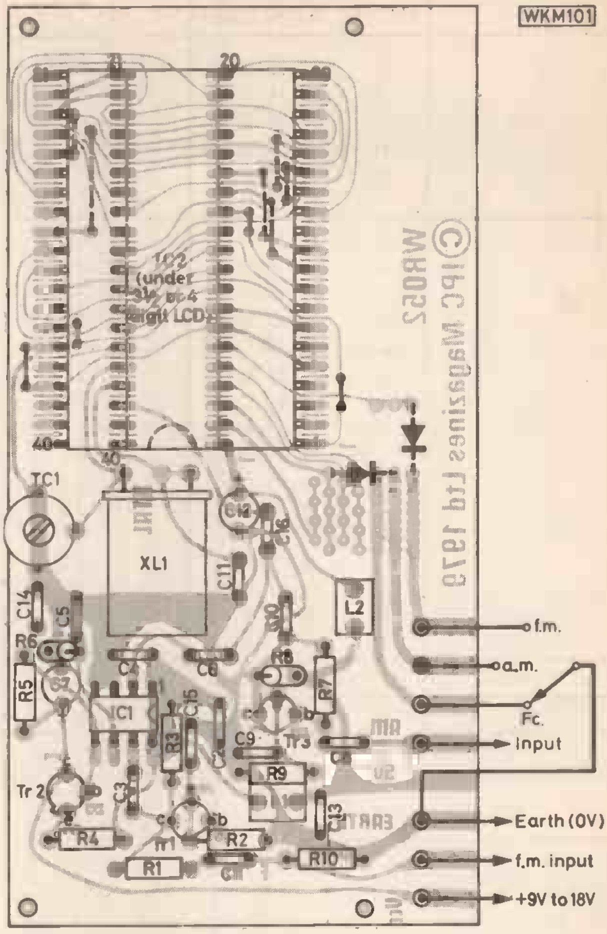
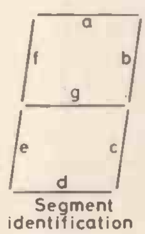
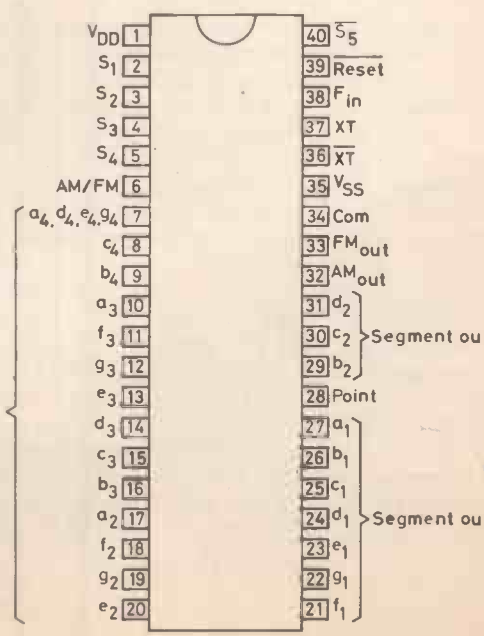


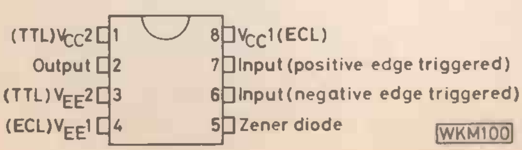
Fig. 2 (above): Full-size track layout of the p.c.b.

Fig. 3 (above right): Component layout and details of external connections to the p.c.b. The switch will normally be part of the wave-change switch of the associated receiver. When using a 3½-digit l.c.d., two "U"-links of insulated wire should be soldered to the track side of the p.c.b., linking pins 2 and 5/6, and pins 3 and 7 of the display

Fig. 4: Pin-outs of the SP8629 (below) and the MSM5526 (right)







★ components

Resistors
0·25W 5%

82Ω	1	R4
100Ω	2	R2, 9
390Ω	1	R3
1·2kΩ	2	R5, 8
100kΩ	1	R6
330kΩ	2	R1, 7
1MΩ	1	R10

Capacitors
Ceramic disc or plate (lead spacing 5mm max.)

33pF	1	C11
150pF	1	C6
1nF	4	C1, 3, 5, 15
10nF	4	C2, 8, 9, 10, 16
22nF	1	C13
47nF	2	C4, 14

Tantalum bead

4·7μF	1	C7
10μF	1	C12

Sub-min trimmer

3–50pF	1	TC1

Semiconductors
Transistors

BF274	2	Tr1, 3
BC108	1	Tr2

Diodes
1N4148 as required for programming (see Table 1)

Integrated circuits

MSM5526	1	IC2 (OKI Electric)*
SP8629	1	IC1

Inductors

1mH	2	L1, 2 (Toko 7BA 144LY–102)*

Miscellaneous
XL1 6·5536MHz Crystal, Style HC13 or HC18 wire-ended*
4-digit (or 3½-digit) liquid crystal display
Socket for l.c.d. (see text)
Printed circuit board Ref. WR052
Terminal pins (8 off)

*Available from Ambit International and Watford Electronics

Switch-on and test

Provided the components are located correctly, then there is nothing to go wrong apart from your soldering. Check the very fine tracks for splashes, and clean the board with flux remover if available. Using a current-limited power supply (for extra security), apply 5 volts at first, gradually turning up to 12V if the current drain is not excessive—indicating a short circuit somewhere. Switch to the desired input, and place a finger on the relevant pre-amp input, when some stray counting should occur from the pickup thus provided. Remember, this is very sensitive.

With a suitable radio to hand, place a pickup coil near the oscillator, and feed this to the counter input via r.f. coaxial cable. Something is almost certain to happen, and usually no more trouble than this is necessary. In fact, a single-ended pickup is frequently enough, though not suitable if more than 150mm long. If you don't know the exact i.f. offset, assume 10·7MHz high for f.m., and in the f.m. mode, tune to a station of known frequency. If the display reads incorrectly—say 89·2 instead of 89·1 with the tuning indicator zeroed—then the i.f. offset should be adjusted to 10·79MHZ (the closest to 10·8MHz available) by diode programming. Many of the finer variations of offset will not be apparent unless you have a very accurately calibrated signal source handy.

To set the internal clock accurately, switch to Direct Count and with a signal generator and reference counter, tune to 999kHz so that the generator output reads 999·4999kHz. Tuning to 999·501 should cause the counter to change over to 1000kHz, and the trimmer capacitor on the crystal input to the MSM5526 may then be adjusted to provide this threshold point. With the trimmer approx 30 per cent enmeshed, the whole unit is sufficiently accurate to be self calibrating anyway, so do not worry too much about these very fine adjustments if you cannot get access to appropriate equipment. Another way is simply to count the crystal oscillator frequency on a separate counter so that it is trimmed for exactly 6·5536MHz (take care not to load the crystal—try to use inductive coupling if possible).

To set the a.m. offset, tune to a known frequency with the offset pre-programmed for 469·5kHz (nearest available to 470kHz) for most UK- and European-made sets, and 455kHz for most Japanese sets, and check the error. Simple maths will tell you what to do—e.g. if the station is known to be on 910kHz, and the counter says 905 when the i.f. is set for 470kHz, then reprogramme the offset for 465·5 and all will be well.

Applications

Apart from new equipment, there is obviously a large retrofit application for improving existing equipment—since the accuracy of frequency display has let down many otherwise good designs. Varicap diode designs can occasionally put strains on analogue scale design, since the end-point capacitance can vary widely, although the diodes themselves remain well matched. This display takes away those problems, and does away with the last remaining mechanical headaches of the set designer.

One point which is very important about the MSM5526 is the fact the display is totally static. This means that there is no multiplexing interference—and the only potential source is in the shape of the backplane strobe, which is very, very low power for an l.c.d. Thus without screening, this device can readily be used without problems in any radio environment, from supplies ranging from 8V to 20V d.c. (thanks to the regulator on board). So next time the drive cord snaps, forget about a replacement and fit a digitally accurate alternative. ●

SPECIAL PRODUCT REPORT

CONTINENTAL SPECIALTIES CORPORATION

CSC

LOGIC PROBE KIT

If you are involved in digital electronics it is essential that you have some means of detecting pulses and logic states. Without this necessary equipment you will be totally in the dark when trying to find out why your latest creation does not work.

There are many logic probes on the market but for the amateur they tend to come a touch on the pricey side. Continental Specialties Corporation, who also make a range of logic probes, have recently introduced a kit for a probe which will detect and display logic levels, pulses and voltage transients.

The kit is complete down to the last piece of wire and even includes a length of solder. All the components appeared to be of good quality and fitted the holes drilled in the glass fibre printed circuit board without any problems.

The instruction manual is very comprehensive and covers not only the building of the probe but also notes on how to use it.

★ specifications

Input impedance: 300kΩ
Threshold: Logic 1 (Hi-l.e.d.) 70% Vcc
Logic 0 (Lo-l.e.d.) 30% Vcc
Detectable pulse width: 300 nanoseconds min.
Input signal frequency: 1·5MHz max.
Pulse detector: High-speed pulse train or single events (positive or negative transitions), active 0·1 second pulse stretcher
Input voltage: ± 50V continuous, 120V a.c. for less than 15 seconds
Power requirements: 5 volt Vcc at 30mA
15 volt Vcc at 40mA
25 volts max., with power lead reversal protection
Physical size: 147 x 25·4 x 17·8mm
Weight: 85 grams

Construction proved to be very simple and straightforward, the step-by-step assembly instructions proving easy to follow. Unlike traditional British component placement drawings however this one did not show the copper track pattern of the p.c.b. and no holes are shown so that it is very important to check twice that the components are correctly placed.

No problems were encountered and the probe worked first time, but if you are unfortunate a page is devoted to trouble-shooting and two pages to testing the probe following construction.

The plastics case, which is available separately and has been used for the *PW* Car Test Probe, is very neat and the two labels supplied with the kit are self-adhesive giving the finished probe a professional look.

The probe is simple to use, requiring the power leads to be clipped to suitable voltage rails on the circuit under test and the probe tip to be held against the test point.

Indication of the status of the point is by a combination of three l.e.d.s which light, or pulse, depending upon the logic state being investigated.

As a simple means of determining logic states this kit is very good value for money.

Dick Ganderton

SEE NEXT MONTH'S ISSUE OF PRACTICAL WIRELESS FOR DETAILS OF A SPECIAL INTRODUCTORY OFFER FEATURING THIS KIT

Ideas DEPARTMENT

Some original circuit ideas provided by our readers. These designs have not been proved by us, and we cannot therefore guarantee their effectiveness. They should at least provide a basis for experimentation.

Why not send us your idea? If it is published, you will receive payment according to its merits. Articles submitted should follow the usual style of PW in circuit diagrams and the use of abbreviations. Diagrams should be clearly drawn on separate sheets, not included in the text.

Each idea should be accompanied by a declaration that it is the original work of the person submitting it, and that it has not been accepted for publication elsewhere.

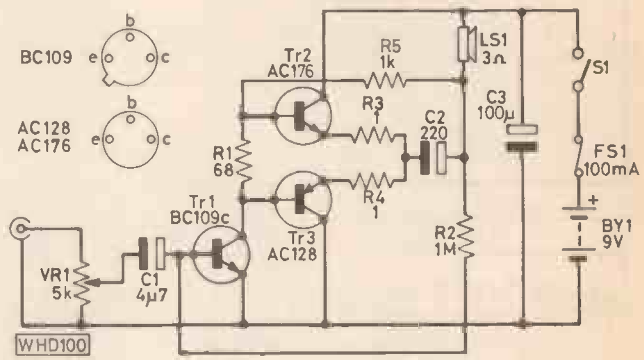
WORKBENCH AMPLIFIER

Although there are plenty of amplifier i.c.s and modules available, there are many applications where discrete circuitry can hold its own on cost and simplicity. One of these is a battery-powered audio amplifier for workbench use.

The input signal goes via the volume control VR1 to Tr1, which is a high-gain voltage amplifier. Its output is applied to the bases of Tr2/Tr3, the complementary output pair, with R1 providing the necessary standing bias. For reasons of simplicity and cost, no form of temperature compensation has been included.

Two negative feedback paths are included. Resistor R5, which is basically the collector load for Tr1, also provides bootstrapping for the output stage. Resistor R2 provides base bias for Tr1 and also overall negative feedback. Audio quality may be improved at the expense of reduced output by lowering the value of R2. Capacitor C3 decouples the supply, and helps to maintain audio quality when the battery approaches the end of its life.

Transistors Tr2 and Tr3 should be purchased as a matched pair, and must be fitted with heat-sinks—the push-on, finned type should suffice. With no signal applied, the total consumption of the amplifier should be less than 35mA.



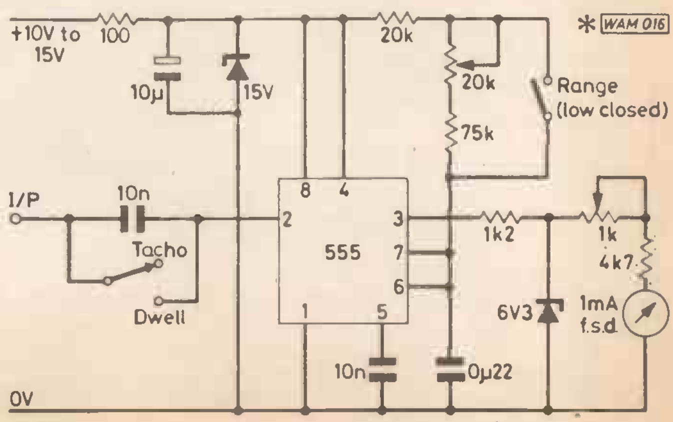
D. L. Jones,
Denbigh,
Clwyd.

TACHOMETER/DWELL METER

This circuit utilises a 555 timer chip in a dual function as a tachometer or dwell meter. In the tachometer mode, the input signal is taken from the car's contact breaker as a square-wave and fed via a capacitor to pin 2 of the timer, realising a high mark/space ratio. The two switched ranges, 0 to 1000 r.p.m. and 0 to 5000 r.p.m., are calibrated by a 20kΩ and a 1kΩ potentiometer.

In the "dwell" mode, the input capacitor is by-passed, maintaining a square-wave at the input of the device, which means that the output at pin 3 is an inverted version of the input waveform. In the "dwell" mode, only the lower of the two tacho ranges should be switched in.

The circuit requires a minimum supply of 12V for consistent operation.



R. J. Jenkins & M. E. Taylor,
Knebworth,
Herts.

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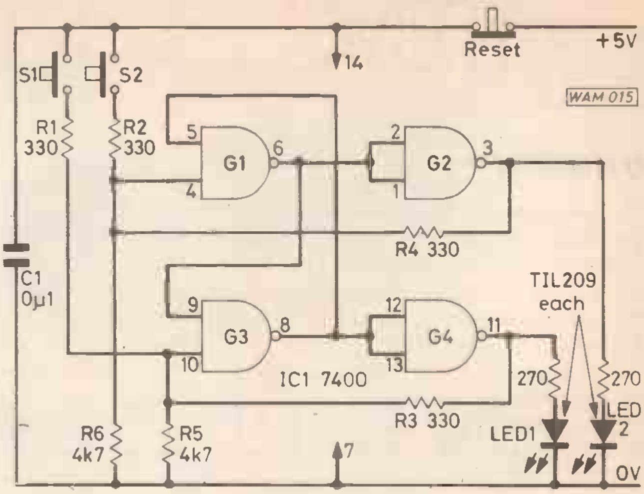


TTL "SNAP" INDICATOR

At switch-on R6 holds the input to gate 1 low, making the output high. This is coupled to inverter gate 2, the output of which is low and is coupled back to pin 4 by a 330 ohm resistor. These gates remain in this state as do gates 3 and 4 and in this condition no l.e.d.s are lit.

Note that the high at pins 6 and 8 are cross-coupled to the inputs of gates 1 and 3. Suppose S2 is pressed: pin 4 is connected to a high via R2. As pin 5 is also high the output of gate 1 goes low causing gate 2 to change state at pin 3, which goes high causing l.e.d. 2 to be lit.

Pin 4 is kept high via R4 so that the l.e.d. is "latched" on when S2 is released. Since pin 9 of gate 3 is held low by the output of gate 1, closing of S1 cannot change the state of gate 3 and l.e.d. 1 cannot be lit.

A complementary sequence occurs if S1 is pressed first. The power supply must be broken by the reset button to restore the circuit to its original state. C1 decouples the supply lines and prevents random triggering of the l.e.d.s at switch-on.

J. Bloxham,
Stratford-on-Avon,
Warwickshire.

Learning to spell

The latest learning aid from Texas Instruments, known as "Spelling B", uses proven word/picture association techniques to help children progress in spelling regardless of their basic writing skills. Using an alphabetical calculator-type keyboard and display, combined with a picture book containing 264 carefully selected, colourful pictures of familiar objects, "Spelling B" is designed to provide an early introduction to word recognition, and also incorporates a series of simple and entertaining word games to improve basic reading skills.

In operation, the "Spelling B" selects and displays a picture number, the child finds the numbered picture in the book, and then spells the name of the picture by pressing the letter keys. As the letters are keyed they appear in the display, and at the end of each word the display signals "right or wrong". If the word is misspelled, the child is given a second attempt, and if this is wrong the correct answer is displayed. The number of correct answers is displayed as a "score" at the end of each set of five words.

"Spelling B" is programmed so that one of three different levels of difficulty can be selected. In addition, a variety of pre-spelling activities for younger children plus word games for all ages are available.

Among the games which add fun and variety to "Spelling B" are: "Starts with", a pre-spelling exercise in which the child only has to enter the first letter of the displayed word; "Missing letter", in which a word is selected at random and displayed with letters missing; "Mystery word", a variation of "Hangman" in which players have to guess words one letter at a time; and "Scramble", in which up to five words can be put into a memory in anagram form and recalled for "unscrambling" at a later stage.

The "Spelling B" costs £19·95 (r.r.p. including VAT), and is available through the usual distributors.

Texas Instruments Ltd., European Consumer Division, Manton Lane, Bedford MK41 7PA.

Portable 'scope

The new Model SB15M lightweight portable oscilloscope from Albol Electronic is claimed by the makers to break all records for cost-effectiveness for a professional/amateur instrument.

Albol say that the bandwidth goes up to 15MHz within 3dB limits and nine ranges cover, with an accuracy of 5% 10mV to 20V/cm on the 45 by 60mm measuring area of the c.r.t. Input impedance is 1MΩ±3% in parallel with 30pF, and the maximum input voltage is 400V.

