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RADIO & ELECTRONICS WORLD
MARCH 1983

RADIO & ELECTRONICS WORLD

THE COMPLETE ELECTRONICS MAGAZINE

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85p

TELEPHONES EXPLAINED

The characteristics and protocols involved in making a phone call

PROJECTS

Sound Shaper

SW Notch Filter

White Noise Generator

PLUS

2m Transverter: 28-144 MHz

SONY CAMERA SELECTOR

REVIEWS

Gould Digital Storage Oscilloscope

High Quality RGB Monitor

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Polar Orbiting Satellites

FREE INSIDE
COMPUTING PULL-OUT
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D71699

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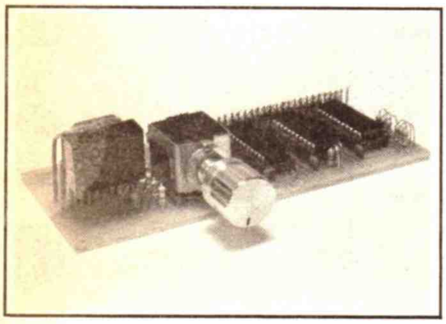
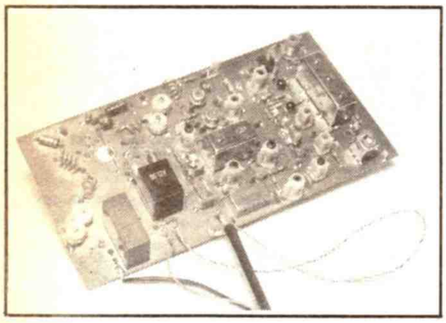
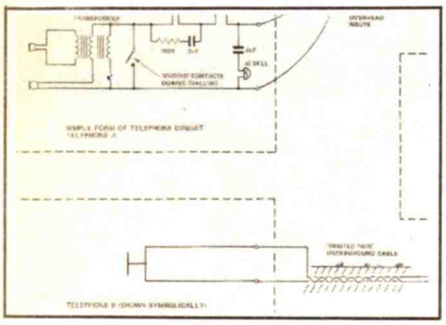
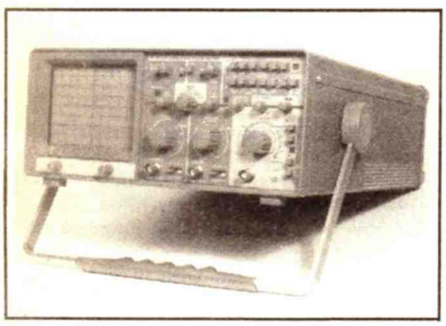
MARCH 1983









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Roland Perry

Consultants
Computing Jonathan Burchell
Projects Keith Collins

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	22 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	0.58
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	0.16
4078	23 04078	0.16
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	0.80
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	3.50
4566	23 04566	1.20
4568	23 04568	1.45
4569	23 04569	1.70
4572UB	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	0.85
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	0.14
74LS30	31 07430	0.14
74LS32	31 07432	0.14
74LS33	31 07433	0.14
74LS37	31 07437	0.14
74LS38	31 07438	0.14
74LS40	31 07440	0.18
74LS42	31 07442	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	0.38
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 74195	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	4069	
74C08	29 07408	0.35
74C10	29 07410	0.35
74C14	4584	
74C20	29 07420	0.35
74C30	29 07430	0.35
74C32	29 07432	0.35
74C42	29 07442	1.05
74C48	29 07448	1.75
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 07486	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	
74C161	40161	
74C162	40162	
74C163	40163	
74C164	29 74164	1.15
74C165	29 74165	1.10
74C173	4076	
74C174	40174	
74C175	40175	
74C192	40192	
74C193	40193	
74C195	40195	
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
74HC08	30 07408	0.56
74HC10	30 07410	0.56
74HC20	30 07420	0.56
74HC32	30 07432	0.60
74HC86	30 07486	0.74
74HC132	30 74132	1.20
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	0.88
74HC175	30 74175	1.20
74HC273	30 74273	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	1.59
74HC160	30 74160	1.33
74HC161	30 74161	1.33
74HC162	30 74162	1.33
74HC163	30 74163	1.33
74HC4538	30 04538	2.10
74HC85	30 07485	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	0.80
74HC257	30 74257	0.90

SMALL SIGNAL AUDIO

Device	Stock No	1-24	25-99	100+
BC182	58 00182	0.10	0.08	0.07
BC212	58 00212	0.10	0.08	0.07
BC237	58 00237	0.08	0.06	0.05
BC238	58 00238	0.08	0.06	0.05
BC239	58 00239	0.08	0.06	0.05
BC307	58 00307	0.08	0.06	0.05
BC308	58 00308	0.08	0.06	0.05
BC309	58 00309	0.08	0.06	0.05
BC327	58 00327	0.13	0.11	0.09
BC337	58 00337	0.13	0.11	0.09
BC413	58 00413	0.10	0.08	0.07
BC414	58 00414	0.11	0.09	0.08
BC415	58 00415	0.10	0.08	0.07
BC416	58 00416	0.11	0.09	0.08
BC546	58 00546	0.12	0.10	0.08
BC550	58 00550	0.12	0.10	0.08
BC556	58 00556	0.12	0.10	0.08
BC560	58 00560	0.12	0.10	0.08
BC639	58 00639	0.22	0.17	0.16
BC640	58 00640	0.22	0.17	0.16
MPSA13	58 04013	0.30	0.25	0.20
MPSA63	58 04063	0.30	0.25	0.20
ZTX108	58 01108	0.10	0.08	0.07
ZTX212	58 01212	0.10	0.08	0.07
ZTX653	58 01653	0.20	0.18	0.16
ZTX753	58 01753	0.20	0.18	0.16
2N2904	58 02904	0.25	0.22	0.20
2N2905	58 02905	0.25	0.22	0.20
2N3905	58 03905	0.10	0.08	0.07
2SB646A	58 03646	0.30	0.27	0.23
2SB648A	58 03648	0.40	0.35	0.30
2SD666A	58 03666	0.30	0.27	0.23
2SD668A	58 03668	0.40	0.35	0.30
2SA872A	58 02872	0.19	0.18	0.17
2SA1084E	58 01084	0.25	0A	0A
2SA1085E	58 01085	0.25	0.24	0.23
2SC1775A	58 01775	0.19	0.18	0.17
2SC2546E	58 02546	0.24	0A	0A
2SC2547E	58 02547	0.24	0.23	0.22

AUDIO POWER

Device	Stock No	1-24	25-99	100+
BD139	58 15139	0.29	0.23	0.19
BD140	58 15140	0.31	0.24	0.20
BD165	58 15165	0.46	0.42	0.38
BD166	58 15166	0.48	0.44	0.40
BD179	58 15179	0.38	0.29	0.24
BD180	58 15180	0.41	0.31	0.36
TIP31A	58 15031	0.35	0.32	0.29
TIP32A	58 15032	0.35	0.32	0A
MJ2955	58 12955	0.88	0.81	0.58
2N3055	58 13099	0.58	0.52	0.47
2SB720	58 15720	0.60	0.54	0.59
2SD760	58 17600	0.60	0.54	0.59
2SJ49	60 01049	3.10	3.00	2.75
2SJ50	60 01050	4.25	3.75	3.35
2SJ83	60 01083	3.55	3.40	2.88
2SK134	60 00134	3.10	3.00	2.75
2SK135	60 00135	4.25	3.75	3.35
2SK227	60 00227	3.55	3.40	2.88
2SD753	58 03753	2.34	1.98	1.65

SMALL SIGNAL RF

Device	Stock No	1-24	25-99	100+
BFY50	58 06500	0.22	0.18	0.16
BF241	58 06241	0.18	0.14	0.12
BF273	58 06273	0.18	0A	0A
BF274	58 06274	0.20	0A	0A
BF362	58 06362	0.49	0.40	0.32
BF440	58 06440	0.21	0.18	0.16
BF441	58 06441	0.21	0.18	0.16
BF479	58 06479	0.66	0.55	0.44
BF6795	58 06679	0.55	0.47	0.33
BFR91	58 07091	1.33	1.10	0.95
BFT95	58 10095	0.99	0.88	0.77
BFW92	58 08092	0.60	0.51	0.42
BFY90	58 09090	0.90	0.85	0.70
NE21936	58 21936	5.00	4.30	3.90
ZTX323	58 36232	0.60	0.55	0.45
2N2369A	58 02369	0.38	0.34	0.30

RF POWER

Device	Stock No	1-24	25-99	100+
BFW16A	58 08016	0.65	0.60	0A
MRF237	58 14237	3.20	2.80	2.45
MRF238	58 14238	16.50	14.00	12.00
MRF245	58 14245	40.00	35.00	0A
MRF449A	58 14449	16.50	14.00	12.00
MRF472	58 14472	1.25	0.99	0.75
MRF475	58 14475	4.60	4.15	3.90
MRF629	58 14629	4.99	3.75	3.25
PT8811	58 18811	9.50	8.75	8.05
TP2320	58 12320	10.24	9.26	7.82
VN66AF	60 02066	0.95	0.87	0.81
2TX3866	58 03866	0.45	0.40	0.33
2N3866	58 13866	1.20	0.98	0.89

SMALL SIGNAL FET

Device	Stock No	1-24	25-99	100+
BF256	58 00256	0.38	0A	0A
BF960	60 06960	0.89	0.85	0.75
BF961	60 06961	0.70	0.62	0.54
BF963	60 06963	0.89	0.85	0.75
J310	59 02310	0.69	0.60	0.54
J176	59 02176	0.65	0.52	0.48
2SK55	59 01055	0.32	0.29	0.26
2SK168	59 01168	0.37	0.33	0.28
3SK45	59 04045	0.40	0.34	0.26
3SK51	59 04051	0.54	0.44	0.34
3SK60	59 04060	0.58	0.48	0.36
3SK88	59 04088	0.99	0.85	0.79
40673 see 3SK51				
40822 see 3SK51				
40823	60 03823	0.65	0.49	0.41
3SK112	60 04112	4.60	4.20	3.80

DIODES

Device	Stock No	1-24	25-99	100+
AA112	12 01126	0.25	0.20	
BA244	12 02447	0.17	0.12	0.10
BA379	12 03797	0.35	0.32	0.30
NO4981 7E	12 49817	0.31	0.44	0.38
OA91	12 00916	0.07	0.06	0.05
OA47	12 00476	0.10	0.09	0.08
PW02	12 62006	0.75	0.65	0.59
S04	12 24006	0.45	0.40	0.36
W005	12 10506	0.28	0.25	0.22
1N4001	12 40016	0.06	0.05	0.04
1N4002	12 40026	0.07	0.06	0.04
1N4004	12 40046	0.07	0.06	0.05
1N4148	12 41486	0.05	0.04	0.03
1N5404	12 54046	0.16	0.13	0A
1N6263	12 62637	0.62	0.50	0.41

VARICAPS

Device	Stock No	1-24	25-99	100+
BA102	12 01025	0.30	0.27	0.24
BA121	12 01215	0.30	0.27	0.24
BB105B	12 01055	0.30	0.23	0.21
BB109B	12 01098	0.27	0.24	0.18
BB204B	12 02045	0.38	0.30	0.24
BB212	12 02125	1.95	1.88	1.22
ITT210	12 02105	0.30	0.23	0.20
MVAM115 see KV1236				
MVAM125 see KV1225				
KV1210	12 12105	2.45	0A	0A
KV1211 see KV1236				
KV1225	12 12255	2.75	2.25	1.80
KV1235	12 12355	2.75	2.25	1.80
KV1236	12 12365	2.55	2.04	1.30
KV1310	12 13105	0.40	0.30	0.26
KV1320	12 13205	0.40	0.30	0.26

ZENER DIODES

BZY88C 400mW 5%

Device	Stock No	1-24	25-99	100+
2V7	12 00278	0.10	0.08	0.07
3V3	12 00338	0.10	0.08	0.07
3V9	12 00398	0.10	0.08	0.07
4V7	12 00478	0.10	0.08	0.07
5V1	12 00518	0.10	0.08	0.07
5V6	12 00568	0.10	0.08	0.07
6V8	12 00688	0.10	0.08	0.07
8V2	12 00828	0.10	0.08	0.07
9V1	12 00918	0.10	0.08	0.07
10	12 01008	0.10	0.08	0.07
11	12 01108	0.10	0.08	0.07
12	12 01208	0.10	0.08	0.07
15	12 01508	0.10	0.08	0.07
18	12 01808	0.10	0.08	0.07
22	12 02208	0.10	0.08	0.07
27	12 02708	0.10	0.08	0.07
33	12 03308	0.10	0.08	0.07

SCRS TRIACS

Type	Stock No	1-24	25-99	100+
BRY55-100	52 55100	0.50	0.40	0.48
C106D1	52 00106	0.70	0.65	0.50
C122D1	52 00122	1.45	1.35	1.20
2N6403	52 06403	2.22	2.00	1.80
2N6073A	58 06073	0.98	0.85	0.80

BALANCED MIXERS

Type	Stock No	1-24	25-99	100+
SBL1	12 00003	4.88	4.22	0A
SBL1 8	12 00013	5.00	4.50	0A
SBL1 X	12 00023	6.33	5.70	0A
SRA1	12 00033	10.80	10.26	0A
SRA1 1	12 00043	12.77	12.14	0A
SRA1H	12 00053	16.34	15.52	0A
SRA3	12 00063	15.35	13.85	0A

LEDs

3mm round types

Type	Stock No	1-24	25-99	100+
CQX25 Red clear	15 20250	0.15	0.13	0.12
V178P Red	15 01780	0.15	0.13	0.12
CQX26 Green clear	15 20260	0.16	0.15	0.14
V179P Green	15 01790	0.16	0.15	0.14
CQX27 Yel/clear	15 20270	0.18	0.17	0.16
V180P Yellow	15 01800	0.18	0.17	0.16
CQX41A Or/red	15 20410	0.19	0.18	0.17

Standard 5mm DIA LEDs

Type	Stock No	1-24	25-99	100+
CQY40L Red	15 10400	0.12	0.10	0.09
CQY72L Green	15 10720	0.15	0.14	0.13
CQY74L Yellow	15 10740	0.15	0.14	0.13
CQX38A Or/red	15 20380	0.20	0.18	0.17
CQX39B Or/red/clr	15 20390	0.29	0.25	0.23

Rectangular 2.5 x 5mm LEDs

Type	Stock No	1-24	25-99	100+
CQX10 Red	15 20100	0.17	0.16	0.15
CQX11 Green	15 20110	0.20	0.18	0.17
CQX12 Yellow	15 20150	0.20	0.18	0.17
CQX40 Orange red	15 20400	0.24	0.21	0.19

Infra-Red LEDs

Type	Stock No	1-24	25-99	100+
CQY99 Emitter	15 10990	0.56	0A	0A
BPW41 Detector	15 30410	1.51	0A	0A

I-R Optocoupler

Type	Stock No	1-24	25-99	100+
BNY37	15 40370	1.44	1.28	0.99

FLAT DIFFUSED

Type	Stock No	1-24	25-99	100+
V320	15 03200	0.17	0.16	0.15
V321	15 03210	0.26	0.22	0.20
V322	15 03220	0.20	0.18	0.17
V323	15 03230	0.20	0.18	0.17
V330	15 03300	0.17	0.16	0.15
V331	15 03310	0.26	0.22	0.20
V332	15 03320	0.20	0.18	0.17
V333	15 03330	0.20	0.18	0.17
V340	15 03400	0.17	0.16	0.15
V341	15 03410	0.26	0.22	0.20
V342	15 03420	0.20	0.18	0.17
V343	15 03430	0.20	0.18	0.17
V510	15 05100	0.17	0.16	0.15
V511	15 05110	0.26	0.22	0.20
V512	15 05120	0.20	0.18	0.17
V513	15 05130	0.20	0.18	0.17
V520	15 05200	0.17	0.16	0.15
V521	15 05210	0.26	0.22	0.20
V522	15 05220	0.20	0.18	0.17
V523	15 05230	0.20	0.18	0.17
V530	15 05300	0.17	0.16	0.15
V531	15 05310	0.26	0.22	0.20
V532	15 05320	0.20	0.18	0.17
V533	15 05330	0.20	0.18	0.17
V540	15 05200	0.17	0.16	0.15
V541	15 05410	0.26	0.22	0.20
V542	15 05420	0.20	0.18	0.17
V543	15 05430	0.20	0.18	0.17
V550	15 05500	0.17	0.16	0.15
V551	15 05510	0.26	0.22	0.20
V552	15 05520	0.20	0.18	0.17
V553	15 05530	0.20	0.18	0.17

TRI COLOUR

Type	Stock No	1-24	25-99	100+
V518	15 05180	0.60	0.57	0.53

LEDs WITH CHROME MOUNTING BEZEL

Type	Stock No	1-24	25-99	100+
Prominent Type (3mm LED)				
Red	15 60850	0.52	0.48	0.41
Green	15 60860	0.53	0.47	0.42
Yellow	15 60870	0.54	0.48	0.43
Or/red	15 60880	0.58	0.52	0.48
Recessed Type (3mm LED)				
Red	15 61850	0.52	0.48	0.41
Green	15 61860	0.53	0.47	0.42
Yellow	15 61870	0.54	0.48	0.43
Or/red	15 61880	0.58	0.52	0.48
Prominent Type (5mm LED)				
Red	15 62850	0.62	0.56	0.51
Green	15 62860	0.65	0.59	0.54
Yellow	15 62870	0.66	0.60	0.56
Or/red	15 62880	0.68	0.62	0.58
Recessed Type (5mm LED)				
Red	15 63850	0.62	0.56	0.51
Green	15 63860	0.65	0.59	0.54
Yellow	15 63870	0.66	0.60	0.56
Or-Red	15 63880	0.68	0.62	0.58

LINEAR ICs

Type	Stock No	1-24	25-99	100+
LM10CN	61 00010	3.88	3.50	3.12
MF10	61 00011	[illegible]	[illegible]	[illegible]
L149	61 00149	1.85	1.55	0.85
ZNA234	61 02340	8.50	7.60	0A
U237B	61 00237	1.28	0.98	0.83
U247B	61 00247	1.28	0.98	0.83
U257B	61 00257	1.28	0.98	0.83
U267B	61 00267	1.28	0.98	0.83
LM301AH	61 03010	0.67	0.60	0.54
LM301AN	61 03011	0.27	0.25	0.24
LM308H	61 03080	0.70	0.65	0.59
LM308CN	61 03081	0.65	0.62	0.59
LM324N	61 03240	0.45	0.43	0.41
LM339N	61 03390	0.66	0.63	0.60
LF347	61 00347	1.80	1.68	0A
LM348	61 03480	0.90	0.80	0.75
LF351	61 03510	0.49	0.47	0.45
LF353	61 03530	0.76	0.70	0.65
LM380N	61 03800	1.00	0.75	0.45
LM381	61 00381	1.81	1.22	0A
LM382	61 00382	1.81	1.22	0A
ZN418CE	61 04180	1.98	1.72	1.55
ZNA423	61 04230	1.00	0.95	0.90
ZN425E8	61 04250	3.50	3.00	0A
ZN426E8	61 04260	3.00	2.60	0A
ZN427E8	61 04270	6.20	5.44	0A
ZN428E8	61 04280	4.78	4.14	0A
ZN429E8	61 04290	2.10	1.80	0A
ZN432CJ10	61 04320	28.09	24.39	0A
ZN433CJ10	61 04330	22.58	19.60	0A
ZN440J	61 04400	8.80	7.75	0A
ZN450E	61 04500	7.61	6.06	0A
NE542	61 05420	1.20	0.95	0.75
NE544	61 00544	1.80	1.40	1.12
NE555N	61 05550	0.20	0.19	0.18
NE556N	61 05560	0.50	0.48	0.45
SL560C	61 05600	1.98	1.79	0A
NE562	61 00562	4.05	0A	0A
NE564	61 00564	4.28	3.42	2.99
NE565	61 00565	1.00	0.88	0.68
NE566	61 00566	1.30	0.95	0.70
NE567	61 00567	1.30	1.05	0.90
NE570N	61 00570	3.85	2.25	0A
SL624	61 00624	3.28	2.84	2.55
uA709HC	61 07090	0.60	0.58	0.58
uA709PC	61 07091	0.38	0.34	0.32
uA710HC	61 07100	0.64	0.61	0.56
uA710PC	61 07101	0.59	0.56	0.50
uA711CN	61 07110	0.85	0.80	0.75
uA733CN	61 07330	0.89	0.86	0.83
uA741CH	61 07410	0.66	0.62	0.55
uA741CN	61 07411	0.20	0.19	0.18
uA747CN	61 07470	0.70	0.67	0.63
uA748CN	61 04780	0.38	0.28	0.27
uA758	61 00758	2.35	0A	0A
TBA820M	61 00820	0.78	0.65	0.45
TDA1028	61 01028	2.11	1.82	1.52
TDA1029	61 01029	2.11	1.82	1.52
TDA1034	61 01034	2.10	1.95	1.75
LM1035	61 01035	2.10	1.95	1.75
TDA1054M	61 01054	1.45	1.12	0.88
TDA1062	61 01062	1.95	1.65	1.45
TDA1072	61 01072	2.09	0A	0A
TDA1074A	61 01074	5.04	4.22	3.35
TDA1083	61 01083	1.95	1.60	1.35
TDA1090	61 01090	3.05	2.30	1.95
HA1137	61 12411	1.20	1.00	0.95
HA1196	61 01196	2.00	1.70	1.25
HA1197	61 01197	1.00	0.92	0.84
TDA1220	61 01220	1.40	1.22	0.90
LM1303	61 01303	0.99	0A	0A
LM1307	61 01307	1.55	0A	0A
MC1310P	61 01310	1.90	0A	0A
MC1330	61 01330	1.20	0.99	0A
MC1350	61 01350	1.20	0.99	0A
HA1370	61 11370	1.90	1.65	1.45
HA1388	61 01388	2.75	1.95	1.85
LM1458N	61 14580	0.45	0.43	0.41
MC1496P	61 01496	1.25	0.90	0A
SL1610	61 01610	1.92	1.60	1.60
SL1611	61 01611	1.60	1.50	1.35
SL1612	61 01612	1.60	1.50	1.35
SL1613	61 01613	2.06	1.85	1.67
SL1620	61 01620	2.50	2.20	1.95
SL1621	61 01621	2.50	2.20	1.95
SL1623	61 01623	2.44	2.35	2.20
SL1625	61 01625	2.50	2.20	1.95
SL1626	(SL6270)			
SL1630	61 01630	1.62	1.52	1.40
SL1640	61 01640	2.25	1.95	1.85
SL1641	61 01641	2.25	1.95	1.85
MC1648	61 01648	2.75	2.55	2.75
TDA2002	61 02002	1.25	1.04	0.85
ULN2240	61 02240	3.25	2.62	2.12
ULN2242	61 02242	3.05	2.30	1.95
ULN2283	61 02283	1.00	0.85	0.75
CA3080	61 03080	0.70	0.55	0.45
CA3089	61 03089	1.84	1.38	1.15
CA3123	61 03123	1.40	1.30	0.99
CA3130E	61 31300	0.80	0.76	0.72
CA3130T	61 31301	0.90	0.86	0.81
CA3140E	61 31400	0.46	0.42	0.35
CA3189E	61 03189	2.20	1.80	1.50
CA3240E	61 32400	1.27	1.20	1.14
MC3357	61 03357	2.85	1.95	1.35
MC3359 (see ULN3859)				
ULN3859	61 03859	2.95	2.05	1.45
KM3701	61 03701	85.53	72.20	0A
KM3702	61 03702	74.84	61.00	0A
LM3900	61 39000	0.60	0.57	0.54
LM3909N	61 39090	0.66	0.62	0.59
LM3914N	61 03914	2.80	2.40	1.90
LM3915N	61 03915	2.80	2.40	1.90
KB4400	61 04400	0.80	0.75	0.60
KB4412	61 04412	1.95	1.55	1.24
KB4413	61 04413	1.95	1.55	1.24
KB4417	61 04417	1.80	1.55	1.24
KB4420B	61 04420	1.09	0.90	0.85
TDA4420	61 14420	2.65	1.75	1.60
TDA4421	61 14421	2.65	1.75	1.60
KB4423	61 04423	2.30	1.95	1.45
KB4424	61 04424	1.65	1.12	0.82
KB4430	61 04430	2.30	1.98	1.54
KB4431	61 04431	1.95	1.55	1.22
KB4432	61 04432	1.95	1.55	1.15
KB4433	61 04433	1.52	1.45	0.95
KB4436	61 04436	2.53	2.05	1.55
KB4437	61 04437	1.75	1.55	1.30
KB4438	61 04438	2.22	1.82	1.10
KB4441	61 04441	1.35	1.25	1.10
KB4445	51 04445	1.29	1.00	0.85
KB4446	61 04446	2.75	2.34	1.85
KB4448	61 04448	1.65	1.22	0.95
NE5044	61 05044	2.26	1.85	1.38
MC5229	61 05229	9.60	8.64	0A
NE5532	61 55320	1.85	1.75	1.66
KM5624	61 05624	4.35	0A	0A
SD6000	61 06000	3.75	0A	0A
SL6270	61 06270	2.03	1.74	1.65
SL6310	61 06310	2.45	2.05	1.95
SL6440	61 06440	3.38	2.95	2.75
SL6600	61 06600	3.75	3.22	2.90
SAS6610	61 06610	1.48	1.08	0.91
SL6640	61 06640	2.75	2.50	2.40
SL6690	61 06690	3.75	3.45	3.30
SL6700	61 06700	2.75	2.30	2.20
SAS6710	61 06710	1.48	1.08	0.91
LS7225	61 07225	3.65	3.20	2.86
ICM7555	61 75550	0.80	0.75	0.70
CL8038CC	61 08038	4.50	3.97	3.35
MSL9362	61 09362	1.75	1.45	0.95
MSL9363	61 09363	1.75	1.45	0.95
K10170	61 10170	1.87	1.55	1.02
TK10321	61 10321	2.75	2.30	1.94
HA11223	61 11223	2.15	2.05	1.55
HA11225	61 11225	1.45	1.30	1.25
HA12002	61 12002	1.22	0.99	0.75
HA12017	61 12017	0.80	0.69	0.54
HA12402	61 12402	1.95	1.60	1.35
HA12411	61 12411	1.20	1.00	0.95
HA12412	61 12412	1.55	1.40	1.25
LF13741	61 13741	0.33	0.31	0.28
MK50366	61 50366	3.35	2.75	2.25
MK50375	61 50375	3.85	3.10	2.56
MM53200	61 53200	3.90	3.51	3.12

