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RADIO & ELECTRONICS WORLD

THE COMPLETE COMMUNICATIONS MAGAZINE

85p

SSB for the SX200-N

RF TMOS Devices

CENTRAL HEATING CONTROLLER
MPU based design

12 PROJECTS

Pass-Band Tuning

Signal Analysis

RADIO AMATEUR'S TEST CARD
Transmit a personalised call-sign

FREE INSIDE:

The Complete Communications Cross-Reference Card

100-PAGE Special Edition

D71699

Play the AMBIT numbers game ......

The long awaited implementation of on-line order processing is with us at last, and whilst this means that orders for in-stock items can now be processed more efficiently, it also means that orders should be submitted using stock codes for best results. Our current catalogue (75p) includes all order codes (watch out for the new expanded Spring edition), but here's an abstract from some of the more popular lines to use as a quick reference.

Remember that you can also access our catalogue via REWSHOP on REWTEL, which now includes on-line current price and delivery information. You need a 300 baud MODEM and RS232 terminal, (various suitable configurations based on popular micros have been published in recent past issues of Radio and Electronics World).

Prices shown here exclude VAT, and the P&P charge is currently 60p per order (unless otherwise indicated). Remember that our tele-sales service operates with human beings (not 'dumb' machines) from 8am to 7pm (and frequently later) Monday to Friday, and 9am to 6pm on Saturdays. REWSHOP operates 24 hours a day, 365 days a year with full price and delivery information.

ALWAYS USE STOCK NUMBERS WHEN ORDERING PLEASE.

4000 CMOS

Type	Stock No.	Price
4000UB	22-04000	0.11
4001	23-04001	0.11
4002	23-04002	0.12
4007	23-04007	0.13
4008	23-04008	0.50
4009UB	22-04009	0.25
4011	23-04011	0.11
4011UB	23-04011	0.11
4012	23-04012	0.14
4013	23-04013	0.25
4015	23-04015	0.50
4016	23-04016	0.22
4017	23-04017	0.40
4020	23-04020	0.55
4021	23-04021	0.55
4022	23-04022	0.55
4023	23-04023	0.15
4024	23-04024	0.33
4025	23-04025	0.15
4027	23-04027	0.26
4028	23-04028	0.50
4029	23-04029	0.55
4035	23-04035	0.67
4040	23-04040	0.68
4042	23-04042	0.50
4043	23-04043	0.60
4044	23-04044	0.68
4046	23-04046	0.60
4049UB	22-04049	0.24
4050	23-04050	0.24
4051	23-04051	0.55
4052	23-04052	0.55
4053	23-04053	0.55
4060	23-04060	0.75
4066	23-04066	0.30
4068	23-04068	0.16
4069UB	22-04069	0.14
4070	23-04070	0.16
4071	23-04071	0.16
4072	23-04072	0.16
4073	23-04073	0.16
4075	23-04075	0.16
4076	23-04076	0.55
4077	23-04077	0.18
4078	23-04078	0.18
4081	23-04081	0.18
4082	23-04082	0.18
4093	23-04093	0.30
4099	23-04099	0.80
4175	23-04175	0.80
4502	23-04502	0.60
4503	23-04503	0.50
4506	23-04506	0.70
4507	23-04507	0.37
4508	23-04508	1.50
4510	23-04510	0.55
4511	23-04511	0.45
4512	23-04512	0.55
4514	23-04514	1.25
4515	23-04515	1.25
4516	23-04516	0.60
4518	23-04518	0.35
4520	23-04520	0.60
4521	23-04521	1.30
4522	23-04522	0.89
4526	23-04526	0.60
4527	23-04527	0.80
4528	23-04528	0.65
4529	23-04529	0.70
4531	23-04531	0.65
4532	23-04532	0.80
4534	23-04534	4.00
4536	23-04536	2.50
4538	23-04538	0.85
4539	23-04539	0.80
4543	23-04543	0.80
4549	23-04549	3.50
4553	23-04553	2.70
4554	23-04554	1.20
4555	23-04555	0.35
4556	23-04556	0.40
4557	23-04557	2.30
4558	23-04558	0.80
4559	23-04559	3.50
4560	23-04560	2.50
4561	23-04561	1.00
4562	23-04562	2.50
4566	23-04566	1.20
4568	23-04568	1.45
4569	23-04569	1.70
45672UB	23-04572	0.32
4580	23-04580	3.25
4581	23-04581	1.40
4582	23-04582	0.70
4583	23-04583	0.80
4584	23-04584	0.27
4585	23-04585	0.45
4702	23-04702	4.50
4703	23-04703	4.48
4704	23-04704	4.24
4705	23-04705	4.24
4706	23-04706	4.50
4720	23-04720	4.00
4723	23-04723	0.95
4724	23-04724	0.95
4725	23-04725	2.24
40014	23-40014	0.54
40085	23-40085	0.99
40098	23-40098	0.54
40106	23-40106	0.69
40160	23-40160	1.05
40161	23-40161	1.05
40162	23-40162	1.05
40163	23-40163	1.05
40174	23-40174	1.05
40175	23-40175	1.05
40192	23-40192	1.08
40193	23-40193	1.08
40195	23-40195	1.08

74LSXX

Type	Stock No.	Price
74LS00	31-07400	0.11
74LS01	31-07401	0.11
74LS02	31-07402	0.11
74LS03	31-07403	0.11
74LS04	31-07404	0.14
74LS05	31-07405	0.14
74LS08	31-07408	0.14
74LS09	31-07409	0.14
74LS10	31-07410	0.14
74LS11	31-07411	0.14
74LS12	31-07412	0.14
74LS13	31-07413	0.32
74LS14	31-07414	0.32
74LS15	31-07415	0.14
74LS20	31-07420	0.14
74LS21	31-07421	0.14
74LS22	31-07422	0.14
74LS26	31-07426	0.14
74LS27	31-07427	0.30
74LS28	31-07428	0.18
74LS30	31-07430	0.14
74LS32	31-07432	0.14
74LS33	31-07433	0.14
74LS37	31-07437	0.18
74LS38	31-07438	0.14
74LS40	31-07440	0.18
74LS42	31-07427	0.30
74LS47	31-07447	0.75
74LS48	31-07448	0.40
74LS49	31-07449	0.80
74LS51	31-07451	0.14
74LS54	31-07454	0.14
74LS55	31-07455	0.14
74LS74	31-07474	0.21
74LS75	31-07475	0.21
74LS76	31-07476	0.25
74LS78	31-07478	0.19
74LS83	31-07483	0.33
74LS85	31-07485	0.44
74LS86	31-07486	0.15
74LS90	31-07490	0.24
74LS91	31-07491	0.36
74LS92	31-07492	0.32
74LS93	31-07493	0.24
74LS95	31-07495	0.36
74LS107	31-74107	0.31
74LS109	31-74109	0.25
74LS112	31-74112	0.21
74LS113	31-74113	0.21
74LS114	31-74114	0.21
74LS122	31-74122	0.27
74LS123	31-74123	0.36
74LS125	31-74125	0.27
74LS126	31-74126	0.27
74LS132	31-74132	0.27
74LS133	31-74133	0.24
74LS136	31-74136	0.20
74LS138	31-74138	0.30
74LS139	31-74139	0.30
74LS151	31-74151	0.30
74LS153	31-74153	0.34
74LS155	31-74155	0.30
74LS156	31-74156	0.33
74LS157	31-74157	0.27
74LS158	31-74158	0.27
74LS160	31-74160	0.34
74LS161	31-74161	0.36
74LS162	31-74162	0.36
74LS163	31-74163	0.36
74LS164	31-74164	0.40
74LS165	31-74165	0.60
74LS166	31-74166	0.58
74LS168	31-74168	0.69
74LS170	31-74170	0.63
74LS173	31-74173	0.47
74LS174	31-74174	0.37
74LS175	31-74175	0.40
74LS181	31-74181	0.87
74LS183	31-74183	1.05
74LS190	31-74190	0.39
74LS191	31-74191	0.39
74LS192	31-74192	0.39
74LS193	31-74193	0.39
74LS194	31-74194	0.39
74LS195	31-74196	0.39
74LS196	31-74196	0.39
74LS197	31-74197	0.47
74LS221	31-74221	0.50
74LS240	31-74240	0.60
74LS241	31-74241	0.60
74LS242	31-74242	0.55
74LS243	31-74243	0.55
74LS244	31-74244	0.60
74LS245	31-74245	1.00
74LS251	31-74251	0.36
74LS253	31-74253	0.36
74LS257	31-74257	0.36
74LS258	31-74258	0.36
74LS259	31-74259	0.51
74LS260	31-74260	0.26
74LS266	31-74266	0.20
74LS273	31-74273	0.70
74LS279	31-74279	0.35
74LS283	31-74283	0.40
74LS290	31-74290	0.40
74LS293	31-74293	0.40
74LS298	31-74298	0.54
74LS365	31-74365	0.34
74LS366	31-74366	0.40
74LS367	31-74367	0.30
74LS368	31-74368	0.30
74LS373	31-74373	0.72
74LS374	31-74374	0.72
74LS375	31-74375	0.31
74LS377	31-74377	0.60
74LS378	31-74378	0.44
74LS379	31-74379	0.44
74LS385	31-74385	1.30
74LS386	31-74386	0.27
74LS390	31-74390	0.51
74LS393	31-74393	0.48
74LS398	31-74398	0.80
74LS399	31-74399	0.65
74LS490	31-74490	0.60
74LS670	31-74670	1.15

74CXX

Type	Stock No.	Price
74C00	29-07400	0.35
74C02	29-07402	0.35
74C04	4069C	
74C08	29-07408	0.35
74C10	29-07410	0.35
74C14	4584C	
74C20	29-07420	0.35
74C30	29-07430	0.35
74C32	29-07432	0.35
74C42	29-07442	1.05
74C48	29-07448	1.50
74C73	29-07473	0.75
74C74	29-07474	0.75
74C76	29-07476	0.60
74C83	29-07483	1.30
74C85	29-07485	1.30
74C86	29-07485	1.30
74C89	29-07489	3.60
74C90	29-07490	1.05
74C93	29-07493	1.05
74C95	29-07495	1.25
74C107	29-74107	0.60
74C151	29-74151	2.10
74C154	29-74154	3.05
74C157	29-74157	2.10
74C160	40160	
74C1610	40161CM	
74C1620	40162CM	
74C1630	40163CM	
74C164	29-74164	1.05
74C165	29-74165	1.10
74C173	4076C	
74C1740	40174CM	
74C1750	40175CM	
74C1920	40192CM	
74C1930	40193CM	
74C1950	40195CM	
74C200	29-74200	6.50
74C221	29-74221	1.55
74C901	29-74901	0.55
74C902	29-74902	0.55
74C903	29-74903	0.55
74C904	29-74904	0.55
74C905	29-74905	6.50
74C906	29-74906	0.55
74C907	29-74907	0.55
74C908	29-74908	1.10
74C909	29-74909	2.10
74C910	29-74910	5.00
74C914	29-74914	1.10
74C918	29-74918	1.30
74C925	29-74925	6.00
74C926	29-74926	6.00
74C927	29-74927	6.00

74HCXX

Type	Stock No.	Price
74HC00	30-07400	0.56
74HC02	30-07402	0.56
74HC04	30-07404	0.68
74HC10	30-07410	0.56
74HC20	30-07420	0.56
74HC86	30-07486	0.74
74HC132	30-74132	1.26
74HC266	30-74266	0.81
74HC4002	30-04002	0.56
74HC4075	30-04075	0.56
74HC242	30-74242	2.00
74HC243	30-74243	2.00
74HC74	30-07474	0.74
74HC109	30-74109	0.68
74HC175	30-74175	1.08
74HC373	30-74373	2.40
74HC374	30-74374	2.40
74HC533	30-74533	2.40
74HC534	30-74534	2.40
74HC165	30-74165	1.96
74HC173	30-74173	1.20
74HC160	30-74160	1.33
74HC161	30-74161	1.33
74HC162	30-74162	1.33
74HC163	30-74163	1.33
74HC4538	30-74538	2.10
74HC85	30-74280	2.95
74HC280	30-74280	2.95
74HC42	30-07442	1.00
74HC138	30-74138	1.08
74HC139	30-74139	1.08
74HC4514	30-04514	3.40
74HC4543	30-04543	2.75
74HC157	30-74157	0.92
74HC158	30-74158	0.90
74HC257	30-74257	0.90

LINEAR ICs

Type	Stock No.	Price
LM10CN	61-00010	3.88
MF10	61-00011	5.05
L149	61-00149	1.86
ZNA234	61-02340	8.50
U237B	61-00237	1.28
U247B	61-00247	1.28
U257B	61-00257	1.28
U267B	61-00267	1.28
LM301AH	61-03010	0.67
LM301AN	61-03011	0.27
LM308H	61-03080	-0.70
LM308CN	61-03081	0.65
LM324	61-03240	0.45
LM339N	61-03390	0.66
LF347	61-00347	1.60
LM348	61-03480	0.90
LF351	61-03510	0.49
LF353	61-03530	0.76
LM380N	61-00380	1.00
LM381	61-00381	1.81
LM382	61-00382	1.81
ZN419CE	61-00419	1.98
ZNA423	61-04230	1.00
ZN425E 8	61-04250	3.50
ZN426E 8	61-04260	3.00
ZN427E 8	61-04270	6.28
ZN428E 8	61-04280	4.78
ZN429E 8	61-04290	2.10
ZN432CJ10	61-04320	28.09
ZN433CJ10	61-04330	22.59
ZN450E	61-04500	7.61
NE542	61-05420	1.20
NE544	61-00544	1.80
NE555N	61-05550	0.20
NE556N	61-05560	0.50
SL560C	61-05600	1.98
NE562	61-00562	4.05
NE564	61-00564	4.29
NE565	61-00565	1.00
NE566	61-00566	1.30
NE567	61-00567	1.30
NE570N	61-00570	3.85
SL624	61-00624	3.28
uA709HC	61-07090	0.64
uA709PC	61-07091	0.36
uA710HC	61-07100	0.64
uA710PC	61-07101	0.59
uA711CN	61-07110	0.85
uA733CN	61-07330	0.89
uA741CH	61-07410	0.66
uA741CN	61-07411	0.20
uA747CN	61-07470	0.70
uA748CN	61-04780	0.30
uA758	61-00758	2.35
TBA820M	61-00820	0.78
TDA1028	61-01028	2.11
TDA1029	61-01029	2.11
ZNA1034	61-01034	2.10
LM1035	61-01034	2.10
TDA1054M	61-01054	1.45
TDA1062	61-01062	1.95
TDA1072	61-01072	2.89
TDA1074A	61-01074	5.04
TDA1083	61-01083	1.95
TDA1090	61-01090	3.05
HA1137	61-12411	1.20
HA1196	61-01196	2.00
HA1197	61-01197	1.00
TDA1220	61-01220	1.40
LM1303	61-01303	0.99
LM1307	61-01307	1.55
MC1310P	61-01310	1.90
MC1330	61-01330	1.20
MC1350	61-01350	1.20
HA1370	61-11370	1.90
HA1388	61-01388	2.75
LM1458N	61-14580	0.45
MC1496P	61-01496	1.25
SL1610	61-01610	1.92
SL1611	61-01611	1.92
SL1612	61-01612	1.92
SL1613	61-01613	2.06
SL1620	61-01620	2.50
SL1621	61-01621	2.50
SL1623	61-01623	2.50
SL1625	61-01625	2.50
SL1626	(SL6270)	
SL1630	61-01630	1.62
SL1640	61-01640	2.25
SL1641	61-01641	2.25
MC1648	61-01648	3.25
TDA2002	61-02002	1.25
ULN2240	61-02240	3.25
ULN2242	61-01090	3.05
ULN2283	61-02283	1.00
CA3080	61-03080	0.70
CA3089	61-03089	1.84
CA3123	61-03123	1.40
CA3130E	61-31300	0.80
CA3130T	61-31301	0.90
CA3140E	61-31400	0.46
CA3189E	61-03189	2.20
CA3240E	61-32400	1.27
MC3357	61-03357	2.85
MC3359 (see ULN3859)		
ULN3859	61-03859	2.95
KM3701	61-03701	85.53
KM3702	61-03702	74.84
LM3900	61-39000	0.60
LM3909N	61-39090	0.68
LM3914N	61-03914	2.80
LM3915N	61-03915	2.80
KB4400	61-04400	0.80
KB4412	61-04412	1.95
KB4413	61-04413	1.95
KB4417	61-04417	1.80
KB4420B	61-04420	1.09
TDA4420	61-14420	2.65
TDA4421	61-14421	2.65
KB4423	61-04423	2.30
KB4424	61-04424	1.65
KB4430	61-04430	2.30
KB4431	61-04431	1.95
KB4432	61-04432	1.95
KB4433	61-04433	1.52
KB4436	61-04436	2.53
KB4437	61-04437	1.75
KB4438	61-04438	2.22
KB4441	61-04441	1.35
KB4445	61-04445	1.29
KB4446	61-04446	2.75
KB4448	61-04448	1.65
NE5044	61-05044	2.26
MC5229	61-05229	9.60
NE5532	61-55320	1.85
KM5624	61-05624	4.35
SD6000	61-06000	3.75
SL6270	61-06270	2.03
SL6310	61-06310	2.45
SL6440	61-06440	3.38
SL6600	61-06600	3.75
SAS6610	61-06610	1.48
SL6640	61-06640	2.75
SL6690	61-06690	3.75
SL6700	61-06700	2.75
SAS6710	61-06710	1.48
LS7225	61-07225	3.65
ICM7555	61-75550	0.80
CL8038CC	61-08038	4.50
MSL9362	61-09362	1.75
MSL9363	61-09[illegible]	1.75
K10170	61-10170	1.87
TK10321	61-10321	2.75
HA11223	61-11223	2.15
HA11225	61-11225	1.45
HA12002	61-12002	1.22
HA12017	61-12017	0.80
HA12402	61-12402	1.95
HA12411	61-12411	1.20
HA12412	61-12412	1.55
LF13741	61-13741	0.33
MK50366	61-50366	3.35
MK50375	61-50375	3.85
MM53200	61-53200	3.90

PRESCALER

Type	Stock No.	Price
U264	61-02640	2.27
U265	61-02650	3.16
U266	61-02660	2.43
11C90DC	61-01190	12.95
MSL2312R	61-02312	3.94
MSL2318	61-02318	3.84
MSM5523	61-05523	11.30
MSM5524	61-05524	11.30
MSM5525	61-05525	7.85
MSM5526	61-05526	7.85
MSM55271	61-55271	9.75
ICM7106CP	61-07106	9.55
ICM7107CP	61-07107	9.55
LC7137	61-07137	7.50
ICM7216B	61-72161	19.50
ICM7216C	61-72162	19.95
ICM7217A	61-07217	9.50
SP8629	61-08629	3.85
SP8647	61-08647	6.00
SP8793	61-08793	7.70
95H90	61-09590	7.80
HD10551	61-10551	2.45
HA12009	61-12009	6.00
HD44015	61-44015	4.45
HD44752	61-44752	8.00
MC145151P	61-14151	6.00
MC145152P	61-14151	6.60
MC145156P	61-14156	4.60

SMALL SIGNAL AUDIO

Type	Stock No.	Price
BC182	58-00182	0.10
BC212	58-00212	0.10
BC237	58-00237	0.08
BC238	58-00238	0.08
BC239	58-00239	0.08
BC307	58-00307	0.08
BC308	58-00308	0.08
BC309	58-00309	0.08
BC327	58-00327	0.13
BC337	58-00337	0.13
BC413	58-00413	0.10
BC414	58-00414	0.11
BC415	58-00415	0.10
BC416	58-00416	0.11
BC546	58-00546	0.12
BC550	58-00550	0.12
BC556	58-00556	0.12
BC560	58-00560	0.12
BC639	58-00639	0.22
BC640	58-00640	0.22
MPSA13	58-04013	0.30
MPSA63	58-04063	0.30
ZTX108	58-01108	0.10
ZTX212	58-01212	0.10
ZTX653	58-01653	0.20
ZTX753	58-01753	0.20
2N2904	58-02904	0.25
2N2905	58-02905	0.25
2N3905	58-03905	0.10
2SB646A	58-03646	0.30
2SB648A	58-03648	0.40
2SD666A	58-03666	0.30
2SD668A	58-03668	0.40
2SAB72A	58-02872	0.19
2SA1084E	58-01084	0.25
2SA1085E	58-01085	0.25
2SC1775A	58-01775	0.19
2SC2546E	58-02546	0.24
2SC2547E	58-02547	0.24

AUDIO POWER

Type	Stock No.	Price
BD139	58-15139	0.29
BD140	58-15140	0.31
BD165	58-15165	0.46
BD166	58-15166	0.48
BD179	58-15179	0.38
BD180	58-15180	0.41
TIP31A	58-15031	0.35
TIP32A	58-15032	0.35
MJ2955	58-12955	0.68
2N3055	58-13099	0.58
2SB720	58-15720	0.60
2SD760	58-17600	0.60
2SJ49	60-01049	3.10
2SJ50	60-01050	4.25
2SJ83	60-01083	3.55
2SK134	60-00134	3.10
2SK135	60-00135	4.25
2SK227	60-00227	3.55
2SD753	58-03753	2.34

SMALL SIGNAL RF

Type	Stock No.	Price
BFY50	58-06500	0.22
BF241	58-06241	0.18
BF273	58-06273	0.18
BF274	58-06274	0.20
BF362	58-06362	0.49
BF440	58-06440	0.21
BF441	58-06441	0.21
BF479	58-06479	0.86
BF6795	58-06679	0.55
BFR91	58-07091	1.33
BFT95	58-10095	0.99
BFW92	58-08092	0.60
BFY90	58-09090	0.90
NE21936	58-21936	5.00
ZTX323	58-06232	0.60
2N2369A	58-02369	0.38

RF POWER

Type	Stock No.	Price
BFW16A	58-08016	0.65
MRF237	58-14237	3.20
MRF238	58-14238	16.50
MRF245	58-14245	40.00
MRF449A	58-14449	16.50
MRF472	58-14472	1.25
MRF475	58-14475	4.60
MRF629	58-14629	4.99
PT8811	58-18811	9.50
TP2320	56-12320	10.24
VN66AF	60-02066	0.95
ZTX3866	58-03866	0.45
2N3866	58-13866	1.20

SMALL SIGNAL FET

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BF961	60-06961	0.70
BF963	60-06963	0.99
J310	59-02310	0.69
J176	59-02176	0.65
2SK55	59-01055	0.32
2SK168	59-01168	0.37
3SK45	60-04045	0.49
3SK51	60-04051	0.54
3SK60	60-04060	0.58
3SK88	60-04088	0.99
40673 see 3SK51		
40822 see 3SK51		
40823	60-03823	0.65
3SK112	60-04112	4.60

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Type	Stock No.	Price
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BA379	12-03797	0.35
ND4981 7E	12-49817	0.51
OA91	12-00916	0.07
OA47	12-00476	0.10
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S04	12-24006	0.45
W005	12-10506	0.28
1N4001	12-40016	0.06
1N4002	12-40026	0.07
1N4004	12-40046	0.07
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1N6263	12-62637	0.62

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BB109B	12-01095	0.27
BB204B	12-02045	0.36
BB212	12-02125	1.95
ITT210	12-02105	0.30
MVAM115 see KV1236		
MVAM125 see KV1225		
KV1210	12-12105	2.45
KV1211 see KV1236		
KV1225	12-12255	2.75
KV1235	12-12355	2.75
KV1236	12-12365	2.55
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KV1310	12-13205	0.40

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3V9	12-00398	0.10
4V7	12-00478	0.10
5V1	12-00518	0.10
5V6	12-00568	0.10
6V8	12-00688	0.10
8V2	12-00828	0.10
9V1	12-00918	0.10
10	12-01008	0.10
11	12-01108	0.10
12	12-01208	0.10
15	12-01508	0.10
18	12-01808	0.10
22	12-02208	0.10
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33	12-03308	0.10

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V180P-Yellow	15-01800	0.18
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CQX12 Yellow	15-20150	0.20
CQX40 Or/Red	15-20400	0.24
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V321	15-03210	0.26
V322	15-03220	0.20
V323	15-03230	0.20
V330	15-03300	0.17
V331	15-03310	0.26
V332	15-03320	0.20
V333	15-03330	0.20
V340	15-03400	0.17
V341	15-03410	0.26
V342	15-03420	0.20
V343	15-03430	0.20
V510	15-05100	0.17
V511	15-05110	0.26
V512	15-05120	0.20
V513	15-05130	0.20
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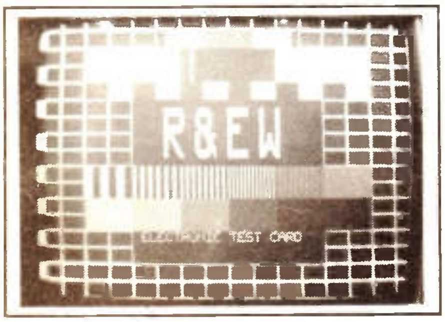
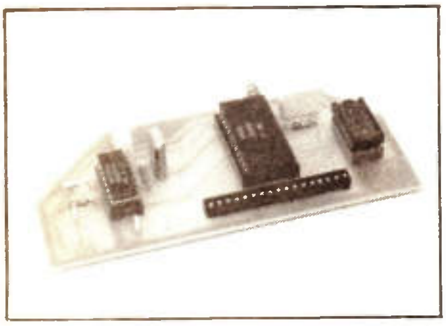
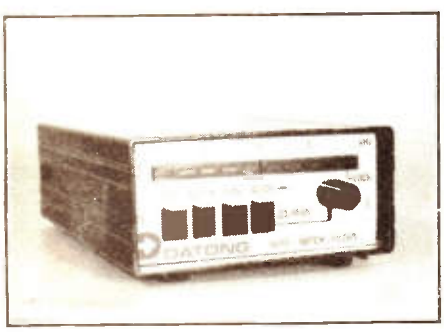
JULY 1983







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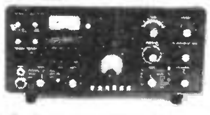

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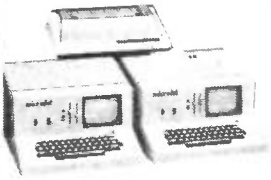

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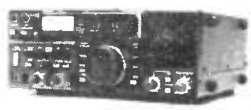

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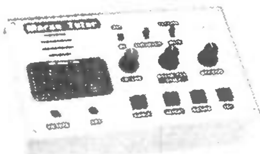

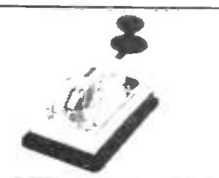

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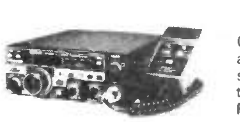

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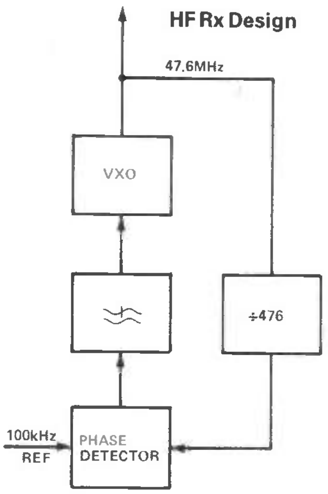
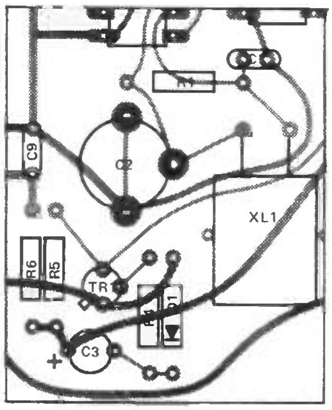
Rather than highlighting a topical piece of news, this month we've turned the spotlight on some items nearer to home — the latest 'REWgrets'. There's quite a collection, though they're not all concerned with projects. For instance, in the *HF Receiver Design (February '83)* feature, *Fig. 11* showed a crystal oscillator for the 47.6MHz generator, which should have used a 'fourth phase locked loop' as shown below.

HF Rx Design





Rewbichron II

Last month's DFM may have confused a few readers, since there were no pin designations on IC4. These are shown in the table at top right of this page.

In addition, *Fig.7* shows R3 floating, whereas it should be connected, via the gate switch, to either pin 28 or 29 of IC1.

The *Rewbichron II (May '83)* requires a small addition to the PCB foil so that C2 locates properly (see diagram). Also, IC6 should be 74LS373 (not LS365) and Q1-6 are better as 2N2905 — the BC307's specified may produce a dim display. Finally, on the logic board, the power input pin should be labelled +8/15V.

1	CS	9	2Z	17	4X	25	7Y	33	BD1
2	V_{DISP}	10	2Y	18	5Z	26	7X	34	BD2
3	COM1	11	2X	19	5Y	27	8Z	35	BD3
4	COM2	12	3Z	20	5X	28	8Y	36	GND
5	COM3	13	3Y	21	6Z	29	8X	37	A0
6	1Z	14	3X	22	6Y	30	AN1	38	A1
7	1Y	15	4Z	23	6X	31	AN2	39	A2
8	1X	16	4Y	24	7Z	32	BDO	40	+V

Digital Frequency Meter

The third set of corrections results from the continuing saga of the *2m Transverter (March '83 and June '83)* — a few just won't come to life! If you are not in the majority whose transverter works perfectly, take note of the following:

1. Add ferrite beads to bases of Q7 (3866) and Q6(2369A after filter).
2. Change capacitors C6, C11 and C20 to 12p, 27p and 18p respectively. Measure these values and also those for C15=20p, C16,27=8p2 and C35=22p.
3. Make sure R28 is 10R ±5%.

Our test figures for the prototype are: output power = 8.75W (28MHz @ 0dBm); IPs (3kHz spacing) = −46dB; 3rd harmonic = −68dB; 116MHz (cans on T3,4) = −44dB; spurii = −55dB, 28MHz =<−70dB.

Finally, an apology to Dr. A.C. Gee for omissions to *Amateur Satellites (April '83 and May '83)*. Rather than print the missing text and diagram, readers may write to us (enclosing an SAE) for a free copy ... and you can't say fairer than that!

SNIPPETS

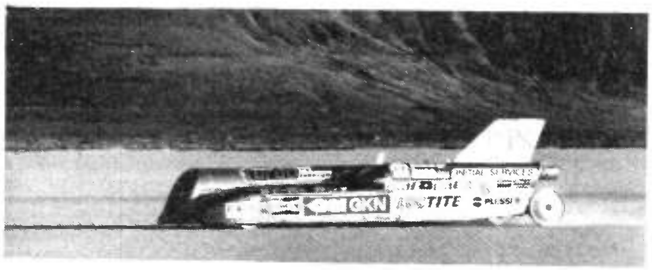
Boys Brigade Centenary

One hundred years ago in Glasgow the first Boys Brigade Company was founded by William Smith. In this, the centenary year, many special events have been arranged to celebrate the birth of a youth movement which has grown from strength to strength and today is active internationally. One such event will involve Amateur Radio in an exercise to link up boys and officers of the Brigade throughout the UK and indeed world-wide. The event, called "Anchor Chain", will take place on Sunday 21st August, with pre-arranged HE and VHF stations around the country.

Durst And Panasonic

Durst (UK) Limited and National Panasonic (UK) Limited announce the Panacopy KV-5000 colour slide processor.

Panacopy can produce a 35mm colour slide from an original in three minutes, due to the development of a new organic photo- conductor film which makes the process less time consuming than the conventional silverhalide method. Since it uses a premounted slide cartridge, Panacopy offers an economic method of colour slide reproduction. Each exposure can be used individually.



Good Vibrations?

Vibration-resistant electrical terminals, supplied by CTT of Bristol, will be among other British made products fitted to the 34,000 horse power Rolls Royce Avon-powered jet car, Thrust 2, when in July, driver Richard Noble will try and eclipse the 622.427 MPH world land speed record of California's Gary Gabelich set in 1970.

More CDs From EMI

The decision by EMI Music to introduce a range of titles on compact disc is a significant and welcome development, according to Ian Duffell, Group Audio Manager for Sony (UK) Limited.

Award for BT-man

Dr. John Midwinter, Special Head of Optical Communications Technology Division at British Telecom's Research Laboratories, has been elected a Fellow of the Institute of Electrical and Electronic Engineers.

RADIO AMATEUR'S TEST CARD

A single board Test Card generator, with EPROM for storing personalised call-signs or other information. Design by Colin Edwards.

As an alternative to putting a piece of cardboard in front of a camera to provide a test card — in most cases, with amateur cameras, giving poor results — here is the "logical" approach: an electronic test card, which can also be useful for mobile ATV from, say, the top of a local mountain.

The test card, as pictured, is produced in the form of composite video into a low impedance, 75R, with the only input being 10 to 15 volts at 400mA. Although the circuit is straightforward, few liberties have been taken with the 625 line TV specification, apart from the removal of interlace to avoid jitter on the characters.

As well as providing station identification over the air, the unit is very useful for setting up transmitting stations and, with a modulator, for fixing your television — the card will soon point out any mismatch or bandwidth problems in the equipment.

Design

The following features have been included within the card picture:

1) Crosshatch pattern to provide a rough linearity check and align the frame.
2) Black rectangle within white, to test the low frequency response, and a white needle pulse to test for reflections. On a local test, reflections of the needle pulse are a sure sign of an impedance mismatch.
3) 150 kHz square wave, 100% to 0%, and 75 kHz square wave, 30% to 60%, to test for transient response.
4) Up to 8 bold characters for call-sign.
5) Multi-burst bandwidth response test, producing 6us bursts of 0.5,1.0,1.5,2.0,2.5 and 4.0 MHz.
6) Grey scale for adjusting contrast (amplitudes of 0%, 20%, 40%, 60%, 80%, and 100%).
7) Two lines of up to 20 characters.

Circuit Description

All the circuit timing is derived from an 8 MHz crystal in an oscillator, based on two TTL inverters biased as amplifiers. This provides the video 'dot rate', which is divided down to 1 and 2 MHz by IC1. This IC counts up from 8 to 15, giving convenient signals for the character clock and control signals.

The 1 MHz clock drives the address counter, IC3 and IC4, which is incremented for each character cell on the display (there are 64 character row addresses). In each character cycle, the address of the character is latched through a multiplexer into IC5, IC6 and IC7. The character corresponding to this address is read from the EPROM (IC8), then multiplexed, and latched back into the EPROM address along with the character scan line number from the address counter. This address gives the character number and scan line number for the character generator, which is also contained within the EPROM. The data output then forms the dot pattern which is converted into serial form, by a shift register (IC9), and onto the screen. If, when the character is read from the EPROM, data bit 7 is set, the dot pattern (when read) is latched by IC10 *instead of the shift register*. It is then used to control the grey scale, sync pulses and address counter reset.

The reset is used to put the address counter back to zero at the end of each frame. Sync is then sent from the latch to the composite video generator. The grey scale is derived from a resistor ladder which is multiplexed by a CMOS analogue switch. Unfortunately these do not work very well at 5V, producing a variable high impedance. To cope with this, a charge pump is used to generate −8V from the +5V rail (using Q5), which increases the voltage on the switches to 13V.

The composite video is generated by an emitter-follower circuit, using D1 in order to add OV6 to the video input. This voltage is grounded by Q2 to produce sync pulses. IC12 is a 5V regulator which powers the whole board and allows the use of a 13V6 battery or PSU. If a source of 5V is available this could be used saving some power.

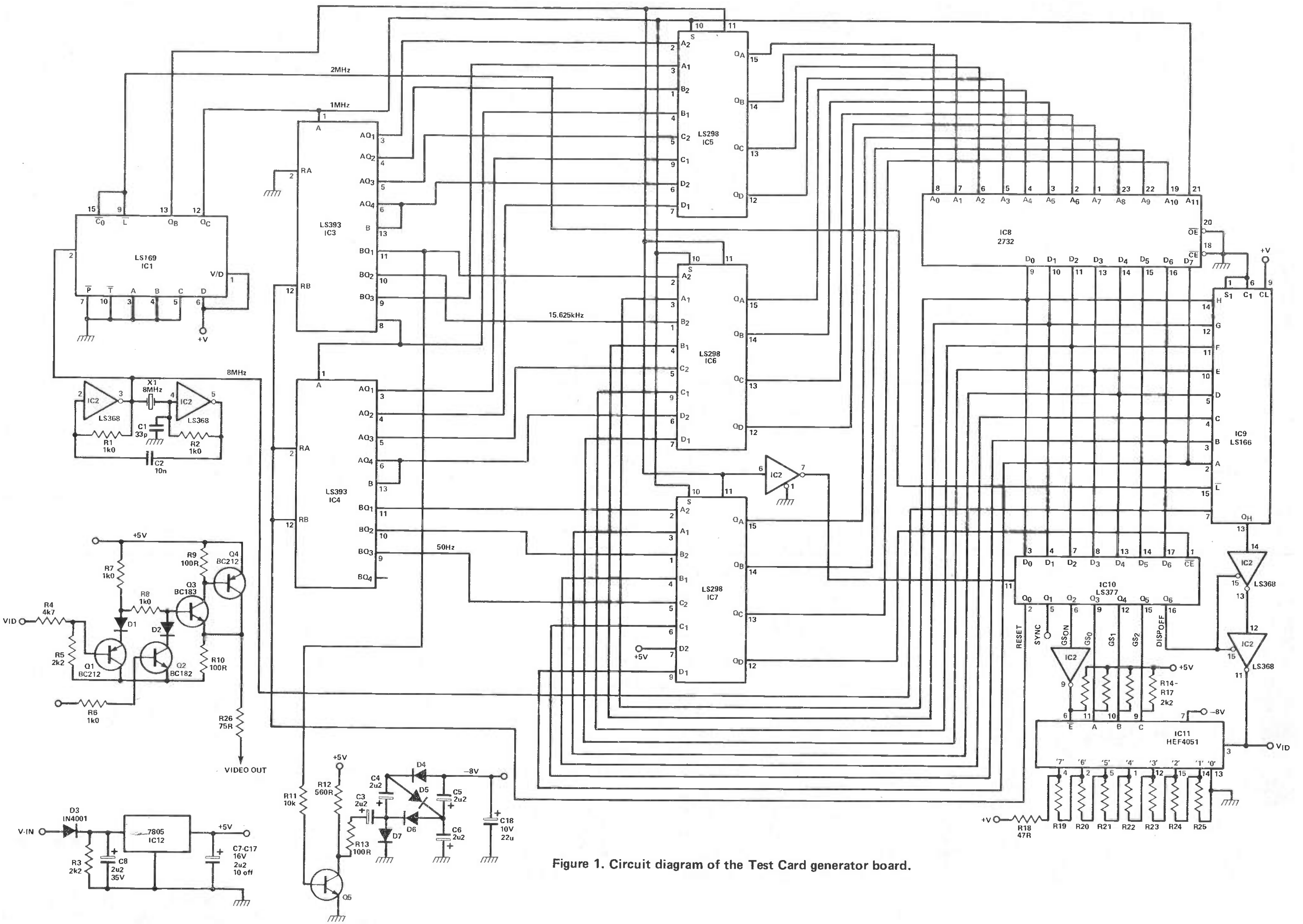


Figure 1. Circuit diagram of the Test Card generator board.

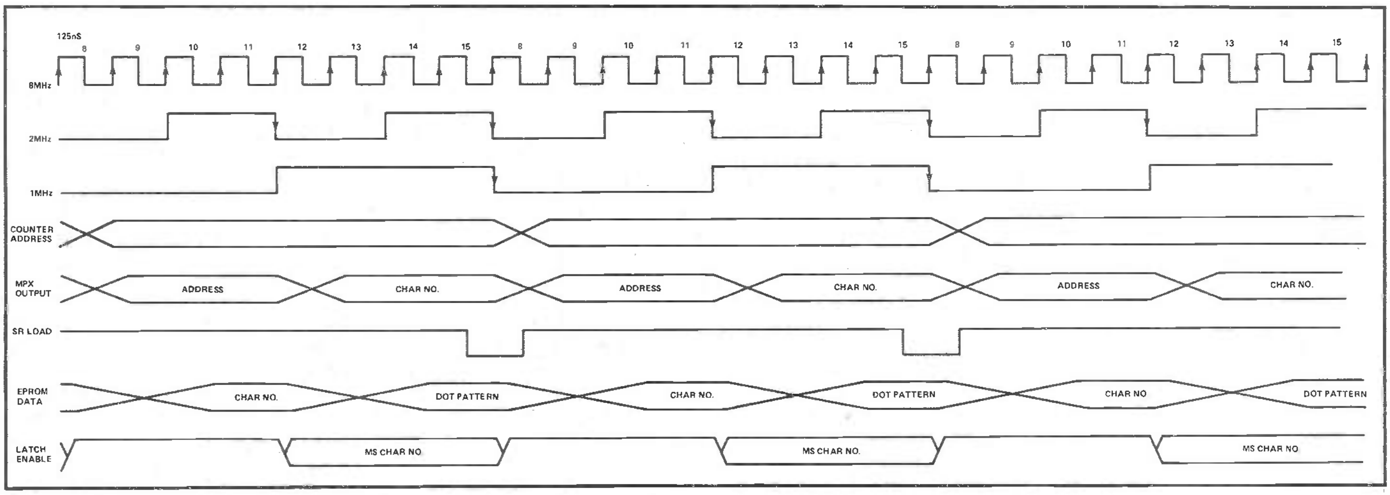
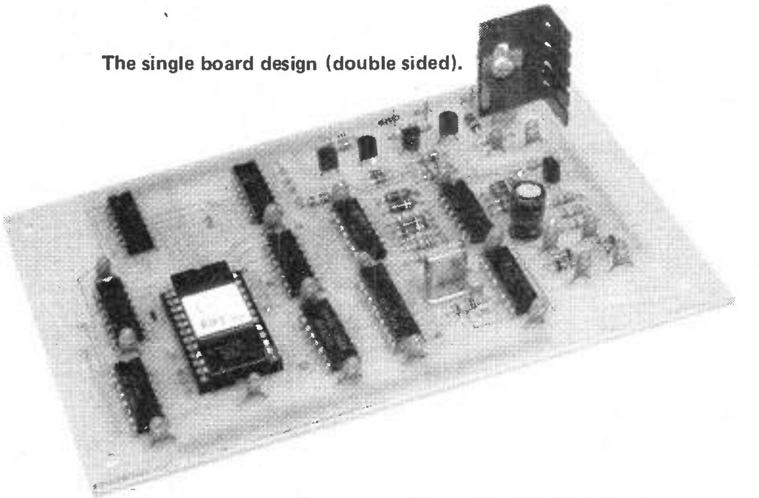


Figure 2. Timing diagram for the EPROM sections.

Characters available on the EPROM.



The single board design (double sided).

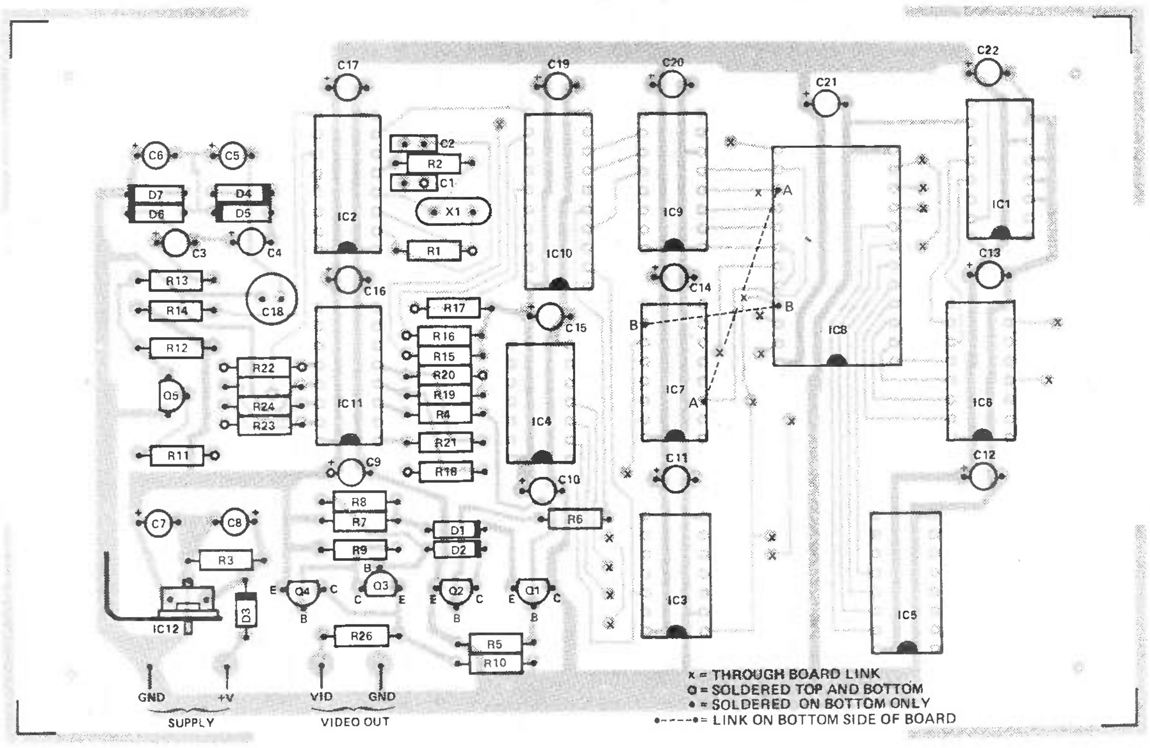


Figure 3. The Test Card component overlay.

YOU'RE LOOKING AT 31 ANTEX SOLDERING IRONS!

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PARTS LIST

Resistors

R1,2,7,8,6	1k
R3,5,14,15,16,17	2k2
R4	4k7
R11	10k
R9,10,13	100R
R12	560R
R18,19,20,21,22,23,24,25	47R
R26	75R

Capacitors

C1	33p Ceramic
C2	10n Ceramic
C3-17	2u2 Tant Bead 16V
C18	22u 16V Al Elec
C19	2u2 Tant Bead 35V

Semiconductors

D1,2	1N4148
D3	1N4001
D4,5,6,7	0A47
TR1,4	BC212
TR2,3,5	BC182
IC1	74LS169
IC2	74LS368
IC3,4	74LS393
IC5,6,7	74LS298
IC8	2732
IC9	74LS166
IC10	74LS377
IC11	HEF4051
IC12	7805

Miscellaneous

24 pin socket 8MHz crystal (HC-18) PCB
4 Terminal pins.
An EPROM service is being offered by:
Cropredy Electronics,
13, Mallow Close,
Horsham, Sussex
EPROM £11.10
Character format as follows:
Bold Type (8 characters) --------
Small Type (2x11 characters) --------
(See character list)
PCB double-sided plated through £12.00
Built and tested unit £48.60

Construction

Using the layout provided, a double-sided board can be made, soldered top and bottom and linked via the holes shown (***Fig.3***). To allow for the use of a socket on the EPROM, all its connections are on the solder side. The EPROM has to be individually coded for each call sign, and since each contains over 4000 characters, a special rig has been built to "blow" these to order *(see above)*. The only other oddment is the choice of IC11, which does affect the quality of the grey scale. A Mullard LOCMOS circuit is recommended, though CMOS-B series will work.

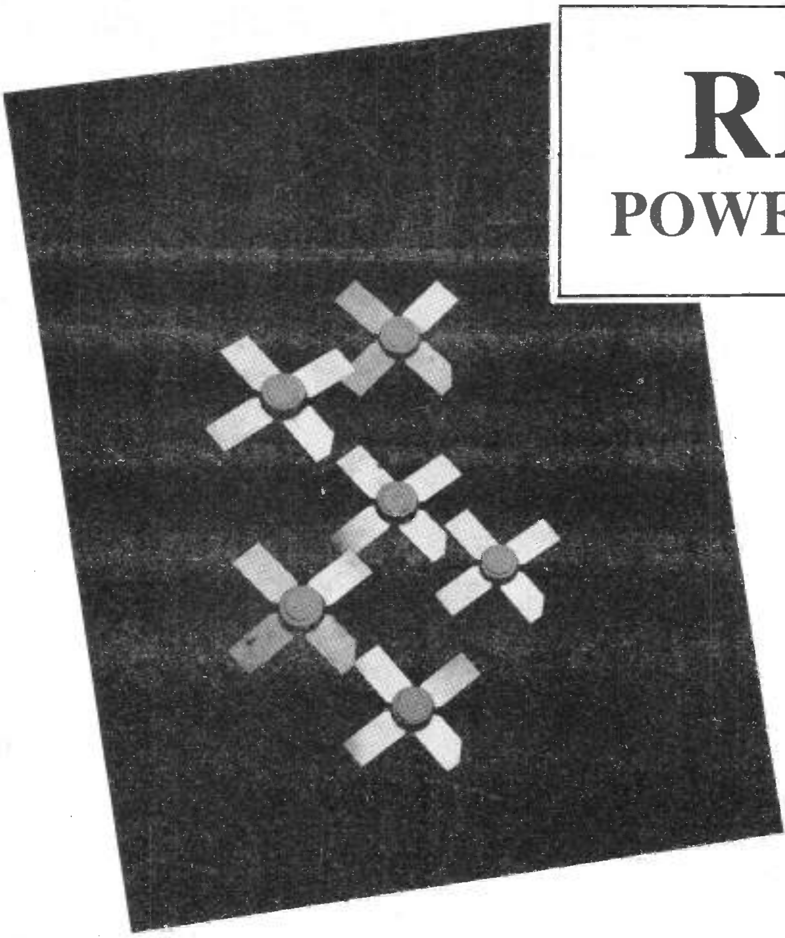
The board can be assembled in any order, but it is generally easier to put the low components in first. Only the PROM requires a socket, as you may wish to change it. Make sure that all the capacitors are the right way round and that the can of X1 is not shorting out any tracks.

As the input is protected from reverse polarity and reasonable over-voltages, switching-on should not be too harrowing an experience (a small pile of sandbags will stop most of the exploding capacitors you put in reversed polarity!).

A quick look at the output with a scope or monitor will show if everything is OK. If not, first check for dry joints and short circuits, then switch on again and check the voltages and frequencies marked on the circuit diagram. Even if the circuit appears to work, it is worth checking IC11 pin 7 for a negative bias of −8 to −12 volts.

■ R&EW

RF TMOS
POWER TRANSISTORS



William Poel previews Motorola's European strategy for re-establishing itself in the RF market

Not so long ago, Motorola and RF were synonymous in the RF semiconductor market. Currently, however, their involvement with 6800 family developments and their subsequent pre-eminence in that field, has deflected some of the internal attention away from RF. However, the European RF market has gradually been eaten away by a variety of newcomers, notably people like TRW, Thomson and, latterly, Siliconix with its VMOS RF range.

RF is a relatively tiresome business for the suppliers, since although the UK offers the second largest RF power semiconductor market in the world, the very high levels of customer support, the frequent attachment of all sorts of aerospace and military approvals and the relatively small annual volume makes it a business that requires careful marketing. Add to that the legendary radio amateur/enthusiast element in the UK radio communications engineering industry, and more than one RF marketing manager has been known to complain about supplying more free samples than actual sales.

Motorola has recently decided that it wants to get back into the volume RF markets of Europe and has set up a special team to prepare the ground and formulate a strategy. One of **R&EW's** contacts was good enough to give us some names to ask, and we unearthed what looks like being the best RF 'package deal' on the market. Cardiff publishing's excellent concise bi-monthly *RF Design* magazine signalled Motorola's intentions, with a feature on Power MOSFETs versus Bipolar Devices, in their 1981 November/December issue. The MRF150 devices in the cover picture had 'sample' stamped on them — but now they are available for business.

TMOS

The TMOS process employs a vertical channel like the Siliconix VMOS and International Rectifier HEXFET. It is basically a process refinement to circumnavigate some of the intricacies of the V groove etching process. The bottom line is that a TMOS power device occupies a die size that is about 50% larger than a corresponding bipolar process device. Semiconductor price is all about efficient die size, so there had to be some good reasons for using the TMOS process when Motorola already have a very broad range of bipolar parts.

The advantages are those which are already well known and widely

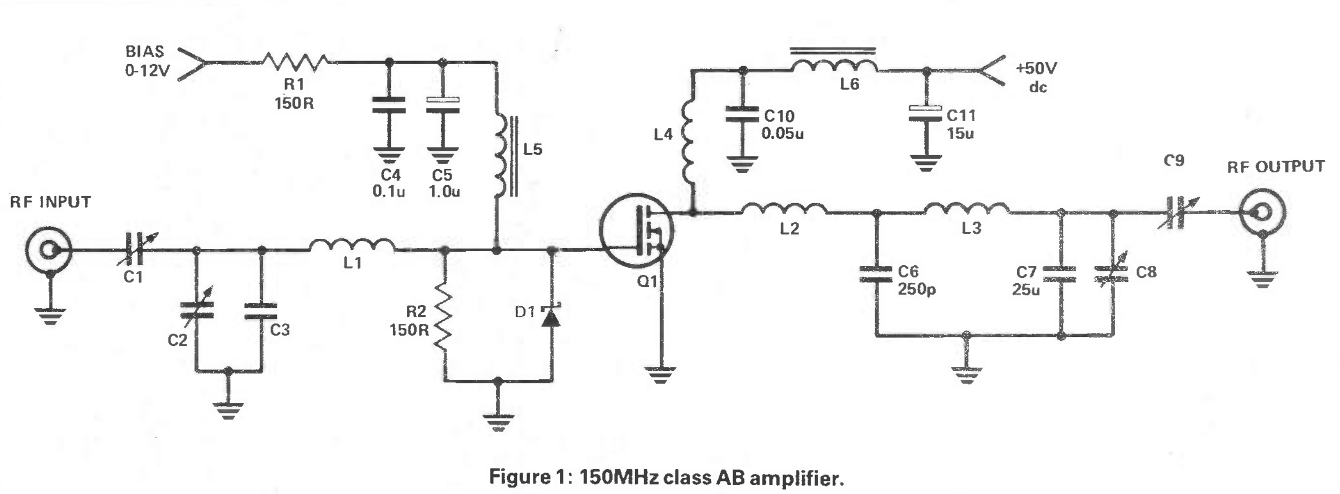


Figure 1: 150MHz class AB amplifier.

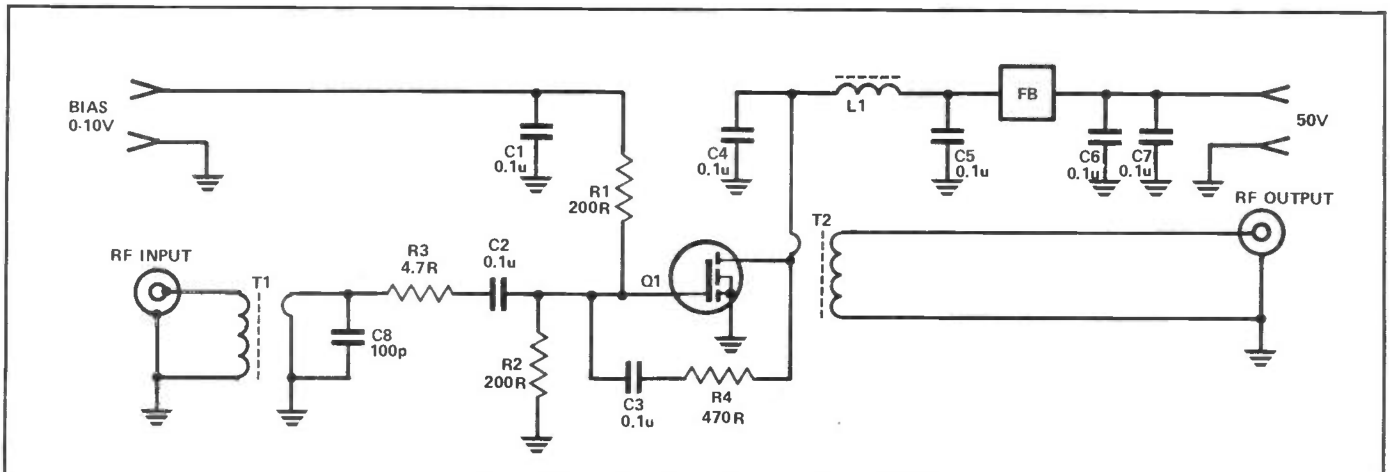


Figure 2: Broadband amplifier circuit (2-50MHz)

broadcast in the great MOS versus bipolar debate — lack of secondary breakdown, prevention of thermal runaway, easy parallel configurations, low drive power requirements. However, in RF applications there is one feature that is perhaps more significant — input impedance remains far more constant under varying drive levels.

One further feature claimed for all RF FETs is the low noise generated in adjacent channels — particularly pertinent on sites where repeaters and other transponders are used.

The results of all these factors are lower high order IMD and easier combination in broadband and parallel systems. Bearing in mind the substantial vested interests of Motorola in bipolar RF technology (witness their enormous and very useful RF data handbook), the fact that they are now proclaiming MOS is very significant for the RF fraternity.

The RF TMOS family presently consists of a limited number of devices, but since they are all specified across a frequency range of 2 to 200 MHz (the MRF140 is only rated to 150MHz), this lack of numbers should be put in the context of one TMOS part fitting the applications of as many as 10 bipolar devices, covering the same frequency range, operating modes etc.

TABLE 1. MOTOROLA DEVICE SPECIFICATIONS

Device	Frequency Range	Power Out	Voltage	Gain
MRF134	2–400MHz	5W	28V	11dB/150MHz
		5W	28V	10.6dB/400MHz
MRF171	2–200MHz	45W	28V	12dB/150MHz
MRF172	2–200MHz	80W	28V	10dB/150MHz
MRF174	2–200MHz	125W	28V	9dB/150MHz
MRF140	2–150MHz	150W	28V	15dB/30MHz
MRF148	2–175MHz	30W	28V	18dB/30MHz

This is certainly one of the most important, if less visible, advantages for the user, who is certainly going to be grateful that he only needs to stock/familiarise himself with a very limited range of devices.

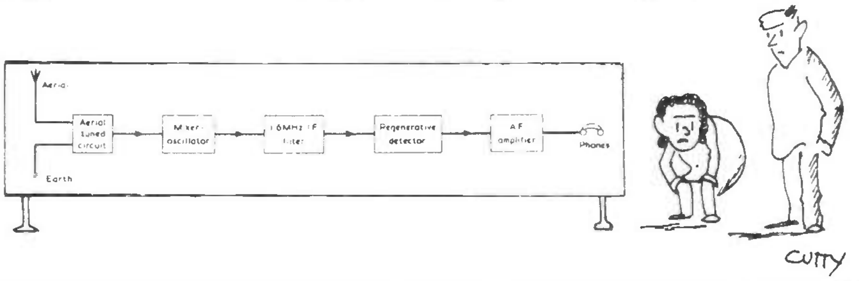
The devices in ***Table 1*** are those currently released with specification information and parameter measurements up to the very high standard established by Motorola for its RF semiconductors. Noteworthy points at this early stage are that the MRF148 cites amateur radio equipment amongst its uses, and offers a 120V drain/source rating, as opposed to the 65V of the other parts in the series. All parts are rated to a 30:1 SWR, at all phase angles of load mismatch.

Operation at 28V is largely dictated by aerospace applications, and 13V8 operation, in mobile situations, is usually a nuisance for the RF designer, who has to cope with low impedance earths for the substantial earth currents involved. Transistors designed for operation around 12/13V also have lower gain and saturation problems.

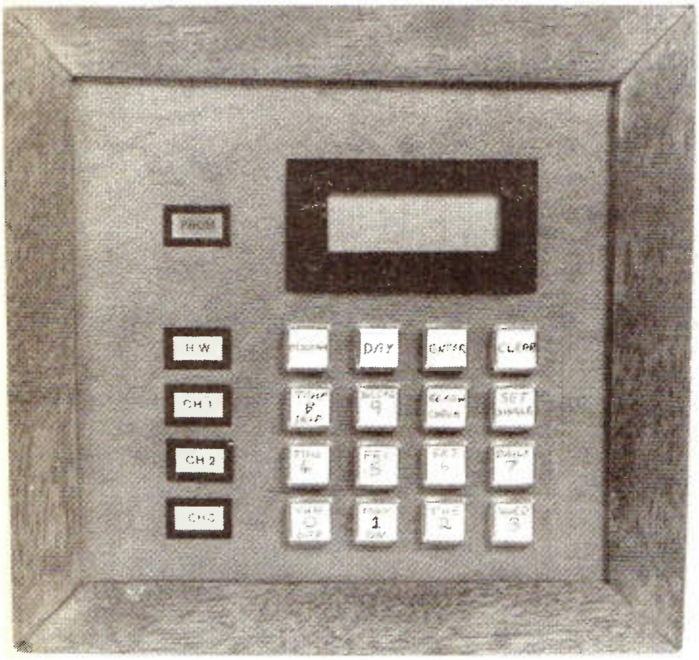
The 50V working range of the MRF148 may grieve those of you with big 13V8 power supplies, but since most amateur experimental work is likely to be mains powered anyway: enjoy the advantages offered by lower earth currents and higher gain and construct a 50V PSU (or extract one from an audio amplifier). One watt input for 40 watts output in a broadband HF stage, as simple as that shown, is an advance that should not be shackled by conventional RF transistor design considerations.

■ R&EW

"I know you got it out of the book, but it still doesn't sound right!"



CENTRAL HEATING CONTROLLER



★ Independent control of up to four "zones" of heating, each with its own thermostat.

★ Programmable timer cycle, variable from one day to ten weeks.

★ Up to 240 switching operations per cycle.

★ Facilities for making temporary or permanent additions to, or deletions from, the program.

★ Eight programmable temperature limits.

★ Programmable frost protection.

★ Battery back up, to prevent data loss in the event of mains failure.

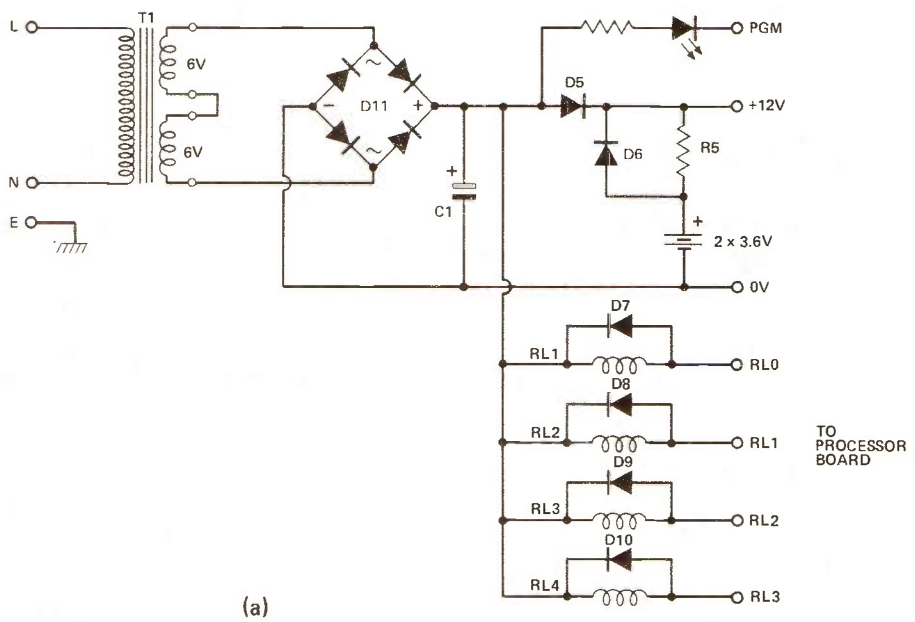
A microprocessor-based system for controlling domestic central heating. Design by D.A. Pickles.

This controller combines the functions of a time switch and thermostat in an oil or gas fired central heating installation, to provide versatile control of the system. In conjunction with suitable central heating hardware, the controller ensures the energy that is used is better matched to need.