The timebase can be freely running or triggered, and is displayed on 19 calibrated ranges from 0·5s/cm to 0·5µs/cm. Synchronisation can be either internal or external, with the a.c. mode giving 20Hz to 1MHz, and the h.f. mode 1 to 15MHz. Trigger sensitivity is said to be 0·5cm of the display on "internal", or 0·5V p–p on "external".

Bandwidth of the X amplifier, within 3dB, goes from d.c. to 3MHz, with an input impedance of 1MΩ in parallel with 45pF. The X deflection coefficient varies from 0·3 to 1·5V/cm. An attractive feature of this truly portable scope is that it can operate from 220 to 240V mains (using the optional adaptor) at 50 to 400Hz, with a power consumption of 40VA, or else from internal 1·5V cells giving 12V d.c. (rated then at 27W).

The width of the SB15M is 150mm, depth 340mm, and height 280mm, and it weighs only 7·6kg. Price is £150 plus VAT.

Available from: *Albol Electronic & Mechanical Products Ltd., 3 Crown Buildings, Crown Street, London SE5 OJR. Tel: 01-703 2311.*

New Sinclair DFM

Latest from Sinclair's new instrument product range, is a high specification, low cost, digital frequency meter, called the PFM200.

Designed to provide the performance of high quality bench-style instruments with the portability of a 158 × 76 × 45mm unit in a light (6oz) but rugged case, the PFM200 is priced at only £49·80 plus VAT, which should permit most laboratory engineers, service technicians, students and hobbyists to possess their own personal digital frequency meter.

Its bright, sharp 8-digit display with variable accumulation period gives high resolution coverage from low audio frequencies right up to v.h.f. without the need for complex range changing and with exceptional sensitivity of 10mV. Guaranteed range is 20Hz to 200MHz, typically higher, with a frequency resolution down to 0·1Hz. Power is from a 9V battery or approved a.c. adaptor.

Supplied complete with test leads and probes, protective wallet and operator's manual, optional extras are a.c. adaptors for 117V, 220V or 240V; de-luxe padded carrying case with lead storage compartment; and a connector pack comprising BNC, coaxial, DIN and phono adaptors plus telescopic aerial for direct signal pick-up from nearby transmitter.

A technical information leaflet on the PFM200 is also available from: *Instrument Sales, Sinclair Radionics Ltd., London Road, St Ives, Huntingdon, Cambs PE17 4HJ. Tel: (0480) 64646.*

numbers without tears

Dr G. BROWN

The aim of this design was to produce an educational toy capable of teaching rapid number recognition to children of $2\frac{1}{2}$ years and upwards. The absolute minimum of instruction should be necessary, the idea being that the child learns as he plays, without external influence. The toy should thus be interesting to play with.

To a young child this means: (a) visual stimulation—things should be seen to happen; (b) tactile stimulation—the instrument should respond to touch, to pressure—there should be something to turn, something to switch.

This simple unit has all these facilities and can hold a child's attention for remarkably long periods. It can also double as a single die for use with other games.

General Features

Fig. 1 shows the basic design blocks. A swept-frequency clock generator feeds the first decade counter, the digit outputs of which are used to drive ten light-emitting diodes (l.e.d.s) arranged in a circle. A second decade counter, fed from the same clock source, drives a single 7-segment l.e.d. numeric display. As the clock frequency rises from zero, the circular l.e.d. display assumes a rotating motion with a visible acceleration. As the clock frequency then falls to zero, the "flywheel" effects slows and stops at a random position.

The l.e.d.s are labelled 0 to 9, as are the positions on the manual number selector, which is a rotary switch. Provided that both decade counters are reset to zero initially, they will always remain synchronised, i.e., if the flywheel stops at position "4", then the 7-segment outputs will correspond to the figure 4 also.

The number selector is wired such that the 7-segment display is only illuminated when this switch is turned to the same number at which the flywheel has stopped. The normal fixed-frequency clock is used when the device is employed as a die.

Some simple logic is included to make the toy more interactive with the child, and will be described in the appropriate sections.

The Swept-frequency Clock Generator

For this particular application, a manually-initiated frequency sweep was required from zero up to about 100Hz and back again to zero. The circuit is shown in Fig. 2.

The clock is designed around the ubiquitous NE555V integrated circuit connected in the astable mode.

If the circuit to the left of the dashed line is studied, the timing components R1 and C1 are easily recognised. C1 is charged up through R1, and IC1 will discharge C1 when the voltage at point A reaches 0·67Vdd. The negative-going edge corresponding to the discharge of C1 retriggers the cycle and the system becomes astable, the frequency of oscillation being given by:

$$f = \frac{1{\cdot}44}{R1 \times C1}\text{Hz}$$

In the circuit to the right of the dashed line Tr1 and Tr2 are connected as a Darlington pair controlled by the touch plate connected to the base of Tr2. The quiescent-state voltage at point A is controlled by resistors R1, R2, and R3, the two transistors being effectively open-circuit. A simple Ohm's Law calculation shows that point A is held at 0·65Vdd and, because IC1 will not discharge C1 until point A reaches 0·67Vdd, the clock oscillator is biased off, its output being a logic "1" in this condition.

When a finger is applied to the touch plate, charge flows into the electrolytic capacitor, C2. As this charges up, the potential at point B rises. With C2 fully charged (after about one second), both transistors are turned fully on and point B is taken almost to Vdd. Thus the Darlington pair may be regarded as a variable resistance, Rt, between point B and Vdd, this resistance varying from infinity to near zero. As soon as Rt becomes finite, point A is lifted above the threshold value of 0·67Vdd and oscillation begins.

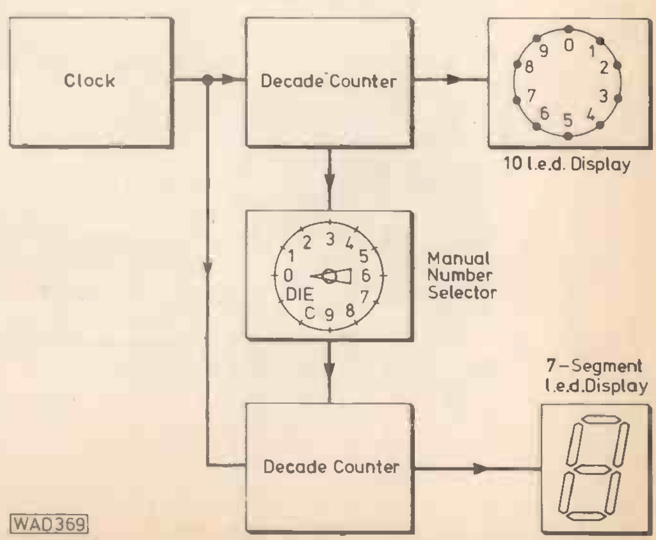


Fig. 1: The basic block diagram of the numbers toy

The frequency of oscillation is still given by the above equation, except that R1 must be replaced by the effective instantaneous value of R1, R2 and Rt. In the limit, with Tr1 and Tr2 turned fully on, R1 and R2 are virtually in parallel between Vdd and point A, and have an effective resistance of 24·8kΩ. This gives a theoretical upper frequency limit of:

$$f = \frac{1 \cdot 44}{2 \cdot 48 \times 10^4 \times 3 \cdot 3 \times 10^{-7}} = 176\text{Hz}$$

This figure is not attained in practice because Rt never falls completely to zero.

When the finger is removed from the touch plate, C2 discharges slowly through Tr1 and R3, and Rt increases correspondingly. The frequency of oscillation falls and finally reaches zero when point A falls again below its threshold value. This decay time is of the order of 10 to 15 seconds.

Switching R4 into the biasing network by closing S1 holds point A just above threshold and a constant-frequency output of about 15Hz is produced. The use of this clock frequency is described in a later section.

The touch plate is very sensitive in its action, and this encourages the child to experiment as he watches the effects of his finger's pressure illustrated on the flywheel display.

The Decade Counters

Apart from the NE555V oscillator, this instrument employs c.m.o.s. devices which are relatively cheap and are ideal for this purpose. Fig. 3 shows the circuit diagram of

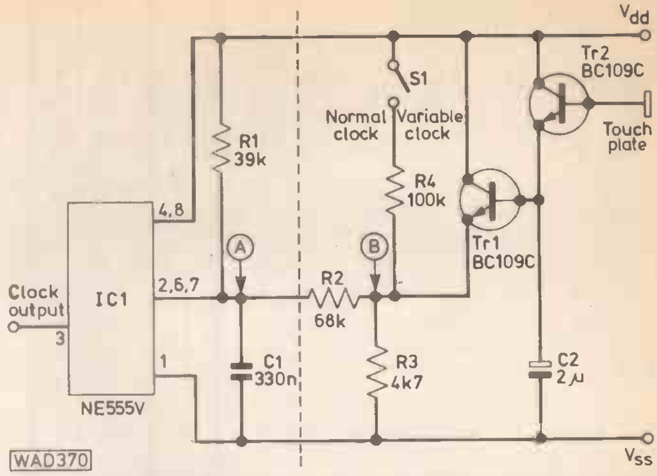


Fig. 2: Circuit diagram of the swept-frequency clock generator

the first decade counter and the transistor drivers for the 10–l.e.d. flywheel display. The 4017 decade counter is fed from the clock generator described above. In order to drive the flywheel l.e.d.s at 20mA, ten transistors operating as emitter followers are used. As only one l.e.d. is illuminated at any instant, only one current limiting resistor, R10, is necessary. It will be noted from Fig. 3 and Fig. 4 that the "reset" and "clock inhibit" functions are made common to both decade counters. This is to ensure complete synchronism of the two counters at all times. The combination of C3 and R5 resets both counters to zero when power is first applied.

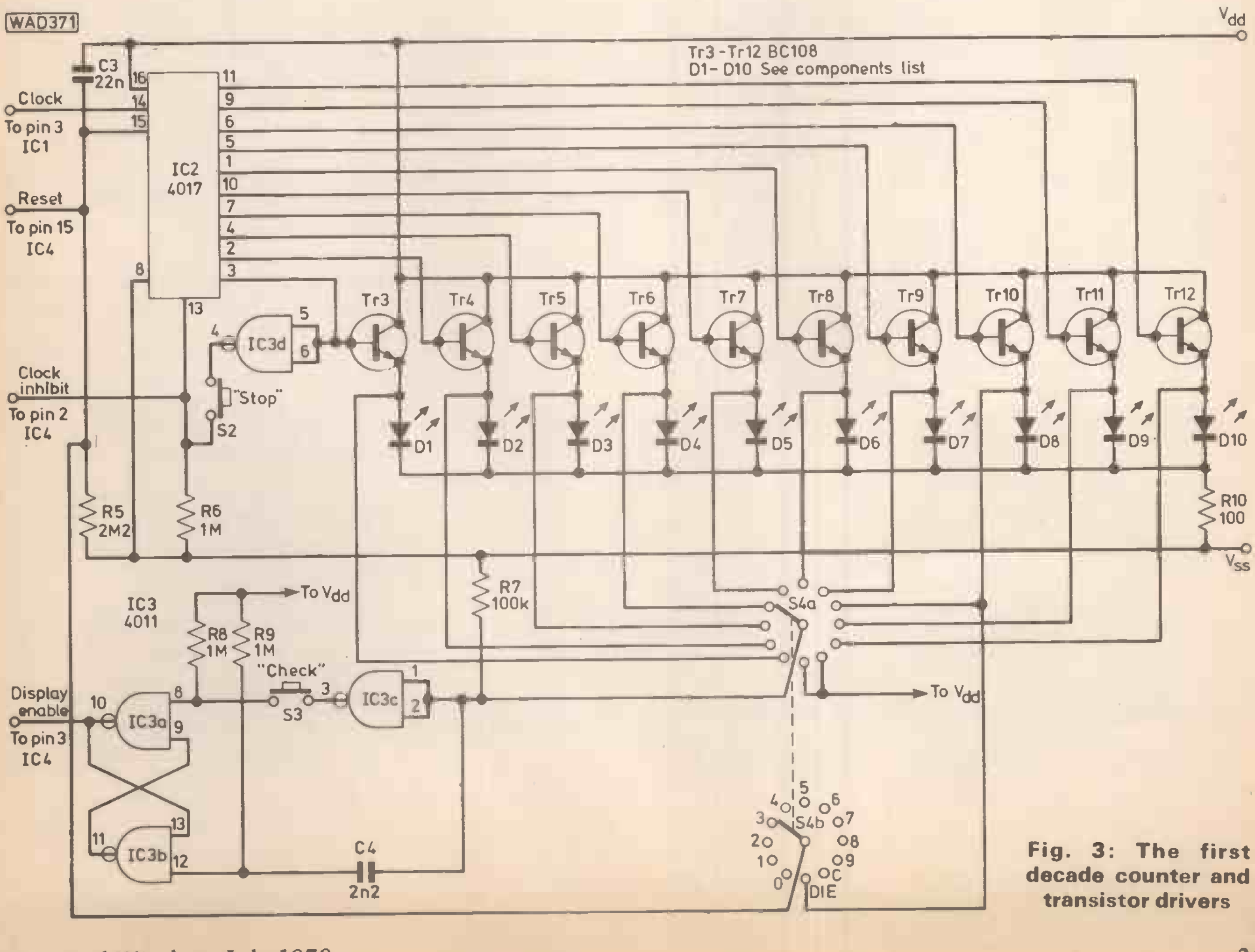


Fig. 3: The first decade counter and transistor drivers

Switching Logic

The switching logic provided by S3, S4 and IC3 has two important effects, which are now described.

Suppose the flywheel display has stopped at "4". It would be trivial to connect the pole of S4*a* to the "display enable" pin of the second counter (see Fig. 4) to illuminate the 7-segment display when S4*a* is turned to position "4". This operation would not require any numerical knowledge on the part of the child: he would just turn S4 until the 7-segment display came on. To avoid this, IC3*a*, *b* and *c* are interposed between S4*a* and the "display enable" pin of the second counter. IC3*a* and *b* form a toggle whose normally-off output is taken to the "display enable" input of the 4026 counter, thus keeping the 7-segment display off under normal conditions.

Taking pin 8 of IC3 to Vss will turn the toggle on and, with it, the 7-segment display. Similarly, taking pin 12 of IC3 to Vss will reset the toggle and extinguish the 7-segment display.

Signals to control the state of the toggle are taken from the pole of S4*a*. The "on" state of toggle and display is controlled by the position of S4*a*, by the inverter IC3*c*, and by the push switch S3. If S4*a* is turned to position "4" to match the flywheel display, then the pole is taken to logic "1"; logic "0" thus appears at pin 3 of IC3.

If S3 is momentarily pressed, the resulting logic "0" applied to pin 8 of the toggle will switch both itself and the 7-segment display on. Thus the child must not only select a number, but must press the CHECK button, S3, to see if his selection was correct.

What happens if the selector switch is turned after the 7-segment display has been illuminated? If the display were to remain illuminated with the electro-switch now showing a different number, the child would be confused, so provision is made to extinguish the display (a) when the selector switch is turned from the correct position, and (b) when the flywheel is started again. These requirements are simultaneously fulfilled by connecting the pole of S4*a* via C4 to the "reset" input of the toggle, pin 12.

Suppose the previous procedure has resulted in a "4" being indicated by both the displays. If S4*a* is turned away from "4" the pole is taken from logic "1" to logic "0", and the negative-going edge so produced is passed by C4 to reset the toggle and extinguish the display.

Similarly, if the flywheel is started, the negative-going edge produced as l.e.d. "4" goes out resets the toggle via C4 and the 7-segment display is extinguished.

Thus, in normal use, there can never be any ambiguity between the numbers on the displays and the number set on the selector switch.

The presence of R7 from the pole of S4*a* to Vss is worth nothing. There is no reason why the digit positions on the S4*a* wafer should not go direct to the digit outputs of the 4017 counter: in this case R7 would be unnecessary. However, there is a very good practical reason why this is not done. The ten l.e.d.s and the selector switch S4 are mounted on the front panel. The integrated circuits and transistors are on a single circuit board mounted on the base of the metal box. Thus there are ten flexible leads from the emitters of Tr3–Tr12 to the l.e.d.s on the front panel. Ten more flexible leads would be needed from the S4*a* wafer to the digit outputs of IC2, but these leads can be eliminated by simple wiring to S4*a* from the anodes of the l.e.d.s, which are on the same panel. When this is done, a pull-down resistor, R7, to Vss is needed for the inputs of IC3*c* to keep them at logic "0" except when a logic "1" is fed to the pole of S4*a* from the flywheel display.

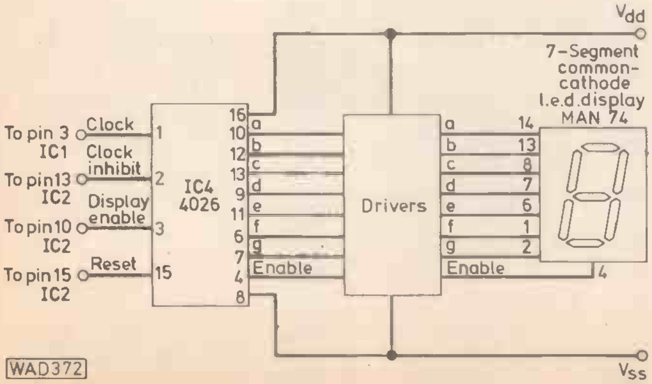


Fig. 4: The second decade counter

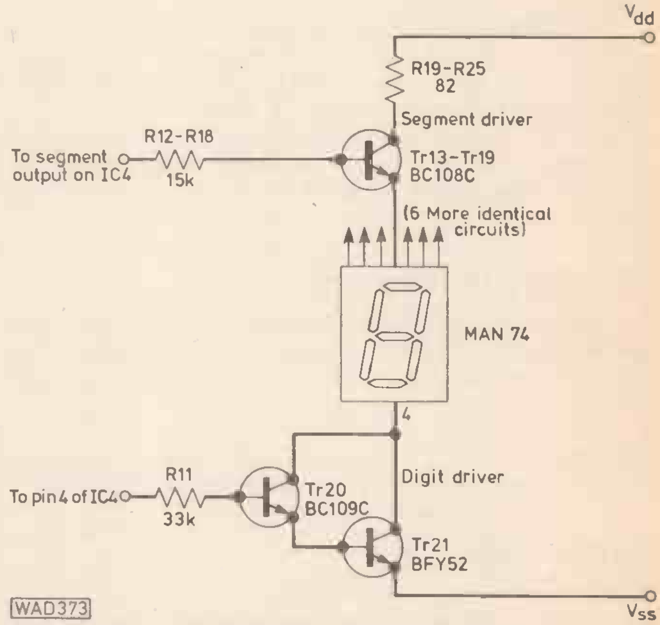


Fig. 5: Driver circuits for the second decade counter

The second decade counter and its associated circuitry are shown in Figs. 4 and 5. The counter is a Type 4026 c.m.o.s. device which has outputs for a 7-segment display. These figures require very little explanation. The 4026 counter operates in parallel with the 4017 counter, and the 7-segment common-cathode display is fed by seven segment driver stages, Tr13–Tr19, and one digit driver stage, Tr20–Tr21. The current-limiting resistors, R19–R25, give segment currents of 19mA. To "enable" the display, the digit driver Darlington pair, Tr20–Tr21, is switched on by a logic "1" from pin 4 of the 4026 counter, thus providing a low-resistance path from the display cathodes to Vss. Tr21 must be capable of carrying 7 × 19 = 133mA, and the Darlington configuration has been used so that Tr21 can be very conservatively rated, ensuring high reliability.