PRESCALER

Type	Stock No	1-24	25-99	100+
U264	61 02640	2.27	2.14	0A
U265	61 02650	3.18	2.98	0A
U266	61 02660	2.43	2.29	0A
11C90DC	61 01190	12.95	11.00	0A
MSL2312R	61 02312	3.94	2.71	2.40
MSL2318	61 02318	3.84	2.61	2.35
MSM5523	61 05523	11.30	8.00	6.35
MSM5524	61 05524	11.30	8.00	6.35
MSM5525	61 05525	7.85	6.45	4.95
MSM5526	61 05526	7.85	6.45	4.95
MSM55271	61 55271	9.75	7.85	5.25
ICM7106CP	61 07106	9.55	0A	0A
ICM7107CP	61 07107	9.55	0A	0A
LC7137	61 07137	7.50	5.75	4.80
ICM7216B	61 72161	19.50	0A	0A
ICM7216C	61 72162	19.95	0A	0A
ICM7217A	61 07217	9.50	0A	0A
SP8629	61 08629	3.85	2.95	0A
SP8647	61 08647	6.00	5.10	0A
SP8793	61 08793	7.70	6.65	5.95
95H90	61 09590	7.80	6.00	4.97
HD10551	61 10551	2.45	1.95	1.20
HA12009	61 12009	6.00	4.55	3.25
HD44015	61 44015	4.45	3.25	2.75
HD44752	61 44752	8.00	5.75	3.75
MC145151P	61 45151	6.00	5.40	4.86
MC145152P	61 45151	6.60	5.95	5.14
MC145156P	61 45156	4.80	4.14	3.72

MIN ELECTROLYTICS

RADIAL PCB MOUNTING

Type		Stock No	1-24	25-99	100+
0.47	50V	05 47408	0.07	0.06	0.05
1u	50V	05 10508	0.07	0.06	0.05
2u2	50V	05 22508	0.07	0.06	0.05
3u3	50V	05 33508	0.07	0.06	0.05
4u7	50V	05 47508	0.07	0.06	0.05
10u	16V	05 10606	0.07	0.06	0.05
10u	50V	05 10608	0.07	0.06	0.05
22u	10V	05 22605	0.07	0.06	0.05
22u	25V	05 22607	0.07	0.06	0.05
22u	63V	05 22608	0.09	0.08	0.07
33u	6.3V	05 33605	0.07	0.06	0.05
33u	25V	05 33607	0.08	0.07	0.06
47u	10V	05 47605	0.07	0.06	0.05
47u	16V	05 47606	0.08	0.07	0.06
47u	25V	05 47607	0.08	0.07	0.06
47u	63V	05 47608	0.10	0.09	0.08
100u	10V	05 10705	0.08	0.07	0.06
100u	16V	05 10706	0.09	0.08	0.07
100u	25V	05 10707	0.08	0.08	0.07
100u	63V	05 10708	0.18	0.15	0.12
220u	16V	05 22706	0.10	0.09	0.08
220u	25V	05 22707	0.14	0.12	0.11
220u	50V	05 22708	0.18	0.15	0.12
330u	16V	05 33706	0.14	0.12	0.11
330u	25V	05 33707	0.18	0.15	0.12
470u	6.3V	05 47705	0.10	0.09	0.08
470u	16V	05 47706	0.14	0.12	0.11
470u	25V	05 47707	0.18	0.15	0.12
470u	63V	05 47708	0.28	0.23	0.18
1000u	16V	05 10806	0.23	0.17	0.13
1000u	25V	05 10807	0.28	0.23	0.18
1000u	63V	05 10808	0.88	0.55	0.41
2200u	16V	05 22806	0.28	0.23	0.18
2200u	35V	05 22807	0.68	0.55	0.41
4700u	16V	05 47806	0.88	0.55	0.41
1u	50V	05 10511	0.08	0.07	0.06
2u2	50V	05 22511	0.08	0.07	0.06
3u3	50V	05 33511	0.08	0.07	0.06
4u7	35V	05 47511	0.08	0.07	0.06
10u	16V	05 10609	0.08	0.07	0.06
10u	35V	05 10611	0.09	0.08	0.07
22u	16V	05 22609	0.09	0.08	0.07
22u	35V	05 22611	0.09	0.08	0.07
33u	16V	05 33609	0.09	0.08	0.07
47u	25V	05 47610	0.10	0.09	0.08
100u	16V	05 10710	0.10	0.09	0.08
100u	35V	05 10711	0.10	0.09	0.09
220u	16V	05 22709	0.10	0.09	0.08
220u	35V	05 22711	0.11	0.10	0.09
330u	16V	05 33709	0.16	0.14	0.12
470u	16V	05 47709	0.25	0.22	0.19
470u	25V	05 47710	0.29	0.27	0.25
1000u	25V	05 10810	0.29	0.27	0.25
1000u	35V	05 10811	0.35	0.33	0.30
1000u	63V	05 10812	0.45	0.40	0.36
2200u	16V	05 22809	0.45	0.40	0.36
2200u	25V	05 22810	0.45	0.40	0.36
2200u	63V	05 22812	0.49	0.46	0.44
4700u	16V	05 47809	0.49	0.46	0.44
4700u	35V	05 47811	0.87	0.83	0.75

ULTRA MINIATURE

Type	Stock No	1-24	25-99	100+
1uF	05 10514	0.09	0.08	0.07
2u2	05 22514	0.09	0.08	0.07
4u7	05 47514	0.09	0.08	0.07
10u	05 10613	0.09	0.08	0.07
10u	05 10614	0.09	0.08	0.06
22u	05 22612	0.09	0.08	0.07
22u	05 22613	0.10	0.09	0.08
22u	05 22614	0.11	0.10	0.09
47u	05 47612	0.11	0.10	0.09
47u	05 47613	0.11	0.10	0.09
100u	05 10712	0.11	0.10	0.09
100u	05 10713	0.14	0.12	0.10
220u	05 22712	0.14	0.12	0.10

ULTRA LOW LEAKAGE

Type	Stock No	1-24	25-99	100+
0.1uF	05 10210	0.08	0.07	0.06
0.22uF	05 10404	0.12	0.10	0.08
0.47uF	05 47404	0.12	0.10	0.08
1uF	05 10504	0.12	0.10	0.08
2u2	05 22504	0.12	0.10	0.08
4u7	05 47504	0.14	0.12	0.10
10uF	05 10604	0.14	0.12	0.10
22uF	05 22604	0.14	0.12	0.10
33uF	05 33604	0.14	0.12	0.10
47uF	05 47603	0.14	0.12	0.10
47uF	05 47604	0.18	0.14	0.12
100uF	05 10703	0.18	0.15	0.13

HIGH RIPPLE CAPACITOR

Type	Stock No	1-24	25-99	100+
10000uF	05 10915	5.50	4.95	4.45

COMPUTER GRADE

Type	Stock No	1-24	25-99	100+
15000:10	04 15915	3.88	3.49	0A
47000:10	04 47915	7.22	6.50	0A
150000:10	04 41015	15.58	14.01	0A
15000:25	04 15916	5.72	5.15	0A
68000:25	04 68916	15.58	14.01	0A

TANTALUM BEAD ELECTROLYTICS

Type	Stock No	1-24	25-99	100+
0.22	05 22402	0.15	0.13	0.11
0.33	05 33402	0.15	0.13	0.11
0.47	05 47402	0.16	0.14	0.12
0.68	05 68401	0.16	0.14	0.12
1u	05 10501	0.18	0.16	0.13
2u	05 22502	0.20	0.18	0.15
4u	05 47501	0.22	0.19	0.15
4u	05 47502	0.26	0.23	0.20
10	05 10601	0.29	0.25	0.21
10	05 10602	0.36	0.32	0.28
22	05 22601	0.40	0.35	0.31
22	05 22602	0.42	0.38	0.34
22	05 22603	0.43	0.40	0.38
47	05 47601	0.45	0.40	0.38
47	05 47602	0.92	0.84	0.75
10	05 10701	0.94	0.85	0.76

BI-POLAR

Type	Stock No	1-24	25-99	100+
1u	04 10513	0.20	0.18	0.16
1u5	04 15513	0.21	0.19	0.17
2u2	04 22513	0.22	0.20	0.18
3u3	04 33513	0.23	0.21	0.19
4u7	04 47513	0.24	0.22	0.20
6u8	04 68513	0.28	0.23	0.21
10u	04 10613	0.28	0.25	0.22
22u	04 22613	0.34	0.31	0.28
33u	04 33613	0.45	0.41	0.37

MONOLITHIC

Type	Stock No	1-24	25-99	100+
1n	04 10204	0.14	0.12	0.09
4n7	04 47204	0.18	0.11	0.10
10n	04 10304	0.17	0.12	0.10
47n	04 47304	0.18	0.13	0.11
100n	04 10404	0.18	0.13	0.11

CERAMIC PLATE

Type	Stock No	1-24	25-99	100+
2.2pF	04 22901	0.05	0.04	0.03
2.7pF	04 27901	0.05	0.04	0.03
3.3pF	04 33901	0.05	0.04	0.03
3.9pF	04 39901	0.05	0.04	0.03
4.7pF	04 47901	0.05	0.04	0.03
5.6pF	04 56901	0.05	0.04	0.03
6.8pF	04 68901	0.05	0.04	0.03
8.2pF	04 82901	0.05	0.04	0.03
10pF	04 10001	0.05	0.04	0.03
12pF	04 12001	0.05	0.04	0.03
15pF	04 15001	0.05	0.04	0.03
18pF	04 18001	0.05	0.04	0.03
22pF	04 22001	0.05	0.04	0.03
27pF	04 27001	0.05	0.04	0.03
33pF	04 33001	0.05	0.04	0.03
39pF	04 39001	0.05	0.04	0.03
47pF	04 47001	0.05	0.04	0.03
56pF	04 56001	0.05	0.04	0.03
68pF	04 68001	0.05	0.04	0.03
82pF	04 82001	0.06	0.05	0.04
100pF	04 10101	0.06	0.05	0.04
120pF	04 12101	0.06	0.05	0.04
150pF	04 15101	0.06	0.05	0.04
180pF	04 18101	0.06	0.05	0.04
220pF	04 22101	0.06	0.05	0.04
270pF	04 27101	0.06	0.05	0.04
330pF	04 33101	0.06	0.05	0.04
390pF	04 39102	0.06	0.05	0.04
470pF	04 47102	0.06	0.05	0.04
560pF	04 56102	0.06	0.05	0.04
680pF	04 68102	0.06	0.05	0.04
820pF	04 82102	0.06	0.05	0.04
1000pF	04 10202	0.06	0.05	0.04
1200pF	04 12202	0.06	0.05	0.04
1500pF	04 15202	0.06	0.05	0.04
1800pF	04 18202	0.06	0.05	0.04
2200pF	04 20202	0.06	0.05	0.04
2700pF	04 27202	0.06	0.05	0.04
3300pF	04 33202	0.06	0.05	0.04
4700pF	04 47202	0.06	0.05	0.04

DISC CERAMIC

Type	Stock No	1-24	25-99	100+
10n	04 10303	0.05	0.04	0.03
22n	04 22303	0.06	0.05	0.04
47n	04 47303	0.06	0.06	0.04
100n	04 10403	0.09	0.08	0.07

FEEDTHROUGHS

Type	Stock No	1-24	25-99	100+
1000pF	04 10210	0.08	0.07	0.066

SCREW IN FTs

Type	Stock No	1-24	25-99	100+
1000pF	04 10215	1.50	1.35	1.21

MYLAR

Type	Stock No	1-24	25-99	100+
1n	04 10206	0.05	0.04	0.03
2n2	04 22206	0.05	0.04	0.03
3n3	04 33206	0.05	0.04	0.03
4n7	04 47206	0.05	0.04	0.03
6n8	04 68206	0.05	0.04	0.03
10n	04 10306	0.05	0.04	0.03
22n	04 22306	0.06	0.05	0.04
33n	04 33306	0.06	0.05	0.04
47n	04 47306	0.06	0.05	0.04
68n	04 68306	0.06	0.05	0.04
100n	04 10406	0.08	0.06	0.05
220n	04 22406	0.10	0.08	0.07
330n	04 33406	0.11	0.09	0.08
470n	04 47406	0.14	0.12	0.10

POLYESTER (C280 TYPE)

Type	Stock No	1-24	25-99	100+
10n	04 10305	0.06	0.05	0.04
15n	04 15305	0.06	0.05	0.04
22n	04 22305	0.06	0.05	0.04
33n	04 33305	0.06	0.05	0.04
47n	04 47305	0.08	0.07	0.06
68n	04 68305	0.08	0.07	0.06
100n	04 10405	0.09	0.07	0.06
150n	04 15405	0.10	0.08	0.07
220n	04 22405	0.10	0.08	0.07
330n	04 33405	0.17	0.16	0.14
470n	04 47405	0.17	0.16	0.14
680n	04 68405	0.17	0.16	0.14
1uF	04 10505	0.24	0.22	0.18

POLYESTER (SIEMENS)

Type	Stock No	1-24	25-99	100+
10n	04 10307	0.10	0.08	0.07
22n	04 22307	0.10	0.08	0.07
33n	04 33307	0.11	0.09	0.08
47n	04 47307	0.11	0.09	0.08
68n	04 68307	0.12	0.10	0.08
100n	04 10407	0.13	0.11	0.10
150n	04 15407	0.18	0.14	0.11
220n	04 22407	0.18	0.15	0.12
330n	04 33407	0.22	0.19	0.16
470n	04 47407	0.28	0.22	0.19
680n	04 68407	0.38	0.32	0.28
1uF	04 10507	0.42	0.38	0.29
2u2	04 22507	0.65	0.55	0.44

LEADLESS CERAMICS

Type	Stock No	1-24	25-99	100+
18pF	04 18011	0.06	0.05	0.04
22pF	04 22011	0.06	0.05	0.04
180pF	04 18111	0.06	0.05	0.04

POLYSTYRENE

Type	Stock No	1-24	25-99	100+
10pF	04 10009	0.08	0.07	0.06
15pF	04 15009	0.08	0.07	0.06
18pF	04 18009	0.08	0.07	0.06
22pF	04 22009	0.08	0.07	0.06
27pF	04 27009	0.08	0.07	0.06
47pF	04 47009	0.08	0.07	0.06
56pF	04 56009	0.08	0.07	0.06
68pF	04 68009	0.08	0.07	0.06
100pF	04 10109	0.09	0.08	0.07
180pF	04 18109	0.09	0.08	0.07
220pF	04 22109	0.09	0.08	0.07
270pF	04 27109	0.09	0.08	0.07
330pF	04 33109	0.09	0.08	0.07
390pF	04 39109	0.09	0.08	0.07
470pF	04 47109	0.10	0.09	0.08
680pF	04 68109	0.10	0.09	0.08
820pF	04 82109	0.10	0.09	0.08
1nF	04 10209	0.11	0.10	0.09
1n2	04 12209	0.11	0.10	0.09
1n5	04 15209	0.11	0.10	0.09
2n8	04 18209	0.11	0.10	0.09
2n2	04 22209	0.12	0.11	0.10
2n7	04 27209	0.12	0.11	0.10
3n3	04 33209	0.12	0.11	0.10
3n9	04 39209	0.12	0.11	0.10
4n7	04 47209	0.13	0.12	0.11
5n6	04 56209	0.13	0.12	0.11
6n8	04 68209	0.13	0.12	0.11
10nF	04 10309	0.13	0.12	0.11

SILVER MICA

Type	Stock No	1-24	25-99	100+
2.2pF	04 22908	0.20	0.18	0.15
4.7pF	04 47908	0.20	0.18	0.15
10pF	04 10008	0.20	0.18	0.15
22pF	04 22008	0.20	0.18	0.15
33pF	04 33008	0.20	0.18	0.15
47pF	04 47008	0.20	0.18	0.15
56pF	04 56008	0.20	0.18	0.15
68pF	04 68008	0.20	0.18	0.15
100pF	04 10108	0.20	0.18	0.15
120pF	04 12108	0.20	0.18	0.15
150pF	04 15108	0.20	0.18	0.15
220pF	04 22108	0.23	0.18	0.16
330pF	04 33108	0.32	0.29	0.26

MICA UNELCO

Type	Stock No	1-24	25-99	100+
10pF	04 10014	1.10	0.98	0.88
22pF	04 22014	1.10	0.98	0.88
47pF	04 47014	1.10	0.98	0.88
100pF	04 10114	1.10	0.98	0.88
220pF	04 22114	1.10	0.98	0.88
470pF	04 47114	1.10	0.98	0.88
1000pF	04 10214	1.10	0.98	0.88

POLYVARICON VARIABLES

Type	Stock No	1-24	25-99	100+
2x266pF	06 26102	0.92	0.82	0.74
2x335pF/3x20pF	06 33102	1.85	1.45	1.25

DILECON CAPACITORS

Type	Stock No	1-24	25-99	100+
300pF	06 30006	3.12	2.80	0A
500pF	06 50006	3.12	2.80	0A

JACKSON C804

Type	Stock No	1-24	25-99	100+
25pF	06 02506	3.55	2.00	0A
50pF	06 05006	3.55	2.00	0A
100pF	06 10006	4.01	3.57	0A

C638W

Type	Stock No	1-24	25-99	100+
3x426pF	06 42603	5.80	4.96	4.36
1x100k	06 42603	5.80	4.96	4.36

CERAMIC TRIMMERS

5mm DIAMETER TYPES

Type	Stock No	1-24	25-99	100+
1.8 to 6pF	06 60903	0.15	0.14	0.13
2.8 12.5pF	06 12003	0.15	0.14	0.13
3.5 20pF	06 20003	0.15	0.14	0.13
5 30pF	06 30003	0.15	0.14	0.13
9 50pF	06 50003	0.15	0.14	0.13

10mm DIAMETER CERAMIC TYPES

Type	Stock No	1-24	25-99	100+
5 30pF	06 30005	0.23	0.22	0.21
8 50pF	06 50005	0.23	0.22	0.21
16 100pF	06 10005	0.23	0.22	0.21

MINIATURE CERAMIC TRIMMERS

CTZ31 - 3.7mm

Type	Stock No	1-24	25-99	100+
3 10pF	06 10007	0.14	0.12	0.11
4.5 20	06 20007	0.14	0.12	0.11
6.5 30	06 30007	0.14	0.12	0.11

CTZ31

Type	Stock No	1-24	25-99	100+
2.5 6	06 06008	0.14	0.12	0.11
3 10	06 10008	0.14	0.12	0.11
4.5 20	06 20008	0.14	0.12	0.11
5.5 30	06 30008	0.14	0.12	0.11
7.5 50	06 50008	0.14	0.12	0.11
9 70	06 70008	0.14	0.12	0.11

FOIL TRIMMERS

Type	Stock No	1-24	25-99	100+
1.5 10pF	06 10001	0.18	0.15	0.14
2 22pF	06 22001	0.20	0.16	0.14
3 36pF	06 36001	0.27	0.23	0.19
5 60pF	06 60001	0.26	0.22	0.18
3 90pF	06 80001	0.29	0.24	0.22

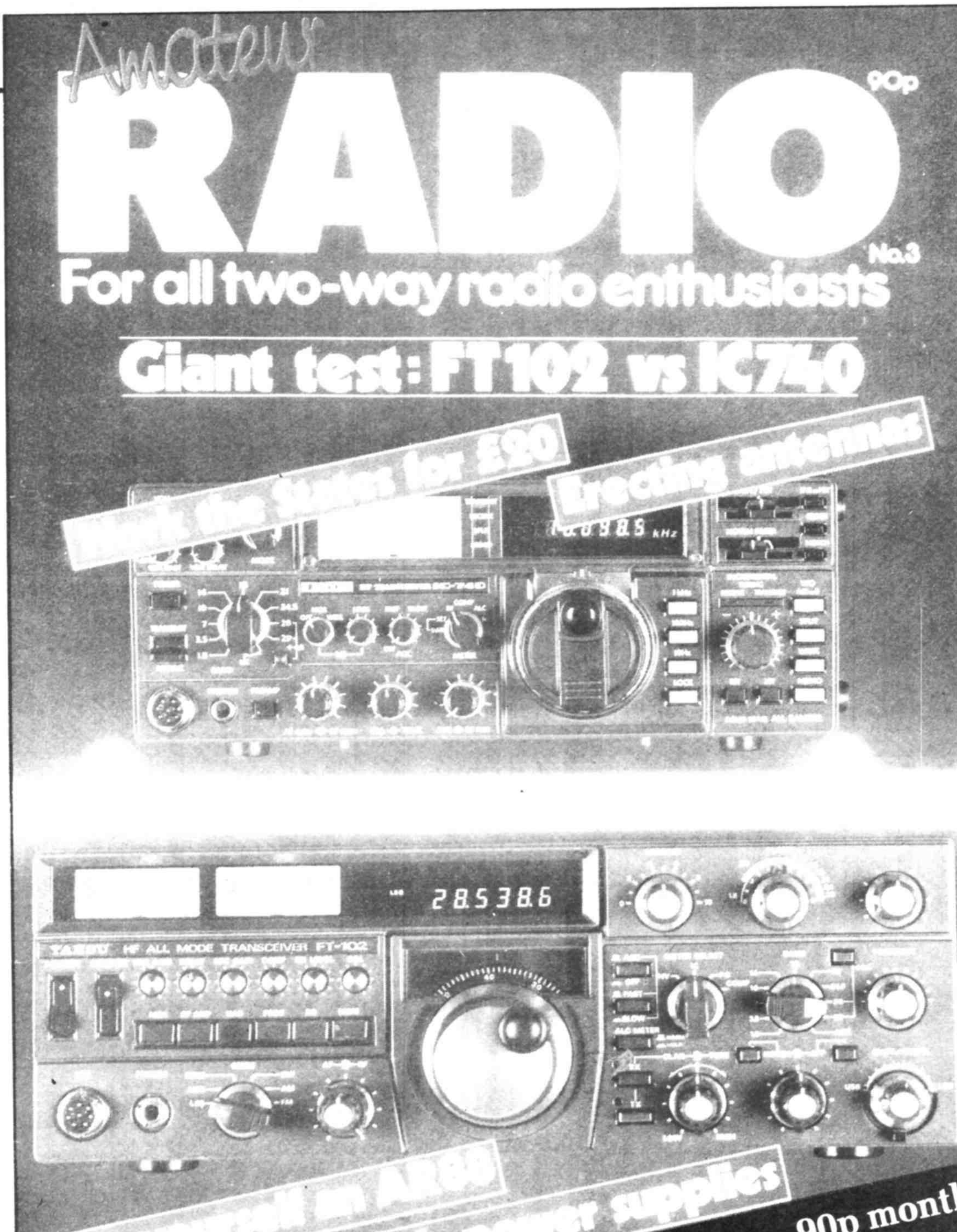
COMPRESSION TRIMMERS

Type	Stock No	1-24	25-99	100+
10 80pF	06 08006	0.24	0.21	0.18
30 140pF	06 14006	0.24	0.21	0.18

Ambit international

200 North Service Road
Brentwood, Essex
CM14 4SG

Telecom directory:
Consumer 0277-230909
Industrial 0277-231616
Telex 995194 AMBIT G
DATEL 0277-232628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BULLETIN BOARD

REWCARD LATEST

We've had a very good response to our Rewcard discount scheme with sack fulls of cards together with application forms arriving at our offices each day.