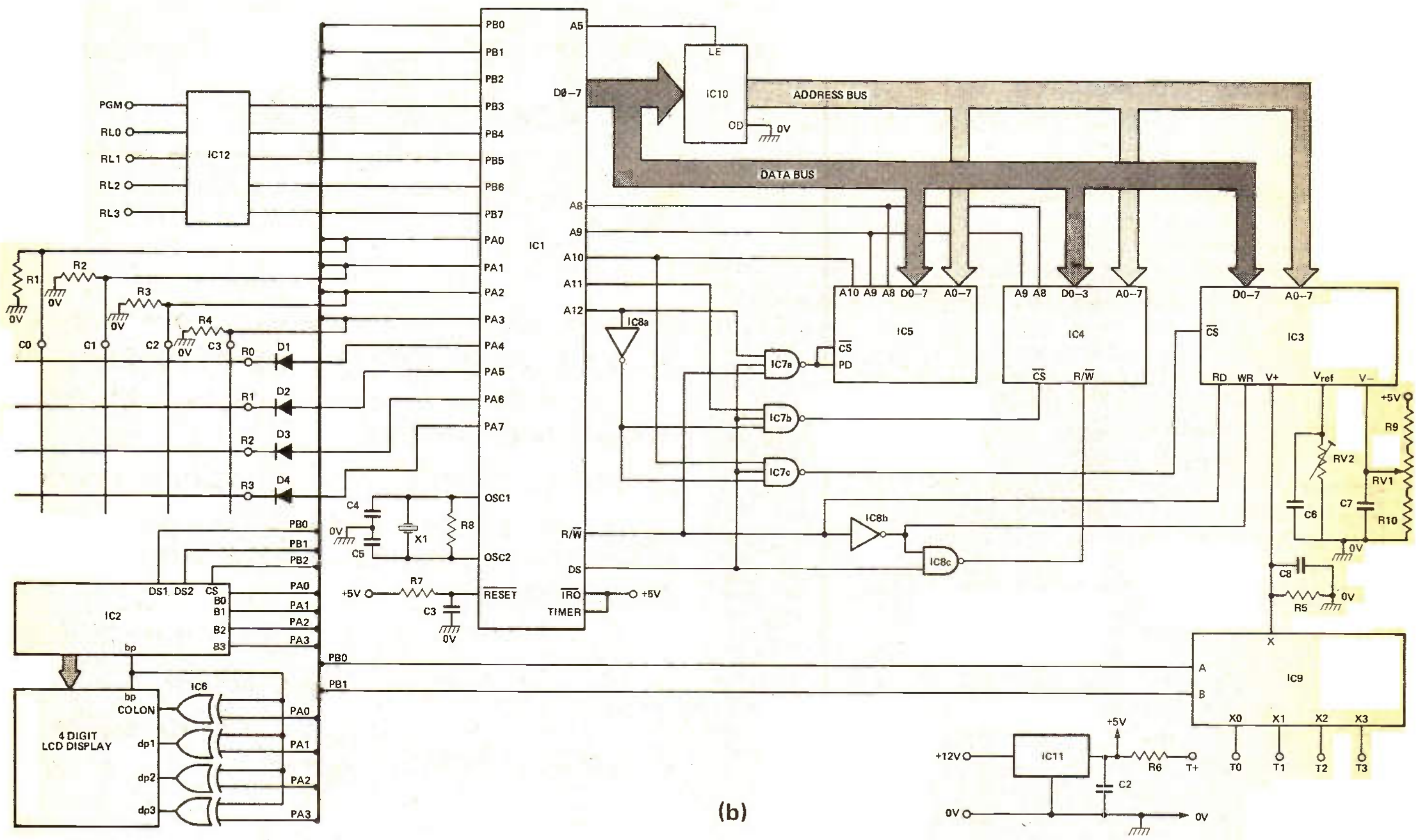
Design

The controller output is in the form of four relays. Each 'relay channel' may have an associated temperature sensor, which controls the operation of the relay in accordance with the program.

The controller maintains a list of eight temperature limits. Temperature control is exercised by allocating one of these to a channel, whereupon the relay is energised for as long as the temperature of its sensor is below the limit. Comparisons are performed once per minute. Hysteresis can be

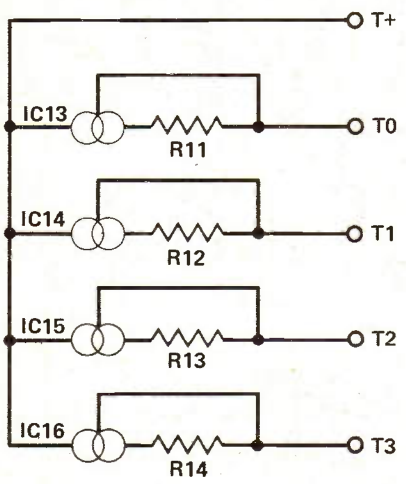


(a)



(b)

Figure 1: Circuit diagrams for the PSU (a), the main processor board (b) and the temperature sensors (c).



(c)

Circuit Description

The circuit diagram of the controller is shown in ***Fig. 1***. The unit is based on a single-chip microcomputer, the Motorola MC14680E2. This is a CMOS device, similar to the 6800 series, but having two 8-bit I/O ports and a timer/counter on chip, as well as 112 bytes of RAM. The bottom 8 address lines are multiplexed with the data bus, and are separated by IC10, an 8-bit latch.

The processor clock is derived from a 3.2768MHz crystal. This frequency is divided down by the timer counter on chip and used to generate an interrupt every 50ms.

Eight of the processor I/O pins are used to operate the keyboard, which consists of 16 key switches arranged as a 4 x 4 matrix. The 4-digit liquid crystal display is driven by IC2. The colon and decimal points on the display are driven directly by the processor via exclusive OR package IC6.

In order to connect all the peripheral circuits to the processor, some I/O pins have several functions. For example, four of the lines used to scan the keyboard also act as outputs to the display driver and drive the display decimal points.

The output from the unit is in the form of four relays, driven by the processor via a Darlington driver array. Front panel LEDs are connected in parallel with the relays to indicate their state. A further LED is used to indicate that the controller is in Program Mode.

The temperature-sensing function is carried out by LM334Z constant-current sources. The current through these devices is proportional to absolute temperature, over a wide range of applied voltage, and is unaffected by cable resistance or thermoelectric effects. Four such sensors may be connected to the unit, the appropriate one is selected by analogue gate IC9 and applied to the input of A/D converter IC3. The range and offset of the converter are adjusted so that the full digital output range (0-255) corresponds to a temperature range of 0 to 64 degrees C.

If temperature control is not required then IC9, IC3 and associated components may be omitted.

The operating schedule of the timer is stored in IC4, a 1k x 4 bit CMOS RAM, and the processor program in EPROM IC3. The latter is responsible for most of the quiescent current drain of the unit, which is about 20mA.

The back-up battery specified will keep the processor operating normally for about 5 hours in the event of mains failure. The relays and LEDs are not powered by the battery in order to reduce current demand, but most heating systems will not run without mains supply anyway.

programmed into the operation of the channel in order to prevent excessive on-off switching. Limit 0 is an OFF state, but may be overridden to provide frost protection. If no temperature control is required, then limit 0 is OFF and limit 1 is ON.

The association of a temperature limit to a channel can be done either manually, at the keyboard, or automatically at programmed times. The list of these "events" constitutes the operating schedule of the controller. The schedule can be examined and edited at the keyboard.

The normal operation of comparing a channel's temperature with its limit is suspended if the temperature reading is zero. This is a safety feature, to guard against vast fuel bills in the event of a temperature sensor going open circuit.

Construction

The controller comprises three printed circuit boards. The processor and associated circuitry plus the liquid crystal display are mounted on one board, the relays, mains power supply and the back up battery are mounted on another (this ensures that mains voltages are kept away from the CMOS devices, and also allows for the unit to be mounted in two boxes if desired). A third board is used to mount the key switches for the keyboard.

The processor board layout is shown in ***Fig. 2***. Insert the wire links first, using sleeved tinned copper wire — many links pass under ICs. Sockets are recommended for the micro and the EPROM.

The LCD display is mounted on the board in a socket made from a 40-pin IC socket cut in half, the display driver sits underneath. Note that the display is fitted 'upside down', that is with the decimal points at the top.

The relay board layout is shown in ***Fig. 3***. The contact rating of the specified relays is 5A at 250V AC. If reactive loads are to be switched then suppression capacitors should be fitted across the contacts. Loads over 5A will require a heavier duty relay, however bear in mind the 3VA rating of the power supply when choosing a suitable device.

The keyboard layout is shown in ***Fig. 4***. The 16 discrete key switches are labelled with their function using small pieces of card under the clear plastic keytops.

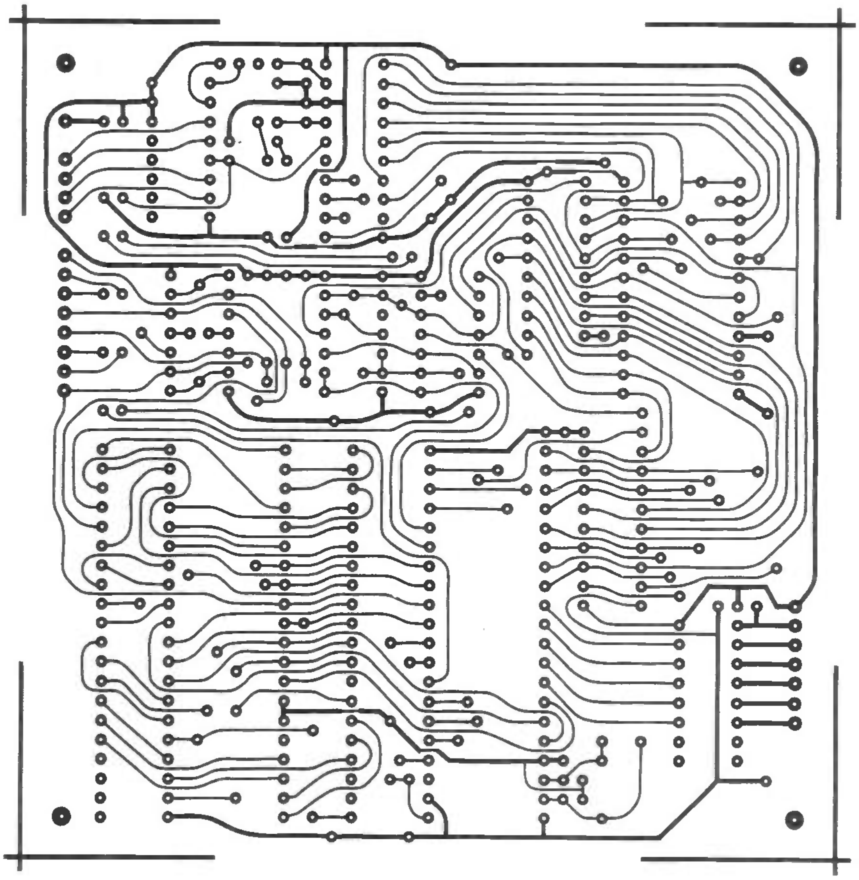
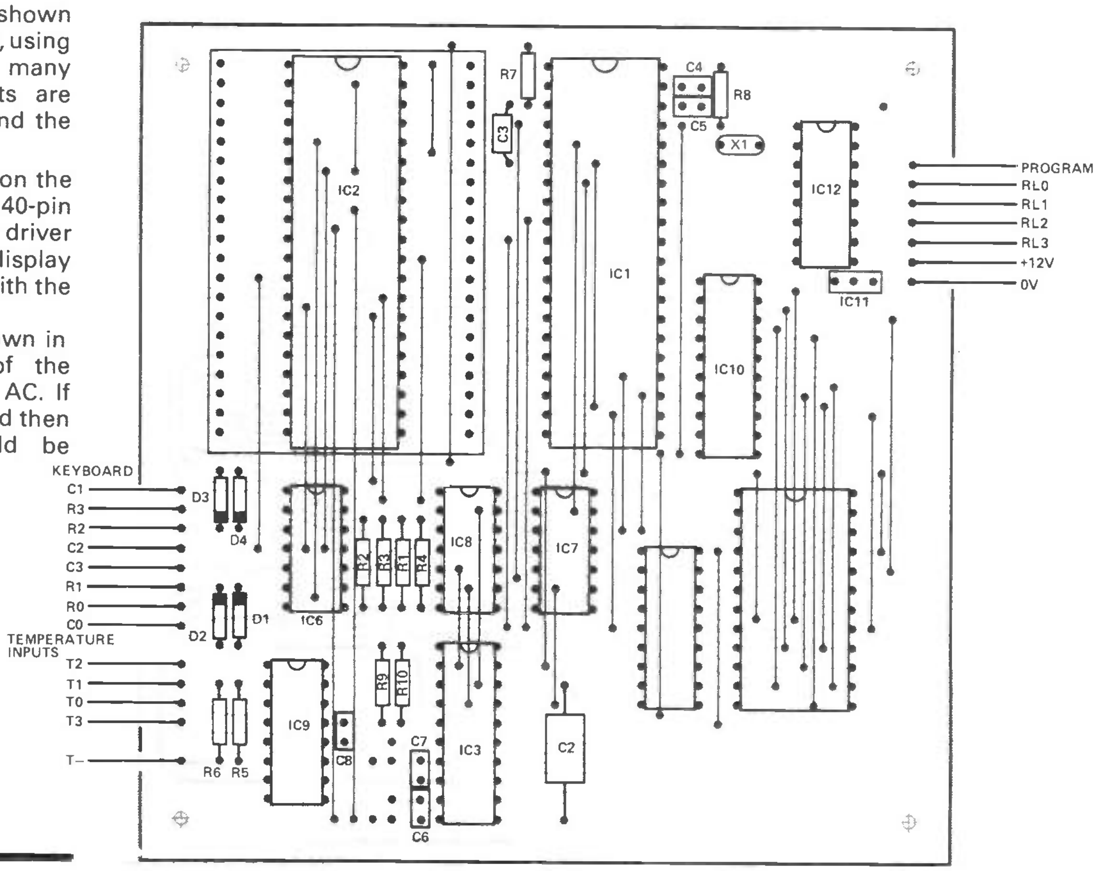


Figure 2: The PCB foil (above) and component overlay (below) for the processor board.



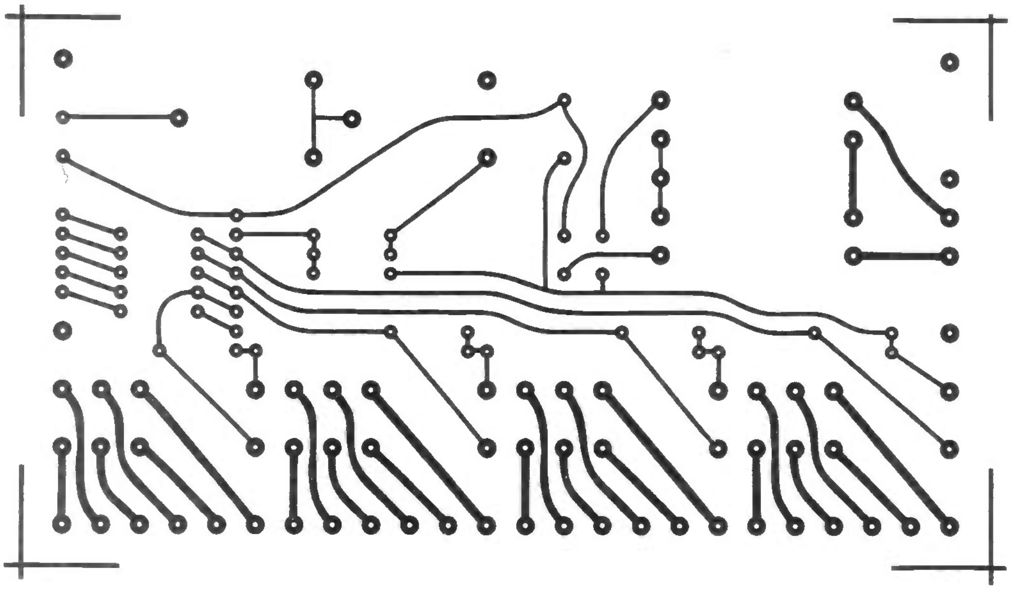
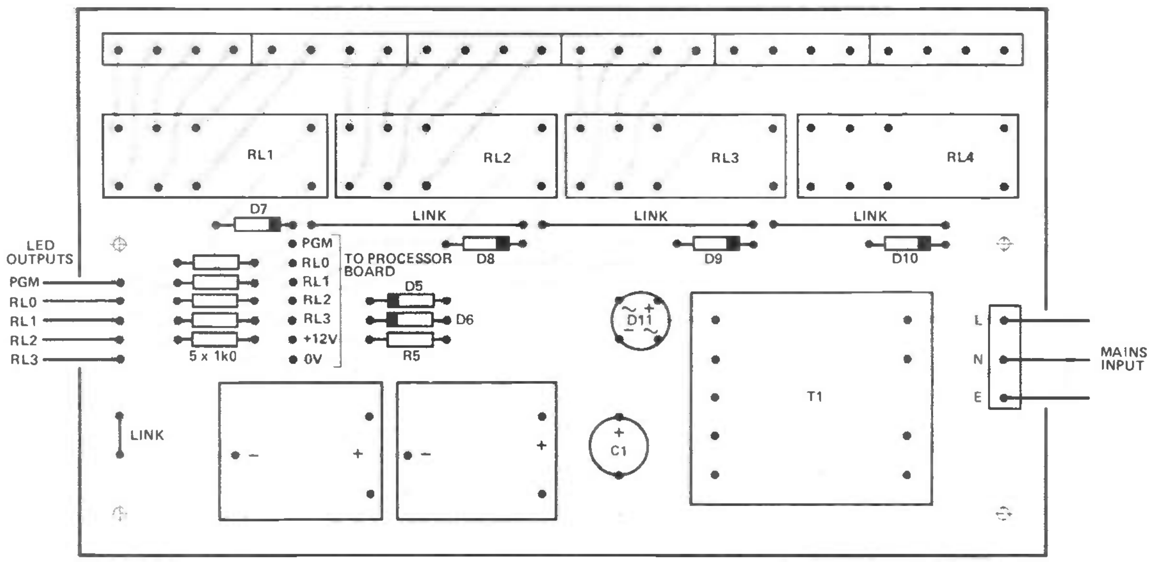
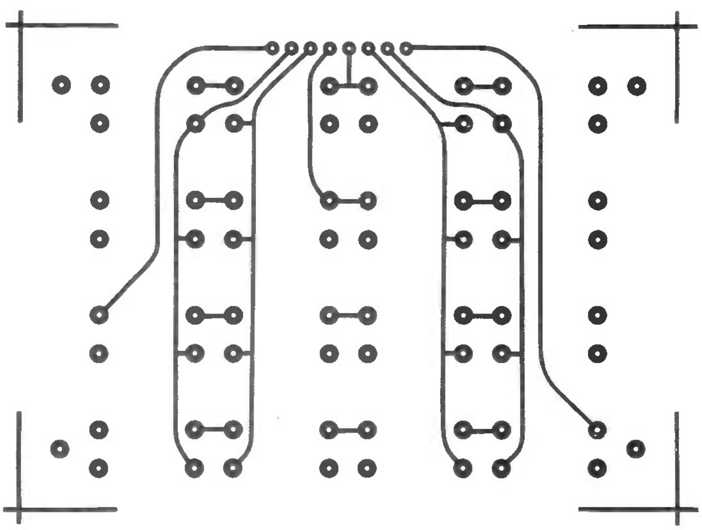


Figure 3: Foil pattern (top) and overlay (bottom) of the relay circuitry.





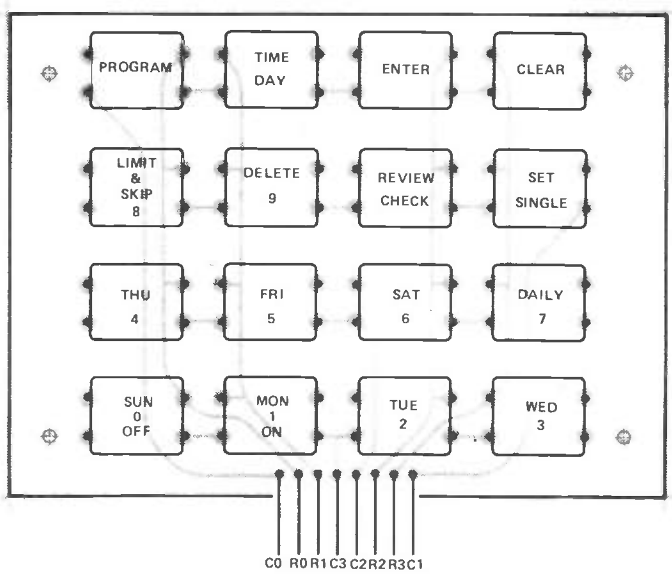


Figure 4: Keyboard PCB foil (left) and component placing (right).

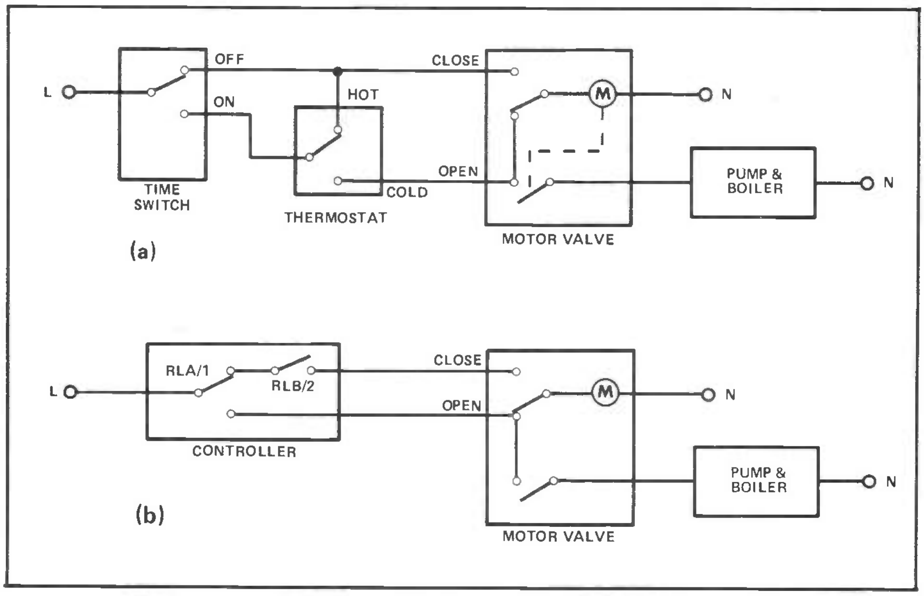


Figure 5: A standard central heating system (a) and integrating the controller (b).

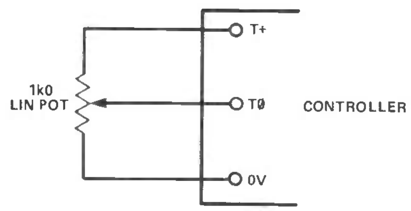


Figure 6: The setting-up circuit.

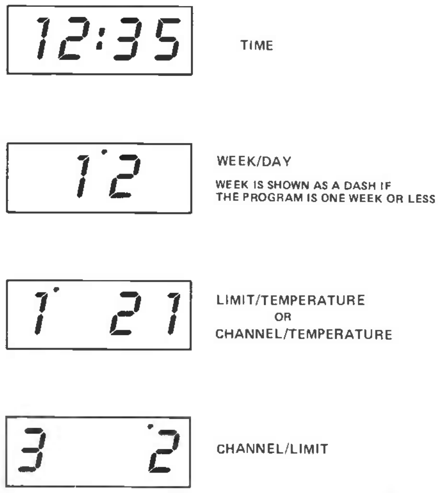


Figure 7: Some typical displays.

Installation

There are many different types of central heating system, the wiring of the type most suitable for use with this controller is shown in ***Fig. 5a***. This uses two or more motorised valves to direct the hot water from the boiler to the hot water cylinder or the radiators. A similar arrangement is sometimes found using a two-position 'Y' valve. The modified wiring is shown in ***Fig. 5b***. Heating systems using 'gravity' (thermosyphon) to feed the hot water cylinder are less amenable to conversion, as there is no way to stop hot water being generated.

The location and mounting of the controller is largely a matter for individual preference. In the author's case the unit was built into a plywood box, which was placed on the kitchen wall next to the boiler.

The safety of the installation is of course of paramount importance. The controller should not be fitted in a location where it could be subject to splash or condensation, or where it is within the reach of small children. All metal parts accessible on the outside

Table 1. Details of start-up procedures and display command.

Start Up Procedure

On first switching on the unit it is necessary to specify the operating mode of each of the four channels. The mode is specified as a number from 0 to 5, according to the following: the controller will display "PO" on first switch on. The mode number for channel 0 should then be entered, followed by the ENTER key. If a mistake is made at any point in the start-up sequence, the CLEAR key will return to the start point. If a mode number of 2 or greater is entered, the display will show "HO", the user must then enter a two digit number corresponding to the desired temperature hysteresis in quarters of a degree centigrade. A value of 01 was found optimum for the author's central heating, 00 is allowed but will cause excessive cycling of the boiler due to jitter in the A/D converter. 63 is the maximum number permitted, corresponding to 16 degrees C.

Once the data for channel 0 has been entered, the display will show "P1", requesting the data for channel 1, and so on for channels 2 and 3.

Following the data for channel 3, the unit requests the number of weeks and days in the schedule. Two decimal digits should be entered followed by the ENTER key. A value of zero weeks one day may be entered, the cycle then repeats daily; the maximum is 9 weeks 6 days. Once this has been entered the display reverts to time mode and the unit is ready for use.

Display Commands

Under normal circumstances the display shows the current time in 24 hour format. Access to the other displays is obtained via the key sequences described below. In each case the display reverts to TIME at the end of the current minute.

DAY The current week and day number are displayed.

N The current temperature of sensor N (0-3) is displayed in degrees C. If the channel mode is 0 or 1 the instruction is ignored.

LIMIT L The value of temperature limit L is displayed in degrees C. Ignored if all channels are in modes 0 or 1.

CHECK N The current limit number for channel N is displayed. Ignored if the channel mode is 0.

Set Command

The SET command allows manual control of the system. The command format is;

SET N L ENTER where N is the channel number and L is the limit number. If channel N is in mode 0 the command is ignored, in mode 1 only limit numbers 0 and 1 will be accepted. The command may be aborted at any time up to the final ENTER by pressing CLEAR.

Program Commands

Pressing the PROGRAM key places the controller in program mode, allowing access to the internal storage registers. The red program lamp will remain lit while the controller is in this mode. Any program sequence may be aborted at any time by pressing CLEAR.

TIME

The internal clock is set by
PROGRAM DAY W D ENTER HH MM ENTER
The seconds count is set to zero at the final ENTER, allowing the clock to be set exactly. Attempts to set a week/day beyond the current cycle length or to enter a non-valid 24h time will be rejected. If a one week cycle or less was specified the week number is not entered, the display shows a 0 in the week position.

LIMIT

The temperature limits 0-7 may be set by
PROGRAM LIMIT N LL ENTER
where **LL** is a two-digit temperature less than 64. The command is ignored if all channels are in modes 0 or 1.

DELETE

This function deletes all entries in the program memory and resets the schedule cycle length.
PROGRAM DELETE W D ENTER
where WD is the schedule cycle length in weeks/days. This function should not be confused with the DELETE function in REVIEW mode, see below.

ENTER

New entries in the program memory may be made by
PROGRAM ENTER W D ENTER HH MM ENTER N L ENTER
if D=DAILY then an entry is made on each day in the specified week. Entries are automatically sorted and therefore need not be entered in any order. If an entry is made at the same time as an existing entry, the new event is entered one minute later, as events cannot be simultaneous. As for the TIME function, the week number is not entered for one week or less cycle length.

SINGLE

This function is the same as ENTER except that the entry thus made in the program memory will automatically be deleted as the event is executed. This is one way of making temporary changes to the program.

REVIEW

Entry to this function is by PROGRAM REVIEW. The display will show the week/day of the next scheduled event. Repeatedly pressing REVIEW will display the time and channel/limit of this event, followed by details of subsequent events in chronological order. The sequence may be exisited by pressing CLEAR.

Pressing DAY while in review mode causes the display to jump forward one day. This is useful when editing events entered using the DAILY function.

The review command also allows details in the memory to be changed. Pressing DELETE while in review mode removes the currently displayed event from the memory, the display then moves on to the next event. Pressing SKIP marks the currently displayed event as to be skipped on the next cycle, this is identified during REVIEW by two dashes in the channel/limit display. A skipped event can be unskipped by pressing SKIP again.

Note that the timer function is suspended while in PROGRAM REVIEW mode, any events scheduled to occur during this time will be missed.

should be earthed.

The location of the temperature sensor for monitoring room temperature will need to be determined by trial and error. It is unlikely that the position used by conventional bi-metal strip thermostats will be suitable, as these use an internal heating resistor to provide positive feedback and reduce response time. The best position seems to be in a rising convection current, such as close to the ceiling.

The hot water tank sensor should be mounted in thermal contact with the tank, about one-third down from the top. Screened cable is advisable for the sensor wiring, as the processor can generate RFI which could be radiated by the cables.

PARTS LIST

Resistors

R1-5	10k
R6	330R
R7	470k
R8	10M
R9,10	1k
R11-14	240R metal film

Potentiometers

RV1,2	1k Cermet

Capacitors

C1	100u 25V radial
C2	220u 16V axial
C3	1u 35V tantalum
C4,5	33p ceramic
C6-8	100n ceramic

Semiconductors

IC1	MC146805E2P
IC2	ICM7611A
IC3	ADC0804L
IC4	TC5514 or uPD444
IC5	2716 (programmed)
IC6	4070
IC7	4023
IC8	4011
IC9	4052
IC10	74HC373
IC11	78L05
IC12	ULN2003
IC13-16	LM334Z
D1-10	1N914
D11	Bridge Rectifer 50PIV 1A

Miscellaneous

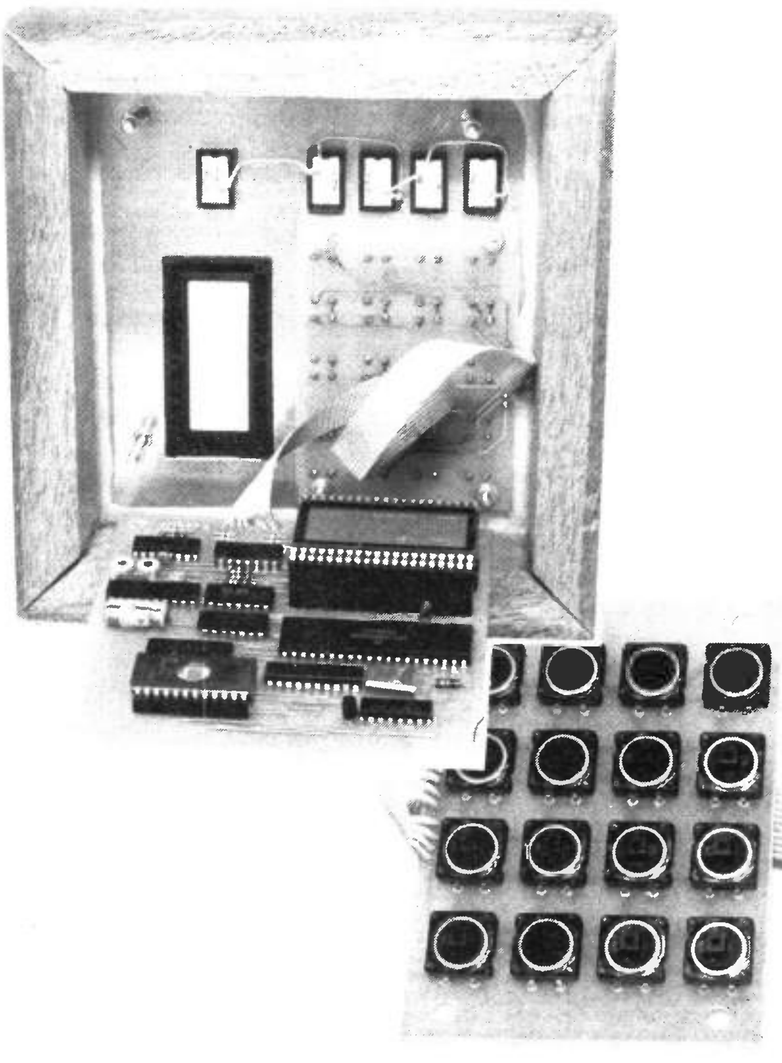
3.2768 MHz HC18/U. RL1-4, 12V 200 ohm coil, Contacts 250VAC 5A DPCO, T1, 2 x 6V (3VA total), LCD display, Batteries, Socket, Bezel, Switches, Switchcaps, PCB, Solder etc.

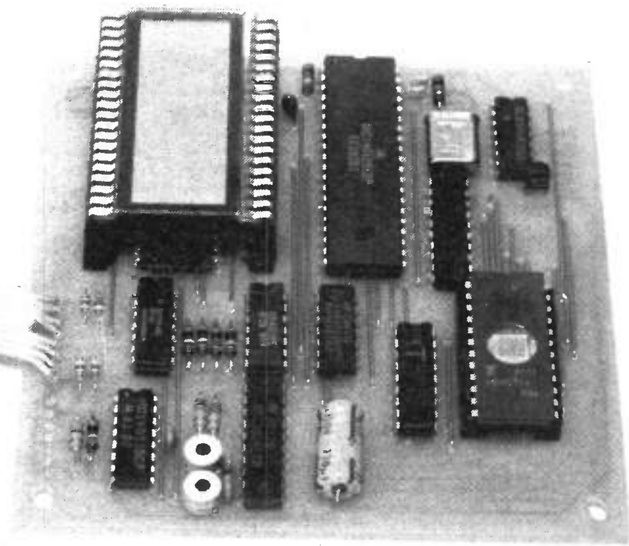
Setting Up

The range and offset controls for the A/D converter must first be set. Ideally a digital voltmeter is used, though the adjustment can be made using a temperature sensor and a thermometer. If a DVM is available, then set up the circuit shown in ***Fig. 6***. Set RV1 and RV2 fully clockwise. Set the pot to obtain a DVM reading of 3.35V, and adjust RV2 to obtain a channel 0 temperature of 62 degrees. Repeat these two steps until no further adjustment is necessary. If no DVM is available the adjustment can be made using two known temperatures near 0 and 63 degrees, adjusting RV1 at the lower temperature and RV2 at the upper.

It is also necessary to calibrate the individual temperature sensors. R14-17 should be adjusted by adding series resistors to obtain the same reading on each channel (the sensors at the same temperature). Increasing the resistance will reduce the temperature reading. It is not recommended that variable resistors be used, due to their high temperature coefficient.

■ R&EW





Zilog Lesson 3 Z8000 Course

INTERRUPTS, TRAPS, AND OTHER CONTEXT SWITCHES

PROGRAM STATUS

Multiprocessing, multitasking and other systems allow programs to make individual, repeated use of the machine on a sequential, perhaps arbitrary, schedule. Any processor intended to manage such a system effectively must provide a convenient means for representing the current *environment* of the current program. It must allow for changing that environment when other programs are given control. In fact, such a processor must provide a means for remembering and restoring an earlier environment so that when one task is completed, those tasks running previously can then be finished. The Z8000 can manage *context switches* between competing tasks, allowing a hierarchical arrangement of these tasks which can distinguish operating-system programs from user programs.

The Z8000's *status registers* provide all the information needed to define the current environment in which instructions are being executed:

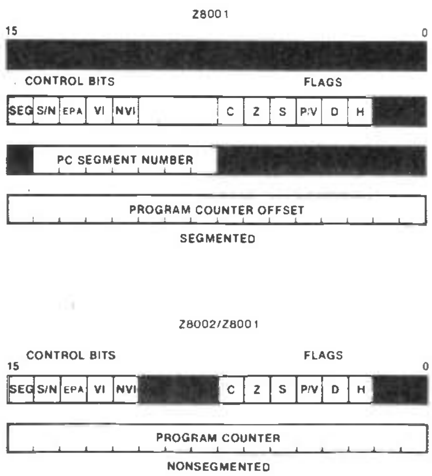


Figure 1
Z8000 Status Registers

Flag and Control Word

The *flag-and-control word* (FCW) contains: 1) control bits that define the current mode of operation and 2) flag bits that reflect the result of preceding instructions. The *program counter* (PC) simply contains the address of the memory cell from which the next instruction's first word can be fetched. In these diagrams, all blackened areas are *reserved* for future use. (Of course, in the Z8002, only the nonsegmented form of the status registers has meaning.) The two halves of the FCW are different in importance and accessibility, as will be explained.

The FCW's *control bits* have the following functions:

SEG	Z8001 only, "ON" means addresses are to be in segmented form.
S/N	"ON" means system mode is in effect; "OFF" means normal mode.
EPA	This bit may only be "ON" in Z8000s with extended-architecture, and then only when used with slave processors (EPUs).
VI, NVI	These bits enable (ON) or disable vectored and nonvectored interrupts.

S/N BIT

The most important control bit is S/N. It establishes what instructions are executable and what memory is used, if memory hardware uses the N/$\overline{S}$ output to create two spaces. This bit implements the segregation of normal (user) programs and data from the operating system. It has effect even if no memory-space distinction is made, because only in *system mode* are *all* Z8000 instructions executable. In normal mode, to protect the system and hardware from improper use, many instructions are *illegal*. Input/Output (I/O), FCW control-bit manipulation, and other important activities are all disabled in normal mode. In fact, they generate *privileged-instruction traps* if their execution is attempted. The system should contain a routine to service such events.

VI and NVI Bits

The VI and NVI bits control whether interrupt requests on the corresponding inputs to the Z8000 will be honored. If either is enabled, and if requests are allowed in from hardware, the system must contain a routine to service interrupts.

EPA Bit

The EPA (extended processor architecture) bit has meaning only in Z8000s with extended architecture. When set, it allows an external Z-bus extended processor unit (e.g., a floating-point device) to interact systematically with the CPU via the $\overline{STOP}$ input.

SEG Bit

The last control bit, SEG, has effect only in the Z8001, where it defines how addresses may be formatted. If it is "ON," then long or short forms of segmented addresses must be used. If "OFF," then only 16-bit offsets are addresses, as in the Z8002.

Flag Bits

The FCW's *flag bits* are affected by instructions in various ways. They reflect the result of the previous instruction's execution for use in establishing conditions for jumps and other program decision making:

C	When "ON," typically indicates that an instruction's execution caused a *carry* out of the leftmost bit of a destination operand.
Z	Indicates that an instruction's execution caused a zero result.
S	Indicates that the *sign* of a result is negative (leftmost bit "ON").
P/V	Indicates that the *parity* of the result is even or that *overflow* occurred. The particular meaning depends on which instruction last affected the bit. Parity has meaning for some instructions, overflow for others.
DA	Indicates that a subtraction was last done, rather than an addition.
H	Indicates a *half-carry* occurred (from the right-hand four bits of a byte into the left-hand four).

The processor uses these flags, in various logical combinations, to establish conditions for jumps, and so on. Assembly language represents conditions mnemonically, by *condition codes*. Thus, "NZ" stands for "not zero" and will produce a runtime check for a zero (Z) flag. The DA and H flags are used *only* 1) by BCD (binary-coded-decimal) digit manipulations, and 2) by the DAB instruction, which reformats binary numbers in bytes as two-digit BCD numbers (four bits per digit). This is useful, for instance, when instrumentation data, which is often supplied in BCD notation, is processed.

For the purposes of interrupts and traps, only the control bits in the FCW and the PC are of great importance. In fact, because the flag bits do not affect the Z8000's mode of operation, they are accessible in both system and normal modes.

If the FCW represents the current environment under which a program is running, then there must be a way of switching environments to execute service routines for such unpredictable occurrences (exceptions) as interrupts or traps.

SSP and PSAP

Two sets of registers in the Z8000 aid this switching of context: 1) the system-mode stack pointer (SSP), and 2) the program status-area pointer (PSAP). The system stack pointer is simply R15 (or RR14 in a Z8001 with SEG = 1) with the *S/N bit on*.

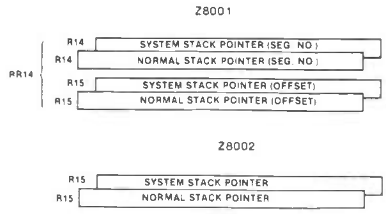


Figure 2
Z8000 Stack Pointers

The system stack pointer is important because the current FCW and PC will be saved on that stack when a trap, interrupt or system call occurs. Before any such events can occur, this stack and its pointer must be set up during system initialization — before interrupts are enabled, for instance.

Status saving is only the first step in changing environments, however. The Z8000 must know where to find new values for FCW and PC so that an unpredictable event can be serviced by the appropriate routine. The Z8000's PSAP register fills this need. Just as SSP must be initialized, PSAP must be loaded with the address of an area (status area) in memory that has itself been initialized with a table of FCW and PC values. These values must cover all trap or interrupt service routines needed by the system:

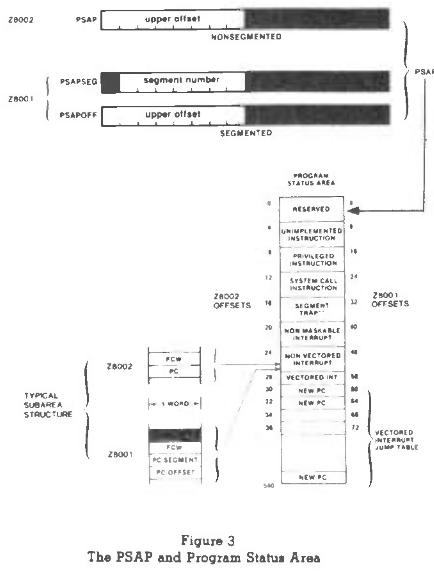


Figure 3
The PSAP and Program Status Area

The status area is simply indexed into starting at its base address as provided by PSAP. Each type of internal or external event that the Z8000 can conceivably handle is represented in a unique place in this table (at a unique index beyond PSAP) by an FCW and PC value. In the case of vectored interrupt, one FCW applies to all vectors. The format of each status in the area is processor dependent, *not* mode dependent.

CONTEXT SWITCHES

When a trap or interrupt occurs, the Z8000 goes into a well-defined protocol:

First, system mode is entered. Competing events are examined for relative *priority* and one is acknowledged. If the event was external in source, then a special timing cycle is begun to acknowledge a peripheral's interrupt and to receive a vector or identifier. (This cycle will be described later.) Event priority is: internal, NMI, segment trap, VI, and NVI.

Second, the current *status* words (FCW and PC) are *saved* on the system stack (using SSP). In the Z8001, this is *always* done in segmented mode regardless of the value SEG had. Thus two PC words are saved even if a Z8001 was running in nonsegmented mode at the time of the event.

Third, the reason, or identifier word, related to the event is pushed on the system stack. For internal events, this will be the first word of the trapped instruction. For external events, it will be the content of the data bus as sampled at T3 during the acknowledge cycle. External devices may use this word to identify themselves or otherwise communicate with their service routines.

Fourth, having saved prior status and, perhaps, acknowledged an external event, the Z8000 indexes into the status area (identified by PSAP) by an amount corresponding to the category of the event. From this subarea (four words in a Z8001, two in a Z8002) it extracts a new PC value and a new FCW value. It then proceeds to fetch the next instruction using the new PC address and under the modes/flags in the new FCW. In short, the service routine is run.

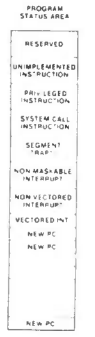


Figure 4
The Program Status Area

Vectored Interrupts

For *vectored interrupts,* the value of the vector (low eight bits of the data bus during acknowledgement) is used to index into the VI subarea to obtain one of many PC values. In the Z8001 there are 128 possible segmented PC values. In the Z8002, because only one word addresses are used, the VI subarea can hold 256 PCs. Vectors supplied to a *Z8001* must, therefore, be *even* values. Z8002 vectors can be even or odd (0 to 255).

NVI and NMI

Like vectored interrupts, *nonvectored* (NVI) and *nonmaskable* (NMI) interrupts are external and asynchronous (unpredictable). However, their subareas in the status area hold only one PC and therefore activate only one service routine. This is true for all events *other* than VI. It is always possible to have more than one status area and change PSAP to select the one currently appropriate. This can, of course, be done only while in system mode.

Segmentation Trap

To support the need for memory management, particularly in Z8001 systems, *segmentation trap* is an additional type of external event represented in a status area. Such events are generally synchronous, unlike interrupts, because they are directly related to the timing of memory cycles and thus to the CPU clock. (This is, in particular, true when Z8010s are used with the Z8001, as will be described in another lesson.) If segment addressing can be checked by some memory-management device and traps generated by illegal accesses, then a service routine can be included as part of the system. Its address can be placed in the segmentation trap subarea. When a trap occurs, the 'reason' word on the system stack could be information passed back from the trapping memory manager.

Unimplemented and Privileged Instructions

Unimplemented and *privileged* instructions are, as their names imply, permanently or temporarily illegal. In the case of EPUs with slaves, turning on the EPA bit in FCW causes some special, built-in instructions to become legal. Privileged instructions, however, are the same in all Z8000s and are simply those that may only be executed in system mode (S/N = 1). They are: all I/O, LDCTL, LDPS, IRET, EI, DI, HALT, and multimicro instructions.

I/O instructions are privileged so that only the operating system can have direct control over external hardware. Normal-mode programs, like users on timesharing systems, thus see the hardware around the Z8000 indirectly, through the operating system.

System Call

One way to provide the user access to the operating system is the Z8000's *system-call* feature. An SC instruction automatically begins the service routine identified in the system-call subarea. The SC instruction takes one operand as an immediate byte value. This operand will appear in the 'identifier' word on the system stack when the system-call service routine is entered. In fact, the entire SC instruction is on the stack, since it is one word.

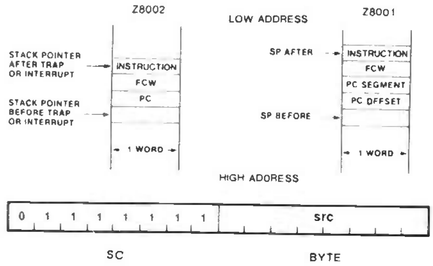


Figure 5
The System Call Instruction and System Stack

The byte passed in this way from normal-mode program to system-mode service routine can correspond to an action defined for that routine. It may be used, for instance, to implement simple I/O operations or other privileged functions.

Other Context Switches

Thus, the Z8000 implements a uniform protocol for handling both internal and external synchronous and asynchronous events that require context switching for service. Another way of switching context is to use the *LDCTL* (load control) instructions to change mode bits in the current FCW. Or, use EI and DI (enable/disable interrupt) instructions to change just the VI and NVI bits. However, more complete switches can be obtained with the *LDPS* (load program status) instruction, which loads the FCW and PC from an area in memory formatted in the same way as a status-area subpart. Note, though, that no old status is saved, so this is a way of *permanently* switching context — for example, when initializing system operation. (It should be clear now why many instructions are considered privileged.)

The system-call feature is not the only way an operating system can allow normal-mode tasks to perform privileged operations. One can simply design the privileged- and/or unimplemented- instruction service routines so that they try to interpret the word found on top of the system stack upon trapping. In this way, normal-mode programs can simply try to execute, for instance, I/O instructions. Each time any of these were trapped, the service routine (as interpreted) would try to simulate their effect.

Service Routines

In the Z8000, all service routines, for all events listed in the status areas, are entered with three (Z8002) or four (Z8001) words on the *system stack:*

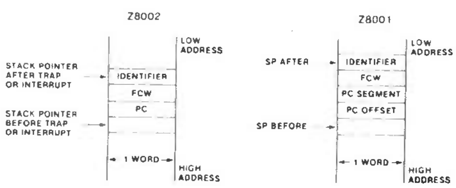


Figure 6
Effect of Interrupt or Trap on System Stack

This information must be cleaned up when the service routine is done. The Z8000 has *one* instruction for doing this regardless of the source of the event: IRET. Execution of IRET in a Z8002 automatically pops three words from the system stack and restores the old FCW and PC values thus found. In the Z8001, four words must be popped, because four are always pushed, even if SEG = 0 when the event occured; thus, a Z8001 *must* be in *segmented mode* (SEG = 1) before IRET is executed.

It is important to understand how the protocol outlined above affects the passing of additional information to or from a service routine. Suppose that a user (normal) program makes a system call. Data may be passed in the immediate byte in the SC instruction; but this must be known at assembly time and is of limited use apart from specifying one of various operations. The registers could be used, because *all* are accessible to system-mode programs. In fact, any true reentrant system would save all registers automatically before it runs, and restore them just before its IRET. The LDM (load multiple) instruction is useful for this. The space available in the Z8000's registers may be limited in relation to some needs. If so, the user might be tempted to push data on the stack or simply to put it in an area of memory and pass its address in a register to the system-call routine.

Whether this works or not will depend on how memory is partitioned by hardware and the operating system. Suppose that system and normal memory are segregated in a Z8002, thus creating two 64K program spaces, data spaces, and stack spaces. Once the SC instruction is executed, the Z8002 will be in system mode. Though the normal-mode user has passed the address of his data, the system-call routine cannot access it because hardware, looking at the N/$\overline{S}$ output, will automatically access the corresponding address in system memory. If such a scheme is to work, an area of memory that is accessible in both system and normal mode must exist. In fact, it is generally best to allow the system program to see *all* memory and normal-mode programs to see only normal-mode memory. Similar problems can arise with the Z8001, but astute memory management will mitigate difficulties.

Context Switching: Further Discussion

A few other subtleties of context switching should be pointed out. The *status area* is accessed by the Z8000 with the IFn condition emitted on the ST lines. Thus the status area must exist in *program space* if memory hardware makes such a distinction. The LDPS instruction, however, reads its FCW and PC values with normal data memory cycles, so its operands must refer to data space. It is, therefore, *not* possible to simulate a trap or interrupt via LDPS if memory hardware or management distinguishes data memory from program memory. In any case, if LDPS were to be used in this way to simulate exceptions, the system stack would have to be adjusted properly to allow the inevitable IRET to function. For the same reason, any trap, interrupt or system-call routine cannot simply POP the identifier word from the system stack, because an IRET will eventually do so.

An important practical consideration for system initialization is the potential existence of NMI events. As the name implies, NMI cannot be disabled. Therefore, in theory and practice, a Z8000 system must be ready to handle an NMI at any time after power-on reset. This is, of course, not possible, because a finite number of instructions and amount of time will be required for minimal initialization, even if the program and status area are in firmware. The PSAP and SSP must be loaded after initial status is fetched upon reset. Thus, an NMI occurring before this has happened will surely be mishandled. Some hardware provision for NMI delay must be included in any real system if NMI is to be handled properly. This is, of course, true for all processors that have NMI or its equivalent.

TRAP/INTERRUPT TIMING

External assertion of $\overline{NVI}$, $\overline{VI}$, $\overline{NMI}$, or $\overline{SEGT}$ inputs to the Z8000 initiates what is called generically the interrupt-acknowledge cycle. Because of the modularity in the Z8000's timing sequences, a shorter cycle (minus the actual acknowledgement and vector/identifier transfer) is used for internal events. It is enough, therefore, to display the timing for external events, up to the point of status saving:

One important feature of the Z8000's trap/interrupt handling is apparent: external events can be acknowledged only *after* the current instruction has completed its execution. If an external $\overline{NMI}$ request has been made prior to the end of T2, or if a $\overline{VI}$, $\overline{NVI}$ or $\overline{SEGT}$ input is active at T2's end, then the acknowledge cycle will occur. Internal events, such as privileged instructions, generally consist of only one machine cycle, and they dispense with the third portion, from T1 to T5, that interacts with external devices.

Resolving Priority

Once one or more external/internal events have been sensed at the end of an instruction, the processor readies itself to resolve priority and initiate the acknowledge cycle, if needed. To do this, the Z8000 pretends to fetch another instruction. But it does not update the PC and aborts this fake fetch after seven clock periods. Priority is established at the end of T1 in this cycle and one of the competing events will win. If the winner is external, the acknowledge cycle will be entered. Otherwise, the Z8000 will begin saving the current status (FCW and PC) and follow PSAP to find new status values.

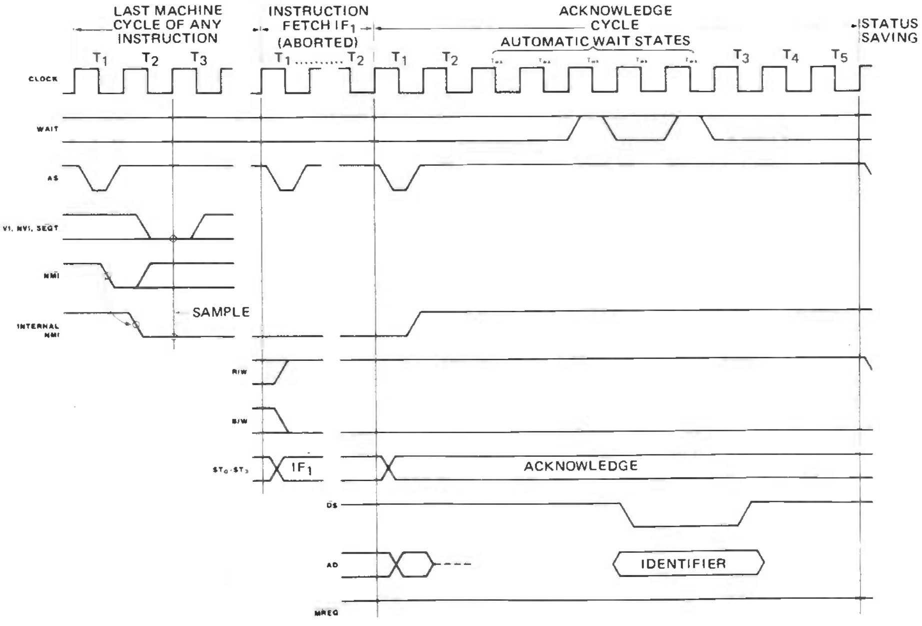


Figure 7
Interrupt Acknowledge Cycle

Acknowledge Cycle

The external-event acknowledge cycle consists basically of 1) a standard I/O read cycle with a meaningless port address, and 2) a $\overline{DS}$ (data strobe) delayed by five clock cycles. This delay allows sufficient time for proper settling of IEI-IEO signals on a daisy chain of about ten Z8000 peripherals. The hardware will decode the ST lines to provide the appropriate acknowledge signal for each daisy chain.

Because the 16-bit data bus is read at T3 during the acknowledge cycle, any peripheral can respond with data (identifier) useful to a service routine. Those connected to the $\overline{VI}$ input are obligated to supply their vectors on AD7:O, but they can use the upper byte for any purpose. In the case of $\overline{SEGT}$ requests from Z8010s, only AD15:8 are meaningful and indicate to the service routine which memory manager(s) generated the trap.

Of all the external events, only $\overline{NMI}$ is edge triggered. Hence, the proper way to design peripherals in a Z8000 interrupt chain is to have them assert a $\overline{VI}$ or $\overline{NVI}$ and maintain it until acknowledge is received. Peripherals can effectively delay their response with, for example, a vector by asserting $\overline{WAIT}$ to delay $\overline{DS}$.

Saving Program Status

Once acknowledge is complete for an external event or an internal event has won the priority competition, *status saving* begins. This consists of a series of system-stack pushes, followed by IFn cycles to load PC and FCW from the proper status subarea:

ST3:0	Clock Cycles	Action
Stack	4	Push PC offset
Stack	3	Z8001 only - Push PC segment
Stack	4	Push FCW
Stack	7	Push Reason (Instruction/Identifier)
IFn	3	Read Status Area FCW
IFn	3	Z8001 only - load PC segment from status area.
IFn	3	Load PC offset from status area and load FCW with value read earlier.
IFl	—	Fetch first instruction in service routine.

It is an important feature of *all* status manipulations, including those by IRET and LDPS instructions, that the FCW is installed *last*, just before the next instruction is executed. It would not make sense to install FCW sooner, because the modes defined by it might be incompatible with those needed to complete the context switch.

Interrupt Response Time

From the table above and Figure 7, you can calculate the response time for an interrupt. The *minimum* time between an interrupt assertion and execution of its service routine's first instruction is achieved when the interrupt just meets the specified setup time to the rising clock edge between T2 and T3 of the last cycle of an instruction. (This minimum time does *not* include wait states injected by a particular system's memory.) The Z8000 guarantees no more than 10 clock periods between machine cycles. Thus, the onset of the aborted fetch can be little more than eight clock periods later. This, plus the fact that six clock periods in status saving are peculiar to the Z8001, lead to the following minimum delays: *46 clock ticks for the Z8002, 52 for the Z8001.* Internal events obviously require at least ten fewer cycles in each case.

The *maximum* delay can be estimated by assuming that the interrupt/trap setup time was not met. In this case another complete instruction must be fetched before the next sampling time will occur. The delay thus depends on the longest instruction executed during any interruptable portions of all programs on the system. Obviously this is irrelevant for internal events and segment traps from Z8010s because they are synchronous to the clock.

Certain Z8000 instructions (like DIV) can take many clock cycles to complete execution. Some, like block transfers, are repetitive and, for good system responsiveness, are interruptable at each repeated step. Because this type of instruction must use some registers for step computations, it is essential that trap/interrupt routines save all registers. Otherwise repeating instructions would not resume properly. All interruptable instructions are described in a subsequent lesson.

HALT

An interrupt-driven system is sometimes designed to execute a HALT instruction and wait for an interrupt to arise. HALT in a Z8002 simply generates an unending series of three-clock-period internal or refresh cycles. However, HALT has an interesting timing feature: an interrupt must be asserted at *two successive* T2-T3 boundaries to be acknowledged. This means that only four periods at minimum or seven at maximum lie between a successful interrupt and the aborted fetch. Therefore, at least 42 periods for a Z8002 and 48 for a Z8001 lie between service and interrupt during HALT. The maxima are 45 and 51.

What happens if an interrupt is asserted only at the end of one T2? In that case, the HALT acts like a NOP (no operation). Execution continues with the instruction following the HALT and no priority resolution, acknowledge cycle, or status saving occur. This feature can be used to achieve very fast (4-clock periods) interrupt response, but at the expense of being able to access only the code following the HALT. IRET obviously cannot terminate such a routine. Special methods must be used to identify the interrupting device if more than one can produce an interrupt input.

This technique can also be used to synchronize multiple Z8000s in special parallel-processing arrangements. HALTs are placed at the points that mark bounds of code to be synchronized. Before each HALT an appropriate I/O instruction communicates the fact of reaching that HALT to external logic. When all processors have similarly halted, the external logic simply generates a single T2-T3 interrupt to all processors and they proceed onward. A simple way to guarantee an interrupt hits only one T2-T3 boundary is to toggle it in on alternate $\overline{AS}$ (address strobe) signals. These normally occur in every T1 during HALT.

RESET

Finally, the most important status manipulation is the one induced by RESET. It is described here because it behaves like an interrupt or trap with everything but the loading of new status removed. See Figure 8.

The timing shown is for the Z8002. The Z8001 requires an additional memory cycle to fetch the PC segment after fetching FCW, just as when the interrupt status-saving sequence ends. This allows the PC segment to be emitted early for the first fetch. Thus, releasing $\overline{RESET}$ is followed by a nine clock-period delay (excluding $\overline{WAIT}$) in the Z8002 (twelve in the Z8001) before the first instruction in the system is fetched.

An important constraint on RESET is that the clock must run for at least five periods before RESET comes high (inactive). The Z8000 clears all pending interrupt/trap requests upon RESET (unlike the Z80, which does not clear NMI). The Z8000 also voids all resource-sharing signals, such as BUSAK and the multi-micro output. RESET can occur at any time as long as it is held for at least five clock periods.

RESET, therefore, behaves like the last three memory cycles of interrupt status saving (two cycles in the Z8002) when new status is fetched. However, RESET fetches status from location 2 in either a Z8001 or Z8002 system's memory. Like status saving, this is done in system mode with ST3:O indicating IFn.

Figure 9
Status Area for Reset

This space in system program memory must, of course, be permanent — ROM, for instance.

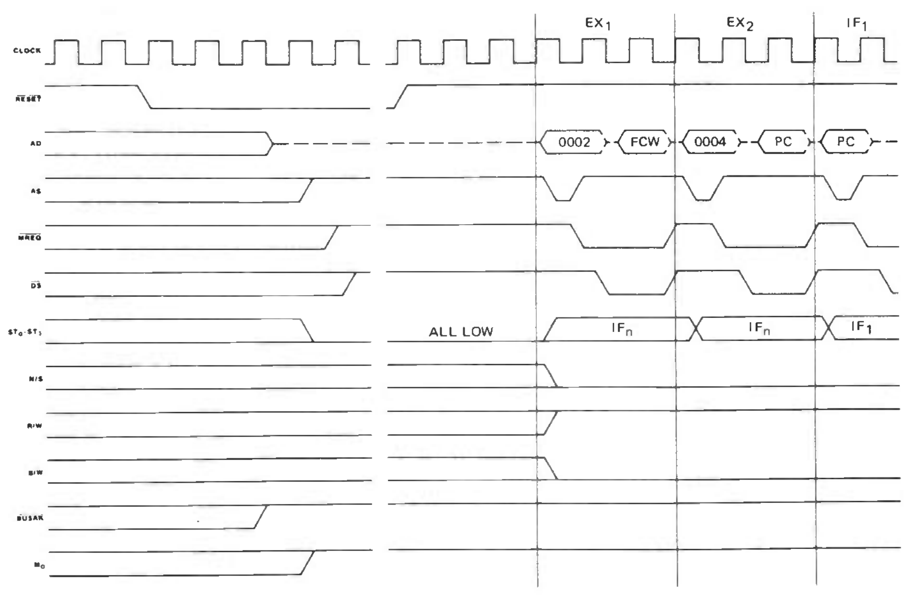


Figure 8
Reset Timing

Quiz for Lesson 3

QUESTIONS

1. In the Z8000, program status is defined as:
   ____ A. The PC and PSAP.
   ____ B. The stack pointers and the PC.
   ____ C. The status area and the PSAP.
   ____ D. The PC and FCW.

2. The PSAP and the status area it points to define:
   ____ A. Possible future FCW and PC values.
   ____ B. Responses to interrupts and traps.
   ____ C. Addresses of vectored-interrupt routines
   ____ D. All of the above

3. In the Z8002 each status subarea PC occupies:
   ____ A. One word.
   ____ B. Two words.
   ____ C. Three words.
   ____ D. One or two words depending on the SEG bit in FCW.

4. In the Z8001, with SEG = 0 (nonsegmented mode), an interrupt or trap causes:
   ____ A. Four words to be pushed on the system stack.
   ____ B. Four words to be pushed on the current (system or normal) stack.
   ____ C. Three words to be pushed on the system stack.
   ____ D. Three words to be pushed on the current stack.

5. Setting the extended processor bit on or off in a Z8000 affects:
   ____ A. The response to bus requests.
   ____ B. The number of unimplemented instructions.
   ____ C. The number of privileged instructions.
   ____ D. The number of peripherals that the Z8000 can handle.

6. System initialization after RESET requires that the system and normal stack pointers be loaded and the PSAP be pointed to a proper status area. The greatest danger to completion of these tasks is posed by:
   ____ A. A segmentation or other trap.
   ____ B. A vectored interrupt.
   ____ C. A nonmaskable interrupt.
   ____ D. A non-vectored interrupt.

7. Vectored interrupts in the Z8002 may access how many PC values, compared with the Z8001?
   ____ A. More.
   ____ B. Fewer.
   ____ C. Same.
   ____ D. None - because Z8002 addresses are always nonsegmented.

8. The Z8000 allows the PSAP to point to:
   ____ A. Exactly one status area.
   ____ B. Any status area.
   ____ C. Any status area that starts at an address multiple of 256.
   ____ D. Any status area that starts at an address multiple of 266.

9. Which FCW control bit(s) determine the number of executable instructions?
   ____ A. S/$\overline{N}$.
   ____ B. SEG.
   ____ C. S/$\overline{N}$ and SEG.
   ____ D. VI.

10. The control bits in the FCW are accessible:
   ____ A. In system mode only.
   ____ B. In normal mode only.
   ____ C. In both system and normal modes.
   ____ D. In system mode only in the Z8001 and in both system and normal modes in the Z8002.

AUDIO BRIEF

SONY TC-D5M

A professional quality live-performance cassette recorder, tested by David Strange.

The Sony recorder has an air of precision about it, and the way it's been put together is reminiscent of a very up-market Japanese camera — no plastic parts on this one. The front is a one-piece contoured moulding of aluminium and the rest of the case consists of pressed metal panels screwed together. The controls take the camera analogy further, since these are turned out of solid aluminium, anodised black and have white numbers around their tops. The base and back of the recorder are covered in a very sensible no-slip rubber, which not only provides grip on smooth slippery surfaces but also a certain amount of protection to the recorder on gritty or sharp surfaces.

There are two machines in the range from Sony, this one and another called the TC-D5PRO — the difference between the two is that the pro' version has XLRs fitted instead of jack sockets (for microphones), and the inputs are balanced. The performance of the two versions is similar, but without the XLR sockets there is certainly room for a DIN socket — a facility that many who buy the non-professional machine might like in addition to the phonos already fitted.