Provision has been made to illuminate the 7-segment display while the flywheel is running. This adds to the visual appeal of the instrument before the child is ready to tackle number recognition and matching. This is the function of position "C" (continuous display) on the selector switch S4. When "C" is selected and S3 pressed, the display will remain on throughout the flywheel cycle.

A final word now about the use of the instrument as a die. On the "DIE" position of the selector switch, S4*a* provides a constant logic "1" on its pole (as in the "C" position), and when S3 is pressed the 7-segment display is constantly illuminated. S4*b* comes into operation at this point and connects the "7" digit of the l.e.d. flywheel to the "reset" pins of both counters. Thus both of the displays count repetitively from "0" to "6" when the clock runs. The swept-frequency clock can be used for this, but it has been found that the use of a constant 15Hz clock (selected by S1) is more satisfactory, in that the procedure is less involved for the child.

To "throw" the die, all that the child does is press S2: both displays stop immediately, showing a number between "1" and "6". On releasing S2, counting begins again. This function utilises the "clock inhibit" pins of both counters. When these pins are taken to logic "1", counting will cease, even though the clock is still running. The last NAND gate of IC3 is used for a rather devious purpose in this mode. Both IC2 and IC4 are counting from "0" to "6" yet it would clearly be incorrect to allow the die to stop at "0".

Instead, the die is slightly "weighted" such that it can never be stopped at "0"! The probability of throwing a given number on a die is 1 : 6. On this die, the probability of throwing a number between 2 and 6 is 1 : 7 and the probability of throwing a 1 is 2 : 7.

In use by young children, or even unsuspecting adults, this would never be noticed. To prevent a "0" being thrown, the signal to inhibit the clock is taken from the "0" digit output (pin 3) of the 4017 counter. If, at the moment S2 is pressed, a number from "1" to "6" is being displayed, pin 3 will be at logic "0". IC3*d* inverts this to logic "1" and inhibits the clock. However, if "0" is being displayed when S2 is pressed, pin 3 is at logic "1" and the logic "0" produced by IC3*d* will *not* inhibit the clock. Instead, it waits for the next clock pulse which increments both counters to the digit "1", at which instant pin 3 of the 4017 goes to logic "0" and IC3*d* then inhibits the clock with logic "1" at its output.

Power Supply

A single-polarity, stabilised 5 volt supply is used, employing an integrated circuit regulator. Stabilisation is to be preferred here, because the current taken from the supply varies between about 23mA with only the flywheel display on, to about 160mA with the 7-segment display showing an "8". Fig. 6 shows the circuit used. The regulator is mounted on the metal box to dissipate the small amount of heat generated. The use of 15V d.c. supply for the regulator may seem excessive. In fact, this supply rail will drop to 12 volts on full load and, as the regulator needs a supply of at least 8·5 volts, the supply is not too conservatively rated. A transformer with a 9–0–9 volt secondary could be used, provided that the supply rail for the regulator did not fall below 9 volts on full load.

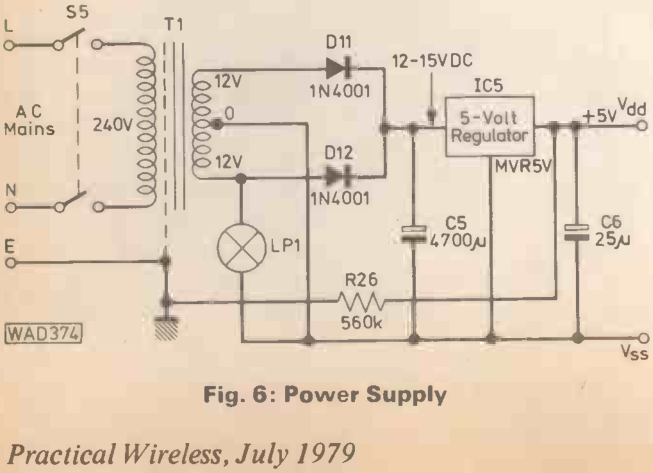


Fig. 6: Power Supply

★ components

Resistors
¼W 5% carbon film

82Ω	7	R19, 20, 21, 22, 23, 24, 25
100Ω	1	R10
4·7kΩ	1	R3
1·5kΩ	7	R12, 13, 14, 15, 16, 17, 18
33kΩ	1	R11
39kΩ	1	R1
68kΩ	1	R2
100kΩ	2	R4, 7
560kΩ	1	R26
1MΩ	3	R6, 8, 9
2·2MΩ	1	R5

Capacitors
Electrolytic

2µF 6V	1	C2
25µF 6V	1	C6
4700µF 25V	1	C5

Polycarbonate or polyester

2·2nF	1	C4
22nF	1	C3
0·33µF	1	C1

Semiconductors
Diodes

1N4001	2	D11, 12
LED	10	D1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Transistors

BC108C	17	Tr3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
BC109C	3	Tr1, 2, 20
BFY52	1	Tr21

Integrated circuits

MVR5 regulator	1	IC5
NE555V	1	IC1
4011	1	IC3
4017	1	IC2
4026	1	IC4

Switches

s.p.s.t.	1	S1
Push to make	2	S2, 3
2p 12w rotary	1	S4
s.p.d.t. slide	1	S5

Miscellaneous
12–0–12V 200mA transformer T1 (1); 12V panel lamp (1); 7-segment red l.e.d. display, common cathode MAN74 (1); Veroboard (see text), case.

Constructional Notes

Apart from the power supply, displays and switches, the entire circuit was constructed on a single piece of Veroboard measuring 95 × 63mm. The layout is not important, so no details are given, but it is advisable to take all Vss leads to a common point.

In general, this precaution is unnecessary, but in this circuit the emitter connection of the digit driver Tr21

Continued on page 60

Selective sound OPERATED switch

C.R.HARRIS

This unit was developed after I was asked by a friend to build a device with which he could turn a light on by clapping his hands.

Obviously this could be done by using a simple sound operated switch comprising a microphone, audio amplifier and trigger circuit, but such a simple circuit would respond to any sound of sufficient volume. Clearly something more sophisticated was required.

After a number of tests had been made, it was found that satisfactory operation could be obtained by making the circuit respond only after receiving two sounds with a fixed time interval between them of around one second. This achieves a good compromise between simplicity, spurious operation from background noise and ease of use. The human brain is very bad at estimating short time intervals and a sequence of more than two sounds becomes impossible to generate with any accuracy. The circuit also incorporates a filter and a level trigger so only sounds of the correct pitch and sufficient volume will be detected.

Circuit Operation

IC1 and associated components amplify the sound picked up from the microphone and include rough frequency filtering. VR1 is a gain control and VR2 adjusts the d.c. level of the output from this stage. This is fed to a Schmitt trigger comprising Tr1 and Tr2 and also has a time delay (C4, R2) to prevent multiple triggering. The components following (Tr3-Tr5) form a driver stage for the logic circuit, and the l.e.d. D2 indicates when a sound has been detected. The circuit gives a logical '0' on receiving an input above a preset threshold set by VR2.

The output from this stage is first fed to a monostable comprising G1 and associated components which in turn triggers two more monostables G3, G4 and associated components. Monostable G1 has a period of about 5 seconds and is included to prevent the other two monostables re-triggering before the circuit has finished its cycle. G3 has a period of about 1 second and G4 about 3 seconds.

The circuit comprising G6-G11 and FF1 looks for the state in which, after a pulse has triggered the monostables, a second pulse arrives during the period when G3 has turned off again and G4 is still on, i.e. 1-3 seconds after the first pulse. When this happens a logical '1' is sent to FF2 which then changes state and opens or closes the relay via Tr9 and Tr10. If the second pulse arrives before or after the allowed period it is ignored and will also work the latch G9, G11 to make the circuit ignore all further inputs until G1 has reset. Thus on receiving two sounds with a time interval of about 1 second between them the circuit will operate the relay, turning the load circuit on or off.

Construction

Construction is simplified by the use of printed circuit boards. Start by soldering in the smallest components, i.e., resistors and diodes and add the tallest components (capacitors and transistors) last. The c.m.o.s, integrated circuits (IC2-IC5) should be connected using i.c. sockets, installing them in after all the other components have been soldered. Standard c.m.o.s. handling precautions should be used. Sockets should also be used for the other integrated circuits. Take great care to connect all components such as diodes, transistors, i.c.s and electrolytics the correct way round as incorrect connection can cause a large range of puzzling faults.

At this point, something should be said about the microphone and the mains transformer. The microphone used is a high impedance balanced armature earpiece which is better than a crystal microphone in this application. There is also space on the circuit board for putting a resistor in series with C2 to adjust the low frequency characteristics (10-100Ω).

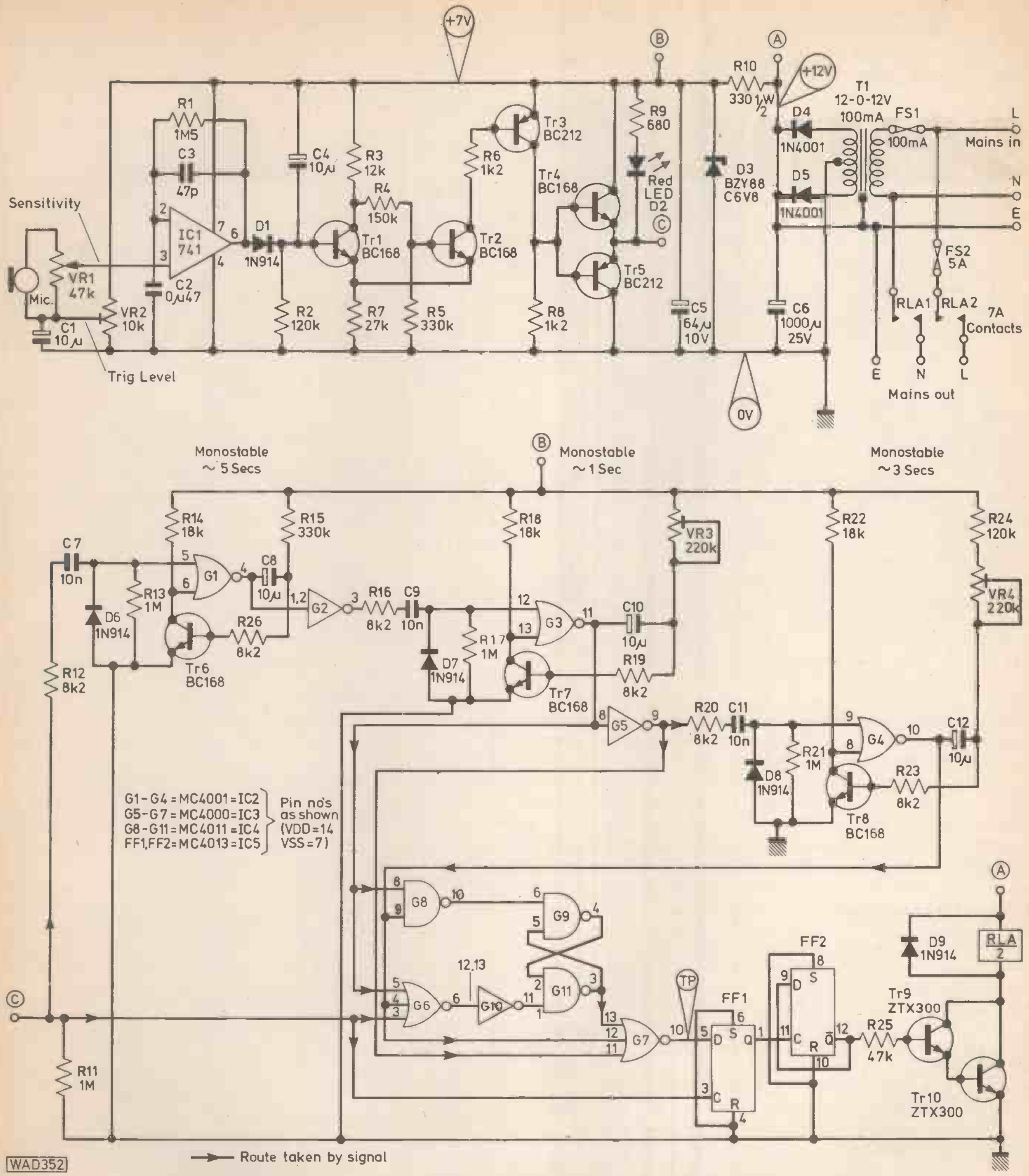
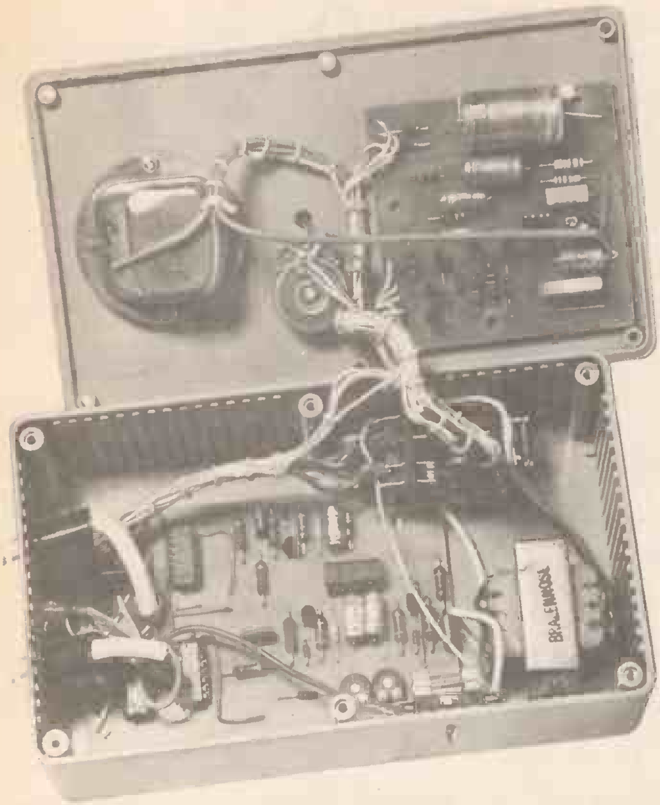


Fig. 1: Circuit diagram of the selective sound operated switch

The mains transformer is a 12-0-12V type designed to supply up to 100mA d.c. from a full-wave rectifier. Most of the current is drawn by the relay (60-80mA) with the rest taking less than 20mA. Thus if a relay is used which draws more than 80mA a larger transformer will be needed. A 100mA fuse is shown connected to the primary of the transformer and this is necessary for safety. If it is found that the fuse blows on switch-on an anti-surge fuse can be fitted. The other fuse supplying the appliance being controlled should be rated according to the relay contacts and mains cable used.

A suitable case for the unit can be made from a plastics Bimbox. When fitting components into the case, it is important to keep all the high voltage components (relay, transformer and fuse holders) well away from the other components so that there is no chance of any live connections touching any other part of the circuit. Holes are drilled in the case for the microphone, the l.e.d. and the gain control VR1. The circuit boards should be positioned within the case such that the presets VR2-VR4 can easily be reached to be adjusted. The boards are held in place using self-adhesive pads. When wiring up between the circuit boards, it is very important that all the supply rails are connected up correctly because the c.m.o.s. chips can be damaged if an input is fed to them before the power rails are connected.



The components and p.c.b.s are fitted into a plastics Bimbox. The two p.c.b.s are attached to the box base and lid using self-adhesive foam pads

Setting Up

First set VR3 and VR4 midway along their tracks. Set the gain control VR1 to minimum. It should be found that as VR2 is moved the l.e.d. will light at one end of the track and be extinguished at the other. Adjust VR2 until it is just extinguished. Then turn the gain control VR1 up a little. It should now be found that any loud sound near the microphone will cause the l.e.d. to flash on for just under a second. If it stays on or does not come on at all then adjust VR2 until the response is satisfactory. Next, connect a voltmeter between the 0V rail and pin 10 of IC3 (marked TP in the diagram) or, if no meter is available, disconnect R25 from IC5 and make a temporary connection from that end of the resistor to pin 10 of IC3.

It should now be found that if, after at least 5 seconds of silence, a sound is made near the unit loud enough to make the l.e.d. flash, then a short pulse of approximately +7V will be indicated on the meter, or the relay will close momentarily about one second after the sound. If this does not happen adjust VR3 and VR4 until it does. This is the period during which the device is sensitive and it will switch the load if a second sound is made during this period. Adjust VR3 and VR4 until the time period is satisfactory. Note, however, that if the values of the presets are made too low then the monostables will stop working, so that if a satisfactory time period cannot be achieved then it may be necessary to change C8 or C12. Do not make the "sensitive" period too short or it will be found very difficult to estimate the required time interval.

After R25 has been replaced in its correct position and the lid has been attached, then the unit is ready for use.