There's still time to join the scheme and if you haven't sent your card to us for validation yet, why not do so now. We'll be accepting new applications until the end of March.

All Rewcard members will receive details of an exciting value for money offer that, at present, is only available to Rewcard holders.

BT Appointments

British Telecom has appointed the Swedish company Viewdata AB as its local Scandinavian marketing agent for Prestel. Viewdata AB, which is part of the Axel Johnson group, will provide a full sales and support facility to market Prestel's 200,000 pages of computer-held information in Sweden, Denmark, Norway and Finland. The company will additionally provide local assistance for those Scandinavian companies who wish to publish information on Prestel.

Space Invaders

The Satellite Division of Marconi Space and Defence Systems Limited, based at Portsmouth, has been awarded a contract by the European Space Agency to study advanced orbital propulsion systems for future communications spacecraft. The study, which will take one year, is considered of major importance in the field of spacecraft technological advances. It will provide a clear comparative assessment of the various propulsion alternatives and will identify the propulsion developments needed in Europe over the next decade.

The Marconi Satellite Division is currently engaged in the design and development of spacecraft payloads for business systems, direct broadcasting of television, military and maritime communications, meteorological and remote sensing systems. The UK space industry is in a phase of rapid growth and Marconi is now recruiting staff to increase considerably its existing strength over the next few years to take full advantage of the opportunities.

Lightline Across The Solent

Britain's first operational undersea Lightline — a £600,000 fibre-optics cable — has just been ordered by British Telecom. It will carry phone calls across the Solent as pulses of laser light in hair-thin strands of ultra-pure glass.

The 23km (15 mile) cable, linking Portsmouth and Ryde, will enter service in 1985.

Ambi-faux-pas

The person responsible for project packs at Ambit International has informed us of a small slip-up regarding the Airband Receiver kit. Despite protestations to the contrary from Motorola, their MC12016 will not directly replace the SP8793. So, all those in possession of a receiver kit containing the Motorola chip may return it to Ambit for a replacement IC.

Gobble, Gobble

Kuma has just announced the first item in a range of application and entertainment software for the Newbrain microcomputer. It is an entertainment program called GOBBLER which uses the excellent hi-res graphics of the Newbrain to good effect. There is a maze to be negotiated with lots of hazards, and the choice of eating the pursuers or being eaten by them. The chances are dependent on whether an energiser can be found in time. Tricky! Lots of fun.

REWgrets

Morse Speed Readout (Feb '83) the unused gate on IC3 should be linked to +Vcc - connect pin 12 and 13 to pin 14.

HF Receiver Design (FEB '83): Apologies to Jon (not John) Dyer G4OBU for misspelling his name. On page 50, under the title "Frequency Synthesisors" the two block diagrams referred to in the first paragraph as "above and below", are in fact Figures 9 & 10 above.

On many of the figures, for bs read fs (ie, signal frequency);

In ***Fig. 6***, for "4 to 14.5MHz" at the input, read "14 to 14.5MHz".

In ***Fig. 10***, output of VFO should be 5.545 to 4.545MHz.

In ***Fig. 13***, in the display box ignore the "086.9". (Something like "12.3456" would have been more suitable).

In ***Fig. 15***, for "Alter Response" read "Filter Response". (Now is NOT the time to say .... "I do"!)

In ***Fig. 5***, output of VFO should be 2.955 to 3.455MHz.

In ***Fig. 8***, input should be 1 to 30MHz, VFO output 2.455 to 3.455MHz.

In ***Fig. 9***, filter should be marked "ROOF 20kHz WIDE".

SNIPPETS

Amorphous Heads

Sanyo Electric Company has developed an amorphous head for VTRs which obtains a recording density double that from conventional VTR heads.

When the recording density of magnetic tape is increased, material with a highly saturated magnetic flux density for magnetic heads is required. The company developed a sendust head in 1981 for VTRs using metal-particle tape. The amorphous head, incorporating the company's own precision manufacturing technology, succeeds this.

SAWs Material

Sumitomo Metal Mining plans to double its production of $LiNbO_3$ crystal, the material for SAW filters, by the end of March. Although demand has been lower in Japan for SAW filters, Sumitomo decided to boost its $LiNbO_3$ crystal output to satisfy a growing demand for export to Europe.

Sharpen Your Axe

Competition is getting hot in the video and camera market. In 1981, Sony, Matsushita, Ikegami and RCA introduced their video combination cameras at an NAB show and started delivering them last autumn. Competition is now sharpening among three groups — the Betacam group of Sony and Thomson-CSF of France, the M format group of Matsushita, Hitachi, Ikegami, RCA and Ampex, and a group of makers, including Hitachi Denshi, which proposes to use quarter-inch tape.

Logical Co-operation

Toshiba has arranged a technical assistance agreement with SGS-ATES of Italy, under which the Japanese company is to jointly develop super high-speed logic ICs utilizing CMOS technology.

Toshiba previously concluded an agreement with SGS-ATES to provide technology for fine processing of CMOS memories.

NEC RAM

Nippon Electric will start shipping its 256K RAM in March. In a 256K RAM about 600,000 transistors and other elements are integrated on a square silicon substrate of several millimetres to achieve a storage capacity of about 32,600 alphanumeric characters.

Murata Chips In

Murata Manufacturing has developed a chip-type ceramic filter for FM radios, which is the first of its kind. The newly developed SFEC series is said to equal performance of the company's u series ceramic filters for FM radios.

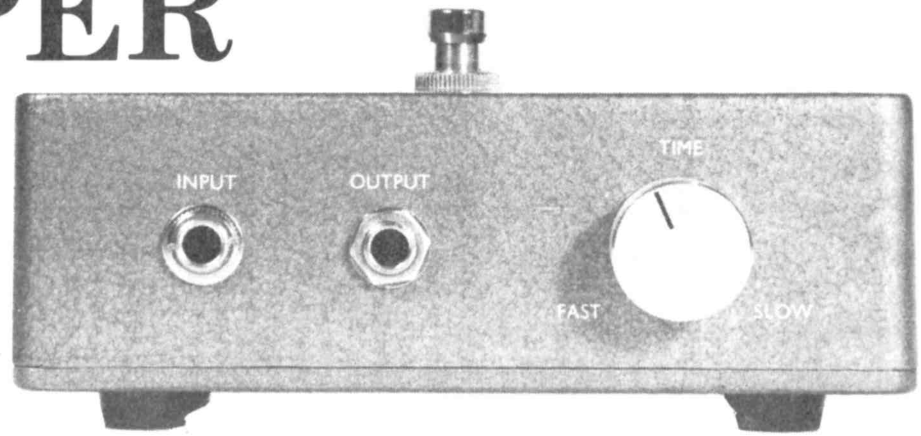
Japanese Plant

Fairchild Camera and Instrument Corporation of the United States will start construction of its plant in Isahaya City, Kyushu, Japan this spring, for operation in the autumn. The plant will manufacture 64K RAM, mainly bipolar ICs, and some MOS ICs. Fairchild will be the third American IC maker to establish a production facility in Kyushu, following Texas Instruments (Japan) and the Materials Research Corp.

SOUND SHAPER

An effects unit for guitarists and other musicians.

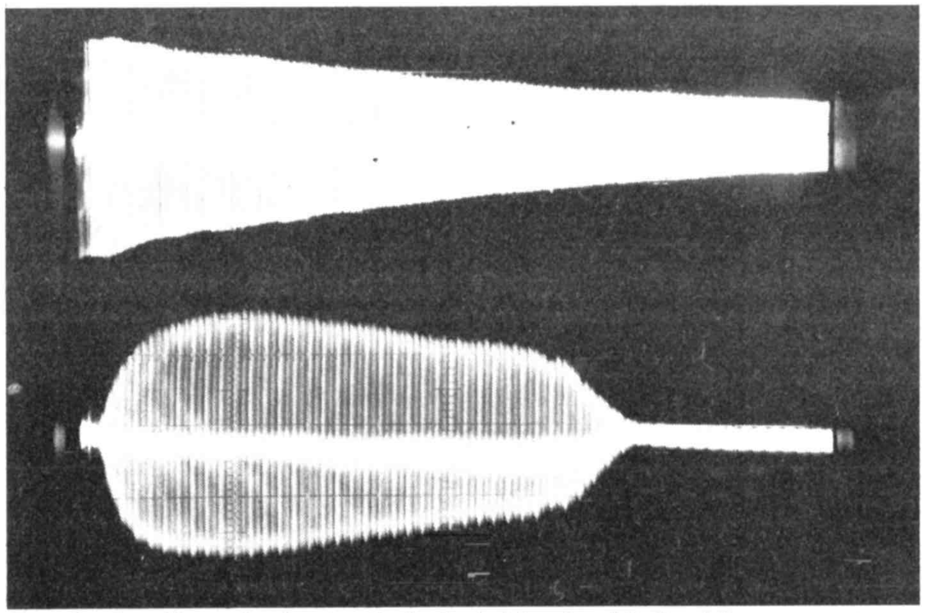
Design by I. M. Attrill.



CERTAIN MUSICAL instruments produce a waveform with fast attack and comparatively slow decay, which becomes progressively slower as the note dies away. It is the almost instant attack time of the signal that gives a guitar, for instance, its 'hard' initial sound. By providing a slower build-up, this unit provides a much 'smoother' sound, substantially different to the unprocessed signal. The unit also gives a brisker decay to the signal; although often notes are not allowed to die away naturally, but rapidly damped in the process of playing the next note.

Figure 1 shows the make up of the Sound Shaper in block diagram form. A preamplifier is used at the input, to ensure that the subsequent level is high enough to give a good signal-to-noise ratio. Some of the output from the preamplifier is fed to a voltage controlled amplifier, and then via another amplifier to the output. This second amplification stage is needed in order to compensate for the drop in volume caused by removing the attack section of the input signal.

The preamplifier is used to drive a retriggerable monostable multivibrator with an output pulse duration of about 25 milliseconds. In the presence of a suitably strong input, it is constantly retriggered — its output almost continuously in the high state — until the input signal falls below the level which produces triggering. A simple RC circuit, at the ouput of the monostable, gives suitable attack and decay times; the former being adjustable so that some control over the type of effect is possible. The resultant voltage is used to control the VCA by way of a buffer amplifier.



Two signal oscillographs showing (top) a typical input and (bottom) the processed output.

Construction

An aluminium diecast box provides adequate screening for the circuit and the printed circuit board is designed to slot into it. SW1 is mounted on the top panel, while the two sockets and RV3 are mounted on one of the sides (which effectively becomes the front panel). It is essential that SW1 is a heavy duty type, capable of being repeatedly operated without becoming 'noisy'.

Electrical construction is quite straightforward, and details of the printed circuit board and hard-wiring are given in ***Figure 3***. Although IC4 is a CMOS device it has built-in protection circuits that render the normal CMOS handling precautions unnecessary.

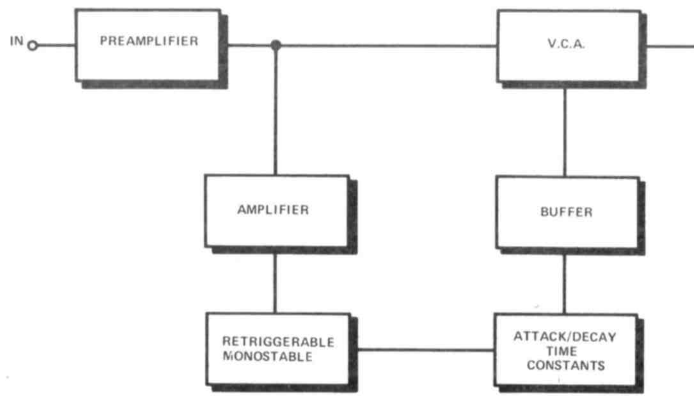


Figure 1: Basic stages for the shaper's operation.

Circuit Description

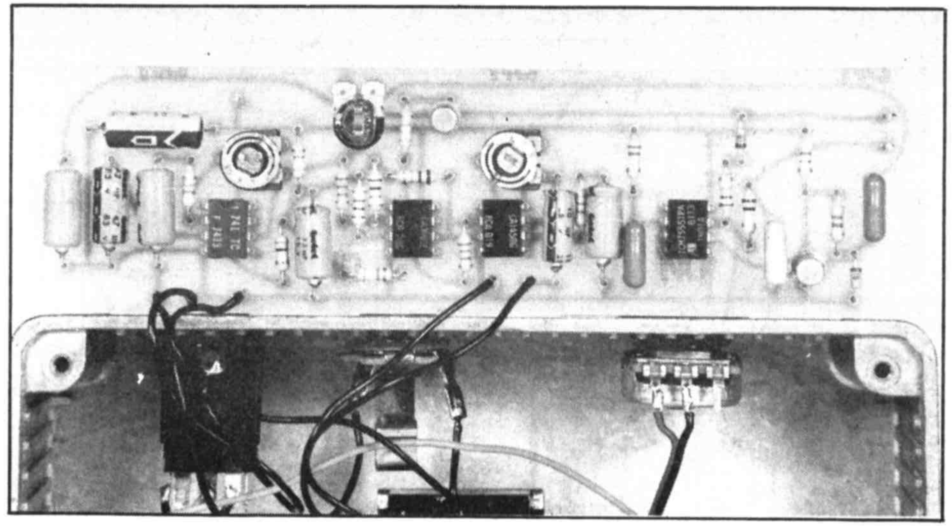
Figure 2 shows the full circuit diagram of the Sound Shaper. IC1 is used as the preamplifier. It is a straightforward 741 inverting amplifier with an input impedance of 47k and variable gain from 0 to about 20dB via RV1. IC2 is a transconductance amplifier, used as the basis of the VCA, and R9 is the output load resistor. A unity gain buffer stage (IC3a) ensures that IC2 operates into a suitably high impedance.

Resistors R5 and R10 form a negative feedback network, which sets the closed loop gain of IC2 at unity *only when* the current fed to pin 5 is high enough. Below this threshold, the gain of IC2 is roughly proportional to the bias current fed to pin 5. R8 is used in series with the amplifier bias input so that IC2 is effectively voltage and not current operated.

IC3b is used in the output amplifier; a non-inverting type with 0-20dB voltage gain.

The monostable uses a standard 555 configuration, although IC4 is actually the CMOS version with low current consumption. Its trigger input (pin 2) is fed direct from the collector of Q2. This is used as a common emitter amplifier, but under quiescent conditions IC4 is not triggered since the collector of Q2 is biased above the IC2 ⅓V trigger threshold. However, Q2 is fed with the output signal of IC1 and, in the presence of an input signal of adequate amplitude, IC4 will be triggered on negative half cycles at Q2's collector.

R12, RV3, and C7 determine the attack time of the circuit, while the decay time is largely controlled by the values of C7 and R13. Q1 is used as an emitter follower to avoid problems with excessive loading, and its output is connected direct to the control input of the VCA. C8 prevents output pulses from IC4 finding their way into the main signal path via stray coupling.



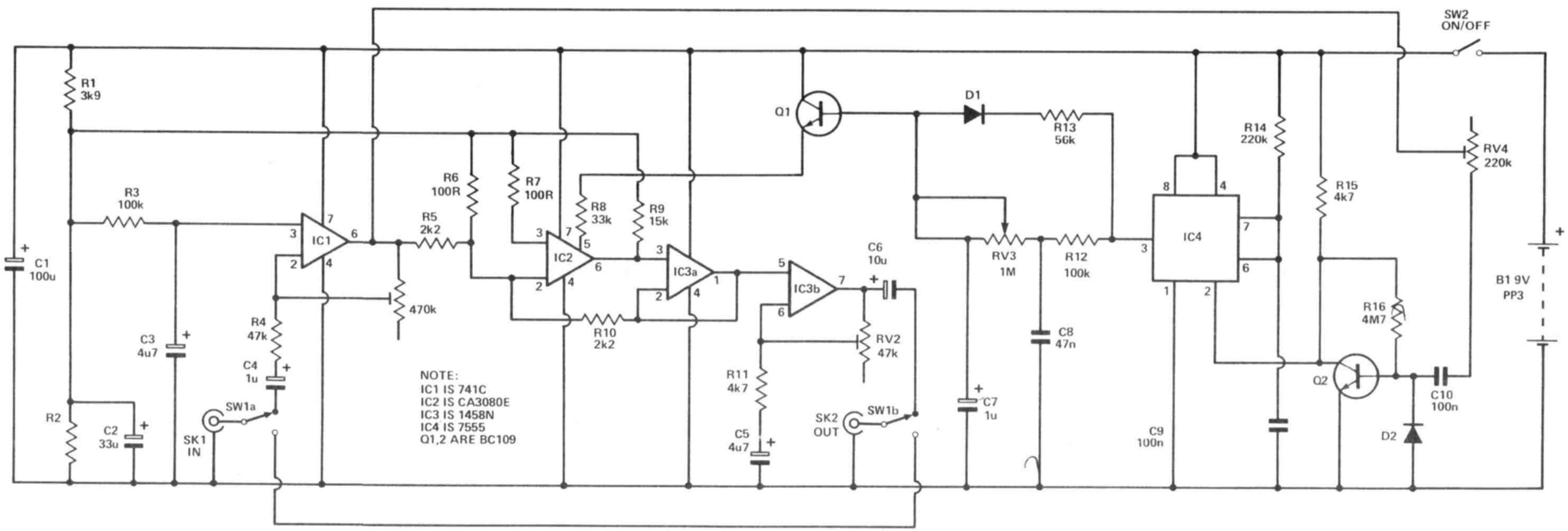


Figure 2: Circuit of the Sound Shaper.

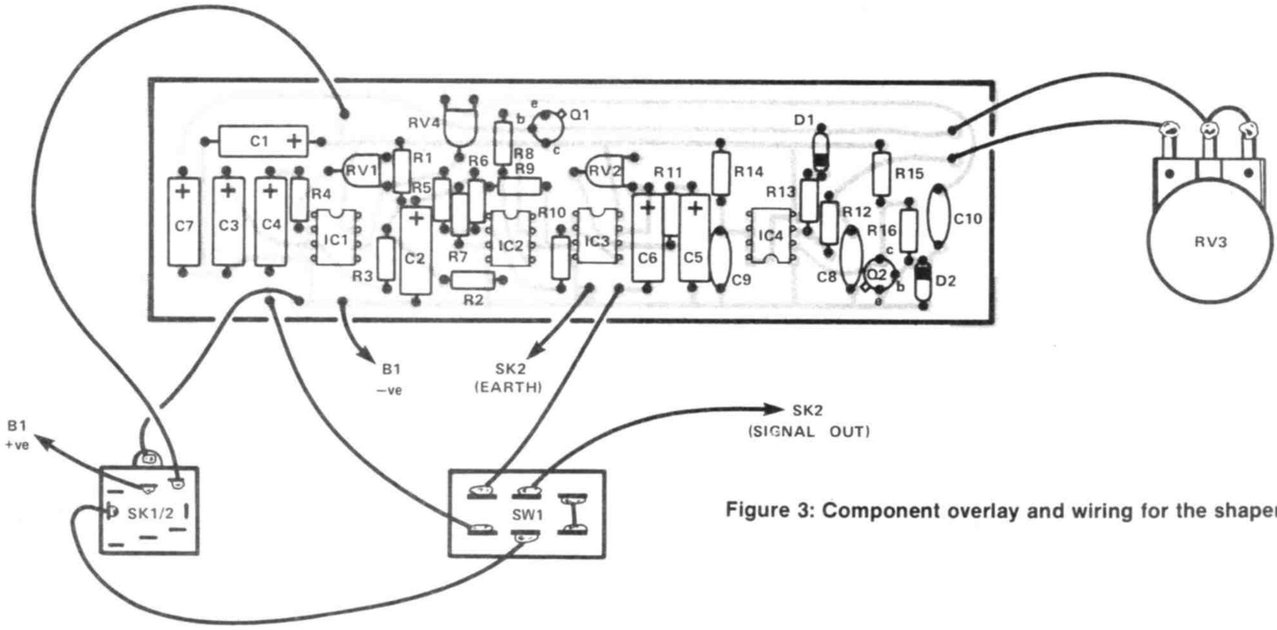


Figure 3: Component overlay and wiring for the shaper.

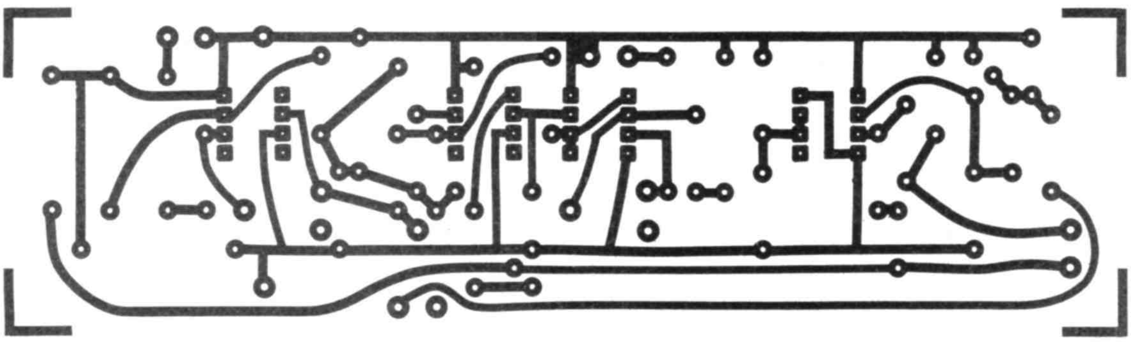


Figure 4: PCB foil pattern.

Adjustment

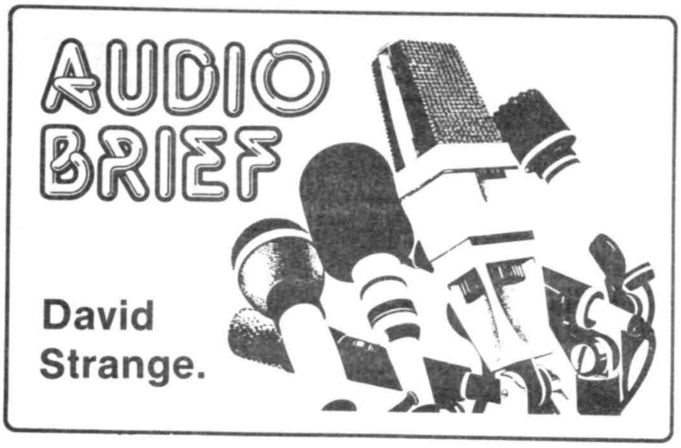
Initially, set RV1 at low gain (near to fully anticlockwise), RV2 for unity voltage gain (fully anticlockwise), and RV4 for high sensitivity (almost fully clockwise). With a low input signal (eg, a guitar) it should be found that advancing RV1 produces an increase in output level, without overloading. Then RV1 should be set for fairly high gain in order to produce optimum noise performance. With high input levels, RV1 will need to be kept well trimmed in order to avoid distorting the output.

Best results will probably be with RV4 set to give a maximum note duration of about one second or so, but this is up to the individual. RV2 is set so there is no apparent change in volume when the effect is switched in and out. The volume is affected to a limited extent by the setting of RV3, since a long attack time results in the VCA only reaching full gain when the input signal has reduced in amplitude. The nature of the processed and unprocessed signals is also very different. The optimum setting for RV2 is therefore a subjective matter and, to an extent, something of a compromise. In normal use RV3 will need to be set for a relatively fast attack time. However, quite a weird sound is obtained with RV3 set for maximum attack since the sound takes around one second to reach full intensity.

■ R&EW

PARTS LIST

Resistors	
R1,22	3k9
R3,12	100k
R4	47k
R5,10	2k2
R6,7	100R
R8	33k
R9	15k
R11,15	4k7
R13	56k
R14	220k
R16	4M7
Potentiometers	
RV1,4	470k preset
RV2	47k preset
RV3	1M linear
RV4	220k preset
Capacitors	
C1	100u 16V axial
C2	33u 16V axial
C3,5	4u7 50V axial
C4,7	1u 50V axial
C6	10u 25V axial
C8	47n polyester
C9,10	100n polyester
Semiconductors	
Q1,2	BC109
IC1	741C
IC2	LM1458C
IC3	CA3080E
IC4	7555
D1,2	1N4148
Miscellaneous	
SW1	DPDT heavy-duty push button
SW2	(part of SK1)
SK1	6.35mm jack with DPDT contacts
SK2	6.35mm jack
B1	9 volt PP3
Battery connector, die-cast case, knob, PCB etc.	



Noise and its reduction — a complete overview of this confusing subject.

'PREVENTION is better than cure', and at every step along the audio processing chain care is required to prevent noise becoming part of the signal. However, there are some stages in the chain that are *inherently* noisy — any remedies must be taken either at source (master recording) or as a last resort during playback.

From here on, we shall refer to noise as being 'the unwanted part of the information' and the signal as being 'the wanted information'. In general, the signal may be mixed with single frequency noise, pulsive noise, broadband noise and *if you're really lucky* all three mixed together.