The TC-D5M is powered from two (yes, just two!) 1.5 volt 'D' size cells; the alkaline variety giving 5.5 hours of continuous recording. The cells are inserted by turning a well designed catch in the base of the recorder and removing a small panel. Once the

SPECIFICATIONS

Recording system
4-track 2-channel stereo

Fast winding time Approx. 150 sec. with Sony C-60 Cassette

Bias frequency Approx. 85 kHz

Signal-to-noise ratio
DOLBY NR OFF
- With TYPE IV cassette (Sony METALLIC) 58 dB at peak level
- With TYPE III cassette (Sony FeCr) 59 dB at peak level
- With TYPE II cassette (Sony EHF or CD-α) 56 dB at peak level
- With TYPE I cassette (Sony HFX or BHF) 53 dB at peak level

DOLBY NR ON
Improved by 5 dB at 1 kHz
10 dB above 5 kHz

Total harmonic distortion
1.0% (TYPE III or IV)

Frequency response
DOLBY NR OFF
- With TYPE IV cassette (Sony METALLIC) 20—19,000 Hz; 30—17,000 Hz (±3 dB); 30—13,000 Hz (±3 dB, 0 VU recording)
- With TYPE III cassette (Sony FeCr) 20—19,000 Hz; 30—17,000 Hz (±3 dB)
- With TYPE II cassette (Sony EHF or CD-α) 20—18,000 Hz; 30—15,000 Hz (±3 dB)
- With TYPE I cassette (Sony HFX or BHF) 20—17,000 Hz; 30—14,000 Hz (±3 dB)

Wow and flutter 0.06% WRMS (NAB) ±0.17% (DIN)

Speaker Approx. 5 cm (2 inches) dia.

Power output 200 mW (at 10% harmonic distortion) at dc operation

Inputs Two microphone input jacks (phone jacks) sensitivity 0.25 mV (−70 dB) for low impedance microphone
Two line input jacks (phono jacks) sensitivity 77.5 mV (−20 dB) input impedance 47 kilohms

Outputs Two line outputs (phono jacks) output level 0.435 V (−5 dB) at load impedance 47 kilohms suitable load impedance more than 10 kilohms
Headphones jack (stereo binaural jack) max. power output 20 mW (at load impedance 8 ohms) for 8 to 150 ohm headphones

General

Power requirements
3 V dc, two batteries IEC designation R20 (size D)
External power input jack: required voltage 6 V:
from 120 V ac with optional AC-61 AC Power Adaptor available in the U.S.A.,
from 110, 127, 220 or 240 V ac with optional AC-122 AC Power Adaptor available in European countries,
from 110, 120, 220 or 240 V ac with optional AC-122 AC Power Adaptor available in Japan,
from a 12 V car battery with optional DCC-127A or DCC-120 Car Battery Cord

Power consumption
15 W ac at 60 Hz with AC-61 AC Power Adaptor available in the U.S.A.
16 W ac at 50 Hz with AC-122 AC Power Adaptor available in European countries
16 W ac at 50 Hz, 15 W ac at 60 Hz with AC-122 AC Power Adaptor available in Japan

Battery life
Approx. 2 hours of continuous recording using Sony SUM-1S Super Batteries
Approx. 1.5 hours of continuous recording with metal tapes using SUM-1S
Approx. 5.5 hours of continuous recording using Sony Eveready AM1 Alkaline Batteries or Eveready No. E95 Alkaline Batteries
Approx. 4 hours of continuous recording with metal tapes using AM1 or No. E95

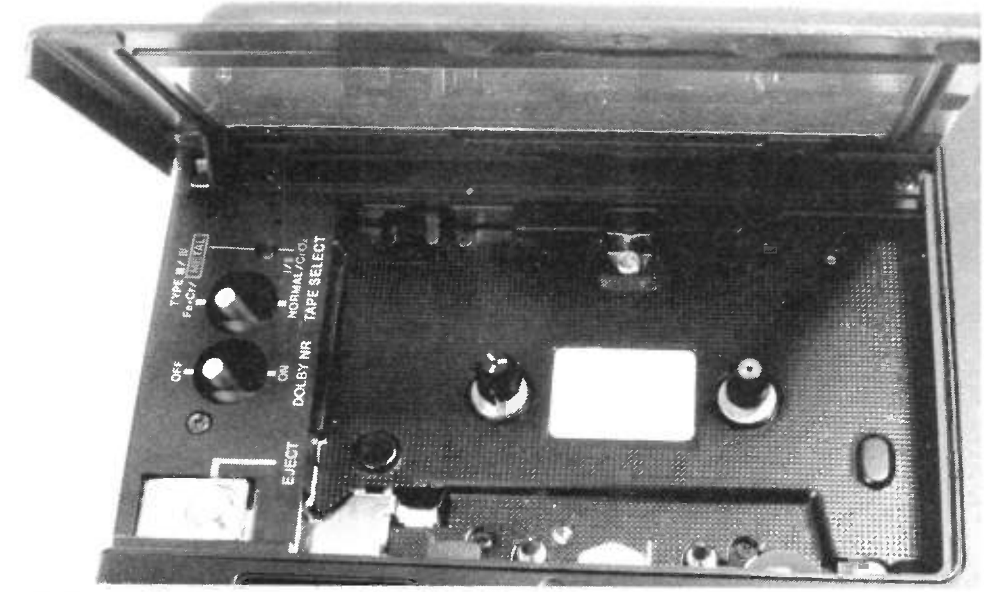
Dimensions Approx. 237 × 48 × 168 mm (w/h/d) ($9^3/_8 \times 1^7/_8 \times 6^5/_8$ inches) incl. projecting parts and controls

Weight Approx. 1.7 kg (3 lb 12 oz) incl. batteries panel is replaced and the catch returned to its normal position, the cells are as secure as a film in the camera (no likelyhood of them spilling out when the recorder is carried). As an alternative to batteries, power may also be supplied to the TC-D5M from an external 6V DC power source via a calculator type socket. Sony omit to say how much power is required in this mode and mention instead the part number of a suitable device they manufacture — good business sense, I suppose.

Operation

It's a little baffling at first as to how to get the cassette flap open and insert the tape. However, it turned out that the flap is just opened directly, revealing the Dolby IN/OUT switch, the tape bias select switch, eject button for the cassette and automatic metal/CrO2 indicator and selector. The cassette locates in a 'none-too-positive' fashion when inserted, and appears to be slightly mis-aligned in its setting — not that there is any fear of it falling out, even with the flap open.

The first operation tried was replay of a pre-recorded tape — the quality has to be heard to be believed and even the Dolby tracked beautifully. The level off-tape is indicated by two meters and considering the overall quality, it's a pity that Sony installed VU meters — peak reading meters would better suit the purposes to which the machine might be applied, especially the pro' version. Monitoring during replay, as on record, can be made using stereo headphones and the volume can be adjusted by a front panel control which also adjusts the level from the internal speaker on replay if the headphones are not plugged in. Back to the meters though, and it should be said that they are augmented by a peak overload LED and may be illuminated for working in poor lighting conditions. The problem with the illumination is that it is actuated by the same button as the battery test — a bit frightening when at one stage on a long recording I decided it was time to check the battery condition and found that the light came on flattening the already low battery even more (the illumination turns itself off after about ten seconds).

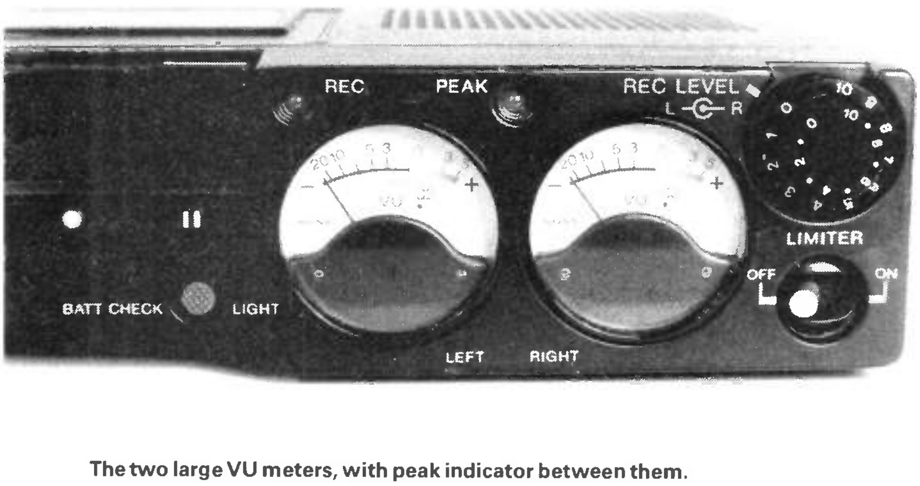


Inside the cassette compartment, showing Dolby, EQ and bias switching.

Taping It

Recordings may be made from the microphone inputs (−70dB) or phono level inputs (−20dB), and both types of input are controlled from dual concentric potentiometers located just right of the meters. In addition to these controls, a 20dB pad may be switched in, to reduce the microphone sensitivity to −50dB. The input impedance of the phono inputs is 47k and the microphone inputs will accept 600-ohm source microphones. A useful facility that is missed is automatic commoning of the microphone channels when only one microphone is connected — a stereo recording is not always needed and under some circumstances less preferable to mono.

Recording is initiated by pressing both the record and forward keys. Whilst the record level is set, the tape may be held in position by the application of the pause key. Once the level has been set the limiter may be switched in. The limiter was found to be particularly good and in one situation, recording mixed voices in a room with the recorder left unattended, when the microphone gain was increased to maximum, the limiter *still* switched in. The results were excellent for anyone interested in bugging devices *(Not that we are — Ed!)* because the optimised attack and recovery times, along with the inherent quality of the recorder anyway, made everything very intelligible. The recorder *really* came into its own on outside recordings — first of all its lightness, weighing just 3lb 12oz, gave perfect portability and being familiar with other recorders of similar quality weighing 3 or 4 times as much, the TC-D5M has to be recommended. Secondly, the TC-D5M has remarkable wow-and-flutter figures of ±0.17% (DIN), due to the servo control of the motor. Even under the most arduous motional conditions, perfect recordings resulted with no signs of speed instability.



The two large VU meters, with peak indicator between them.

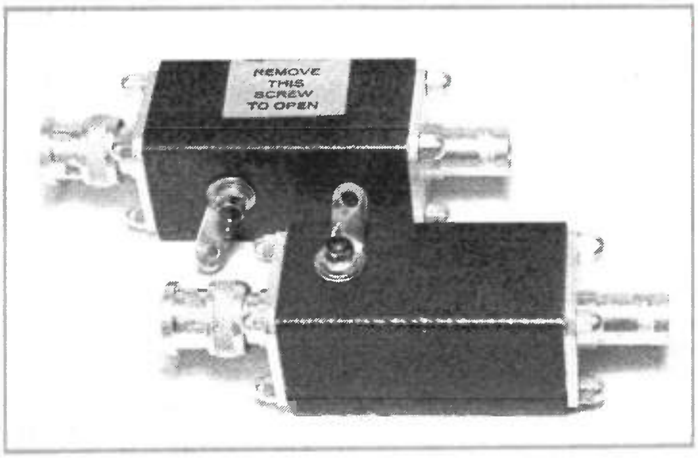
Final Comments

The TC-D5M is a high quality lightweight recorder, and with a mains adaptor would be the ideal companion to a hi-fi system with the added advantage of portability as well. Unfortunately, the fast winds have no automatic shut off, but the wind was fast and has to be initiated whilst the user is in attendance anyway. Another useful facility would be the possibility of review on fast rewind, but this, like automatic shut-off, is missing. However this machine, for its size, is of the highest quality and probably the best cassette recorder of this type available.

■ R&EW

In the Next Issue of R&EW

The Complete Communications Magazine



Wideband RF Amps

Two projects for the price of one — a pair of RF amplifiers covering the range 10MHz-900MHz — both incorporating the latest thin-film hybrid technology.

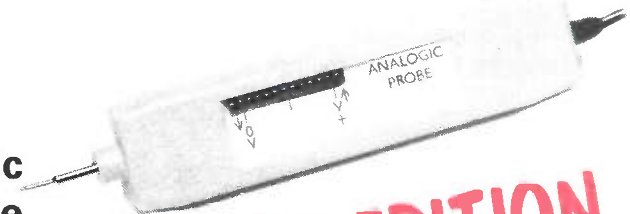
4-Channel Stereo Mixer

With a host of applications for combining various signals — a high quality stereo mixer from one of our resident engineers.

STARTING NEXT MONTH:

A new series of easy-to-build projects, designed especially to be built in a single evening — "One Night Stands".

ANALOGIC PROBE



Not the usual run-of-the-mill logic probe, but a neat solution to the problem of coping with TTL and CMOS, as well as a wide range of analogue and interface circuits.

AUGUST EDITION On Sale 7th July

Other exciting features coming your way in the August issue:

Designers' Update — *devoted to circuits and applications.*
Welcome Aboard The Airwaves — *how to get started as a Radio Amateur.*

R&EW Data Brief

CPS 1001A

DC-DC converters for fluorescent displays.

The CPS 1001A (from Toko) is a converter developed especially for use with flourescent displays, to enable their use in mobile or battery operated equipment, and also for more permanent applications where only a single DC supply is available. The unit is built into a fully shielded metal case, to keep radiated noise levels low, and it requires very few external components.

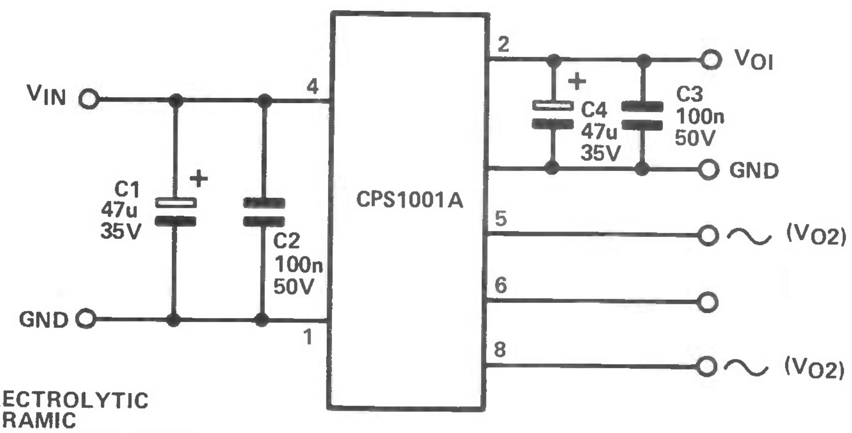
In use, for an input of +9 to 16 volts DC, the device produces an output of −9 ±3V DC at approx 40mA, and also AC 3 ±0.6V RMS, centre tapped, at up to 78mA, satisfying the supply requirements of the majority of flourescent displays where an AC filament supply is required.

The output (V_{01}) of the device is rectified but unsmoothed, and is therefore a ripple waveform which will require an output filter. For most uses the capacitors shown will suffice, but for applications involving use near RF signal circuitry, it may be advisable to employ a choke coil and extra capacitors on both input and output to prevent line noise entering the device, and conversely, converter noise reaching external circuits.

SPECIFICATIONS

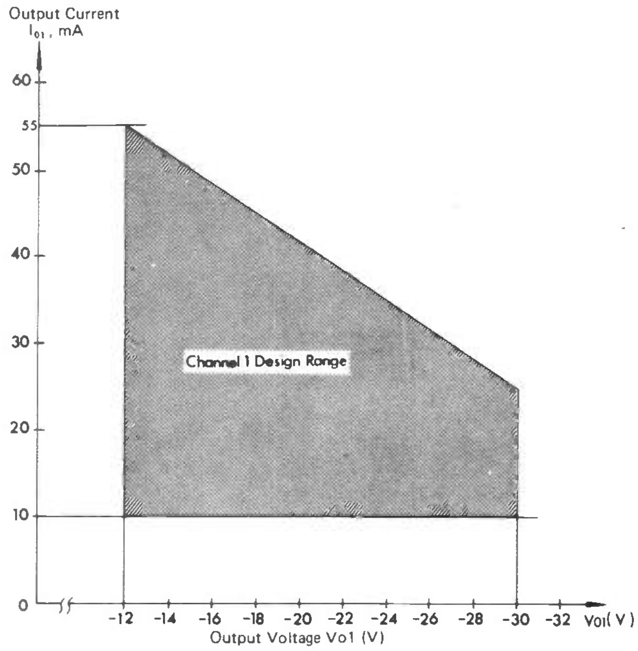
ITEM	SYMBOL	CPS 1001A	CONDITION
Input Voltage	V_{IN}	+9 to +16V	
Output Voltage	V_{O1}	-19 ± 3V	V_{IN}: +9 to +16V
	V_{O2}	AC 3 ± 0.6V RMS	101, 102: MAX
Output Current	I_{O1}	40mA, MAX	
	I_{O2}	AC 78mA, MAX	
Efficiency	π	55% MIN.	
Ripple Voltage	V_{RPL}	200mV p-p	
Temperature	Ta	-20°C to +65°C	
Humidity	Ha	10% to 85% R.H.	
Dimensions	DxWxH	14.5x26.0x12.0mm	

π and V_{RPL} are for V_{IN} at +12V, I_{01} and I_{02} at full load and Ta at 25°C

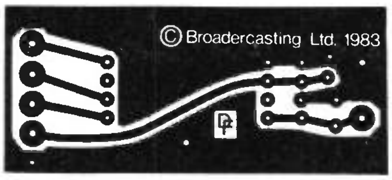


NOTE:
C1 & C4 ARE ELECTROLYTIC
C2 & C3 ARE CERAMIC
ALL CAPACITORS SHOULD BE MOUNTED LESS THAN 20mm FROM DEVICE PINS.
V_{O2} IS FLOATING FROM GROUND

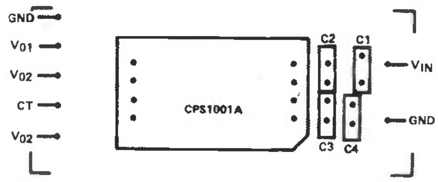
Circuit Diagram



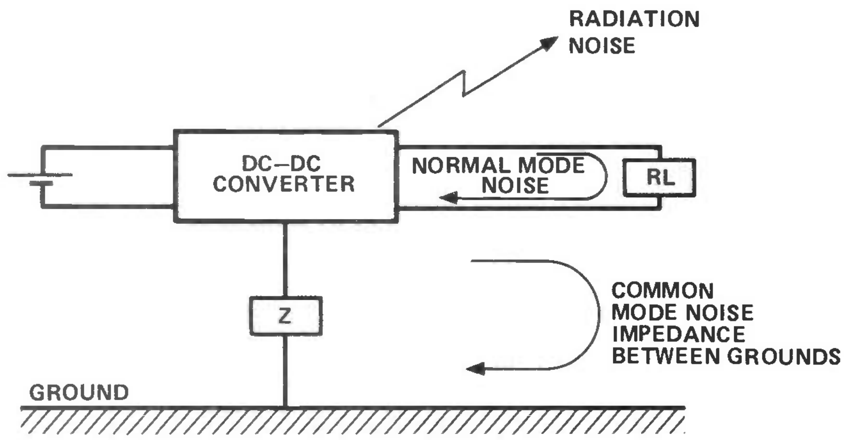
Graph showing design range



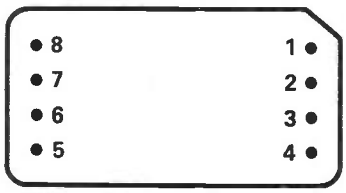
PCB Foil



PCB Overlay

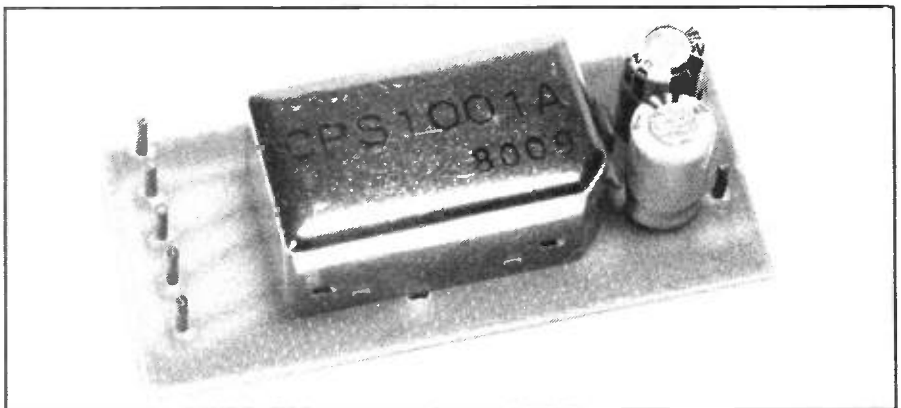


Radiation Noise



PIN ASSIGNMENT:

1. GROUND	5. V_{O2}
2. V_{O1}	6. CENTRE TAP
3. NC	7. NC
4. V_{IN}	8. V_{O2}



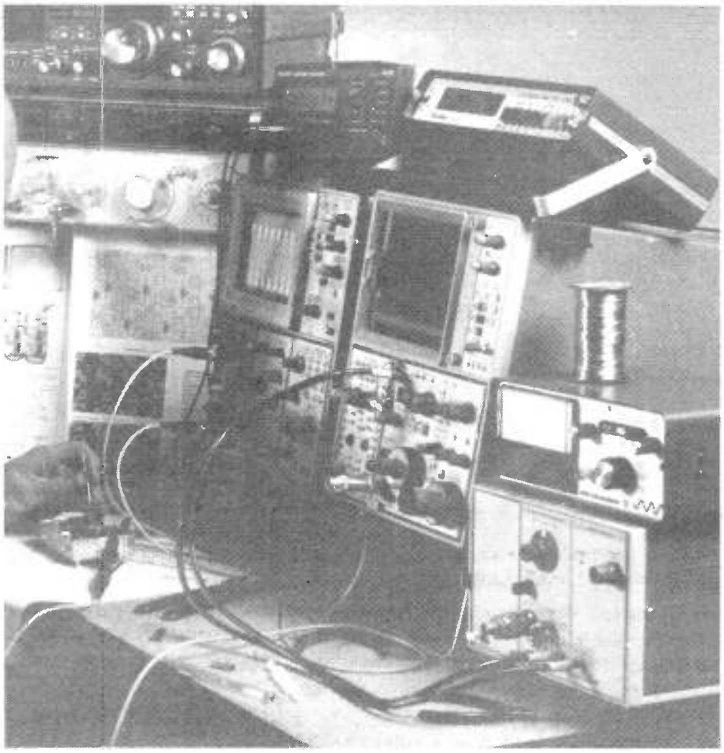
A certain amount of unwanted noise will be radiated from the converter, which must be considered when deciding upon physical placement of the unit within any system where such radiation would be a problem. The majority will come from the unshielded portion of the unit (i.e., the PCB), and it is recommended that a board layout similar to that shown is used, or alternaively a full earth-plane board.

The oscillation frequency of the unit is in the 50-400kHz range, with a square waveform, consequently long external leads will cause induced effects and nullify the filtering effects. For this reason keep connecting lines as short as possible and mount filter components within 20mm of the device pins.

If all of the above makes the use of this device sound rather daunting, do not be put off,` it is really a very useful, compact building block which will save the expense of a specially wound transformer and a complex power supply when updating existing, or designing new, equipment.

■ R&EW

High Frequency Receiver Design II



The second part of our comprehensive series deals with receiver performance.

Jon Dyer G4OBU

The first article in this series on HF Communications (**R&EW** February '83), traced the design and development of the modern HF Receiver, detailing the various changes it has undergone during a long evolution. This month, moving on from aspects of design, the rather complex and often misunderstood subject of receiver performance is examined, paying particular attention to the wide range of parameters encountered within receiver specifications.

When measuring performance, it is important that all specified parameters are accurate and complete. Many manufacturers (and reviewers!) have been guilty of specifying performance inadequately, with ambiguous and misleading results. For example, a sensitivity quoted as '0.5uV' is meaningless, and '0.5uV for 10dB' is not much better. Some performance parameters (eg, intermodulation and reciprocal mixing) have only recently been fully understood, whilst other design changes have not been made in the sole interest of improving performance (some have *actually* been responsible for reducing performance, like the current widespread use of frequency synthesis, which can introduce spurious receiver responses if not carefully designed).

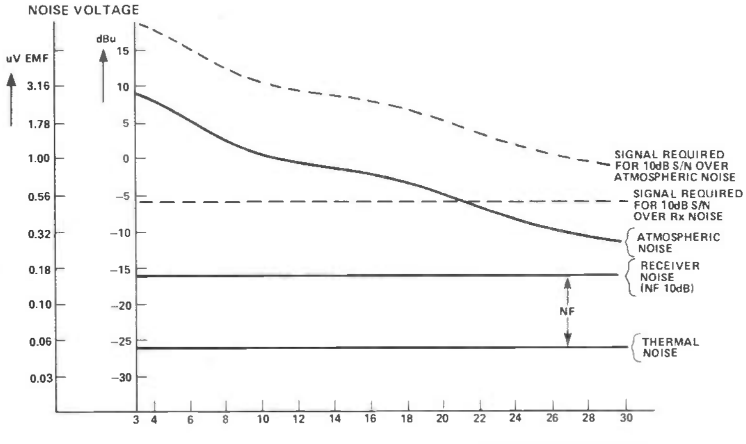


Figure 1: Thermal noise, and typical receiver and (quiet) atmospheric noise voltages on HF in a 3kHz bandwidth. Note between 1 and 10uV EMF is required for 10dB S/N on HF due to the atmospheric noise.

Noise And Sensitivity

A fundamental concept underlying many facets of receiver performance is noise. It is linked to a host of other parameters, but perhaps the most important is sensitivity — expressed as the smallest signal required to give a specified signal-to-noise ratio, for a particular receiver bandwidth (in the case of AM, for a given modulation level).

In fact, signal-to-noise ratio is more accurately quoted as 'signal-to-noise' to noise (S+N/N) or better still, 'signal plus noise plus distortion-to-noise plus distortion' (SINAD). For ratios of 10dB or more, however, there is little difference.

In the days of (noisy) valves, good sensitivity was hard to achieve without compromising other aspects of performance. Now, however, using bipolar transistors and FETs, sensitivities of better than 0.5uV (EMF) for 10dB S/N ratio in a 3kHz bandwidth, can easily be achieved on HF for a SSB or CW signal. Since AM is usually specified at 30% modulation level the figure will be 10dB (3.16 times) worse than the SSB/CW figure; in this case 1.6uV (EMF).

Thermal noise is due to the random movement of particles in the components making up the effective impedance at the input to the receiver (at ambient temperature). It cannot be avoided (except by cooling the whole antenna system down to near absolute zero!), and is even present if a screened 50 or 75-ohm resistor, representing the aerial impedance, is plugged into the receiver input. It is given by:

$$V_{TH} = \sqrt{4.k.t.\Delta f.R}$$

where: V_{TH} is RMS noise voltage (EMF)
k is Boltzmann's constant,
t is temperature in °K
Δf is receiver bandwidth in Hz
R is resistance/impedance in Ω

From this, for a given aerial impedance and nominal ambient temperature (taken as 300K or 27°C), the only way to reduce the thermal noise threshold is to reduce the receiver bandwidth. For a 50-ohm impedance, ambient temperature of 300K and a bandwidth of 3kHz, the above expression works out to −26dBu (dBu is a dB relative 1uV EMF).

The Noise Factor (NF) can be defined as the ratio of the S/N of a hypothetically perfect (noiseless) receiver to that of a real receiver, which adds its own noise to the thermal threshold noise. Being the ratio of *two* ratios, it has the advantage of being independent of bandwidth, temperature,

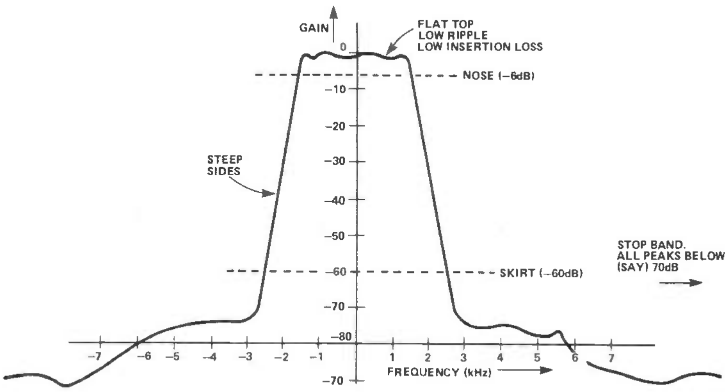


Figure 2: Ideal filter response. Flat top with steep sides and a stop-band at least 70dB down.

and impedance. ***Fig. 1*** shows the thermal threshold noise and receiver noise for a NF of 10dB, at −16dBu. To achieve a S/N of 10dB, a signal will need to be at −6dBu or 0.5uV, which thus establishes the relationship that a NF of 10dB is equivalent to a sensitivity of approximately 0.5uV (EMF) for a 10dB S/N in a 3kHz bandwidth.

The most significant conclusions to be drawn from ***Fig. 1*** are concerned with atmospheric noise. This is plotted for a quiet area, and is between 5 and 25dB above receiver noise. Thus, for a receiver with NF of 10dB, it's the atmospheric noise, not receiver noise, that limits receiver performance. Indeed the NF could be increased to 15dB (1uV sensitivity) without loss of performance, except perhaps at 25 to 30 MHz.

There is no point in reducing NF below 10dB, especially as sensitivity can only be obtained at the expense of dynamic effects such as intermodulation. It is also worth noting that claims of 0.15uV (EMF) for 10dB S/N (seen recently for a SSB transceiver) are quite impossible. Even a perfect receiver with 0dB NF needs 0.16uV (−16dBu) to give 10dB S/N, due to the thermal threshold at −26dBu.

Figure 1 shows that under real operating conditions a receiver with a sensitivity of 0.5uV (EMF) will, in fact, need between 1uV (at 30MHz) and 10uV (3MHz) EMF for a 10dB S/N ratio on HF — remember, this is for a quiet atmosphere (no QRM!)

Noise is proportional to the square root of the bandwidth. Thus, if bandwidth is reduced from 3kHz to 300Hz, all noise voltage (thermal, receiver and atmospheric) drops by $\sqrt{10} =$ 3.16 times, or 10dB. This explains the continuing use of CW in the HF bands; a CW signal can still be copied where SSB would be lost in the noise.

Note that all voltages above are EMF. Recently it has become common for some manufacturers (and others) to specify sensitivities and other parameters using potential difference (PD) instead. This practice makes sensitivity figures look twice as good (6dB better), because, in an impedance matched system, PD is always half EMF!

Selectivity

Static selectivity, as opposed to dynamic selectivity (see later) used to be achieved via distributed-tuned circuits in the IF strip, which meant to obtain good values, a low second IF was required (eg 455kHz). Selectivity is achieved by means of block filters (crystal, mechanical, or ceramic); an ideal response for one having a flat top, with low ripple, and steep sides falling to a stop-band a long way down and extending a long way out (***Fig. 2***).

The old constraint of low second IF no longer applies. It is also easier to design crystal filters for higher frequencies; IF's of 1.4, 1.6, 9 and 10.7MHz being often used.

Selectivity is usually quoted at the nose bandwidth (6dB down) and skirt bandwidth at 60dB down; good figures for 8-pole SSB filters being 2.7kHz and 4.4kHz. A measure of filter performance often quoted is the shape factor (SF), which is the ratio of the skirt bandwidth to the nose bandwidth. The ideal SF is 1:1, and anything less than 2:1 for a 3kHz SSB filter is considered good. Mechanical and crystal filters can get quite close to the ideal (at cost), and some much cheaper ceramic filters give surprisingly good results. Impedance matching, into and out of a filter, is of great importance and insertion loss (the loss caused by the filter in the middle of the passband) must be made up by amplification (usually less than 10dB). A typical 'suite' of filters for a high grade communications receiver might be 8kHz (AM), 2.7kHz (SSB) — often with two asymmetrical filters, one for USB, one for LSB — and 1kHz, 300Hz and 100Hz for CW. The trend in amateur equipment is for the tightest possible SSB filter (2.4kHz), with 600Hz or 300Hz for CW.

A good (multi-pole) audio filter can be a useful addition to any system, especially if a linear detector is being used (a product detector is linear, an envelope detector is not!). Also, if a steep sided SSB filter is available, the audio image can be rejected if the BFO injection is made to coincide with the edge of the passband.

Image Rejection

In the normal superhet process, a wanted signal (fs) beats in the mixer with the local oscillator (or synthesiser output) frequency (f_{LO}), and one of the resultant products of the mixing process, usually f_{LO}-fs, at the intermediate frequency (IF), is picked out by the IF selectivity filter.

However, another frequency called the image or second channel frequency (f_{LO}+IF) will also beat with the local oscillator frequency to produce a product at the IF. This frequency must be rejected by some form of RF tuning, either ganged to the 'tune' control or using a separate 'pre-select' control.

Since the image frequency is equal to fs plus twice the IF, the higher the first IF, the further away from fs will be the image frequency, and the easier it will be to reject. If up-conversion techniques are used, the first IF will be in the range 40 to 90MHz and the image frequency will also be at VHF. Thus it can be rejected by a simple 35MHz low-pass filter at the receiver input.

Image frequency is specified as the ratio in dB of an unwanted signal above 1uV to give the same output as a 1uV signal on tune. 50dB is a poor performance, while 80dB or more can be considered good.

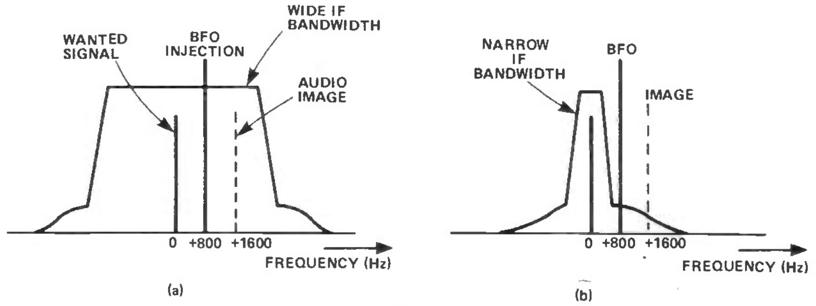


Figure 3: Rejection of audio image (a), showing how a narrow IF passband (b) is needed to reject the audio image (unless a steep sided filter is used with BFO injection fixed at the filter skirt). ▶

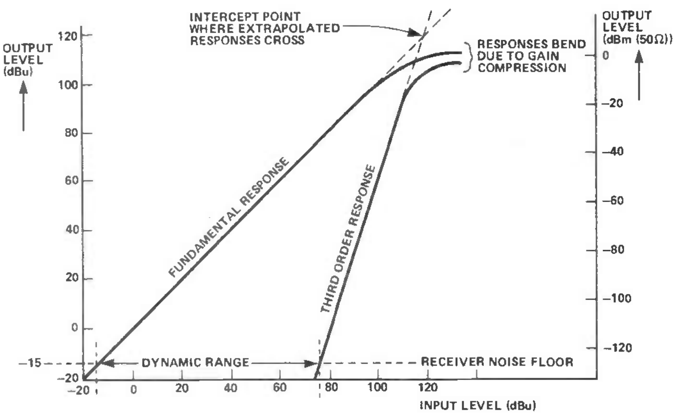


Figure 4: Intercept point and dynamic range for a receiver with a NF of 11dB and thus a noise floor at −15dBu. The dynamic range is 90dB and intercept point 120dBu or +7dBm(50Ω).

IF Rejection

Intermediate Frequency rejection occurs when a strong signal, at a receiver IF, directly breaks through the early stages and into the IF. It is quantified as for Image Rejection and should be quoted for all the IF's in a receiver (often in a double conversion receiver the figure for the second IF is worse than that for the first — a figure of 80dB is acceptable). Good screening is necessary between IF and RF stages, and IF traps in early pre-IF stages can be employed to reduce IF breakthrough. Together, IF and image rejection are sometimes referred to as 'rejection to external spurii'.

Dynamic Effects

Dynamic interference effects, such as intermodulation and cross-modulation, have often been largely ignored in the past — only in the last ten years or so has their true importance been understood. The situation was not helped with the introduction of bipolar transistors in the 1960s.

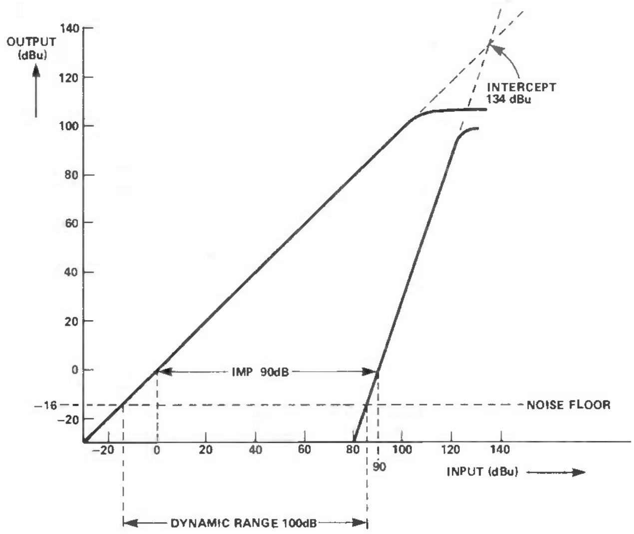
Dynamic effects are caused by large off-tune signals, which cause the receiver to operate in a non-linear manner. It is these effects (together with reciprocal mixing) that currently determine the performance of the communications receiver. One effect, dynamic range, can be loosely described as the range of input signals over which dynamic interference effects produce outputs which are not significant (ie, which are below the noise floor). To arrive at a suitable definition for dynamic range, consider the intercept point as shown in ***Fig. 4***. This occurs because the power level of the dynamic product increases at a greater rate than that for the wanted signal. Second order products increase as the square-of-the-input (twice as many dB), and third order products as the cube — more of these later. Dynamic range is usefully defined as two thirds of the difference in level between the noise floor and the intercept point, or alternatively as the difference between the fundamental response input level and the third order response input level, as measured along the noise floor (see ***Fig. 4***). Note that as dynamic range, by definition depends on the noise floor level, it will increase as bandwidth is reduced.

Beating IMPs

Intermodulation products (IMPs) occur when two large unwanted signals beat together (inter-modulate), in a non-linear receiver stage, to give a product at the wanted frequency. With second order IMPs, the unwanted product is simply equal to $f_1 \pm f_2$ (where f_1 and f_2 are the two unwanted frequencies). The process is made clear by ***Fig. 5***, where the two unwanted signals are at 11 and 21MHz causing a beat at 10MHz.

A point to note about second order IMPs is that at least one of the unwanted signals must be outside the passband of any octave filter response that includes f_s, so it can be rejected by any reasonably tight RF tuning, such as a good octave filter or sub-octave (less than an octave) filter.

Third order intermodulation products are at $f_1 \pm 2f_2$. Thus both signals can be very close to the wanted signal and well within the RF passband, regardless of the type of RF tuning in use (***Fig. 5***).



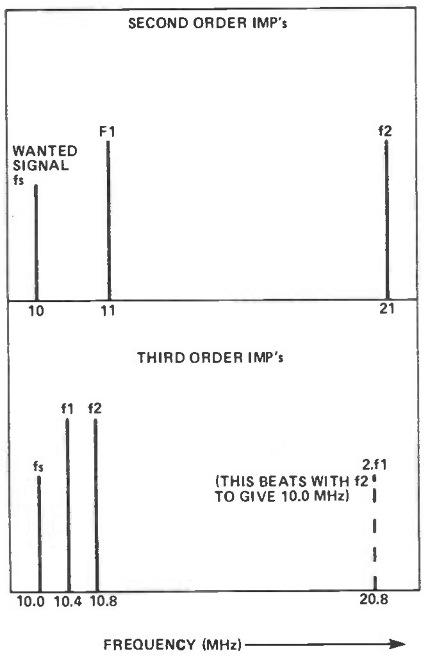
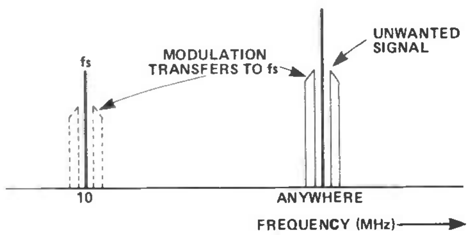


Figure 5: (Left) Second (upper) and third (lower) intermodulation products.

Figure 6: (Above) The receiver has a NF of 10dB, a dynamic range of 100dB, and the intercept point is at 134dBu or +21dBm (50Ω). It's a pretty good receiver!

Figure 7: (Below) Cross Modulation is where modulation from an unwanted signal can superimpose itself onto a wanted carrier.



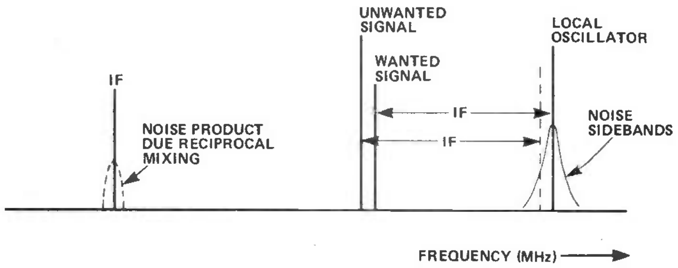


Figure 8: Reciprocal Mixing. An unwanted strong off-channel signal beats with the local oscillator noise sidebands to produce on-channel noise.

Intermodulation Performance

Typically specified as the levels of two unwanted signals, not less than (say) 20kHz off tune to give a 0dBu (1uV EMF) response. A good receiver will have a third order IMP performance of 70 to 90dBu. It is easy to see why the higher figure is needed, since 90dBu corresponds to 32mV (EMF), and at almost any time there will be tens of broadcast (and other) stations putting between 10 and 100mV onto a wideband aerial, with hundreds of others in the range 1 to 10mV (EMF)!

Second order IMP performance is often not stated. This can be particularly misleading in the case of receivers like the Trio R1000 or Yaesu 7700 where third order performance is quite good (due to the use of FETs,) but second order performance is poor enough to present a real problem if using a wideband aerial without an aerial tuning unit (ATU). The problem lies in the use of unscreened octal filters of less than perfect performance.

In-Band Modulation

This is where two signals within the IF passband intermodulate to produce extra products. It is normally of little significance in HF communications except where multi-channel 'Voice Frequency Telegraphy (VFT)' systems, such as 'Piccolo', are in use. A typical level of performance for a good receiver is for a product of −40dB with reference to two in-band signals.

Cross Modulation

When modulation from an unwanted signal transfers itself across and 'modulates' the wanted signal, the effect is called cross modulation. It is due to non-linearities in the early receiver stages, and sometimes the same modulation will re-appear on each adjacent signal tuned in. Cross modulation is a third order effect, so good third order IMP performance will tend to mean good cross modulation performance. Looking at ***Fig. 7***, the cross modulation may be specified as the level required (in dBu) for a 30% modulated carrier greater than (say) 20kHz off-tune to cause 3% cross modulation. A level of 70 to 90dBu can be considered good.

Blocking

Blocking, or de-sensitising, is similar to cross modulation, but in this case the large off-tune signal causes a reduction in wanted signal output. It is specified as the signal required to reduce wanted output by 3dB. It can often be caused by a strong CW signal, causing gain to go up and down with the keying. Figure of 90 to 110dBu can be considered a good performance, for a wanted 1mV(EMF) signal.

The practice of fitting protection diodes at the receiver input (often found on marine main-receivers), will also cause non-linearity, as will diodes used to switch filters etc. If all these points are carefully watched, linearity can be made very good — the intercept at ≥140dBu. This sort of performance should ensure that IMPs and cross modulation products are below atmospheric noise on HF.

Reciprocal Mixing

Due to large unwanted signals mixing with the noise sidebands of the local oscillator/synthesiser, this produces a noisy product at the wanted frequency (***Fig. 8***). It is another phenomenon, which until recently has been more or less ignored. The defining characteristics are its level (in dB) above a wanted signal, for an unwanted signal at a specified frequency off-tune (eg, 50kHz) at a specified bandwidth (usually 3kHz), to reduce the S/N ratio of a wanted on-tune signal by 3dB.

Oscillator noise can be reduced by means of a high 'Q' in the oscillatory circuit and using high powers in the oscillator. This is because the noise sidebands will then be relatively weaker, thus improving S/N. Phase locked loops can be very poor in this respect, as they contain numerous noise sources which add together in the output, together with jitter etc. Frequently they use low 'Q' and low power VCOs in the output and the noise produced is phase modulated and cannot be removed by limiting.

The action of reciprocal mixing in introducing off-tune signals into the IF at levels proportional to the distance away from the wanted signal (see ***Fig. 8***), effectively reduces the selectivity of the receiver. This is shown in ***Fig. 9***, where the response curves indicate the dynamic selectivity of the receiver, that is, the selectivity of the receiver in a practical situation — a band full of signals. As can be seen, it's the stopband of the filter response that's been changed (with 70dB reciprocal mixing, a considerable loss of performance occurs).

Increasing the reciprocal mixing to 90dB, produces a fairly minor effect on filter response. A frequency-synthesised receiver can achieve 90dB, while a good (valve or FET) crystal oscillator can give 110dB or better.

Synthesiser Noise

Internal spurious responses are the result of interactions between signals generated within the receiver itself. These signals can be fixed (eg, reference frequencies), or can move when the receiver tuning is changed. They cause problems when they occur at the signal frequency (or an IF), and are generated by any oscillators within the receiver, or by digital circuitry such as synthesisers and frequency counters. As before, its a problem with frequency synthesis, since there are not only large numbers of frequencies being generated in the synthesiser, but also many of the waveforms are

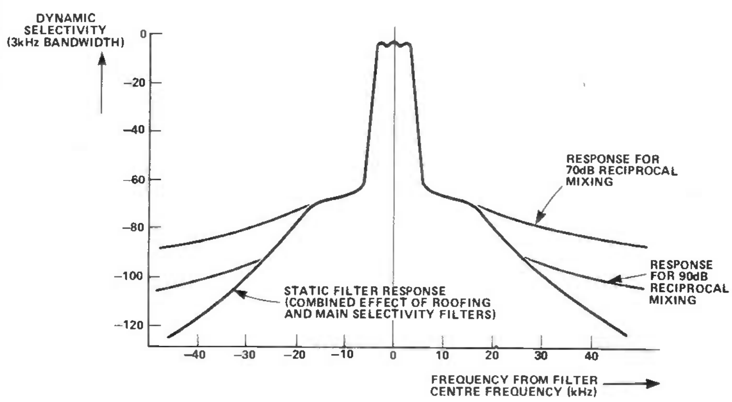


Figure 9: Dynamic Selectivity, showing how the effect of Reciprocal Mixing can reduce the effective stop-band selectivity of a receiver.

Frequency Coverage
50kHz to 30MHz (unbroken coverage, using full synthesis)

Frequency Display
7 digit, resolution 10Hz

Reception Modes
CW, FSK(RTTY), SSB(USB & LSB), ISB, AM, NBFM.

Input Impedance
50Ω

Sensitivity (500kHz to 30MHz)
SSB, CW, ISB — 0.5μV EMF for 10dB SINAD in 3kHz.
AM — 2.2μV EMF for 10dB SINAD in 8kHz, modulation 30%
FM — 0.8μV EMF for 10dB quieting in 15kHz bandwidth, 60% deviation

(Noise Factor 10dB)

IF Selectivity

Filter	Available on:	Response (kHz) −6dB	Response (kHz) −60dB	Shape Factor
15kHz	FM	15.0	33.0	2 2
8kHz	AM	7.8	14.0	1.8
2.7kHz	SSB, ISB, CW	2.7	4.3	1.6
1kHz	CW	1.0	2 0	2.0
300kHz	CW	0.28	0.75	2.7

Dynamic Range
104dB.(Intercept Point 140dBμ, +27dBm (50Ω)(3kHz b.w.)

Third Order Intermodulation
94dBμ. The levels of two unwanted signals both greater than 20kHz off tune will be 94dBμ (or −19dBm(50Ω)) to give a 1μV(0dBμ) response.

Second Order Intermodulation
90dBμ. The levels of two unwanted signals both greater than 20kHz off tune will be 90dBμ (−23dBm(50Ω)) to give a 1μV(0dBμ) response.

In-band Intermodulation
−40dB. Two signals in-band of equal amplitude will produce greater than 40dB down.

Cross Modulation
100dBμ. A 30% modulated carrier greater than 20kHz off tune must be 100dBμ(−13dBm(50Ω)) to cause 3% cross modulation.

Blocking
110dBμ. A signal greater than 20kHz off tune will be 110dBμ (−3dBm(50Ω)) to cause a 3dB reduction of wanted 1mV EMF(60μ) signal.

Reciprocal Mixing
90dB. An unwanted signal 50kHz off tune will be 90dB above the level of a wanted on tune signal to reduce its SINAD by 3dB, in a 3kHz bandwidth.

Image Rejection
90dBμ. The image frequency must be 90dBμ (−23dBm(50Ω)) to give a 1μV(0dBμ) response.

IF Rejection
90dBμ. For the first and second IF the level of an unwanted signal will be 90dBμ (−23dBm(50Ω)) to give a 1μV(0dBμ) response.

Crosstalk
−50dB. On ISB mode the crosstalk between two equal 0dBm(600Ω) outputs shall be less than −50dB relative to output at 1kHz.

Response to Internal Spurii
All internally generated spurious signals are less than 3dB above receiver noise (3kHz bw).

Stability
After 10 min. warm-up, better than 1 in 10^8/°C. Long term crystal ageing less than 1 in 10^9 per day.

Antenna Radiation
Less than 10μVPD into 50Ω(2pW)

Protection
Receiver can withstand 30V at antenna input continuously. A spark gap is provided.

AGC Performance
For an input change of 90dB, the output change will be less than 3dB for all signal levels great than 3μVEMF(10dBμ).

AGC Time Constants

	Slow Attack	Slow Hang	Slow Decay	Fast Attack	Fast Hang	Fast Decay
ISB, SSB, CW	10ms	2s	200ms	5ms	200ms	50ms
AM, FM	20ms	–	20ms	5ms	–	5ms

BFO Range (CW)
±3kHz

AF Outputs
Main — 2W 8Ω @ <3% Total Harmonic Distortion.
Phones — 20mW 600Ω
Line — 600Ω balanced line independent of AF Gain control, settable from −10 to +10dBm(600Ω) i.e. 245mV to 2.5V PD.

Muting
0V on Mute terminal to mute. Mute level at least 60dB down.

Metering
Meter reads signal strength (in dBμ) or AF Line level (in dBm(600Ω)).

Power Requirements
200 to 250V AC, 45 to 65Hz, @50VA.

Environment
Operates −10 to +40°C
Storage −40 to +70°C
R.H. up to 95% at 40°C (non condensing)

MTBF
8000 hours.

Dimensions
350 wide, 180 high, by 250 deep (mm).
Weight 40lbs.

Table 1. Specifications for a receiver with the sort of performance required to merit the tag 'very good'. Note that worst case figures are stated; not to be confused with 'typical values'.

digital — square waves with fast risetimes, rich in harmonics. CMOS and LSI (N-MOS) are usually better in this respect than TTL, which has faster risetimes. Careful design is important with adequate low-pass and bandpass filtering and with high 'Q' output circuits. With good design it is possible to keep spurious outputs 100dB down on the main output level. This sort of performance should ensure that all spurious responses are less than 3dB above receiver noise level.

Causes And Cures

As previously mentioned, dynamic effects are caused by large off-tune signals driving the receiver into non-linearity. There are three ways of preventing the off-tune signals getting in, improving the linearity of the early stages of the receiver (prior to and including the roofing filter) and reducing the level of all signals. This latter method works because the response to unwanted (dynamic) signals falls off at a faster rate than for wanted signals (*Fig 4*).

The third approach is implemented by means of a front-end attenuator or by a wideband AGC loop (separate from the main AGC loop), which operates on the RF amplifier on large signals only and can be thought of as being an automatic attenuator. Both methods have the disadvantage of reducing receiver sensitivity, so other solutions must be found.

The first method involves the use of sub-octave filters or some sort of pre-selector tuning. It can be very effective in reducing second order effects, but third order products can be too close for any sort of tuning to have an effect.

The only real solution is to improve linearity, using the second method. Bipolar transistors are particularly poor in this respect, but FETs are approximately square-law devices and are therefore very good in terms of third order effects, though not so good for second order products. Linearity can be improved by using high voltage supply rails and keeping pre-roofing filter gain down to a minimum — consistent with required sensitivity — therefore keeping noise levels down.

The mixer may be a double balanced, switching-type, diode mixer, with volts of local injection to switch hard and thus improve linearity. Components normally considered to be linear, passive, and reciprocal must be carefully checked to ensure that they are. This especially applies to ferrite

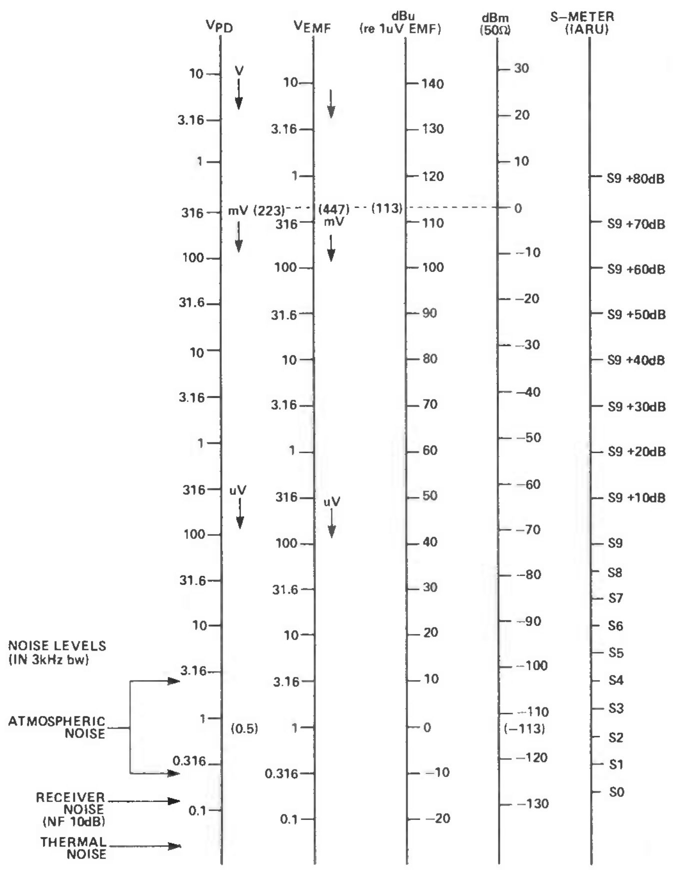


Figure 10: Relationships between levels specified in V(EMF), V(PD), dBu and dBm (50Ω). Also shown in S-meter response (IARU), which specifies that S9 is at 100uV(EMF) with S-point spacing at 6dB intervals.

cores, used for RF coils and transformers, and crystal filters, which are often non-linear and non-reciprocal (ie, of different characteristics if connected the 'wrong' way round).

Stability

A fully synthesised receiver can have a stability equal to that of the frequency reference source. If an ovened crystal oscillator is used, stability of less than 0.1Hz/°C can be achieved. With partial synthesis, the stability is governed by the stability of the VFO, but with cool, buffered solid state designs it is possible to achieve long term drift rates of 100Hz/hour, with short term drift (including lifting the receiver an inch and dropping it!) of 10 to 20Hz. The latter is more than adequate for normal SSB/CW/RTTY/AM communications, but rather more exotic systems such as Lincompex, Kineplex and Piccolo, need the stability provided by full synthesis.

Conclusions

The performance of the HF receiver has increased markedly in recent years. As activity on the HF bands has increased, this improvement in performance has been of vital importance to maintain the ability to communicate. Generally speaking the cost of equipment has gone up in proportion to complexity, but recently a number of receivers have become available that offer high performance at reasonable cost — the Yaesu FRG7700, for instance, at just over £300, represents remarkable value for money.

Future trends will include more extensive use of ICs, with possibly a single chip full-synthesiser and microprocessor control of the receiver. Direct conversion (a sort of superhet with an IF of zero frequency!) remains, as ever, on the horizon. It seems likely that more extensive use will be made of remote control of receivers via data link, and that in communications centres a central mini-computer will be linked to each operating position, performing a variety of useful functions. On the domestic scene, the home-computer can be linked to the receiver via a RS232 line — used to decode RTTY and SSTV signals etc. It could also be used as a 'big memory' to store channels (frequencies/modes/filters and a channel ident) for instant recall.

■ R&EW

RECOMMENDED READING

1) Winn, R.F.E. (Racal Communications Ltd.) Synthesised Communications Receiver. Wireless World Oct, 74pp 413-417.

2) Winn, R.F.E. Effects of Receiver Design in Communications Systems, IERE Proceedings of the conference on Radio Receivers and associated Systems 4-6 July, 72pp 193-204.

DATONG ANF

An automatic notch filter from Datong.

Review by J.L. Mills.

As any user of the HF communication spectrum will know, congestion resulting from interfering heterodynes is becoming increasingly common. Some adjacent channel interference can be reduced with good quality filters, within the receiver, coupled with care in design to reduce cross and inter-modulation products. However, after all these measures have been included, heterodynes will still be present near to the signal frequency of a congested band space. The only effective way to eliminate any remaining tones is by placing a deep audio notch within the audio chain of the receiver.

Unfortunately, not all whistles occur at the same frequency, therefore, a tunable filter is required. However, by having a very sharp notch it becomes impossible to keep the notch in track with the whistle over normal operating conditions. The new Datong Automatic Notch Filter (ANF) overcomes this problem by employing an automatic sweeping technique.

General Description

The Datong ANF assumes that the operator's primary function is to copy the wanted signal and not to have to bother with heterodyne elimination. All operations on the ANF have selectable auto/manual functions for this requirement.

The ANF will search continuously over the normal audio communication range (270Hz to 3500Hz) until it finds an unwanted audio heterodyne. Once found, the unit stops the search function and phase-locks the notch filter onto the heterodyne's frequency. Due to the phase-lock circuitry, the unit will also cope well with drifting tones within its passband. Once the heterodyne disappears, the unit automatically resumes search mode.

Whilst automatic operation will normally be most effective, the unit may be locked to a weak heterodyne when a second stronger one appears. In this instance, the operator can select "MANUAL" and tune the notch onto the offending heterodyne. Even in "MANUAL" mode the ANF has limited AFC applied — once tuned within 100 Hz the ANF will automatically lock on.

To assist operation, the unit is provided with a 10-LED bargraph display showing the frequency to which the notch is tuned. In addition, the tenth LED also functions as a "LOCK" indicator. The ANF also provides a very effective 4-pole CW filter when "PEAK" mode is selected. Again the frequency of the filter is tunable over 270 Hz to 3500 Hz with the LED display showing the centre frequency selected.

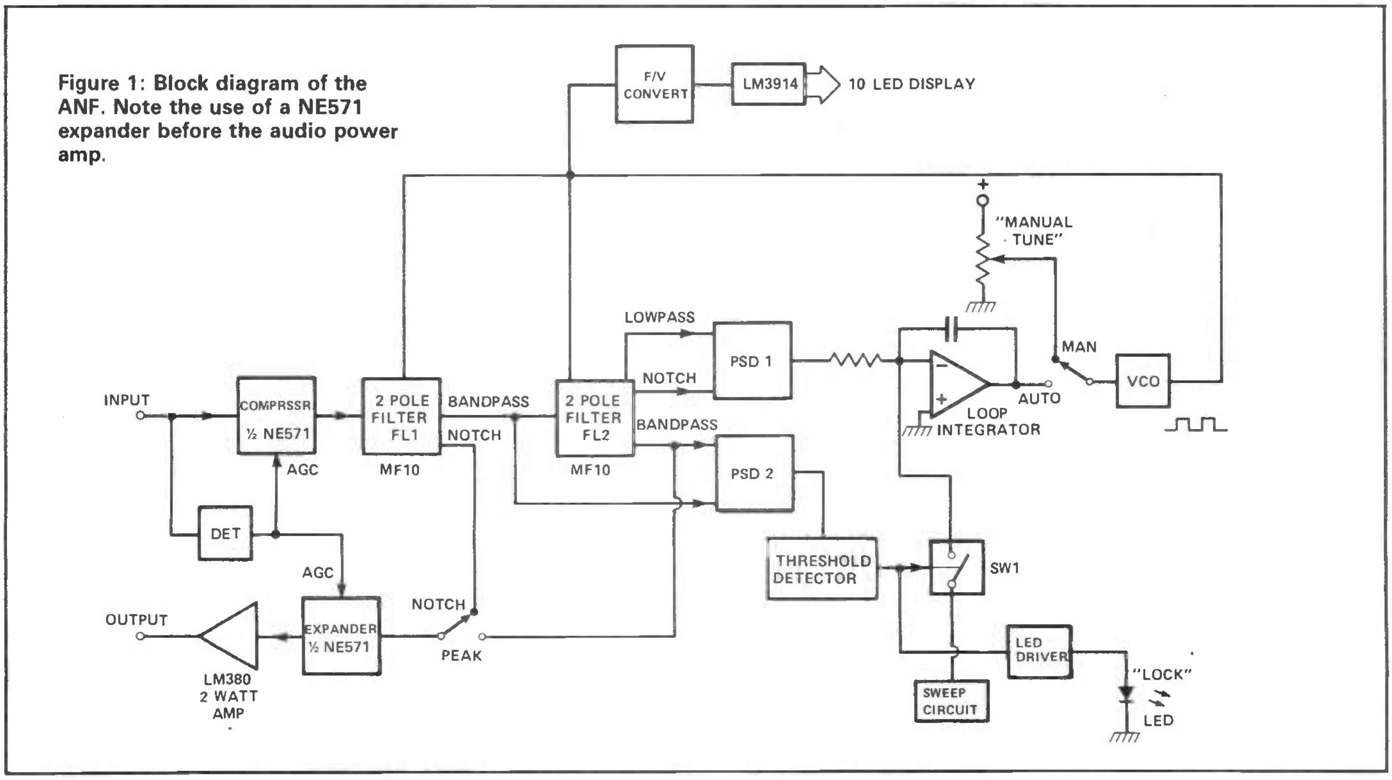


Figure 1: Block diagram of the ANF. Note the use of a NE571 expander before the audio power amp.

About The Circuit

Referring to ***Fig.1***, it can be seen that the ANF contains some interesting and up-to-date circuitry. One major problem with any filter in the audio stage of a receiver is ensuring a constant audio level for correct operation. The problem is overcome in the ANF by using half of a NE571 as a compressor at the audio input of the unit. The NE571 ensures a constant level into the remaining circuitry despite any alteration of the receiver volume control.

After the compressor, the audio signal passes through two variable 2-pole filters (FL1 and FL2), utilising the MF10 switched capacitor IC's from National (described in Oct '82 **R&EW**). The outputs from FL1 and FL2 are selected, depending on the function required, and the audio is passed into the other half of the NE571. This half functions as an expander and is linked by the AGC line with its counterpart at the input. Consequently the audio output from the unit is adjusted automatically to match the input level.

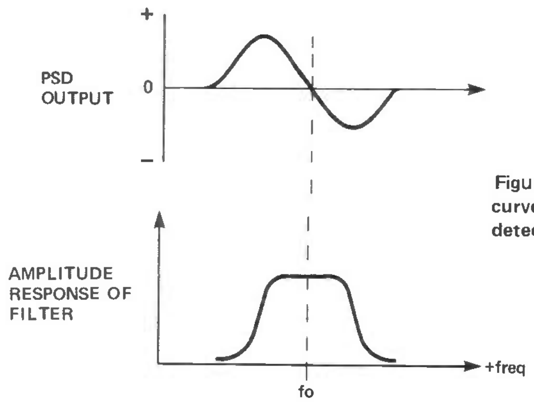


Figure 2. Response curve of phase-sensitive detector.

Auto Tuning

As previously shown, the filter must be auto-tuned exactly to the interfering frequency and then remain locked to it. There are three main requirements to achieve this:

1) The circuit must generate a voltage proportional to the degree of mis-tune of the filter and which can be used in a negative feedback loop to track the filter with the input frequency.

2) The filter must sweep over its entire range to be able to locate interference heterodynes within that range.

3) The filter must recognize a signal in its passband to enable it to change from search mode and lock onto the offending heterodyne.