★ components

Resistors

$\frac{1}{4}$W 5%		
680Ω	1	R9
1·2kΩ	2	R6, R8
8·2kΩ	6	R12, 16, 19, 20, 23, 26
12kΩ	1	R3
18kΩ	3	R14, 18, 22
27kΩ	1	R7
47kΩ	1	R25
120kΩ	2	R2, 24
150kΩ	1	R4
330kΩ	2	R5, 15
1MΩ	4	R11, 13, 17, 21
1·5MΩ	1	R1
$\frac{1}{2}$W 5%		
330Ω	1	R10

Potentiometers

Horiz. miniature preset		
10kΩ Lin.	1	VR2
220kΩ Lin.	2	VR3, 4
$\frac{1}{4}$inch shaft		
47kΩ	1	VR1

Capacitors

Disc ceramic		
47pF	1	C3
10nF	3	C7, 9, 11
Polyester		
0·47μF	1	C2
Electrolytic		
10μF 25V	5	C1, 4, 8, 10, 12
64μF 16V	1	C5
1000μF 16V	1	C6

Semiconductors

Diodes		
1N4001	2	D4, 5
1N914	5	D1, 6, 7, 8, 9
Red l.e.d.	1	D2
BZY88 C6V8	1	D3
Transistors		
BC168	6	Tr1, 2, 4, 6, 7, 8
BC212	2	Tr3, 5
ZTX300	2	Tr9, 10
Integrated circuits		
741	1	IC1
4000	1	IC3
4001	1	IC2
4011	1	IC4
4013	1	IC5

Miscellaneous

Bimbox (190 × 110 × 60mm BIM 2006/16); Mains transformer 12-0-12V 100mA (1); Relay 12V 80mA max. 7A 240V d.p.c.o. (1); Fuse holder (2); Fuses 100mA and 5A; Balanced armature earpiece (see text) (1); Printed circuit board (2 in set); Sockets, 14 pin d.i.l. (4); 8 pin d.i.l. (1); Knob (1); Mains cable, socket and cable clamps.

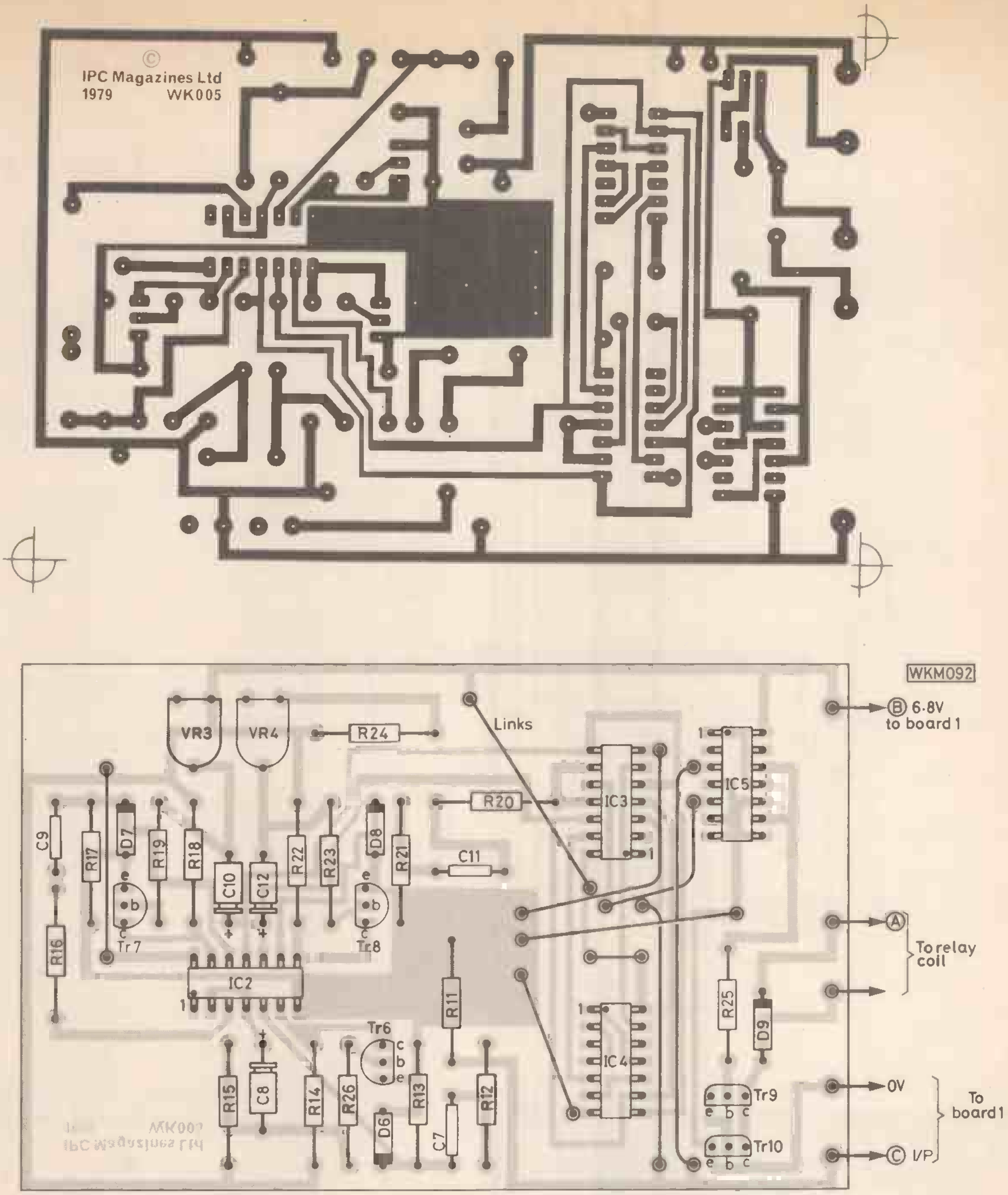


Fig. 2: The copper track pattern and component placement drawing for Board 2 shown full size.

Using the Switch

Adjust VR1 so that the l.e.d. will not flash from background noise in the room, but will reliably respond to a hand clap. The l.e.d. will be found very useful for indicating whether the unit has "heard" a sound or not, when setting the sensitivity.

Although originally intended purely as a gimmick, the device has been found to be extremely reliable and may well have more practical uses. The prototype was left in an average sitting room for a week without triggering spuriously, but would immediately respond on hearing the correct sound sequence.

There could be practical uses where it is necessary to operate equipment remotely, possibly by a disabled person, or in other cases where it is not possible to operate a switch directly.

Fault-finding

Once the design had been finalised, it was found that the units could be relied upon to work correctly immediately they had been assembled and adjusted. Most faults are likely to be caused by wire links in the wrong places and diodes or transistors the wrong way round. Remember that the circuit uses both *npn* and *pnp* transistors. A puzzling intermittent fault in one unit was traced to C6 being open-circuit. This resulted in the supply rails

WKM093

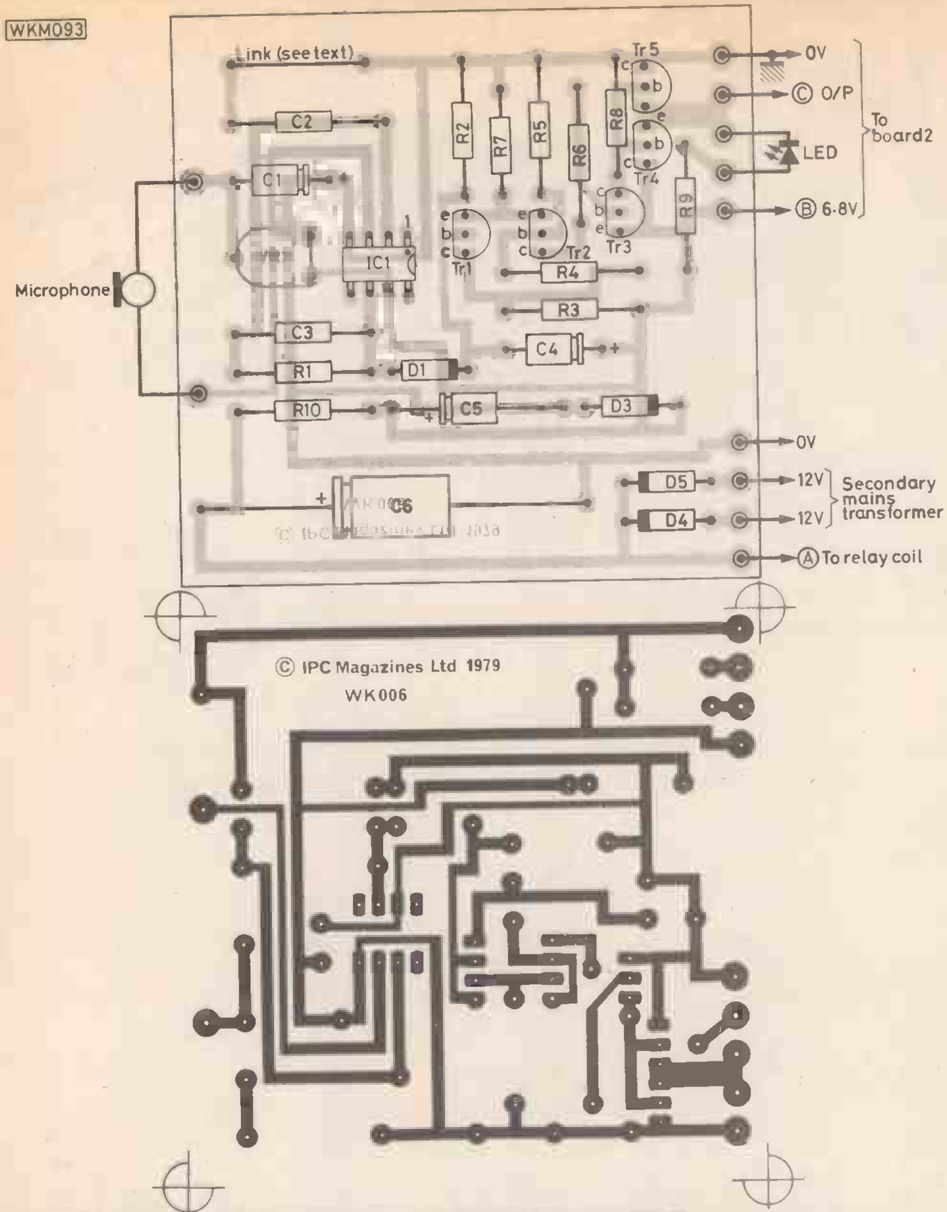


Fig. 3: The copper track pattern and component placement drawing for Board 1 shown full size

carrying unsmoothed a.c. and played havoc with the logic functions.

Provided that the l.e.d. flashes in response to sounds then faults are best traced by first checking the outputs of the monostables (pins 4, 10, 11 of IC2) and then following the voltage levels through the rest of the circuit. Remember that the monostables give an inverse output, i.e. "1" in the quiescent state and "0" when active, and remember also that the circuit takes 5 seconds to complete its cycle and if it receives an input before G1 has reset it will ignore it.

If the l.e.d. does not light up then first check IC1. The voltage on pin 6 (output) should equal that on the wiper of VR2, except at extreme settings of VR2. The Schmitt trigger, Tr1, Tr2 should turn on when the voltage on Tr1 base exceeds about 5V, turning on the l.e.d. via Tr3-Tr5, and should turn off sharply as the voltage is lowered. These functions can easily be checked with a multimeter and should show up the location of any fault. However, provided the unit is constructed carefully, there is no reason why it should not work first time. ●

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practical WIRELESS

ON SALE 6TH. JULY

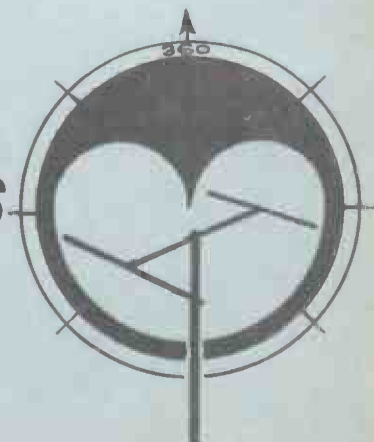
Automatic Intercom

Unwanted salesman? Tired after a hard day? PW's Automatic Intercom allows you to answer callers from your armchair without even pressing a button, while the front door remains securely bolted. Digital and analogue techniques are combined in this comprehensive, yet easy-to-install aid to basic security for the old, infirm or just plain lazy.

Ultrasonic Remote Control

A short introduction to the use of ultrasonics for cordless on/off control of domestic appliances etc. The article suggests some suitable circuits based on i.c.s intended for use in other fields, allowing the construction of very small transmitters and receivers.

Aerial Design with Scale Models



Aerial designs can be tested and developed easily by building scale models of the proposed systems and making measurements at u.h.f. This article describes how a surplus marine radar display can be adapted to plot the resulting polar diagrams automatically

Plus SPECIAL PRODUCT REPORT on the LOWE SRX~30 Receiver

VMOS top band tran

J. R. Green BSc, G3WVR*

This low-power a.m. transmitter design illustrates the use of power f.e.t. devices—in particular, the VN66AF recently introduced by Siliconix Ltd.—and takes full advantage of modern semiconductor technology. The unit is particularly suitable for use within the 160-metre band, although operation at higher frequencies is quite possible.

Design Considerations

The Author has carried out a great number of experiments with low-power transmitter circuitry using bipolar (i.e. "conventional") devices over the last few years. Some degree of success was achieved in later designs, using the now-defunct BD123, but en route many pitfalls for the unwary were uncovered.

Technically, however, the bipolar device fell down on several counts, notably:

1. High drive power was required; typically 10%, even at low frequencies.
2. Difficulty was experienced in achieving really linear amplitude modulation, even when modulating both the driver and p.a. stages. Modulation of the p.a. only, by swinging the supply rail, was unsuccessful. Modulation of the driver as well was essential and far more modulator power was required.
3. Problems were encountered in achieving stability in the transmitter r.f. strip. Often appreciable "slugging" was called for to prevent h.f. or v.h.f. parasitics.
4. Modulation excursions also tended to introduce instability, often producing undesirable steps of modulation non-linearity in the modulated r.f. carrier envelope.
5. It proved remarkably easy to destroy the p.a. transistor(s) if instability occurred or the transmitter was mis-tuned.

These difficulties led the Author to the conclusion that solid-state transmitter design could be much simplified if a device existed which exhibited the characteristics of a thermionic valve. In particular, low drive power, modulation linearity and stability were desirable in addition to the ability to operate from low voltages. In other words, a high-power f.e.t. was needed.

During 1978, Siliconix Ltd. produced the VN66AF and samples were supplied to further the Author's experiments. The ultimate results are incorporated into the transmitter featured in this article. Whilst the published form is for 160-metres, the basic circuit could be used to produce a transmitter capable of at least 10MHz and possibly more.

Circuit Description

The transmitter employs a crystal oscillator which incorporates a twice-frequency, parallel-resonant crystal, with a TIS88A f.e.t. as the oscillator transistor (Care with substitutes! The circuit may fail to oscillate with devices requiring different d.c. conditions.). This stage provides sufficient drive to switch Tr2, a 2N2369A switching transistor which provides a twice-frequency 5 volt peak-to-peak square-wave to drive IC1. This i.c. is a 7473 flip-flop wired to divide-by-two, thus producing the output frequency "*f*".

The 7473 limits the "2*f*" crystal to around 6MHz (therefore the output frequency "*f*" to 3MHz) but this may be extended by substituting a Schottky 7473 (i.e. a 74S73).

From IC1 the signal is passed to Tr3, another 2N2369A switching transistor, to present 12 volts peak-to-peak square-wave drive to the output devices. With Tr3 looking into 100Ω the two VN66AF p.a. devices are easily driven. Their input capacity of 50pF each is the prime limiting factor with untuned drive, although a BFY50 could be substituted for Tr3 and R11 reduced in value to increase the operating frequency or drive more than two p.a. devices. A power output of 6 watts is typical for a 10 watt d.c. input.

A simple "constant K" type low-pass filter is provided, together with transformer matching to transfer the output power effectively into a 50Ω load and remove harmonics.

* *Senior Development Engineer—Gould Instruments Division*

smitter

Note that since a 1:1 mark-space square-wave drive is derived for the p.a., optimum efficiency with minimal second-harmonic radiation in the unfiltered output is assured, with the filter biting hard at the third and subsequent harmonics.

Filter values shown are for a cut-off frequency of 2500kHz, but others may be calculated from the expressions:

$$C = \frac{1}{f_c \pi z} \quad \text{and} \quad L = z^2 C$$

$$\text{where } z = 50\Omega \quad \text{and} \quad L = L1 = L2 = L3$$

$$C = C_{10} = C_{11} \quad \text{and} \quad C_9 = C_{12} = \frac{C}{2}$$

f_c is the cut-off frequency.

The modulator circuit is merely a modified version of the Author's hi-fi amplifier design and should not present any problems. A speaker matching transformer rated at 10 watts (T2) is used to transfer the modulator power to the p.a. This should have a core area of around 25mm square and a winding resistance between the 0 and 16Ω taps of not more than 1Ω. The modulator input sensitivity is in the order of 100mV, so a pre-amplifier will be necessary for microphone level signals.

The r.f. matching transformer T1 was wound on a Mullard binocular "balun" ferrite block, measuring approximately 25 × 20 × 8mm and consists of three turns on the primary (transistor) side and nine on the secondary (filter) side. Experiments using these baluns showed a power-handling capability of 100 watts peak! Substitutes should have the following characteristics:

1. Suitable for the intended operating frequency.
2. 1:3 turns ratio for 6 watts, 50Ω output with wire gauge as large as possible.
3. 50Ω secondary reactance to be ≫50Ω at operating frequency.
4. Peak power rating of at least 20 watts.

If a suitable ferrite block cannot be found, three Mullard FX2249 blocks can be used.

No Adjustments Needed!

It will be apparent from the r.f. circuitry that no tuning is required on the r.f. strip, which should work from switch-on. Trimmer VC1 is used for very fine frequency adjustment and could well be omitted, replacing it with a fixed capacitor of 18pF if the facility is not required. The pre-set potentiometer VR2 should be rotated until Tr11 and Tr12 just start to conduct—say 50mA of standing current.

The VMOS VN66AF devices performed very impressively throughout the development of the prototype transmitters. Only very low drive was necessary and very linear upward and downward modulation was produced. In every respect, the devices performed entirely to specification and simply shut down if an unacceptably-low load was connected.

Possibly it will be found that the modulator output is not quite sufficient to achieve 100% upward modulation but with a suitable transformer the quality is very good indeed and certainly far superior to so-called "communications quality", which covers a multitude of sins!

Construction

The construction techniques are clearly seen in the photograph, most of the components being soldered and mounted on one side of a double-sided "earth-plane" printed-circuit board, measuring 160 × 100mm. The top of the board, the component side that is, forms an earth-plane and the copper should be cleared (using a drill and an outsized bit) around the larger holes indicated in Fig. 2. The remainder form earth-plane connections. Details of the p.c.b. are given in Fig. 2 and the component locations are shown in Fig. 3.