Single Frequency Noise

Mains hum or heterodyne whistle will be masked by the signal so long as the energy *in* the signal is greater than the energy of the noise, in the same frequency band. As the signal frequency gets further away from the noise frequency,the noise will become noticeable — usually the audio signal will be continuously varying in frequency content, so the noise breakthrough will vary.

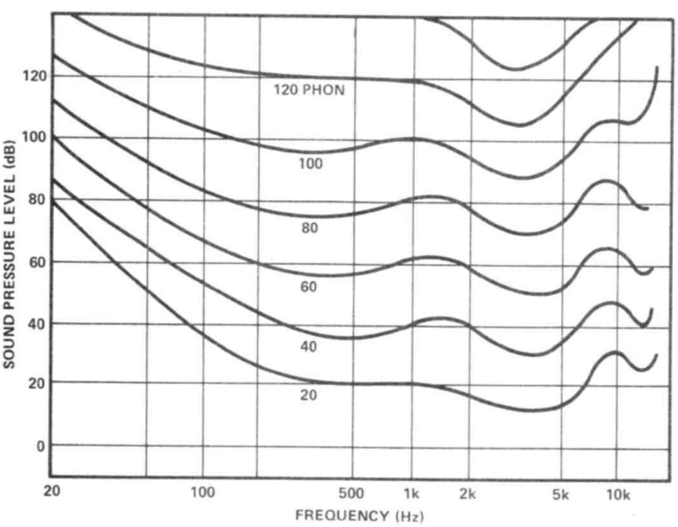


Figure 1: Contours of perceived equal loudness against frequency (after Robinson and Dadson).

Pulsive Noise

This is the type of noise encountered on telephone circuits and worn gramophone records. It tends to be of higher amplitude than our ears lead us to believe and its frequency content consists of a fundamental and a number of lower amplitude harmonics. It occurs randomly and the duration of a pulse varies mostly from 0.3 to 7 milliseconds. Shorter duration pulses are masked when the signal is sufficiently high, despite their real amplitude which may be more than the signal.

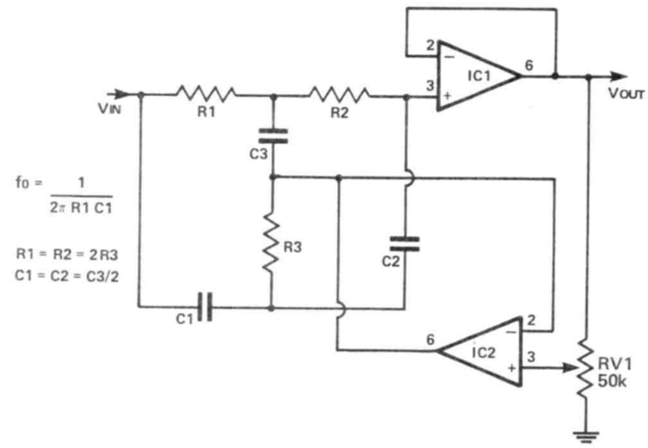


Figure 2: Practical circuit of a notch filter with adjustable Q.

Broadband Noise

As the name suggests, this type of noise covers a number of frequencies. It is sometimes called 'hiss' because there is an impression that it consists of purely high frequencies; far from the truth because our ears deceive us, since at low signal levels, we are less sensitive to low frequency sounds (see the equal loudness contour graph of ***Fig. 1***). To give the same perception of level, the intensity must be much higher for low frequencies *and* reduced between 2 and 5 kHz. This phenomenon, as we shall see, is one on which noise reduction systems rely.

A saving grace of broadband noise is that it *does* tend to be of a lower amplitude than the signal (unless something went badly wrong) and can therefore be masked by it. Once again, the rule "when the signal is greater than the noise, in bandwidth and energy, the noise will be masked" applies.

Having now briefly outlined some characteristics of noise, let's turn to methods of dealing with it. It is easy when talking about noise reduction to immediately leap to 'high-tech', highly patented devices like Dolby, forgetting traditional things such as filters — all have their place. The best method for dealing with noise is going to depend on the nature of the noise and signal together, and whether the noise has been inherited with the signal or added by something under *our* control.

Noise Inheritance

Let's first consider some noise reduction methods applicable to the noise inherited *with* the signal; although in a sense its making the best of a bad job, as some compromises may have to be made. We have a choice of five methods:

1. High or low pass filtering
2. Notch filtering
3. Dynamic filtering
4. Blanking
5. Gating

High pass filtering can be very successful at removing rumble or hum from a signal, especially when that signal has little or no low frequency content. Success will largely depend on the steepness of the filter slope and its -3dB point. An 18dB/octave filter can be configured around a single op-amp, and such a filter, with -3dB point at around 280Hz, would reduce 100Hz

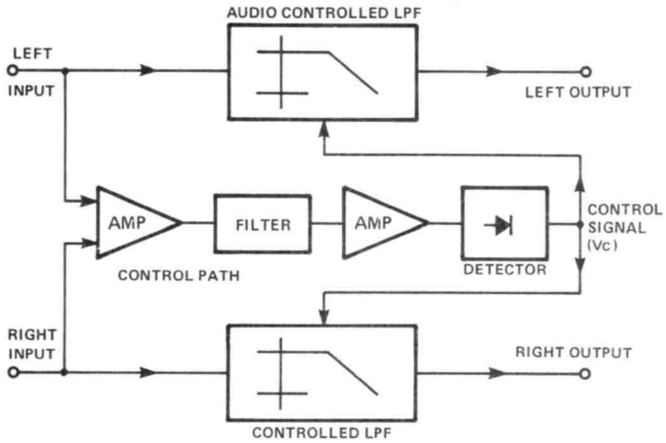


Figure 3: Block diagram of essential components in the DNR system.

hum by some 20dB (10 times) and 50Hz by 40dB (100 times). Low pass filtering can, to some extent, reduce annoying broadband noise depending on the nature of the signal. For instance, the filter would be more than effective at silencing a noisy bass guitar amplifier, because the signal contains so little high frequency. Again, like its high pass counterpart, the low pass filter can be configured around a single IC.

Notch filtering or band-pass filtering, can be very useful for reducing single frequency noise, such as hum or heterodyne whistles, leaving the signal virtually unaffected. Easily tuned notch filters can be configured around op-amps and can be swept onto a particular frequency band (***Fig. 2***).

Dynamic noise filtering is a non-complementary noise reduction system — unlike other systems (which compress the signal prior to, say, passing it through a recording chain and then expanding it on replay) DNR can only filter the signal according to its level and frequency content. In fact, DNR relies upon the signal masking the noise when large enough. However, when the signal drops to a point where the noise can no longer be masked, a low pass filter is proportionally introduced to make the noise seem less prominent. The system works best on highly compressed sounds, such as pop music, but on wide dynamic range material a 'dulling' of the sound occurs as the signal level drops and the filtering operates. Left and right signals are passed through voltage controlled filters which, when no signal is present — no control voltage — low pass from 1kHz. The roll-offs of the filters are proportionally raised as the signal level increases, until (at maximum) the -3dB point is outside the audible range (30kHz).

The single control voltage is derived from both left and right channels, and operates both voltage controlled filters in order to avoid stereo image drifting.

To ensure that only the high frequency content of the signals is responsible for pushing back the response of the filters, the control signal path contains a high pass filter preceeding the peak rectifier.

Blanking can be useful for eliminating pulsive noise, such as gramophone record scratches. The system works by interrupting the signal whenever a pulse or scratch appears. Unfortunately, the width of an imperfection or click is indeterminate and therefore some compromise is required as to how long the blanking period should last.

The input, of noise and signal, is fed to a differentiator and the FET in the signal path. The differentiator exaggerates any high transient pulses, which are then passed onto a rectifier of variable gain so that the trip threshold may be set. The output of the rectifier, when of sufficient amplitude, triggers the timer which adjusts the blanking period required. The timer turns the FET off just as a noise pulse arrives, and turns on again (hopefully) when it has passed — silence is less noticeable than a loud click.

There *are* variations on this theme. In one, the signal path is delayed by the same number of milliseconds as the timer — you hear either the delayed or real time signal depending upon whether the device has been triggered or not. These fill in the otherwise blank gaps with some other signal.

Noise gating is operated by the signal, and can be looked upon as the opposite of noise blanking, where it is *the noise* that does the work of operating the gate. Gating is particularly effective where broadband noise is present at a low level, but would be obtrusive because the signal is spurious (as with speech or percussion). When a noise gate is used and there is no signal at the input, absolute silence prevails. However, when a signal arrives which would mask the noise, the gate opens (***Fig. 5***). A DC voltage is derived, by a peak detecting circuit, and this is given an attack and decay time constant before being compared to a fixed DC potential. The level of the fixed potential is set so that the threshold for the comparator operation is just above that caused by the noise. When the comparator sees this voltage, the change of state turns on the FET, allowing only that noise which will be masked by signal through to the output.

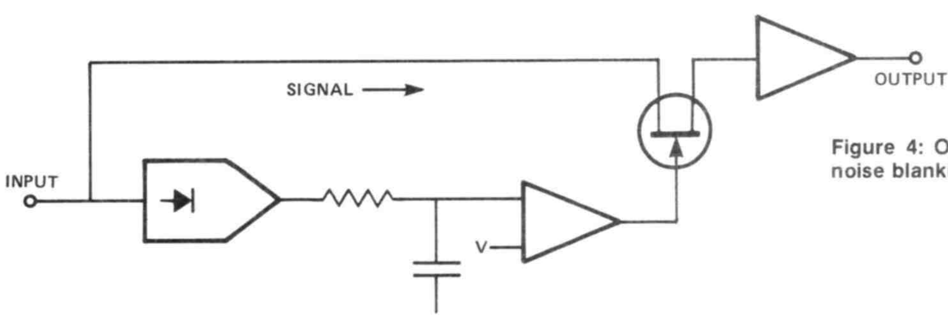


Figure 4: Operating principle of a noise blanking circuit.

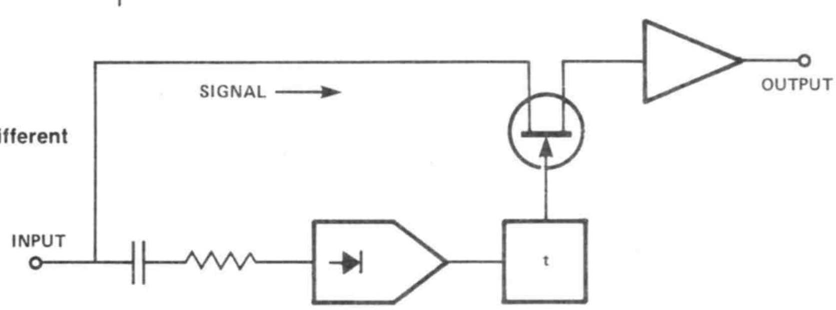


Figure 5: A noise gate has a different working format.

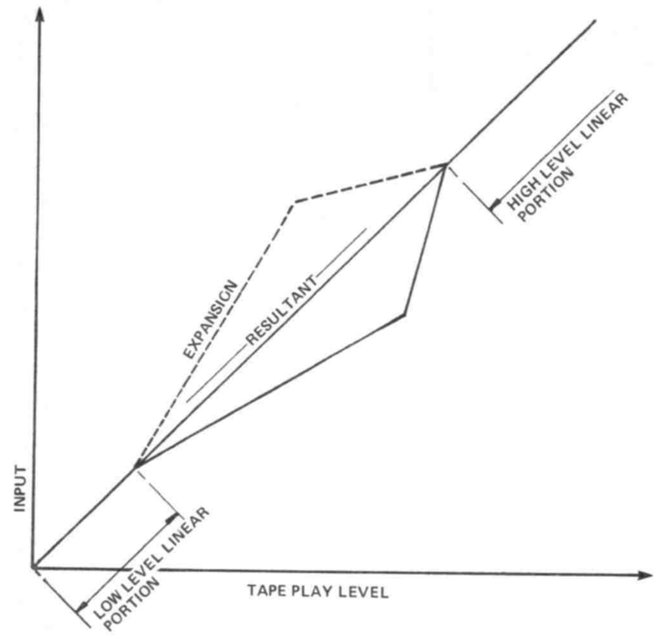


Figure 6: Ideal curves for record/playback processing.

Origin Of Signal

Moving on to situations where there is access to the original signal, we can give consideration to using a complementary method of noise reduction. That is not to say, however, that one or more of the methods *already* mentioned may be preferable; especially since all complementary methods deal only with broadband noise at low levels.

A mention was made earlier as to complementary noise reduction systems being "compression on record, with expansion on playback", but this is only true to a small degree. A straightforward and constant slope compression 'on record' and the very precise inverse of this (expansion) 'on playback' presents us with the danger of signal overload and distortion. These are in addition to other audible effects, such as noise modulation caused by LF signals pushing the 'noise floor' up and down.

The transfer characteristic of ***Fig. 6*** is much more preferable, since it is only at lower levels the compression and expansion takes place, leaving room at the upper end for a return to unity gain — reducing the possibility of overload and distortion. In theory also, with this type of system, any results of mistracking are less obvious (*in theory* because the assumption is made that the recording system is linear, which is far from the truth). The off-tape frequency response of a cassette at various amplitudes is shown in ***Fig. 7***, and from this it can be seen that the high and low amplitude responses differ widely, due to HF tape saturation and other effects such as head mistracking and poor biassing.

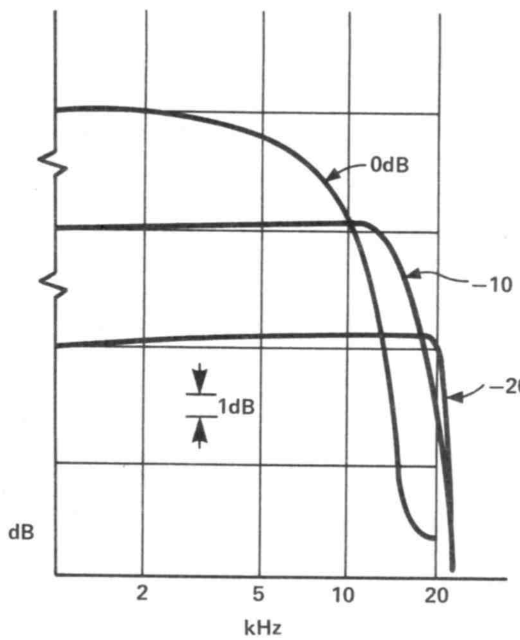


Figure 7: High frequency response of a typical cassette recorder.

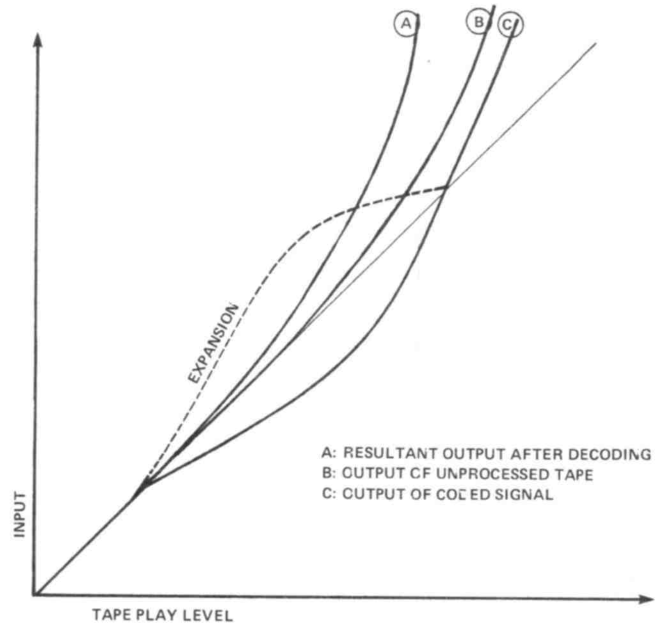


Figure 8: Non-ideal record/playback characteristics.

Unfortunately, due to the less than ideal linear 'signal level-to-high frequency' performance of the cassette, the use of a noise reduction system may degrade the frequency response of the cassette recorder beyond that which would have happened if no system was employed in the first instance. In other words you may save on noise, but worsen the frequency response. ***Figure 8*** shows the input to off-tape level curves at 5kHz. Curve (b) was obtained by recording, without noise reduction, the increasing tone level and curve (c) with the noise reduction in-circuit during recording. Notice that this curve is marginally closer to being linear. Curve (a) is the expanded version of (b), but due to non-linearities of the tape system, once the expansion is applied more HF loss results than if noise reduction was not used altogether.

The ears characteristic 'fooling' of the listener into thinking most of the broadband noise is concentrated towards the high frequency end of the audio spectrum, is also used in noise reduction systems, On record, the signal is passed through a (5kHz) 6dB/octave filter which is used to boost the signal whilst tracking the transfer characteristic of the compression curve. The low level high frequency content is therefore increased on replay. The added low level high frequency content is subtracted by tracking the expansion transfer curve, so that the original frequency response, not withstanding non-linearities in the system, is restored. The result of this is that the signal has been mirror-filtered and so therefore appears back to normal, but tape noise has been low-pass filtered and therefore is less noticeable. The high level high frequency content of the signal is transferred linearly. However, it is of sufficiently high level to mask any noise.

As stated before, the main drawback with complementry systems, when applied to tape, is the inherent non-linearity of the tape medium. One big improvement, and a giant leap for hi-fi, would be a cheap method of instantaneous feedback from the tape to the reduction system so as to keep track of what was actually going onto the tape in the first place — quick, *and* with the added bonus that we might not have to go digital after all !!

■ R&EW

POLAR ORBITING SATELLITES

Terry Weatherly describes the NOAA and METEOR series of polar orbiting satellites.

The current Polar Orbiting Weather satellites transmit pictures in the 136-138 MHz satellite band for reception by any suitably equipped ground stations. Reception of signals in this band is achieved using tried and tested techniques since it is near to the two metre amateur band. Two series of satellites will be discussed, the NOAA series launched by NASA and the METEOR series launched by the USSR.

In The Beginning

Historically the first weather satellites launched were the TIROS series of the early sixties launched by NASA. The pictures were relatively crude by todays standards but they did give scientists some hint of the potential of the satellite system. These early American satellites were followed by the NIMBUS and ESSA series. The most successful was probably the ESSA 8 satellite launched in 1968. This was a wheelshaped satellite stabilised by slowly spinning it in orbit. When the camera was facing the earth a 600 Hz tone was sent indicating that a picture was about to start. A TV camera with a storage tube was activated and an image was stored. This was scanned at four lines a second and relayed to earth. One complete picture was transmitted in 200 seconds. When the satellite was next in a favourable position another picture was transmitted. Experience showed that up to three pictures could be received during an overhead pass. This spacecraft gave excellent service over 8 years until camera failure caused an end to its useful life. The ESSA series was followed by the NOAA series which used a scanning radiometer instead of a TV camera. As the satellite moves a rotating mirror focuses a narrow beam onto a series of sensors and thus a continuous picture is built up line by line for transmission to earth. The USSR launched a number of experimental weather satellites in the COSMOS series and these were followed by the operational METEOR series of weather satellites.

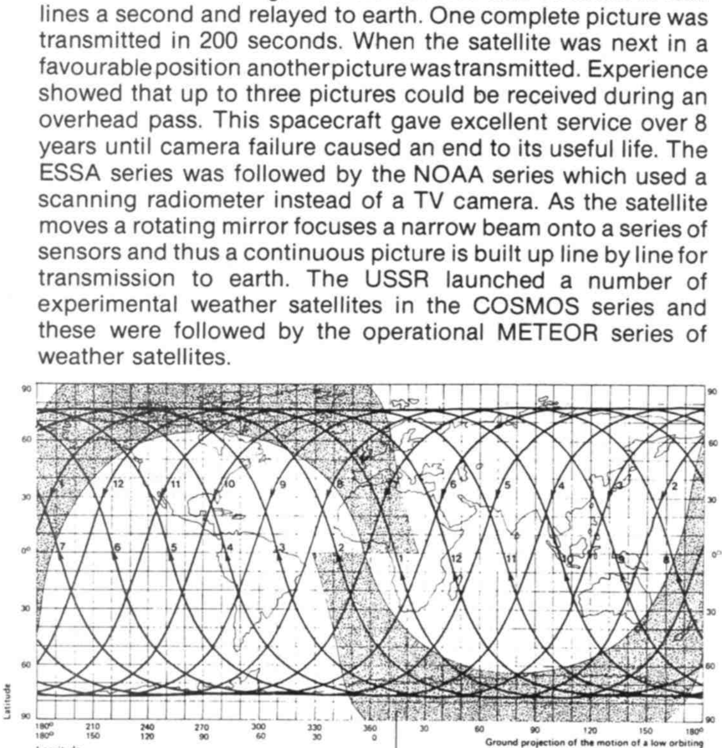


Figure 1: Ground track of a NOAA satellite on a mercator projection map.

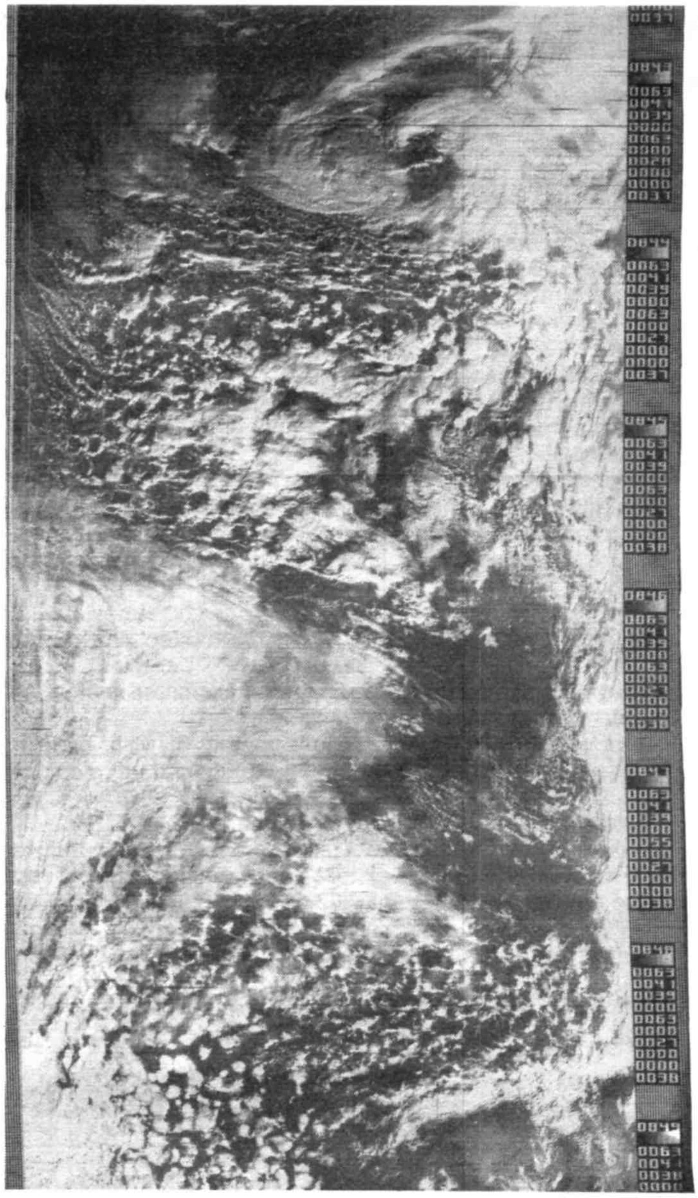


Figure 2: A MET 30 picture taken on 26th December 1980.

Orbital Orientation

The orbits of all weather satellites are basically similar. They are described as near polar sun-synchronous orbits. The orbits chosen are near circular giving a mean satellite height above the earth of 900km with an inclination of between 95 to 05 degrees. Satellites at this height have an orbital period of 102 minutes. During a twenty four hour period the satellite is able to 'see' the whole of the earth's surface. It appears 'overhead' at about the same 'local time' for anywhere on the earth's surface. The current NOAA satellites appear 'overhead' at about 9.30 am and 2.30 pm every day.

Figure 1 shows the ground track of such a satellite on a mercator projection map. It will be seen that a receiving station can expect to be able to receive three good daytime and three good nightime passes during a twenty four hour period Daytime passes are north bound, the satellite appearing to the south, while the night-time passes appear from the north and travel south.

The current American satellites NOAA 6&7 are two in the series of improved TIROS satellites. The most recent NOAA 7 was launched on June 22nd 1981 from the Vandenburgh Air Force Base. The orbital parameters are as follows:-

Inclination 98.9
Apogee 859.00km
Perigee 841.00km
Orbital Period 102.04 minutes (at orbit 0)

As well as the imaging device the satellite also carried the following instruments. ▶

1. Tiros Operational Vertical Sounder
This package consisting of a high resolution infra red sound, a stratospheric sounding unit (provided by 'our' Met Office) and a microwave sounding unit. Together these instruments provide a vertical temperature profile of the atmosphere.
2. The Data Collection System
This system is able to locate and collect data from fixed platforms moving buoys, balloons and aircraft.
3. The Space Environment Monitor.
This package provides continuous measurements of proton alpha and electron flux activity near the earth.
4. The Contamination Monitor
This package measures contamination on the earth viewing panel.