When the filter is exactly in tune with the input signal, there will be a zero phase shift between input and output. If these signals are compared in a phase-sensitive detector (PSD), the output will swing either positive or negative as the filter passes through resonance, resulting in a discriminator-like response curve (***Fig.2***). A better and more sensitive response can be obtained by comparing the phase of the notch output with that of the lowpass output. Below resonance, the two are in phase, above resonance they are 180 degrees out-of-phase, so this method gives a very abrupt indication and is the one that is used.

As can be seen from ***Fig.1***, the ANF has two PSD's. A "LOCK" signal is generated by PSD2. If it has no output, the electronic switch (S1) is closed allowing the sweep circuit to tune FL1 and FL2 across the range via the loop integrator and VCO. If, during a sweep a signal is detected in the passband, PSD2 goes high thereby disabling S1 and the sweep circuitry. PSD1 then takes over and drives the integrator/VCO to keep the filter locked to the detected heterodyne. Even if the heterodyne drifts, the unit will automatically track it over the entire tuning range (270 Hz to 3500 Hz).

When manual operation is selected, the VCO is driven directly from the manual tuning control, whilst a much attenuated voltage is fed to the integrator to provide the previously described AFC function. The unit also incorporates a frequency-to-voltage converter to drive the 10-LED frequency display via a LM3914 driver.

Table 1: SPECIFICATIONS FOR THE DATONG ANF

Overall audio gain:	Unity.	
Supply voltage:	11 to 18 volts DC.	
Supply current:	75mA quiescent, 400mA maximum output.	
Input impedance:	100k	
Filter tuning range:	270 to 3500 Hz.	
Notch depth:	better than 40dBs at 3.5kHz.	
Notch filter type:	2-pole, Q=30, state variable.	
Input threshold for correct operation:	1mVrms (ie, well below usable listening levels).	
Lock threshold:	will lock onto tones 6 dBs below noise level. Adjustable by internal preset.	
Lock time:	An interfering tone will be removed within typically one second.	
CW filter bandwidth:	60Hz at -3dBs at 800 Hz centre frequency. Filter comprises two cascaded 2-pole sections with Q's of 30 and 10.	
Audio power output:	2 watts into 8ohms with 15V supply. 1.5watts into 4ohms with 10V supply.	
Connections:	input and output by phono jack, power supply by standard coaxial power jack, phones by 3.5mm jack.	
Functions:	OFF–	disconnects power and connects input jack to output jack
	NOTCH–	switches filter to notch mode for removing whistles.
	PEAK–	switches filter to bandpass mode for CW reception.
	MAN/AUTO–	selects manual tuning via knob or automatic search and lock mode.
	BYPASS–	(press NOTCH & PEAK together) allows user to monitor the input to the filter.
Display:	line of 10 red LEDs shows filter frequency at all times.	
Protection:	the unit is protected against reversed supply polarity and loudspeaker short circuit or overload	
Dimensions:	150x90x44mm(5.9x3.5x1.7 inches). Feet add 4mm (0.15 inches).	
Weight:	475gms (17 ounces).	

Presentation

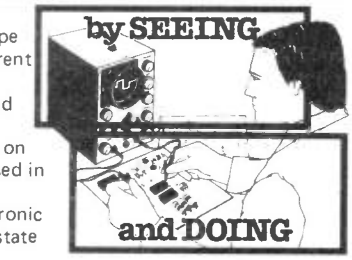
The ANF is ruggedly built with two PCB's secured via a sandwich construction bolted to four brass corner pieces. The whole assembly is very rigid in this form and housed in a well styled aluminium-extruded case. The front panel is uncluttered and comprises the 10-LED display, manual tuning knob and push button switches for "OFF", "NOTCH", "PEAK" and "AUTO/MANUAL" functions.

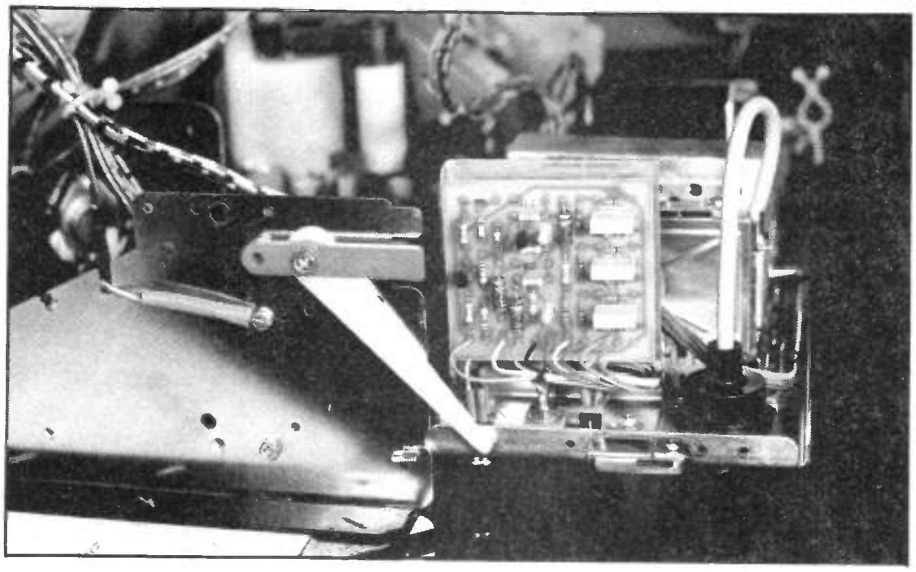
At the rear, input and output connections are via phono sockets. Power is supplied via a DC jack and a 3.5mm socket is provided for headphones. Two leads terminated at one end with phono plugs and a plug to mate with the DC socket are also provided with the unit.

Clear, easy-to-read instructions are provided to give initial connection, setting up and operating information. Adjustment data is also provided for the internal presets — these set the upper and lower frequency limits, level adjustment and notch depth. (***Table 1*** shows the notch depth is more than 40 dB @ 3500 Hz).

In use, the unit becomes indispensable. Normally set, in "AUTO NOTCH", the ANF will remove heterodynes two seconds after they appear. Indeed at times, the unit locked to heterodynes so quickly that the tone was never observed. For CW addicts the 2 x 2 pole sections with a bandwidth of 60 Hz at −3dB (800 Hz centre frequency) will be found very useful; though, in this mode, the unit is best left set to an operator-chosen ("MANUAL") centre frequency. The receiver tuning is then varied to place the required CW signal centrally in the filter band. By pressing both "NOTCH" and "PEAK" buttons, the operator can monitor the filter input to judge the effect without the filter.

The Datong ANF is, in the author's opinion, a very useful addition to any busy HF station — whether ham or SWL. Remember, although intended for use with SSB, the ANF will still remove any heterodynes produced by two close AM stations. ■ R&EW





TX10-RGB

An easily constructed project, which allows the Thorn TX10 to accept RGB inputs from the BBC Micro. Design by Paul A. Pitts.

This project was conceived to demonstrate just how easily Thorn's TX10 receiver can be adapted to take red, green and blue signals from the popular BBC Micro. A mains isolation transformer is not required (check earthing arrangements outlined in the December issue of **R&EW**), and the modification consists of a small aluminium chassis, which carries the input connectors, switch and printed circuit board. Ten wires leave the PCB to be wirewrapped onto the appropriate pins of the receiver — there is no need to cut any tracks or drill a single hole.

The general layout can be seen in the photograph. A phono socket allows sound to be used on the set's own speaker and a double pole switch sets the unit up for RGB or normal inputs.

Circuit Description

At present, Thorn have at least two versions of their TX10 chassis on the market. The older version, using the PC1501 signal card, being superceded by the newer PC1551. The modification shown here works equally well with either version, but there are minor differences in nomenclature.

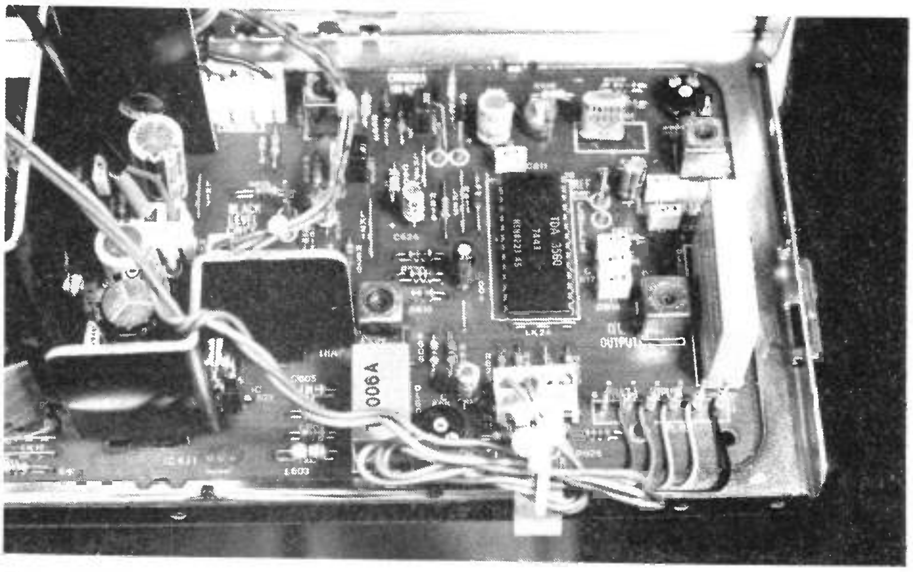
Both chassis use the Mullard TDA3560 PAL decoder chip, IC601, in the arrangement shown in ***Fig.1***. This chip was designed for Teletext, with three pins (13, 15 and 17) allowing data insertion. Depending on the voltage applied to pin 9, the chip output can be either the decoded version of the composite video input signal or the RGB signals, from the micro, placed on the data insertion pins. When pin 9 is taken low, the chip works as a decoder, and when high, about 1V5, it routes external RGB to the tube (the switching delay, incidentally, is less than 20ns).

Mullard's input levels are one volt peak-to-peak for full output. Remember the contrast and colour controls on the television are bypassed when the set is switched to RGB, just as they are for Teletext (the operation of the brightness control is not affected). Mullard also recommend that the data inputs should be AC coupled via 100n capacitors. so each input attenuator looks like ***Fig.2***

The BBC's output stage sees a 75R load, that is, two of 75R in series across the 150R input resistor, and the TDA3560 sees half the computer's output, sourced and terminated again with 75R through the 100n capacitor. This attention to impedance matching is important because the TV and micro may need to be separated by a long lead. Purists may frown, but it was not felt necessary to use coaxial conductors, even up to five metres.

The six cored cable carries red, green, blue, earth syncs and sound. ***Fig. 3*** shows these connections on the BBC micro. Notice that the centre pin carries +5V and this is not used in the conversion unit. The sixth wire on the cable is brought out of the DIN cover, sleeved, and taken to a phono socket, which needs to be added to the rear of the micro. Looking at the multitude of connectors on the BBC, it does seem a little odd that a sound output is not provided. The easiest method is to take a twisted pair from the speaker plug, PL15, and insert a 680R resistor in series with the signal lead (negative end of C16) to prevent damage in case the output is accidentally shorted. At the TV end of the flex, six wires enter a five pin locking DIN, wired number-for-number to match the micro.

Audio from the phono socket is terminated on R1 and passed via C1 to the base of Q1, which acts as a switchable sound buffer. Q2,



The TDA3560 *in situe*

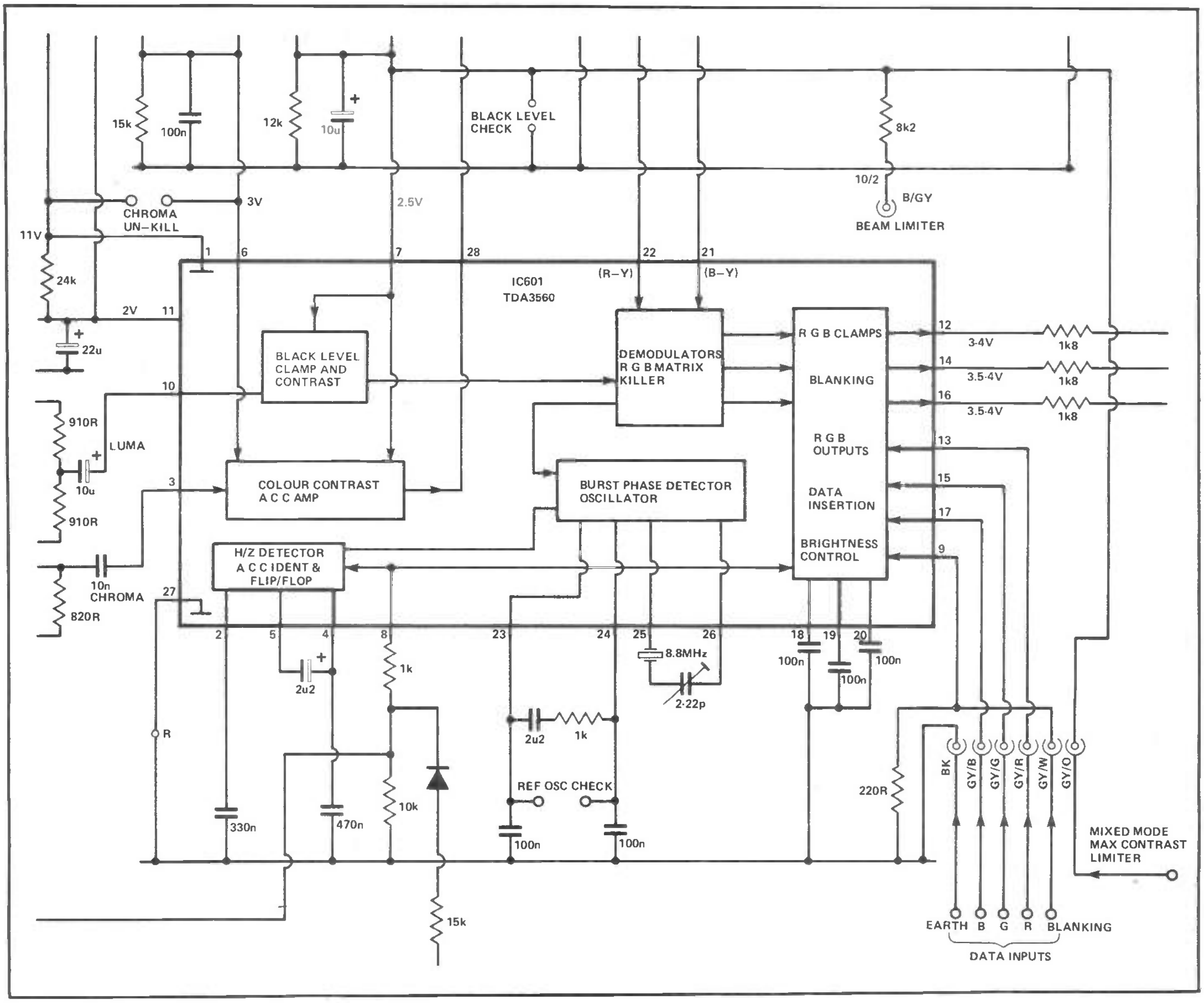


Fig. 1. The TDA3560 and associated circuitry.

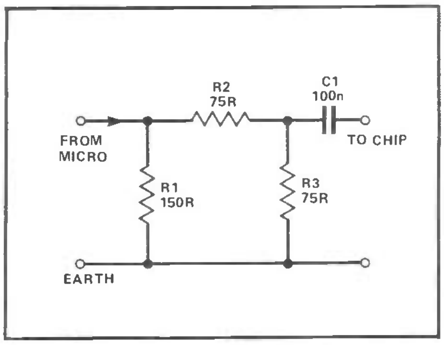


Fig. 2. Impedance matching circuit.

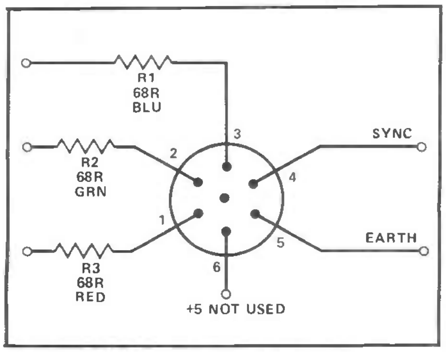


Fig. 3. Pin connections on the BBC's RGB socket.

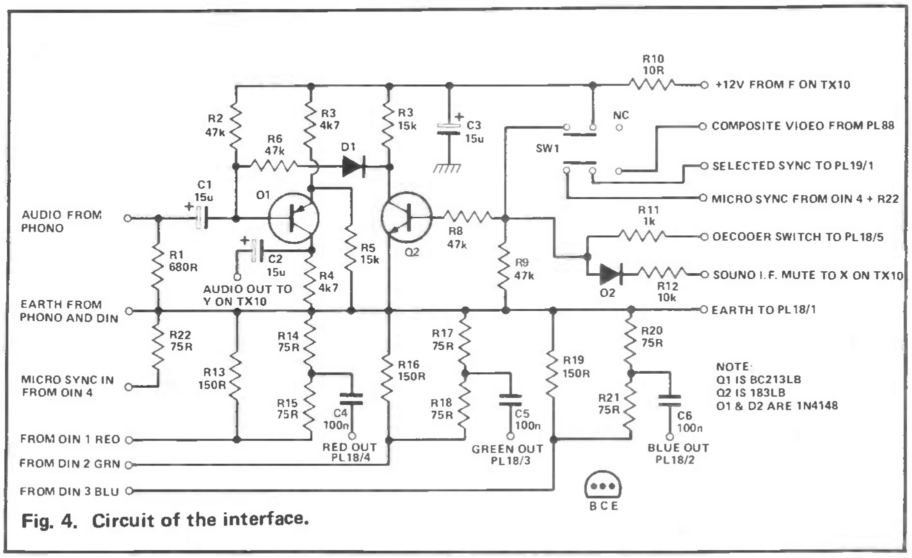


Fig. 4. Circuit of the interface.

whose base is switched by SW1 to +12 volts, determines whether Q1 is biased on or off, and therefore whether audio is available on C2 or not. R11 sets the decoder switch to 1V5 for RGB working, and D2 and R12 switch off the sound IF when taken high. The other pole of SW1 selects either composite video from PL88 or micro syncs from pin four of the DIN plug. This is routed to the sync separator, IC71, via PL19/1 (one terminal of SW1 is not connected).

The circuit diagram shows the three identical resistive attenuators already described. Figures 5 and 6 show the PCB foil pattern and component placement, respectively. The numbers on the foil indicate the pads from which the wires to the TX10 are taken. They

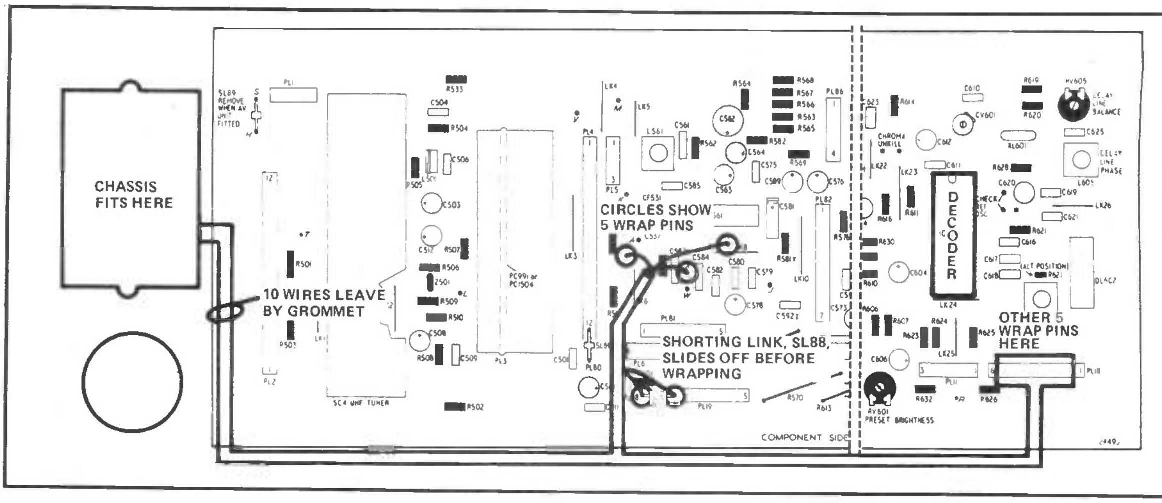
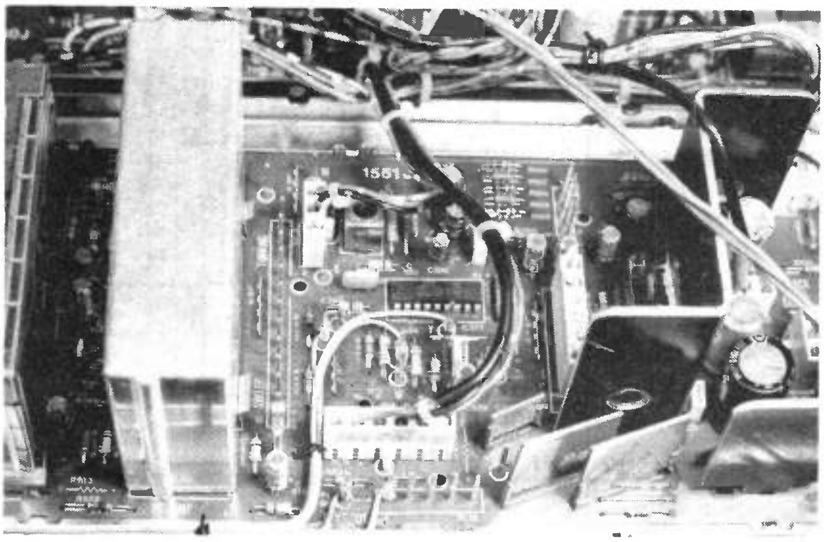


Fig.5. Interfacing the board to the TX10 – the broken lines show where some of the printed circuit board has been omitted.



Internal and external views

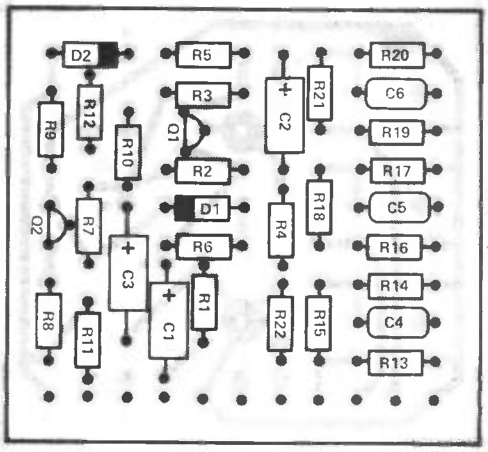
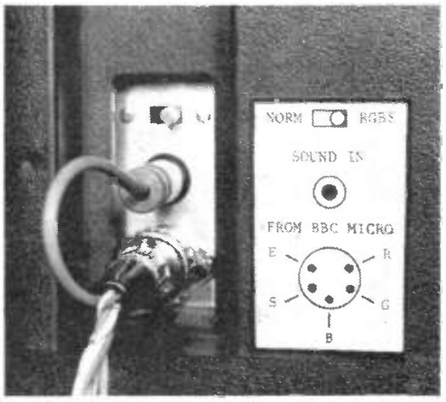


Fig.5: Component overlay.

connect as follows: 1 — Red output to PL18/4; 2 — Green output to PL18/3; 3 — Blue output to PL18/2; 4 — is simply where the stranded wire from the centre of the switch is conveniently joined to the 24 SWG solid wire that continues on to PL19/1 as selected sync; 5 — is a similar pad, used between the wirewrap from PL88 to the stranded wire for SW1 as composite video; 6 — is audio out to Y on the TX10; 7 — supply (+12V) from F on the TX10 to R10; 8 — where R12 goes to X on the TX10. The free end of R11 takes the HI/LO switch to the decoder, and then via the DIN socket to PL18/1.

Construction

After changing the two core mains lead for three core (as detailed in December's conversion) and earthing the chassis, determine which signal board you have — the PC1501 has no X and Y pins, and in this case substitute C and D respectively and check that composite video comes from pin A. The wire link near PL19 marked TXT then needs to be removed. If you have PC1551, you will have to remove shorting link SL88 on PL19 before



wirewrapping.

When the module is installed and wirewrapped, check the programme sound from the speaker operates when switched to RGB and the micro's sound is present at equal volume. If you tune a spare channel on the receiver to the BBC's UHF out and then switch from Normal to RGB you will see 'arcade' quality pictures on a standard off-the-shelf receiver.

■ R&EW

PARTS LIST

Resistors

R1	680R
R2,R6,R8,R9	47k
R3,R4	4k7
R5,R7	15k
R10	10R
R11	1k
R12	10k
R13,R16,R19	150R
R14,15,17,18,20,21,22	75R

Capacitors

C1,C2,C3	15u 16V Elect
C4,C5,C6	100n Poly

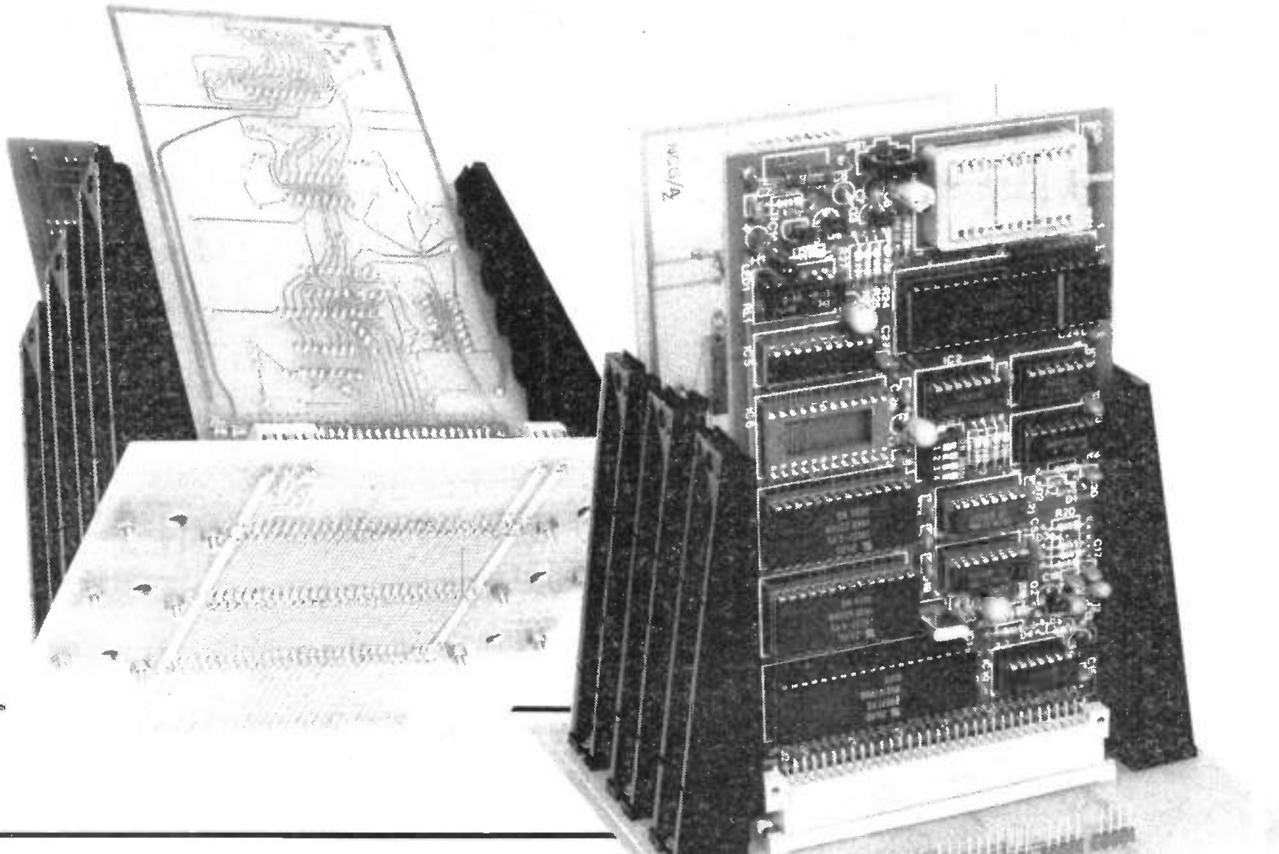
Semiconductors

Q1	BC213LB
Q2	BC183LB
D1,2	1N4148

Miscellaneous

Isolated Phono socket, Miniature slide switch, 5 pole locking DIN socket, Aluminium chassis, P.C.B and pillars, 24 SWG wrappable wire.

Note. A complete kit of parts is available for £25 (or £30 ready built) from:
7 Inglewood Drive, OTLEY LS21 3LD, West Yorkshire



Z8 BACKPLANE

An essential interface to facilitate future Z8 TBDS expansions. Design by Chris Harris.

Since the publication of the original Z8 system, in the February 1982 issue of **R&EW**, many readers have discovered a wide range of applications. With the addition of the backplane described here, provision is made for further hardware expansions, permitting more ambitious projects to be developed.

The backplane allows peripheral boards to be plugged in to form the basis of a complex system. It is a single-sided board, with seven topside wire links. The track layout is designed to accept eurocards with the same format as the Z8 TBDS board. Space is provided for three cards, and molex connectors are used for connecting up tape interface and RS232 terminal, together with ports 2 and 3 allowing easy connection direct to the I/O ports. A useful feature on port 2 & 3 connectors is a spare pin brought out to a solder pad to facilitate adding an extra line, such as power, should the need arise.

Power is brought to the backplane through on-board terminal blocks ensuring the Z8 Interconnect cable doesn't become redundant. De-solder it from the edge connector and screw onto the board.

Table 1. Bus connections for the Z8. ▶

PIN No.	ROW A	DRIVE	ROW C	DRIVE
1	GND	–	GND	–
2	GND	–	GND	–
3	−12	–	+12	–
4	−12	–	+12	–
5	–	–	AUX SER IN	–
6	–	–	TTL SER IN(P30)	–
7	–	–	–	–
8	A12	3LS	TTL SER OUT(P31)	3LS
9	A13	3LS	AUX SER OUT	60LS
10	A15	3LS	A14	3LS
11	RS232 OUT	–	RS232IN	–
12	–	–	–	–
13	–	–	–	–
14	–	–	P36	5LS
15	–	–	P31	5LS
16	$\overline{\text{RESET}}$	20LS	P27	5LS
17	$\overline{\text{DS}}$	4LS	P26	5LS
18	R/$\overline{\text{W}}$	2LS	P25	5LS
19	$\overline{\text{AS}}$	4LS	P24	5LS
20	P35	5LS	P23	5LS
21	P32	5LS	P22	5LS
22	AI/DI	2LS	P21	5LS
23	AO/DO	2LS	P20	5LS
24	A7/D7	2LS	P33	5LS
25	A6/D6	2LS	P34	5LS
26	A5/D5	2LS	A8	4LS
27	A10	4LS	A9	4LS
28	A11	4LS	A4/D4	2LS
29	+25	–	A3/D3	2LS
30	+25	–	A2/D2	2LS
31	+5	–	+5	–
32	+5	–	+5	–

▶

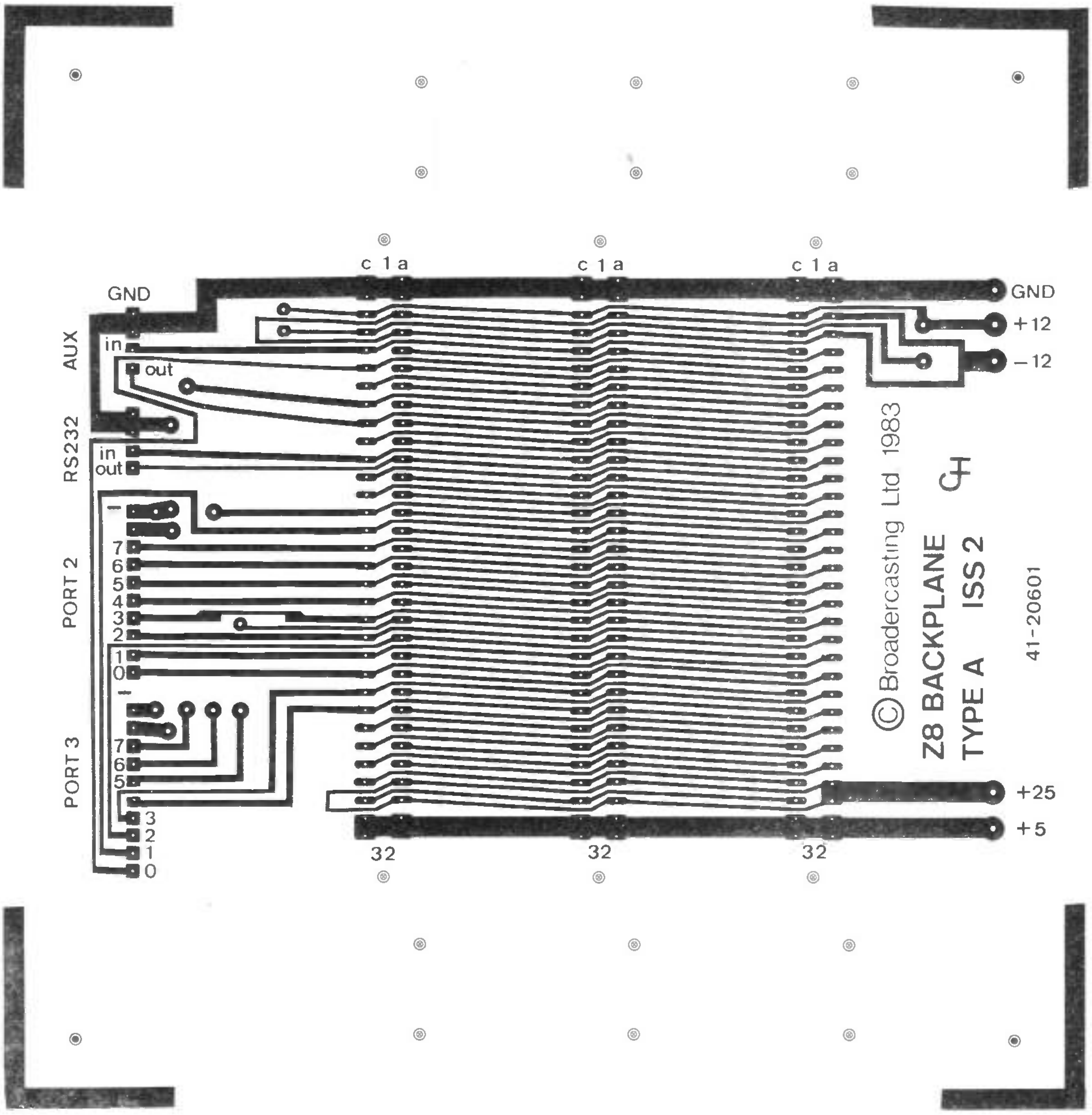


Figure 1: The PCB pattern for the backplane board

Construction

The PCB is straightforward and easy to construct. Start by inserting all topside board links, as the overlay shows, preferably using insulated wire. Continue with the 64 way indirect sockets, insert as many as you require. Take special care to ensure the board sockets are the right way round so that the pin numbers conform with those on the PCB. Failure to do this will certainly result in a ruined PCB when you attempt to desolder 64 pins!

Secure each socket before soldering with the 6BAx¼" bolts, the head being topside. Tighten the nut under the PCB until firm, over-tightening may cause the connector to crack so take care.

Finish off soldering with the molex and terminal block connectors, and check thoroughly for solder bridges.

Next the back support. Take the card supports and push fit the card guides into the underside. Secure the supports to the PCB with 6BA x ⅜" bolts and tighten the nuts on the copperside, adjusting for optimum board width.

The backplane is at home either free standing or in a case, and it only remains to mount the board as desired and complete the wiring with the interconnecting cables.

Testing

With no boards in the backplane, apply power and check for the correct voltages on each of the edge connectors. When satisfied that all is well, switch off, plug in the TBDS board, connect up a terminal and switch on. If there are no signs of initialisation following RESET: switch off. Check that RS232 input and output connections are the right way round. If the TBDS board has always powered up correctly until now, but refuses to initialise, the fault is bound to be a short circuit between tracks of the data, address or control lines on the

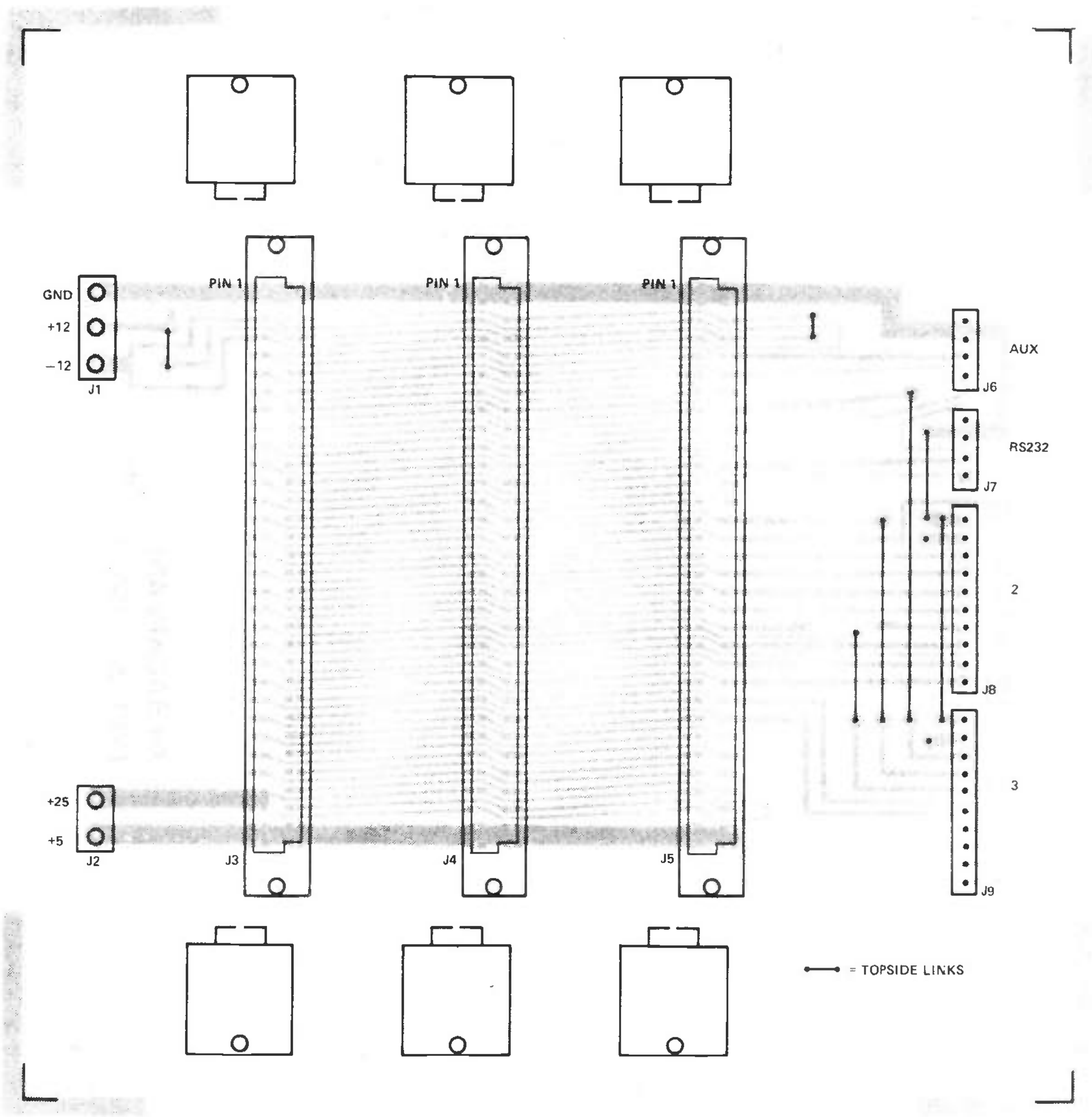


Figure 2: Placing the connectors and pins on the PCB.

PARTS LIST

J1	3 way PCB terminal block
J2	2 way PCB terminal block
J3,4,5	Solder pin, 64 way indirect edge connector
J6,7	0.1" 4 way Molex plug
J8,9	0.1" 10 way Molex plug

Card guides (Harwin U1407-98) 6 off. Plastic mounting brackets (Harwin U1407-98) 6 off. 6BA bolts ¼" 6 off. 6BA bolts ⅜" 6 off. 6BA nuts, washers 12off. Small veropins 2 off.

backplane. If this is the case disconnect everything from the backplane and systematically check every possible combination of the 64 wires for continuity and shorts between adjacent pins.

When the TBDS board powers up correctly the backplane is ready for use.

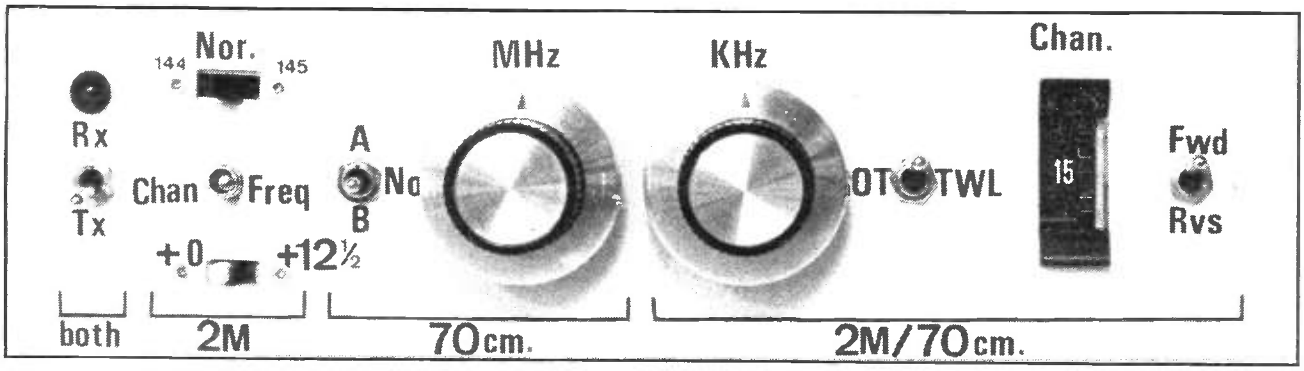
The Z8 has only a limited drive capability (high 250uA, low 2mA), before reducing noise margins. Hence the recommended load on any Z8 output pin should be kept to a maximum of 5LS TTL.

The TBDS board already presents a load on the Z8, so **Table 1** shows bus pin connections together with the drive capability available from the TBDS for use on the backplane.

Ideally each board to be plugged into the backplane should present no more than one LS TTL load to the bus. By using high speed CMOS buffers, the amount of drive can be increased.

The Z8 TBDS board requires +5 volts at 800mA, +12 volts and −12 volts at 20mA and 25 volts at 30mA when programming EPROMS. When connecting extra boards into the backplane, ensure that the power supply will be able to produce enough power.

■ R&EW



SYNTHESISER CONTROL SYSTEM II

The second part of our control system, by Ian Chapman, describes the display functions.

The LCD display used with this system was designed to show the current frequency status in an easy-to-read, unambiguous way. The concept embodied in the design is for a display which is sophisticated and versatile enough to be 'user-friendly' in its original 70cms environment, easily tailored for use in any other frequency band. With a combination of onboard linking and software contained in the 2532 EPROM on the main control board, this concept has been fully realised.

To show the true power of the design, some typical displays are reproduced in ***Table 1***. These can be achieved with the hardware and software stipulated in each case.

Functionally, the display is divided into four fields:

DIGIT:	1	2	3	4	5	6	7	8
FUNCTION:	H2	H1	D4	D3	D2	D1	E	S

H2–H1	=	'Hard-wired' display digits. These can be blanked from software.
D4–D1	=	Variable display digits. These carry the changing portion of any frequency display.
E	=	'Extra' display digit. Used in 2m design to display ½kHz offset selected as required by links.
S	=	'Shift' indicators. Three segments of this digit can be switched 'on' or 'off' by software. Used to display a frequency shift (Tx/Rx).

Design

The essential criterion for any LCD display is that no segment should have a static input — an AC signal should be supplied to every segment. The 'common' connection to all the segments is termed the 'backplane' and is supplied with a 125 Hz squarewave signal from the integrated circuit display driver used. This signal, BP, is the fundamental from which every segment input should be derived. An 'off' segment, that is, one which is transparent, has its segment input signal exactly in phase with BP. An 'on' segment, that is, a darkened one, has its input signal exactly in anti-phase with BP (ie, 180 degrees out-of-phase).

The first consequence of this requirement is that segments which must be 'off' all the time, should be connected to BP (not left unconnected like LED displays). There is no problem with loading the BP output since each segment takes a current measured in fractions of microamperes. The segments involved are those 'off' in the two 'hardwired' digits H2-H1, the spare decimal points, the unused segments of the 'shift' indicator S, and

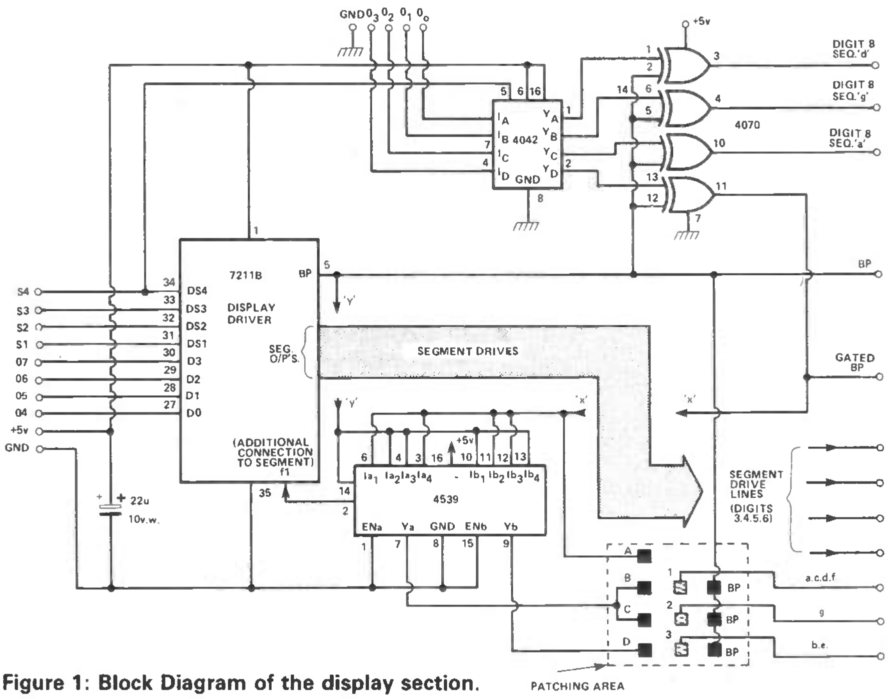


Figure 1: Block Diagram of the display section.

possibly some or all of the 'extra' digit E (depending on the configuration of the system used — see details of the link options).

The most significant, unchanging digits are displayed by H2-H1 (except when blanked from software), thus, for 70cm use, they will show '43'; in 2m use, they will show '14'; for other bands, they can be wired as is appropriate. 'Pads' are provided on the LCD display (mounting) PCB so that each segment of the digits H2 and H1 can be wired individually to either BP ('off') or to the 'on unless blanked' signal.

The 'on unless blanked' signal must, as a result of the nature of the display, output 'inverse BP' when the digits are to be switched on, and BP when the digits are to be blanked. Since a switchable inverter is needed, an EX-OR gate is called into action. This is one quarter of a CMOS 4070, such that the 'on unless blanked' signal emerges from pin 11.

The control signal for the blanking of these digits H2-H1, as well as for the three 'shift' indicators of digit S, comes from the main control board. A spare 4-bit data slot is available as surplus from the Motorola synthesiser design. O3-O0 from the main 2532 EPROM carry this data when select line S4 goes high. This data is latched by a CMOS 4042 (as shown on the circuit diagram), such that the Ya-Yd outputs hold these control bits.

Functions And Features

The protocol adopted in the 70cm and 2m designs was that a 'blank' shift digit S would imply that a simplex channel is being used — the transmit frequency is the same as the receive frequency. An 'up' bar (top segment on) would mean that a positive frequency offset is in use — in receive mode, it implies that transmit will be 'up-shifted' and in transmit mode, it implies that the receiver is 'listening' on a higher frequency than that currently being transmitted on. The opposite effect of a down-shift, is implied if the bottom segment of S is on. Thus, S always indicates what will happen to the frequency when the transmit/receive state is changed (ie, what is about to happen). The middle bar of digit S is not used in either the 70cm or 2m design, but is available for special purposes of indication in other systems.

The functions of the four control lines from the main control board are summarised in ***Table 2***. The four data digits D4-D1 are driven directly by the 7211B display decoder/driver. These carry the 'changing' portions of the

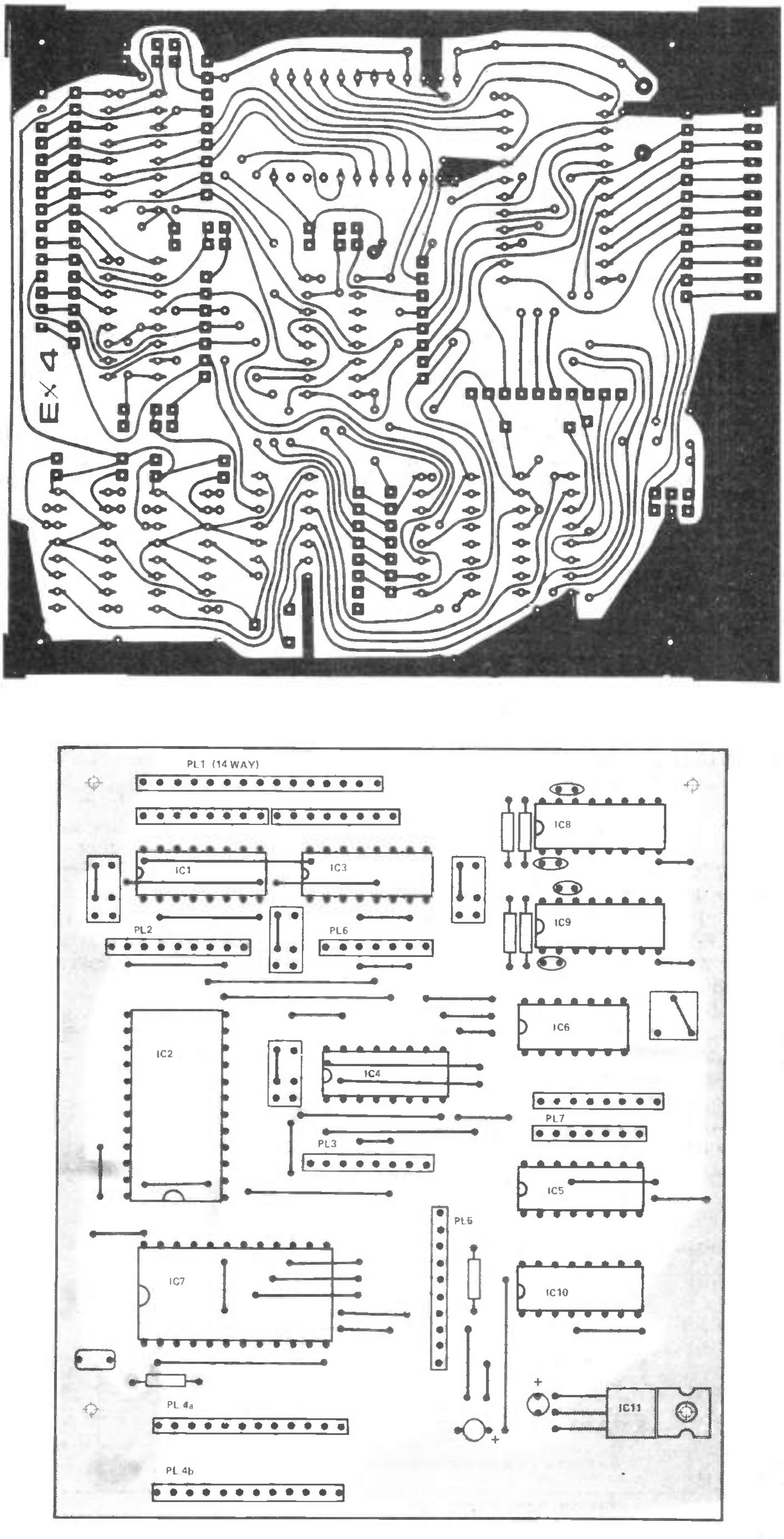


Figure 2: PCB foil pattern (top) and overlay (bottom) of the main board.

Circuit Description

In systems such as those for 2m, when frequency steps go in increments of 12 ½ kHz (not an integer), it is of ergonomic importance to display the extra ½ kHz digit. However, it is not necessary to introduce decoding for another digit — this can be extrapolated using a logic 'fiddle'.

When the E digit is in use, it would be expected to follow the kHz x 1 digit. If this digit (D1) is showing a '2' or a '7', one would expect the E5 digit to show the additional '5'. If D1 is showing a '0' or a '5', one would expect the E digit either to be 'off' or to display a '0': the choice being made by links. No other cases for D1 need be considered since these would be erroneous frequency displays (using 12 ½ kHz steps). If a channel number or special display is put up, the E digit should be blanked automatically, so that this contingency is not a problem.

The logic used on the LCD board achieves this function by the rather devious use of a CMOS 4-to-1 line multiplexer (a 4539). Examination of the segment patterns in use in digit D1 will show that segment 'fl' is 'on' for both a '5' and a '0', and is 'off' for both a '2' and a '7'. Thus, this line can be used to select the necessary digit for E.

The 4539 multiplexer is used to direct either BP or the 'on unless blanked' signal (see earlier reference) through to the appropriate segments on digit E. The two address select inputs, A0 and A1, are connected to BP and 'fl' respectively. If these two signals are in phase ('fl' off) then the combinations 00 and 11 will be called up. If they are in antiphase ('fl' on) then combinations 01 and 10 will be called up alternately. By commoning the 00 and 11 inputs and the 01 and 10 inputs (each separately) on each half of the multiplexer, it will become a two-pole, two-way switch, which is switched depending on whether digit D1 shows ('0'/'5') or ('2'/'7').

The 'g' segment of digit E needs to be 'on' for a '5' and 'off' for a '0' to be displayed on E. Thus, it is connected to the 'a' pole of the multiplexer, which directs BP through to it (segment off) for the 01 and 10 combinations (D1 shows '0'/'5') and 'on unless blanked' through to it for the 00 and 11 combinations (D1 shows '2'/'7'). Thus, unless H2-H1-E blanking is selected (in which case the segment is off all the time), the 'g' segment will be 'on' or 'off' according to the digit that has to be displayed.

The reverse logic applies to the 'b' and 'e' segments of digit E. These need to be 'on' for a '0' and 'off' for a '5'. Thus they are connected by links to the 'b' pole of the multiplexer, which directs BP through to it (segment off) for the 00 and 11 combinations (D1 shows '2'/'7') and 'on unless blanked' through to it for the 01 and 10 combinations (D1 shows '0'/'5'). Thus, the 'b' and 'e' segments of digit E also follow digit D1 appropriately, unless they are blanked, in which case they will be 'off'.

Segments 'a','c','d' and 'f' of the digit E should be 'on unless blanked', and so are wired straight to the 'on unless blanked' signal by the appropriate link. Thus, the 'frame' for a '0' or a '5' — the common segments to both digits — are always on unless blanked.

The above description assumes that digit E is to display either '0' or '5' all the time a frequency is shown. For some applications, it may be more convenient to have digit E off in all cases except when a ½ kHz offset is in use. In this case, segments 'a', 'c', 'd', 'f', and 'g' of digit E should all come on together, and so are all connected to the 'a' pole of the multiplexer using the links given. Thus, they will all come on only when a '5' has to be displayed. Segments 'b' and 'e' are then 'off' all the time and so are linked to BP.

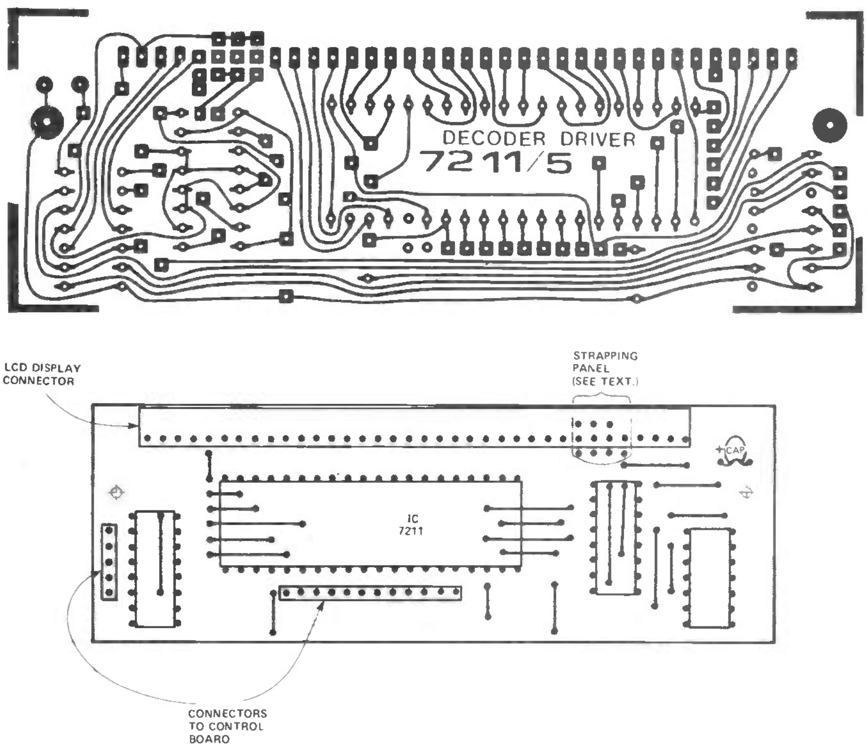


Figure 3. The PCB foil pattern (above) and component placing (below) on the decoder board.

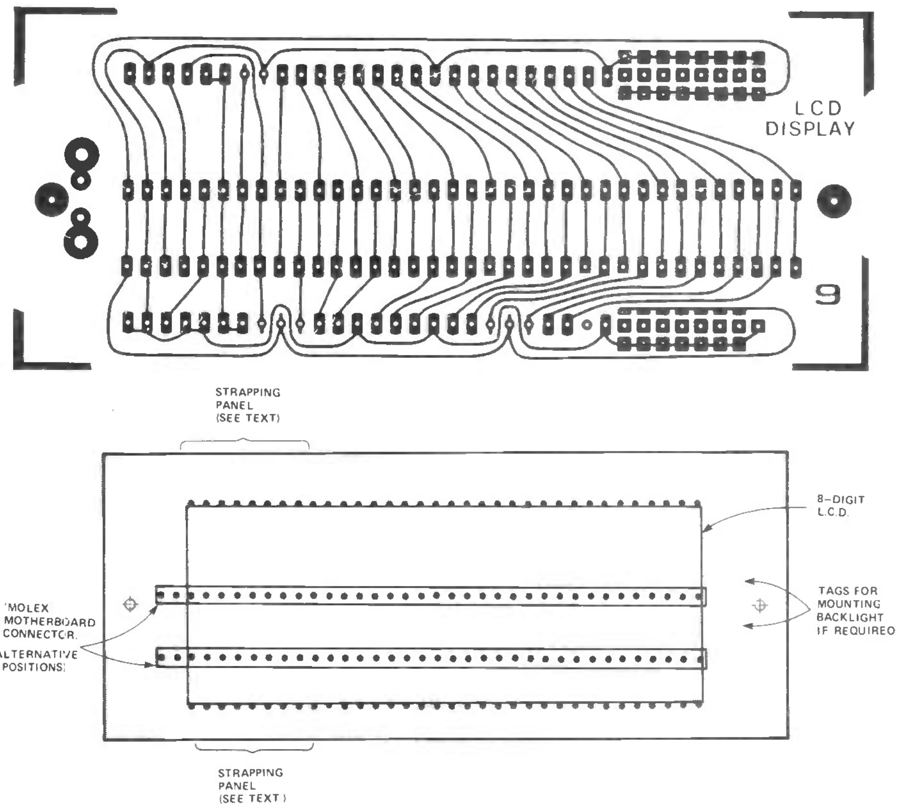


Figure 4: Display board foil (above) and overlay (below).

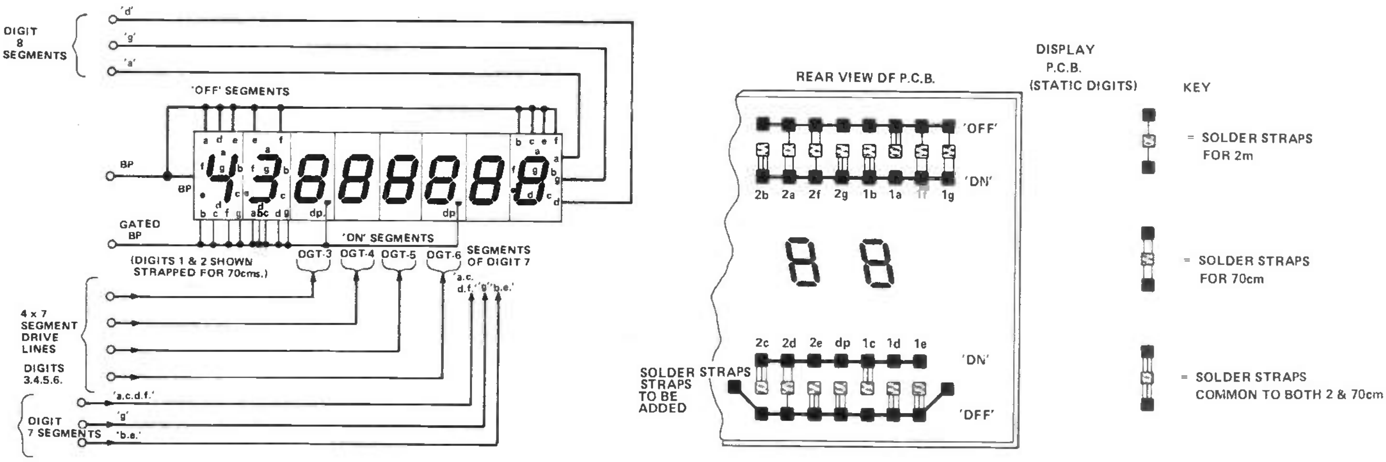


Figure 5: Connections for the LCD display, showing differences between 70cm and 2m versions.

frequency display, that is, the MHz x 1, kHz x 100, kHz x 10 and kHz x 1 digits. From software residing in the main 2532 EPROM, these digits can be set independently to any one of the 16 segment patterns available from the 7211B (the set of characters is shown in ***Table 3***).

The data on the input lines D3-D0 (on the 7211B) comes from the output lines O7-O4 of the 2532 EPROM on the main board; as shown in the circuit diagram and table. The select lines S1 to S4, from the main board, strobe the four 4-bit packages of data on these lines into the 7211B via the data select lines DS1-DS4 (pins 31 to 34).

Clearly, the digits D4-D1 will normally carry frequency data (for example, (43)3.525 or (14)5.550). However, if the first two digits are blanked as described previously, a channel number or even an idiosyncratic message can be placed on the display to identify the channel selection in use. The range of characters is limited, but a little ingenuity can produce interesting effects. In the prototype 70cm system, simplex channels SU16-SU55 were displayed as -nn, and repeater channels RB0-RB15 were displayed as Pnn: other conventions could be used in different systems.

The extra digit E is not needed for 70cm systems. In this case, its segments should all be connectd to BP by appropriately wiring links 1,2 and 3 on the LCD components board. Also, the 4539 is not needed with this arrangement, and can be left off the board entirely.

Connecting Up

A summary of the links that have to be connected in each of the three possible cases for digit E, is shown in ***Table 4***.

The 36 signal lines have to be passed from the LCD decoder (components) board to the LCD display (mounting) board (see ***Fig. 2***). These comprise the 28 segment lines for digits D4-D1 (controlled directly from the 7211B); the three lines for the 'up', 'middle' and 'down' segments of the 'shift' indicator S; backplane BP for the unused segments; gated inverse BP ('on unless blanked') for digits H2 and H1; segments 'a','c','d' and 'f' of the extra digit E (commoned); segments 'b' and 'e' of digit E (also commoned) and a segment 'g' of digit E. The two boards can either be mounted in a 'T' shape using a PCB edge connector and board pins; or as a 'sandwich' — back to back — using ribbon cable.