The modulation transformer T2 is mounted on the bottom panel of the West Hyde Developments instrument case, as are Tr4 and 5 (on insulated washers). Transistors Tr11 and 12 are mounted on the extrusion as shown in the photograph. (In fact, the VMOS devices could also be fixed in the same manner, if preferred).

For the prototypes, the p.c.b.s were made by the rather laborious drilling-painting-etching-cleaning techniques, which are more arduous than difficult. However, constructors who wish to purchase ready-made boards will find them available from advertisers.

Components used in the output filter should be exactly as specified—i.e., abnormally high voltage capacitors to take high circulating currents and air-cored inductors to avoid the saturation which would occur with the smaller type of ferrite cores. Remember that the filter is passing 6–7 watts of r.f. energy and retaining 1–2 watts of harmonic energy.

Loss of harmonic power and the bottoming resistance of the power f.e.t.s are the principal causes of efficiency loss in this transmitter. The filter values may be "scaled" for other frequencies.

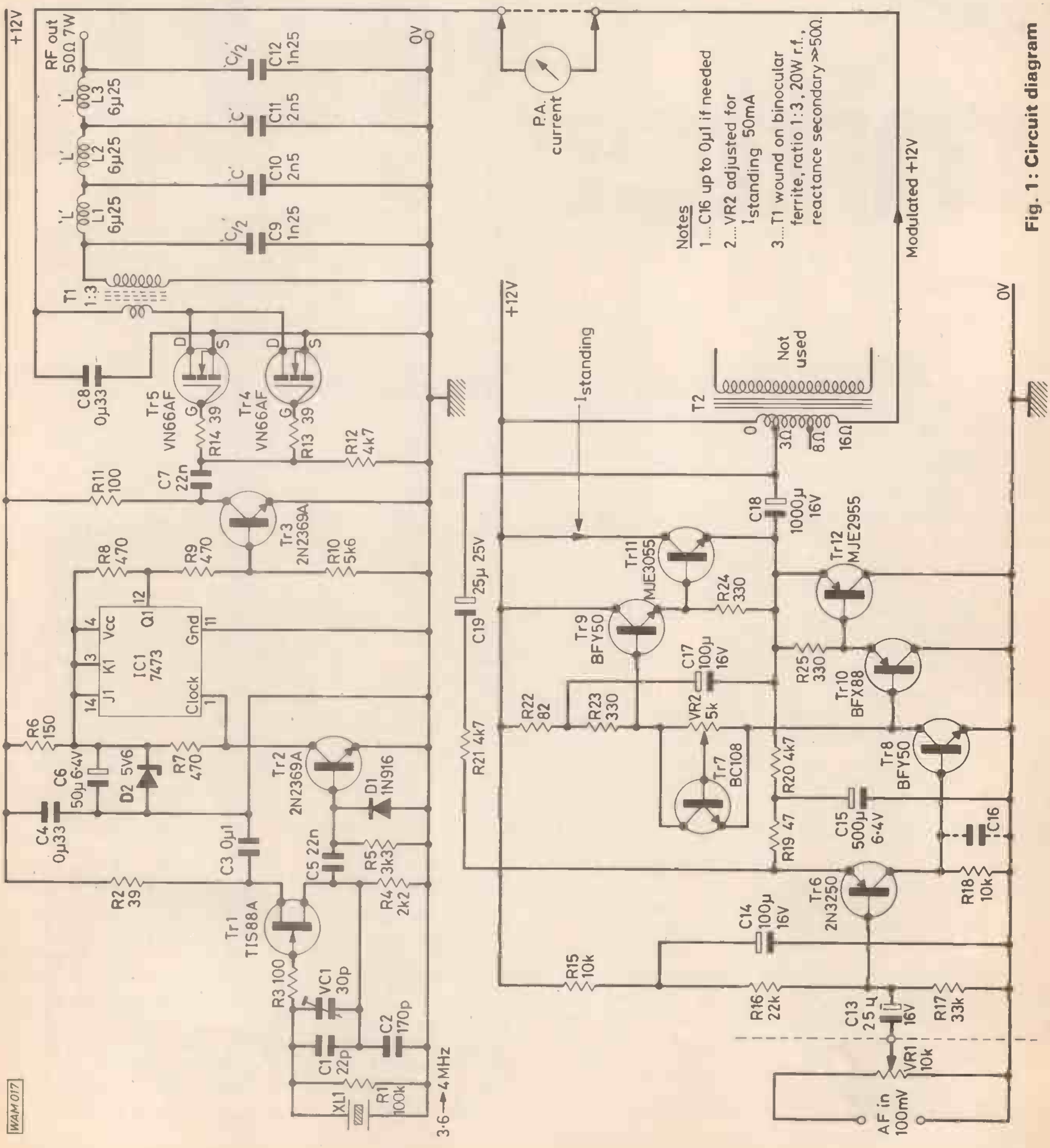


Fig. 1: Circuit diagram

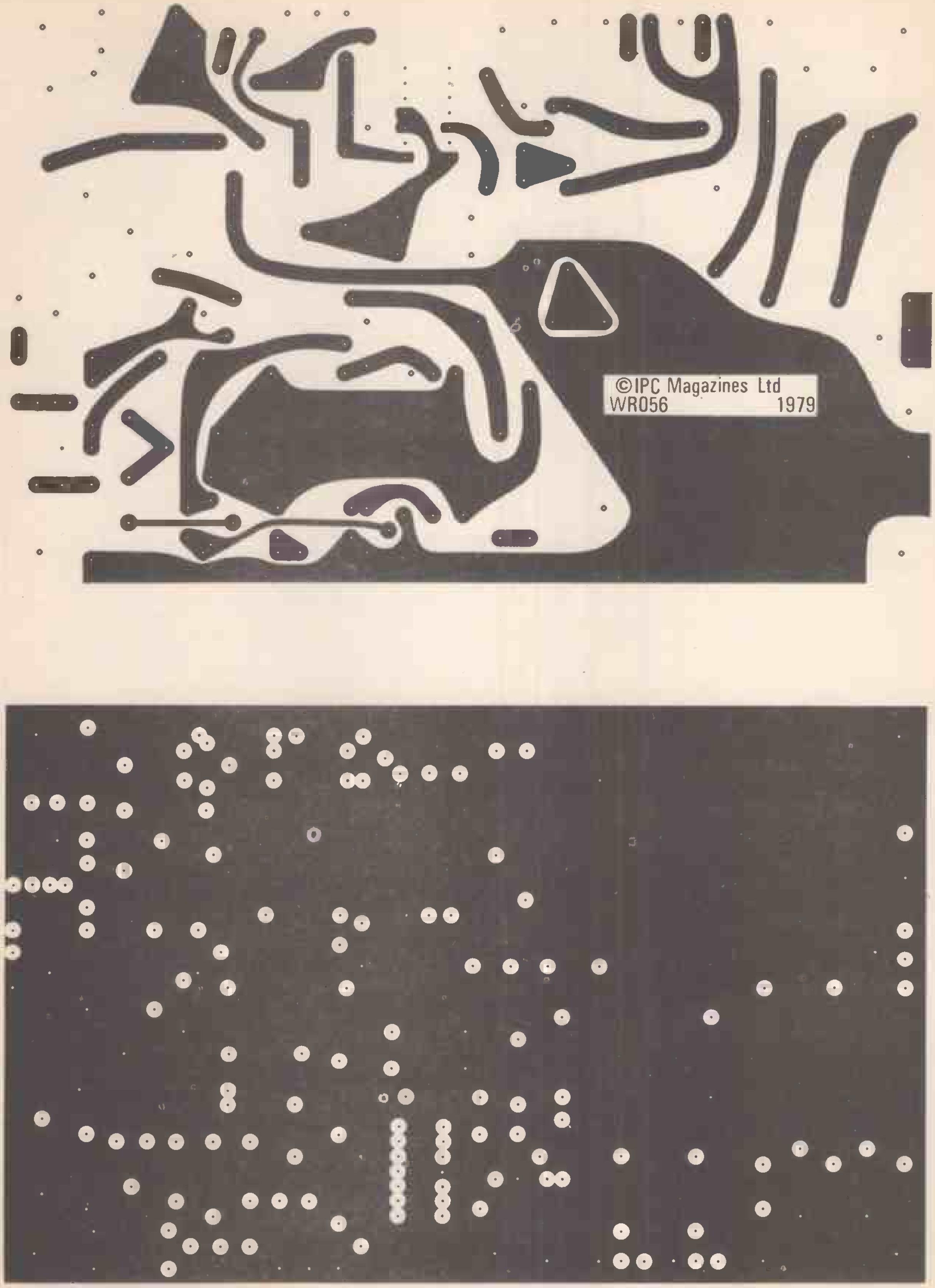


Fig. 2: The copper track side of the p.c.b. is shown full size at the top with the copper ground plane on the component side below it.

★ components

Resistors
¼ watt 5% Metal Oxide

39Ω	3	R2, 13, 14
47Ω	1	R19
82Ω	1	R22
100Ω	2	R3, 11—see text
150Ω	1	R6
330Ω	3	R23, 24, 25
470Ω	3	R7, 8, 9
2·2kΩ	1	R4
3·3kΩ	1	R5
4·7kΩ	3	R12, 20, 21
5·6kΩ	1	R10
10kΩ	2	R15, 18
22kΩ	1	R16
33kΩ	1	R17
100kΩ	1	R1

Potentiometers

5kΩ	1	VR2 Skeleton pre-set
10kΩ	1	VR1 Log. Panel mtg. pre-set with locking nut and cap

Capacitors

Silver Mica

22pF	1	C1
170pF	1	C2 180pF may be necessary

Ceramic disc

22nF	2	C5, 7
0·1μF	2	C3, 16 see text
0·33μF	2	C4, 8

Polystyrene 350 volt

1·25nF	2	C9, 12 (Use 1·2nF)
2·5nF	2	C10, 11 (Use 2·2nF)

Tantalum bead, 16 volt

25μF	1	C13
47μF	1	C14 100μF may be used

Electrolytic, axial leads

25μF 25V	1	C19
50μF 6·4V	1	C6
100μF 16V	1	C17
220μF 16V	1	C15 470μF may be used
1000μF 16V	1	C18

Trimmers
Dau type ceramic

3–30pF	1	VC1 see text (from J. Birkett)

Semiconductors

Diodes

1N914	1	D1 1N916 may be used
1N5339B	1	D2 5·6 volt Zener

Transistors

TIS88A	1	Tr1
2N2369A	2	Tr2, 3
VN66AF	2	Tr4, 5 (from C. Bowes & Co.)
2N3250	1	Tr6
BC108	1	Tr7
BFY50	2	Tr8, 9
BFX88	1	Tr10
MJE3055	1	Tr11
MJE2955	1	Tr12

Integrated circuit

SN7473N	1	IC1 SN74S73N for higher frequency operation

Crystal
XL1 Twice-frequency HC6U type, parallel-resonant

Inductors
Calculated filter values for 160 metres:
6·25μH, fc = 2·5MHz.

L1, 2, 3 — 38 turns of 26 s.w.g. enamelled copper wire on 25mm long 8mm diameter former, air cored.

Transformers
T1 20 watt rating r.f. transformer (peak). Turns ratio 1:3, secondary reactance ⩾50Ω, wound on suitable binocular balun-block ferrite (or 3 type FX2249, see text).
T2 10 watt rating speaker matching transformer with 0–3–8–16Ω taps. The step-up ratio using 0Ω as common 3Ω as input and 16Ω (or 15Ω) as output is a fraction in excess of 1:2.

Hardware
Insulating kits for VN66AF transistors (2), MJE3055 and MJE2955. Socket for crystal. 50Ω BNC connector (or SO239). West Hyde Developments instrument case type "Classic" CL2ADK (See advertisers' index). Printed-circuit board.

Setting Up

A very short section this! No tuning is required and the r.f. strip should work straight away. The d.c. input current to the final stage can be monitored and should be about 800mA when looking into 50Ω. Other loads will affect the p.a. current and in extreme cases may require some sort of matching transformer.

Poor quality "inactive" crystals will reduce the oscillator drive level and this may reach proportions where Tr2 will not switch and consequently there will be no output.

The quiescent current of the modulator should be set at around 50mA by means of VR2. If this adjustment is a smooth one all is well, but if the current flicks up to a high value check for amplifier instability. This can be cured by fitting C16, which also helps to keep r.f. from reaching the modulator.

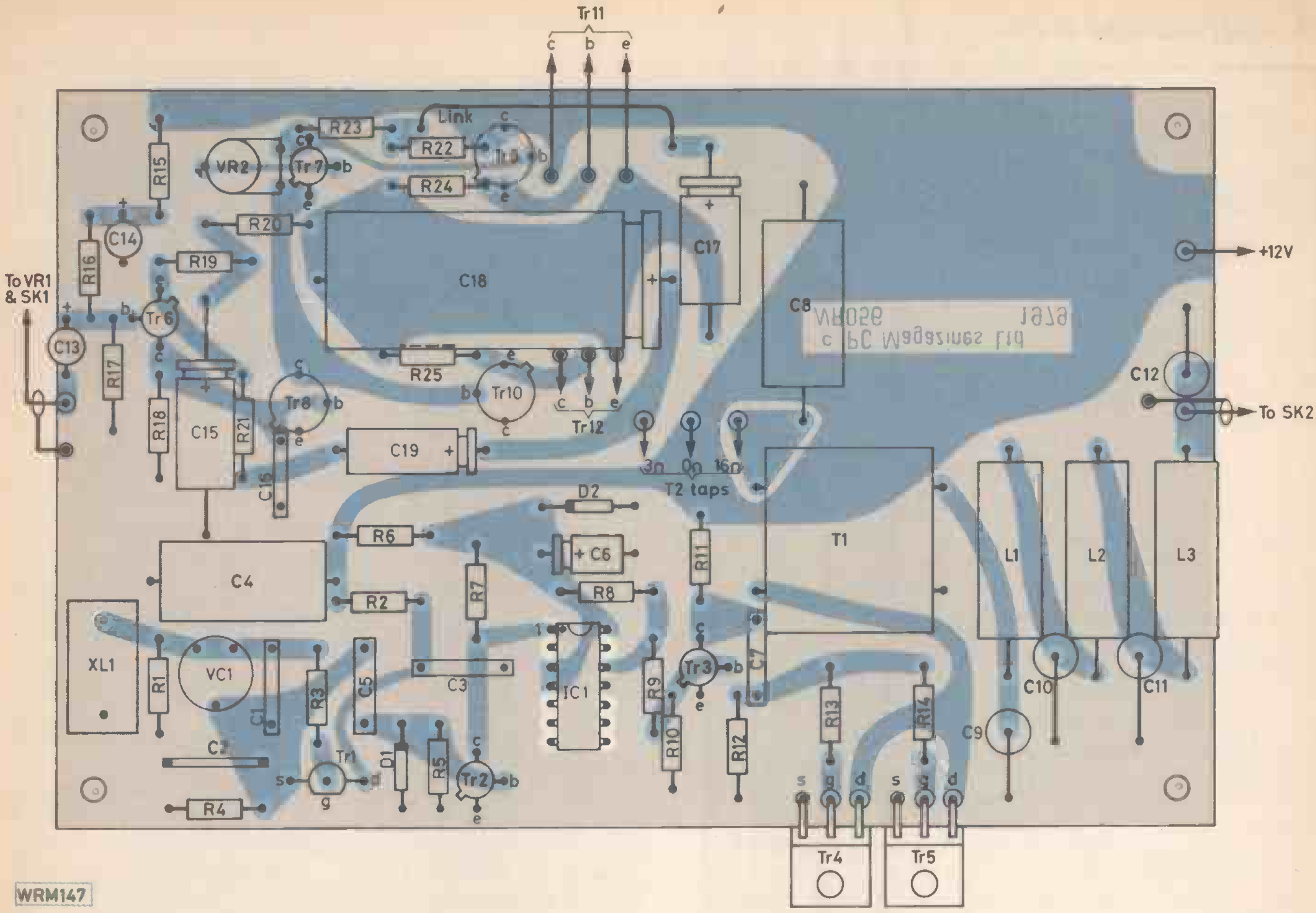
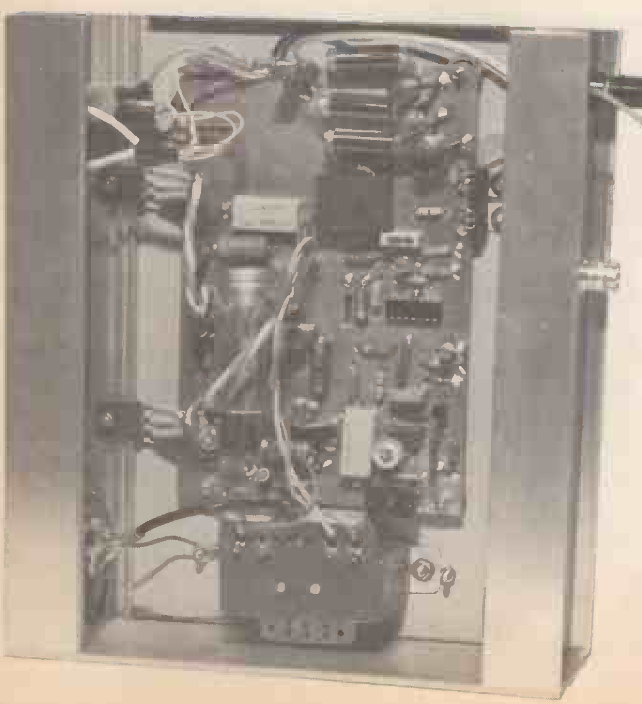


Fig. 3: The component placement drawing of the p.c.b. showing the ground plane (component) side of the board.



Aerial Matching

Most low-frequency aerials in amateur use are unlikely to present a good 50Ω match due to their small electrical size. The following techniques, based on a little theory and a lot of experimentation, are suggested.

The transmitter filter is quite tolerant of a mis-match—say 30–80Ω—but placing a low impedance load on the output may violate the d.c. input power requirements. A really low load will cause the VN66AFs to overheat, but do not worry if this should occur; adequate protection is afforded within the devices, and they will merely shut down.

VFO Operation

Those who develop the transmitter may well wish to add the facility of v.f.o. operation. This is easily achieved by feeding the twice-frequency v.f.o. signal, at 2 volts peak-to-peak, into C5, in place of the injection from the crystal oscillator.

No problems with f.m. pulling should be encountered, as the v.f.o. and output frequencies are not the same.