The imaging system is a scanning radiometer which is sensitive in four spectral regions. The Earth directly below the spacecraft is scanned at a rate of 360 lines per minute. After some on board processing the image is transmitted in digitised form to earth via the S-band transmitter.

Data for the APT transmissions in the 137MHz band is obtained by averaging the high resolution data reducing resolution to 4 km. The APT transmission rate is 120 lines per minute and this is obtained by transmitting every third line from the high resolution data. Two pictures are transmitted in the APT mode; a visible light picture and one taken at infra red. These are time multiplexed and thus two pictures are received side by side at 120 lines/min or one picture at 240 lines/min if the unwanted picture is suppressed by alternate line blanking.

Russian Activity

The METEOR series of weather satellites launched by the USSR transmit visible light pictures to the same standard, 120 lines per minute. The usual frequencies for transmission are 137.2, 137.3 and 137.4MHz. The transmissions are dependent on a sensor receiving enough light from the earth. An interesting METEOR sending excellent pictures at about 10 am each day is MET 30. This transmits its data at 240 lines per minute on 137.150MHz. *Fig. 2* is a MET 30 picture of 26th December 1980 and covers an area from the Mediterranian to Northern Norway. The figures on the right hand edge are various housekeeping telemetry and a grey scale for setting up the printer.

The Tiros spacecraft correct the picture prior to transmission to remove 'bottle distortion' caused by the curvature of the earth. This distortion causes picture detail at the edges to appear long and narrow. *Fig. 3* and *4* illustrate this. *Fig. 3* shows the UK at the edge of an uncorrected MET 30 picture. Ireland is particularly distorted. *Fig. 4* shows the UK in a similar position from a NOAA 7 pass. The correction allows Ireland to be its familiar shape up to picture edge.

Receiving Equipment

Pictures are received here in Lowestoft using half of the set up described for meteosat (see **R&EW** August 1982). A ground plane antenna cut for 137.5MHz is used to receive the signal. Using a ground plane avoids the need to track the satellite. This

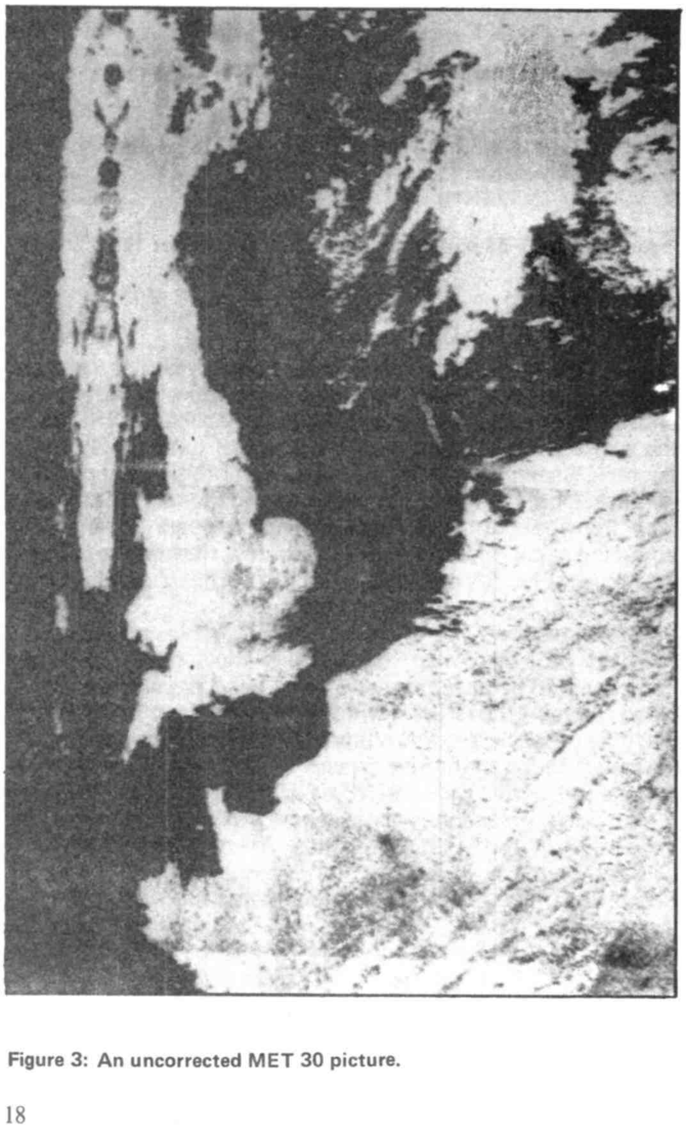


Figure 3: An uncorrected MET 30 picture.

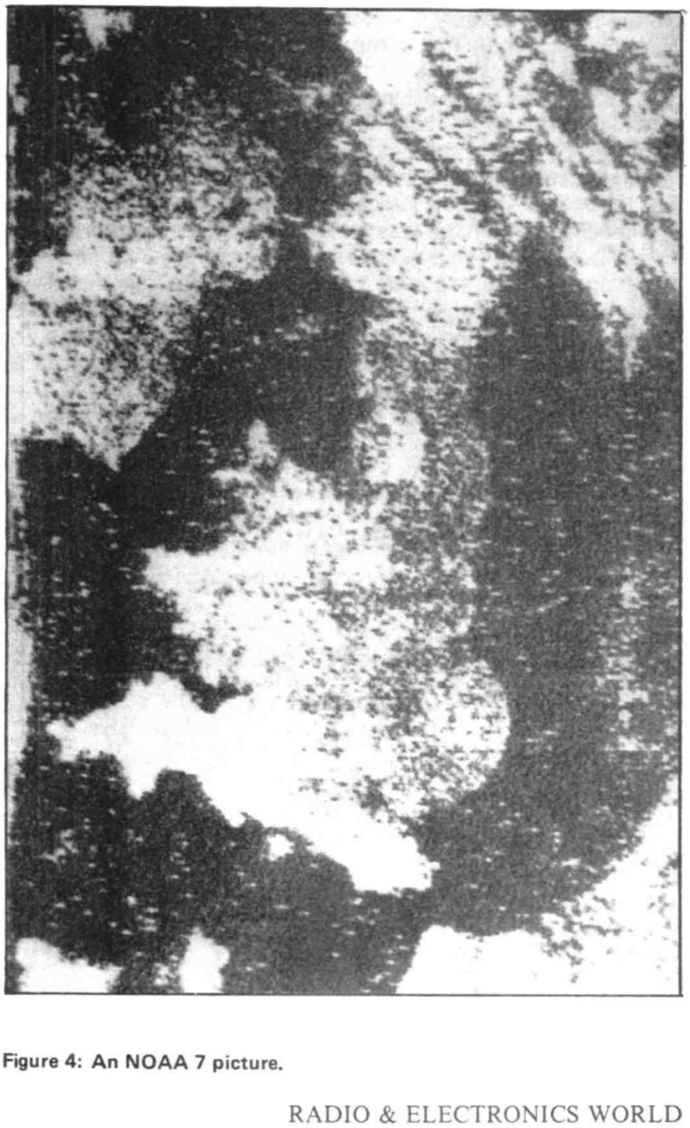
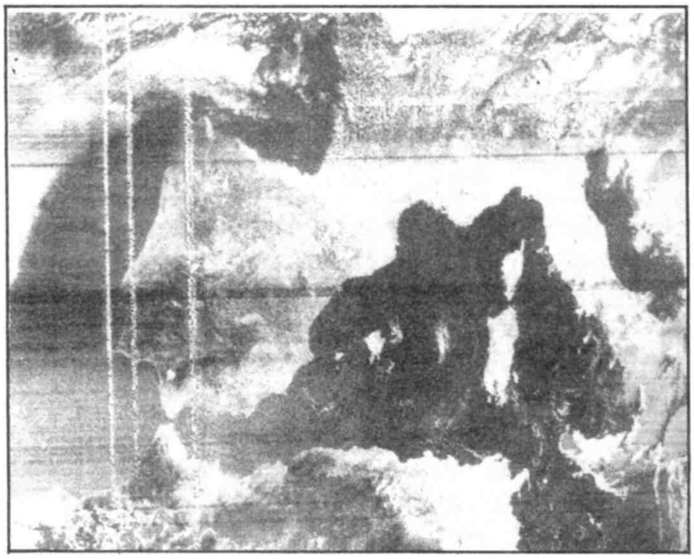
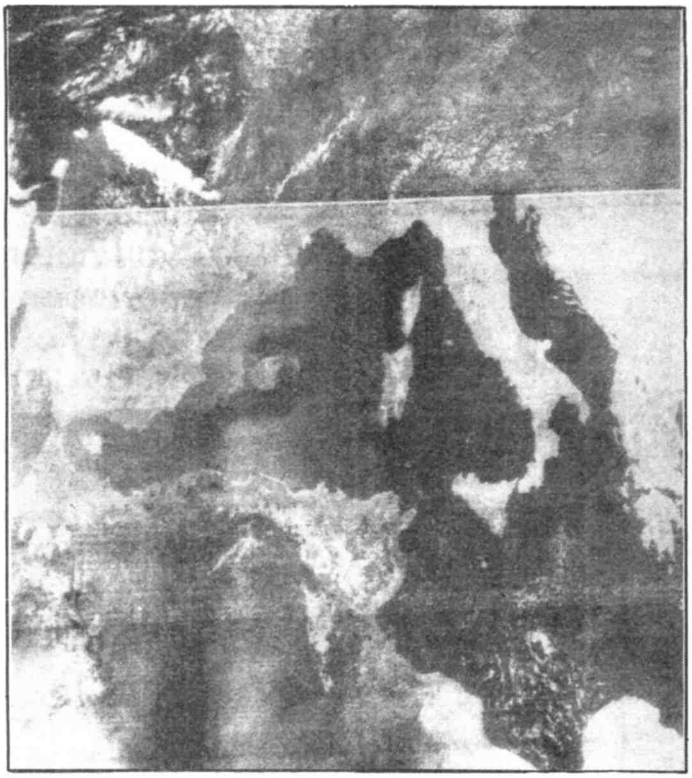


Figure 4: An NOAA 7 picture.





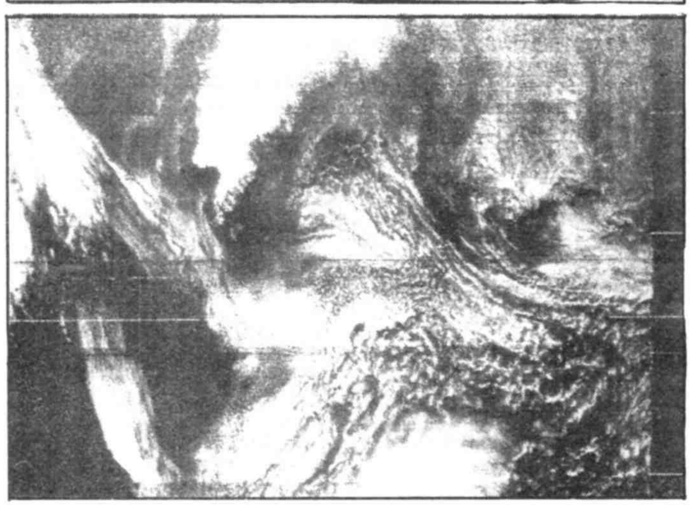


Figure 5: (Above) A WEFAX picture taken during August showing Greece, Turkey, Crete and Cyprus very clearly. The position of the satellite at the instant of transmission is in the centre of the picture.
Figure 6: (Top right) A view of the Mediterranean and North Africa. (The vertical lines are local QRM).
Figure 7: (Right) The Alps as depicted by WEFAX.
Figure 8: (Bottom right) Ice covered Greenland and some of the arctic summer weather systems.

signal is then fed into the Microwave Modules 136-138MHz converter then to the 28MHz receiver and thence to the D900S Fax machine.

The Fax machine is fine for receiving pictures to WEFAX standards but the vertical speed is too fast for APT. This results in pictures which are stretched vertically. To overcome this the vertical feed rollers were replaced. The drive roller was replaced by one half the diameter and the pressure roller by one twice the diameter. The effectively halves the vertical speed.

Some of the results of this system are shown in *Figs. 5-8*.

Currently there is a problem with the radiometer on NOAA 6. The instrument is still losing sync in an unpredictable manner. NOAA 7 is still fully operational and is an afternoon spacecraft. It crosses the equator northbound in daylight at approximately 14.51 local time and southbound at night at 02.50 local time. The transmission frequency is 137.62MHz.

The next NOAA launch is expected in mid February 1983.

■ R&EW

References

The New Weather Satellite Handbook. Dr. R. E. Taggart, 73 Magazine
73 Magazine November 1980.
APT information notes NOAA Washington D.C.

What to look for in the April Issue of R&EW

MAINS SIGNALLING SYSTEM

Two units — both of which plug into the mains wiring of your home/office.

The transmitter features a microphone which, in the presence of noise exceeding a certain level, will transmit a 200 kHz tone to the receiver unit via the ring main. This signal activates an audio alarm which forms part of the receiver. Based on the 567 tone decoder IC, this project has a multitude of uses — including a telephone or door bell repeater.

On Sale March 3rd

The Complete Electronics Magazine

DVM Module Applications

Circuits galore, as Ray Marston looks at a host of designs based around 3½ digit DVMs.

You'll find voltmeters, capacitance meters, thermometers and more design ideas and tips that should give you plenty of food for thought.

1983 + 1 =

It's not quite 1984 yet and we still have no desire to be seen as a 'Big Brother' but we'd like to know more about you.

What do you think of R&EW? *what things would you like to see in the magazine?*

Next month you'll get the chance to tell us in the questionnaire to end all questionnaires.

REWBICHRON 2

Our REWBICHRON clock was the first MPU based Rugby receiver design published in the UK and is still the most elegant Rugby decoder you're likely to find.

Next month the designer, John Robinson, presents an updated version of the design that, instead of using the alpha-numeric display module of the original, drives any 4 or 6 digit numeric display as well as producing a simultaneous parallel data output.

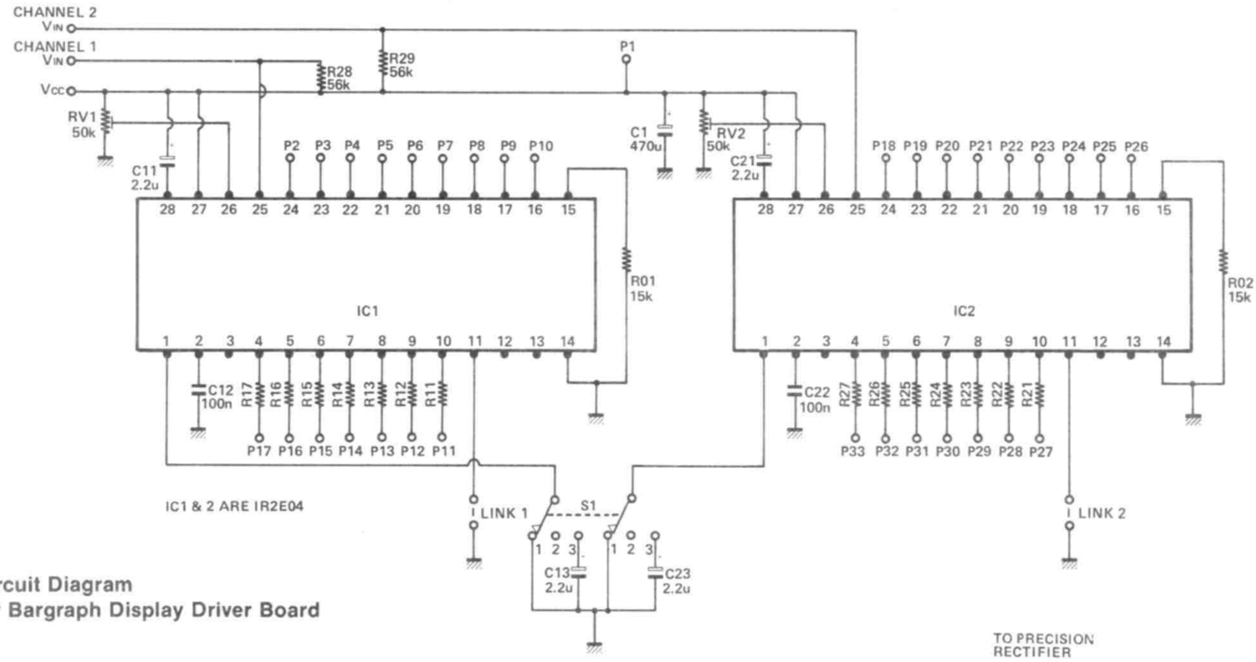
All you computer owners who've been waiting for an accurate real time clock need look no further.

Place an order with your newsagent now

STILL THE BEST VALUE FOR MONEY

R&EW Data Brief

IR–2E04



Circuit Diagram for Bargraph Display Driver Board

Bar Graph Display Driver

The Sharp IR-2E04 is a driver for LED bargraph displays. Using two of these IC's, we developed a driver board for a stereo VU meter with peak hold functions.

Both channels of the driver are identical, giving a range from -30dB to +10dB (*Table 1*). The peak hold function is selected by SW1 for both channels. There are three modes of operation:

1) Manual hold — constant hold until reset by the switch (pin connected direct to GND.)

2) No hold — (pin 1 O/C)

3) Automatic hold — held for a time determined by a capacitor (pin 1 via switch 1 to GND), then automatically reset.

PARTS LIST

Resistors

R01,02	15k
R11-17,21-27	1k5
R28,29	56k
VR1,2	50k linear preset

Capacitors

C1	470u 25V Electrolytic, axial
C11,13,21,23	2u2 10V Electrolytic, radial
C12,22	100n monolithic ceramic

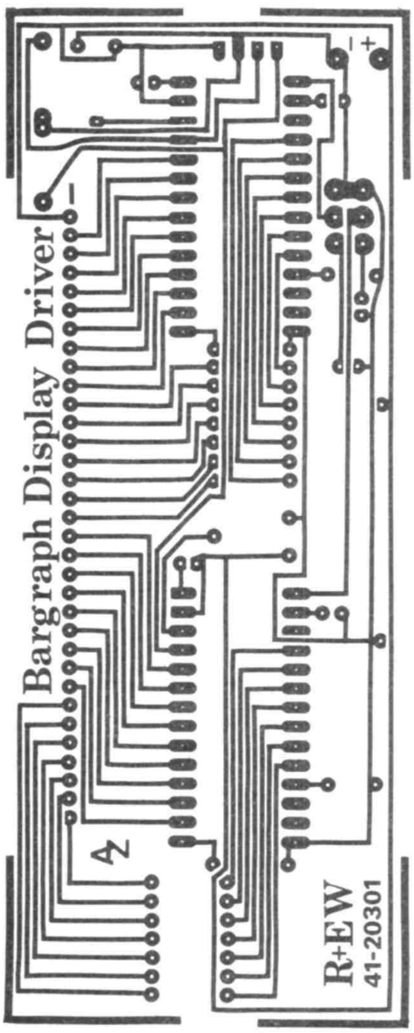
Semiconductors

IC1,2	IR-2E04

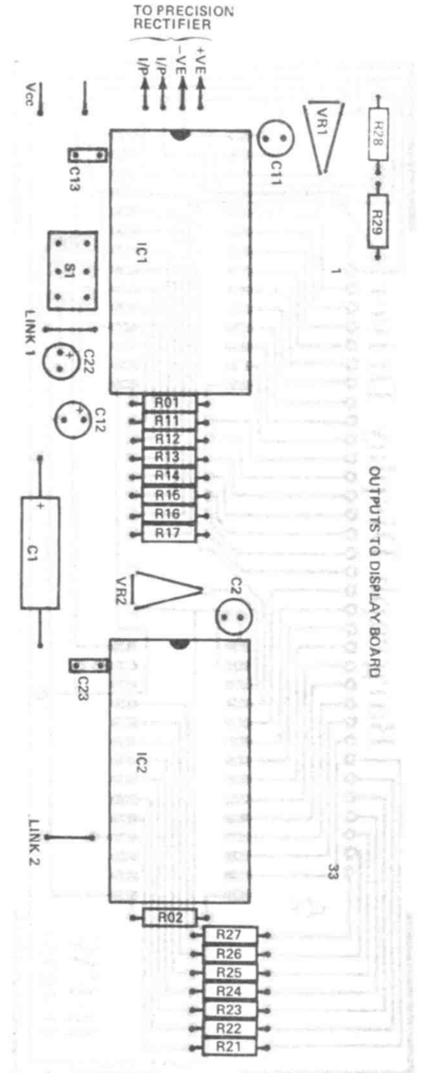
Miscellaneous

S1	DPDT centre off

Two 28 pin IC sockets
12 pc ½ pins
PCBs: Bargraph Display Driver, Bargraph Display



PCB foil pattern for Bargraph Display Board



PCB overlay for Bargraph Display Board

The input pulse width required to register a hold is decided by the capacitor (pin 2 to GND). At the 0dB level (LED J), change-over is possible with or without the hold function. Leave pin 11 open-circuit for hold function, short-circuit for no-hold function. The resistor between pin 15 and ground determines the current flow in LED's A to I by

$$I\,(mA) = 35\ \frac{(V_{CC} - 1.5)}{(R + 1)}\ \frac{V}{k}$$

V_R, the reference voltage is set by presets RV1, RV2 giving the maximum input voltage, ie, at V_{ref} it is 3.0V; Vin + 10dB = 3.0V, hence full scale is set by V_{ref}.

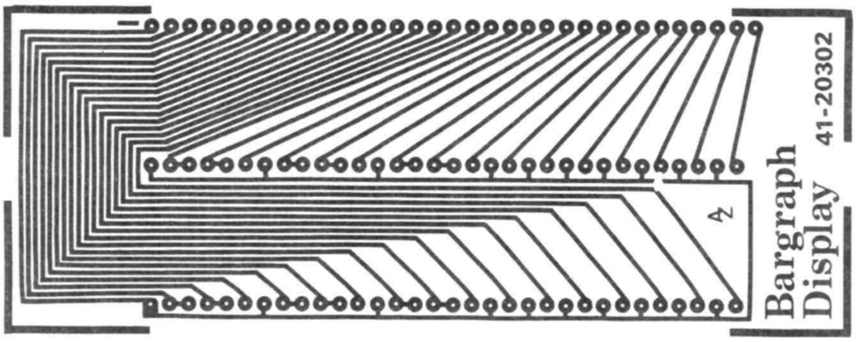
We have included a display board for wiring the LED's (discrete) neatly into a bar graphic display, that is, there are two boards! However, we hope to be able to offer the Sharp LT3300M complete dual bar graphic display, with its reduced difference in luminescence, as well as package dimensions.

NOTE:

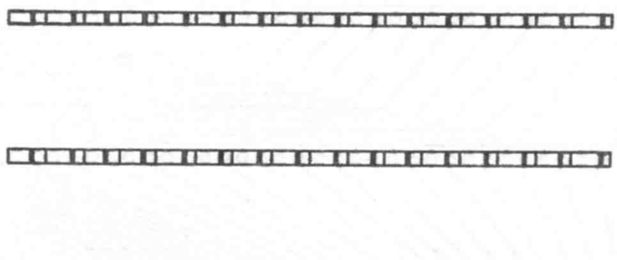
Designed for use with DC signals, the driver inputs need to be rectified. See Data Brief 2 for a suitable precision rectifier circuit.

LED	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
dB	−30	−20	−15	−10	−7	−5	−3	−2	−1	0	+1	+2	+3	+5	+7	+10

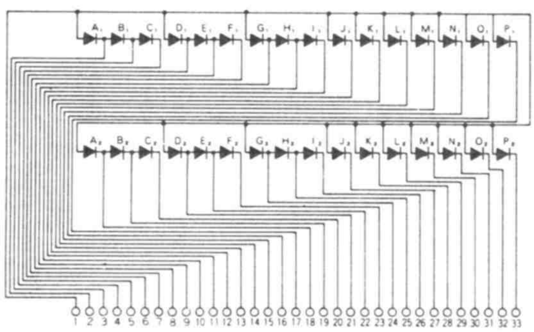
Table 1: LED calibration levels.