■ R&EW

433.500	–	70cm design (showing SU20)
433.100	–	70cm design (showing RB4 and 'up' shift)
S.25	–	all designs (showing a simplex channel)
145.525	–	2m design (showing S 21)
145.4875	–	2m design (showing 12½kHz step)
HELP	–	all designs (special display)

FUNCTION	LINKS TO BE MADE
70 cm use – E to be off all the time.	1,2 and 3 all to BP
2m use – 12½ kHz steps E to show 5 or blank when in use.	1 to B, 2 to C, 3 to BP
2m use – 12½ kHz steps E to show 5 or Ø when in use.	1 to A, 2 to C, 3 to D

Tx/Rx	Ya(Ø)	Yc(02)	Yd(03)	MODE IMPLIED	
R	Ø	Ø	Ø	Blank H2-H1.	No shift on Tx
T	Ø	Ø	Ø	Blank H2-H1.	No shift on Rx
R	Ø	Ø	1	H2-H1 on.	No shift on Tx
T	Ø	Ø	1	H2-H1 on.	No shift on Rx
R	Ø	1	Ø	Blank H2-H1.	Up shift on Tx
T	Ø	1	Ø	Blank H2-H1.	Up shift on Rx
R	Ø	1	1	H2-H1 on.	Up shift on Tx
T	Ø	1	1	H2-H1 on.	Up shift on Rx
R	1	Ø	Ø	Blank H2-H1.	Down shift on Tx
T	1	Ø	Ø	Blank H2-H1.	Down shift on Rx
R	1	Ø	1	H2-H1 on.	Down shift on Tx
T	1	Ø	1	H2-H1 on.	Down shift on Rx

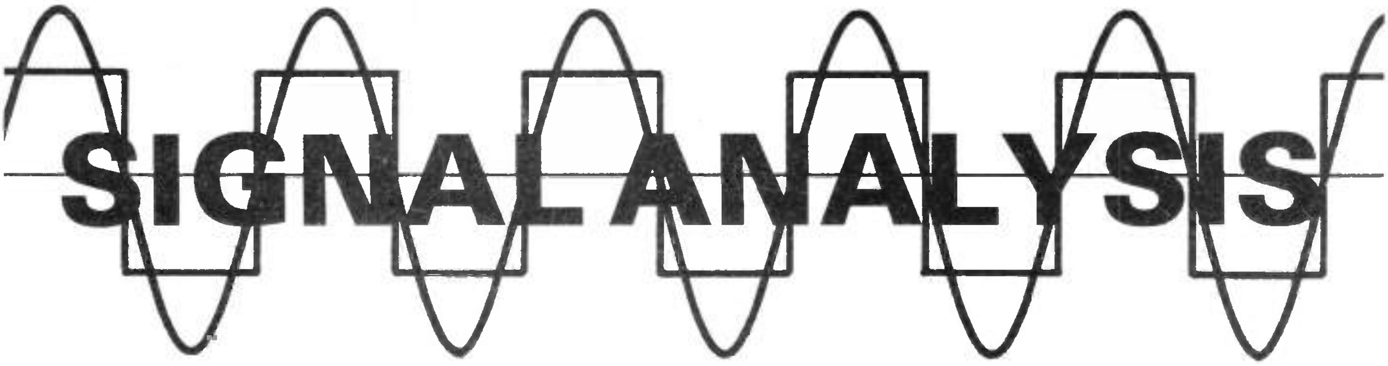
(('Nonsense' combinations and Yb(01) have been ignored))

07	06	05	04	HEX	DECIMAL	CHARACTER
Ø	Ø	Ø	Ø	Ø	Ø	Ø
Ø	Ø	Ø	1	1	1	1
Ø	Ø	1	Ø	2	2	2
Ø	Ø	1	1	3	3	3
Ø	1	Ø	Ø	4	4	4
Ø	1	Ø	1	5	5	5
Ø	1	1	Ø	6	6	6
Ø	1	1	1	7	7	7
1	Ø	Ø	Ø	8	8	8
1	Ø	Ø	1	9	9	9
1	Ø	1	Ø	A	10	-
1	Ø	1	1	B	11	E
1	1	Ø	Ø	C	12	H
1	1	Ø	1	D	13	L
1	1	1	Ø	E	14	P
1	1	1	1	F	15	(blank)

(THE 'B' CODE)

Tables 1-4. Typical displays (top left), 'digit E' links (top right), control line functions (middle) and character set (bottom) for the synthesiser control system.

The synthesiser board, designed specifically to match our control system (including the Motorola synthesiser chip mentioned in part one), will appear next month along with final assembly details.



SIGNAL ANALYSIS

J.S.B. Dick takes a look at Walsh and Fourier techniques and their application.

Fourier analysis is named after a French mathematician (and confident of Napoleon), who introduced the techniques in the early 19th Century. The mathematical nature of the analysis, though rather daunting, hides the simple concept that a periodic function may be expressed as a series of sine and cosine functions of certain amplitude and frequency. The example in ***Fig. 1*** shows how a square wave (which might be the output from a flip-flop) may be approximated by various series, each containing successively more terms. As terms of frequency 9f... are reached, the discrepancy between the real signal and the synthesised version is so small as to be ignored.

In general, most signals can be expressed as a Fourier series — if the signal is sampled T times during its period, then the value at time, t, where t = 0 to T is given by:

$$\text{signal (at t)} = A_0 + A_1 \cos\left(\frac{2\pi t}{T}\right) + A_2 \cos 2\left(\frac{2\pi t}{T}\right) + A_3 \cos 3\left(\frac{2\pi t}{T}\right) + \;.....\; B_1 \sin\left(\frac{2\pi t}{T}\right) + B_2 \sin 2\left(\frac{2\pi t}{T}\right) + B_3 \sin 3\left(\frac{2\pi t}{T}\right) + \;.....$$

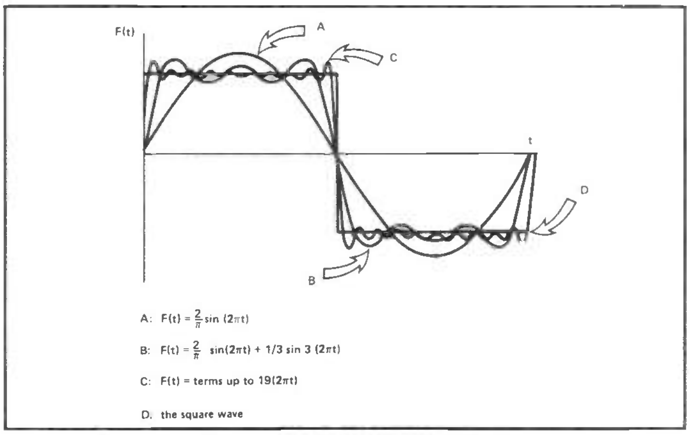


Figure 1: Approximating a square wave with Fourier Series.

where Ao, A_1...., B_1.... are constants determined by taking the Fourier transform of the signal (see later). If the coefficients are known, almost any function can be "made" by "mixing in" sine and cosine signals with frequencies f, 2f, 3f, 4f.... of the appropriate amplitudes. Since a cosine wave is a sine wave shifted in phase, conceptually they amount to the same. If the sine and the cosine terms of the

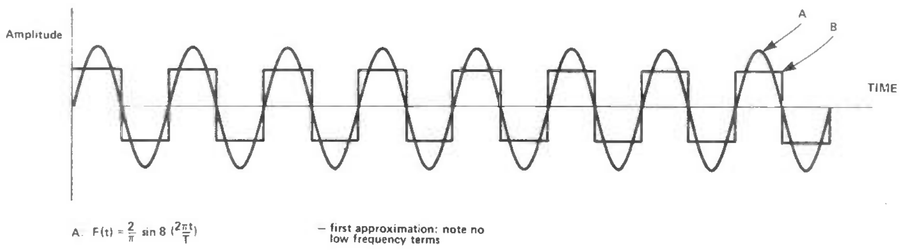


Figure 2: First approximation for increased frequency square wave.

```
procedure FWFT (in: FFT? , LOG2N ; inout: DATA )
   type logical FFT?   — set TRUE for FFT, FALSE for FWT
   type integer LOG2N -- log(base2) of number of samples
   type integer N     -- number of samples
   type integer HALFN,NLESS1,POINTER,LOOP,LOOPA,LOOPB,K,L,HALFL,I
   type real constant PI = 3.1415926535
   if(FFT? = TRUE)then
      type complex DATA(1024),U,W,TEMP,function CMPLX
   else
      type real DATA(1024)
   end if
   N=2**LOG2N
   HALFN=N/2
   NLESS1=N-1
   POINTER=1
   do LOOP = 1 to NLESS1 step 1
      if (LOOP lessthan POINTER) then
         TEMP=DATA(POINTER)
         DATA(POINTER)=DATA(LOOP)
         DATA(LOOP)=TEMP
      end if
      K=HALFN
      do while (K lessthan POINTER)
         POINTER=POINTER-K
         K=K/2
      end do
      POINTER=POINTER+K
   end do
   do LOOP=1 to LOG2N step 1
      L=2**LOOP
      HALFL=L/2
      if (FFT? = TRUE)then
         U=(1.0,1.0)         -- sets the value of the complex variable
         W=cmplx(cos(PI/HALFL),-sin(PI/HALFL))
      end if
      do LOOPA = 1 to HALFL step 1
         do LOOPB=LOOPA to N step HALFL
            I=LOOPB+HALFL
            if(FFT? = TRUE)then
               TEMP=DATA(I)*U
            else
               TEMP=DATA(I)
            end if
            DATA(I)=DATA(LOOPB)-TEMP
            DATA(LOOPB)=DATA(LOOPB)+TEMP
         end do
         if(FFT? = TRUE)then
            U=U*W
         end if
      end do
   end do
   do LOOP=1 to N step 1
      DATA(LOOP)=DATA(LOOP)/float(N)
   end do
end;

complex function CMPLX( )
   -- returns a complex value from two real in arguments
end;
```

Figure 3: Listing of the FFT/FWT program.

RADIO & ELECTRONICS WORLD

The Complete Communications Cross-Reference Card

Teletype codes

AMTOR		RTTY	LETTERS/	FIGURES
100	0111	00011	A	–
111	0010	11001	B	?
001	1101	01110	C	:
101	0011	01001	D	WRU
101	0110	00001	E	3
001	1011	01101	F	%
110	1001	11010	G	@
110	1001	10100	H	£
100	1101	00110	I	8
001	0111	01011	J	BELL
001	1110	01111	K	(
110	0101	10010	L	)
011	1001	11100	M	.
101	1001	01100	N	,
111	0001	11000	O	9
010	1101	10110	P	0
010	1110	10111	Q	1
101	0101	01010	R	4
100	1011	00101	S	'
111	0100	10000	T	5
100	1110	00111	U	7
011	1100	11110	V	=
010	0111	10011	W	2
011	1010	11101	X	/
010	1011	10101	Y	6
110	0011	10001	Z	+
111	1000	01000	CARR RTN	
110	1100	00010	LINE FEED	
101	1010	11111	LETTER SHIFT	
011	0110	11011	FIGURE SHIFT	
101	1100	00100	SPACE	
110	1010	00000	BLANK	
110	0110	–	REPEAT SIG	
011	0011	–	BETA	
000	1111	–	ALPHA	
110	0101	–	CNTRL 1	
110	1010	–	CNTRL 2	
101	1001	–	CNTRL 3	

Transmit RH bit first. Logic1=higher of two frequencies.

Amateur 'Q' codes

QRL	–	I am busy.
QRL?	–	Are you busy? Used to check for a clear frequency before transmitting in CW.
QRM	–	I am experiencing interference.
QRN	–	I am bothered by static noise.
QRP	–	Now used to indicate low power. Original meaning was decreased power.
QRP?	–	Shall I decrease power?
QRQ	–	Send more quickly.
QRQ?	–	Shall I send more quickly?
QRS	–	The cri de coeur of the novice! Send slower.
QRS?	–	Shall I send slower?
QRT	–	Stop sending.
QRT?	–	Shall I stop sending? Now often used to indicate intended temporary close down of station.
QRV	–	I am ready.
QRV?	–	Are you ready?
QRZ?	–	Who is calling?
QSB	–	Your signal is fading.
QSL?	–	A request for acknowledgement. Generally a request for a QSL card to be sent.
QTH	–	My location is.

Morse code

LETTERS

A	di-dah	N	dah-dit
B	dah-di-di-dit	O	dah-dah-dah
C	dah-di-dah-dit	P	di-dah-dah-dit
D	dah-di-dit	Q	dah-dah-di-dah
E	dit	R	di-dah-dit
F	di-di-dah-dit	S	di-di-dit
G	dah-dah-dit	T	dah
H	di-di-di-dit	U	di-di-dah
I	di-dit	V	di-di-di-dah
J	di-dah-dah-dah	W	di-dah-dah
K	dah-di-dah	X	dah-di-di-dah
L	di-dah-di-dit	Y	dah-di-dah-dah
M	dah-dah	Z	dah-dah-di-dit

NUMBERS

1	di-dah-dah-dah-dah	6	dah-di-di-di-dit
2	di-di-dah-dah-dah	7	dah-dah-di-di-dit
3	di-di-di-dah-dah	8	dah-dah-dah-di-dit
4	di-di-di-di-dah	9	dah-dah-dah-dah-dit
5	di-di-di-di-dit	0	dah-dah-dah-dah-dah

PUNCTUATION MARKS AND SPECIAL CHARACTERS

Period (.) di-dah-di-dah-di-dah	Wait (AS) di-dah-di-di-dit
Comma (,) dah-dah-di-di-dah-dah	Pause (BT) dah-di-di-di-dah
Question Mark (?) di-di-dah-dah-di-dit	Invitation to Transmit (K) dah-di-dah
Fraction Bar (/) dah-di-di-dah-dit	End of Message (AR) di-dah-di-dah-dit
Error in Transmission di-di-di-di-di-dit	End of Work (VA) di-di-di-dah-di-dah

Gray code

DECIMAL	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GRAY CODE	0000	0001	0011	0010	0110	0111	0101	0100	1100	1101	1111	1110	1010	1011	1001	1000

DECIMAL	BINARY	OCTAL	HEX	ASCII	EBCDIC POSITION
0	0000 0000	000	00	NUL	00
1	0000 0001	001	01	SOH	01
2	0000 0010	002	02	STX	02
3	0000 0011	003	03	ETX	03
4	0000 0100	004	04	EOT	37
5	0000 0101	005	05	ENQ	2D
6	0000 0110	006	06	ACK	2E
7	0000 0111	007	07	BEL	2F
8	0000 1000	010	08	BS	16
9	0000 1001	011	09	HT	05
10	0000 1010	012	0A	LF	25
11	0000 1011	013	0B	VT	0B
12	0000 1100	014	0C	FF	0C
13	0000 1101	015	0D	CR	0D
14	0000 1110	016	0E	SO	0E
15	0000 1111	017	0F	SI	0F
32	0010 0000	040	20	SP	40
33	0010 0001	041	21	!	5A
34	0010 0010	042	22	"	7F
35	0010 0011	043	23	#	7B
36	0010 0100	044	24	$	5B
37	0010 0101	045	25	%	6C
38	0010 0110	046	26	&	50
39	0010 0111	047	27	'	7D
40	0010 1000	050	28	(	4D
41	0010 1001	051	29	)	5D
42	0010 1010	052	2A	*	5C
43	0010 1011	053	2B	+	4E
44	0010 1100	054	2C	,	6B
45	0010 1101	055	2D	–	60
46	0010 1110	056	2E	.	4B
47	0010 1111	057	2F	/	61
48	0011 0000	060	30	0	F0
49	0011 0001	061	31	1	F1
50	0011 0010	062	32	2	F2
51	0011 0011	063	33	3	F3
52	0011 0100	064	34	4	F4

DECIMAL	BINARY	OCTAL	HEX	ASCII	EBCDIC POSITION
53	0011 0101	065	35	5	F5
54	0011 0110	066	36	6	F6
55	0011 0111	067	37	7	F7
56	0011 1000	070	38	8	F8
57	0011 1001	071	39	9	F9
58	0011 1010	072	3A	:	7A
59	0011 1011	073	3B	;	5E
60	0011 1100	074	3C	<	4C
61	0011 1101	075	3D	=	7E
62	0011 1110	076	3E	>	6E
63	0011 1111	077	3F	?	6F
64	0100 0000	100	40	@	7C
65	0100 0001	101	41	A	C1
66	0100 0010	102	42	B	C2
67	0100 0011	103	43	C	C3
68	0100 0100	104	44	D	C4
69	0100 0101	105	45	E	C5
70	0100 0110	106	46	F	C6
71	0100 0111	107	47	G	C7
72	0100 1000	110	48	H	C8
73	0100 1001	111	49	I	C9
74	0100 1010	112	4A	J	D1
75	0100 1011	113	4B	K	D2
76	0100 1100	114	4C	L	D3
77	0100 1101	115	4D	M	D4
78	0100 1110	116	4E	N	D5
79	0100 1111	117	4F	O	D6
80	0101 0000	120	50	P	D7
81	0101 0001	121	51	Q	D8
82	0101 0010	122	52	R	D9
83	0101 0011	123	53	S	E2
84	0101 0100	124	54	T	E3
85	0101 0101	125	55	U	E4
86	0101 0110	126	56	V	E5
87	0101 0111	127	57	W	E6
88	0101 1000	130	58	X	E7
89	0101 1001	131	59	Y	E8
90	0101 1010	132	5A	Z	E9

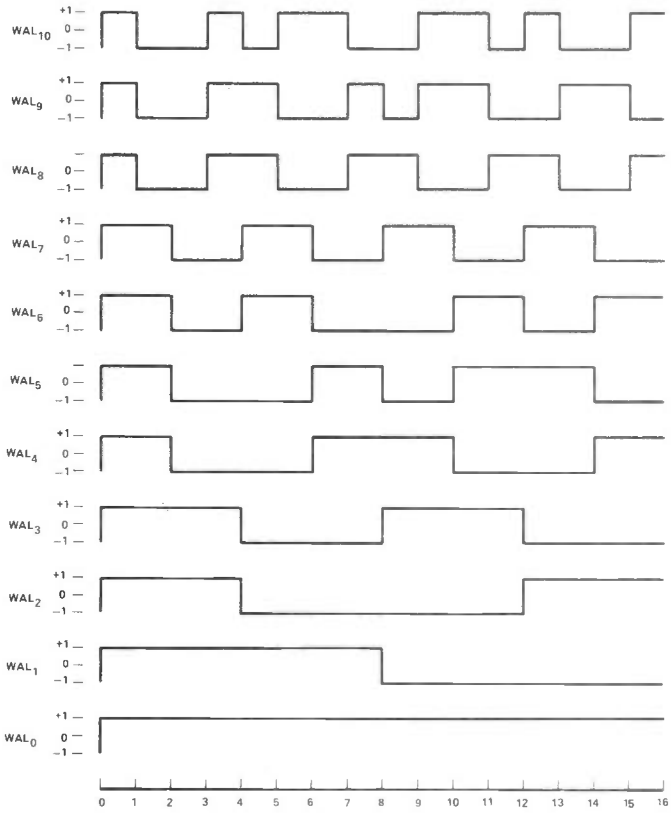


Figure 4: The first ten Walsh functions.

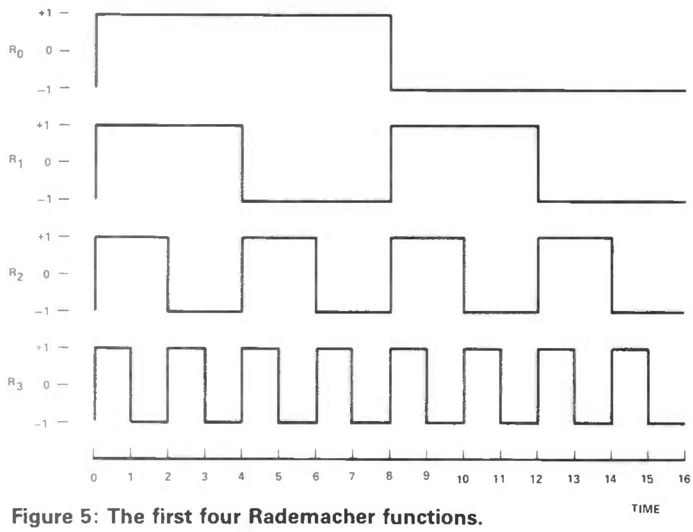


Figure 5: The first four Rademacher functions.

same frequency are treated as the same "species", then, by including them in the Fourier series, power at that frequency is being added. For example, if the square wave in ***Fig. 1*** is moved through 90° in phase, the Fourier series cosine coefficients become non-zero while the sine coefficients vanish. The power being used to synthesise the function at frequencies, f, 2f, 3f, 4f... remains the same — only its phase has been changed. The power contained in a frequency *nf* is found from:

$$\sqrt{A_n^2 + B_n^2}$$

A plot of the power at the *n*th frequency against n is called the 'Power Spectrum'. If the DC component of the signal is changed, only A_0, the *zero*th frequency coefficient, changes. The signal is repeated at a higher frequency in ***Fig. 2***, and here the power appears in a correspondingly higher frequency term.

The FT Index

The Fourier transform (FT) allows calculation of the required coefficients. Mathematically these may be expressed as:

$$A_n = 1/\pi \int_{-\pi}^{\pi} \text{signal}(t) \cos(nt)\,dt \quad \text{and} \quad B_n = 1/\pi \int_{-\pi}^{\pi} \text{signal}(t) \sin(nt)\,dt\,.$$

However, most users of the Fourier transform prefer the Fast Fourier Transform (FFT) algorithm, accredited to Cooley and Tukey, which swallows sampled data values and spits out the Fourier coefficients — no tedious maths either! The number of samples taken from a signal has to be a power of two, but requires a lot less computing time when compared to the Fourier Transform (the mechanism by which this computational advantage is gained is not simple to understand and readers are referred to the references at the end of the article).

There is a limit to the number of terms in the Fourier series that can be determined from a given sampling rate. Nyquists's theorem states that if a signal containing frequencies up to a maximum f_{max} is to be fully recovered, then the sampling must be carried out at 2 f_{max}.

Walsh Functions

Having used FTs to show that a function may be expressed as a series of sine and cosine terms, many scientists and engineers were contented enough not to pursue the digital equivalents — Walsh functions and the FWT. Yet the reasons for this are exactly why Walsh-derived techniques should be looked at carefully.

The American mathematician J.L. Walsh defined a set of orthogonal functions in 1923, with the property that the sum of any function multiplied by any other function, from the same set of functions, is zero over the defined range. Also the sum of a function multiplied by itself, over the range, is unity. Various other people worked on the Walsh functions with the result that by the 1930's the descriptive mathematics were complete. The functions were then forgotten, since the method of tackling problems then, was analytical in nature. Mathematicians found the trigonometrical functions of Fourier techniques simpler to deal with than the discrete levels and step transitions of the

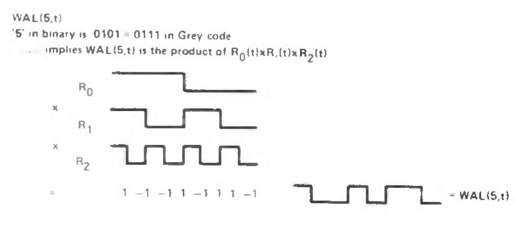


Figure 6: Generating WAL(5,t) from Rademacher functions.

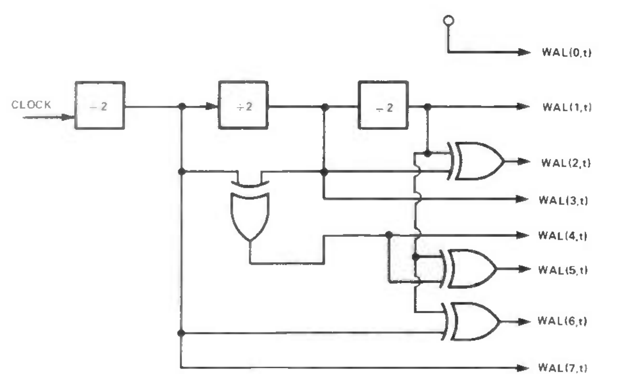


Figure 7: Circuit for a Walsh function generator (first eight).

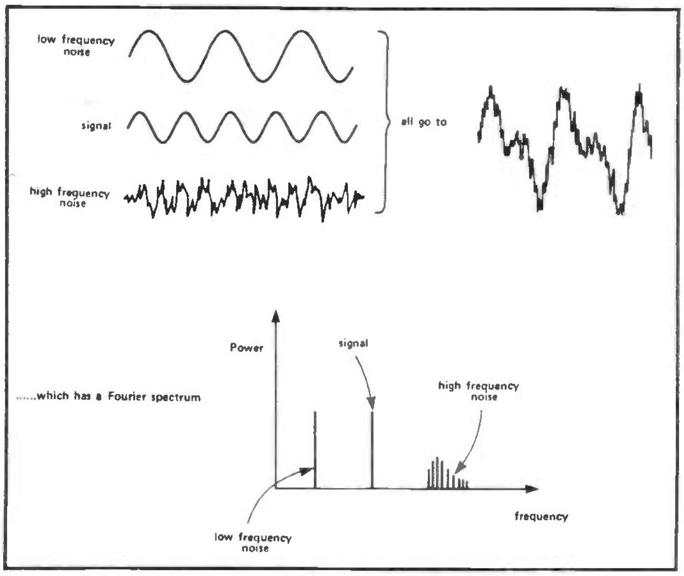


Figure 8: Diagrams to show noise and signal spectra.

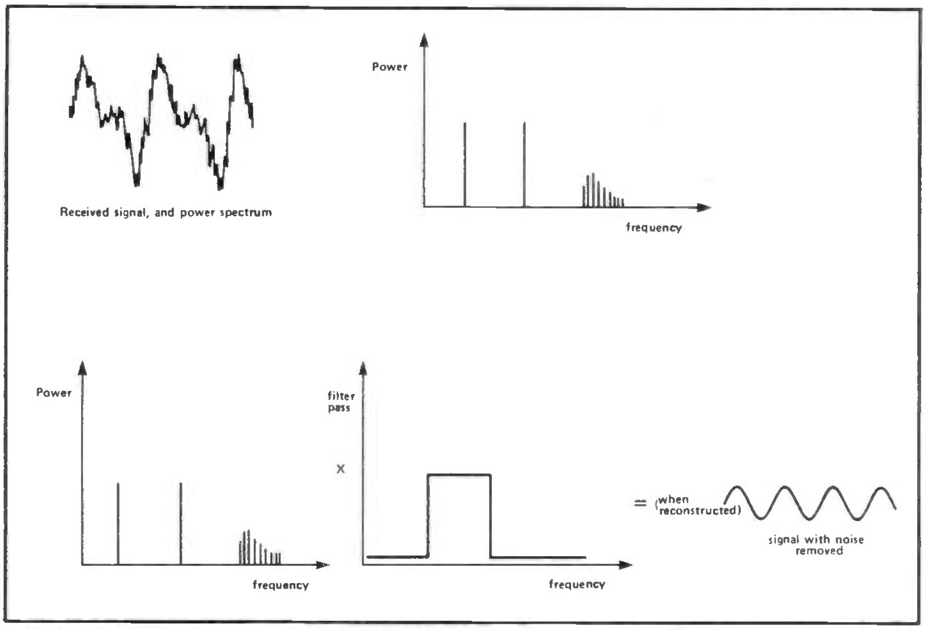


Figure 9: Reconstructing a signal from a filtered frequency spectrum.

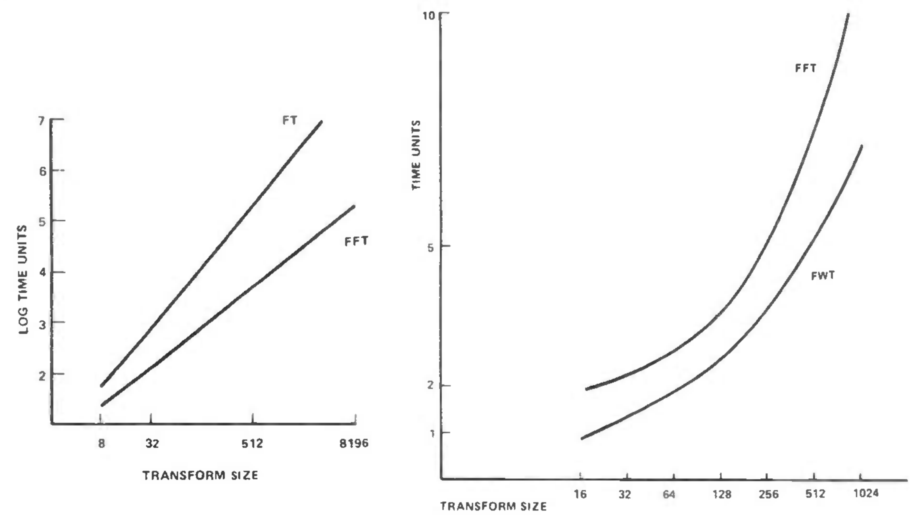


Figure 10: Comparing CPU run times for Fourier, Fast Fourier and Walsh Transform.

Walsh functions.

Modern computers, have reverted to these 0 or 1 levels, rather than the fickle-valued trigonometrical functions. Walsh functions and the associated FWT are finding increasing use where speed and processor memory size are important. They allow efficient coding of digitised speech and image signals — reducing the quantity of telemetry from space-craft, for instance.

Generating Series

Figure 4 shows the first sixteen Walsh functions. Notice that the shape is predominantly similar to that of the Rademacher functions shown in ***Fig. 5,*** but contains variations — WAL (5,t) being the most obvious. The Rademacher functions refer to square waves with periods $2_{(1-r)}$, where r is the order of the function. The functions are incomplete because there are no even ones — WAL (4,t) is odd, WAL (3,t) is even, for example, and none of the Rademacher functions share the symmetry of WAL (3,t), hence they only represent a subset of the Walsh functions.

One method of generating the Walsh functions involves the use of the Rademacher functions, as follows: define WAL (n,t) as being the Walsh function of sequency n over a range t = 1 to T (n is, essentially, the number of zero crossings made by the function over the range given). To generate WAL (n,t), convert n to binary and then to Gray code. If b(i) is the *i*th bit of the binary number equivalent to n, then g(i), the *i*th bit of the Gray code equivalent, is g(i) = b(i) XOR b(i+1), and WAL (n,t) is the product of the Rademacher function where g(i) is set to unity. The Rademacher function R (m,t) is equal to

SIGN (SIN ($2_m \pi$ t)), as shown in ***Fig. 6***. In use, this Rademacher function may be calculated from examining the bit in position

$\log_2$(T)-1-m in the binary value of t — zero equates to -1.

This is ideal for software generation, though the Walsh functions can also be generated using hardware. ***Fig. 7*** shows a simple arrangement for producing the first eight Walsh functions. For applications relying on a rapid count rate, care must be exercised to avoid glitches caused by ripple in the flip-flop chain.

Walsh Transforms

It has been established that a square wave may be represented as a series of sine waves. Fourier analysis transforms a function of time (square wave) into a function in frequency space (coefficient of the sine wave terms). Fourier analysis using the Fast Fourier Transform (FFT) may, therefore, be used to remove (or find!) components of a given frequency, or range of frequencies, from a stream of data. ***Fig. 8*** shows a signal containing low, middle and high frequencies and the Fourier spectrum of the signal. The effect of reconstructing the original signal from a filtered FFT is shown in

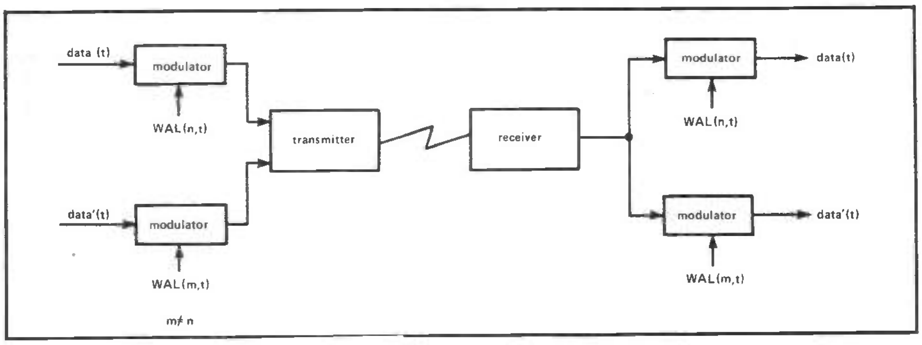


Figure 11: Code division multiplexing.

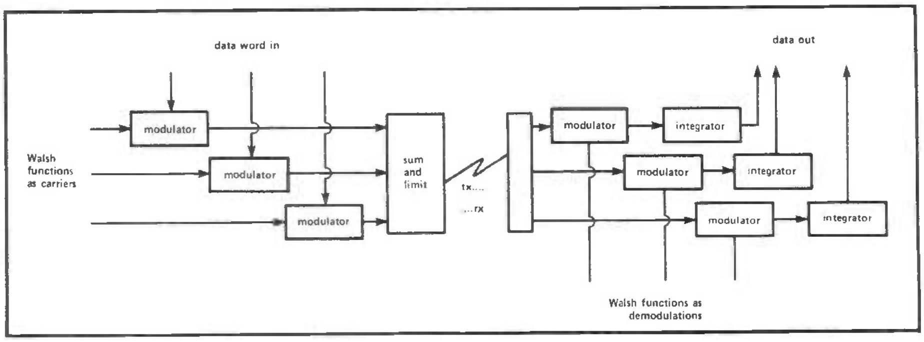


Figure 12: Majority-vote systems.

is shown in ***Fig. 9***.

The Fast Walsh Transform (FWT) performs a transform into sequency space. Since sequency is analogous to frequency, the FWT may be used in place of the FFT in, for example, filtering situations. In such cases, the FWT requires half the storage (because the variables used are not complex) and executes faster. ***Fig. 10*** shows the total CPU time for FFT and FWT's against different sizes of data arrays taken by a minicomputer.

Applied Science

Walsh and Fourier techniques have found so many applications in data processing that it is only possible to mention a few. The first is multiplexing — a technique which allows several data channels to be imposed on one carrier. In frequency division multiplexing, each data channel is allocated to a different part of the modulation spectrum. In code division multiplexing, orthogonal Walsh functions modulate the data channels at the transmitter and demodulate at the receiver. ***Fig. 11*** shows a basic system, where, because of the orthogonality, any individual data channel modulated by, say WAL (3,t), will only be restored when demodulated by the same signal — if WAL (17,t) is used, the integral over time of their product will be zero.

Fig. 12 shows a majority-logic multiplexor. Again selected Walsh functions are used as carriers for multiple data channels. The modulator outputs are summed and hard limited; only the sign of the coded data stream is then transmitted. At the receiver, the data stream is modulated again with the same functions, summed, and hard limited to recover the data. Due to "majority-vote" effect, the system is resilient to errors during transmission.

As mentioned earlier, Walsh techniques are faster than the Fourier equivalents and occupy less memory storage. This makes them suitable for rapid filtering of data. ***Fig. 12*** shows schematically how noise may be removed from a signal by truncating the Fourier coefficient before the signal is reconstructed.

Although most transmitters radiate sine-like waves, it is possible to transmit Walsh functions. One application is "close target" resolution. ***Fig. 13*** shows that the signal received from the far target lags behind the near target return by a small amount. It is clearly obvious that the Walsh function system spots the two targets more easily than the sine-based system.

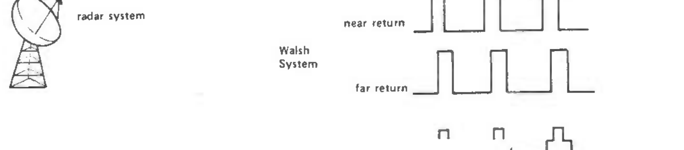


Figure 13: Radar 'close targets' resolution.

Condensation

Recently, Walsh transforms have been used to reduce the amount of data transmitted from, for example, spacecraft. When a picture is taken, it is digitised (or maybe it is from a pixelled detector like a CCD) and split into sub-images. A 256 x 256 image may be split into 16 x 16 subframes each of which has its Walsh transform truncated to exclude the high sequency terms which are thought of as noise. At the ground station, the picture is reconstituted from the lower-sequency terms. With little picture degradation, a reduction of a half in transmitted data may be obtained; scene-specific coding may achieve a reduction of 80%.

Synthesising waveforms is made easier using Walsh functions. A typical fourier-based synthesiser requires access to sine and cosine signals of frequencies, f, 2f, 3f.... which are difficult to generate without using many phase-locked loops. A Walsh-based system uses the circuit shown in ***Fig. 7***, where only the highest frequency used need to be supplied — the remaining Walsh functions are produced by binary dividers and exclusive-or gates; no analogue processing has to be done.

■ R&EW

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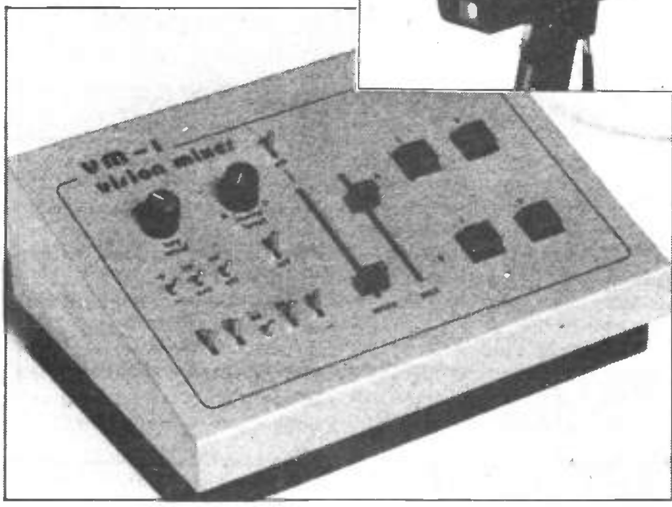
VIDEO NEWS

Peter Luke takes a 'slow' look at a new breed of recorder and focuses on a camera from Sharp.



With current video recorders offering timer specifications that often exceed five events over three weeks, in most cases it's the four-hour maximum 'tape length' that proves the practical limitation when it comes to recording all your favourite TV programmes. The tape run-time limitation can also prove a problem if, over a weekend, there's a film and a couple of other programmes that you wish to save for posterity. The physical constraints of the VHS/ Beta cassette housings, and the minimum tape thickness consistent with reliable transport, means that the only way to overcome the problem is to offer a slower tape playback speed.

Those familiar with reel-to-reel audio recorders will be aware of the tape speed Vs quality rule — a lower tape speed means a degraded record/ playback performance. It was the fear that the British 'videophile', used to the extremely high technical standards set by broadcast TV, would not tolerate this reduced definition picture that has, until now, prevented the launch of two speed players in the UK.

Across the Atlantic, dual speed machines have been available for a number of years but, with the somewhat variable quality of the American NTSC encoding system, the USA market accepted any reduction in ultimate performance quite readily. A number of manufacturers now feel that they have managed to squeeze enough out of their signal processing circuitry in order to make the half speed performance of the machines good enough for the discerning British viewer.

One of the first of these machines is the Fisher FPH-630. At £549 the machine is competitively priced. And, with an E240 cassette, will offer up to eight hours running time — more than enough to make full use of the machine's timer. The recorder should be available around autumn this year.

No news of a half speed Beta machine yet, Sony's next model is likely to be a hi-fi video recorder, but a Beta stack for the front loading C9 should soon be available. This allows a carousel of cassettes to be sequentially loaded into the recorder under control of the C9's timer/end-of-tape detection circuitry.

As for extended play from the V2000 camp, an auto-reversing recorder is on the cards, offering a continuous eight hours from the 2x4 V2000 cassette.

Fisher Family

The Fisher brand-name may not be very familiar at present, but the company are starting a major campaign aimed at penetrating the UK video/hi-fi market. They have a wide range of hi-fi, ranging from budget combinations to sophisticated racking systems, and have recently introduced two video recorders, the 520 and 530 models, in the UK.

Later this year, in addition to the two-speed 630, the company will launch a Dolby stereo machine designated the 730. This will give Fisher a useful product range with the 630 providing the focus of attention.

Double Vision

The March issue of **R&EW** carried a review of Sony's camera selector unit. This provides a means of mixing one colour and one black-and-white video signal to produce captions for video productions. A new mixer from Video City productions goes one better in that it allows two colour signals to be mixed.

As with the Sony mixer, one of the cameras must be capable of being 'gen-locked' — JVC's G71-P is a good example of such a camera.

At £299 the unit looks good value for money — further details from Video City Productions at Lion House, 227-229 Tottenham Court Road, London W1.

Sharp Focus

Sharp are joining the ranks of those offering auto-focus cameras with the launch of their new XC-77 camera. The auto-focus system in contrast to Panasonic's auto-focus system, uses an infra-red rather than ultra-sonic ranger.

The camera has a 17mm saticon tube, said to reduce image lag and comet-tailing, a x4 700m lens and a built-in condenser microphone. Price is £580, and it should be at your video dealer soon.

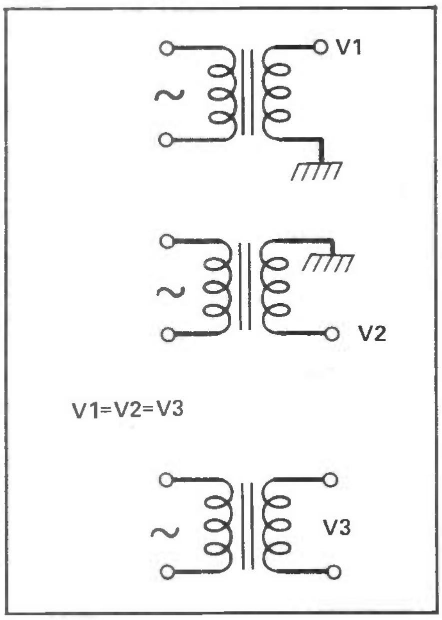
Quota Of Quotes

A few further words on the import quotas that we mentioned a couple of months back. These are likely to increase the prices of video recorders over the next few months but there's also likely to be at least one other side effect — a dearth of portable recorders. The demand for portables has always been rather weak and with a limit to the number of units that any one company can bring into the UK, they're bound to concentrate on the more popular mains-based models

The low demand for portables has always surprised this author, as these recorders now offer a similar spec to their mains based counterparts, albeit at a slightly higher price, yet provide so much more versatility... but then the buying public are such illogical people.

CIRCUIT BLOCKS

A solid state transformer. Design by David Strange.



A balanced output is often required from audio equipment. Normally a transformer would be used, since it has the advantage of completely isolating the sending equipment from the line. However, transformers can be expensive and also restricted in frequency response.

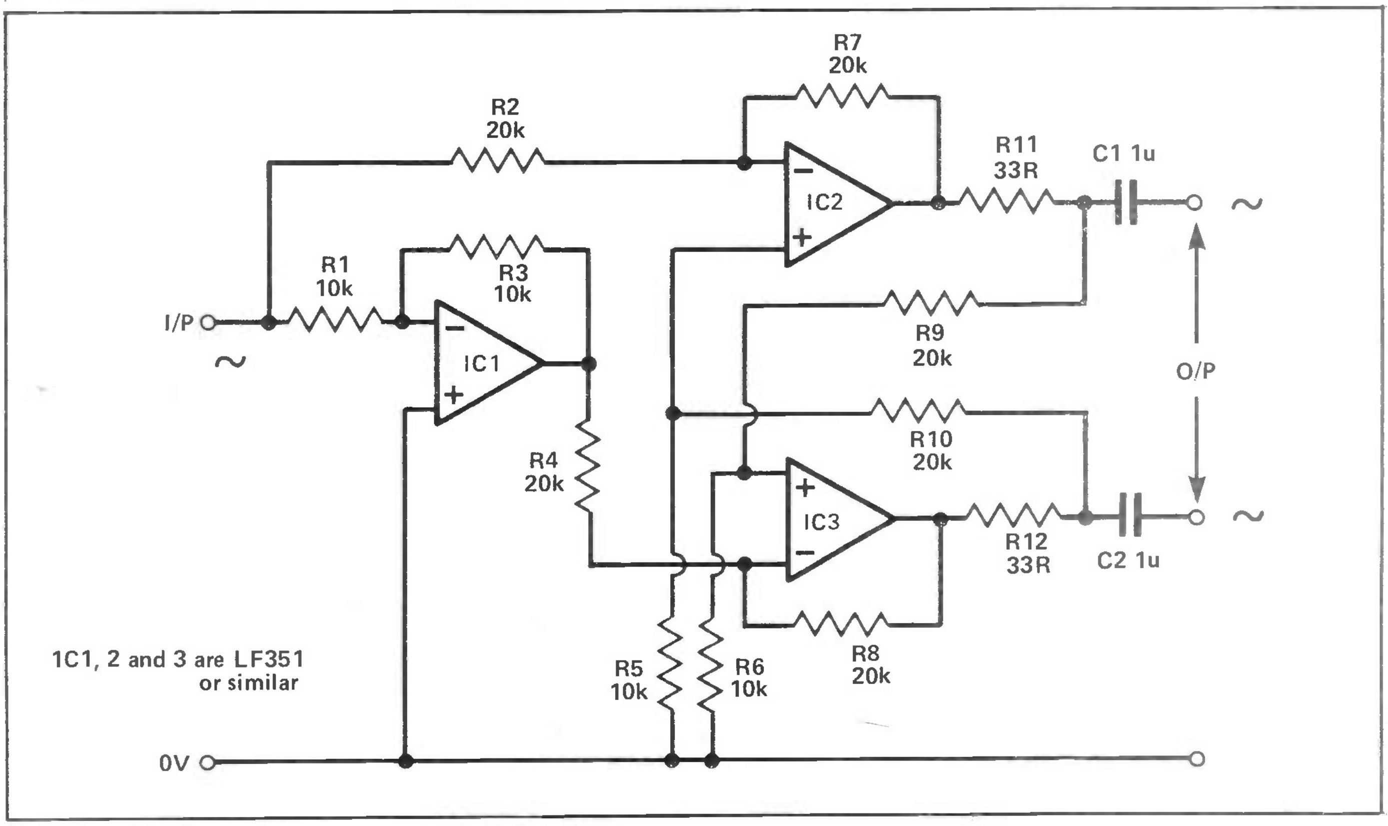
When exceptional isolation is not required, a solid state transformer may be applicable. This will duplicate the frequency response, but its difficult to achieve the ability to allow either leg of the floating output to be grounded, not affecting the output level (***Fig. 1***). In the ***Fig. 2*** circuit, grounding of either leg is possible because of the protection afforded to each op-amp by R11 and R12 and the cross-coupling of feedback. IC1 is used as a unity gain 180° phase shifter to feed IC3, whilst IC2 is fed with in-phase signals.

In addition to *normal* negative feedback, both output amplifiers are fed with negative feedback via their non-inverting inputs being coupled to its neighbours' output — 180° out of phase. When one of the outputs is grounded the extra feedback is removed from the ungrounded amplifier, allowing its gain to increase in compensation. The circuit is therefore self-compensating and behaves like a transformer. It has unity gain, which may be varied by reducing the values of R2 and R4. In order to maintain the best balance, 2% or better resistors should be used.

■ R&EW

◀ **Figure 1. Standard transformer coupling.**

▼ **Figure 2. Solid State Transformer circuit.**



RF FILTER DESIGN

P.C. Gill backs up the first part on theory with some practical examples.

Having completed the design work, we can now consider how to put theory into practice with a look at the way a professional filter is constructed.

Referring to ***Fig.1***, the cavity is normally machined out of solid metal. Since the skin conductivity, particularly at higher frequencies, is important the material should be chosen carefully - copper is good whereas brass is poor unless silver plated. The best compromise is pure aluminium, although cast alloys are used up to VHF; albeit with a poorer performance than the pure metal. The internal finish should be polished for optimum performance. In order to achieve this, the cavity holes are usually bored rather than drilled.

The cover should be machined in the same material as the cavity and should fit well, with at least six fixing screws securing it to achieve a homogeneous unit.

The tuning screws should be large enough to penetrate up to one third of the coil's length, at about half of the winding diameter. They are usually made of brass and are either ordinary screws or slotted studding. Tuning friction is best achieved by the use of lock-tight nuts or a similar thread gripping device.

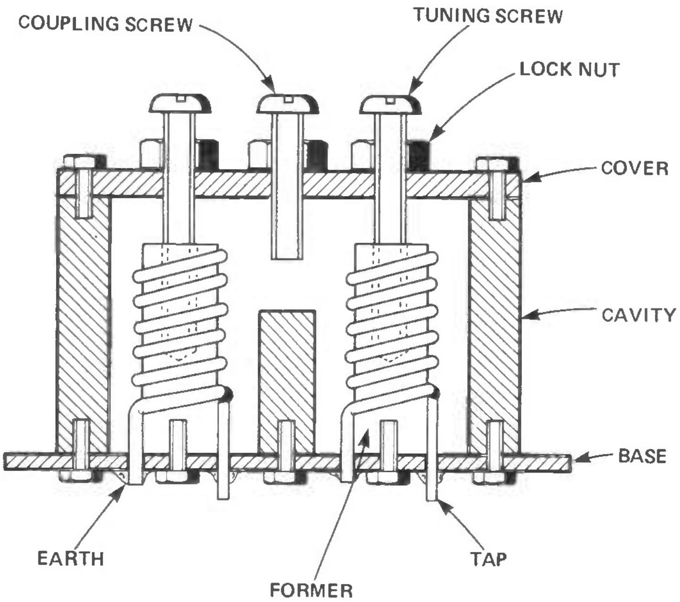


Figure 1. Section through a typical filter. Both the cover and the cavity are machined from solid metal.

It will be noticed from ***Fig. 1*** that a screw penetrating the coupling slot has been added, in order to make final adjustments to the coupling. This screw should, again, be of brass and could be smaller than the tuning screws depending on the range of adjustment required.

The formers support the coil and resist microphony. They are usually grooved in order to maintain an accurate winding spacing. The coil could, however, be wound on a smooth former and then secured in place with varnish or adhesive. To achieve a well controlled diameter-spaced winding, the best method is to wind two wires together, next to each other, to produce a tight double winding, and then unwind one wire leaving a diameter-spaced winding behind. The former material is important and should be non-polarised plastic, particularly if any power is to be passed through the assembly. If polarised plastic, such as perspex, were used it would heat up like meat in a microwave oven. Materials such as polypenco (Q=200.5) or stycast are ideal, but for normal low power applications any hard plastic will suffice.

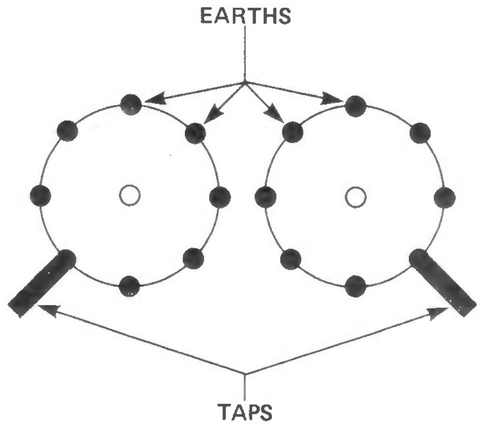


Figure 2. Earth hole options to allow tap variations.

The ends of the former are normally faced off and the former mounted to the base using nylon screws or adhesive. The centre of the former is normally counter-bored to take the tuning screw and the dielectric between the coil. The screw will increase the voltage breakdown limit as well as increasing the capacitance.

The coil should be wound with pure copper or silver plated wire. Most varnish-finished copper wire is acceptable, though lead-tinned wire is of lower performance. The earth end of the coil is dropped vertically down the axis of the cavity and earthed at the base. The tap can be a twisted wire around the coil and is also dropped vertically along the axis and soldered to the correct point in the circuit. The base is

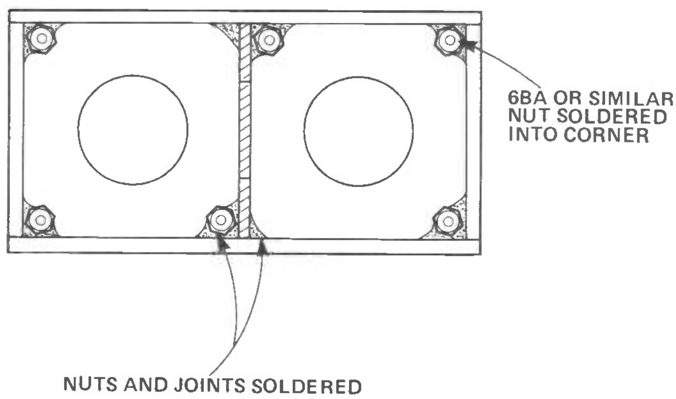


Figure 3. Attaching the base and cover around the filter.

normally a double sided PCB, which is often the circuit board itself with input and output track terminations. In order to facilitate tap variations, fix the tap position and rotate the coil assembly using one of the earth hole options shown in ***Fig. 2***. (Note: the design outlined uses brass screws, aluminium cavity and cover and lead tinned PCB. Professional designers should pay close attention to this use of dissimilar metals and the need for passivation).

The form of design outlined is difficult for the amateur builder to realise, but a useful alternative can be built by constructing a square section filter cavity using double-sided PCB, soldered together along the seams.

Miscellaneous Mathematics

In order to convert our design for square section, we must use new formulae. If L is the length of one side then:-

1. $Q_{UR} = 60L\sqrt{f_o}$
2. $N = 1600/(f_o L)$
3. $\Upsilon = 1.44L/N$
4. $d = 0.66L$
5. $b = L$

The wire diameter $= \Upsilon/2$ and the overall height of the cavity is given by $H=1.6L$ for tap calculations $Z_o=81500/f_o L$.

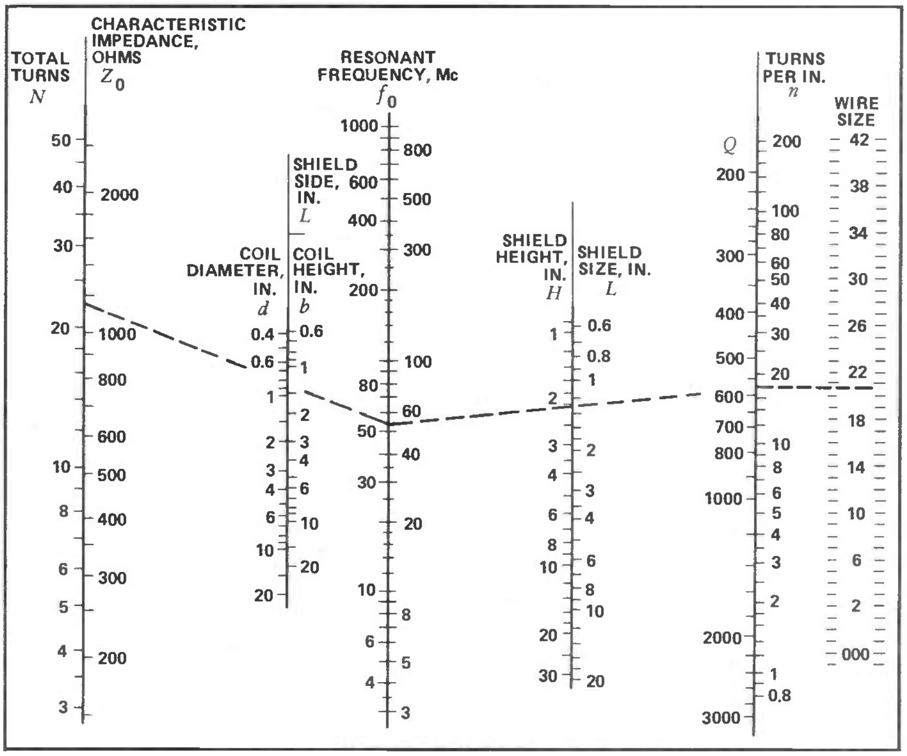


Figure 5. Square section filter nomogram.

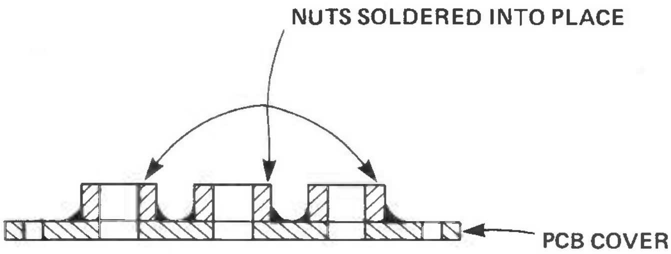


Figure 4. Using a PCB cover to attach the tuning nuts and bolts.

Assembling The Bits

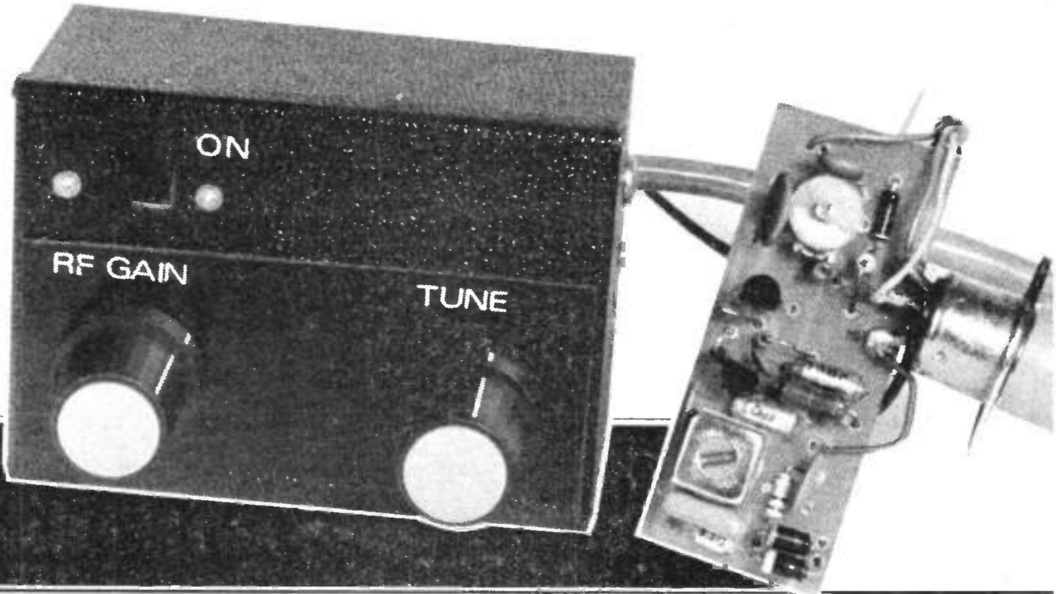
The basic cavity is constructed of double-sided PCB, soldered so that all internal surfaces are well connected along their joints. The cover and base are attached as shown in ***Fig. 3***. The insertion of 6BA or similar nuts in the corner positions will allow the unit to be assembled and disassembled for development or servicing. The tuning and coupling screws can be fitted to a PCB cover using nuts attached as shown in ***Fig. 4***.

Finally, we present a nomogram (***Fig. 5***), which should enable the design of square section filters, for most frequencies and unloaded Qs, for construction as detailed above.

■ R&EW

EVENTS: MOBILE RALLIES June 1983

June 12th	RNARS Mobile Rally	HMS Mercury Petersfield, Hants.	G4DIU
June 19th	Denby Dale & DARS Mobile Rally	Shelley High School Skelmanthorpe, Nr. Huddersfield	J. Clegg G3FQH
June 21-23rd	ElectroNorth '83	Harrogate Exhibition Centre	V. McGarry Oxten 08833
June 26th	26th Longleat Mobile Rally	Longleat Park, Longleat, Wilts	C. Rose G87CV
July 10th	Worcester & DARC Annual Mobile Rally	Droitwich High School Ombersley Road Droitwich	B. Jones G8ASO Worcester 351565
July 16-24th	British Amateur Electronics Club 18th Annual Exhib.	The Shelter, Esplanade Penarth, S. Glam.	
July 17th	Sussex Mobile Rally	The Racecourse, Brighton.	Miss W. Firmager Flat 2, 23 Chatham Place, Brighton.



SSB FOR THE SX200-N

A compact add-on to provide single side-band with the SX200-N scanning receiver. Design by Bill Wilson.

The SX200-N has one drawback — it cannot resolve SSB/CW signals. This limits its usefulness on the VHF amateur bands, which is a pity since the stability of the set is excellent — the inclusion of a BFO together with a RF gain control would give it real versatility.

The SSB unit requires only one 'hot' connection to the receiver and is easy to incorporate using a main BFO inside the set, together with a plug-in external control head (as there is no space for extra controls on either the front panel or rear of the receiver). The control unit holds the BFO tuning, RF gain and BFO on/off controls and is linked to the unit, inside the receiver, by a 5-pin DIN connector and cable (all controls are DC). The box could be mounted on the side of the receiver, so that when it is unplugged, the receiver reverts to its original state — performance is not compromised.

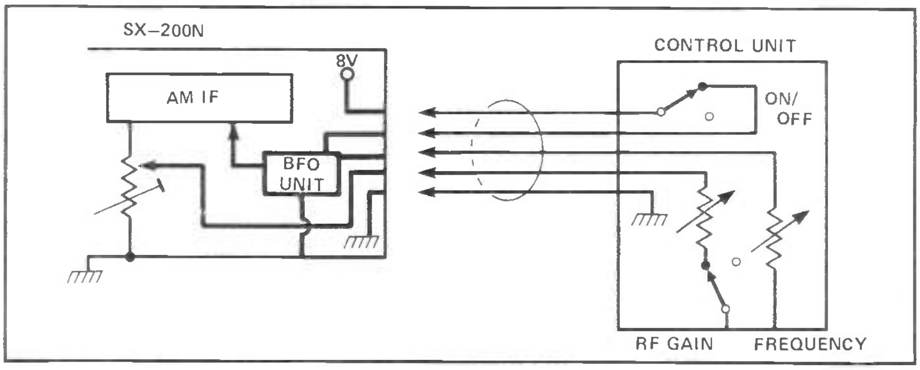


Figure 1: Block diagram for the SSB adaptor.

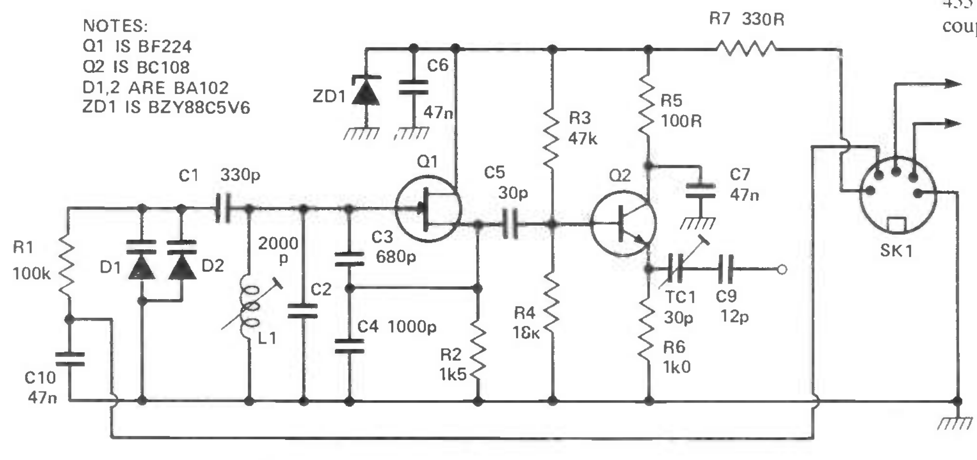


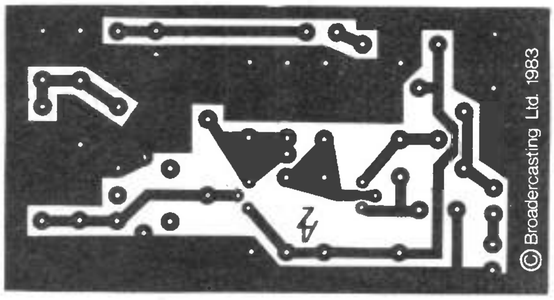
Figure 2: Full circuit for the adaptor.

Circuit Description

The block diagram (***Fig. 1***) shows that the BFO signal is injected into the AM detector of the SX-200; varicap tunable around 455 kHz. In order to balance the fixed output level of the BFO, the gain of the IF amplifier can be reduced by RV2 for strong signals. SW1 enables the BFO and gain control to be switched on and off.

Looking at ***Fig.2.*** Q1 is a stable oscillator on 455 kHz and Q2 buffers the output before coupling into the receiver detector. D1 and 2 tune the oscillator between the limits 453.5 and 456.5 kHz, so both LSB and USB signals may be resolved. The designers of the SX-200 have, with commendable forethought, provided the receiver with a preset AM gain control, which is paralleled by RV2 in the control unit to provide a user control of IF gain. RV1 (BFO tuning) should be a 'centre-click' type and, with careful setting up, this central position can correspond to 455 kHz and the track limits of the potentiometer to the appropriate LSB and USB frequencies. C8 then sets the level of the BFO injection into the receiver.