Well, now you know how to build and operate your VMOS transmitter. Incidentally, the VN66AFs should only cost around £1 each. We hope it brings you enjoyment.

Changes in BROADCAST-BAND LISTENING on Short Waves

PART 1

Jonathan MARKS

If you follow *Practical Wireless* regularly, then by now you may have put together or bought a short-wave general coverage receiver. Tuning around between 3 and 30MHz it soon becomes apparent that the spectrum is divided into blocks which are used for various purposes. If you listen between the frequencies 5950–6200, 7100–7300, 9500–9775, 11 700–11 975, 15 100–15 450, 17 700–17 900, 21 450–21 750 and 25 600–26 100kHz you'll hear radio programmes originating from broadcasting organisations all over the world. These radio stations are obviously different from the BBC or IBA domestic broadcast channels that the general public are used to, since their target audience is often a whole continent if not the world, rather than a single country or indeed a particular town.

A first flick through any short-wave (usually abbreviated to s.w.) broadcast band may prove disappointing. Many stations seem to be talking in foreign languages and are all crowded together. The secret with this hobby though is slow, careful tuning and frequent checks on "who's around". Most stations put out a magazine-style programme of about half-an-hour's duration in a number of languages, and with English the most common international language there are few stations without an English section. Indeed many s.w. stations broadcast specifically to Great Britain and Ireland every evening with programmes in English.

Station Types

Short-wave broadcasting stations fall into two main categories. The first group of stations aim to provide their listeners with news which is unlikely to hit world headlines (and therefore overseas newspapers and radio bulletins), yet never-the-less would be interesting to people with a desire for information on world events and culture. Such stations are usually given a grant by their government, but the journalists and broadcasters are given a free hand to make programmes without government censorship. Hence the programmes give an objective, often critical insight into current affairs in the country, the reaction of its people to world events and a sample of the culture, music and perhaps even language. Stations in this category include Radio Finland, the Swiss Broadcasting Corporation, Radio Canada International, Austrian Radio, Radio Sweden and the BBC World Service.

In the second category are the government-run stations, whose main aim is to put over the political views of the government in power. As a result programming is rather one-sided, promoting only national achievements and churning out masses of statistics. That aside, such stations can be a source of quite fascinating information, and it is often interesting to compare their version of a news story with others, either in your national newspaper or on TV. Such government-run stations include Radio Moscow, Radio Peking, Radio Berlin International, Radio Tirana and the Voice of Vietnam.

ABOUT THE AUTHOR

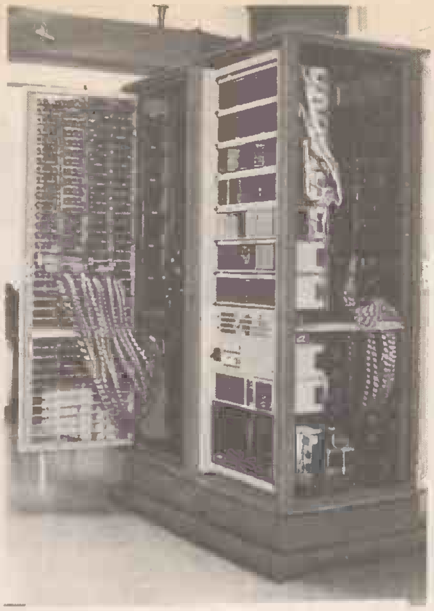
Jonathan Marks is a broadcaster/journalist who formerly worked in Vienna for the Austrian Radio Short Wave Service, becoming involved with the weekly SWL news programme "Austrian SW Panorama", broadcast world-wide every Sunday. Since returning to the UK, he has continued to make regular contributions to the programme, and is an active DX enthusiast

A view of the BBC Monitoring Service listening room, as seen from the console

Photo courtesy BBC

Austrian Radio studio centre in Vienna, with s.w. section in foreground

Photo courtesy ORF, Vienna



Computer-controlled switching gear selects appropriate transmitters and aerials to suit propagation conditions

Photo courtesy ORF, Vienna

Continuity suite for Radio Sweden. The cartridge machine on the left provides multi-lingual station identifications

Photo courtesy Arne Skoog, R. Sweden

Reception Reports

While reading *PW*'s "On the Air" feature you may have heard of QSLs and reception reports. These are really terms adopted by the broadcasting stations from the amateur radio world, and go back to the early thirties when many s.w. stations started up. In those days, stations didn't know if they were being heard in the target areas at all, and so in return for a listener sending in a report of reception (containing details of time, date, frequency and quality of reception, plus notes on the programme heard and receiving equipment used), stations would issue a confirmation card or QSL. This consisted of a picture postcard with the time, frequency and date of the transmission heard confirmed in writing on the back.

Many stations still send out QSLs, but since the thirties there have been a lot of changes on the technical side. Stations now use very much higher power (many in the order of 500kW), and because of the existence of professional monitoring stations, the larger broadcast stations know exactly how they are being received in target zones. Thus, as far as these stations are concerned, listeners' reception reports are now of marginal interest and the QSL card is more of a public relations venture since the reports are not checked. However, the smaller stations operating in only a few languages (especially religious stations), still need reception reports from listeners. They have only a limited budget and very much lower powered equipment, so regular reports on more than one frequency remain very important.

How can you judge if the station wants your report? The answer is to look in an excellent annual publication called the *World Radio and Television Handbook* which is available through most bookshops. It lists all known radio organisations in the world and where and when to listen out for them. It will give you a clear idea as to the size of the station, its QSL policy and the exact address to send your report to. In general, the smaller the station the more welcome your reception report, with the exception of small stations in West and Central Africa and South Amercia. Stations in these areas use s.w. for domestic broadcasting in much the same way as v.h.f. is used in Europe, and distant reception reports are usually QSLd only out of courtesy.

Programmes

All international broadcast stations, large or small, welcome your comments on the programmes heard. Over the last 10 years, programming standards have improved enormously compared with the sixties when most stations were of the "cold war" variety, deadly dull and boring. Then, the hobbyist could do little but send a technical reception report. In 1979, though you'll still find some pure propaganda stations, most stations in the Western world (and even a few in the Eastern Bloc) have woken up to the fact that sheer political fact switches Mr Average SWL off. Instead you can now find interesting, well-presented cultural material, whether it be tips on hitch-hiking across Sweden, eating out in Brussels, getting around in Tokyo or exploring caves in the Alps of Austria. Younger listeners too are catered for, with music programmes which broaden one's outlook on the pop music scene and enable one to get world-wide contacts. It is also important to point out that listeners who provide stations with critical constructive comments are well respected by the editorial staff.

Who listens to these international s.w. programmes? In the UK, s.w. broadcast listening is not widely known. Radios sold today in the average British hi-fi shop have no facilities for s.w. listening, but this is not the case in other parts of Europe. In West Germany or Finland for example, thanks to publicity of SWL clubs and the availability of suitable sets, SWL means more to the man in the street. There are signs though that the UK may be catching up on its European neighbours, as good s.w. receivers become cheaper thanks to integrated circuits, and digital readout eases the tuning problem. Also with more holidays being taken abroad, people like to keep in touch with countries they've seen. In the USA and Canada, s.w. is catching on simply because listeners are fed up with their local station full of commercials, time and weather men and rip-and-read news.

The more factual style of s.w. is also important in the developing countries, where radio is very different to Europe. There is usually no v.h.f. or m.w. service, and s.w. radio is the only means for the government to reach listeners in its own country. Thanks to ionospheric propagation though, signals from other countries (e.g. in Europe) can also reach developing countries. The BBC's African Service for example, thanks to a network of on-the-spot correspondents, provides a very fast, accurate picture of what is going on in Africa for African listeners, often before the national radio station reports it. Of course politics comes into play here. Many stations in the Western world beam vernacular programmes towards a developing country which disagree with what the national government station in that country is saying; something which often worries the latter if it is trying to influence its population.

Local Stations

Most stations in Latin America broadcast on the 60 metre tropical s.w. band (4750–5060kHz) instead of medium waves, which are full of static due to tropical thunderstorms. Propagation is such that from about midnight until dawn in the UK you can hear these stations broadcasting to their local population: an excellent insight into Latin America with wide opportunities to study the language or simply enjoy the music. Such small stations in the jungle run on a shoe-string and provide amusing stories for those who've visited them.

The official time signal on one station in Peru for example, turned out to be made by a simple audio oscillator triggered by the DJ watching the second hand on an ancient clock. A station in Bolivia came up on the wrong frequency for over a month because the station engineer had plugged in the wrong crystal. Similar stories come from Asia where the national station in Nepal sometimes comes on the air late when they forget to switch on the carrier of the transmitter. All this added together makes for a fascinating hobby.

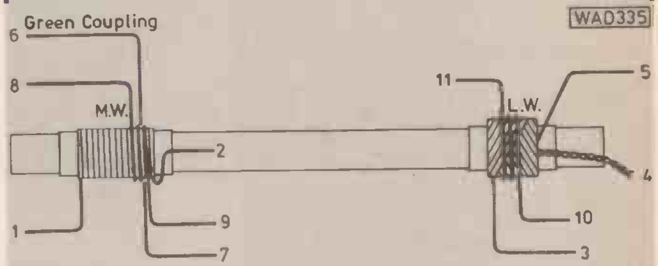
The secret is to know when and where to look. One of the best ways is to contact one of the UK Broadcast DX Clubs as well as reading "On the Air". In addition stations themselves put out SWL programmes to assist listeners, for example: *Sweden Calling DXers* (Radio Sweden), *World Radio Club* (BBC World Service), *Austrian SW Panorama* (Austrian Radio), *World DX News* (AWR, Portugal) and *DX Juke Box* (Radio Nederland) to name just a few. In addition, an organisation exists in the UK, called the Handicapped Aid Programme, to help introduce this hobby to the disabled. Undoubtedly, broadcast listening can open up new horizons for a person who is house-bound, and no licence is needed.

Finally, if you would like to combine your hobby with a holiday, then you might consider joining a DX camp for a few days. These take place during the summer months in Austria, West Germany, Sweden, Finland and, starting in 1979, in the UK. These meetings offer an excellent chance to try out new equipment and antennas as well as meeting fellow DXers and SWLs. Such camps are often co-ordinated under the European DX Council which acts as an umbrella organisation for European clubs and has a number of useful publications for broadcast band listeners. Meetings on a local basis also explode the myth that a typical SWL is someone who hibernates in his shack, to find friends all over the world but none in his own country!

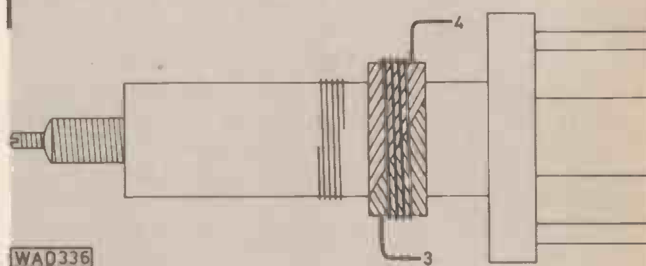
CONTINUED NEXT MONTH

KINDLY NOTE!

PW Imp 3-Waveband Receiver May 1979
The details of the extra windings to be added to the coils were unfortunately omitted from Figs. 5 and 6. They are given below.



Additional reaction windings. 38s.w.g. enamelled copper wire. 8-9, 2 full turns in sense shown above; 11-10, 2 full turns in sense shown above. Note that the coils should be on the rod as shown so that the windings are in the same direction from the 'live' ends (1 and 3).



Reduce winding 5-7 to 2 turns. Add 12 turns of 38s.w.g. enamelled copper wire on top (3-4) in direction shown above.

RADIO

SPECIAL PRODUCT REPORT

FRG-7

YAESU

GENERAL COVERAGE RECEIVER

There are many types of communications receivers currently available, the choice of which is initially determined by where the user's interests lie. General-coverage receivers, as the name implies, cover a range of frequencies which include broadcast bands, amateur bands and other communications channels, and the Yaesu FRG-7 falls into this category.

On the other hand, if only the amateur bands are required, then receivers for this purpose, offering a greater bandspread over these frequencies, are available.

In both instances, the tuned frequency may be displayed by "conventional" analogue means, or a digital readout, which gives the tuned frequency in illuminated digits.

The FRG-7 tested by *PW* was already fitted with a digital readout when supplied by SMC Ltd. This is an option which can be retro-fitted to existing FRG-7s and replaces the original dial unit with a $4\frac{1}{2}$-digit red l.e.d. display. The digital display indicates the kilohertz part of the frequency to which the receiver is tuned, while the megahertz part is set using the original MHz knob in conjunction with the "Lock" indicator lamp and the "Band" switch.

A Preselector control is provided which enables the r.f. circuits to be tuned for optimum signal. This control operates a vertically mounted drum which has four bands marked on it. The Band switch selects the basic range over which the Preselector and MHz controls operate, at the same time illuminating the appropriate preselector band.

The "Lock" indicator lamp is extinguished when the MHz tuning control is correctly set to mid-band.

The main tuning control is fitted with a large diameter handwheel knob which has a large felt washer fitted behind it to provide a measure of friction although by no stretch of the imagination could the control be described as flywheel. The fine tune control is fitted just to the right of the main tuning knob and was positioned too close to the main knob for comfort. It proved to be annoying when, after getting the main control set, operating the fine tune meant that one's thumb or index finger caught the large knob putting the set off tune. The fine control also seemed to be much too coarse in operation making precise adjustment of setting, so essential for successful s.s.b. listening, very difficult. In fact with an adjustment of ±6kHz over 180° swing it was only four times better than the main control and it was almost as easy to set the tuning using only the main control and ignoring the fine one. As supplied the fine control operated in reverse to the main control but this was easily altered by slackening the grub screw of the knob and turning the knob through 180°.

An input attenuator is fitted with a three position switch labelled DX, NOR, Local. The handbook indicates that in the DX position a station which is swamping the set can be attenuated to enable a weaker distant station to be received. We were not able to verify this as in the Bournemouth area no signals seemed strong enough to overload the front-end. All the attenuator seemed to do was cut down the signal strength, so the set was operated with the attenuator in the normal position.

The Tone switch changes the audio response of the receiver and has three positions, 250Hz to 3kHz, 400Hz to 2·5kHz and 250Hz to 1·5kHz.

The other front panel controls fitted are a volume control and the Mode switch. A horizontal scale S-meter is fitted above the tuning dial. The dial lamps can be switched off independently of the main power, which cuts down on current drain from the battery pack when running from batteries.

The audio output, rated at 2 watts, is not hi-fi but is presentable and enables the receiver to be used on the broadcast bands.

A pair of phones can be used instead of the speaker fitted, the phone jack being on the front panel together with the jack for the record output.

The performance of the FRG-7 on a.m. was excellent with a very good single-signal response. However, on s.s.b. and c.w. the set lacked selectivity with the standard filters. Alternative filters are available as optional extras but were not tried in this test.

Three sockets are provided on the rear of the case for aerials. Two of these are push-type terminals for long-wires while the third is a SO239 socket for use with a coaxial type

THE WADLEY LOOP

The FRG-7, in common with many other contemporary communications receivers, employs the Wadley Loop, triple-conversion superheterodyne system. This offers a number of advantages in terms of performance.

A high first intermediate frequency can be used, in this case around 55MHz, giving good image (second-channel) rejection. The problems inherent in achieving satisfactory frequency stability in the first oscillator ("MHz Set"), which must operate in the v.h.f. band and tune over a range of some 30MHz (55·5–84·5MHz), are overcome by mixing its output in twice, so that any errors due to drift are self-cancelling.

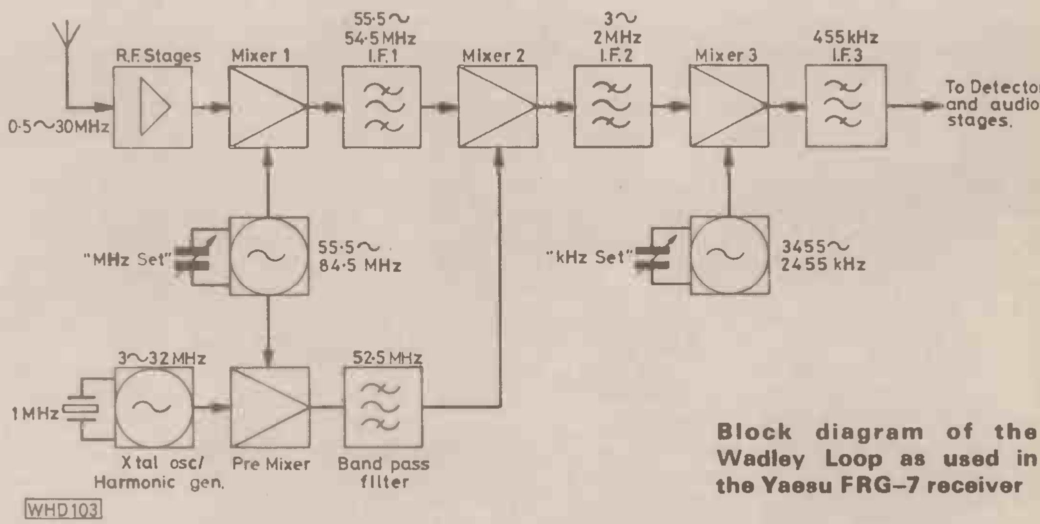
As shown below, this is done by mixing the first oscillator output with a spectrum of harmonics from a stable 1MHz crystal oscillator. The product at 52·5MHz is selected by the Band-pass Filter and mixed with the 1MHz-wide band of signals coming from IF1 to translate them to the band 3-2MHz for IF2.

The output of IF2 is mixed with the output of the "kHz Set" oscillator in Mixer 3. Because this oscillator operates at a reasonably low frequency, and over a band just one megahertz wide, it is not too difficult to make it adequately stable. The output of Mixer 3 is at 455kHz, and is passed to a conventional i.f. filter/amplifier chain, detectors and a.f. stages.

Because there are no conventional band switches other than in the r.f. preselector stage, problems due to varying contact resistance in the oscillator circuits (a common cause of instability) are eliminated. Because the whole range of 0·5–30MHz is tuned in bands 1MHz wide, the tuning resolution of the receiver is the same at 1MHz as at 30MHz.

Disadvantages of the system are the large number of mixing stages employed, calling for careful screening and filtering if spurious products are to be kept low, and the need to design efficient filters operating in the v.h.f. band, for IF1 and the Band-pass Filter.