PCB foil pattern for Bargraph Display Driver Board



PCB overlay for Bargraph Display Driver Board



Circuit for Bargraph Display

Symbol	Description	Symbol	Description
V_{CC}	Power supply	C_1	Minimum pulse width setting
GND	Grounding		
V_{IN}	Input voltage	C_2	Peak-hold time setting
$V_{REF\text{-}MAX.}$	Highest reference voltage		
$O_1 \sim O_{16}$	LED output	H	0dB peak-hold setting
C	Connection of condensor for ACL		
		I_{OADJ}	Output current regulating

Pin Description

Parameters		Symbol	Conditions	Ratings	Unit
Power supply voltage		V_{CC}		18	V
Input voltage		V_{IN}	$V_{CC} < 10V$	10	V
		V_R		10	V
Output current		I_O		25	mA
Power dissipation derating ratio		P_D	$Ta \leq 25°C$	1500	mW
			$Ta \geq 25°C$	15	mW/°C
Operating temperature range		Topr		−10 ~ +60	°C
Storage temperature range		Tstg		−55 ~ +150	°C

(Ta = +25°C)

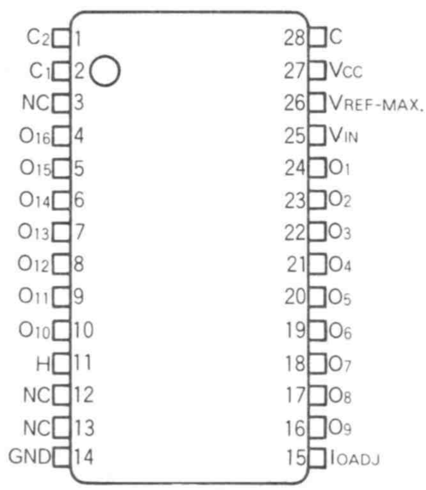
Absolute maximum Ratings

Parameters	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power supply voltage	V_{CC}		8		15	V
Input voltage	V_{IN}		0		6.5	V
	V_R		1.5		6.5	V
Input current	I_{IN}	$V_{IN} = 0V$	−1			μA
	I_R	$V_R = 3V$	−1			μA
Peak-hold time	T_H	$(C_2 : \mu F)$		$C_2/10$		s
Minimum input pulse width for holding	T_P	$C_1 \geq 4 \times 10^{-3} C_2\ (C_1 = \mu F)$			$200C_1$	s

Inflow current: + , outflow current: −

(Ta = +25°C)

Electrical Characteristics



Pin Configuration

NOISE GENERATOR

A high quality design that offers both white and pink noise signals.

The use of white and pink noise in the testing of amplifier speaker combinations and in determining the acoustic characteristics of listening environments has been extensively described in various technical journals over the years. The **R&EW** noise generator provides a source of white and pink noise, both adjustable in amplitude, and available as a continuous signal or as a burst of noise.

Nature Of Noise

A constructional article such as this is not the place to go into extensive details of amplifier and speaker evaluation by means of a noise source but briefly white noise is random noise (akin to that produced by an off-station FM tuner) having equal energy per cycle over a specified frequency band (usually 20Hz — 20kHz). Pink noise is random noise having equal energy per constant per cent band width — in other words white noise filtered to give a falling frequency response of minus 3dB per octave. Effectively this means that white noise will have an energy content rising at 3dB per octave while pink noise will have equal energy per octave. It is therefore pink noise that is most useful in assessing the performance of audio systems.

One of the important considerations in the design of the noise generation was the dynamic range of the circuit. The ratio of the larger noise 'spikes' to the troughs in the signal can be very large and, if the 'randomness' of the output is not to be disturbed, it is essential that these spikes are not clipped. The use of a 36V supply rail, together with careful biasing of the output stage, result in an output in which fewer than 1 in 10,000 peaks are clipped.

The other point to note is that the **R&EW** circuit is analogue based — it produces none of the cyclic noise often associated with digital, pseudo random noise generation.

In Control

The front panel controls are, in the main, self explanatory — the exception being the relevance of the burst/continuous selector. The burst button is a non-latching control, that allows the output to be pulsed on and off. This is useful in circumstances when a continuous signal is not desirable — for example when attempting to detect colouration of loudspeakers by ear, where a continual noise output may make it more difficult to detect any colouration.

Construction

As one might expect, there is nothing at all critical in the construction of this project. The PCB makes life easy but those that favour other forms of construction should not have any difficulty.

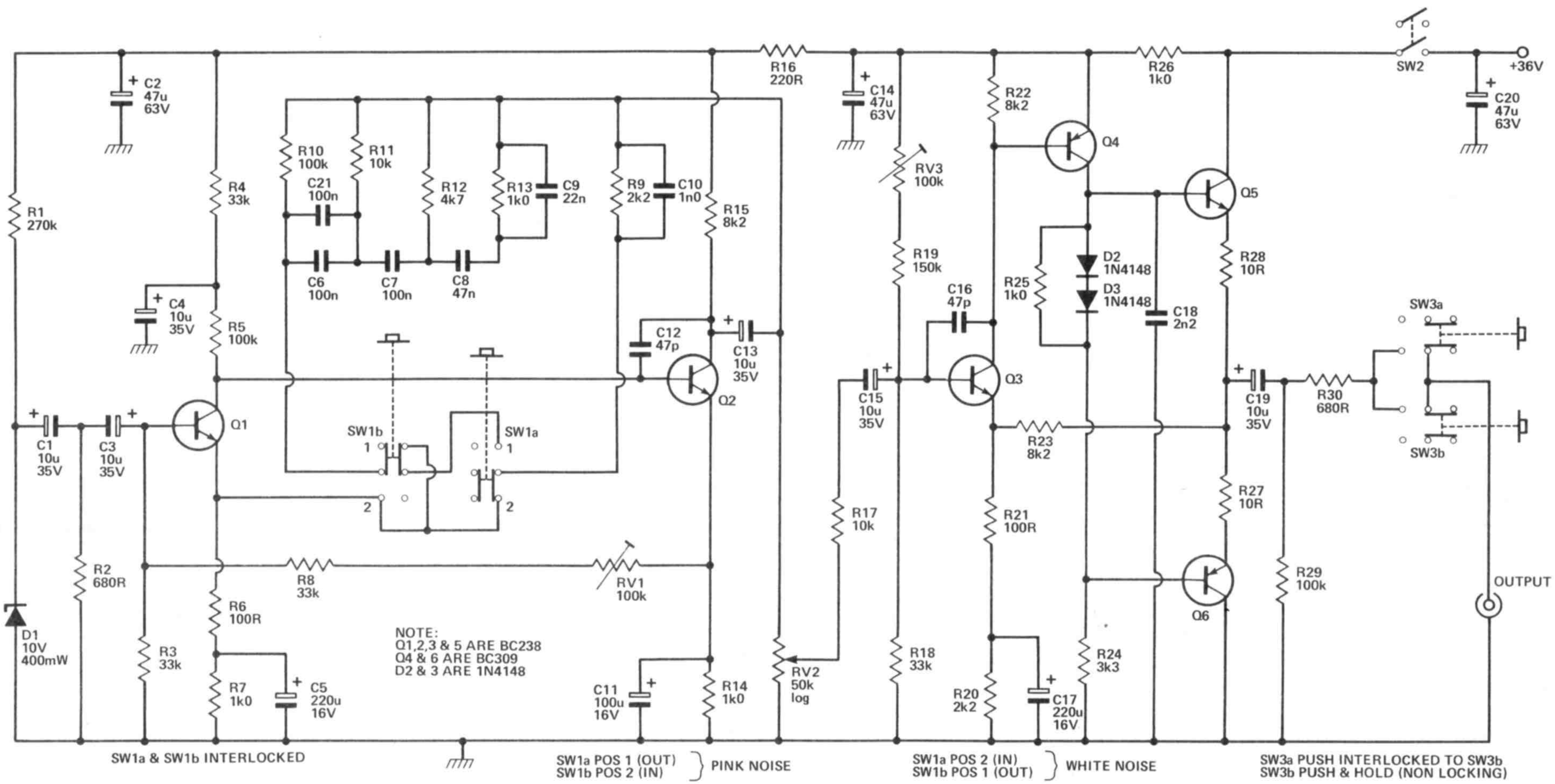
Carefully check the completed board, in particular that all semiconductors and polarity conscious capacitors are correctly placed. The pictures show the Prototype noise generator and the neat external and internal appearance that results from the one board mounting of the switches and pot — no messy wires to clutter things up.

Testing And Aligning

Connect a 36V PSU to the board and, with RV1 and RV3 in their centre position and RV2 at minimum, monitor the current drawn by the circuit. This should be no greater than 15mA. If the current drawn exceeds this figure, the value of R25 should be reduced.

An audio oscillator should now be connected accross D1. This will inhibit the noise output of the diode and allow the preset gain controls to be more readily adjusted. ▶

NOISE GENERATOR



Circuit Diagram

Circuit Description

The noise source of the generator is zener diode D1. The choice of a 10V zener, together with the value of biasing resistor R1, gives an acceptable noise output without resorting to the expense of specialist (and expensive) noise generating diodes.

The output of the noise diode is fed via the low pass filter C1R1 which rolls off at about 35Hz. The noise signal is then fed via DC isolating capacitor C3 to the DC coupled pair Q1,Q2.

Overall gain of this stage is approximately 27dB. RV1 sets the DC conditions of the stage and allows the circuit to be trimmed or symmetrical clipping. Two, frequency selective feedback networks between the output of the amplifier and the base of Q1 determine whether the noise produced will be 'white' or 'pink'.

SW1a selects the white noise frequency spectrum with C10 producing a roll-off in the stage's response above 20kHz.

SW1b selects the pink noise output with, in this case, the network comprising R10,11,12 and 13 together with C6,7,8 and 9 producing the required 3dB per octave roll off between 20Hz and 20kHz.

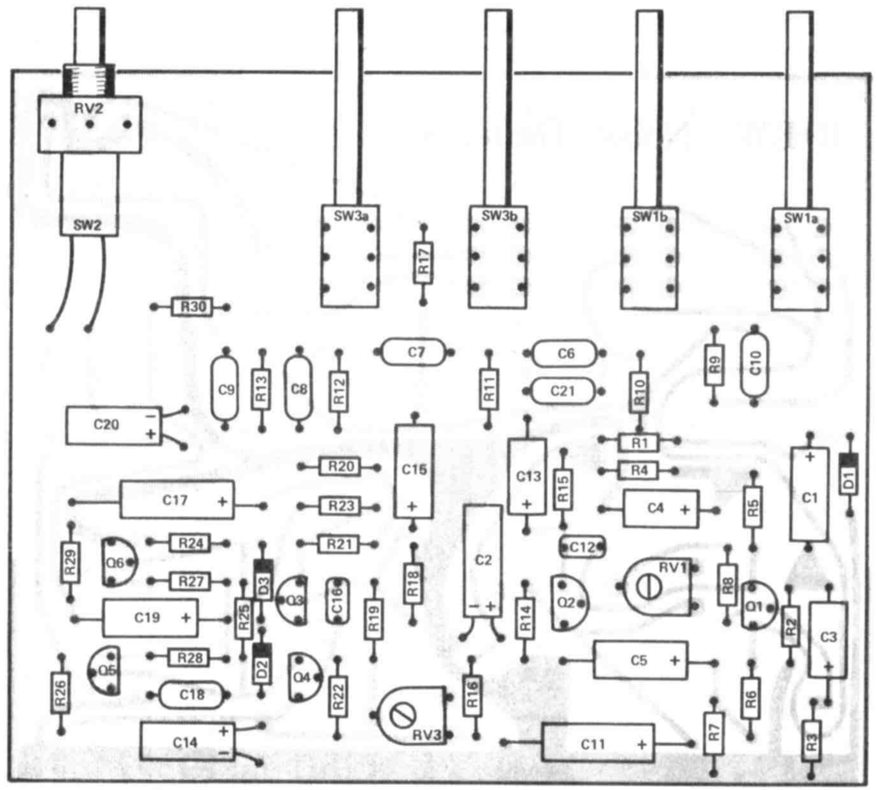
C12 is included to prevent any RF instability in the circuit.

The white or pink noise output is then fed, via level control RV2, to the output stage that owes a lot to Hi-Fi amplifier design. The first stage of the output amplifier is Q3, a straight forward voltage amplifier with C16 included to attenuate any RF signals. This drives Q4 which in turn feeds the signal to the complementary emitter follower output stage. D2 and D3 set the DC conditions of the output pair.

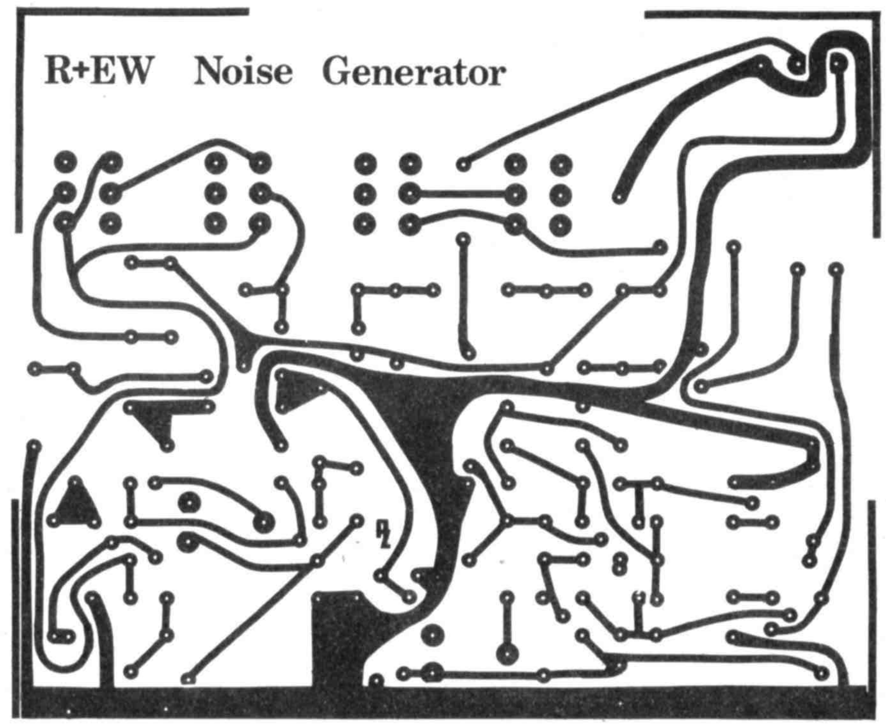
Overall AC gain of the stage is determined by R21 and R23 — the nominal gain being about 38dB.

The high rail voltage of 36V is necessary if clipping of the peaks in the noise signals is not to occur.

The output is DC isolated by C19 and R30 is included in order to limit the current drawn from the supply in the event of a short circuit at the output.



Component Overlay



PCB Foil Pattern

PARTS LIST

Resistors

5% carbon ¼watt.

R1	270k
R2,30	680R
R3,4,8,18	33k
R5,10,29	100k
R6,21	100R
R7,13,14,25,26	1k
R9,20	2k2
R11,17	10k
R12	4k7
R15,22,23	8k2
R16	220R
R19	150k
R24	3k3
R27,28	10R

RV1,3 100k 10mm horizontal carbon preset.
RV2 50k log VM11R pot with switch.

Capacitors

C1,3,4,13,15,19	10u,35V axial
C2,14,20	47u,63V radial
C5,17	220u 16V axial
C6,7,21	100n polyester siemenstype
C8	47n polyester siemenstype
C9	22n polyester siemenstype
C10	1n polystyrene
C11	100u 16V axial
C12,16	47p ceramic
C18	2n2 polystyrene

Semiconductors

Q1,2,3,5	BC238
Q4,6	BC 309
D1	10V 400mV zener
D2,3	IN4148

With a 1kHz sine wave applied to D1, select the white noise frequency network (SW1a), set RV2 to minimum, and adjust RV1 for symmetrical clipping of the output (as monitored on a 'scope at Q2's collector) as the amplitude of the sine wave is increased. The amplitude of the sine wave just prior to clipping should be 190mV.

Next set RV2 to maximum and adjust RV3 for symmetrical clipping of the wave form monitored at the output of the noise generator. Check that, with the rail voltage reduced to 31V, the output voltage is 9V RMS.

The frequency response of the circuit should now be verified. In the white noise position the response should be 3dB down at 20Hz, 0dB at 300Hz and 1kHz and 0.5 dB down at 20kHz. In the pink noise position the output level should fall at a rate of 3dB per octave from 20Hz to 20kHz.

Finally check that the output of the noise generator in normal operation is about 3V RMS into an open circuit when producing white noise (this measurement will depend on the bandwidth of the mV meter used) and, under the same conditions about 1V0 RMS for pink noise.

Beautiful Noise

White and pink noise is, as we've said above, often used in the testing of amplifier/speaker systems and the **R&EW** noise generator should be a valuable addition to any audio technician's bench.

■ R&EW

COMPUTING NEWS

Gary Evans previews.

Mass production techniques when applied to any piece of electronic equipment that features any Adjust On Test components must be subject to a fairly stringent quality control procedure if the product is to leave the factory in perfect order. Quite often though, the conflicting interests of an, often time consuming, line up procedure and the need to get units away from the factory in as greater numbers as possible, can cause problems. Often, the units will leave the factory in perfect order although they may not be operating at their optimum. The purchaser of such an item, if armed with the necessary information, and skill, will often be able to extract just a little bit more performance/quality from his new aquisition.

Sinclair's Spectrum computer is typical of just such a mass produced product and Fountain Computers have produced a sheet of instructions that will allow the display produced by a Spectrum to be improved by tweaking a few of the computer's AOT trimmers.

The display faults that may be cured include a venetian blind effect on colour bars, yellowish (or blueish) whites, characters that change colour at their top and bottom, an unstable colour display and a problem with 'sawteeth' running up and down the edges of colour bars.

All these problems can be cured, or at least minimised, by a couple of ajustments that affect the computer generated colour subcarrier signal.

The instruction sheet gives explicit details of the adjustments that affect each of the above faults. If the instructions are followed to the letter, it should be possible to significantly improve the Spectrum's colour display — it certainly worked with our machine.

Another Epson

The computing supplement included with this issue of **R&EW** features a review of the Epson HX-20 portable computer. A new product from the company is the QX10, a desk top computer that significantly broadens Epson's range.

The QX10 is a fully integrated desktop microcomputer system, with 780A CPU, VDU and Keyboard units in modern functional design, very easy to use for the first time operator, and has 192K upgradable to 256K RAM. The QX 10 is CP/M compatible and Epson claim that this microcomputer has incredible graphics capability with 16:1 zoom facility, RS 232C and parallel interfaces, and multi-font BASIC as standard, making it more than comparable with systems costing double the QX10 price. Other features include: Add on power by slotting in up to five optional interface cards, including networking plus a universal interface card for developing user's own interfaces. Screen is 80 col × 25 lines with full bit image control, 640 × 400 for greater definition, 16:1 zoom and special effects as well as a split screen facility allowing different typestyles and graphics to be shown together for eductional applications.

Also included are clock and calendar with battery back up. The double sided double density disk drives in the QX10 are themselves manufactured by Epson.

" .. AND HE FEELS YOU'RE JUST THE MAN TO DESIGN IT... "

CIRCUIT BLOCKS

A crystal Tester for RF oscillators in the range 1-120 MHz. Design by Mark Barke.

WHEN BUILDING equipment which uses a crystal oscillator, it is extremely useful to know if the crystal you are about to use is OK. Even new crystals can sometimes be faulty, especially if they have been subjected to mechanical shock. The design given here can be used to check crystals with frequencies in the range 1 to 120 MHz (low frequency units will not oscillate in this circuit and overtone crystals always oscillate in their fundamental mode).

The oscillator circuit uses the minimum number of components, consistent with reliable operation. An output suitable for connection to a frequency counter has been provided, but some caution must be exercised in the interpretation of the frequency measured. With fundamental mode crystals, the frequency should not be too far out, however overtone crystals (series resonant) oscillate on their fundamental which is not *exactly* a third/fifth etc, of the marked frequency.

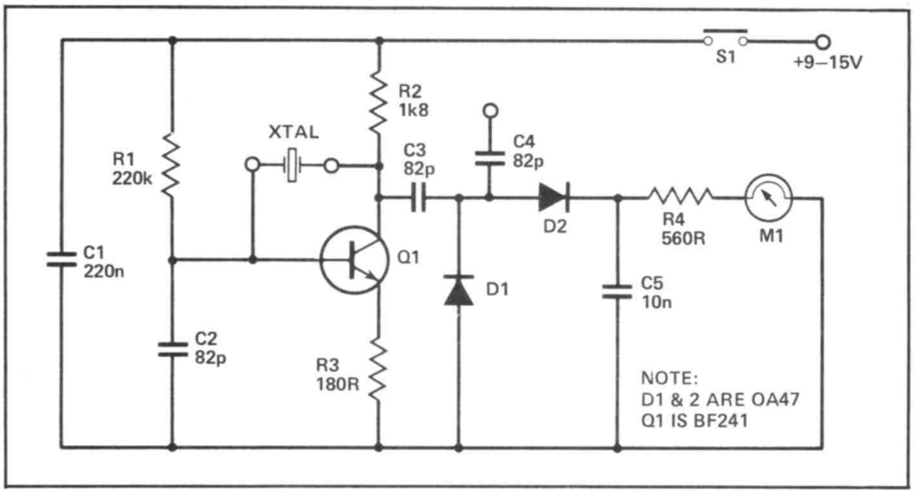
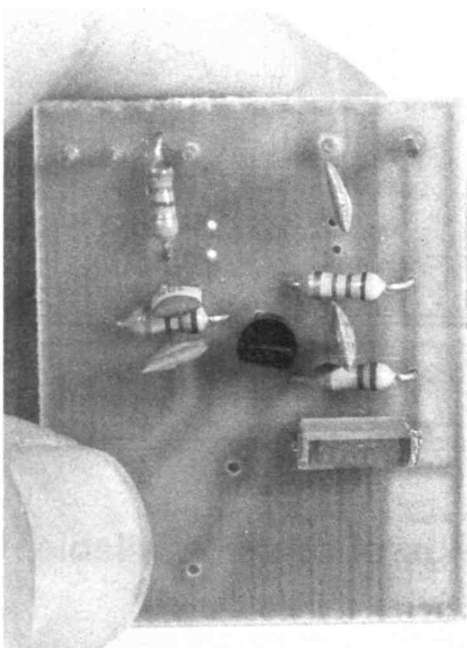


Figure 1: Circuit of the crystal tester.



A voltage doubler/detector is formed by D1,2 and C5. Its output is fed via R4 to the meter. The value required for R4 will depend on the sensitivity of the meter and the supply voltage. In the prototype, 560R was used, with a 15 volt supply and 200 uA meter.

Some indication of the crystal's activity may be determined from the meter reading, however, a few crystals, known to be all right, will be needed to get an idea of the sort of levels involved — low frequency fundamental mode crystals give the highest reading, whilst VHF overtone crystals give the lowest.

The prototype, which has been in use in the lab for many years, was "nested' on a piece of laminate, but a PCB foil pattern has been provided to simplify construction. All components, with the exception of the meter and switch, are mounted on the board. The crystal test sockets are cage jacks, spaced for HC6/u and HC25/u holders; though it is possible to use other sockets (not necessarily board mounted) if desired.

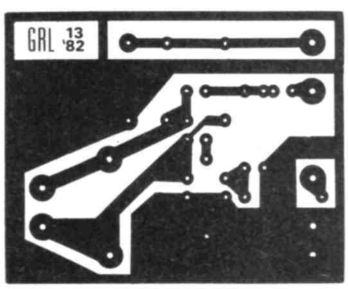


Figure 2: PCB foil pattern

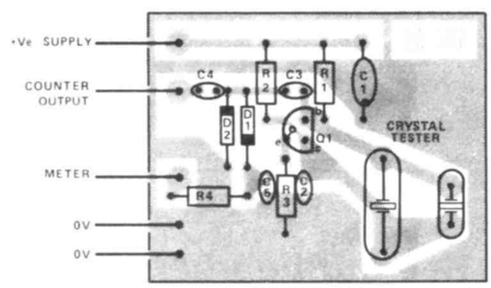


Figure 3: Component placing and wiring for the tester.

EUSTON 7

Peter Luke visited Thames Television's Euston Road Studios to look at video equipment from the professional standpoint.

Thames Television, London's weekday TV station, has two studio complexes within the Capital. One of these is sited in leafy Teddington and is responsible for the production of the station's drama and light entertainment output. The other studio is located in the heart of London's West End. The Euston Road site is primarily concerned with the station's nightly half hour news programme and with the networked 'Afternoon Plus' magazine and some of the company's news and current affairs output. The Euston Road complex also houses Thames' switching centre, the area responsible for controlling the flow of programming to and from the main ITV network and for inserting the station's commercial breaks. The Euston Road studios also provide a number of sophisticated editing suites providing facilities for 2" and 1" formats as well as U Matic programme material.

Our attention during a visit to the Euston Road facility focused on Euston 7, a new studio that is devoted to the nightly half hour news programme 'Thames News At Six'.

First Link

The studio is equipped with four Link 110 cameras, this camera being the studio based standard at Euston. Although the cameras are obviously far more complex than domestic standard types, the major controls — white balance, camera sensitivity etc — will be familiar to any one who has used a single tube camera. The majority of the Link 110's controls are not in fact located on the camera itself, but are located in a room remote from the studio, that houses a CCU (Camera Control Unit) for each camera. The controls that can be seen on the camera are concerned with the lens' zoom and focusing settings and with the extensive talkback facilities that are provided between cameraman and the other studio personnel.