Figure 3: Connections inside the scanner.



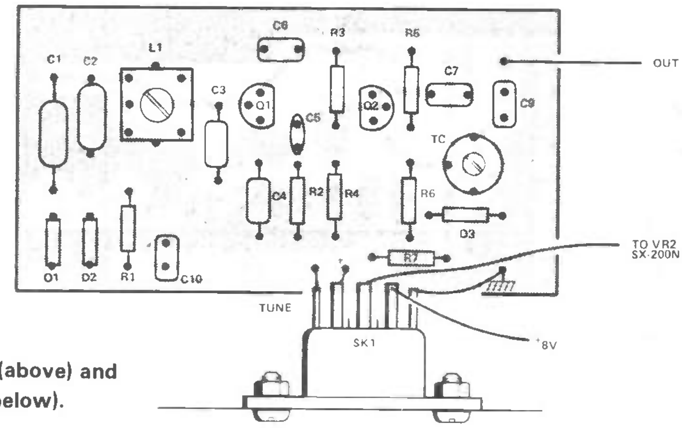


Figure 4: Foil pattern (above) and component overlay (below).

Construction

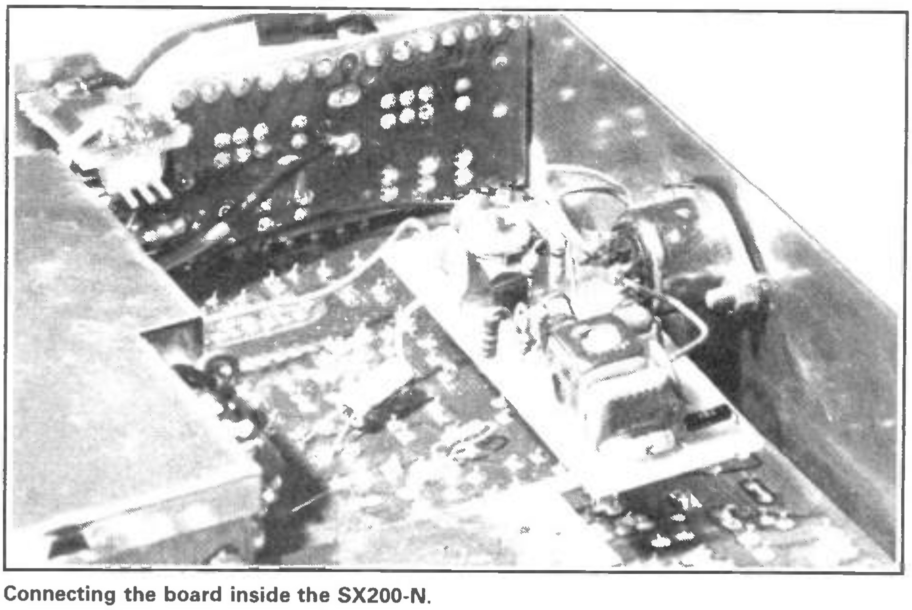
The unit's PCB is soldered directly to a 5 pin DIN socket, in turn mounted on the receiver right-hand chassis wall (when punching the hole for the plug and socket it is wise to make the hole in the outer case first, then to use this as a template for the hole on the chassis wall). Coil L1 can be hand-wound on a scrap Toko former — the 10 EZ type will require 40 turns, and the 10 K type, 50 turns of 30 SWG enamelled copper wire, using the convention of terminating the winding on pins 1 and 3 (remember to crunch off the fixed tuning capacitor, if fitted).

An 8 volt supply is taken directly from the regulator (in the SX-200) — the RF gain lead is taken to the 'hot' end of RV102 (the AM gain preset), and the BFO output, C9, to the AM IF circuit. The earth connection is made directly when bolting the DIN socket to the receiver chassis.

Setting Up

Before installing the unit, check that the oscillator is working and that it is roughly on frequency (connect it to an 8 or 9 volt source and listen for the second harmonic output on a MW receiver tuned to 910 kHz). Adjust the core of L1 until the BFO signal is heard and check that it can be shifted slightly by rotation of RV1. If all is well, install the main unit in the receiver, plug in the control head, set RV1 at centre and RV2 at maximum gain and position the fine tune control of the SX-200 half-way. Then select AM mode. The core of L1 is best set on 455 kHz using a frequency counter tacked on to C9. Alternatively, inject a steady, unmodulated signal into the antenna socket of the receiver — a crystal-controlled source is preferable, but it can be on any frequency within the tuning limits of the scanner.

Once the signal is tuned in, switch on the BFO and adjust L1 carefully for zero beat. Check that RV1 will give an audio tone of about 1.5 kHz at each end of its ▶



Connecting the board inside the SX200-N.

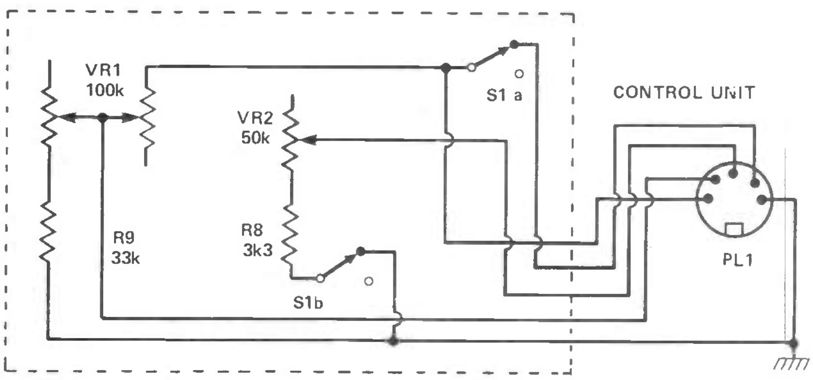


Figure 5: Wiring for the socket added to the scanner.

PARTS LIST

Resistors

R1	100k
R2	1k5
R3	47k
R4	18k
R5	100R
R6	1k
R7	330R
R8	3k3
R9	33k

Potentiometers

RV1	100k balance, centre click
RV2	50k linear

Capacitors

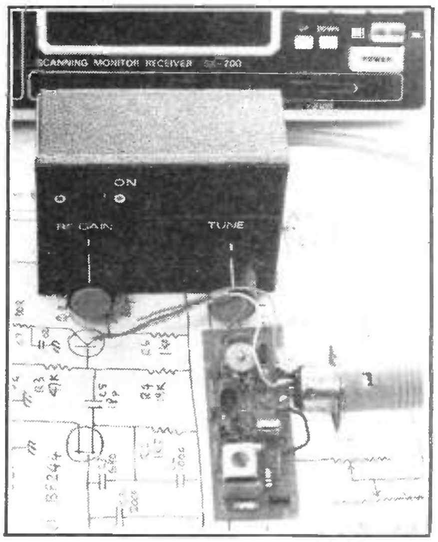
C1	330p polystyrene
C2	2000p mica or poly
C3	680p poly
C4	1000p poly
C5	30p ceramic
C6	47n disc
C7	47n
C8	30p Foil trimmer
C9	12p ceramic
C10	47n disc

Semiconductors

Q1	BF224 or TIS 88
Q2	BC108
D1,2	BA102
ZD1	BZY88C5V6

Miscellaneous

L1, KAN 3333 R or 154FN8A6438 (see text), PL1, 5-pin DIN plug, SK1, 5-pin DIN socket, 2p 2w slide switch.

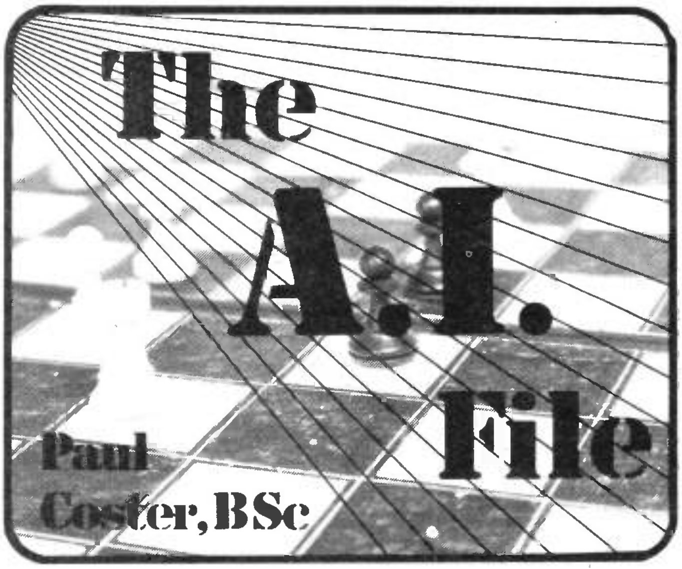


The prototype circuit and finished unit.

track (R9 may be altered to give the required swing). The two limits of RV1 should now correspond to the LSB and USB settings. Switch off the test oscillator and find SSB signals on 27-28 MHz. By setting RV1 at either LSB or USB, it should be possible to resolve signals by using the SX-200 fine tuning control only. Using a fairly strong signal, adjust C8 for best resolution of the signal, so that the BFO signal does not trigger the squelch.

The use of a BFO with a scanning receiver takes a bit of practice, since the correct tuning position will be just outside the limits of the receiver's fine tuning control. A useful tip is to make sure you reduce the RF gain when dealing with strong SSB signals.

■ R&EW



Problem solving is an important area of study within AI. A common approach is to isolate a particular example and then generalise to the rest of the subject. This month, we outline some of the techniques that have evolved through developing machines which play games.

Earlier in the series (March '83), game playing was introduced as a means of illustrating certain key principles of AI research. One of the points made was that machines exist which not only act as worthy opponents in a game situation, but consistently win! Few people, however, would credit these machines — or, more accurately, their programs – as being intelligent, so some other factor must be responsible. Something peculiar to the task, or the procedure for performing that task, creates the impression of a 'thinking opponent'. In reality, there are a number of specialised techniques which enhance the chances of winning for the player who can calculate moves, five or six ahead of the current play — no skill, just memory and mathematics.

Foreseeing The Future

There are two basic methods of optimising a sequence of play without recourse to an indefinable quantity such as skill. The first of these is called minimaxing, which involves the look-ahead strategy mentioned earlier. ***Fig. 1*** shows a game-tree representing four successive moves. The initial choice is between three alternatives, with subsequent selections increasing in number as a result of being unable to predict what will happen as the game progresses. The route chosen, however, is fairly certain, since it is based on the assumption that the other player will try his best to win — make moves that benefit *his* game the most at each turn. So, by referring to the tree, the optimum play results in an arbitrary value of eight — the highest that the opposing player will allow. Any other course of play ends up with a lower score, unless the opponent inadvertently (or deliberately in the case of someone who has played machines before!) makes a move that is not maximising his own score. Using this methodical and consistent approach, the machine is able to minimise losses and maximise gains. It does not, however, produce a winner everytime, nor is it practicable when large numbers of choices are possible at each stage.

One way of improving the minimaxing technique described above, is to increase the depth of search — the ideal being to look ahead to the *n*th move of an 'n-move' game. The problem, of course, is that even with a reasonably low depth search (say 10 moves), the number of possibilities is daunting (a series of ten numbers, raised to increasing powers and added together). A better method makes use of the 'alpha-beta algorithm', which eliminates sections of the game-tree that are not beneficial — low value options merely waste computational time. In fact, programs which employ

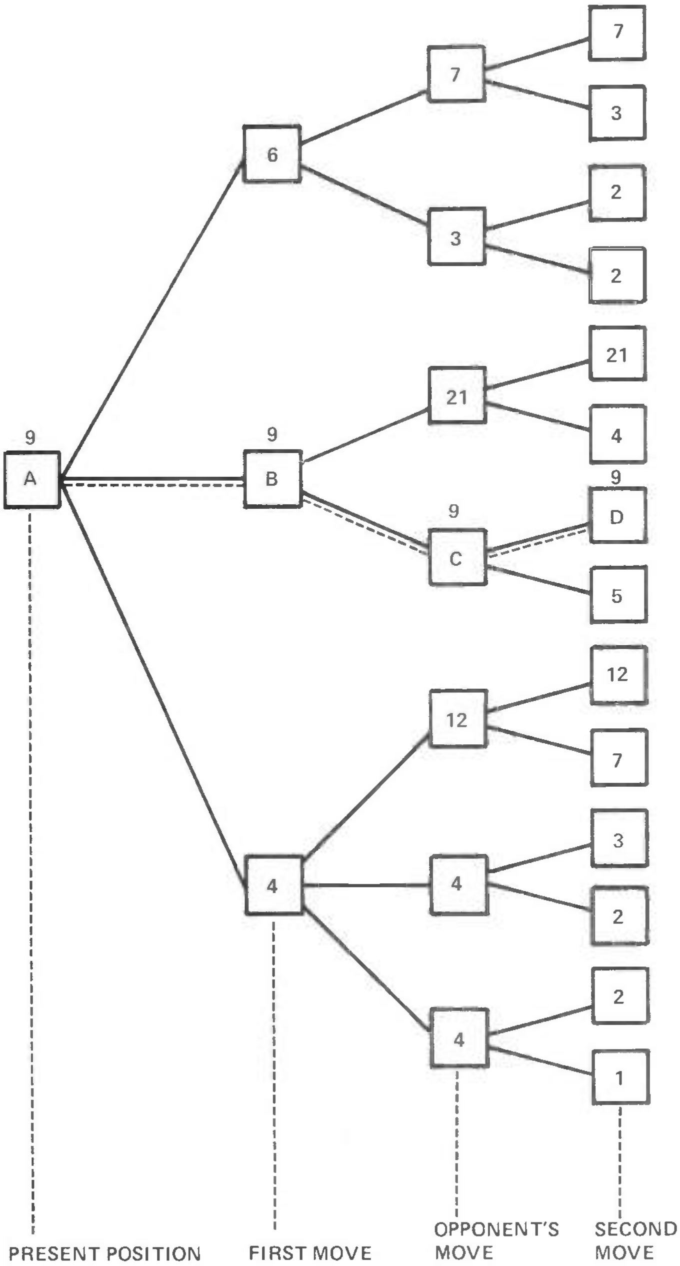
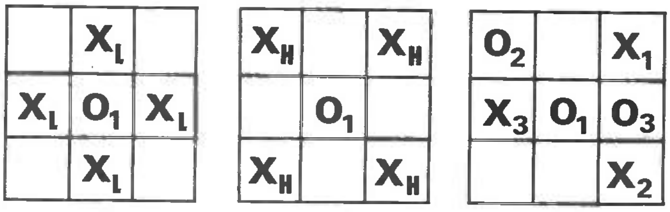


Figure 1: A game tree representing four successive moves. The minimaxing option is shown by the broken line.



(a) Low Value Options — (b) High Value Options — (c) Drawn Game Options

Figure 2: Possible positions in a game of noughts and crosses. The final square (c) shows a game in progress.

alpha-beta minimaxing prove to be at least 500 times faster than those which don't. As a practical example, consider the next move to be made in a game of 'noughts and crosses', following a centre nought. There are eight possible responses, which can be halved by rejecting non-corner positions as representing an inferior outcome (***Fig. 2***).

< Length > (n) < Match > (a, b)

< Position > (n1, n2)

< Type > (a OR b OR c ....)

NOTES: WHERE n REPRESENTS ANY POSITIVE INTEGER OR ZERO AND a, b, c, etc., ARE ONE OR MORE CHARACTERS (INCLUDING NUMBERS) OCCURING CONSECUTIVELY.

Figure 3: Generalized software coding for a pattern recognition language.

Making Advances

Turning away from what might be termed the more 'mechanical' aspects of game-playing, it is worth looking at some of the other ways a game-plan can be structured. The main advantage a machine possesses is access to a vast and reliable memory. With this it is able to remember patterns of play within the current session, past sessions and during sessions of which it hasn't ever had practical experience. Theoretically, the machine can execute a fixed routine of pattern matching, whilst appearing to act in a skilful manner. If you, a previous player or anyone else have played a sequence of moves before, the system can identify the pattern match and base its move on one that gave the best results before. This does not necessarily mean that the computer's move will be predictable, however, since it must still follow the aforementioned optimising principles as well as any other 'quirks' and random elements which go together to comprise the overall strategy. An interesting implication of playing against a machine which recognises patterns within its opponent's play, is that intuitive moves which don't gain an advantage are rejected regardless of their intrinsic value. For example, 'castling' in chess may be expelled from the current repertoire if a particular instance did not achieve an advantage — unfortunate if the machine should need to apply the technique at a later stage.

Identifying patterns within a game playing situation is a fairly straightforward task, which requires no special programming practices. The source language chosen is the main arbiter of how easy it is to code the routines; ***Fig. 3*** sets out a few examples (generalised word patterns). The length function substitutes for a run of characters, in number; as in 'L' *length2* 'K' for LOOK, LEAK, LOCK etc.

```
10   DIM RANDA$(4,6)
20   FOR Y=1 TO 4
30   FOR Z=1 TO 6
40   READ RANDA$(Y,Z)
50   NEXT Z
60   NEXT Y
70   CLS
80   PRINT
90   FOR Z1=1 TO 12
100  PRINTTAB(14)" ";
110  FOR Y1=1 TO 6
120  PRINT RANDA$(RND(4),Y1);" ";
130  NEXT Y1
140  PRINT
150  IF Z1<12 THEN PRINT
160  NEXT Z1
170  END
180  DATA A,B,C,D,E,F
190  DATA G,H,I,J,K,L
200  DATA M,N,O,P,Q,R
210  DATA S,T,U,V,W,X
```

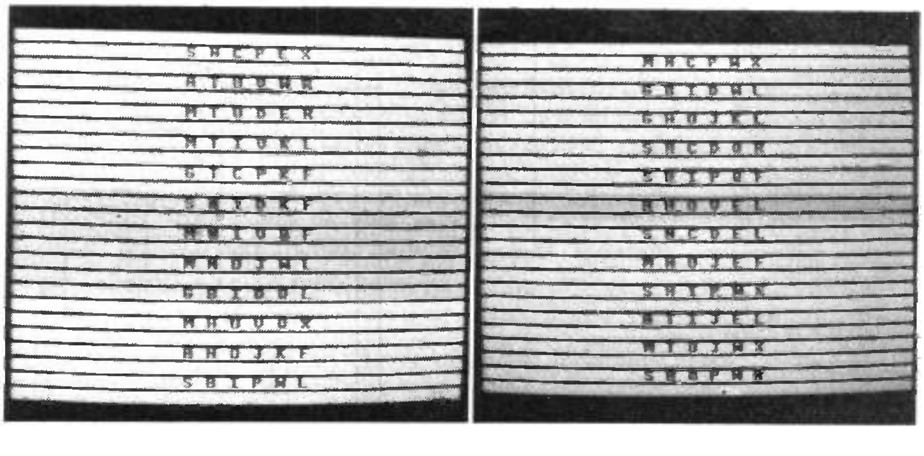
Figure 4: Listing of the BASIC program for carrying out last month's random concatenation.

Position refers to a pattern between two numeric pointers (eg, the pointers to select PEN from SPEND would be 1,4). Match checks two patterns for similarity and type replaces a run of characters contained in a definable group such as 'letters' or 'numbers'. Using these and derived refinements, pattern matching is greatly enhanced, with the result that games programs can be coded more efficiently and effectively.

Bits And Pieces

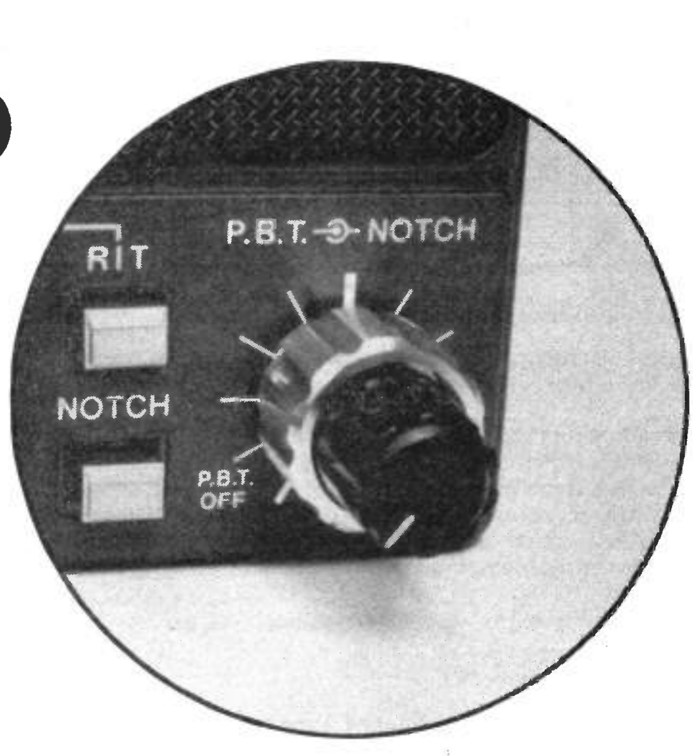
After the April edition's induction to the derivation and use of random numbers, several letters arrived asking for a program listing which would perform the random string concatenation. ***Fig. 4*** shows one possible source coding, in BASIC, for carrying out this function.

■ R&EW



Two examples of the random concatenation program in operation.

PASS BAND TUNING



A concise appraisal of the techniques involved with IF PBT, by William Poel.

Pass Band Tuning (PBT) is another example of a communications technology that has been around since the early days in one form or another, but has only really come into its own with improved technology and the fierce competition amongst ham radio equipment manufacturers. Basically, PBT is a practical means of continuously varying the effective IF bandwidth, without the expense of multiple filters, using two basic intermediate frequencies and a VFO for a parallel mixing shift (***Fig. 1***).

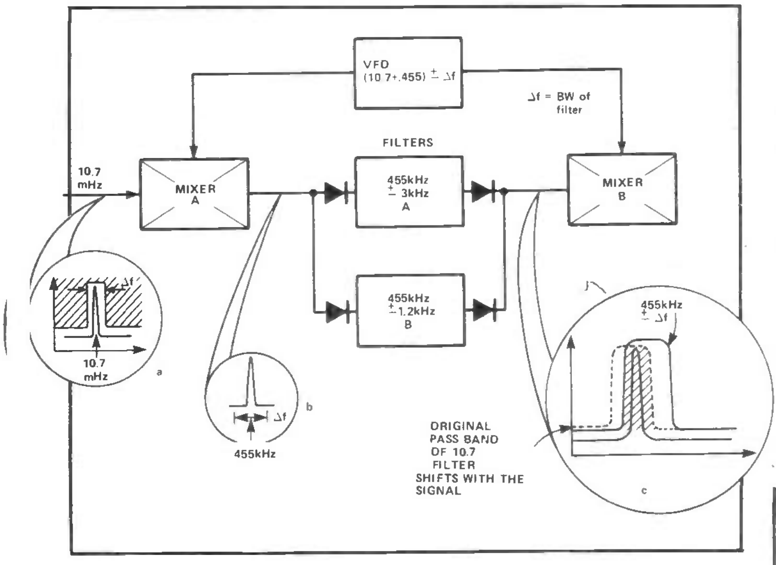


Figure 1: PBT mixing arrangement and VFO

The system relies on at least two IF filters, with good shape factors, since PBT is brought about by bringing the slope of the first filter towards the slope of the second (***Fig. 2a***). Any 'in-difference' in the shape factor of one filter will distort the passband on one of its edges (***Fig. 2b***), as the effect of the process is to superimpose the two filter characteristics upon one another.

Before moving on, you may recall the PBT system of the NRD515 we reviewed a while ago. This is somewhat less intricate in its requirements, basically providing a method of shifting the IF passband, whilst ganging the BFO tuning (without actually narrowing the bandpass in the process). So, it's worth being wary of nomenclature, PBT already means two rather different things to two different manufacturers.

What To Do

One seemingly crass comment, made in the ICOM R70 handbook, is that the PBT function can be used to adjust the 'tone' of the incoming transmission, since varying the IF bandwidth also effectively varies the audio bandwidth. As it happens, applying this technique to allow 10-15kHz of IF bandwidth for AM broadcast signals can produce some superb results during daylight hours, before the night-time profusion of signals sends the listener rushing for every knob that can narrow the bandwidth. So, it's worth bearing in mind that anything you do with the IF bandwidth is reflected in the available audio passband — were it not for the intermodulation problem, all the filtering could be done at audio anyway, assuming the general dynamic range of all circuitry *before* the detector was adequate.

As a means of keeping out unwanted signals, PBT is not immediately relevant in the case of ***Fig. 3a***, where the unwanted signal is removed simply by shifting the frequency slightly higher. It's worth remembering that the expression 'tuning the receiver' now generally relates to moving the IF bandpass up and down in frequency, and has little to do with tuning in its erstwhile sense of 'peaking' an array of track-tuned resonant circuits. Note, also, that the wanted signal is increased when the unwanted signal is tuned out of band. This is because it has been assumed that the unwanted signal will have been invoking the AGC action of the set — another reason for getting it out of the way at

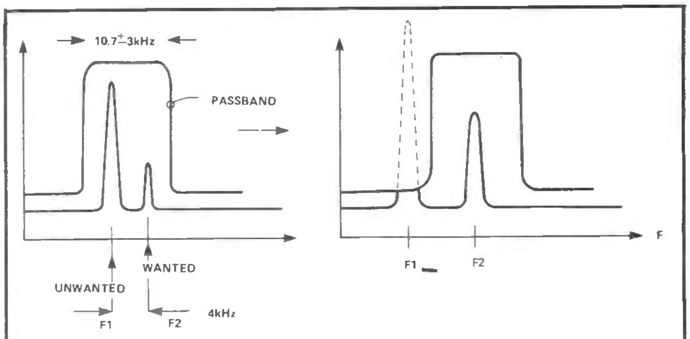


Figure 3a: Tuning bandpass to remove unwanted frequency

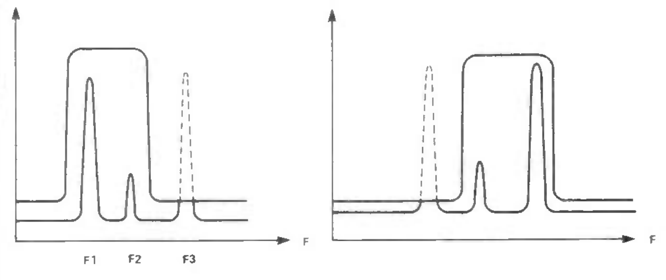


Figure 3b: Fixed bandwidth tuning may cause problems with unwanted signals within the passband.

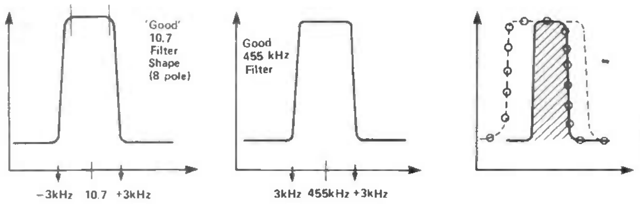


Figure 2a: Combination of 'good' filter shapes

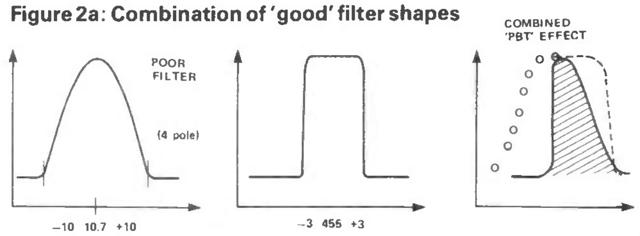


Figure 2b: Combination of 'poor' filter shapes

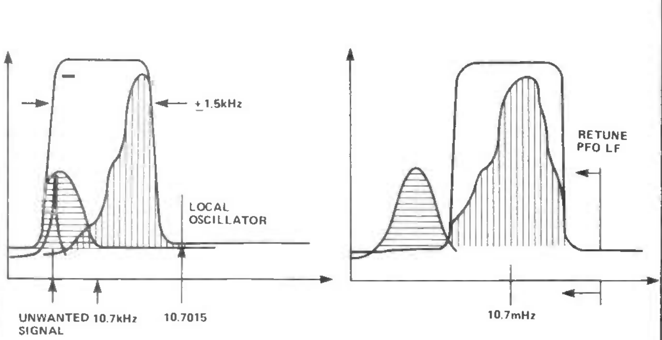


Figure 4: PBT with SSB signals

IF rather than AF. Some 'splatter' from the sidebands is almost unavoidable (the first person to devise a simple means to effectively cancel modulation splatter by reapplying it to the IF signal in the form of negative feedback is invited to write in). *Fig. 3b* gives the reason why PBT is relevant.

The use of PBT with SSB is perhaps even more obvious, since the basic filter bandwidth doesn't allow for any substantial tolerance in the optimum tuning point — it's certainly preferable to leave the BFO in a fixed position. PBT allows for shifting the SSB passband without constantly retuning the BFO and the danger of placing it too far inside the actual IF passband, with the consequent problems of blocking etc. In fact, it's hard to imagine anything particularly negative about the PBT facility.

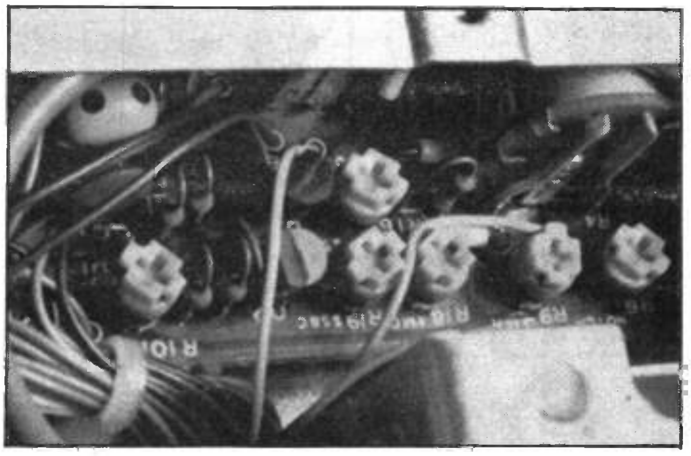
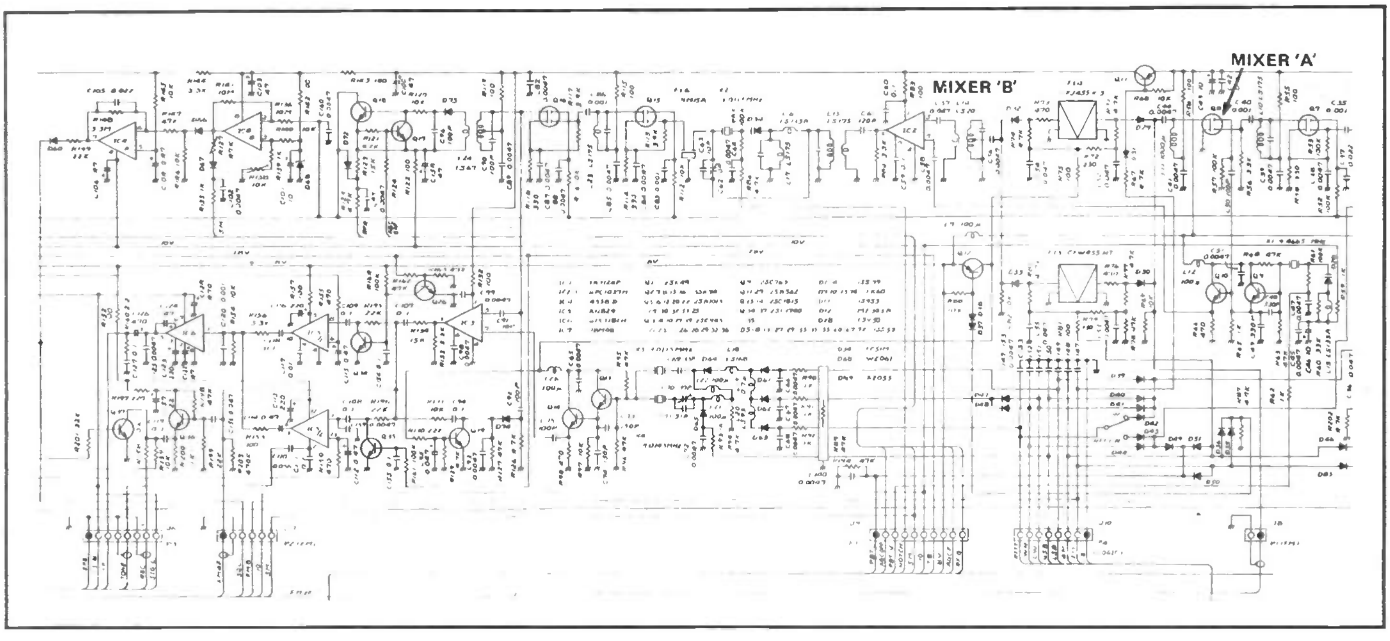


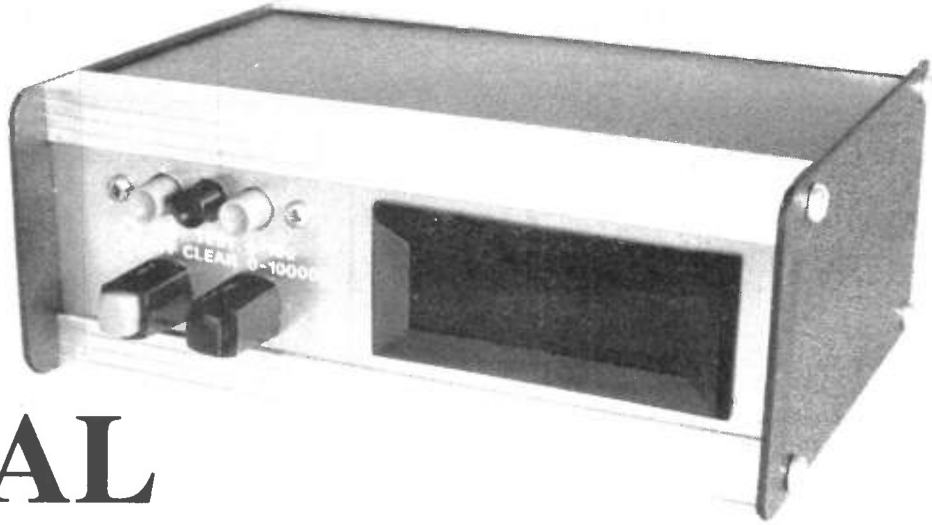
Figure 5: Band Pass Tuning at work on the Icom R70

In Practice

The Icom R70 provides a neat example of PBT at work (*Fig. 5*). The first IF is 9.010MHz and the second 455kHz (the numbers are slightly different, but the result is the same). It is quite straightforward to apply this basic concept to any receiver having its IF (or a first IF) in the range that can be handled by the swing available on a VCXO of the necessary frequency. Generally speaking, it's going to be in the range of 9-11MHz. If you are stuck with 455kHz, then it is possible to produce a good Butterworth filter at about 100kHz by simply top-coupling about 8 or so tuned circuits using coils in the 8mH range. Elegant, calculated solutions are available from a variety of formulae, but empirical methods are usually the best solution for the enthusiast — as long as you're eager and willing to have a dabble. ■ R&EW

In a future issue we'll continue this series with a constructional feature for an add-on PBT system.



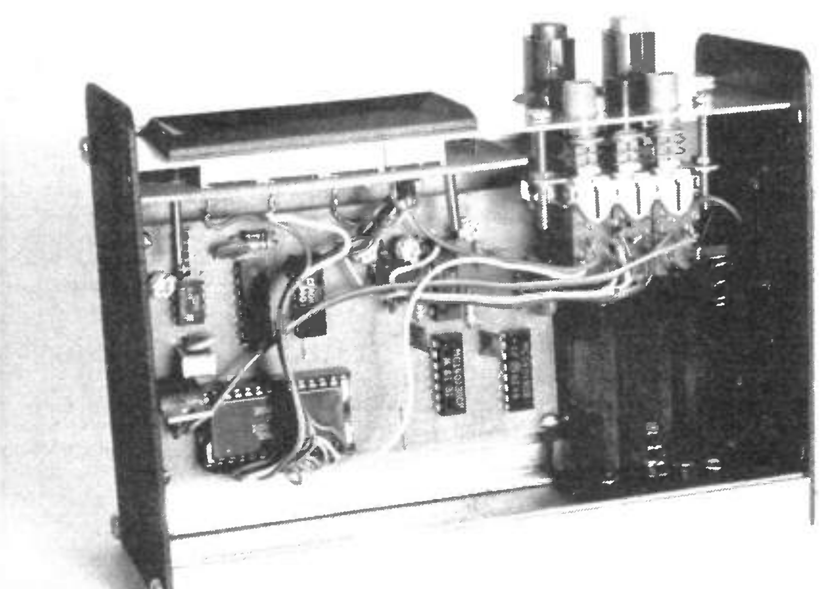


DIGITAL CAPACITANCE METER

Stephen Ibbs describes an accurate and reliable DCM to complement last month's DFM.

Following the application of digital techniques to produce the DFM in the June edition of **R&EW**, we decided to update the DCM from November '81 into a separate unit. The way the original circuit worked was to take negative-going gate pulses from the counter IC, and produce a monostable pulse (inverted to control another monostable), whose period is decided by the unknown capacitance. The output of this monostable opened a gate, allowing an oscillator (running at 1MHz) to flow into the counter. The result was a digital readout directly related to the capacitor's value. The inverted output from the first monostable was also used to control the third input of the gate, in effect closing it for a fraction of a second to null out the circuit stray capacitance that would otherwise give an erroneous reading.

The present design is a two range meter, measuring 0-9999pF, and 0-9.999uF. It uses a simplified oscillator with a 1MHz resonator, and since the counter registers up to 9999 it would have been possible to modify the oscillator to say, 10kHz, but this would have necessitated other changes. So, we decided to stick to the original tested and proved circuit as much as possible.



An internal view of the DCM.

PARTS LIST

Resistors

R1	1M
R2,6	27k
R3	470R
R4	820k
R5	100R ½ watt
R7	220k
R8	3M3
R9	3k3
R10	10k
R11	68R

Potentiometers

RV1	4k7
RV2	470k 6mm sub-min cermet preset
RV3,4	100k

Capacitors

C1,2	22p
C3,9	10n
C4	100n
C5,6	330p
C7	100p
C8	470n Polyester, Siemens type
C10	47n
C11	220n tantalum
C12	22u 16V tantalum

Semiconductors

IC1	4049
IC2	ICM7556
IC3	4023
IC4	ICM7555
IC5	40106
IC6	4011
IC7	ICM7217C
IC8	7805

Miscellaneous

GL8R04 displays (4off), 3 x 2 pole push-push, 1 x 3 way 10mm bracket, 3 knobs type A, 4 digit bezel, Centurion DX1 case, 1MHz resonator, PCBs, mounting hardware etc.

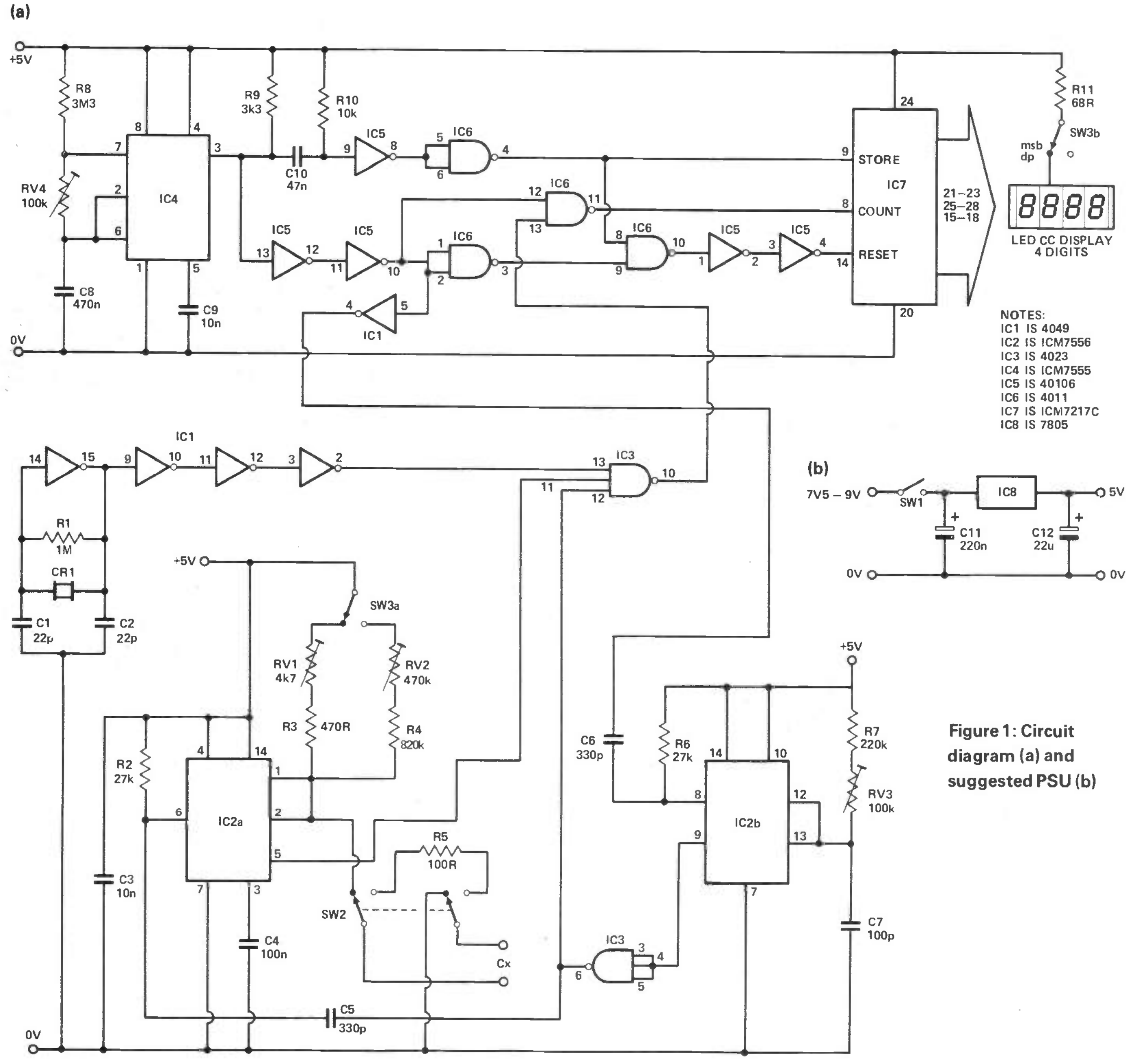


Figure 1: Circuit diagram (a) and suggested PSU (b)

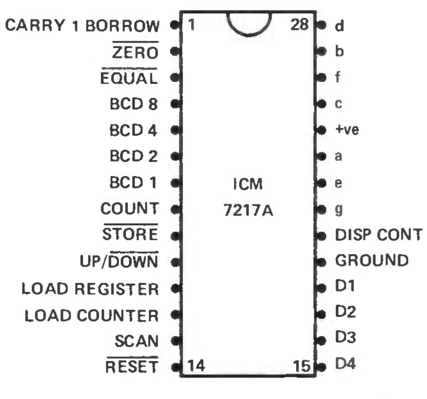


Figure 2: Pin designations for the 7217A.

Circuit Description

The 7216 frequency meter IC used in the original DFM/DCM is replaced by the much cheaper 7217A, which is a 4-digit up/down counter, and consequently does not produce its own gate, store and reset pulses. These pulses are provided by IC4,5 and 6, with IC4 producing a square wave with a duty cycle of (approx) 1 second high, and a very short period low, (less than 1mS), adjusted by RV4. The wave is then inverted, delayed and combined by IC5,6 to give the necessary forms in the correct sequence.

The gate time is tapped off and inverted to provide the negative-going pulse required by the first monostable. Due to space limitations the slightly more expensive 7556 is used rather than two 7555s and the CMOS version is specified to reduce current consumption, which is quite high because of the LED display.

The output of the 7217A drives the multiplexed 4-digit CC display direct, and the second pole of the range switch is used to light the relevant decimal point, so that the meter reads PF direct on the low range and uF on the high. The circuit will, in fact, measure up to 1000uF, but would then require more digits. Those who want to measure above 10uF can easily include more ranges, adjusting the timing resistors accordingly.

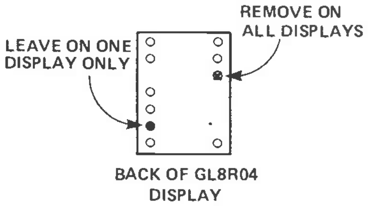


Figure 3: Trimming the pins on the GL8R04 displays.

Construction

The unit was designed for a specific case, so space is at a premium. Mount all the components, not forgetting the wire links, on the PCB and use veropins and ribbon cable for the various interconnections necessary. Place the SUE switches (2 pole, push-push) into the 10mm spaced bracket, and bend over the retaining tabs. This is mounted, using nuts and bolts, onto the front panel, along with the two push-connectors for the capacitors, and the display bezel. The interwiring is then made as illustrated in ***Fig. 1a***. Note that the connecting wires from the capacitor terminals go to the bottom centre contacts of S2, to save on lead length and make the internal appearance better. A 100 ohm ½ watt resistor is soldered across the N/C terminals of S2. The effect of this is to automatically discharge any potentially dangerous charge stored on the capacitor. S2 is then switched in, to place the unknown capacitor into the measuring circuitry. S1 is the on/off switch, and S3 the range switch, one pole selecting either R3 and RV1 or R4 and RV2, the other pole connecting the dp segment to +5V via current-limiting resistor, R11, on the high range (N/O terminals).

The meter uses the GL8R04 displays, mounted on a second PCB. Insert the veropins from the component side, so that they project on the track side. The displays are then trimmed according to ***Fig. 3***. Note that only one display retains its dp pin, and all lose the spare CC pin. They are then mounted, and the connections made via ribbon cable to the back of the display. Two holes are drilled as marked for the mounting bolts from the bezel, and the display is then placed behind the bezel and positioned centrally. Please note that the most significant digit (D4) is the one on the left looking from the front.

After the usual construction checks, mount the PCB into the case, attach a battery and switch on.

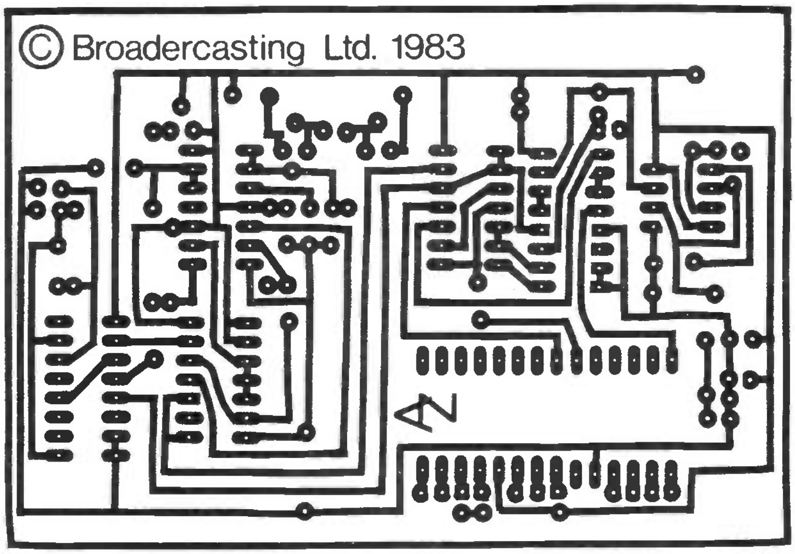


Figure 4: PCB foil pattern for the main board. Note that a separate board for the display is desirable, adhering to the display connections in Figs 1 and 3.

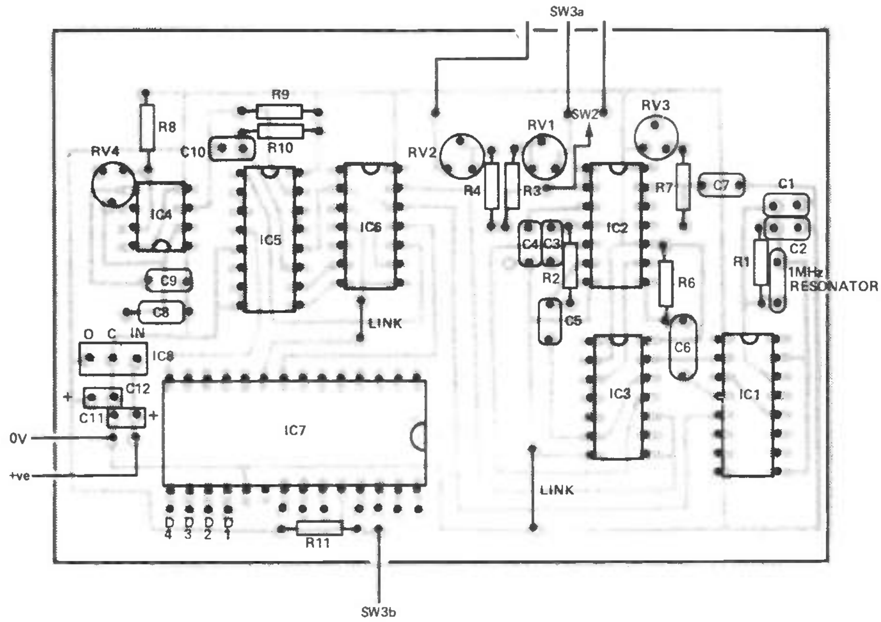


Figure 5: Component overlay for the DCM.

Setting Up

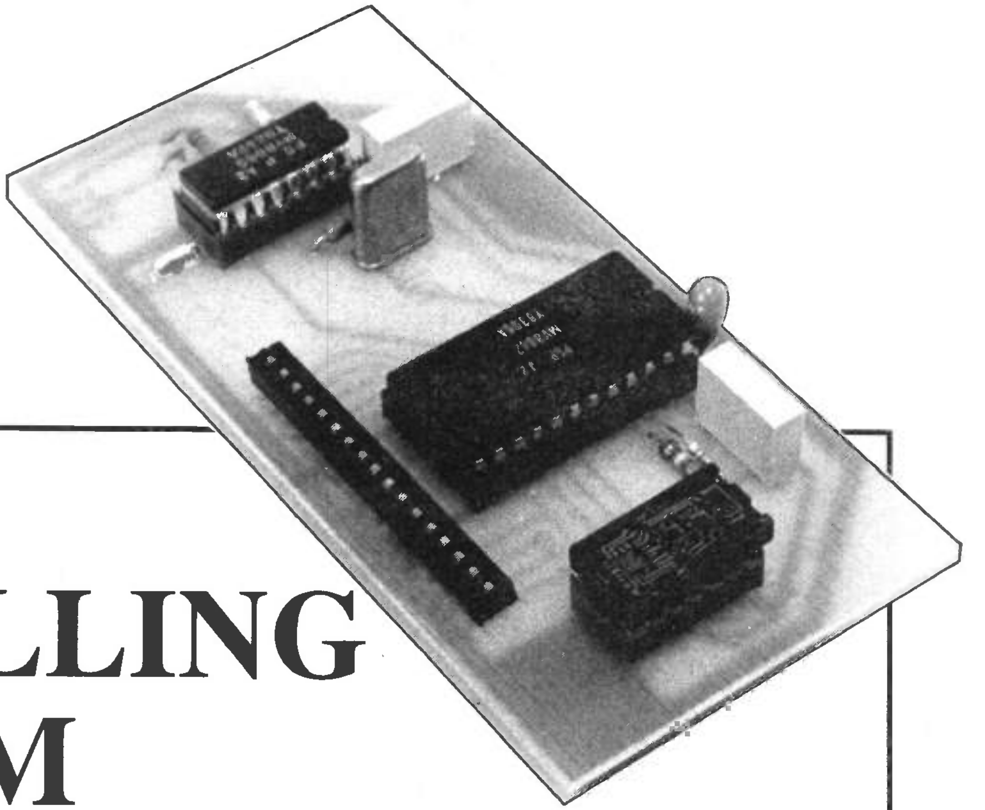
Set RV4 to mid-travel. This sets the gate time and does need to be precise unless constructors are planning to have more than a 4 digit display. Adjust RV3 to give a reading of all zeroes (the LSD may insist on reading 1). Insert a close tolerance capacitor into the terminals, select the appropriate range via SW3 then push in SW2 to place the capacitor into the circuitry. Adjust either RV1 or RV2, dependent on the range selected, to give the correct reading. Repeat the process for the other range with another capacitor. The case can then be bolted together.

In Use

Erroneous readings will be obtained if, for instance, a 15000pF capacitor is measured on the low range. To avoid this an overflow LED can be included by connecting it to the carry/borrow pin 1 via a current-limiting resistor. This goes high for typically 100ns on the transition from 9999 to 0000. The pulse can easily be lengthened if deemed necessary with a simple monostable.

Intersil produce a series of 4½ digit counters, including the 7224 for LCD, and the 7225 for LED displays. These are 40-pin devices, so the PCB would need to be modified, but the same count, store, and reset pulses will work. Similarly the Intersil 7208 can be used with no modifications to the timing pulses, if seven digits are required. This is a 28-pin device but obviously the PCB will still have to be modified. Consult the Intersil data sheets for more details. Ignore the Count Inhibit pin as this can be left floating.

■ **R&EW**



DTMF SIGNALLING SYSTEM

A Dual Tone Multi-Frequency decoder, with the matching encoder. Both designs by Graham Leighton.

This system, originally intended for telephone dialling, provides an excellent control/data transfer system using almost any voice bandwidth transmission medium. Recent reductions in the complexity and cost of DTMF (Dual Tone Multi-Frequency) decoders makes the system attractive for such things as repeater control and remote control or data entry via telephone lines.

Theory...

The DTMF encoder generates a composite signal made from the combination of two tones, selected by line and column addressing of a keyboard. The keyboard arrangement together with the corresponding tone frequencies are shown in ***Fig. 1***. The tone freqencies were originally chosen such that neither harmonics nor intermodulation products fell within the tone detection bauds. The separation between individual tones is about 10%. The fourth column (high tone, 1633Hz) is not usually fitted to telephone sets but is useful to extend the number of control functions available in other systems.

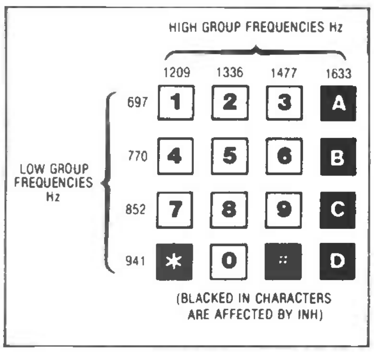


Figure 1. Keypad and tone frequencies obtained.

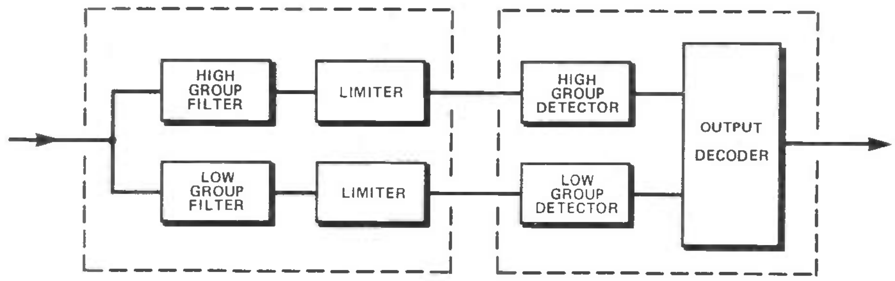


Figure 2. Block diagram of the DTMF receiver.

The decoder (receiver) converts the auto signal to a usable digital format. This is usually hex, binary, or 2 of 8 (ie, similar format to the keyboard). The 2 of 8 format makes connection to pulse dialler ICs simple, thus providing a tone-to-pulse dial converter.

Before IC development made good filters using op-amps and phase-locked loops commercially viable, techniques such as passive LC filters were used. Recently, CMOS decoders and switched capacitor filters have made simple, cheap DTMF decoders possible.

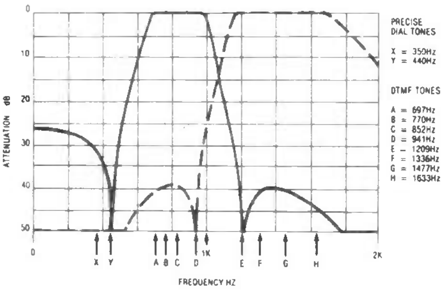


Figure 3. Filter characteristics for the MV8865.

Figure 2 is the block diagram of a two chip reciever. The received DTMF signal is a combination of two tones from the eight that the encoder can generate. One is from the high group and one from the low group. These are separated by a band-split filter, the response of such a filter, the MV8865, being shown in ***Fig. 3***. The outputs ▶

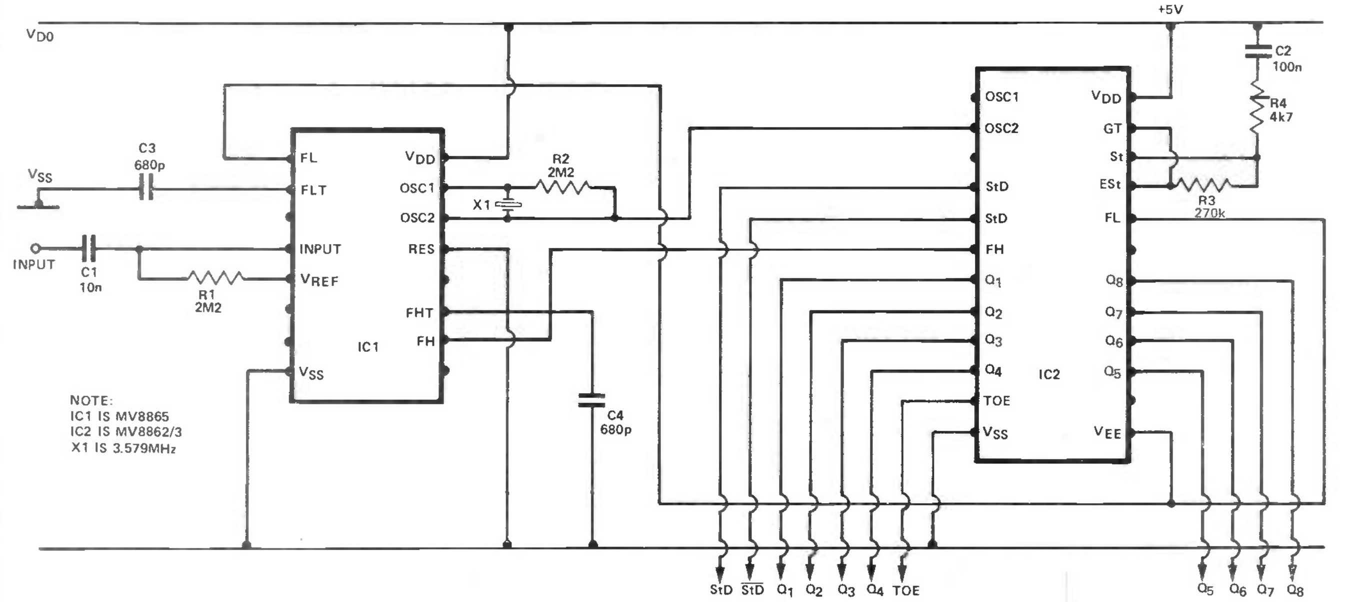


Figure 4 . Circuit of the MV8865 receiver system.

Original Tone Character		TOE	Sel	3862								8863							
				Q_8	Q_7	Q_6	Q_5	Q_4	Q_3	Q_2	Q_1	Q_8	Q_7	Q_6	Q_5	Q_4	Q_3	Q_2	Q_1
	X	L	Ø	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
DR	1	H	L	L	L	L	H	L	L	L	H	L	L	L	L	L	L	L	H
	2	H	L	L	L	H	L	L	L	H	L	L	L	H	L	L	L	H	L
	3	H	L	L	L	H	H	L	L	H	H	L	H	L	L	L	L	H	H
	4	H	L	L	H	L	L	L	H	L	L	H	L	L	L	L	H	L	L
	5	H	L	L	H	L	H	L	H	L	H	H	L	H	L	L	H	L	H
	6	H	L	L	H	H	L	L	H	H	L	H	H	L	L	L	H	H	L
	7	H	L	L	H	H	H	L	H	H	H	L	L	L	H	L	H	H	H
	8	H	L	H	L	L	L	H	L	L	L	L	L	H	H	H	L	L	L
	9	H	L	H	L	L	H	H	L	L	H	L	H	L	H	H	L	L	H
	0	H	L	L	L	L	L	H	L	H	L	L	H	H	L	H	L	H	L
D	*	H	L	H	L	H	L	H	L	H	H	H	H	L	H	H	L	H	H
	#	H	L	H	L	H	H	H	H	L	L	H	L	L	H	H	H	L	L
	A	H	L	H	H	L	L	H	H	L	H	L	H	H	H	H	H	L	H
	B	H	L	H	H	L	H	H	H	H	L	H	L	H	H	H	H	H	L
	C	H	L	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H	H
	D	H	L	H	H	H	H	L	L	L	L	H	H	H	H	L	L	L	L
DR	1	H	H	H	H	H	L	H	H	H	L	L	L	L	H	L	L	L	H
	2	H	H	H	H	L	H	H	H	H	L	L	L	H	L	L	L	L	H
	3	H	H	H	L	H	H	H	H	H	L	L	H	L	L	L	L	L	H
	4	H	H	H	H	H	L	H	H	L	H	L	L	L	H	L	L	H	L
	5	H	H	H	H	L	H	H	H	L	H	L	L	H	L	L	L	H	L
	6	H	H	H	L	H	H	H	H	L	H	L	H	L	L	L	L	H	L
	7	H	H	H	H	H	L	H	L	H	H	L	L	L	H	L	H	L	L
	8	H	H	H	H	L	H	H	L	H	H	L	L	H	L	L	H	L	L
	9	H	H	H	L	H	H	H	L	H	H	L	H	L	L	L	H	L	L
	0	H	H	H	H	L	H	L	H	H	H	L	L	H	L	H	L	L	L
D	*	H	H	H	H	H	L	L	H	H	H	L	L	L	H	H	L	L	L
	#	H	H	H	L	H	H	L	H	H	H	L	H	L	L	H	L	L	L
	A	H	H	L	H	H	H	H	H	H	L	H	L	L	L	L	L	L	H
	B	H	H	L	H	H	H	H	H	L	H	H	L	L	L	L	L	H	L
	C	H	H	L	H	H	H	H	L	H	H	H	L	L	L	L	H	L	L
	D	H	H	L	H	H	H	L	H	H	H	H	L	L	L	H	L	L	L

Table 1. Output codes for the MV8862/3 decoder.

Detected Character	INH	ESt
None	Ø	L
X	L	H
DR	H	H
D	H	L

(b) Inhibit function

ESt	St	GT	StD*	$\overline{StD}$*
L	L	L	L	H
H	L	Z	L	H
L	H	Z	H	L
H	H	H	H	L

(c) Steering

* DELAYED FROM St.

FOR THE PURPOSE OF THESE TABLES CONSIDER

$V_{St} < V_{TSt}$ LOGIC LOW (L)
$V_{St} > V_{TSt}$ LOGIC HIGH (H)

H = LOGIC HIGH
X = ANY CHARACTER
L = LOGIC LOW
Z = HIGH IMPEDANCE
Ø = "DON'T CARE" LOGIC HIGH OR LOW

from the filters are relatively clean and are limited to produce a square wave at the frequency of the original tone. Digital counting algorithms are used in the decoder to determine which tones are being received. Each group is checked for the presence of a DTMF frequency, and when two valid tones are simultaneously detected for the required minimum time the decoded digit is output.

The decoder should give reliable operation in the presence of noise and speech. Modern IC decoders offer acceptable performance in this respect. Any further improvements result in considerable extra complexity.

Circuit Description

The MV8865 separates the high and low group components of the dual tone signal and limits the resulting pair to produce square wave outputs. Separation of the tone groups is achieved by applying the signal simultaneously to the inputs of two sixth order switched capacitor bandpass filters. A notch at 440Hz is incorporated to provide dial tone rejection. Both filters are followed by a single order filter which smooths the signal prior to limiting. Pins FLT and FLH allow the signals to be monitered before limiting. Limiting is performed by high gain comparators which have some hysteresis to improve the operation at low S/N.

The detector outputs are buffered and connected to FL and FH pins.