The actual frequencies adopted in the early stages of receivers using the Wadley Loop principle vary between different models; those shown here are as used in the FRG-7. Anyone checking the sums for themselves may wonder about the fact that the "MHz Set" oscillator tunes down to 55·5MHz, which is within the passband range of IF1, inferring that the receiver will tune down to zero frequency! In fact the lowest band is cut off at just below 0·5MHz by the response of the r.f. stages, and on that band, the signals passed to IF1 are limited to 55–54·5MHz and those in IF2 to 2·5–2MHz. The "kHz Set" oscillator only tunes over 2955–2455kHz on this band. In many Wadley Loop receivers, IF2 is fixed-tuned with a 1MHz passband, but in the FRG-7 it is tuned in step with the "kHz Set" oscillator.



Block diagram of the Wadley Loop as used in the Yaesu FRG–7 receiver

feeder and this is electrically common with the push terminal labelled SW1. This can cause confusion since the coaxial socket is labelled SW1 on the circuit diagram, SW2 on the receiver back panel and to add to the confusion a label immediately above the aerial sockets gives the ranges as SW1, SW2, SW3 and SW4.

The handbook provided with the set was generally good, with an adequate circuit description, a full circuit diagram drawn reasonably well and very legible, a block diagram of the set and a comprehensive components listing.

The operating instructions were generally good but there were some omissions. The English was very good for a Japanese model with none of the usual funny sentences which seem to occur during translation from the original.

Maintenance and alignment information together with a voltage chart and p.c.b. component layout drawings should help if it is ever necessary to overhaul or repair the set.

As well as the operating manual, the FRG-7 is supplied with two lengths of copper flex for use as aerials, all the necessary plugs and two spare fuses.

The maker's guarantee is for twelve months but does not include the semiconductors.

★ specifications

Mode: AM; SSB: (USB, LSB); CW

Frequency range: 0·5MHz–29·9MHz

Sensitivity: SSB/CW better than 0·7μV for 10dB S/N at 30% modulation

Selectivity: 3kHz – 5dB
7kHz – 50dB

Frequency stability: Within 500Hz during any 30 minute period after warm-up

Input Impedance: 0·5MHz – 1·6MHz High Impedance
1·6MHz – 29·9MHz 50–75Ω unbalanced

Output Impedance: 4Ω

Audio Output: More than 2 watts

Power requirements: 100/110/117/200/220/234V a.c. 50/60Hz or 13·5 d.c. Negative ground

Batteries: Type UM–1 x 8

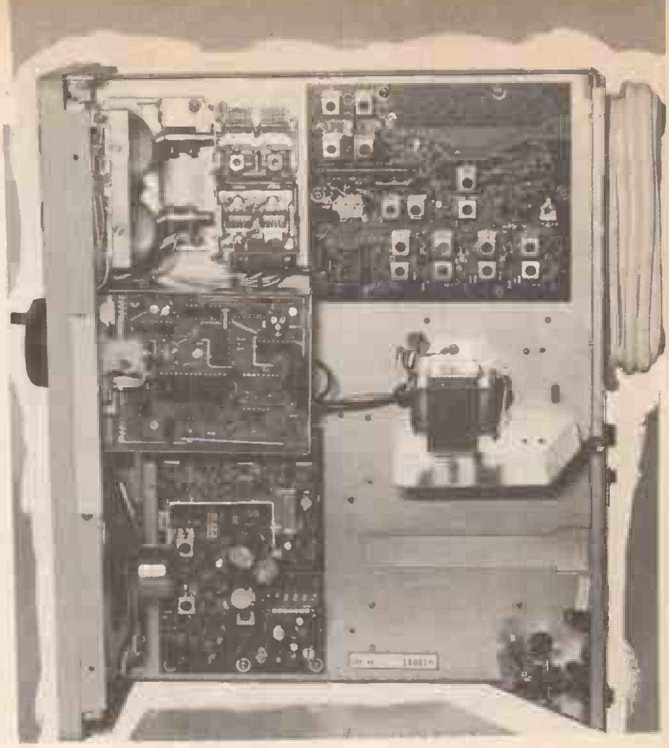
Dimensions: 340 x 153 x 285mm

Weight: 7kg without batteries

The standard of engineering is excellent as can be seen from the photograph of the inside of the set we tested.

The receiver was subjected to several air-tests, using a variety of antennas, ranging from a 132ft long wire to a multi-element rotary beam. On the broadcast bands the receiver performed very well indeed and the s.s.b. capability for amateur reception was also quite good. (The latter mode can be quite dramatically improved, incidentally, by the inclusion of the mechanical filter, produced for the FRG-7 by Ambit International.)

The Wadley Loop provides a good degree of stability in the receiver. This is especially necessary for acceptable sideband resolution—at 29MHz, for the receiver to remain within about 25Hz of the tuned frequency, a stability factor of about one part per million is called for. Long-term stability is perhaps less important to the amateur than stability in the short-term, and the FRG-7 performs quite well in this respect. However, since the Wadley Loop system involves multiple conversion, it is difficult to achieve a wide dynamic range, a problem which is overcome to some extent in this receiver by the use of a balanced mixer.



Internal view of the Yaesu FRG-7

Used in conjunction with a 400 watt p.e.p. transmitter, the receiver performed well. Many contacts were made with W, VK, ZL, ZS and so on, some of these on a simple end-fed long-wire antenna. Copy on the h.f. bands was good, but on the more congested frequencies—such as 40m—it was often felt that a little more selectivity would have been nice. Still, "You pays your money . . ." as the old adage goes, and the FRG-7 represents particularly good value.

A 2·4kHz mechanical filter to improve the s.s.b. performance is available from Ambit International, 2 Gresham Road, Brentwood, Essex, priced at £15·30 (inc VAT). We understand that a Yaesu approved s.s.b. filter may be available from SMC in the very near future.

Prices

Basic FRG-7 receiver £210·37
FRG-7 receiver with digital readout £270·00
Yaesu approved digital readout (SMC) £56·25
(All prices quoted include VAT and carriage)

The FRG-7 receiver reviewed was kindly loaned by South Midlands Communication Company Ltd., Osborne Road, Totton, Southampton SO4 4DN. Tel: 04216 7333, and we would like to thank them for their invaluable assistance in this respect.

NEXT MONTH WE REVIEW THE
LOWE SRX-30
RECEIVER

NUMBERS WITHOUT TEARS

Continued from page 37

should not be taken to Vss via any wire connecting the c.m.o.s. to Vss. When Tr21 is switching a full 140mA, some very strange arithmetic may be evident from the counters if some of the wiring to Vss is common! Anyone contemplating a p.c.b. design is especially warned of this point.

In order to make the touch plate as mechanically simple as possible, a 6BA cheeseheaded bolt was mounted on (but insulated from) the metal front panel and recessed so that the head was flush with the panel. The entire box was earthed and connected to the mains transformer screen, and connected to Vdd via R26 (see Fig. 6).

In this way, a finger placed on the head of the bolt must also touch some of the surrounding painted panel, and this provides sufficient base current to operate the Darlington pair, Tr1 and Tr2. The instrument is thus electrically safe while providing 100 per cent reliable touch operation of the swept-frequency clock.

Fault-finding

It may be found that, on closing S1, the clock does not run. Decreasing R4 to 82kΩ will solve the problem. Similarly, in the swept-frequency mode, it may be found that the clock is still "ticking over" even when C2 is discharged. Increasing R1 to 47kΩ should stop the clock. These problems arise because of the 5% tolerance resistors used to derive quite a precise voltage at point A (Fig. 2). The author has not found this to be a problem, but theory shows that it is quite possible.

The mains switch, S5, is a d.p.d.t. slider switch mounted on the side of the box adjacent to the top of the front panel. It is thus normally out of sight, reducing the temptation to tamper with it.

Summary

This instrument is designed to appeal to children of $2\frac{1}{2}$ years upwards. The visual effects produced by it are pleasant and interesting. There are switches to use, buttons to press, a knob to turn, and a touch-controlled flywheel display. It aids in the teaching of rapid number recognition and matching, without obviously being a "teaching" toy.

It can also be used as a die for other board games when the numbers themselves have become of secondary importance.

With a little judicious help, the child will soon grasp the cyclic nature of counting in the decimal system—the progression from single-digit numbers to dual-digit numbers, the second (tens) digit being the number of complete revolutions of the flywheel, the first (units) digit being the number at which the flywheel stops. ●

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

In general, the author does not have any more information on products than appears in the article.

Microprocessor Miscellany

People have long been chanting that microprocessors are going to end up in "everything". One of the latest applications to reach my ageing eyeballs is in typewriters. The new ET 221 for example is not the established "golfball" but a "daisywheel". Built-in is a Z80-based system that uses a number (note: not just one) of 8-bit, single-chip microcomputers. To be sold in the US for under $2000, this new wonder-writer has a 20-character display for showing what you've been typing in line at a time. It can also store lines and page formats too, so it appears to be bordering on a form of word processor.

Another microprocessor application to loom is in controlling motors. When one considers that there are virtually millions and millions of motors in so many different applications, the enormous market becomes apparent.

There are some very good reasons, too, for using microprocessors in this application. The first is that old chestnut—money. For example, many motors rely on costly feedback loop circuitry required for close speed control. It has been claimed that just over £1 worth of digital chip can replace £5 worth of analogue circuitry to do the same job. The microcomputer can also do far more than adjust speed. For example, it can check the motor current against a table of maximum values which it holds safely stored in its ROM. This very same ROM can contain a program that limits both the instantaneous and surge currents drawn by the motor at any given time. This, besides offering a safety factor, also allows the manufacturer to use smaller, and probably cheaper motors to do exactly the same job.

Big Bang Theory

A few Ginsbergs ago I mentioned Lithium batteries. They appeared to offer advantages, but I now hear of disadvantages—like they explode. Perhaps not all Lithium batteries do this, but it is reported from America that the powerful Federal Aviation Administration has ordered that Lithium-Sulphur-dioxide batteries must be removed from emergency aircraft locator transmitters within 30 days. Apparently half a dozen or so reports were received of $LiSO_2$ batteries exploding. Some 6000 aircraft in the US carry equipment that uses $LiSO_2$ batteries.

Mon Dieu

I note with great interest that a British company has come up with an i.c. certain to cause a linguistic stir. By adding it to your teletext/viewdata decoder set, you can have the potential to display the whole lot in one of 28 different languages—Ha so! Perhaps you don't get the whole 28 in one go, but an order has already been received for the chip from across the pond in Canada, where the new i.c. is to enable delighted viewers to see viewdata information in a 20-row format (32 characters/row) in English and French. Had this happened when de Gaulle was in office, the designers would have been given the Legion of Honour and free wine for life. How about it, Giscard?

Stable Arrays

And pleased I am, too, to tell of another British achievement. A well-known establishment has come up with a new way of addressing twisted nematic liquid crystals. The liquid crystal display matrix can be driven continuously over the whole of its area and thus the annoying flicker associated with multiplexed arrays is eliminated.

Complementary m.o.s. (CMOS) powered by only 15V is used to drive a 100 × 100 matrix at around 5kHz. Researchers believe that 1000 × 1000 element arrays are possible. This, coupled with the low voltages and flicker-free display, could have great impact on the small screen TV and scope development. A pocket oscilloscope with a power consumption of, say, 500mW becomes a reality.

Bye-Bye Noise

The Dolby system of noise suppression in audio and hi-fi equipment is now very well entrenched. But a German company has arrived with an alternative—and the claims are that it's better, too. The new system is called High Com and it claims to be an improvement over the Dolby system in two areas. The first is that it removes an extra 10dB of noise. It is also said to perform this kind act over the audio spectrum—that's 30Hz to 20kHz, not just over a narrow band.

The immediate area of obvious improvement is at the l.f. end. The Dolby system starts to be effective at around 300Hz, so it isn't so effective against our old audio enemy "mains hum" at around 50Hz. The name High Com derives from "high fidelity compander" and during compression the lowest level signals are amplified. Thus any noise that is picked up or contributed by either the storage medium employed or the actual transmission path finds the amplified signal that much stronger and therefore that much higher above the noise level.

The immediate application for such a device is in consumer audio goods and it is rumoured that some 20 European electronics manufacturers are very interested indeed, as are four of the big Japanese producers. One claim is that when the High Com was used on an audio cassette tape recorder, the measured noise was found to be no less than 20dB down. The magic i.c. that helps achieve all these wonderful things is designated U401B and it comes disguised in a 24 pin d.i.l. plastic package. It has been suggested that the new device could be very usefully employed in radio and television. Although it will cost a little more than the Dolby counterpart at present, volume production will doubtless bring the prices tumbling down. Please note: you cannot buy one yet.

Ginsberg

INEXPENSIVE AF electronic voltmeter

M.TOOLEY BA G8CKT

Most multi-range meters offer a rather mediocre performance on the a.c. voltage ranges. The Avo 8 MkIV, which has long been one of the writer's favourite test instruments, exhibits an internal resistance of only 250 ohms on the most sensitive (2·5V) a.c. range. This is clearly very unsatisfactory regarding sensitivity and circuit loading when measurements are to be made on today's electronic circuits. The instrument described was therefore developed as a replacement for the Avo on the a.c. voltage ranges and it offers the advantages of a 1MΩ constant input impedance on all ranges and a frequency response which is substantially flat from 10Hz to well over 100kHz. Six voltage ranges are provided, with a maximum sensitivity of 100mV r.m.s.

The unit uses low cost readily available components and can be built for an outlay of around £10. Battery consumption is minimal and a small 9V battery will provide for many hours of operation.

Circuit Operation

The a.c. voltage to be measured is applied to a switched potential divider, R1 to R6. The range is selected by S1 and capacitor C1 is used to remove any d.c. level present on the input voltage. R7 provides a measure of protection for the field effect transistor, Tr1, and C2 provides a degree of high frequency compensation. Tr1 operates as a source follower and exhibits an extremely high input impedance (greater than 100MΩ) thus minimising the loading effect on the potential divider. Tr1 provides a voltage gain of slightly less than unity, the output voltage being developed across R8.

Silicon transistors, Tr2 and Tr3, form a two-stage high-gain amplifier. Both transistors are operated in the common emitter mode. The amplifier incorporates three feedback loops which help to ensure unconditional stability, a wide operating bandwidth and a high degree of linearity. Stabilisation of the transistor bias is provided by means of direct current feedback from the emitter of Tr3 to the base of Tr2 using R9. C4 provides negative feedback in the second stage of the amplifier. This helps reduce any tendency to oscillation at high frequencies and also ensures that the frequency response "rolls-off" beyond a few hundred kilohertz. VR1, the emitter resistor of Tr2, is used to set the overall voltage gain by controlling the amount of negative feedback present.

Germanium diodes, D1 and D2, from a voltage doubler rectifier arrangement. The arrangement of C6 and C7 provides a means of reducing the surge current through the meter movement during switch-on. Silicon diodes, D3 and D4, provide a "last ditch" protection for the meter movement by offering a shunt path to current when a 600mV voltage drop of either polarity appears at the meter terminals; this corresponds to an eight times overload.

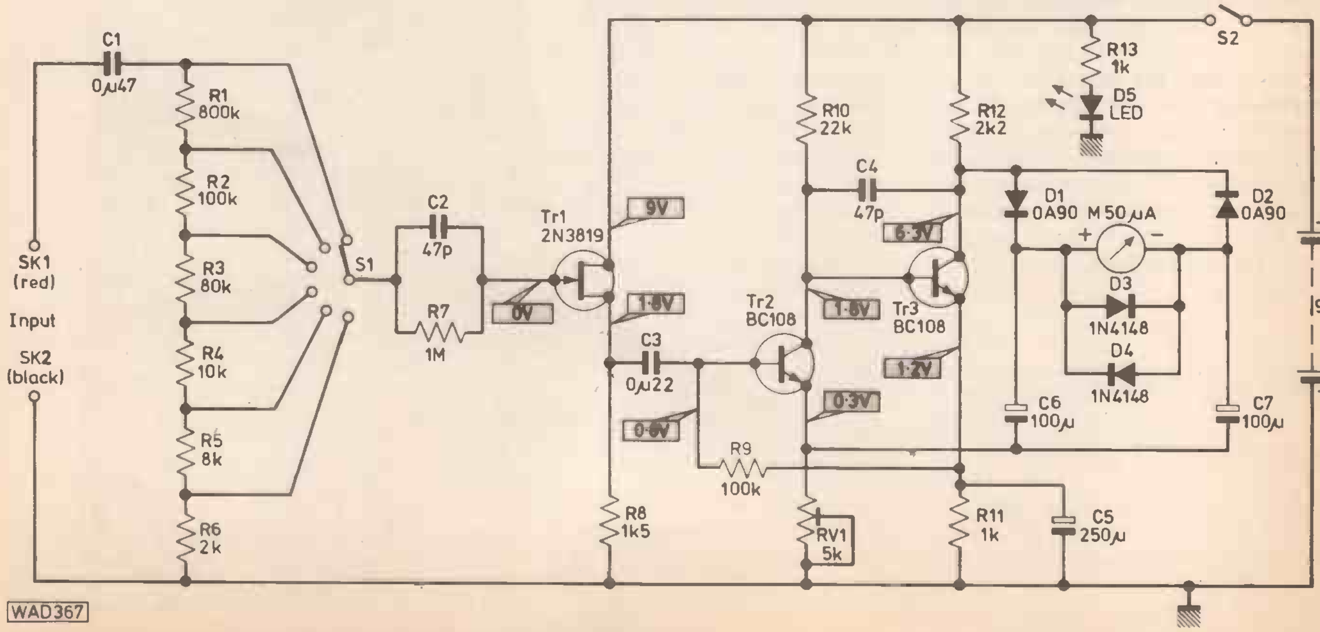


Fig. 1: Circuit diagram of the a.f. electronic voltmeter

★ specifications

Voltage ranges: 100mV, 500mV, 1V, 5V, 10V, 50V

Input resistance: 1MΩ on all ranges

Frequency response: Typically 5Hz to 250kHz at 3dB down

Accuracy: ±5%

Supply: 9V d.c. at 10mA

Construction

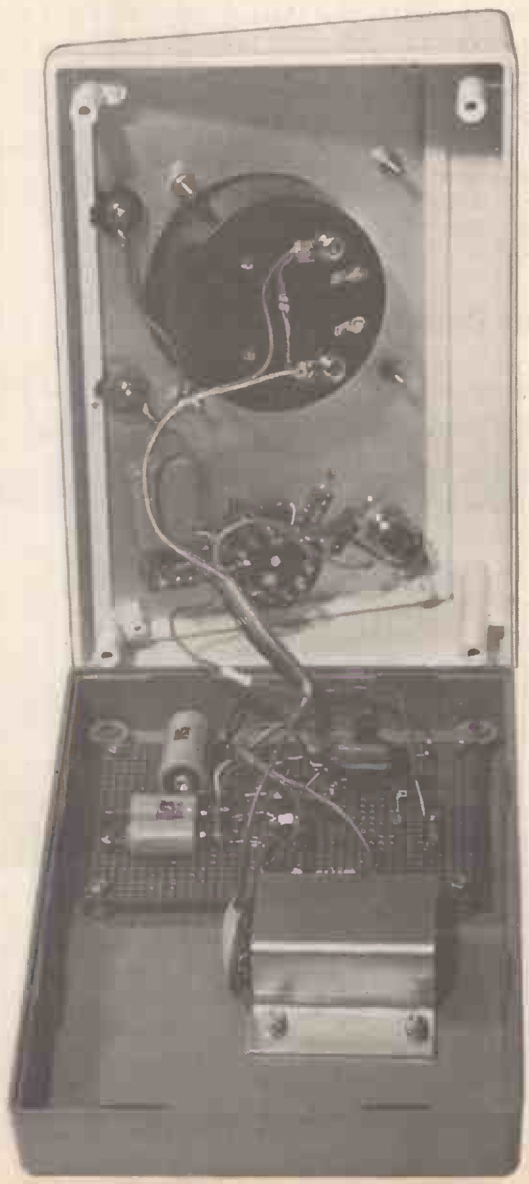
The impedance converter and the amplifier circuit are constructed on a p.c.b. The circuit board layout is shown in Fig. 3. The range selector switch, S1, is mounted on the front panel of the instrument together with the meter movement, power on/off switch, l.e.d. indicator and input sockets. The potential divider resistors, R1 to R6, are most conveniently wired directly to the tags of S1. C1 is wired directly between the input terminal and top end of R1, which is located on S1. Note that the high frequency response of the instrument will depend very much on the stray reactance associated with the input and potential divider wiring. It is essential that all connecting leads be kept as short and direct as possible. The front panel wiring layout is shown in Fig. 4.