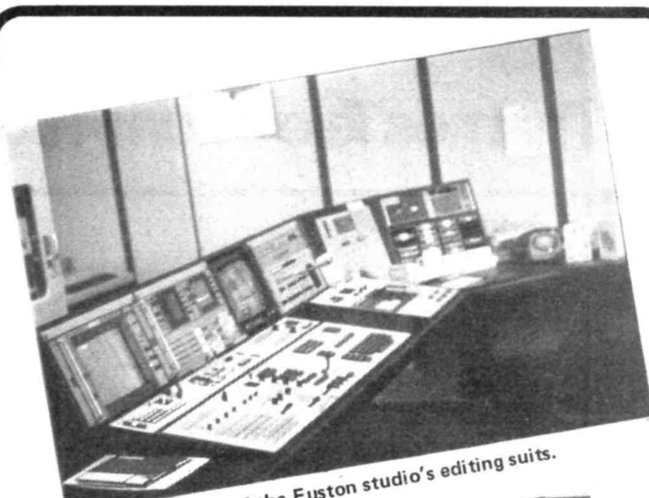
Camera line up, an operation that used to take a considerable length of time, is a fairly quick and straightforward task as, although the CCU has some 180 preset controls, only about six are regularly adjusted and, as the camera electronics are reasonably drift free, once aligned the cameras only need the occasional tweak to keep them in alignment.

On an incidental note, one of the surprising features of the cameras was there sensitivity. The cameras will give, if not broadcast quality, an acceptable output in very low levels of ambient light. The extremely high levels of light found in a TV studio are for dramatic effect rather than necessity.

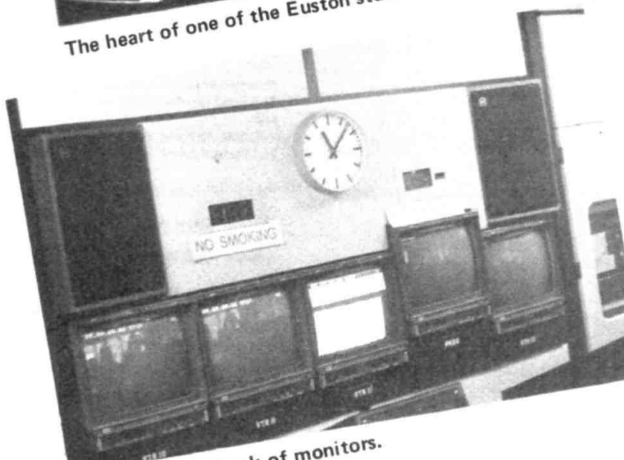
The link 110's are three tube cameras providing an RGB output. It is the philosophy of Thames to 'PAL Encode' signals as soon as possible however, and this encoding takes place at the CCU. All signals passed between the various production areas are encoded and all equipment is designed to lock onto 'colour black'. This simplifies the distribution of signals within the building, the only occasion for requiring an RGB signal is for chroma key work.

Mixing Desk

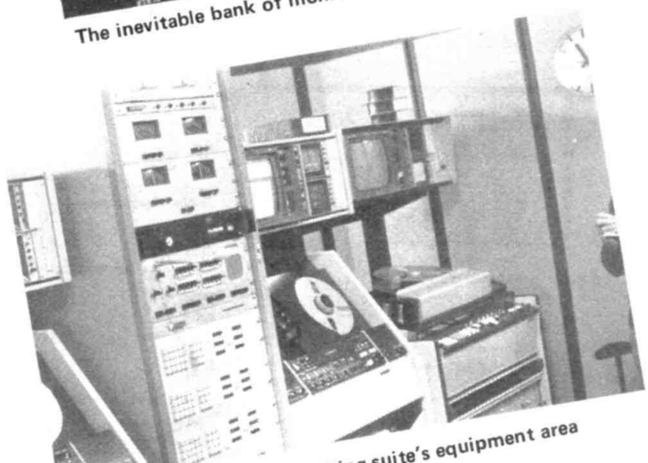
The signals from the cameras and from other vision sources — VTR, telecine etc — are all brought together in studio 7's vision control suite. The vision mixer is a 16 input CDL mixer with a range of effects generation capabilities in the form of wipes and



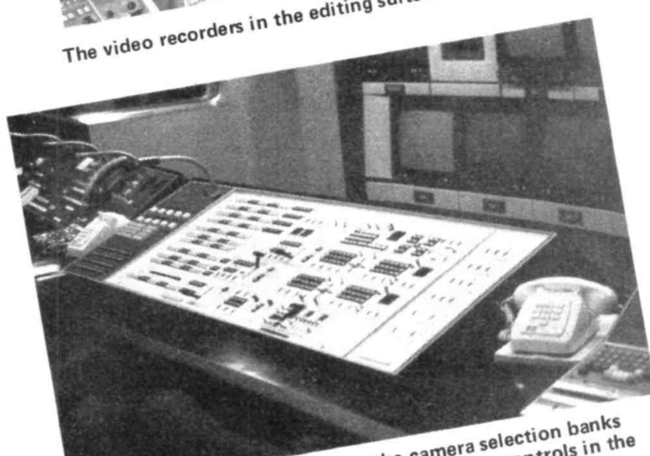
The heart of one of the Euston studio's editing suits.



The inevitable bank of monitors.



The video recorders in the editing suite's equipment area



Studio 7's vision mixing desk - the camera selection banks are on the left hand side of the desk, effects controls in the Quantel system is 'driven' from the area at lower right.

Thames Television Production Resources

Teddington 1

Operational Area
638 sq. metres
7088 sq. feet

4 Cameras
1 Camera additional on request
4 Booms
60 Channel Sound (NEVE)

Sound Gallery
with
Twin Track ¼"
EMT Turntables
Cartridge for Special FX
(inc. 8 Channel Grams Submixer)

Production Gallery
14 Input CD 480 Vision Mixer
with
2 x Sequential FX Units
Split Screen, Title Keyer,
Coloured Borders,
Encoded Chroma-Key,
Pattern Modulator Multiplier,
Soft-Edge Key,
Rotary Wipes,
Shadow Key, etc.

Note:
Cameras to be RCA-TK 47's
from March 1983

Also
4 Handheld Cameras (TKP47's) will be available for sharing between Ted 1, Ted 2, Ted 3.

Teddington Post-Production

1 Music Recording Suite
with
24 Track Recorder
(Studer A800 with Q Lock Synchroniser)
and
32 Channel Sound Desk
1 x 1000 sq.ft. Band

Sound Dubbing Suite (No. 1)
with
16 Track A800 Audio Recorder
TLS 2000 Locking System
and
JVC 6600 U-Matic Video Machine
24 Channel NEVE Main Mixing Console

Sound Dubbing Suite (No. 2)
with
16 Track Studer A800
and
U-Matic Video Recorder

Sound Preparation Room
for
Preparing Dubbing Material using a Cue Memory System

22m / 72 2ft — 29m / 95 1ft

Teddington VTR

Edit Suite-One

VPR 2 – VPR 2 – VPR 2 — OR — AVR 2 2"

1" CDL Time-Code Editing Suite.
Sound + Vision Mixing inc. shared Quantel FX Generator

Edit Suite-Two

OR

VPR 2 – VPR 2 – VPR 2

1" CDL Time-Code Editing Suite
Sound + Vision Mixing inc. shared Quantel FX

VPR 2 VPR 2 / VPR 2 VPR 2 / VPR 2 VPR 2

Six 1" VTR's assignable for Studio RX/Replay and transmissions + 2 M/C Edit. via four separate Control Rooms

AVR 2 AVR 2

Two 2" machines for playback or TX's
(One machine at a time assignable to a fifth Control Room)

AVR 2 – AVR 2 / AVR 2 – VPR 2

TTI Dubbing

Teddington Telecine

2 x 35mm D H Flying Spot:
Studio + Transmission

2 x 16mm D H Flying Spot:
Studio + Transmission

2 x MK VIII 35mm Twin Carrier

MK VII 35mm Single Carrier

35mm: 3 Units (1 per Studio)

VHS Cassette Machine available in area for Telecine Dubs.

18m / 59 1ft — 13m / 42 2ft

Teddington 2

Operational Area
358 sq. metres
3911 sq. feet

4 Cameras (maximum)
4 Boom Arms
60 Channel (max) Sound
As Tedd 1 but supplementary units shared between 1 and 2
Sound Gallery-spec as Tedd 1
Production Gallery-spec as Tedd 1

Note:
Cameras to be RCA-TK 47's
from February 1983

12.5m / 41 0ft — 9.5m / 31 2ft

*VPR2 = 1" Helical Scan with 90 minutes running time, slow motion, still frame

Teddington 3

Operational Area
125 sq. metres
1353 sq. feet

4 Cameras (maximum)
2 Boom Arms
24 Channel Sound (NEVE)
Sound Gallery-spec as Tedd 1
12 Input Vision Mixer
CDL 4 80
1 Chroma Key Amp.

Note:
Cameras to be RCA-TK 47's
from Mid-February 1983

12.5m / 41 0ft — 10m / 32 8ft

Euston ENG Section

4 x ENG Camera/Recorder Units
equipped with
PYE LDK 14 Cameras
SONY BVU 50/100 High band U. Matic Recorders
3 x Volvo Camera Cars

2 x ENG Links Vehicles

equipped with:
Facilities for carrying Camera/Recorder Unit plus lights in addition to fixed equipment as follows:
1 x BVU 110 Recorder
1 x Colour Monitor Receiver
2.5 GHz Transmitter and antenna
13 GHz Starter Link Transmitter/Receiver
Radio Telephone
4 Wire Talkback Transmitter/Receiver
UHF Pocketphone Transmitter/Receiver

ENG Editing Suites

5 x SONY U. Matic High Band Edit Suites
Edit Suites Nos. 1-2 (Operational 1981)

2 x SONY BVU 200 Recorders
1 x SONY BVE 500 Edit Controller
1 x Comprehensive Sound Control Desk
1 x 416 Microphone (for reporter voice over)

Caption Clock Facility
Time Base Corrector
Transmits direct into programme facility

THAMES

Richard Dunn/Peter Kew

The production facilities at both of Thames' London studios. As the company's facilities are continually

Euston 6

9m / 29.5ft × 6m / 19.7ft

Operational Area
54 sq. metres
600 sq. feet

3 Cameras (Link 110)
1 Hand Held (Link 120) available as alternative to one of studio cameras

1 Boom
24 Channel Sound
2 Twin Track ¼
1 EMT Turntable
2 Cartridge Tape
12 Input Vision Mixer (EMI)
Special FX (CDL) without Positioner
Colour Synthesizer
Limited Chroma Key (Blue Key)
Caption Edging
1 Hess Phone-in

Euston 5

18m / 59.1ft × 9m / 29.5ft

Operational Area
162 sq. metres
1800 sq. feet

4 Cameras (Link 110)
(alternative 3 Studio Cameras + 1 Hand Held)
1 Boom
36 Channel (max) Sound
3 Twin Track ¼

1 EMT Turntable
2 Cartridge Tape
8 Channel Mixer
12 Input Vision Mixer (EMI)
Special FX (CDL) with Positioner
Chroma Key Amplifier
Colour Synthesizer
Telemation TKB 3000 Cap. Gen.
Caption Edging
Phone in Facilities (30 Line)
2 Hess Phone-in Units

Hanworth

OB1

Handheld on request

5/6 Philips LDK 5 Cameras + Sony BVP 330P Camera
36 Channel Sound
14 Channel Vision + C/Key
Aston 2 Cap. Gen.
VPR 2 + Editec, Slo/Mo, Still-Frame

OB3

1 IVC 7000P Camera
Remote Field Camera for Racing etc

OB5

Handheld

2 IVC 7000P Cameras
4 Channel Sound
3 Channel Vision
1 VPR 2 + Editec, Slo/M Still-Frame

OB6

Handheld

2 Sony BVP 330P Cameras + possible third
14 Channel Sound
10 Channel Vision
1 VPR 2 + Editec, Slo/Mo, Still-Frame
Ability to take 2nd VPR2 when machine available

OB7

Handheld
Battery Operation

1 Sony BVP 330P Camera
6 Channel Sound
1 VPR 20 (portable)
60 min. max. RX.
Colour replay for checking only

EFP

Handheld
Battery Operation

1 Sony BVP 330P Camera
1 VPR 20 (portable)
4 Channel Sound

Caption Tender

Facilities include
Desk with Monitors
Positions for 2
Caption Generator
Operators, Commentator
and 2 F/M's
Full Communications
System

VTR Tender

Operation date and facilities-TBA

Euston VTR

EDM Editing Suite

VPR 2 – VPR 2 – VPR 2 – AVR 2

1" Time-Code with Sound + Vision Mixing inc. shared Quantel FX Generator with Euston 7 inc. Caption Generator Position

VPR 2, VPR 2, AMPEX 2000, AMPEX 2000, AVR 2 — VTR Central Area

ACR 25, ACR 25, ACR 25, ACR 25 — Commercial/Promo TX. Studio RX/Replay

New VTR Central Area

AVR2/EC2, VPR/EC2, VPR/EC2, VPR/EC2 (RES)

Four Ampex AVR/VPR machines for
Studio RX/Replay
Commercial/Promo Transfers
and Editing with Time-Code

VPR/EC2, VPR/EC2, AVR2 — Three Ampex AVR/VPR machines for 2"/1" playback and transmissions

Note:
The VPR EC2 can be patched in above 4-machine configuration if necessary.

NB
Each broadcast VTR machine in the new Central Area will have its own VHS cassette machine for simultaneous copying

Euston Telecine

2 x 35mm D/H (TC2, TC3)
Studio + Transmissions
2 x 16mm D/H (TC4, TC5)
Studio + Transmissions

35mm Cintel MK III-35mm/16mm/8mm plus Topsy

1 x 35/16mm/Slide (TC6)
Studio Operation
Cintel MK III (TC7)
35mm/16mm/8mm plus Topsy
Studio Operation + Transmissions

35mm Colour Slide
Studio Operation

Presentation Only

Film Facilities

10 Camera Crews (2 + 2)
3 News Crews (1 + 1) } Euston
1 x Projection Theatres (Teddington)
3 x Projection Theatres (Euston)
2 x Commentary Booths (Euston)
2 x Dubbing Suites (Euston)
3 x Transcription Bays (Euston)

31 Editing Rooms
26 x 16mm Steenbecks (Euston)
4 x 35mm Steenbecks (Euston)
6 x 16mm Steenbecks (Teddington)
1 x 16mm/35mm Steenbeck (Teddington)
1 x Preview Theatre (Tott Ct Rd.)

Euston 7

13.5m / 44.3ft × 10.5m / 34.5ft

Operational Area
93 sq. metres
1000 sq. feet

Note:
Restricted Height ie 11' to the Grid

4 Cameras (Link 110)
24 Channel Sound
2 Twin Track ¼
3 Cartridge Tape
16 Input CDL Vision Mixer
Special FX including
Quantel Digital Production FX Unit (shared with Editing Suite)

Chroma Key
Telemation Caption Generator
2 Hess Phone-in Units

<u>Edit Suites Nos. 3-5</u> (Operational 1982/3)
2 x SONY BVU 800 or 800/820 Recorders
1 x SONY BVE 800 Edit Controller

1 Comprehensive Sound Control Desk
Voice over facilities
Caption Clock

ENG News Central

4 x SONY BVU 200 U. Matic High band Recorders for programme playout
1 x SONY BVU 110 High band Recorder
1 x Panasonic VHS Recorder
1 x Revox ¼" Audio Recorder (in future)

Comprehensive facility for routing incoming live ENG signals from Millbank aerial either to Studio, Edit Suites or Record facilities in News Control.

Millbank aerial control and Talk back circuits

ENG Library

Viewing Facilities:
1 x BVU 200
1 x BVU 800
1 x VHS

updated, certain details on this diagram may have changed since this graphic was prepared.

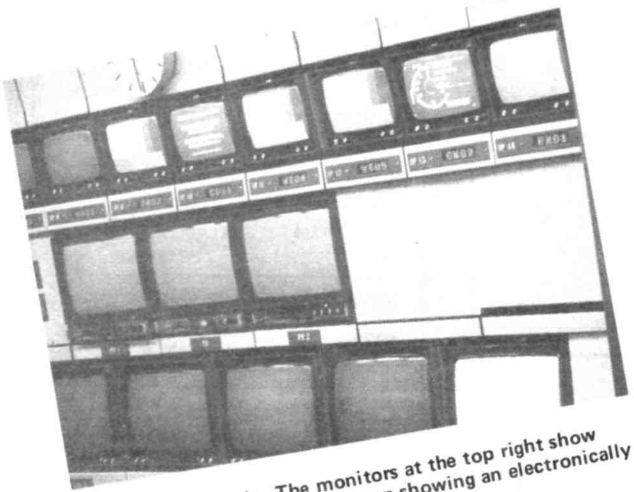
fades, plus access to a single input Quantel Digital FX unit.

The desk itself provides two main switching banks and a number of additional selectors on which effects can be set up and previewed before being fed into the main studio output. This facility to set up shots is mainly used for chroma key composition.

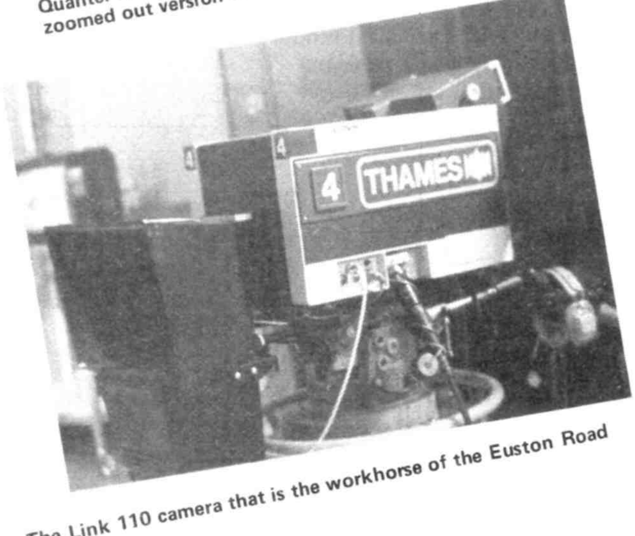
For example the Thames News programme often features two newscasters with a chroma-key back drop — similar to the 'news at ten' set. In this case, newscaster left plus backdrop will be set up on one of the auxilary banks while newscaster right will be configured on another bank. These combined signals are now routed to the main bank which can now switch instantaneously between the two effects shots.

The Quantel capability, which studio 7 shares with one of the facility's editing suites, is capable of producing a variety of electronic effects by manipulation of the information contained in a digital frame store.

The Quantel system can electronically zoom in and out from an established scene and, under joy stick control, can position a scene any where on the screen. Up to seven preset positions can be memorised and the scene moved between these positions at a speed that can also be varied. The way in which the scene moves between these positions can also be controlled. The scene can either 'zoom' in and out between the various established points or it can spin or tumble between them (the difference between spin and tumble being whether the rotation is in a vertical or horizontal plane). Spin and tumble rates can be varied via the Quantel control panel.



Studio 7's monitor rack. The monitors at the top right show Quantel in action - the left most screen showing an electronically zoomed out version of its neighbour.



The Link 110 camera that is the workhorse of the Euston Road facility.

The Qantel system, and frame store techniques in general are responsible for a number of the more dramatic visual effects that are beginning to appear on our screens. The Euston Road facility, being only a single input device cannot produce the cube effect (two signal sources that appear to form the faces of a rotating cube) but never the less, can produce some interesting effects.

The system can also only produce two dimensional effects unlike the latest generation of digital mixing desks that are capable of producing 3D effects. Such a system was demonstrated on BBC TV's 'Tomorrows World' at the start of the year.

Another facility made available over the past few years is computer generation of graphics. As with all news programmes of this type, Thames News features a large number of credits along the lines of "reporter Michael Whale". In the past these would have been printed onto black card and superimposed via the mixing desk. Studio 7 features a computer based graphics system that greatly cuts down the time taken to produce graphics. Several type faces are available, these being loaded from floppy disk into RAM before a day's production. Captions are then simply entered via a keyboard which also determines the caption size. Full scrolling facilities are available and the results produced are indistinguishable from more traditional caption generation techniques.

Thames News makes extensive use of ENG material and the Euston Road complex provides five ENG editing suites. The various ENG units can transmit their signals to a receiving station on the top of London's Millbank Tower, from there they are fed via land line to the studio and the editing suites. The use of U Matic recorders and edit control equipment make it possible to offer a very quick turn round on material — essential in a news environment.

Ever Onward

The final output of studio 7 is fed to the Euston Studio's master control. This is the area to which all signals destined for the transmitter arrive. As well as GPO lines to the company's transmitters within its programme area, two lines — Thames 3 and Thames 5 — link the company to the rest of the ITV network. These allow Thames to supply material to the rest of the ITV network or to transmit programmes originating from other commerical companies.

The master control is also responsible for inserting the commercials into the company's output. Nowadays, up to 80% of commercials are on video tape and the machines responsible for playing back these are amazing combinations of electronics and pneumatics.

Each commercial is stored on a cassette, up to 24 of these being loaded onto a carousel. Two playback sections on either side of the central carousel accept the cassettes in turn, the tape being loaded by jets of high pressure air. The machines offer a start up time of 350 mS and offer great flexibility in operation.

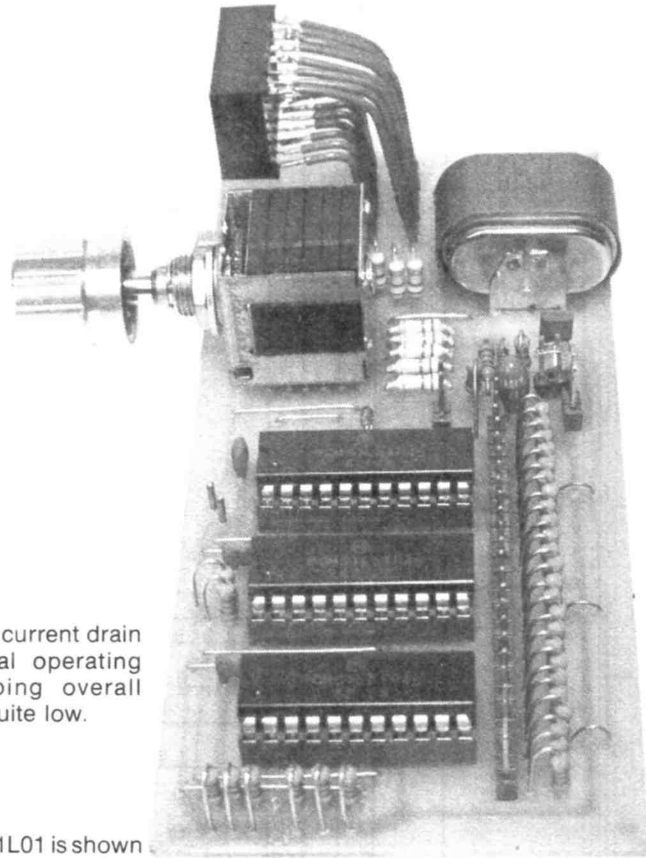
As you can imagine however, with cassettes being thrown around inside it, if things do not happen exactly as planned, an awful mess results. Things go wrong more often than Thames would like and as the cost of a commercial break leads to losses in the region of 100s of 1000s of pounds — each machine must be backed up. This means two machines for the main ITV network and two for Channel four — it is local ITV companies that are responsible for Channel 4 advertising in their area — that means four machines. At ¼ million pounds a time, this represents a lot of capital investment.

The Last Link

From the master control, the last step is for the signal to be fed, via GPO land line, to the IBA's transmitters in the Thames area.

In this brief look at Thames' operation, its only been possible to scratch the surface of the Euston Road studios' operation. Any one area deserves an article in itself and we hope to return to a closer look at the operation of one of the computer controlled editing suites in the near future. ■ R&EW

AIRBAND MEMORY



A 160 channel memory unit for our Airband Receiver and others with BCD coding. Design by John Mills.

A SHORTCOMING of many airband receivers is the need to endlessly flick thumbwheel switches every time a new frequency is desired. The memory unit to be described changes all this, with provision for storing up to 160 channels. Whilst not quite replacing the need for a manual tuning system, the average enthusiast should find the 160 frequencies more than adequate. Any existing thumbwheels are retained, enabling an instant change to any stored frequency in the memory. Bearing in mind the remarks about the demand for 160 channels, the unit utilises a 40 way 'CB type' switch with LED readout of the selected memory programme. The remaining 120 channels are accessed by using two toggle switches (described later).

The unit incorporates a built in Ni-Cad battery, which enables the memory to retain stored data when the receiver is switched off. To provide this facility, a special low-power CMOS static RAM was chosen (Motorola MCM51L01-P45). It is a 256x4 device with special 'power down' facility and standby current drain of about 0.42uA. Typical operating current is 10mA, keeping overall consumption of the unit quite low.