The MV8862/3 are CMOS digital DTMF detector/decoders. The MV8862 differs from the MV8863 only in the output codes available (see ***Table 1***). High and low group signals are operated on by a complex averaging algorithim using digital counting techniques. When both high and low group signals have been decoded simultaneously a flag, EST, is generated. Various validity checks are carried out to prevent false decoding etc. ***Fig. 6*** shows the timing sequence of the decoding process. STD pin has an output when a valid tone has been received.

When Q1-Q8 are connected to a data bus TOE may be connected to external circuitry or directly to STD thereby enabling the outputs when tones are received. The circuit used here is designed to operate from a 5V supply. If other supplies are to be used modification will be required. Only one crystal oscillator is used, in the MV8865, this also drives the MV8862.

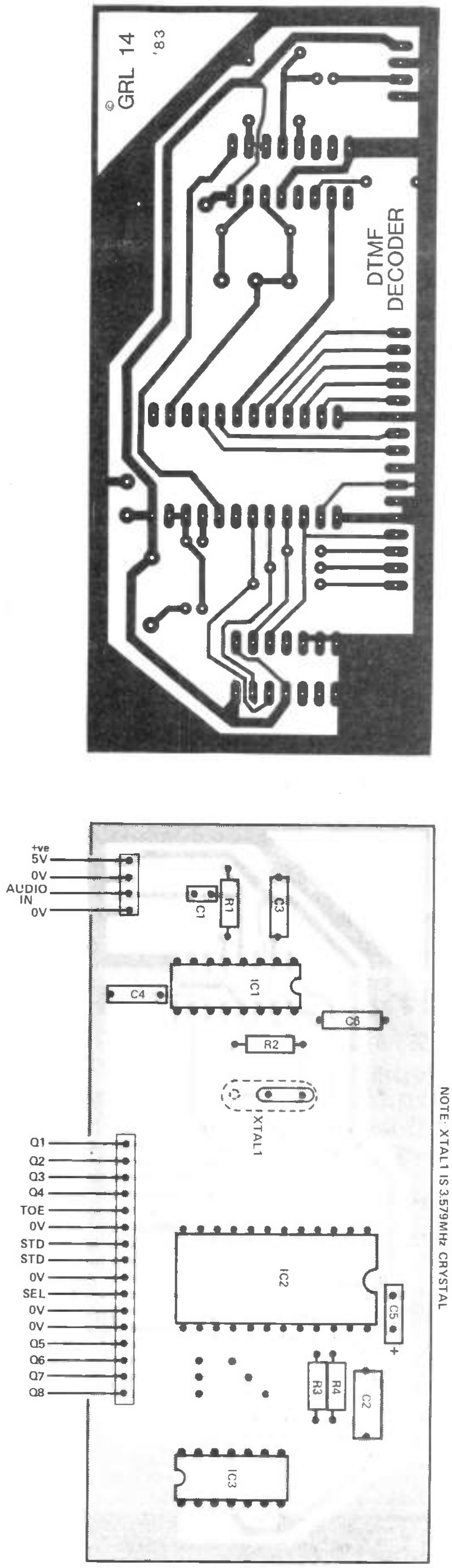


Figure 7: The PBC foil pattern and component overlay

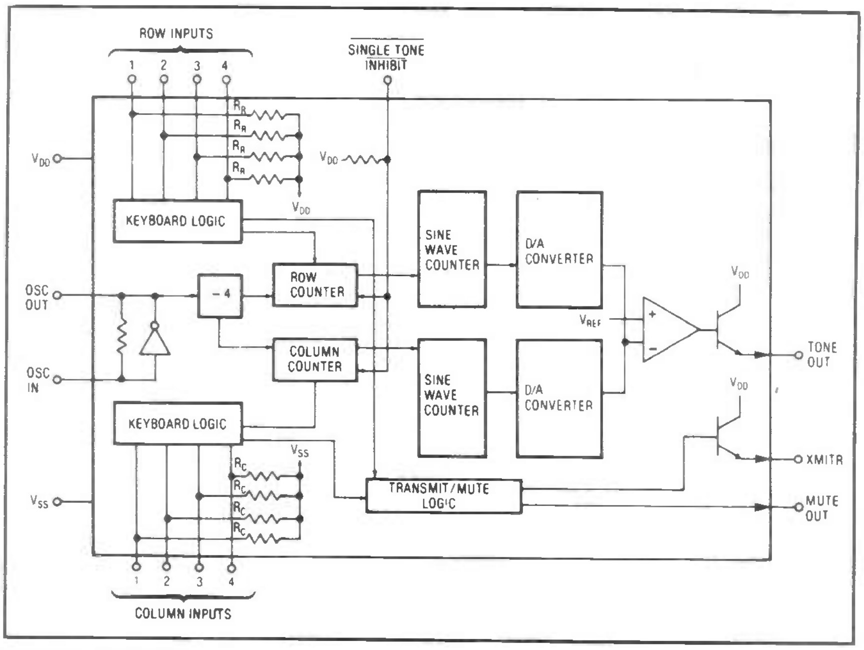


Figure 5: MV5087 internal connections

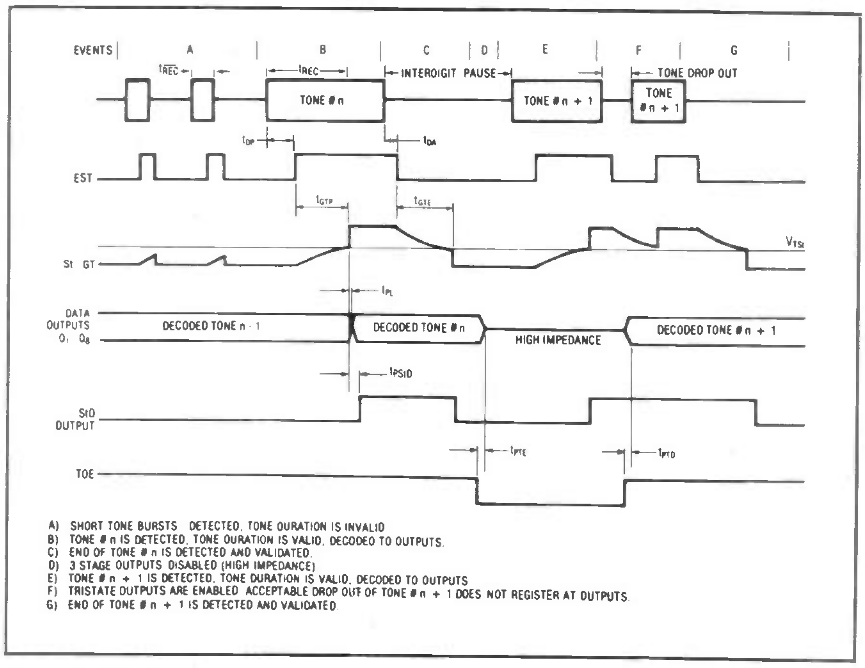


Figure 6: MV8862 decoding timing diagram

PARTS LIST (Receiver Only)

Resistors

R1,2	2M2
R3	270k
R4	4k7

Capacitors

C1	10n ceramic
C2	100n polyester
C3,4	680p polystyrene
C5	33u 10V tant
C6	100n,optional

Semiconductors

IC1	MV8865
IC2	MV8862
IC3	TIL311

Miscellaneous

XTAL1	3.579MHz crystal

4 and 16-pin SIL connectors, terminal pins, PCB etc.

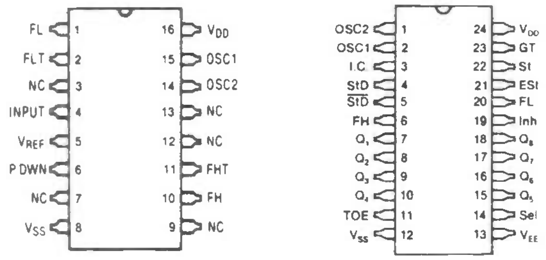


Figure 8: The MV8862/ MV8865 pin designations

...And Practise

There are many DTMF encoders now available. Most use a readily available 3.58MHz crystal (NTSC colour subcarrier) and require few other external components. The MV5087 has 'transmit' and 'mute' outputs which make it especially useful for radio applications. ***Fig. 4*** shows the internal arrangement of the MV5087 The keyboard may be either a 2 of 8 matrix type (2 contacts per key) or a single contact X-Y matrix type. Electronic input is also possible using a Vdd level on the column input and Vss on the row input. The digitally generated sine wave output has typically 7% distortion. If this type of encoder is used in a radio system make sure that the audio processing will remove the harmonics present. The permitted supply voltage range is 2.75 to 10V (Vdd relative to Vss).

The ICs used in this receiver were chosen to provide a versatile system. A single chip decoder has recently been introduced, but provides only a hex output. The MV8862/3 decoder has several output codes including one which permits direct connection to a pulse dialler. The output is tristate which simplifies connection to a processor considerably. Filter and limiter functions are performed by the MV8865. A TIL311 hex decoder/ display has been included on the PCB to monitor operation of the system. This should be removed when driving an external TTL circuit.

Operation

The input level to the decoder should be between 28 and 800mV (approx 30dB dynamic range). The outputs may be used to drive simple hard wired logic or connected directly to a processor data bus. The MV8862/3 will drive up to one standard TTL load. Note that the hex display will not show the same digits as the keyboard except for 0-9. The 'SEL' line has been hard wired to 0V setting the outputs to hex.

After setting the levels correctly the decoder worked very well under operational conditions on a FM radio scheme.

■ R&EW

R&EW Data Brief

ICM7217A

4-digit CMOS Up/Down Counter-Display Driver

- * **Four Decade, Presettable Up-Down Counter with Parallel Zero Detect**
- * **Settable Register with contents continuously compared to Counter.**
- * **Directly drives multiplexed 7 segment common cathode LED displays.**
- * **On-board Multiplex Scan Oscillator.**
- * **Schmitt Trigger on Count Input.**
- * **TTL compatible BCD I/0 port, carry/borrow, equal, and zero outputs.**
- * **Display blank control for low power operation (Dissipation ,5mw).**
- * **All terminals fully protected against static discharge.**
- * **Single 5V operation.**

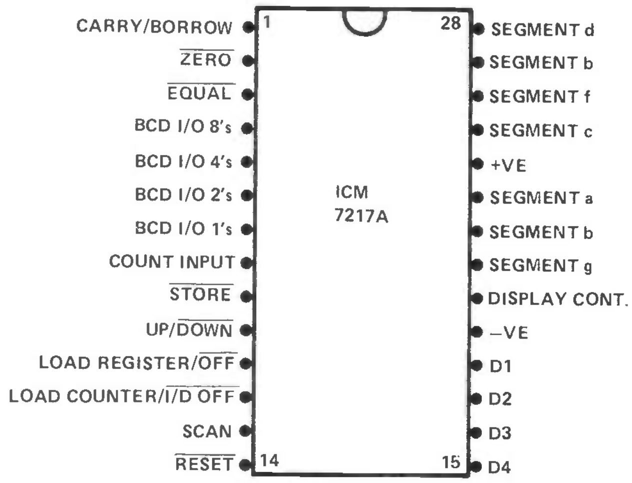


Figure 1: Pin configuration of the 7217

This circuit provides 3 main outputs: A carry/borrow output, which allows for direct cascading of counters, a zero output, which indicates when the count is zero and an equal output, which indicates when the count is equal to the value contained in the register. Data is multiplexed to and from the device by means of a tri-state BCD 1/: port. The carry/borrow, equal, zero, outputs and the BCD port will each drive one standard TTL load. To permit operation in noisy environment and to prevent multiple triggering with slowly changing inputs, the count input is provided with a Schmitt Trigger.

The carry/borrow output is a positive-going signal occurring typically 500 ns after the position-going edge of the count input. It advances the counter from 9999 to 0000 on the upcount and from 0000 to 9999 on the downcount. This allows direct cascading. Note that the equal output assumes a negative level when the contents of the counter and register are equal. Also, the zero output assumes a negative level when the counter contains 0000.

The carry/borrow, equal and zero outputs will drive a single TTL load over the full range of supply voltage and ambient temperature; for a logic zero, these outputs will sink 2mA @ 0.4V (on resistance 200 ohms), and for a logic one the outputs source >60uA.

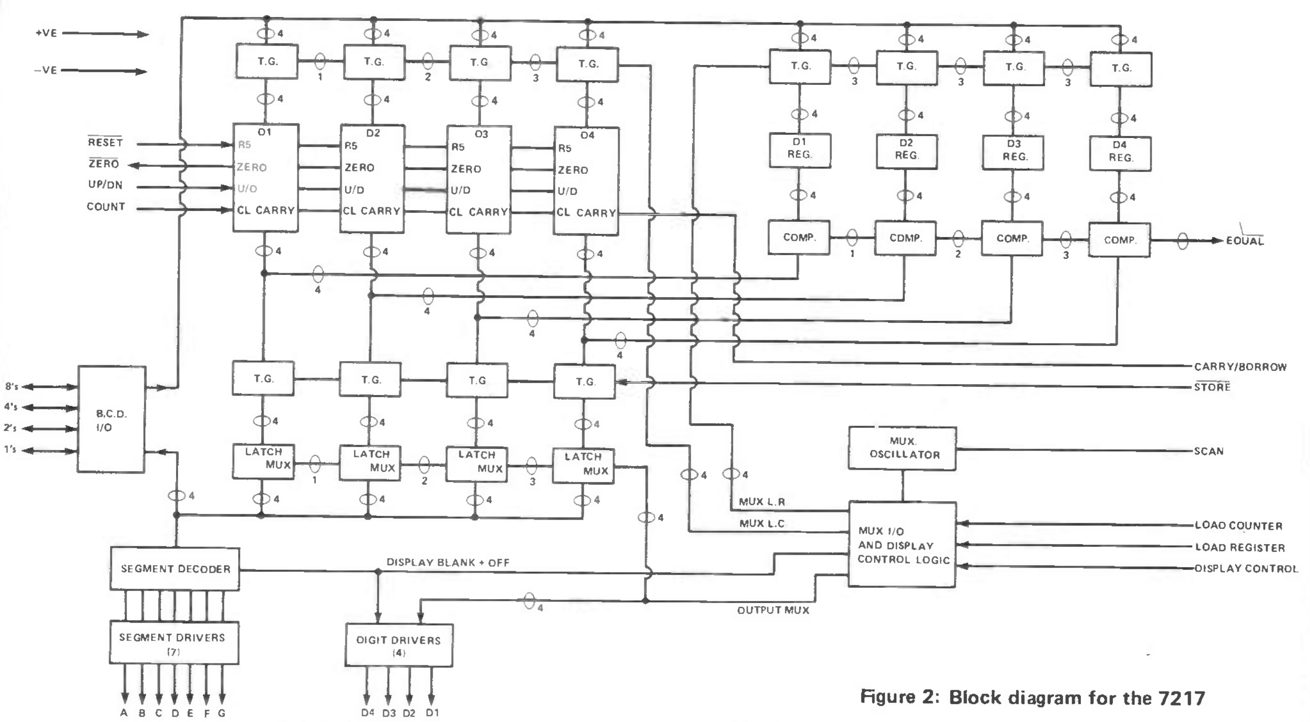
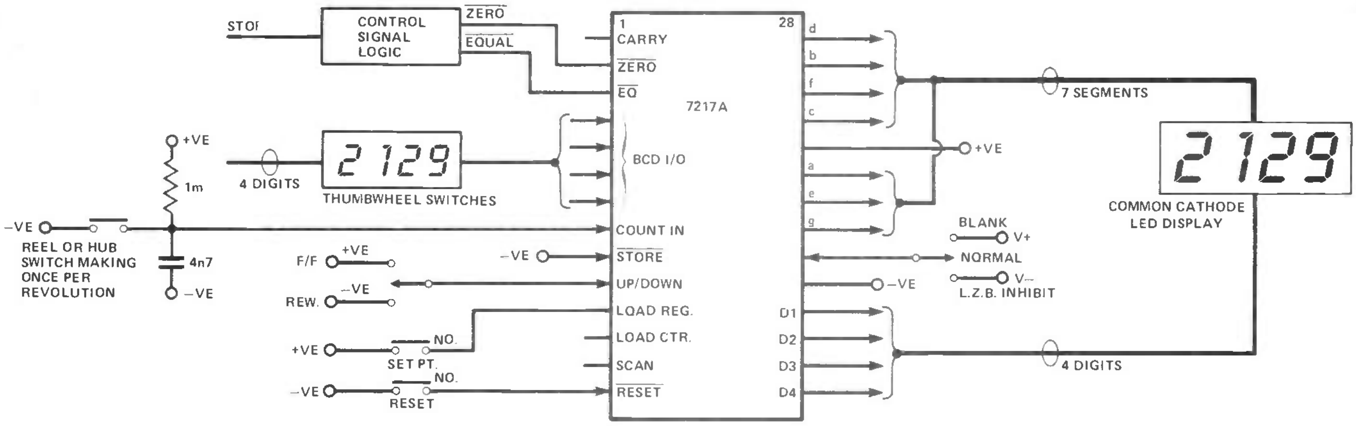
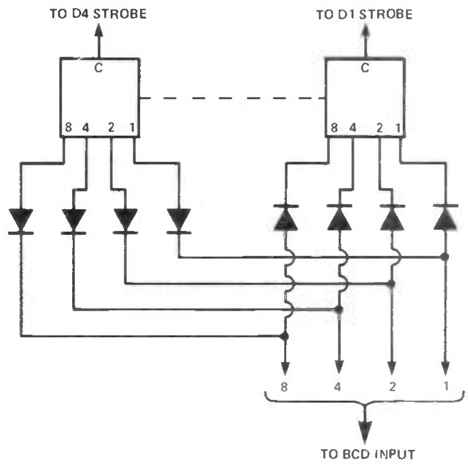


Figure 2: Block diagram for the 7217





▲ **Figure 3: A typical application for the 7217 as a tape recorder position indicator and controller**

◀ **Figure 4: The thumbwheel switch/diode connections**

The onboard multiplex scan oscillator, which has a duty cycle of approximately 25:1, has a nominal frequency of 10 kHz which may be reduced with a capacitor between the scan pin and the supply.

The counter is incremented by the rising edge of the count input signal when U/D is low. Hysteresis is provided by the input Schmitt Trigger. The internal latches are controlled by the ST pin and the signals appearing at the 7 segment and BCD outputs, and bringing the store pin to –VE transfers the contents of the counter into the latches. Thumbwheel switches used with this device should be true BCD coded (ie., all switches open corresponding to 0000) and since they are connected in parallel, diodes should be used to prevent crosstalk.

The multiplex oscillator is disconnected during load counter and load register operations, and allowed to free-run. The carry/borrow output is not valid during load counter and reset operations, the equal output is not valid during load counter and load register operations and the zero output is not valid during a load counter operation.

SCAN CAPACITOR	NOMINAL OSC. FREQUENCY	DIGIT REPETITION RATE	SCAN CYCLE TIME
NONE	10kHz	2.5kHz	400uS
20p	5kHz	1.2kHz	800uS
90p	1kHz	250kHz	4mS

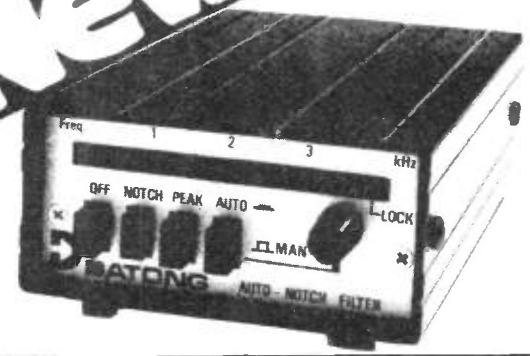
Table 1: Control Input definitions

INPUT	TERMINAL	VOLTAGE	FUNCTION
$\overline{\text{STORE}}$ ($\overline{\text{ST}}$)	9	+VE (OR FLOATING) -VE	OUTPUT LATCHES NOT UPDATED OUTPUT LATCHES UPDATED
UP/DOWN (U/$\overline{\text{D}}$)	10	+VE (OR FLOATING) -VE	COUNTER COUNTS UP COUNTER COUNTS DOWN
$\overline{\text{RESET}}$ ($\overline{\text{RST}}$)	14	+VE (OR FLOATING) -VE	NORMAL OPERATION COUNTER RESET
LOAD COUNTER LC/$\overline{\text{I/O}}$ OFF	12	UNCONNECTED +VE -VE	NORMAL OPERATION COUNTER LOADED WITH BCD DATA BCD PORT FORCED TO HIGH Z CONDITION
LOAD REGISTER LR/$\overline{\text{OFF}}$	11	UNCONNECTED +VE -VE	NORMAL OPERATION REGISTER LOADED WITH BCD OPERATION DISPLAY DRIVERS DISABLED, BCD PORT FORCED TO HIGH Z CONDITION, MPX COUNTER RESET TO D_3 MPX OSCILLATOR DISABLED
DISPLAY CONTROL (DC)	20	UNCONNECTED +VE -VE	NORMAL OPERATION SEGMENT DRIVERS DISABLED LEADING ZERO BLANKING DISABLED

Table 2: Onboard oscillator setting

DATONG

New



AUTOMATIC NOTCH FILTER MODEL ANF

Why suffer when you don't have to? Model ANF provides the high-technology answer to tune-up whistles and other heterodyne interference to SSB communications. It also features an excellent 4-pole tunable bandpass filter to make life easier on CW.
Connected in series with the receiver's loudspeaker Model ANF continuously searches the audio spectrum for continuous tones. When it finds one it stops the search, locks on, and removes it with a really deep, narrow notch.
The filter's centre frequency is shown on a 10 LED bargraph-type display at all times. You can see at a glance the position of the sweep during the search or the approximate frequency of the interference during "lock".
The display is also useful when using the auto-assisted manual tuning mode or the CW mode.
A built-in compandor system eleminates the need for careful input level setting. The receiver volume control works exactly as normal yet the auto-notch performance and signal-to-noise ratio remain just as good at any volume setting.
Built to truly professional quality standards, Model ANF is available now either direct or via Datong Dealers, price £59 plus VAT (£67.85 total). Send for a free copy of the full data sheet.

COMING SOON
The amazing Datong Automatic Woodpecker Blanker – the star of the recent RSGB show at the NEC.

AUTOMATIC WOODPECKER BLANKER MODEL SRB 2

Our latest product provides a long awaited automatic answer to the Russian 'Woodpecker'. It simply connects in series with the antenna and loudspeaker of a receiver or standard HF transceiver an waits. Whenever the Woodpecker appears the device automatically generates RF and AF blanking signals which remove the Woodpecker pulses from audibility and allow you to copy SSB, AM and most CW signals through it.

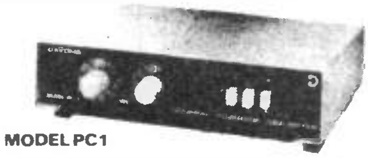
No synchronisation, pulse width, or "in/out" adjustments are required. Instead the blanker itself analyses the Woodpeckers signals and tailors the blanking to suit. It can even remove multiple Woodpeckers at the same time (a situation which occurs fairly often). The unit has a built-in transmit relay and three push-button switches for:- power on/off, selectable 10 or 16Hz pulse rate, and before-and-after comparison.

The unit uses the same case design as model ANF (see this ad), and a panel LED tells you when the unit is actually blanking.

Price **£75** + VAT (**£86.25**total).
Expected availability early July.

GENERAL COVERAGE RECEIVER CONVERTER MODEL PC1

Once upon a time it was the norm to use a ten metre receiver to receive the two metre band. Now, large numbers of special purpose two metre SSB rigs are in use and conversion the other way becomes a very attractive possibility.
With the addition of Model PC1 each of these two metre SSB rigs becomes a really good general coverage receiver (from 50 kHz to 30MHz!).



MODEL PC1

Two metre SSB rigs are not cheap and it makes good sense to get the most out of them. They also tend to have very good performance in terms of sensitivity, selectivity, and big signal handling. Each of these features is just as vital for short wave reception and Model PC1 is designed not to degrade them at all. The result, your two metre SSB rig receives below 30 MHz as well as it receives on two metres. And compared to many medium cost general coverage sets, that is saying a lot!
Try this test: Listen on twenty metres after the band goes dead in the evening. With many general coverage receivers the band never dies. It remains populated with phantoms generated by the receiver from the many very strong signals on forty metres. This is the kind of effect that the higher quality receivers minimise, and that goes for PC1 plus a good two metre rig. Reviews: Rad. Com., April 1982.

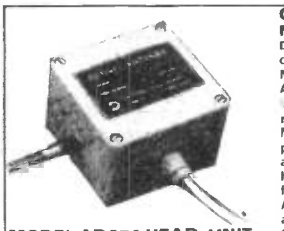
PC-1 £119.50 with VAT £137.42

AUDIO FILTERS MODELS FL2, FL3, FL2/A

Model FL3 represents the ultimate in audio filters for SSB and CW. Connected in series with the loudspeaker, it gives variable extra selectivity better than a whole bank of expensive crystal filters. In addition it contains an automatic notch filter which can remove a "tuner-upper" all by itself.
Model FL2 is exactly the same but without the auto-notch.
Any existing or new FL2 can be up-graded to an FL3 by adding Model FL2/A conversion kit, which is a Fully tested auto-notch module in P.C.B. Form.
Datong filters frequently allow continued copy when otherwise a QSO would have to be abandoned.

Prices: FL2 £78.00 with VAT £89.70, FL3 £112.50 with VAT £129.37, FL2/A £34.00 with VAT £39.67

COMPACT RECEIVING ANTENNAS MODELS AD270/370



MODEL AD370 HEAD UNIT

Datong Active Antennas solve the age-old problem of finding space for a 'good' receiving aerial.
Model AD370 mounted on a roof top or Model AD270 in a loft will give similar sensitivity to much arger conventional aerials yet are only 2½ and 3 metres long respectively
Moreover they do not suffer from interference picked up by the feeder cable; such pick-up can be a problem with conventional dipoles because it is hard to maintain good balance over a band of frequencies
Although active antennas were introduced to the amateur market by Datong only a few years ago they have long been used by military and commercial receiving stations. The performance specifications achieved by the Datong AD270/370 are very close to those of "professional" active antennas selling for ten times the price – a point which is not lost on our many professional customers.
The advanced design ensures two things: that you don't miss signals through inadequate sensitivity and that the antenna does not invent signals which are not there
Datong Active Antennas represent an advanced solution to a common problem and so far as we know have no serious competition in terms of performance at the price (Reviewed in Rad. Com., June 1982)

AD270 £41.00 with VAT £47.15 AD370 £56.00 with VAT £64.40

DATONG ELECTRONICS LIMITED

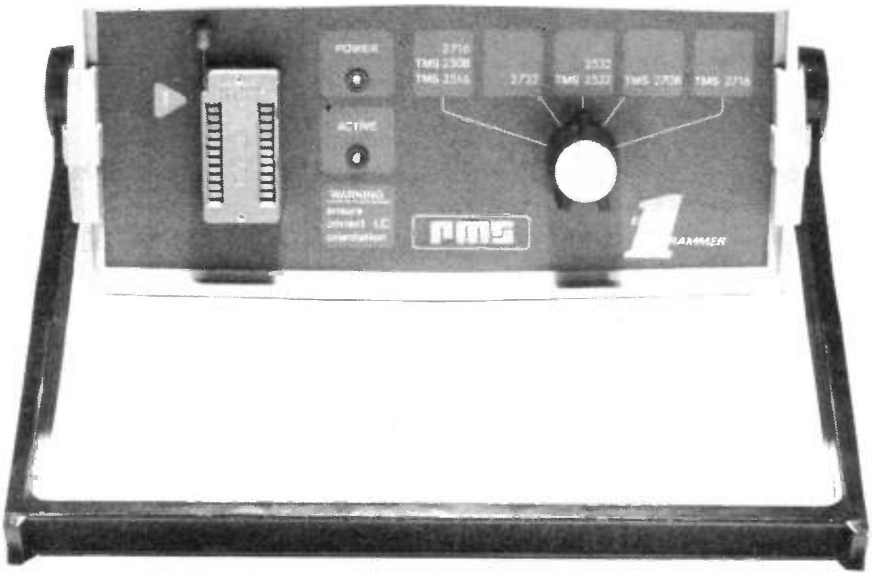
ALL DATONG PRODUCTS ARE DESIGNED AND BUILT IN THE U.K.

PRICES All prices include delivery in U K basic prices in £ are shown with VAT inclusive prices in brackets

FL3	112.50	(129.37)	AD370	56.00	(64.40)	Codecall (Linked)	28.00	(32.20)
FL2/A	34.00	(39.67)	AD270+MPU	45.00	(51.75)	Codecall (Switched)	29.50	(33.92)
FL1	69.00	(79.35)	AD370+MPU	60.00	(69.00)	Basic DF System	149.00	(171.35)
FL2	78.00	(89.70)	MPU	6.00	(6.90)	Basic Mobile DF System	159.00	(182.85)
PC1	119.50	(137.42)	DC144/28	34.50	(39.67)	Complete Mobile DF System	214.00	(246.10)
ASP	72.00	(82.80)	DC144/28 Module	28.00	(32.20)	PTS1	39.99	(45.99)
VLF	26.00	(29.90)	Keyboard Morse Sender	119.50	(137.42)	Model ANF	59.00	(67.85)
D70	49.00	(56.35)	RFA	29.50	(33.92)			
D75	49.00	(56.35)						
RFC/M	26.00	(29.90)						
AD270	41.00	(47.15)						

Data sheets on any products available free on request –

DATONG ELECTRONICS LIMITED
Dept REW Spence Mills, Mill Lane, Bramley, Leeds LS13 3HE, England. Tel: (0532) 552461



PMS PROM1

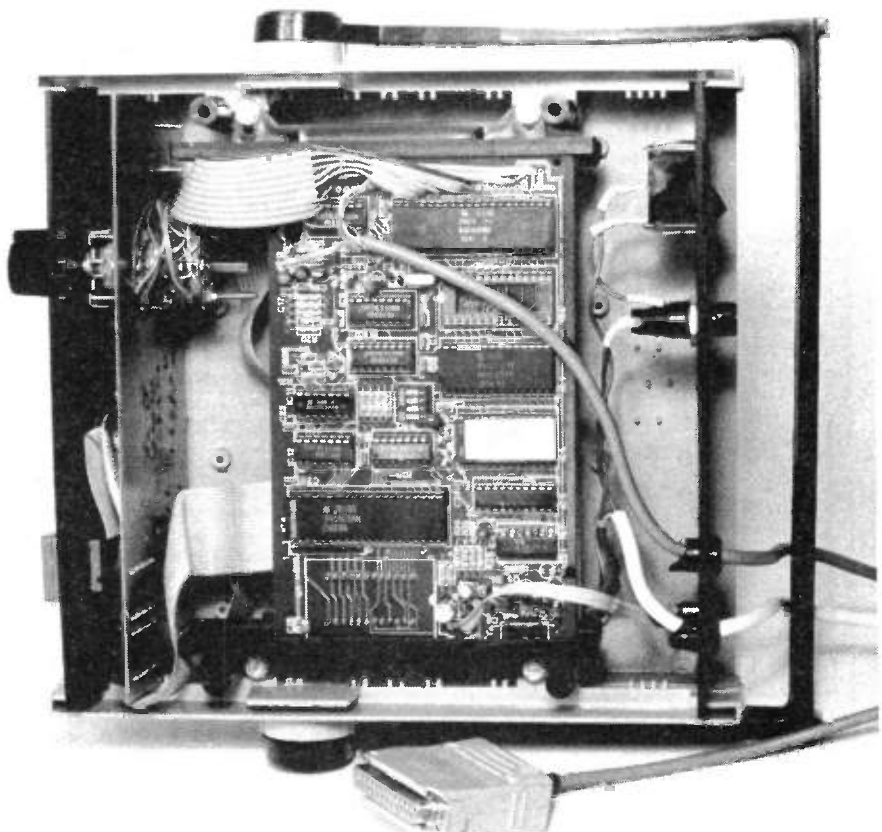
Jonathan Burchell scrutinizes a new EPROM programmer from PMS Developments.

As many people will have already discovered, playing with EPROMs is not always easy — there are a vast array of devices from different manufacturers, all with slightly different programming requirements. Thus, an intelligent device which can be linked to a development system and can handle a wide variety of devices, is worthy of mention, particularly when it offers the value-for-money approach adopted with PMS1.

The PMS 1 EPROM programmer is, in fact, an intelligent satellite subsystem, with built-in microprocessor (**R&EW's** Z8 system), 4K of RAM and software in EPROM. The Z8 communicates with the host system via its RS232 port. A program running in the host system provides file transfer to and from the programmer, as well as storage on the host and editing facilities. The PMS programmer is supplied with software on 8" disk to run on any CPM system – all that's required is a little customisation of the program to suit your terminal and I/0 configuration.

The PROM 1 offers the following features:

1) Disk to Buffer. Allows a file to be copied from the host's disk system into the PROM 1's internal 4K buffer.



Internal view of the EPROM programmer.

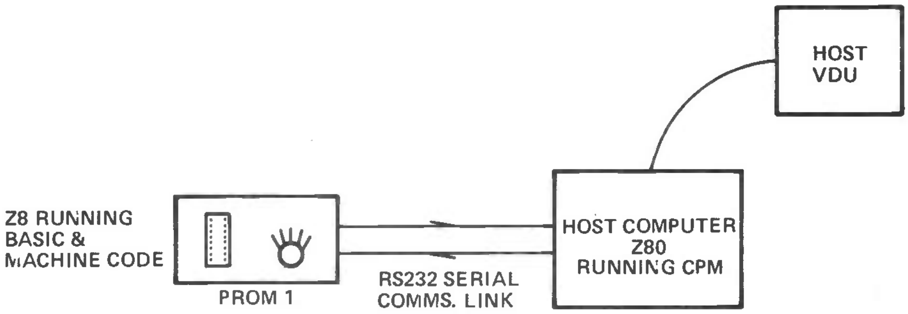


Figure 1: Programming with the PROM 1.

2) Buffer to Disk. Allows the contents of buffer to be stored on host's disk.

3) EPROM to Buffer. Copies the contents of the EPROM in the PROM 1 socket into the PROM 1 buffer.

4) Display Buffer. Displays the contents of the buffer in 128 byte blocks — the buffer contents can be edited via an interactive on-screen editor.

5) Check EPROM status. Checks the EPROM type (eg, 2708, 2716 etc), selected on the PROM 1 front panel, and if the EPROM is blank, or programmed, checks whether or not it is equal to the buffer.

Using The System

In use, the PROM 1 proved to be very reliable and easy to operate. Modification of the assembler program to drive the host was easy, due mostly to the excellence of the program documentation and tight structure. The PROM 1 system is really designed to be used with a terminal with full cursor control and editing (such as H19 etc) and makes use of interactive screen- based displays.

Fig. 1 illustrates the relationship of the host and the programmer. The PROM 1 will part-program devices if required and takes about 210 seconds to program a 2732, which is close to the theoretical maximum of 50ms*4096.

The PROM 1 offers excellent value-for-money, the only minor grumbles being that it is not supplied with a cross-reference chart of different manufacturers' devices, so that sometimes the EPROM type selected involves a degree of guess-work, and, that a function is not provided to read in an INTEL hex file — the format used for data storage on the disk is a 4K file, exactly corresponding to the PROM 1's buffer. However, most assemblers produce INTEL hex output which is not compatible with the PROM 1 (it is possible using DDT under CPM to convert a hex file to an absolute, but it is a little tortuous).

While the current version of the PROM 1 covers devices from 2708-2732, it is understood that a new version able to cope with the larger 2764 is under way.

■ R&EW

The PROM 1 is available from PMS Developments, 22 Tarsmill Court, Rotherwas, HEREFORD HR2 6JZ

ATV on the Air

PRESENTED BY

ANDY EMMERSON, G8PTH

A new series, introducing the exciting world of amateur television.

Welcome aboard **R&EW's** new amateur television column, conceived as a means of sharing the latest ATV news as well as hints and tips on getting the most out of this fascinating branch of the amateur radio hobby. Some of you may already know the author from the activity page in the British Amateur Television Club's journal "CQ-TV", though this column isn't intended to preach just to the converted. It is hoped over the months to explain some of the magic of amateur television (ATV) and let you know what it takes to get into the hobby.

Amateur television is, as stated above, a branch of the ham radio hobby: indeed many of its afficionados consider it the best form of amateur communication — it involves all of the skills of wireless in general, yet allows you to see and be seen, live! Not all people who experiment with television are radio amateurs, though; a lot of folk get a great deal of satisfaction from closed circuit operation or from making video films for showing at club sessions and the like. Some people spend time working closed circuit prior to going on the air, while yet more specialise in restoring old broadcast equipment — not just cameras and monitors but even complete outside broadcast vans.

So far, by television, what's been meant is fast scan or normal TV, since amateurs use the same technical standards as broadcast or industrial television. Not only does this allow you to use domestic or surplus equipment for receiving ATV transmissions, it also enables you to use home video equipment which is getting very popular these days. There is, however, another form of amateur TV known as slow scan TV or SSTV for short. This uses different transmission standards, but allows signals to be sent as audio tones on voice links or recorded on ordinary audio cassettes. Computers are also very good for generating SSTV.

Questions and Answers

The first questions people ask about ATV are usually: How easy is it? How much will it cost? How far can you transmit? And what are you allowed to send? In this introductory article, these questions will be answered. To begin with, we shall deal only with normal fast scan TV: SSTV is really another subject altogether, though we'll include any notes and news which you may care to send in. This column, like the DX-TV one, depends on feedback and input from the readers — please send your ideas and news via the Editor.

So how easy is ATV? Well, if you can operate a home video camera and a two metre transmitter you're half way there. A degree of technical skill is, however, required. You cannot just connect a camera to a transmitter and switch on — a video signal is a complex waveform and must be transmitted in a linear fashion to be received properly at the other end. You must monitor the transmitted signal on a scope or waveform monitor (relying on comments from your QSO partner or on a TV set in the shack is a recipe for disaster). In other words you do need a little technical competence, which can be easily picked up if you visit another ATV'er. Getting hold of a transmitter is easy nowadays, assuming you intend to transmit on 70 centimetres, the most popular band. A few years ago, there were no commercial transmitters and you had to build you own. Now, however, there are two excellent commercial ready-made transmitters on the market, as well as a range of kits for the DIY enthusiast. Linear amplifiers to boost the power are also available, but tend to be more expensive and home-brew is definitely more advantageous here.

How much will it cost? The answer is as much as you want it to. With ATV, home construction is a very good way of keeping the cost down and even if you buy new equipment this can be done in stages. First of all, equip yourself with a good antenna plus preamplifier and feeder cable and possibly a receive converter if your TV set doesn't already tune 70 cm (many do). Then gradually build up the video equipment: this is easy if you are into home video since you may already have camera, monitor and a recorder, and even if you don't, there are plenty

The ATV demonstration usually attracts a crowd at amateur radio rallies...

...though seeing yourself on TV may be a bit of a shock. Still, there's plenty of information and advice available.

of surplus bargains to be had at amateur radio rallies, in secondhand shops and in the small advertisements of "Exchange & Mart".

Finally, acquire or build a transmitter. All this can be bought in stages and you may already possess some of the gear, but if you want to price a notional shopping list, here are some ballpark figures:

— antenna and feeder cable, £40 to £50
— receive converter, £25
— secondhand surveillance camera, £50
— commercial transmitter, £150

This is not the total expenditure you'll be faced with, but it may give some idea.

How far can you transmit? On 70 cm about as far as half the power on two metres. In other words, 10 watts of 70 cm TV will go as far as 5 watts of simplex FM on two metres. The commercial ATV transmitters poke out about 15 to 20 watts, which matches 10 watts of two metres pretty well. Under lift conditions the rules don't apply: 200 to 300 miles can be achieved with less than 10 watts, and because of frequency sensitive ducting you may get the situation where the video signal is fine, but audio communication on 'two' is impossible. So, felt pens and bits of cardboard come out and callsigns and other details are exchanged in writing.

What can you transmit? The licence regulations are agreeably generous in this respect; there are few restrictions as long as the information is of personal interest to your partner. The normal bans on advertising and third party messages apply, of course, and you have to avoid sending music, copyright material or anything offensive. Beyond that, only self-restraint applies and people show views of themselves and the shack, home movies, slides, their stamp collections, circuit diagrams and anything else you care to name.

Things To Come

Hopefully, this brief introduction has inspired you to find out a bit more about ATV. In future columns we'll assume you have some interest in ATV, taking things a stage further. In the meantime, if you want to find out more and see ATV in action the first thing to do is enquire at your local radio club to see if there are any ATV'ers around. Most are sociable types and will gladly show you round their shacks and give any advice wanted. Listening on 144.75 FM, the international ATV calling frequency, should also alert you to where and when the action is: most districts have an ATV net one day a week and this will be coordinated on '75'. The British ATV Club (BATC) membership costs very little and gives you many benefits including cut-price supplies of hard to find items, as well as a superb magazine four times a year. The club also publishes a number of low-cost handbooks and guides on topics relating to ATV. The BATC or a local group also have a stand at many of the amateur radio exhibitions and rallies throughout the year, so you might call in there. Whichever way you get into ATV, do it soon, and if you're already with us stay tuned for in-depth coverage from now on. We'll be featuring operating notes, activity news and technical topics. Microwave TV, ATV repeaters, computers and home video are all on the menu for the next few months — see you next month?

To join the BATC write for a leaflet to:
Brian Summers, BATC Membership Secretary,
13 Church Street,
GAINSBOROUGH,
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■ R&EW

Suppliers of ATV equipment include*
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*When writing to any of the above please enclose a stamped adressed envelope; at the new rates nobody can afford to give away stamps.

Amateur TV means you don't have to use your imagination to visualise who's at the other end. Nick, G4 IMO, finds it easier to demonstrate equipment, too.

Data File

In the final part of the present 'Data File' series, Ray Marston looks at a second generation dual OTA - the LM13600.

This month, to conclude the series, we present an improved 'second generation' IC, the LM13600, which is a dual OTA (as shown by the pin connection diagram of ***Fig. 1***). Each amplifier is an improved version of the CA3080 and incorporates linearizing diodes, greatly reducing signal distortion. They also have coupled output-buffer stages that can be used to give a low-impedance output.

The LM13600 is a very versatile device and can easily be made to act as a voltage-controlled amplifier (VCA), resistor (VCR), filter (VCF) or oscillator (VCO), etc.

LM13600 Basics

An OTA such as the CA3080, consists of nothing more than one differential amplifier and a number of current mirrors, which produce a final output current equal to the difference between the two collector currents of the differential amplifier. It can easily be used as a voltage-controlled amplifier by controlling I_{bias} via an external voltage and a

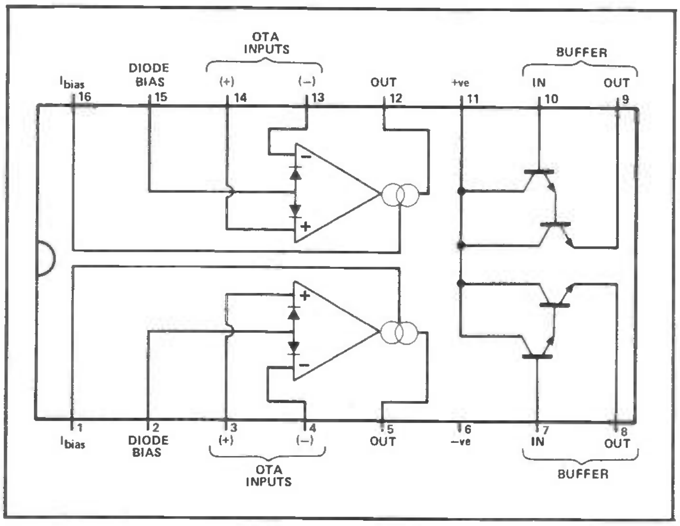


Figure 1. Pin connections of the LM13600 Dual OTA.

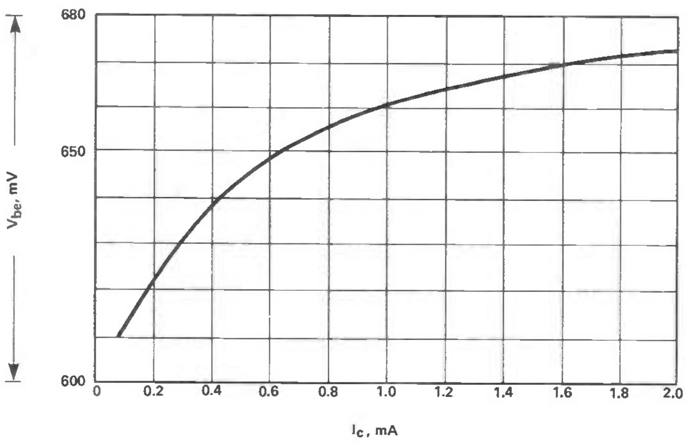


Figure 2. Typical transfer characteristics of a small-signal transistor.

current-limiting resistor. The device does, however, suffer from two significant snags. One of these is that it inherently has a high-impedance output, so that in most practical applications the output signal has to be applied to external circuitry via a high-impedance buffer stage. The other snag is that input signals must be limited to about 25mV peak-to-peak if excessive signal distortion is not to occur. This signal distortion is caused by the non-linear V_{be}-to-I_c transfer characteristics of the transistors in the OTA's differential amplifier.

The graph of ***Fig. 2*** shows the typical transfer characteristics of a small-signal transistor. Thus, if the transistor is used in the common emitter mode (biassed at a quiescent collector current of 0.8mA), an input signal of 10mV peak-to-peak produces an output current swing of +0.2mA to −0.16mA and relatively little distortion, but an input of 30mV peak-to-peak produces an output swing of +0.9mA to −0.35mA and massive distortion.

Linearizing Diodes

Figure 3 shows the circuit forming the basis of one of the improved 'second generation' OTAs inside the LM13600. It is almost identical to that of the CA3080, except for the addition of 'linearizing' diodes D1 and D2, which are integrated with Q1 and Q2 and thus have characteristics that are matched to those of the Q1 and Q2 base-emitter junctions. In use, equal low-value resistors, R1 and R2, are wired between the inputs of the differential amplifier and the common supply line, and bias current I_D is fed to these resistors from the positive supply line via R3 and D1-D2.

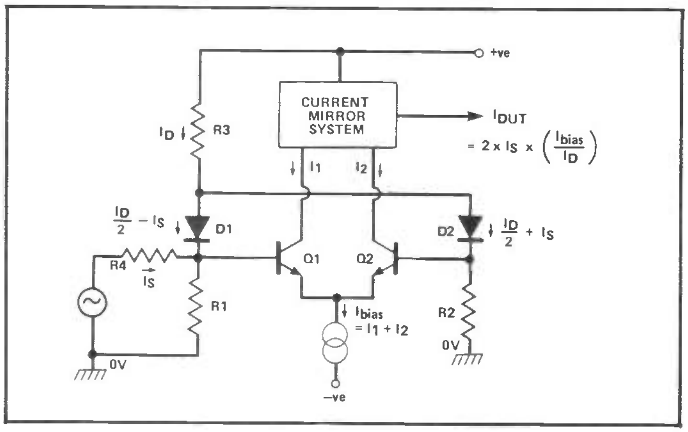


Figure 3. Simplified 'usage' circuit of an LM13600 OTA.

Since D1 and D2 have identical characteristics *and* R1 and R2 have equal values, bias current I_D divides equally into the two resistors to give an R1 current of $I_D/2$ and an R2 current of $I_D/2$.

The circuit's input voltage is applied via R4, which has a large value relative to R1, and thus generates an input signal current of Is. This signal current feeds into R1 and thus generates a signal voltage across R1 which reduces the D1 current to a value of $(I_D/2) - I_s$. The I_D current is, however, constant, so the D2 current rises to $(I_D/2) + I_s$. Consequently, the linearizing diodes of the ***Fig. 3*** circuit apply heavy negative feedback to the differential amplifier and give a substantial reduction in signal distortion. If Is is small relative to I_D, the output signal current of the circuit is equal to $2 \times I_s \times (I_{bias}/I_D)$. The gain of the circuit can thus be controlled via either I_{bias} or I_D.

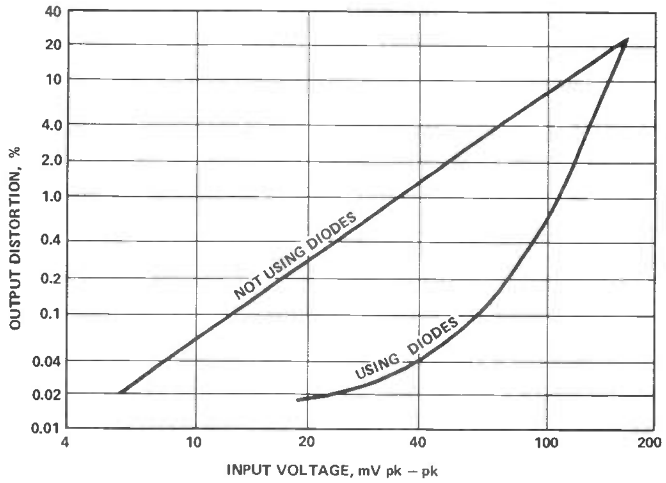


Figure 4. Typical distortion levels of the LM13600 OTA, with and without the use of linearizing diodes.

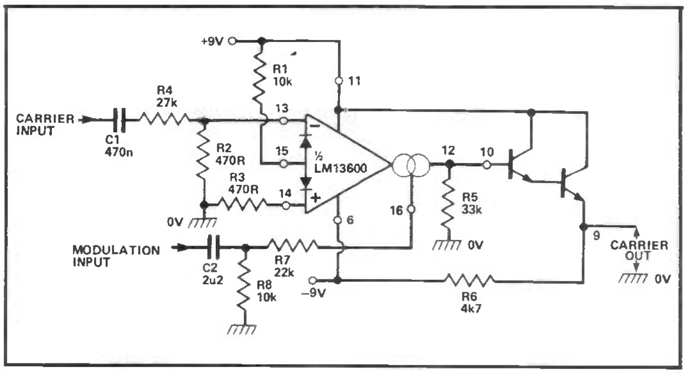


Figure 6. Amplitude modulator or 2-quadrant multiplier.

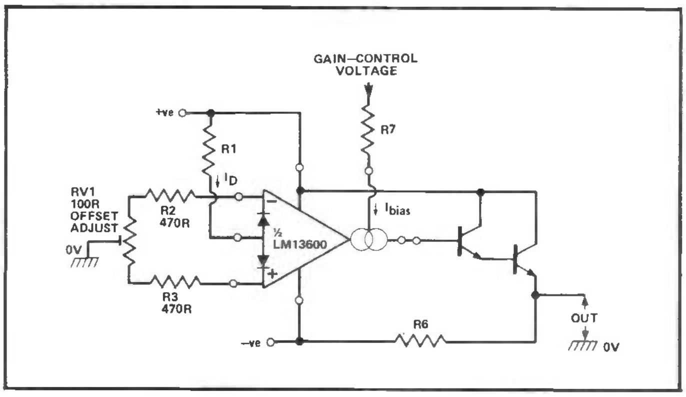


Figure 7. Method of applying offset biasing to the LM13600.

The OTAs of the LM13600 can be used similarly to the CA3080 type by ignoring the presence of the two linearizing diodes, or can be used as low-distortion amplifiers. ***Fig. 4*** shows distortion levels of the LM13600 at various peak-to-peak values of input signal voltage, with and without the use of the linearizing diodes. Thus, at 30mV input, distortion is below 0.03% with diodes but, 0.7% without them, and at 100mV input is roughly 0.8% with diodes but 8% without them.

The two OTA's of the LM13600 share common supply rails, but are otherwise fully independent. All elements are integrated on a single chip, and the OTA's thus have closely matched characteristics (g_m values are typically matched within 0.3dB), making the IC ideal for use in stereo VCA and VCF applications, etc. The standard commercial version of the LM13600 can be powered from split supply rails of up to ±18V, or single-ended supplies of up to 36V. In use, I_D and I_{bias} should both be limited to 2mA maximum, and the output currents of each buffer stage to 20mA max.

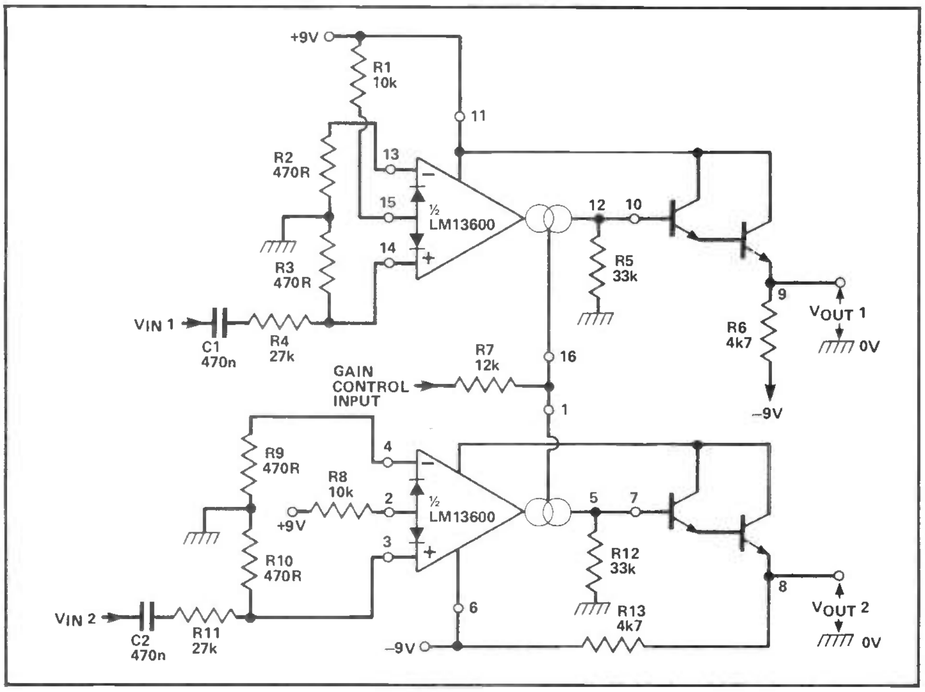


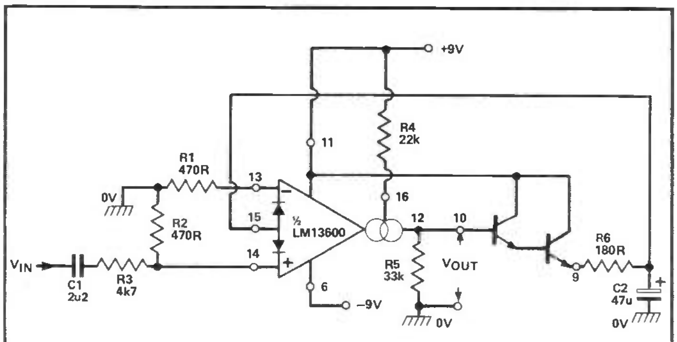
Figure 5. Voltage-Controlled stereo Amplifier.

VCA Circuits

Figure 5 shows the practical circuit of a stereo Voltage-Controlled Amplifier (VCA) made from the two halves of an LM13600 IC. Input signals are fed to the non-inverting terminals via current-limiting resistors. The output signals are made available at a low-impedance level via two buffer stages.

The circuit is powered from dual 9 volt supplies. The I_D current is fixed at about 0.8mA, but I_{bias} is variable via an external 'gain control' voltage. When the gain-control voltage is at the negative supply rail value of −9 volts, I_{bias} is zero and the circuit gives an overall 'gain' of −80dB. When the gain-control voltage is at the positive supply rail value of +9 volts, I_{bias} reaches a value of roughly 0.8mA, and under this condition the circuit gives a voltage gain of roughly 1½ times. The voltage gain is fully variable within these limits via the gain-control input. The two halves of the LM13600, having closely matched characteristics, makes the IC ideal for this application.

The mono version of ***Fig. 5*** can be used as an amplitude modulator or 2-quadrant multiplier by simply feeding the 'carrier' signal to the input terminal and the modulation signal to the gain-control input terminal. If desired, the gain-control pin can be DC biased so that a carrier output is available with ▶



V_{IN}, pk–pk	3V0	300mV	30mV
V_{OUT}, pk–pk	6V0	3V6	1V2
A_V	2	11.7	40

Figure 8. Circuit and performance table of an AGC amplifier.

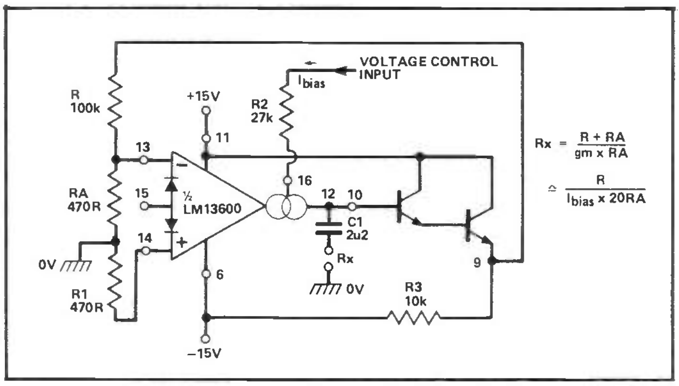


Figure 9. Voltage-Controlled Resistor, variable from 10k to 10M.

no AC input signal applied. ***Fig. 6*** shows a practical example of an inverting amplifier of this type. The AC modulation signal modulates the amplitude of the carrier output signal.

Offset Bias

The circuits of ***Figs. 5*** and ***6*** are shown with input biasing to the OTAs applied by fixed-value 470R resistors wired between the two input terminals and the zero (common) supply line. In practice, this arrangement may cause the DC output level of the circuit to shift slightly when the I_{bias} gain-control is varied from its minimum to maximun value. If desired, this level-shifting effect can be eliminated by fitting the circuits with a presettable 'offset adjust' control, as shown in ***Fig. 7***, which enables the relative values of the biasing resistances to be varied over a limited range.

To adjust the offset biasing control, reduce I_{bias} to zero, note the DC level of the output signal, then increase I_{bias} to maximum and adjust RV1 to give the same DC output level.

An AGC Amplifier

One feature of the LM13600 is that the gain can be varied by altering either the I_{bias} *or* the I_D current. ***Fig. 8*** shows how I_D variation can be used to make an AGC (automatic gain control) amplifier in which a 100:1 change in input signal amplitude causes only a 5:1 change in output amplitude.

In this application, I_{bias} is fixed by R4 and the output signal is taken directly from the OTA via R5. The output buffer is used as a signal rectifier, fed from the output of the OTA, and the rectified output of the buffer is smoothed via R6-C2 and used to apply the I_D current to the linearizing diodes of the OTA. Note, however, that no significant I_D current is generated until the OTA output reaches a high enough amplitude (1.8 volts peak) to turn on the Darlington buffer and the linearizing diodes. An increase in I_D reduces the OTA gain and, by negative feedback action, tends to hold V_{out} at that level.

The basic gain of this amplifier, with zero I_D, is 40. Thus, with an input signal of 30mV peak-to-peak, the OTA output of 1V2 peak-to-peak is not enough to generate an I_D current, and the OTA operates at full gain. At 300mV input, however, the OTA output is enough to generate significant I_D current, and the circuit's negative feedback automatically reduces the output level to 3V6 peak-to-peak, giving a overall gain of just over 11. With an input of 3V, the gain falls to 2, giving an output of 6 volts peak-to-peak. The circuit thus gives 20:1 signal compression over this range.

Voltage Controlled Resistors

An unusual application of the LM13600 is as a voltage-controlled resistor (VCR), using the basic circuit shown in ***Fig. 9***. The theory here is quite straightforward. If an AC signal is applied to the R_x terminals, this signal will feed to the inverting terminal of the OTA via C1 and the buffer stage and via the R-RA attenuator. The OTA will then generate an output current that is proportional to the V_{in} and I_{bias} values. Thus, since R = V/I, the R_x terminal of the circuit acts like an AC resistor with a value determined by I_{bias}.

The effective resistance value of the R_x terminals in ***Fig. 9***, equals (R+RA)/(g_m x RA), where g_m is approximately 20 x I_{bias}. This formula approximates to R_x=R/(I_{bias} x 20RA). If we put component values to the circuit as shown, R_x equals approximately 10M at an I_{bis} value of 1uA and 10k at an I_{bias} value of 1mA. ***Fig. 10*** shows how a pair of these circuits can be used to make a floating VCR, in which the input voltage is direct-coupled and may be any value within the output voltage range of the LM13600.

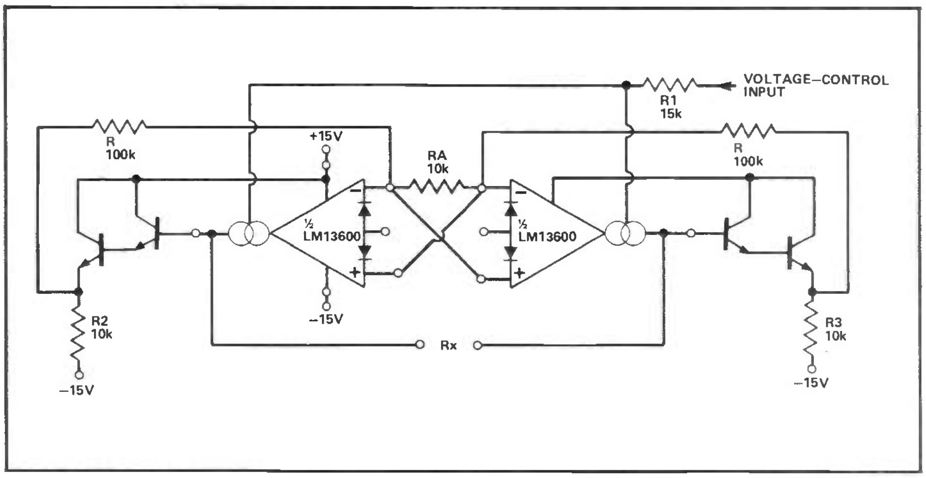


Figure 10. Floating Voltage-Controlled Resistor.

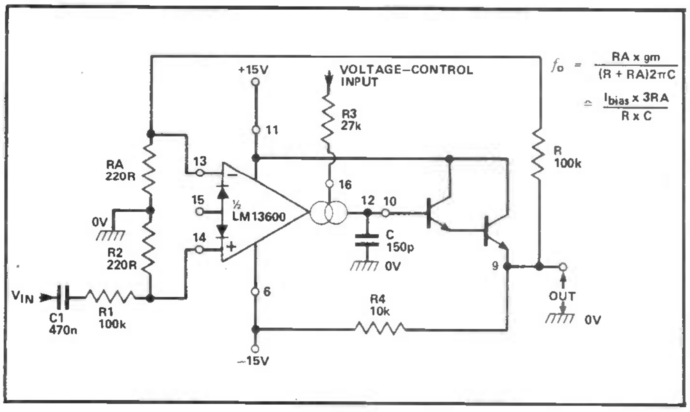


Figure 11. Voltage-Controlled low-pass Filter covering 45Hz to 45kHz.

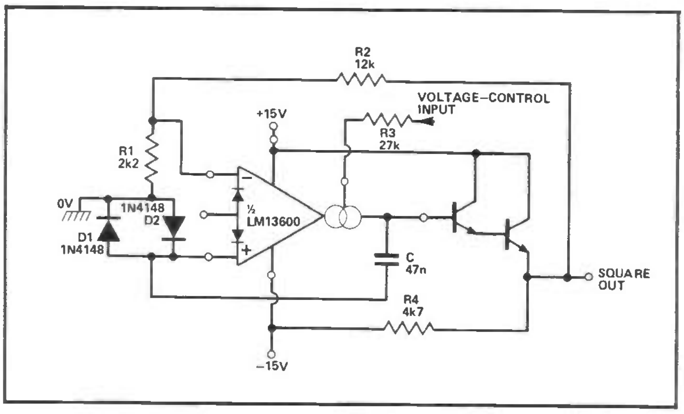


Figure 13. Single-amplifier VCO.

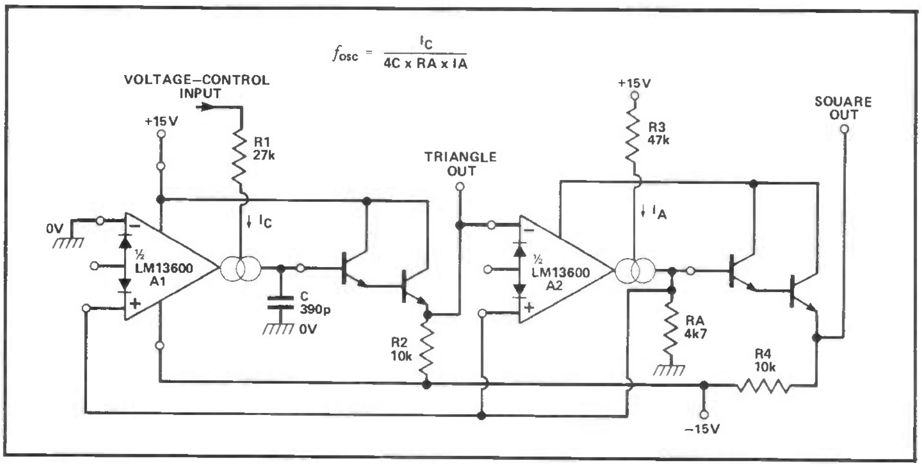


Figure 12. Triangle/Square VCO covering 200Hz to 200kHz.