Earthing of the metal front panel is achieved by means of the body of S1, which may be soldered to directly in order to provide a common earth point. If an alternative switch is substituted for the recommended type, it may be necessary to locate a separate earth tag on the front panel. This may be most conveniently accomplished by using one of the meter securing nuts. The front panel is labelled by means of dry transfers, and then sprayed with clear lacquer to protect the transfers. During this operation the meter should either be removed from the front panel or be protected using several layers of masking tape.

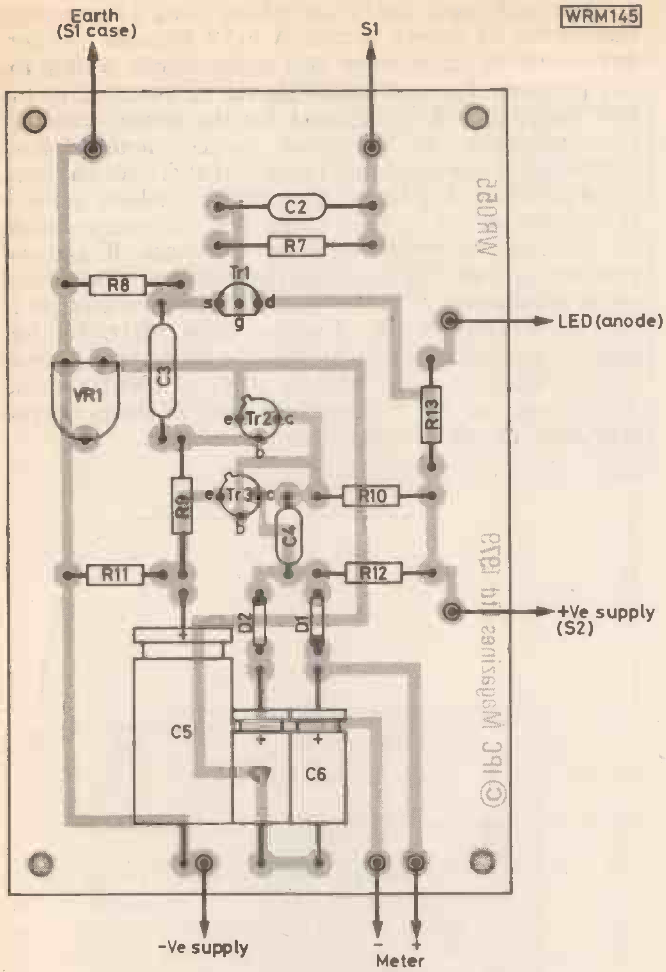
The instrument is housed in a standard Vero case. Any other suitable case may of course be substituted provided that any metal parts are connected to the earth or common rail. It was not found necessary to use a totally screened enclosure for the instrument, as with careful wiring there should be no pick-up of hum or stray signals within the unit. The unit will not, however, give accurate indications in the presence of very strong r.f. fields such as may be experienced when measurements are made on medium or high power transmitters.

Testing and Calibration

After completing the assembly of the instrument it is advisable to carry out a thorough visual check of the wiring. Connect a 9V battery to the instrument and measure the d.c. current supplied. If the circuit is functioning correctly this should be approximately 10mA and will vary slightly according to the setting of RV1. Due to a slight difference in the charging currents of C6 and C7, the meter pointer



Internal view of the complete instrument. This is the prototype which used a matrix board instead of a p.c.b.



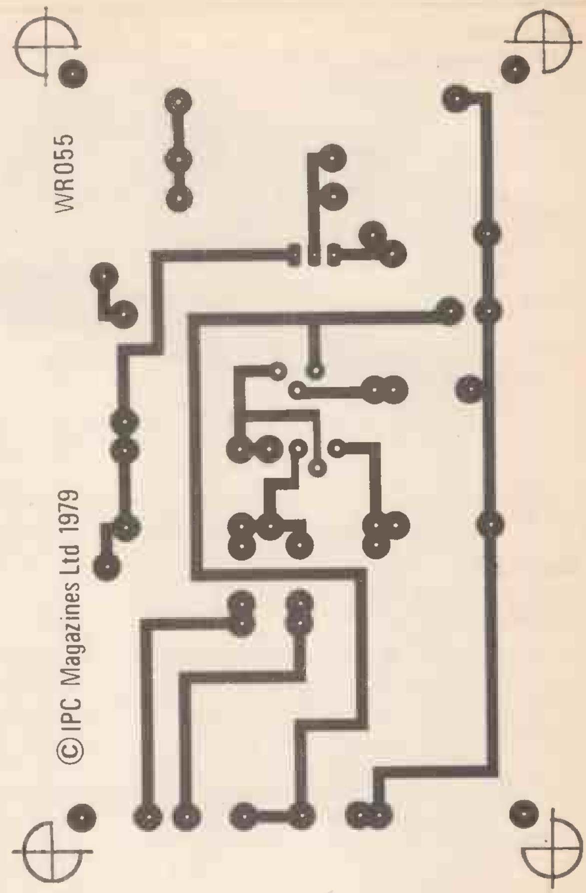
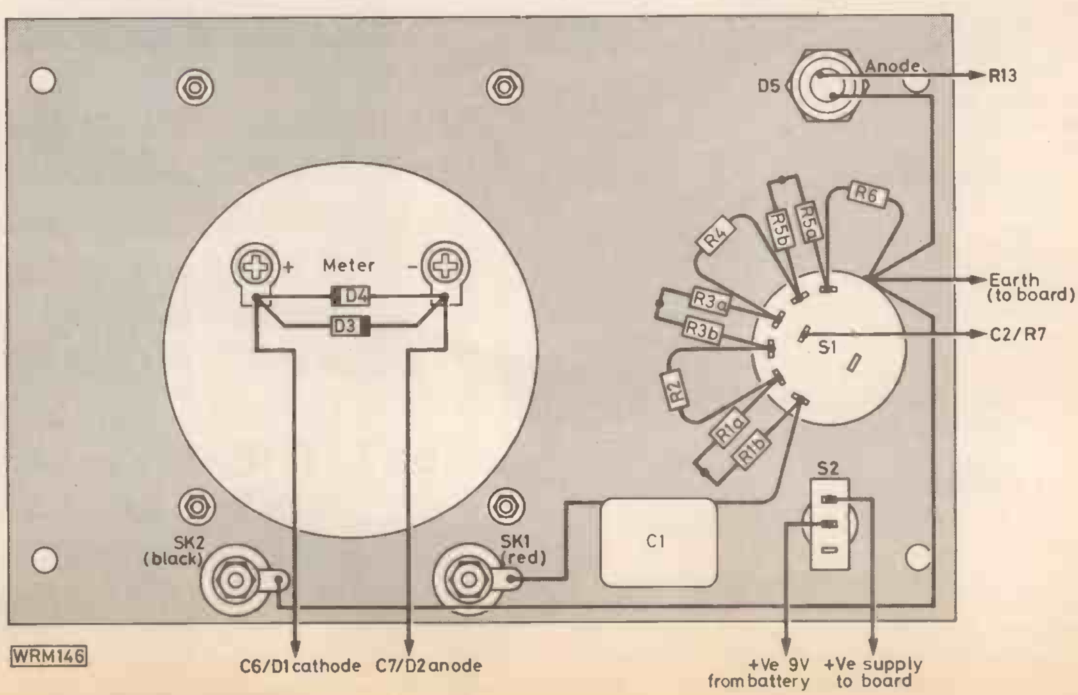


Fig. 2: (above left) The component overlay for the p.c.b. version of the a.f. voltmeter

Fig. 3: (above right) The copper track layout of the p.c.b. shown here full size

Fig. 4: (below) The wiring and layout of the front panel. The resistors on S1 are soldered directly to S1 tags and the end of R6 is soldered directly to the body of the switch



★ components

Resistors		
½W 2% metal oxide		
1·2kΩ	1	R5a
2kΩ	1	R6
6·8kΩ	1	R5b
10kΩ	1	R4
12kΩ	1	R3a
68kΩ	1	R3b
100kΩ	1	R2
120kΩ	1	R1a
680kΩ	1	R1b
½W 5% carbon film		
1kΩ	2	R11, 13
1·5kΩ	1	R8
2·2kΩ	1	R12
22kΩ	1	R10
100kΩ	1	R9
1MΩ	1	R7
Capacitors		
Electrolytic axial leads		
100µF 25V	2	C6, 7
250µF 25V	1	C5
Polystyrene		
47pF	2	C2, 4
Polyester		
0·22µF	1	C3
0·47µF	1	C1
Potentiometers		
Miniature horizontal preset		
5kΩ lin.	1	VR1
Semiconductors		
Diodes		
OA90	2	D1, 2
1N4148	2	D3, 4
LED	1	D5
Transistors		
BC108	2	Tr2, 3
2N3819	1	Tr1
Switches		
1p6w rotary	1	S1
s.p.d.t. min. toggle	1	S2

Miscellaneous
Case Vero 75-1798-k 171 x 121 x 75mm (1); 4mm terminals 1 red, 1 black; Meter, 50µA 4 inch scale 110 x 82mm; Printed circuit board; battery connector, knob SW150 with cap and skirt (Sifam).

may give a momentary indication when switching on. The pointer should however return to zero fairly quickly, and if this is not the case the wiring should be re-checked for faults.

To calibrate the instrument a known source of a.c. voltage is required. A signal generator with a calibrated output level may be used, alternatively a comparison may be made with an existing a.c. voltmeter. If neither is available, a rough calibration can be carried out using a low voltage transformer of known output. A 6·3V filament transformer or the 9V transformer of a power supply is ideal for this purpose. The instrument should be switched to the 10V range and RV1 adjusted for the correct reading. The calibration on the other ranges should follow automatically provided that the potential divider has been wired correctly. If a signal generator is available a check can be carried out on each range. The calibration should be consistent to within ±5% on all ranges. If a signal generator is used, it is suggested that calibration be carried out at a frequency of 1kHz. Where a mains transformer is used the calibration will, of course, be at 50Hz. The frequency response of the instrument should be "good" over a wide frequency range, at least 10Hz to 100kHz at the 3dB points, and the frequency response of the prototype instrument on the 1V range is shown in Fig. 5.

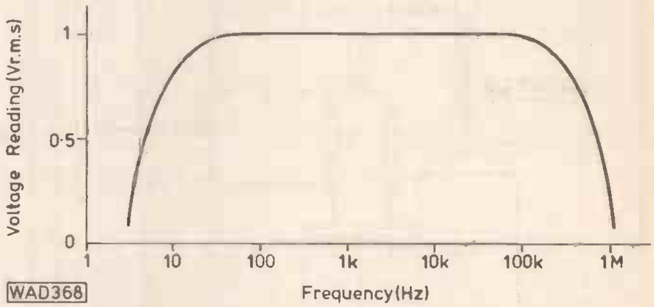


Fig. 5: The frequency response of the instrument

Note that, due to the high input impedance of the instrument, false readings can sometimes be produced on the more sensitive ranges. This is due to pick-up of hum and stray signals on the input leads. The input leads can be screened if desired; the inner lead of the coaxial cable is connected to SK1 (red) and the outer screen to SK2 (black). It is important to note that coaxial cable possesses an appreciable shunt capacitance between the inner conductor and screen (often as much as 100pF per metre). Long screened cables should therefore be avoided since they will impair the high frequency response of the instrument. ●

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ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

The problem of identifying correctly an amateur callsign can present a problem to anyone unaccustomed to listening on the amateur bands. It often seems to be a jargon incapable of being decoded! The answer is not always obvious even if the station is in the clear, but if it is being clobbered with QRM then there really is a problem.

Although there is an ITU phonetic alphabet, given below, it is seldom adhered to by amateur operators who seem to use part of this alphabet and part of their own invention. In a perfect phonetic code the word used to represent a letter, such as "alfa" for A and "bravo" for B, must be neutral, one without any particular connotation and generally understood world-wide.

The approved code starts off all right but then uses "Charlie" for C, although personal and place names ought to be avoided since these can be misleading, especially in amateur use, where station locations and operator's names are constantly being exchanged.

A	Alfa	J	Juliett	S	Sierra
B	Bravo	K	Kilo	T	Tango
C	Charlie	L	Lima	U	Uniform
D	Delta	M	Mike	V	Victor
E	Echo	N	November	W	Whiskey
F	Foxtrot	O	Oscar	X	X-Ray
G	Golf	P	Papa	Y	Yankee
H	Hotel	Q	Quebec	Z	Zulu
I	India	R	Romeo		

There are several words in the phonetics list which I do not agree with personally, but the problem is to find suitable alternatives.

What causes most confusion however is the amateur's own version of the phonetic code, especially the use of "George" for the G in UK callsigns, particularly where the operator is called "Fred"! Might not matter too much among lads and nets on 2m or u.h.f., but used on the DX bands can only make identification of a callsign all that more difficult.

On numbers, the recommended procedure is to use the word "figure" before any number, to indicate that a figure is to follow, thus "Golf, figure four, alfa romeo". This can only help but it is seldom employed by amateurs unless they have been trained on a military or commercial network of some kind. The use of phrases like "Red Hot Momma" for RHM in the suffix of a call may be amusing to some but meaningless to the amateur with little or no knowledge of the English language.

I appreciate that this little homily will have no effect whatsoever, but I hope it will serve to demonstrate to the innocent listener to the amateur bands that there is little or no "system" with amateur phonetics. Initially, it is better to write down in full what is heard and then the callsign ought to become apparent, aided by a good list of prefixes, but, as ever, experience will prove the best teacher.

Here and There

Well known to this column for his SSTV reports in the past, **Paul Barker** of Sunderland is now busy on c.w. and s.s.b. with his new callsign G4HPS, having started off with G8OVD. Paul's first s.s.b. QSO was with FG7AS/FS7 on 10m, which is enough to make anyone's mouth water! He uses a TS520S transceiver to an 18AVT multiband vertical, plus an FT221R on 2m to an indoor 4-element quad. Paul managed to get QSLs from all six continents for SSTV reports before getting his ticket.

In Southport, **Peter Hawks** has got going with a DX160 but, like others, found the manual's calibration chart did not match up to reality. He's talking about a digital readout unit but I think he would be better off initially with a crystal calibrator. **Philip Charlesworth** (Southport) has got going with an outside aerial which he finds "staggering" after his indoor one. As he lives on the only hill in Southport he will find the advantage of much greater importance when he gets his ticket in due course. Philip mentions the PA0AA transmissions on 3750kHz for amateurs, followed by slow Morse transmissions. Details of the latest schedules would be appreciated.

Peter Lucas of Newport, Salop, has dumped his R207 and settled for an AR88 but needs to rewire a lot of it. A circuit or manual would be appreciated at 3 Queen's Drive if anyone can help. Pete's been hearing plenty on 10m of late with only a 16ft vertical. In Chiswick, London, **George Gizebieniak** BRS 41733 has bought an old SX24 receiver for £20 and found it worked fine on the 10m band, with converters for 2m and 70cm.

An appeal from **Jim Timoney** ZS1TK for a spare for his KW2000 transceiver, not having had any success with the descendants of KW in this country. He wants the 3-gang tuning capacitor on the pre-selector, part number C40 on the circuit diagram. Any offers of help to me direct please. Another reader in need of help is **M. David** of 46 Pentathlon Way, Cheltenham, Glos, who has got hold of a Star SR550 for just a £1! It works fine but he'd like a manual for copying and return. He's heard an HK on the 10m band and threatens to send in some logs in future.

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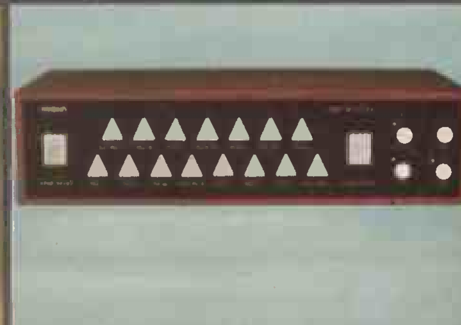

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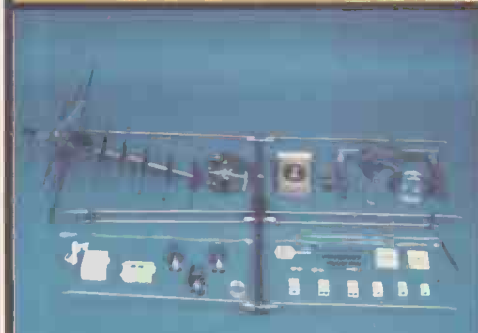

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