Voltage Controlled Filters

An OTA acts as a voltage-controlled AC current source, in which an AC voltage is applied to the input of the amplifier, and the magnitude of the output current depends on the value of this voltage and I_{bias}. This fact can be used to implement a voltage controlled low-pass filter by using one half of an LM13600 in the configuration shown in ***Fig. 11***, in which the values of R, C, and I_{bias} control the cut-off frequency, f_0, of the filter.

The operating theory of the circuit is as follows. Assume initially that capacitor C is removed from the circuit. The input signal is applied to the non-inverting terminal of the OTA via potential divider R1-R2, and the OTA output signal is 'followed' by the buffer stage and fed back to the inverting terminal via an identical potential divider made up of resistors R and RA. The basic OTA thus acts as a non-inverting amplifier, with a gain of R/RA, and the circuit acts overall as a unity-gain voltage follower.

At low frequencies, with capacitor C fitted in place, C has a very high impedance and the OTA output current is able to fully charge C. The circuit thus acts as a voltage follower in the manner already described. As the frequency increases, however, the impedance of C decreases and the OTA output current is no longer able to fully charge C. The output signal voltage then starts to attenuate at a rate of 6dB per octave. The cut-off point of the circuit, at which the output falls by 3dB, occurs when $X_C/20xI_{bias}$ equals R/RZ, as shown by the formula in the diagram. With the component values shown, cut-off occurs at about 45Hz, with an I_{bias} value of 1uA, and at 45kHz using 1mA.

Voltage Controlled Oscillators

To conclude this look at application of the LM13600, ***Figs. 12*** and ***13*** show two ways of using the IC as a voltage-controlled oscillator (VCO). The ***Fig. 12*** circuit uses both halves of the LM13600, and simultaneously generates both triangle and square waves. The ***Fig. 13*** design uses only half of the IC, and generates square waves only.

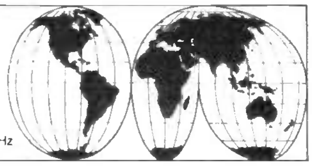
To understand the operating theory of the ***Fig. 12*** circuit, assume initially that capacitor C is negatively charged and that the square wave output signal has just switched high. Under this condition a positive voltage is developed across RA, which this is fed to the non-inverting terminals of the two amplifiers; both of which are wired in the voltage-comparator mode. This voltage causes amplifier A1 to generate a positive output current equal to bias current I_C, and this current flows into capacitor C, which generates a positive-going linear ramp voltage. The ramp is fed to the inverting terminal of A2 via the Darlington buffer stage, until eventually this voltage equals the voltage on the non-inverting terminal, at which point the output of A2 starts to swing in a negative direction. This initiates a regenerative switching action, in which the square wave output terminal switches abruptly negative.

Under this new condition, a negative voltage is generated across resistor RA, causing amplifier A1 to generate a negative output current equal to I_C. This current causes capacitor C to discharge linearly until eventually its voltage falls to a value equal to that of RA, at which point the square wave output switches high again. The whole process repeats *ad infinitum*, causing a triangle waveform to be generated on R2 and a square wave output to be generated on R4.

■ R&EW

Next month, in place of Data File, we present a new series of Designers Update devoted to the latest circuits and design applications.

SHORT WAVE NEWS FOR DX LISTENERS



Frank A. Baldwin

All times in GMT, **bold figures** indicate the frequency in kHz

Last month I dealt with some of the Latin American transmitters that could be relatively easily logged here in the UK during the present 'season' for LA reception - April through to September approximately. In this issue a progression is made to the rather more difficult to log transmitters operating from the South American area.

Tune to **4770** where, from around 0200 onwards you may manage to log Radio Mundial in Bolivar. The schedule is from 1000 to 0400 and the power is 1kW and it is best received here in the UK from 0200 to 0400.

"La Voz de Carabobo" in Valencia is another one to listen for once the dial is set to **4780**. This 1kW transmitter is on the air from 0855 to 0400 (Sunday from 1000 to 0300) but the frequency can vary to **4779** at times. Like all Venezuelan stations the language used is Spanish.

In Arauca the local station is Emisora Meridiano 70 which identifies as "Radio Tropical" and may be heard - if you are lucky - on **4925** where it is listed from 1100 to 0450 (Friday until 0400) with a power of 2.5kW. The problem is that this channel is also occupied by two Brazilians, Radio Dragao do Mar 5kW and Radio Difusora Taubate 1kW until their closing time of 0300. Listen for Radio Tropical therefore from 0300 onwards and I should add that their closing time of 0450 is variable.

Ecos del Atrato in Quibdo occupies the **5020** channel from 1030 to 0400 with a power of 2kW. Problem is - Radio Borborema in Brazil 1kW and Radio Quillabamba in Peru 5kW. The former closes at 0430 and the latter at 0300 variable. The best time would be around the 0330 mark and hope that Ecos del Atrato will dominate the mix with R. Borborema.

Turning our attention now to Ecuador, "La Voz de los Caras" in Bahia de Caraques is to be found on **4795** operating to the schedule 1100 to 0430 with a power of 5kW. On Sunday it closes at 0200 and on Friday at 0500.

Ecuador is on the equatorial Pacific coast, bounded on the north by Colombia and Peru to the south and west.

"Radio Popular" in Cuenca - the capital of Azuay province - has a 5kW signal and operates on **4801** from 1000 to 0700. Wait until RadioLara on **4800** closes at 0400 before trying to log R.Popular Independiente - its full title.

Then there is Radio Luz y Vida in Loja on **4851** 2kW closing at 0430; Radio Amazonas on **4870** signing-off at 0330, this one operating in both Spanish and local Indian vernaculars with a power of 5kW and Radio Federacion in Sucua on **4960** with 5kW closing at 0300 (Saturday at 0400, Sunday at 0100). It uses both Spanish and local Indian languages.

Around The Dial

Ecuador

Radio Iris, Esmeraldas on **3380** at 0202, OM with announcements is Spanish then into a programme of typical Latin American style music. This 10kW transmitter is operating from 1000 (Sunday from 1100) through to 0300, although the actual closing time can vary up to as late as 0520 on occasions.

Honduras

Radio Lux, Olanchito on **4890** at 0135, OM with a newscast in Spanish with several local towns mentioned. The schedule is from 1200 to 0300 but the actual sign-off time can vary - it has been reported closing any time between 0240 and 0400. One of the traits of the Latin American stations is that they quite often close at clock times other than those listed. Being mostly small independent stations they can, and often do, run-out of material, money or spare parts resulting in a very sudden shut-down.

Venezuela

Radio Mundial in Bolivar is on **4770**, where it was logged at 0224 when radiating a programme of songs, the accompaniment being an accordion. Often logged, this one occupies this channel from 1000 to 0400 with a 1kW transmitter. The address is Apartado 123, Ciudad Bolivar.

Radio Tachira, San Cristobal on **4830** at 0146, OM with a political talk in Spanish. The schedule is from 1000 to 0500 and the power is 10kW. Interesting in that I found this programme in parallel on **4770** R. Mundial and also on **4780** La Voz de Carabobo (The Voice of Carabobo - one of the Venezuelan states). It must have been a national hook-up.

Brazil

Radio Emisora Rural, Santarem on **4765** at 0221, OM with announcements in Portuguese, YL with a ballad complete with guitar backing. The schedule is from 1000 to 0400 and the power is 10kW. The other 10kW Brazilian on this channel - Radio Nacional, Cruzeiro do Sul, closes at 0100.

Radio Borborema, Campina Grande on **5025** at 0125, OM announcer with a programme of local pops. This one operates from 0800 to 0300 at 1kW and the address is Caixa Postale 160, 58100 Campina Grande, Paraiba.

DX-TV

Compiled by Keith Hamer & Garry Smith

Our thanks go to the weathermen once again this month! A high-pressure system located over Europe produced yet another spectacular tropospheric opening around the 8th of March. Tropospheric ducting took place since many of the signals noted at around mid-day originated from Central Europe with Dutch and Belgian stations being absent.

During the month Sporadic-E activity increased. By the time this column is read, the 1983 SpE season should be well underway with hopefully a bumper selection of countries in store. Meteor shower (MS) activity provided the bulk of reception with many signals being identified by test cards and clock captions. The star performer during March was Czechoslovakia (CST) which was sighted on no fewer than 12 days. Signals from Austria (ORF) and Norway (NRK) were also noted on frequent occasions. Other countries seen via MS included Denmark, Hungary, Spain, Sweden, Poland, East Germany and Switzerland.

During quiet conditions it is often worth leaving a receiver running on a vacant channel as apart from MS reception, an SpE opening can materialise quite unexpectedly. Such an incident occurred on the 2nd at 2155 on channel E3 when a news programme appeared. It was quickly obscured by a co-channel signal. Channels E2 and E4 were then monitored on other receivers and a similar news programme appeared which was identified as Norway by their logo at 2205GMT. The weather chart and a programme schedule for the following day appeared with the final closedown sequence at 2212.

Later in the month an intense SpE opening occurred quite suddenly during the afternoon of the 24th. It affected the 'R' channels with Russian and Polish transmissions in evidence. Several Eastern European FM radio stations also appeared around 68MHz.

Transmissions from Spain (RTVE) and Portugal (RTP) were observed on the 29th around mid-day with colour bars from RTVE on channel E4. Programmes from RPT were seen on E2 and E3. Reception continued for some thirty minutes before fading into the noise.

The tropospheric opening of the 8th provided perhaps some of the most rewarding reception for a long time. The majority of services were radiating test cards so identification was quick and simple. Due to the ducting effect of the troposphere, many 'exotic' transmitters located in southern Germany were seen. These would normally be obscured by signals from the near Continent such as the Netherlands. The East German electronic test card from DDR:F was snow-free at times and a video recording of it produced quite acceptable colour when a SECAM monitor was used for play back.

The biggest surprise was the sighting of the FuBK test card in PAL colour from Radio-Tele-Luxembourg with the identification 'ECOUTEZ RTL'. Reception was from the channel E27 outlet at Dudelange. Fortunately the more usual channel 27 visitors such as Lille (TDF-France), Lopik (NOS-Netherlands), Rowridge (TVS) and Sandy Heath (BBC-2) were, for some strange reason, not there!

Service Information

West Germany: Regional transmissions from ARD-1 services such as NDR,BR,SFB,HR etc., are limited to only two hours per day from Monday to Saturday, commencing at 1800BST. The same services operating via ARD-3 are normally entirely regional with only the occasional networked programme.

Spain: Signals from this country are regularly received within the UK during the summer DX season. The following details should prove to be of interest to enthusiasts trying to identify regional transmissions:-

The regional news programmes commence between 1300 and 1330BST. There is also a one hour regional programme from the Canary Islands (RTVE) which begins at 1700 local time on channel E3 originating from the Izana transmitter.

The above information was kindly supplied by Juergen Klassen and Gosta van der Linden.

Reception Reports

Juergen Klassen, an avid reader of **R&EW**, has written from West Berlin to report that live BBC and ITN news programmes are regularly watched in the locality served by the channel E52 transmitter at Bad Pyrmont. This outlet is operated by the British Forces Broadcasting Service. Juergen is currently using a Blaupunkt RTV-224 stereo VCR to record his DX-TV reception.

Colombia

Emisora Nuevo Mundo, Bogata on **4755** at 0615, OM identification as "Radio Caracol", promos, local pop songs and music. With a 24-hour schedule, this one has a power of 1kW.

Radio Super, Medellin on **4875** at 0614, OM announcer and promos, local pops and music during the 24-hour schedule. The power is 2kW and the QTH is Apartado Aereo 3399, Medellin, Antioquia. The Gerente is Henry Pava C.

Polynesia

Tahiti on **11825** at 0725, local music and choral songs in Tahitian, YL announcer in French. Papeete was audible until 0750 when the signal was finally lost under co-channel noise. This is the Home Service which operates from 1600 to 0730 but to 0900 on Saturday - that was the day I logged it!

North Korea

Pyongyang on **6576** at 2028, YL with an English programme all about the local revolution, this transmission being timed from 2000 to 2050 and directed to Europe.

South Korea

Seoul on **9870** at 1534, OM with newscast in the Arabic transmission for the Middle East, scheduled from 1530 to 1600.

India

AIR (All India Radio) Delhi on **7280** at 1525, OM with local news in Hindi, YL with the station identification together with a newscast in English at 1530 which lasted until 1545.

AIR Delhi on **17780** at 1132, OM with a talk during the Burmese programme to South East Asia, timed from 1115 to 1215.

Ghana

Accra on **3366** at 0546, OM with a sermon in English, choir with hymns in the English Service radiated on this frequency from 0530 to 0800 (Sunday until 0900) and from 1530 to 2305. The power is 10kW.

China

Radio Beijing (formerly Peking) on **6860** at 2022, OM with announcements in the German transmission to Europe, North and West Africa, scheduled from 2000 to 2100.

South Africa

SABC Meyerton on **3250** at 0205, light orchestral music in the European manner in the All Night Service, timed on this channel from 2200 to 0300. The SABC (South African Broadcasting Corporation) Verwoerd Station at Meyerton also radiates the Radio 5 Programme from 0300 to 0545 and from 1530 to 2200 on this frequency. The power is 100kW.

Afghanistan

Kabul on **4740** at 0217, orchestral music in the 'dreamy' style, YL with announcements in a Home Service 1 presentation. This service is on the air from 0125 to 0330 and from 1230 to 1930.

Senegal

Dakar on **4890** at 2025, OM with a talk in French in the National Service which is in both French and vernaculars. The schedule is from 0600 to 0800 and from 1800 to 2400. Also logged at 0610, OM with quotes from the Holy Quran.

Gabon

Franceville on **4830** at 2032, OM with a talk in French in the Regional Network, scheduled on the air from 0430 to 0700 and from 1600 to 2300. The power is 20kW.

Nigeria

FRCN (Federal Radio Corporation of Nigeria) Lagos on **3326** at 0553, OM with announcements in vernacular, OM's with songs in the Channel 1 Service timed from 0430 to 1000 and from 1700 to 2310 with a power of 50kW.

Somalia

Radio Mogadishu on **6790** at 1616, YL with announcements in Somali, orchestral music in the European style in a Domestic Service transmission.

Pakistan

PBC Rawalpindi on a measured **21756** at 1150, YL with songs then YL with announcements in the Burmese programme for Burma, scheduled from 1100 to 1200.

Morocco

Rabat on **15360** at 1143, OM with announcements in Arabic then a following programme of local-style music and songs in the Domestic Service which may be heard on this frequency from 1100 to 1615.

Kuwait

Radio Kuwait on **17650** at 1140, Arabic music, YL with songs in the External/Domestic Service 1st Programme which is on this channel from 0730 to 2210 (until 0015 during Ramadan).

Lesotho

Maseru on **4800** at 1842, OM with a talk in Sesotho in the Home Service transmission which is on this frequency from 0400 to 2155. The power is 100kW and the address for reports is Lesotho National Broadcasting Service, P.O. Box 552, Maseru 100.

Namibia

Windhoek on **4965** at 1854, YL with folk songs in Afrikaans, pips time-check at 1900, OM with station identification and a newscast in English.

■ R&EW

From Mount Waverley in Victoria, Robert Copeman comments that despite a recent improvement in the Australian SpE DX season, the overall results have been very disappointing. In fact this year's reception has been the worst on record at his location. Robert's DX-TV colleague Todd Emslie has experienced similar conditions in Sydney. On the plus side, troposheric conditions have been unusually good.

During recent enhanced trop conditions in Europe, Robert Hanke (Kaarst, West Germany) successfully resolved the FuBK test card from RTL-Luxembourg on channel E7. The 100kW transmitter is located at Dudelange. The sound accompanying the test card was from the multi-lingual RTL FM community radio service on 92.5MHz. He was surprised to note that RTL have changed their VHF transmission system from C/PAL to B/PAL.

Whilst on the subject of RTL, Hugh Cocks (Robertsbridge, East Sussex) reports that they have, at times, reverted to the old system C standard (625 lines, positive vision modulation and AM sound) on

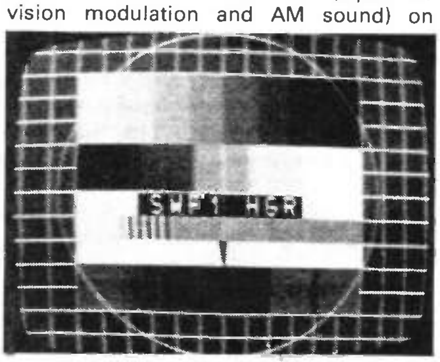


Figure 1. The FuBK test card received during March from the E9 transmitter at Hornisgrinde.

channel E7. During such periods the E27 outlet radiates on reduced power.

Leeds **R&EW** reader Mike Allmark has updated his DX-TV gear with the addition of a Plustron TVR5D multi-band monochrome portable. We understand that these are no longer in production. His other receiving equipment includes dual-standard Bush TV 161s and a Decca 30 colour receiver. A Sanyo 9300 VCR is used for recording DX signals. By using the Plustron, Mike can get Belgium and the Netherlands in Band III on a daily basis. The Italian private television test card which we featured in the April column looked familiar to Mike. Apparently he received a similar pattern on channel E4 in 1979 with "TELEOR CAN B,UHF" identification from a low-power outlet. There are several enthusiasts in the Leeds area interested in DX-TV and a CB hotline has been established for passing on information.

Roger Bunney (Romsey, Hampshire) found the troposheric opening of early March very rewarding as it produced West German Band III reception during the afternoon of the 7th. The following day was more spectacular with the Austrian second network on channel E24 radiating the test card (ORF FS2) from 0850. Suddenly at 1000, BBC-2 Rowridge came on the air and that was the end of ORF! Other reception that day included Luxembourg using system B on E7 and East Germany on E6 and E34.

Highlights of the month from Clive Athowe (Blofield, Norfolk) include the late evening Sporadic-E opening to Scandinavia on the 2nd as previously mentioned, a glimpse of the Rumanian monoscopic test card via meteor shower during the morning of the 19th and various OIRT countries via SpE on channels R1,R2 and R3 on the 25th. The latter opening produced the Russian news programme BPEMR and Polish programmes in SECAM colour using his JVC CX610GB portable. A long list of trops for the 8th include the East German second network on E31, E33 and E34 showing the electronic colour test pattern, and the Swiss FuBK test card from the La Dole transmitter. Both the French (SSR) and German (SRG/DRS) language services were noted on channels E31 and E34 respectively. There were also excellent signals from RTL- Luxembourg received in PAL colour on channel E27. A few West German trops were in evidence with Saarlaendischer Rundfunk from the channel E2 Goettelborner Hoehe transmitter and Bayerischer Rundfunk on E2 and E3 from Gruenten and Kreuzberg.

Finally, a mystery PM5544 test card was located on UHF from a south-easterly direction at 0920 CET on the 9th. The pattern did not carry any identification although a digital clock insert was included to the right of centre. A tone was present and the sound-vision spacing was 5.5MHz.

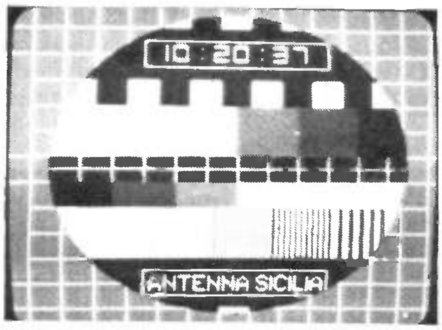


Figure 2. An Italian pirate television test card. This one is radiated in Sicily. Photo by courtesy of Anthony Briffa, Malta.

■ R&EW

NOTES FROM THE PAST

Readers often complain to us about their dealings with unscrupulous service and repair agents. This story, from Centre Tap just after the war, puts things into perspective.

In the early days of the war, a certain enthusiast, at that time a humble NCO, was stationed in a fair-sized country town and in his spare time he set to repairing a few portables and midgets belonging to his buddies. The need for components took him to the local dealer who, incidentally, did not normally stock them for re-sale. After two or three such visits the proprietor asked him if he would undertake some repairs for his Service Dept, as his regular man had been called to The Forces. The enthusiast was a very competent radio engineer, and Army pay being as it was at that time a few shillings a week, he agreed to put in a few evenings when he was free. The proprietor suggested a flat rate of three shillings and sixpence for all repaired sets which our friend thought quite fair.

The "Servicing Dept" turned out to be little more than a large cupboard under the staircase, while the equipment consisted of a DC Avominor with a cracked glass, a cheap soldering iron of Japanese origin (retailed at one shilling and elevenpence pre-war), a small screwdriver and a larger one which evidently came in for many other uses such as levering open packing cases! The dealer was amazed our friend should require more than that — why, his regular man who, he hinted darkly, completely understood wireless, could find most faults without even having recourse to the meter!

Plenty of Work

The first evening he put eight sets in working order. It happened there was nothing more complicated than replacing valves, electrolytics, line-cords, etc. He drew his twenty-eight shillings, less two shillings for the fish and chips that the proprietor's wife fetched for his supper, cup of tea and bread and butter. The next evening he repaired six sets (only one sticky one) and upon paying him the dealer assured him there would be plenty of work coming in as he had advertised his Service Dept was carrying on. At that time there was plenty of work and within a few days the passage was stacked high with waiting sets.

When the waiting repairs became embarrassing with the passage way completely choked and overflowing, the dealer asked him if he had a friend who would care to come along on the same terms. As a matter of fact he hadn't, so in order to speed up the turn around he suggested that if the dealer himself did the removal and refitting of the chassis from the cases, he would be free to spend more time on repairs, pointing out that the dealer was there in any case doing nothing in particular most of the time.

This arrangement resulted in a slight increase of turn-around and the dealer hinted that in view of this new arrangement, the rate of payment should be revised. This was naturally resented by our friend especially as his supper bill had recently risen with the 'cost of living', and the equipment now in use was his own. The fact that he was earning about £4 a week for spare-time work must have irked the dealer, but our friend felt confident that even if, as the dealer put it, he was on a 'Good Thing', he knew perfectly well that the dealer himself was on a still 'Better Thing'.

Consequently, there was a certain amount of feeling on both sides, which most evenings resulted in words, especially as the dealer was not only greedy, but a rather ill-natured fellow. After a run of lengthy jobs which meant three shillings and sixpence hard earned, he ran into three of the simplest repairs imaginable. The first was a receiver which had been 'spring-cleaned' by its owner and two valves had been wrongly replaced. The second was a similar case of spring-cleaning but a grid cap of the open type had been replaced upside-down and was just fouling the metalising of the valve, while the third was a simple case of a loosened grub-screw on the tuning drive. It must have touched the dealer on the raw to see someone earn ten shillings and sixpence in less time than it took him to replace a chassis in a cabinet and it provoked him to more words and ill-concealed hints of easy money, which in turn drove our friend to check up on the charges that were being passed to the customer. The sets for delivery went into the garage and those for collection by the customer went into the shop. It was on the latter he was able to check, as he knew there was no other cost chargeable to them.

The bills for the three sets quoted, varied from twenty-five shillings to thirty-five shillings, apparently based on the value of the set or the estimated means of the customer. The colossal rate of profit (or profiteering if you will) took his breath away, but he saved it up until the next time there was 'words.' Even then the dealer tried to justify the prices by claiming he had to average out costs and that on some of the expensive repairs, such as burn-outs, etc, he actually lost. He couldn't, he explained, take an amount of perhaps half the cost of the set for a repair. Couldn't he? A quick check revealed some that ran into seventy shillings or more!

The Final Blow

There was nothing much our friend could do about it, at least not without a lot of bother, and he was a little bit nervous when he suddenly remembered that he hadn't declared his spare-time earnings for Income Tax assessment. In any case, he was expecting to be moved shortly but before they finally parted company there was a further incident.

A family evacuated from London took an expensive radiogram with them and they had wrecked the mains transformer and almost started a fire by connecting it to DC mains. The dealer warned them it would not only be an expensive job but that they might have to wait many months for replacements. As they were expecting to move again they finally sold it to him in despair, for £10. After repair, it was sold to another dealer for £40. Reckoning the cost of transport at £1, replacements at £2, there is still £27 left, of which our friend's share for doing the job was three shillings and sixpence!

R&EW BOOK SERVICE

ZX81 BASIC BOOK
By Robin Norman
1982; 168pp; 215 x 130; Paperback.
Stock No: 02-11785 **Price: 5.95**
If you have a ZX81, or are thinking of buying one, this book will tell you all you need to know to get the best from it.
This book covers the basic 1K version, the additional facilities offered by the 16K expansion RAM, and how to use the ZX Printer. There are 14 original programs for you to run on the machine (for 1K and 16K versions), and for those confused by computer jargon (and who isn't?) there is a glossary of technical terms.
Robin Norman assumes no initial computing know-how, and his undemanding writing style is a perfect beginner's introduction.

THE SPECTRUM BOOK OF GAMES
By M James, S M Gee, & K Ewband
1983; 146pp; 155 235mm; Paperback
Stock No: 02-20479 **Price: 6.50**
Here is a selection of twenty-one exciting, high quality games written specially for the ZX Spectrum. These games make full use of the Spectrum's facilities, and are fully tested and crash-proofed.
Among those included are variant of popular arcade games such as Spectrum Invaders, Rainbow Squash and Mighty Missile; board games such as Capture the Quark; a compelling adventure game Treasure Island; a conversational game in which the Spectrum answers you back; and a commando game for you to test your skill. Each program is presented to appeal to all Spectrum owners, no matter how old or young, whether you are completely new to computing or fairly experienced.
Each program is accompanied by an explanation of how to play the game and how the program works, including tips on how to modify or 'personalize' it for your own special use.
Normally games of this quality are only available individually on cassette. This book therefore gives you remarkable value.

THE SPECTRUM PROGRAMMER
By S M Gee
1983; 142pp; 155 x 235mm; Paperback
Stock No: 02-20258 **Price: 6.50**
The appearance of the Sinclair ZX Spectrum in 1982 was a major event in personal computing. This book takes the Spectrum user in easy stages from his first steps in programming to a good level of competence.
Early chapters give a brief history of the ZX range, and give advice on how to set up the machine and use the keyboard. Subsequent chapters describe one's first steps in BASIC, looping and choice, handling text and numbers, and functions and subroutines. There are three chapters on graphics and sound while the final chapters is devoted to logic and other advanced topics.
The book includes many programming examples, and most chapters contain at least one complete program listing, mainly for games applications. It is clearly and logically written, and will be invaluable to all spectrum users, in the home, education and small business.

INTRODUCING SPECTRUM MACHINE CODE
By Ian Sinclair

1983; 152pp; 230 x 155mm; Paperback.
Stock No: 02-20827 **Price: 8.50**
GET MORE SPEED AND POWER FROM YOUR ZX SPECTRUM! Many of the things you want, like fast moving graphics for games, cannot be achieved with slow-acting, high level languages such as BASIC. Also, actions which have not already been provided for by your Spectrum's in-built BASIC interpreter are just impossible. For instance, you won't be able to use ZX81 cassettes, you cannot renumber a whole set of lines quickly you cannot send serial printer signals to the cassette output, etc. All these, however, and many others can be accomplished by programming the Spectrum directly in machine code. Sooner or later, all microcomputer users feel the need to get to grips with machine code.
Unlike most books on machine code, this has been written specially for the beginner who is carefully shown what to do in easy stages, step by step. A knowledge of machine code will enable you to really master your Spectrum and open up a fascinating range of extra facilities you would hardly have thought possible!

THE ZX SPECTRUM AND HOW TO GET THE MOST FROM IT
By Ian Sinclair
1982; 130pp; 155 x 235mm; Paperback
Stock No: 02-20185 **Price 6.50**
This book is written for the Sinclair SPECTRUM user who is a beginner or has used other machines, particularly the ZX81. It covers the setting up and operation of the machine in detail but from the viewpoint of the beginner, highlighting the difficulties and illustrating how the machine responds to incorrect commands. The beginner is guided through the difficult early stages until he or she feels confident enough to start designing and entering BASIC programs. The book has also been designed to be used as a reference guide for the more experienced user.

ZX81 USER'S HANDBOOK
By T J Terrell & R J Simpson
1982; 138pp; 215 x 135mm; Paperback.
Stock No: 02-12234 **Price: 5.95**
The ZX81 is a fascinating machine that has brought the power of the computer within everyone's reach. But the user is often bewildered by the many facilities offered by the ZX81, and after mastering some simple BASIC programming, finds himself asking questions about the machine:
What is a string and how is it used?
How can I create moving graphics?
How can I interface external hardware?
Why use machine code?
The ZX81 User's Handbook sets out to answer these and many more questions, covering the structure of the ZX81, binary and hexadecimal arithmetic, flow charts, logic, graphics, the Z80A microprocessor work and machine code.
Original programs illustrate these topics (all running on the standard 1K version), and a glossary of over 100 terms is included.

PROGRAMMING WITH GRAPHICS
By Garry Marshall
1983; 120pp; 155 x 235mm; Paperback.
Stock No: 02-20215 **Price: 6.50**
Computer graphics is a fascinating field. It has also become highly topical, as so many of the new personal computers have high-resolution graphics.
This book provides an up-to-date treatment of the subject, covering the three major methods of graphics production. After introductory chapters describing the background to graphics and the principles of its production, there are three chapters devoted to block, pixel and line graphics. The final chapter considers topics such as colour, movement and three-dimensional drawing, and the Appendix summarises the graphics facilities of various micros.
The book is readily understandable by the non-mathematical user, and has the great advantage over most books on this subject of being machine independent. It will therefore be of great interest to all personal computer users who use or wish to use graphics, whether in the home, in education or in business.

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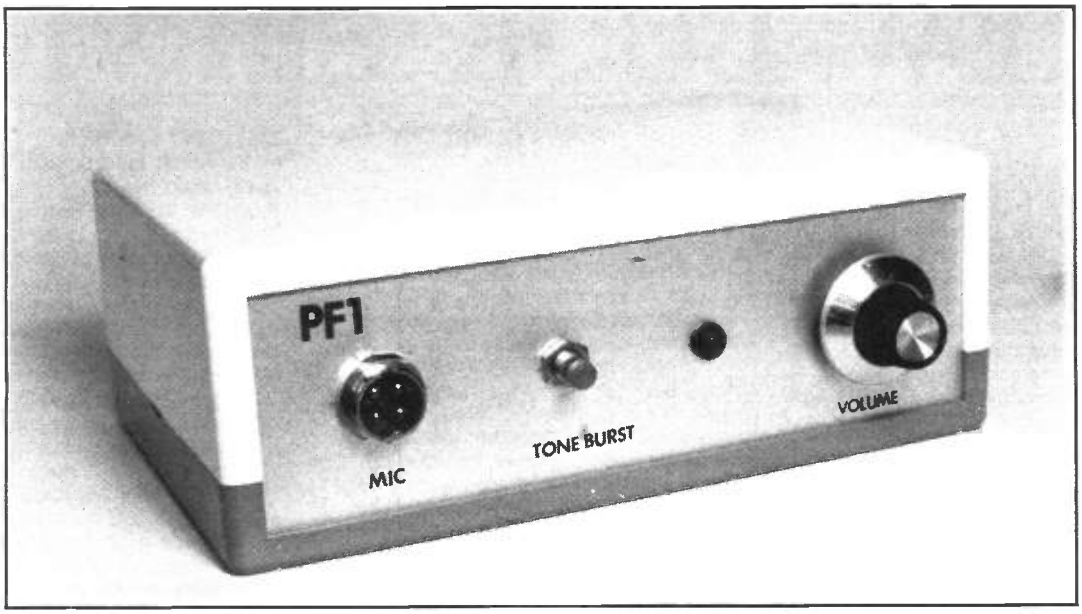


PF1 CONVERSION

Steven Ibbs explains how to transform the PF1 into a 70cm base station.

The PF1 consists of a pair of boxes, one containing the transmitter with a small spring loaded aerial, and the other the receiver. Formerly used by the police, they have been largely replaced by the PF70 and are therefore cheap and easy to come by. The PF1 is a basic single channel rig, built in transducer microphone, with a small grill acting as a receiver aerial. However with a modest amount of attention, they can be converted to become surely the cheapest way onto 70cms.

The Receiver

This requires 9 volts and consists of a double superhet receiver with a first IF of 10.7MHz and a second IF of 100kHz. It has an automatic battery economiser which operates in the absence of an incoming signal. Some have a transducer output, others incorporate a very small speaker.

When a battery is inserted and the unit turned on, a ticking sound should be heard in the speaker, showing the economiser circuit is working. Take out the battery, undo the case screws and remove the circuit board.

The next job is to change the crystal, but *NOT* the one that is immediately visible (this is the 2nd oscillator crystal, operating at 10.8MHz, and attempting to put an 84MHz crystal will upset the receiver). Instead, remove the metal screening can by undoing the small nuts. A second crystal location will be found. Insert the appropriate crystal, check that no solder joins have been made on the very compact track side, and replace the screening-can.

It is usually easier to disable the squelch when tuning; accomplished by temporarily linking the base of Q14 to earth via a short piece of insulated wire. Connect a voltmeter between the base of Q11 and earth. Inject a signal and adjust C2,C6,C11,C18,T2,T3 for the best quieting, reducing the input level to achieve optimum sensitivity — the voltmeter is helpful here because the capacitors can be initially adjusted for maximum dip.

Once this has been done, all sorts of adjustments are possible using crystal IF oscillators etc. However, probably the best course is to make small changes towards the highest quality audio — it may not be very accurate, but it works.

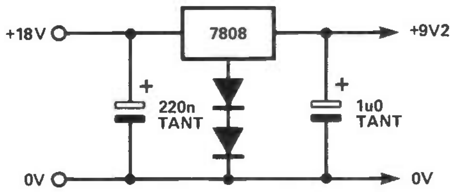


Figure 2. Regulated receiver supply.

Disconnect the temporary link wire and check that the squelch circuit operates properly. The economiser circuit holds the receiver on for a couple of seconds before switching it to economiser mode. If all is satisfactory, receiver modifications are complete.

The Transmitter

Operating on 18 volts, it consists of a phase modulated signal which goes through four stages of multiplication (x3,3,2,2) before being boosted by a 2N3866 PA in common base mode. The conversion usually proves to be a much simpler affair than the receiver.

First, remove the battery, the retaining screws, and the top half of the case. Disconnect the lead to the aerial and connect a co-ax lead to either a terminated power meter or a dummy load via an SWR bridge. Insert the 12MHz crystal, connect the supply and press the PTT switch. The meter should show some deflection and

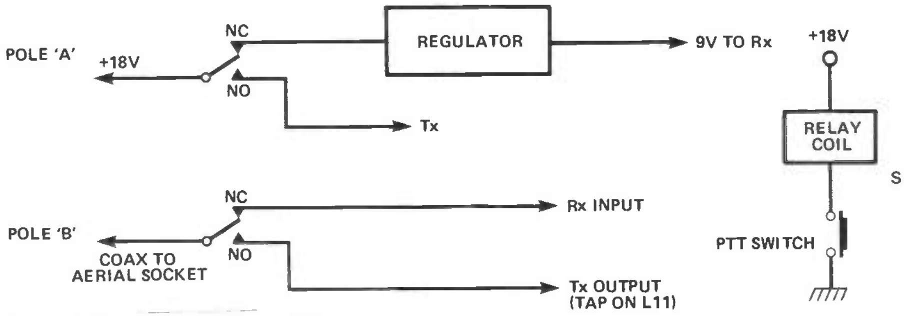
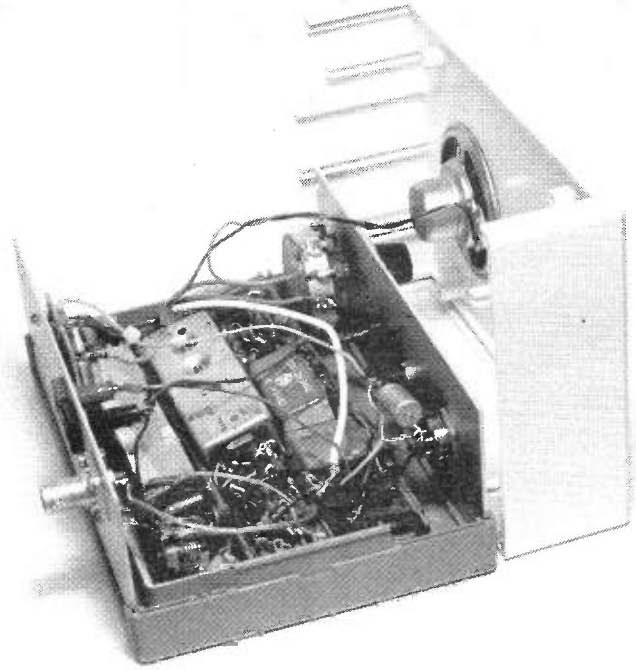


Figure 1. Receive/transmit switching.

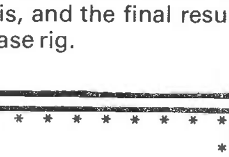


tuning consists of peaking the various stages for maximum RF out. Do not, however, adjust L1, which is furthest away from the PA. Capacitor, C17, (by L1) adjusts the frequency and should be trimmed with reference to a frequency meter or other reliable source. In troublesome PF1s, a simple sniffer (2-3 turns of 18- 20SWG wire, a diode and a 50uA meter movement) is extremely valuable. It can be moved along the transmitter strip and is a good means of finding, say, a useless PA stage or a low gain multiplier — a healthy transmitter should produce at least 100mW!

A Combined Effort

Having finished the conversions to both units, the 'icing on the cake' is to fit both into a single case. The two units are mounted, each resting in one half of its plastic case, into a metal cabinet. The receiver volume control is removed and leads run to a panel-mounted 5k log volume control. The power supply and aerial connections are fed from an 18V relay. This relay is mounted using double-sided sticky pads in the receiver battery compartment. The two units are then sited so that the Tx PA is close to the relay to keep co-ax leads short. The regulator — a 7808 with 2 diodes in series in the common lead — is secured via a small piece of veroboard in the case. The receiver grill aerial is discarded and a co-ax lead run to the relay pole B.

Disconnect the transducer from the transmitter, and run a screened lead from the audio input position to a standard 4 pin mic socket on the front panel. The unit will then need to be retrimmed, but there should be no problem with this, and the final result is a very useful base rig.



NEW PRODUCTS

Precision PSU

A 10A precision laboratory power supply (type NTLO5) from PTM Elektronik is now available in the UK. With an output power of 150W, a voltage range of 0-50V and a current range of 0-3A, this unit outpowers and outprices the competion. The unit employs the Motorola voltage and current regulator, MC1466L, to achieve high voltage and current stability in both voltage and current control mode. An automatic two-stage dissipation control enables cool operation over the entire power range. Two 3-digit LED displays meter current and voltage and can also be used for independant external measurement during normal power supply operation. The outputs are fully protected against short circuits and reverse voltages, making the unit very suitable for the workshop and laboratory in schools and industry. The PSU is priced at £253, and a version may be purchased with fully calibrated DVM modules and detailed assembly instructions for only £184

FREL Ltd.,
Holmbush Industrial Estate,
MIDHURST,
West Sussex,
GU29 9HX.

Keeping A Low Profile

Now available from Kemo is a British designed and manufacturered low-frequency communications receiver, using solid-state digital filters to achieve a high degree of frequency discrimination.

The new Metcom receiver operates over a frequency range of 0.1kHz to 100kHz, and the output is arranged so that the demodulated signal is in the 0-10kHz range, with either upper or lower sidebands demodulated in this range. Resolution is ±1Hz and accuracy is ±10 parts in 10^6 (±1Hz). The receiver functions as a frequency-selective voltmeter with variable bandwidth, and −3dB bandwidths of 250Hz, 1kHz, 4kHz and 8kHz are available. Output signal/noise ratio is typically 60dB, and the circuit techniques used eliminate phase jitter.

An internal crystal-controlled oscillator provides a reference frequency, so that received frequencies can be accurately indicated on a 5-digit LED display. An amplitude-modulated signal demodulator and local-oscillator beat-frequency detector permit the centre frequency to be adjusted without altering the main tuning and LED display.

Three outputs are available: 1V RMS into 2k; ±10V into 100R; and an audio output compatible with a low-impedance headset with volume control.

Kemo Limited,
9-12 Goodwood Parade,
Elmers End,
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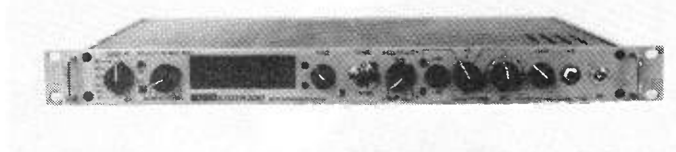
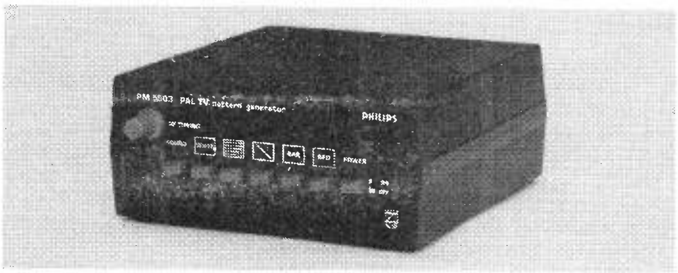
Kent,
BR3 3QZ





Patterns On Your TV

A robust, compact and low-cost PAL colour television pattern generator, aimed at the travelling service engineer, has been introduced by Philips Test and Measuring Instruments. The PM 5503 provides standard grey scale, cross hatch, red pattern and colour bar, as well as a one hundred percent white pattern.

The instrument is tunable between 189 and 205 MHz in the VHF band and between 567 and 615MHz for UHF. It is available in versions compatible with PAL B, G, H and I television systems. Accurate tuning and checking of a television's sound performance is facilitated by the inclusion of a 1 kHz sine-wave source, while a video output allows the instrument to be used for making adjustments to monitors and closed-circuit television systems.

Five test signals provide information for adjustment of the vast majority of television parameters. A one hundred per cent white pattern with alternating burst assists beam current adjustment and is essential for checking the white setting to guarantee optimum colour performance. Centring, vertical/horizontal linearity and dynamic and static convergence can be adjusted using the cross hatch, which consists of 15 vertical and 13 horizontal lines.

An eight-step grey scale is provided for verifying luminance amplifier linearity, for focus setting and to check the grey scale adjustment of colour televisions. Overall colour performance, burst keying, delay colour versus luminance and PAL delay line circuits can be checked with the colour bar.

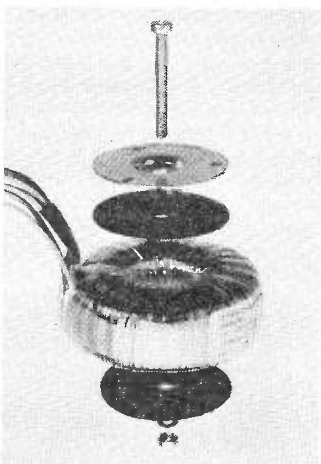
Twice as Nice?

The 'budget range' toroidal mains transformers manufactured by Cotswold Electronics Ltd, are now supplied with 120+120V dual primary windings in addition to the previous single 110V, 220V and 240V primaries. Although classified as 'budget', the transformers are constructed to the same materials standards as used in professional electronics telecommunications and electro-medical etc. Protracted tests have shown that transformers constructed in this manner can be operated at 120 degrees Celsius without deterioration, for short periods. Each transformer is subjected to a 2.5kV peak flash test as an insulation check.

The power ratings include 30, 60, 100, 230, 330 and 530VA types, all of which have single hole fixing using a dished washer, protection pads and nut and bolt provided. The range of dual secondary windings includes combinations of two x 6, 9, 12, 15, 18, 22, 25, 30, 35, 40, 45, 50, 110, 220 and 240V RMS windings, depending on the core size selected.

The transformers are supplied with an information sheet which gives details on operation and installation at a specific load, regulation and temperature characteristic; the budget range can be operated under 'derated' conditions at a lower temperature rise with improved regulation.

Cotswold Electronics Ltd.,
Unit T.1.,
Kingsville Road,
Kingsditch Trading Estate,
CHELTENHAM
GL51 9NX



NEW PRODUCTS

Out Of The Unknown

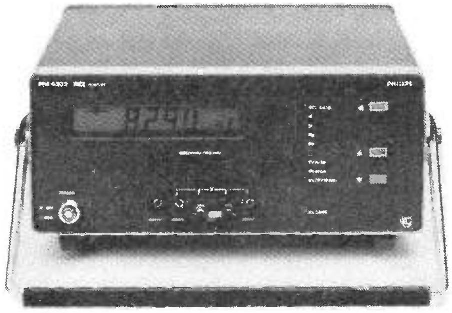
A microprocessor-controlled, fully automatic RCL meter with nine measuring modes has been introduced by Philips Test & Measuring Instruments. In its normal mode, RCL Auto, the PM 63003 identifies the dominant resistive, capacitive or inductive characteristic of the component under test, indicating the magnitude, dimensions and also the effective equivalent circuit on a large liquid crystal display.

The microprocessor eliminates the need for time-consuming manual tuning to obtain the final value, providing results instantly with four-digit resolution and an accuracy of up to 0.25 percent. Optional accessories, including a test fixture which provides fast connections for components of all shapes and sizes and a shielded four-wire test cable, further increase the speed of component testing.

In addition to RCL Auto, the measuring modes available on the instrument's menu include quality and dissipation factors, parallel resistance, series resistance, total impedance, parallel capacitance or inductance, series capacitance or inductance and 2V biased capacitance. Furthermore the instrument can be fully compensated to allow for parasitic capacitances.

All measuring modes produce an equivalent circuit graphic, a feature unique to the PM 6303. For example, the symbol for an inductor with a Q factor of less than 500 is an inductor in series with a resistor, while a capacitor with a Q factor between 1 and 500 is depicted as a capacitor in parallel with a resistor.

The meter can be used for two- or four-wire measurements while batch testing is simplified by using the special test fixture. This is specfically designed to provide rapid and low impedance connection to the instrument whatever the shape and dimensions of the component under test. The four-wire test cable is ideal for in-circuit component testing.



Interesting Switches

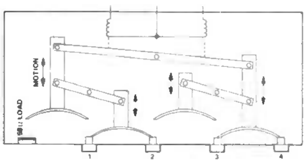
An interesting range of panel-mounted switches and push buttons is available in different versions from Contarnex Ltd. With a body in strong grey plastic, the iluminated switches will accomodate T5.5 miniature bulbs, which push fit from the rear. No part of the switch mechanism is accessible from the front. Fixing of the switches and push buttons is by means of built-in panel grips, and the minimum panel hole dimensions needed are 21mm square or 17.5mm round. Maximum overall depth behind the panel is 30mm.

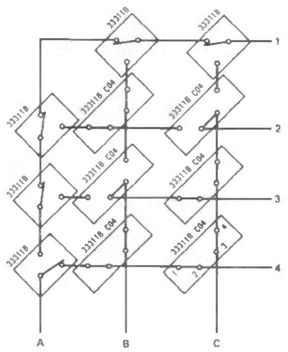
Wiring connections are suitable for screw, soldering or Amp fixing. Contacts are rated a 1 Amp 60V AC (resistive load) or 1/2 Amp 48V DC (maximum voltage), and are arranged for make/break, make/make or break/break.

Lenses of illuminated push buttons and rocker switches are available in red, yellow, green or white and can be engraved if required. The button colour of push buttons can be red, grey or white.

Contarnex Limited,
252 Martin Way,
MORDEN,
Surrey,
SM4 4AW

33311B-C04





Coaxing Microwaves

The new HP 33311B-C04 Coaxial Switch provides a 'cross-bar intersection' switch action. It either connects both crossing lines together with low loss, or passes both signals through the intersection with at least 90 dB or isolation. By combining a number of these switches with standard SPDT switches, a designer can configure more-complicated signal matrices operating from DC to 18 GHz.

A novel feature of the new switch is that terminal 4 reverts back to a 50 ohm termination in its cross-connection mode, so that short, unused segments of connecting coax cable cannot resonate and draw power from signal paths.

The actuating mechanism momentarily requires 24V DC with magnetic latching. The coax switching action uses the 'edgeline' principle, moving only the centre conductor to provide excellent repeatability of less than 0.03 dB even after one million switchings.

Insertion loss and SWR are low, so multiple switches may be assembled. For example, insertion loss of six switch passages in tandem is typically less than 2 dB at 18 GHz (using short semi-rigid coax-connection segments). Similary, composite SWT is typically 1.8 for six tandem switches.

Hewlett-Packard Limited,
King Street Lane,
WINNERSH,
Berkshire,
RG11 5AR

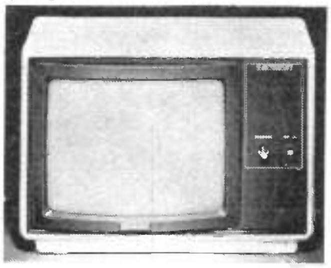
Colour Monitor

Reflex Limited, specialists in computer peripherals, announce the availability of the Electrohome ECM 1302 high-quality, thirteen-inch colour video monitor for the first time in UK.

The ECM 1302 monitor is available with either medium or high resolution, allowing the customer to select a unit that best suits the video performance of the computers.

The Electrohome colour monitors will be available to end-users via the established dealer network. Reflex also have the capability to modify the monitor, or build special interfaces, to meet the needs of system manufacturers.

Reflex Limited,
44 Gallys Road,
WINDSOR,
Berks
SL4 5RA



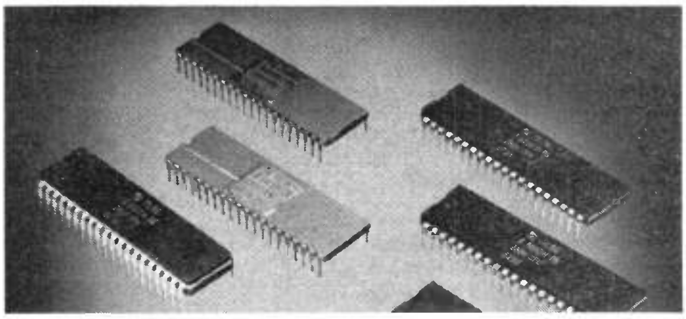
NEW PRODUCTS

High Speed Z80

Zilog has just introduced a new high-speed version of their Z80 8-bit microprocessor. Known as the Z80H, it runs at an 8MHz clock frequency and joins the 2.5, 4.0 and 6.0MHz versions currently available. In addition to offering high-speed operation, the new processor is supported by Zilog's Z8500 family of peripheral circuits, which were primarily designed for use with 16-bit microprocessors.

The Z80H takes full advantage of the Z8500 peripherals, to enhance system throughput by a factor of between four and six times over comparable systems based on the 4MHz Z80A. The combination also provides more efficient data handling than slower Z80s with their 8-bit peripherals. The Z80H is supplied in a 40-pin dual-in-line plastic package and is electrically and pin compatible with the slower Z80 CPUs.

Zilog (UK) Limited
Zilog House
Moorbridge Road,
MAIDENHEAD
Berks
SL6 8PL



Catching Glitches

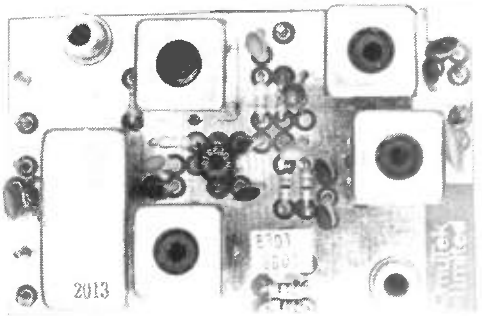
Philips announce the first compact 35 MHz digital storage oscilloscope to offer four channels, 8-trace memory and glitch capture. With a 4096 word memory, the PM 3305 excels at capturing slow single-shot phenomena, up to 250 kHz, such as electro-mechanical and analytical events. However the high frequency 10ns glitch capture can store fast transient events on these slower signals.

Stored signals can be expanded by up to 40 times, and a compare mode is available to check new signals against previously recorded reference signals. Such a breadth of performance stands alone in the market at a very competitive price of £3162.50.

In conventional (non-storage) mode the PM 3305 has a two-channel input and provides 35 MHz real time direct display with sensitivities from 2mV to 10V per division and timebase speeds from 100ns to 0.5s per division. Triggering is very flexible, with a choice of A, B, composite or line sources. Trigger modes include automatic, DC and AC.

In storage operation, the instrument has an 8 K memory – 4096 8-bit words are used for display and the remainder for pre-trigger facilities. There is also a timebase extension to 5s per division and two additional input channels. The two extra channels are floating and can be adapted to 2mA or 20mA inputs for signals from mechanical transducers.

Pye Unicam Ltd.,
York Street,
CAMBRIDGE,
CB1 2PX.



Optimised And Preamplified

MuTek Limited announce availability of their SLNA 145sb Transceiver Optimised Preamplifier for the Yaesu FT290R. The unit provides the definitive solution to 'deafness' problems associated with this transceiver. The premplifier has been engineered to fit neatly within the transceiver and provide a sensitivity improvement sufficient to ensure that external noise is the limiting factor, whilst minimising dynamic range degradation. Additional benefits include much improved front-end selectivity, and an on-board low-loss nitrogen filled antenna transfer relay which eliminates the losses inherent in Yaesu's diode antenna switch.

The SLNA 145sb retails at £24.90 (inc. VAT).

MuTek Limited,
Bradworthy,
HOLSWORTHY,
Devon,
EX22 7TU

Compact Sounds

A new range of compact stereo systems, which can be stacked on a bookshelf, but which also provide high quality stereo sound, has been launched by Pioneer.

Pioneer's Shelf Compos are self-contained, stackable stereos featuring an amplifier, tuner, cassette deck, turntable and speakers which, when stacked, measure just 35 x 21 x 32 cm — no deeper than an average sized book.

The turntable is front loading — it slides forward to receive full sized LP's or singles — and can form a highly attractive and practical addition to a living room bookshelf without infringing on 'valuable' floor-space.

There are three models to choose from: the S-33, with 23 watts of music power and 'Music Search' facility; the S-55 with 35 watts of music power and quartz synthesized tuner; and the S-77 — 55 watts, auto reverse cassette deck, ribbon Sendust heads, Dolby B & C, Music Search — and Index Scan, which lets the enthusiast preview the first five seconds of each track.

Bass, treble and volume controls are calibrated as opposed to push-button controls for those that prefer fine-tuning, and three optional extras will also be available adding to the units' versatility. These include a Sound Processor, which combines a graphic equalizer with microphone facilities; a double cassette deck; and the PX-L9 turntable, which can be programmed to play selected tracks in any order, or to search out individual tracks.

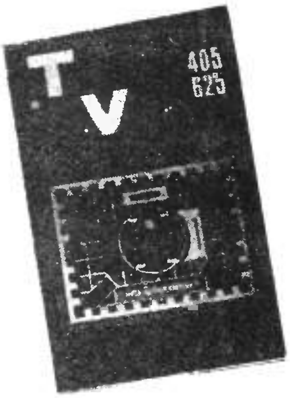
Prices start at £439 complete.

Pioneer High Fidelity (GB) Ltd.,
Field Way,
GREENFORD,
Middlesex,
UB6 8UZ.

SUPPLIERS & SERVICES INDEX

CLASSIFIED ADS

"TV FAULT FINDING"



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HEATHKIT OSCILLOSCOPE Model 10-103 with Heathkit Electronic Switch Model ID-101. Offers? Phone: 01-794-7024.

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FOR SALE. Pair Hi-Fi stereo headphones, Howland West Audio CIS-550. £10.00 o.n.o. Box No. 36.

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Ant Products, All Saints Industrial Estate, Baghill Lane, Pontefract, West Yorkshire. Tel: 0977 700949

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Send your copy to RADIO & ELECTRONICS WORLD, Classified Ads., 45 Yeading Avenue, Rayners Lane, HARROW, Middlesex. Tel: 01-868-4854.

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THE BRITISH AMATEUR ELECTRONICS CLUB. For all interested in electronics. Four Newsletters a year: library of technical books and magazines: help for members by experts: annual exhibition. Subscriptions only £4.50 per year, UK & Eire, if joining before 1st July 1983. Details from the Hon. Sec., J.G. Margetts, 113 South Road, Horndean, Hants., PO8 OER.

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PARTS PROFILE

Last month, a few readers were confused as to the *raison d'etre* behind this set of component listings for R&EW projects. Well, it's quite straightforward – tick the components you require (in the space above the dotted lines), look up your supplier's prices, add it all up and send the complete list with a cheque to cover the cost (including postage and VAT).

It is hoped that this will not only make life easier for those buying components, but also for companies supplying them.

RADIO AMATEUR'S TEST CARD

Resistors
1k(5)______ 2k2(6)______ 4k7______
10k______ 100R(3)______ 560R______
47R(8)______ 75R______

Capacitors
33p______ 10n______ 2u2 16V(15)______
22u 16V______ 2u2 35V______

Semiconductors
IN4148(2)______ IN4001______
OA47(4)______ BC212(2)______
BC182(3)______ 74LS169______
74LS368______ 74LS393(2)______
74LS298(3)______ 74LS166______
74LS377______ HEF4051______
7805______

DTMF (Receiver)

Resistors
2M2(2)______ 270k______ 4k7______

Capacitors
10n______ 100n(2)______ 680p(2)______
33u 10V______

Semiconductors
MV8865______ MV8862______
TIL311______

CENTRAL HEATING CONTROLLER

Resistors
10k(5)______ 330R______ 470k______
10M______ 1k(2)______ 240R(4-MF)______

Potentiometers
1k(2-cermet)______

Capacitors
100u 25V______ 220u 16V______
1u 35V______ 33p(2)______ 100n(3)______

Semiconductors
MC146805E2P______ ICM7611A______
ADC0804L______ TC5514/uPD444______
4070______ 4023______ 4011______
4052______ 74HC373______ 78L05______
ULN2003______ LM334Z(3)______
IN914(10)______ 50V 1A Bridge______

TX10-RGB

Resistors
680R______ 47k(4)______ 4k7(2)______
15k(2)______ 10R______ 1k______
10k______ 150R(3)______ 75R(7)______

Capacitors
15u 16V(3)______ 100n(3)______

Semiconductors
BC213LB______ BC183LB______
IN4148(2)______

SSB

Resistors
100k______ 1k5______ 47k______
18k______ 100R______ 1k______
330R______ 3k3______ 33k______

Potentiometers
100k(centre click)______ 50k lin______

Capacitors
330p______ 2000p______ 680p______
1000p______30p(2)______ 47n(3)______
12p______

Semiconductors
BF224/TIS88______ BC108______
BA102(2)______ BZY88C5V6______

DCM

Resistors
1M______ 27k(2)______ 470R______
820k______ 100R(½W)______ 220k______
3M3______ 3k3______ 10k______68R______

Potentiometers (presets)
4k7______ 470k______ 100k(2)______

Capacitors
22p(2)______ 10n(2)______ 100n______
330p(2)______ 100p______ 470n______
47n______ 220n______ 22u 16V______

Semiconductors
4049______ ICM7556______ 4023______
ICM7555______ 40106______ 4011______
ICM7217C______ 7805______

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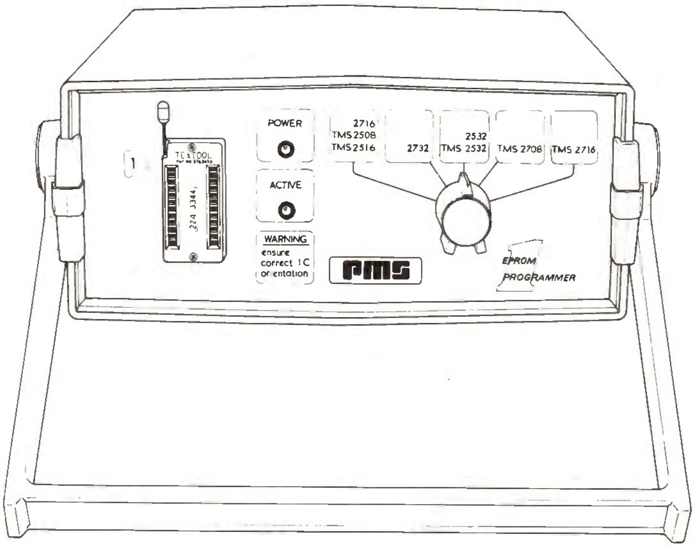
PROM 1



Intelligent EPROM Programmer

The new PROM 1 from P.M.S. offers the user an intelligent, easy to use EPROM Programmer, capable of programming a wide range of common EPROM types. The unit has its own CPU with a 4K memory buffer and communicates to the user's Computer/Terminal over a standard R.S.232 link. Full on-screen editing facilitates easy modification of machine code programs.

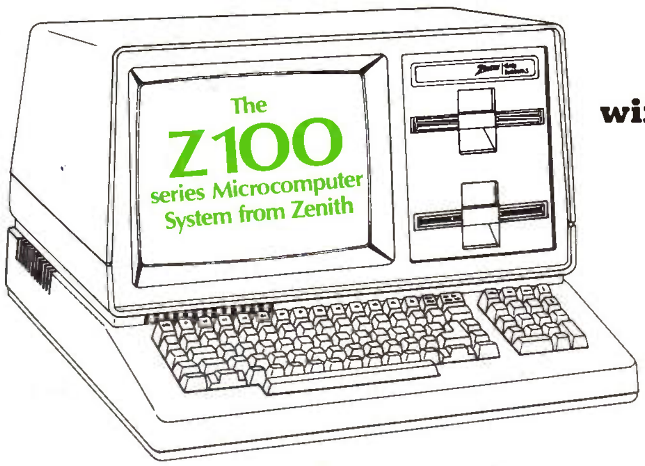
The PROM 1 offers the following functions:-

1. Disk to Buffer. Allows a file to be copied from disk into the PROM 1's internal 4K buffer.
2. Buffer to Disk. Allows contents of buffer to be stored on disk.
3. EPROM to Buffer. Allows contents of EPROM to be stored in Buffer.
4. Buffer to EPROM. Programmes EPROM with current contents of the Buffer.
5. Display Buffer. Displays contents of the Buffer on screen and allows full screen editing of the buffer contents.
6. Check EPROM Status. Checks the status of the EPROM plugged into programmer socket i.e. EPROM type and whether it is blank, equal to or not equal to the buffer.

The PROM 1 can be used with just a terminal but functions 1 and 2 will not apply.
The unit is supplied with full operating instructions, including CP/M routines for system configuration.

R.R.P. **£349.00**

ZENITH data systems

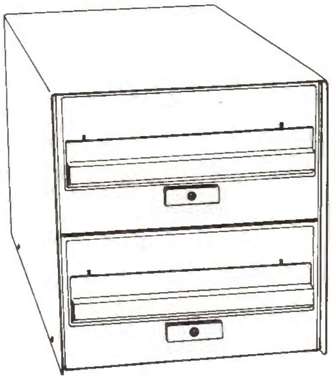


The 16~bit Micro

with 8~bit compatibility and colour graphics

Features 8088 and 8085 processors, 128K user RAM expandable to 768 kb, 2 x 320kb drives, 2 serial ports, 1 parallel port, light pen socket and 4 - S100 bus slots for add on options. Disk controller supports 4 - 8" drives and 4 - 5.25" drives. High resolution graphics (640 x 225 pixels, 8 colours). Supplied with MSDOS, CP/M 85, 16-Bit Microsoft Colour Basic with FULL GRAPHICS implementation and complete documentation.
The Z-100 comes in two basic forms:-

Z-120-22 With integral monitor (as illustated) and 1 colour plane ram set fitted ....£ 2,590
Z-100-22 Low profile version with full colour RAM set ....£ 2,576



Twin 8" Drives (as illustrated), suitable for the Zenith Z-100 series computer with no extra interfacing. Capacity 1.2 Mb per drive ....£ 1,050
Colour Monitor. Zenith ZVM-134 high resolution 13" RGB monitor - Special introductory offer price ....£ 400
Zenith ZVM-121 12" green screen monitors ....£ 85

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PMS Developments

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