Design

The block diagram of the 51L01 is shown in ***Fig. 1***. Four inputs are applied via DI1, DI2, DI3 and DI4. Corresponding outputs are from DO1, DO2, DO3 and DO4 via tri-state buffers, with address inputs in standard BCD format — A0(1), A1(2), A2(4), A3(8), A4(16), A5(32), A6(64), A7(128). Therefore, the maximum number of 4-bit locations available is 256 — though, as will be explained later, ony 160 of these are used.

The operation of pins CE1, CE2, R/W and OD are shown in ***table 1***. Only three of the modes shown are used: Mode 2 for standby, Mode 5 for data writing into the memory and Mode 6 for reading. Transition from read mode to standby is automatic, and from read to write, by external pushbutton switch. Memory cell selection is achieved via a low-cost 40-way switch, originally destined for use in CB rigs. The switch also provides decoding for driving two 7-segment displays to indicate channels 1-40. Thus, with address lines A6 and A7 at low(0v), 40 locations are available and by selecting a combination of A6 and A7 high (6V), this is increased to 160. Locations 41-160 can be coded using two additional LED's to indicate when A6 and A7 are active.

The 40-way switch does not provide true BCD coding and therefore some of the memory locations are missed. ***Table 2***, showing the switch coding, explains this in terms of the way true BCD code is worked out (ie, for switch position 29, the true code is 10111, whereas the switch provides 000101). This has no effect on the operation of the unit, but should be borne in mind if a different application is required. In the event that all 256 locations are needed, the switch/display would have to be replaced with seven BCD thumbwheels or similar.

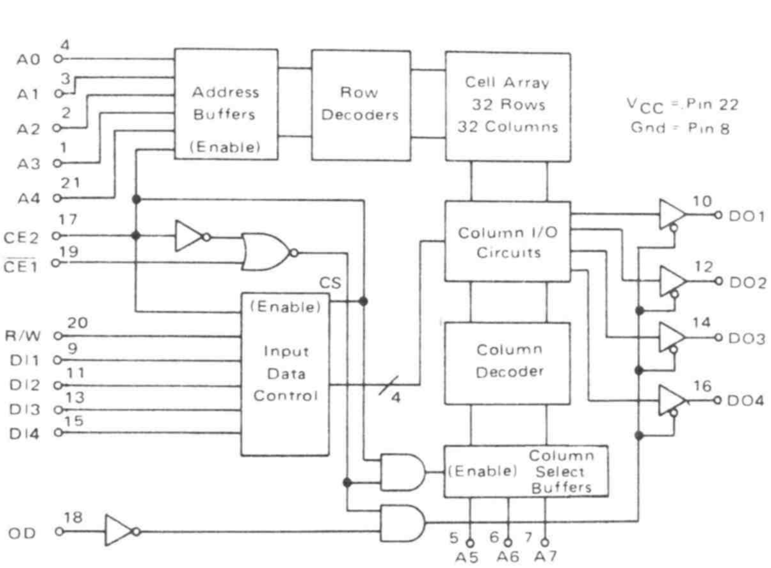


Figure 1: Block Diagram of 51L01

$\overline{CE1}$	CE2	OD	R/W	D_{in}	Output	Mode
H	X	X	X	X	High-Z	Not Selected
X	L	X	X	X	High-Z	Not Selected
X	X	H	H	X	High-Z	Output Disabled
L	H	H	L	X	High-Z	Write
L	H	L	L	X	D_{in}	Write
L	H	L	H	X	D_{out}	Read

Table 1: Operating Modes for 51L01 ▶

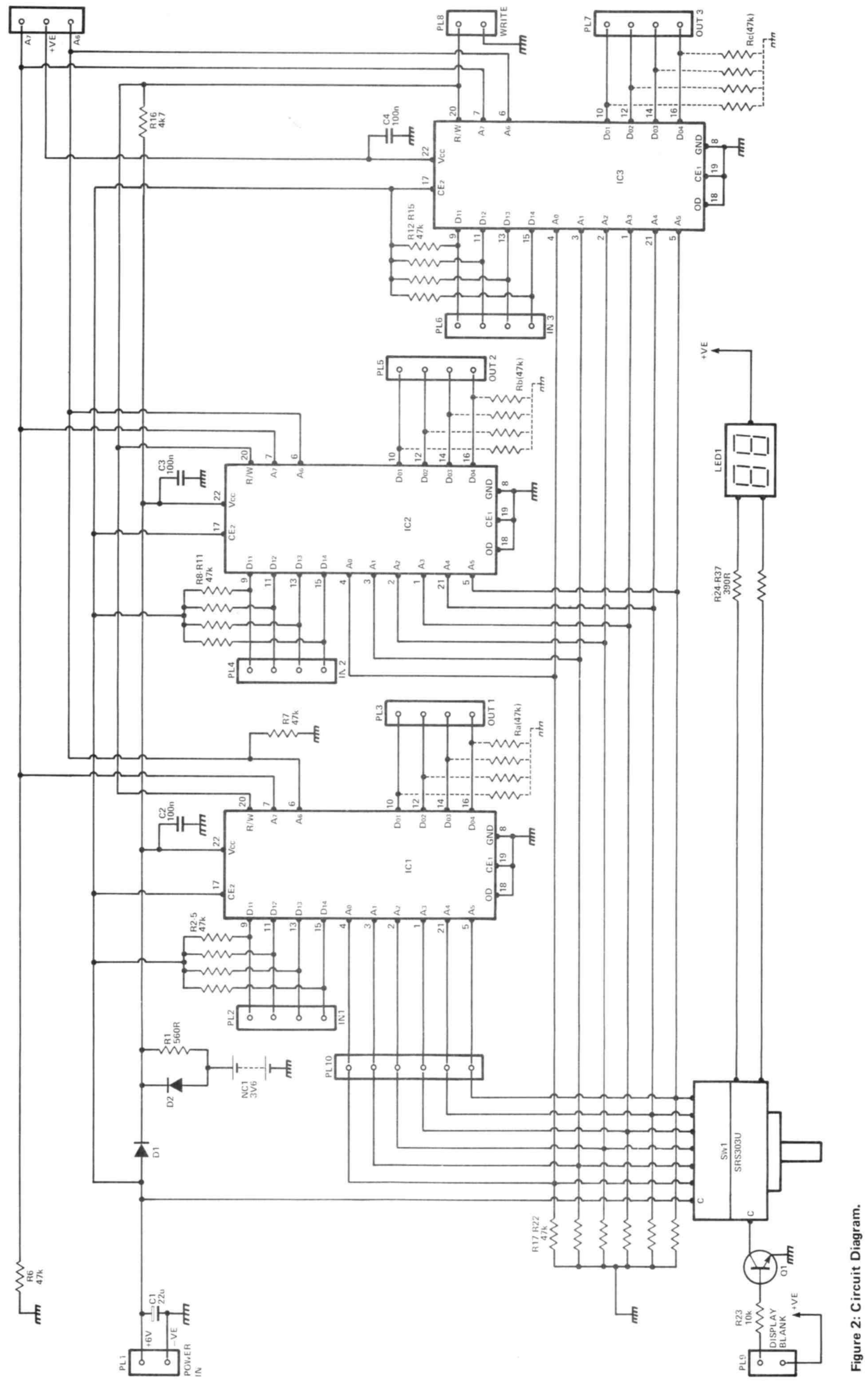


Figure 2: Circuit Diagram.

Circuit Description

During operation the supply voltage (6V) is fed from the receiver (via PL1) to IC1,2,3. Each IC is decoupled by a 100n capacitor. Overall decoupling is provided by C1 (22uF tant). 6V is also supplied to the LED display common anode. Segments are switched by the selector switch via current limiting resistors R24-37 (390R). Trickle charging to the Ni-Cad battery is provided by R1. When the reciever is turned off D2 turns on to provide approx 3V1 to the memory IC's. D1 prevents the battery discharging into the receiver circuitry. CE2 is connected to the receiver side of D1, so at the moment of switch off CE2 goes low putting the unit into 'Mode 2' (standby).

During normal receive, the R/W pins are held high (6V) by R16 — the memories are in 'read' mode. Momentarily shorting PL8 pulls the R/W pins low, changing to 'write' mode. Releasing the R/W pin returns the unit to 'read'.

All address inputs are provided with pull down resistors (R6,7,17-22). External connections are provided for all addresses; A0 -A5 being from PL11 and A6,A7 being made via pads on the PCB.

It should be noted that the data inputs and outputs have been prefixed 1,2,3,4, and not 1,2,4,8 to correspond with the BCD thumbwheels. One reason for this is that IC3 is used to control two banks of Airband thumbwheels — 10's of MHz and KHz (0,25,50,75).

Operation

Operation of the unit is quite straightforward. On initial power up, the memories will have random data stored and the receiver will probably be 'out of lock'. Required frequencies are dialled up on the thumbwheel switches and stored in the selected 'channel' by momentarily pressing the write switch connected to PL8. After using up the first 40 locations on the switch, reselect Channel 1, with A6 'on' and A7 'off' to access a further bank of 40. Then, set A6 'off' and A7 'on' for a further 40, and finally both A6 and A7 'on' to access the remaining 40 locations. For day to day use the first 40 channels will probably suffice, in which case A6 and A7 can be permanently connected low, and the associated switches and LED's eliminated. Take care not to accidently press the 'write' button after loading data into the memories, as this will destroy any previously loaded frequencies.

Once frequencies have been stored, they are retained for as long as required by way of the built in Ni-Cad battery. An external source *could also* be provided, from two 1V5 dry batteries, for standby power. However, using this method increases the risk of losing stored data through bad connections, corrosion etc. The built in Ni-Cad alleviates any of these worries.

During normal receiver operation, the current consumption of the unit can be further reduced by blanking the display once the appropriate location is selected. There is provision for this by turning off Q1's base via PL9 (normally, PL9 is shorted). The data inputs to the three memories are provided with 47k resistors (R2-5, 8-15) which can be

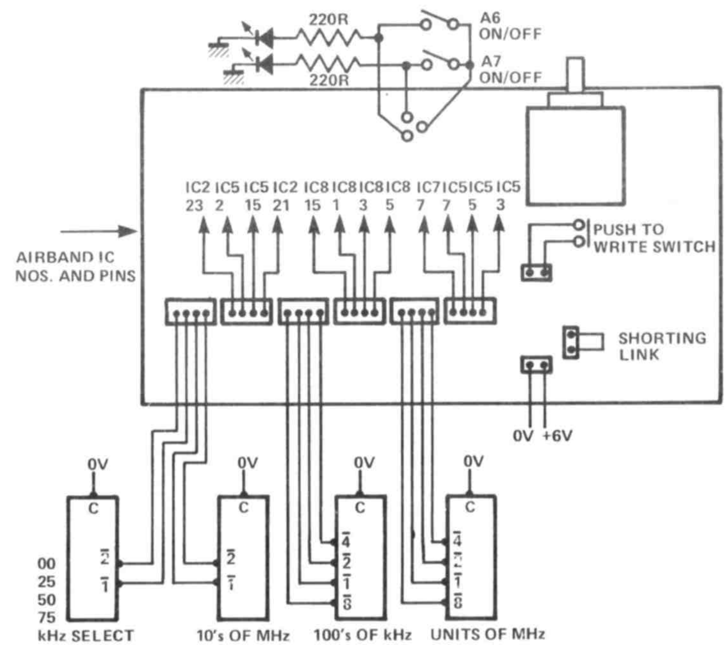


Figure 3: Connections for use with the *R&EW* Airband RX.

POS. / CODE	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	
2			X	X			X	X					X	X			X	X					X	X			X	X					X	X			X	X		
4			X	X	X	X							X	X	X	X							X	X	X	X							X	X	X	X				
8	X	X									X	X									X	X									X	X								
16	X	X	X	X	X	X	X	X	X	X											X	X	X	X	X	X	X	X	X	X										
32	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																				

"X" – ON

Table 2: SW1 coding

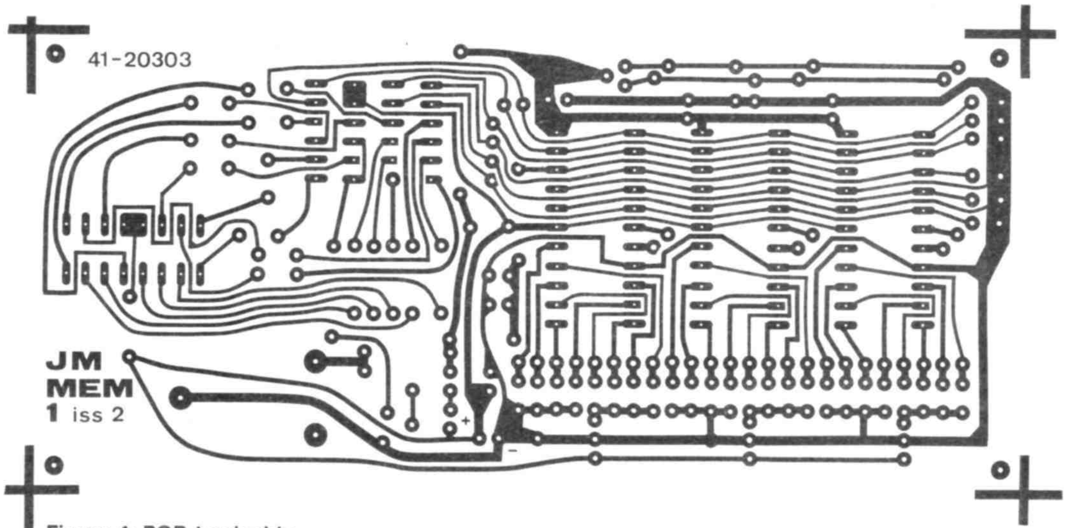


Figure 4: PCB track side.

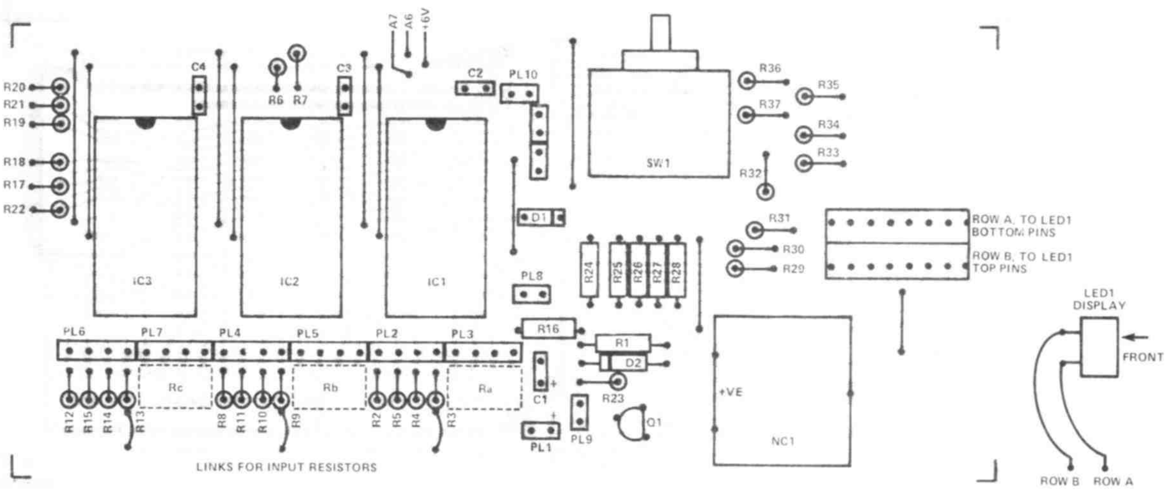


Figure 5: PCB component overlay.

PARTS LIST

Resistors	
R1	560R
R2-15,17-22	47k
R16	4k7
R23	10k
R24-37	390R
Ra,Rb,Rc	47k(optional)
Capacitors	
C1	22u 10V tant
C2,3,4	100n monolith
Semiconductors	
D1	1N4148
Q1	ZTX108
IC1,2,3	MCM51L01(Motorola)
DISP	Dual 7-seg display (LT-532R)
Miscellaneous	
NC1	3V6 NiCad(PCB mount)
SW1	SRS303U(CB type switch)
PL1	2-way molex
PL2,3,5	12-way molex
PL4,6,7	12 way molex
PL8	2 way molex
PL9	2 way molex
PL10	2 way, 4 way molex

pulled high (6v) or low (Ov) depending on how PC links are made. In our Airband Receiver all the resistors are linked high (5V), but if you wish to use normal BCD switches the resistors should be wired low(Ov). Likewise, the outputs have the facility for fitting pull-down resistors. These are not required when used with the **R&EW** Airband Receiver and are therefore coded Ra, Rb and Rc.

Construction

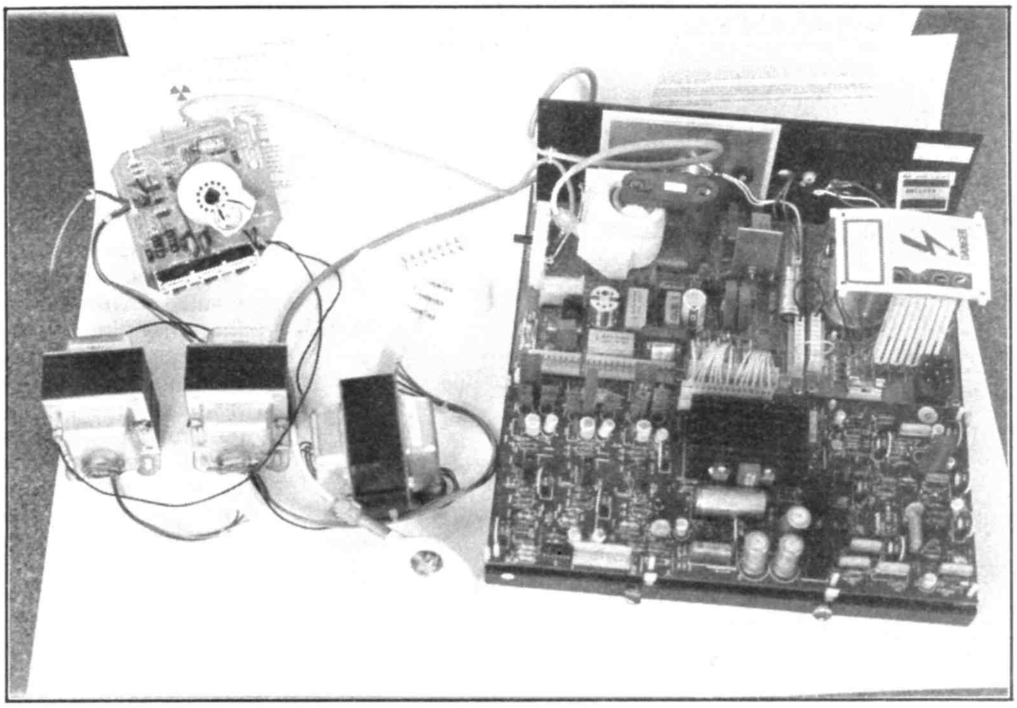
Construction of the unit is fairly easy, though some care is needed when soldering onto the fine PCB tracks — use a good quality iron.

Fit the wire links, diodes, PC plugs, resistors, capacitors and IC sockets first, followed by the selector switch. Check that all the switch pins are located before pushing into position. Next fit the LED display, utilising moulded cable. Finally fit the three memory IC's and solder in the Ni-Cad battery.

Check all connections thoroughly, looking especially for any solder bridges. If all's well, apply +6V to PL1 and short PL9 to check the LED display illuminates. Rotate SW1 and ensure the channel numbers change on the display. Disconnect the supply and connect the thumbwheels to the inputs via PL2,4,6. Connect the outputs from the unit to the appropriate synthesiser pins via PL3,5,7. Turn on the power and select a suitable frequency on the thumbwheels. Short PL8 momentarily and check that the receiver is now tuned to the frequency selected.

If everything functions OK the unit can be fitted to the receiver and frequencies programmed in. Note that PL10 is unused at the moment, since it is provided for the addition of scanner circuitry. Don't forget that if the receiver is being operated from a battery supply, the display blank facility will keep the consumption low.

■ R&EW



RAMTEK MONITOR

A high resolution RGB monitor with 22″ screen — N.C. Parkes evaluates this money saving kit from Opus.

AS ADVANCES IN computer hardware design filter through to the latest microcomputers, there is an ever growing need for some better standard of graphic display. Domestic television receivers are fine for general applications, but when it comes to fine detail or complex graphics in full colour, a RGB monitor with high resolution capability is desirable.

Despite the obvious demand however, such purchases usually give rise to an 'empty feeling' from the depths of that most sacred of pocket-dwellers — your wallet. So one solution is to *build* a monitor, and rather than starting from scratch — no easy task unless you know a lot about TV's — it's a good idea to look for a kit. We decided on one produced by Ramtek and sold by Opus Supplies.

The kit comes supplied with just about everything you need (except the case) to construct a high resolution colour monitor. The electronics consist of a 22″ colour CRT, deflection assembly, input and degaussing circuitry, dynamic correction and line scan PCB's, power supply board, isolating transformers and the various connectors. Also provided are mounting brackets, bolts, crimp-tags and clips, plus instruction manual and extensive wiring diagrams all present to make 'putting it together' as straightforward as possible.

Framing The Subject

The first major realisation surrounding the kit comes about five seconds after removing, oh so gently, the tube from its packing — there's nowhere to put it except back into the box! Then follows a frantic search for someone who keeps old TV frames. Not any old frame, but one that will house a 22" Mullard tube. We tracked down a TV repair-shop owner, who came up trumps when told the problem. He informed this reviewer that brand new 'boxes' are available from most manufacturers — potential kit buyers take note!

Having got the case, you're ready to start wiring up the monitor. The first thing to be secured is the tube itself, then the main boards and isolating transformers. The diagram in ***Fig. 1*** shows the various interconnections for satisfactory operation. Each step in the construction process is outlined in the manual, and all credit is due here for concise yet easy-to-follow instructions. With everything supplied in the kit, it doesn't take very long to assemble.

Putting together the crimp connectors is slightly tedious, but within an hour or so the monitor is complete, apart from wiring the transformers. This turned out to be an amusing (!) task, since there were no markings on either winding. In the end, sheer frustration led to applying the mains across pairs of wires and measuring the outputs. Though this method is *NOT* recommended, it did achieve the desired result — producing a 155 VAC line output. And upon duly connecting this to the PSU input, a high pitched whistle was heard and the screen glowed a 'dirty' white colour — we had lift off.

Rock And Roll

The next step, after making sure the monitor is operating properly, is to connect the appropriate RGB and sync signals. This is the final 'make or break' test, and in our case it turned out to be the latter — the display was rolling and distorting. Despite this the data was still legible — we used the BBC micro with its easily accessible RGB outputs — which proved that the transmission/reception interface was functioning. It was then necessary to adjust the line and frame hold presets to stabilize the image and after a few minutes of trial-and-error the picture stopped jumping. This was the first opportunity to take a look at the display quality and initial impressions were favourable. However, it soon became apparent that the monitor was not 'set for optimum performance' (as stated in the instruction manual), and some further tuning would be necessary. So, armed with my trusty blade ▶

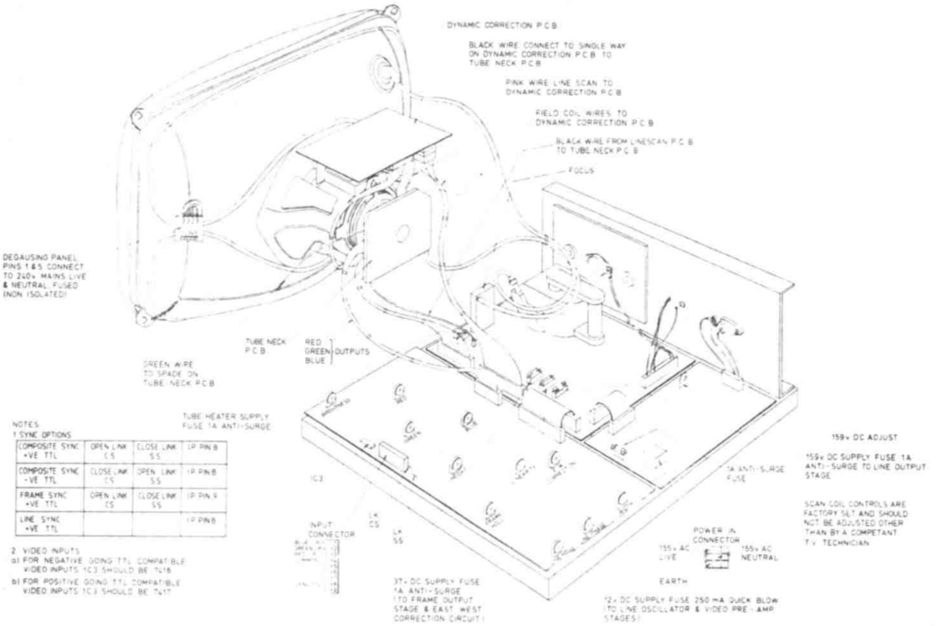
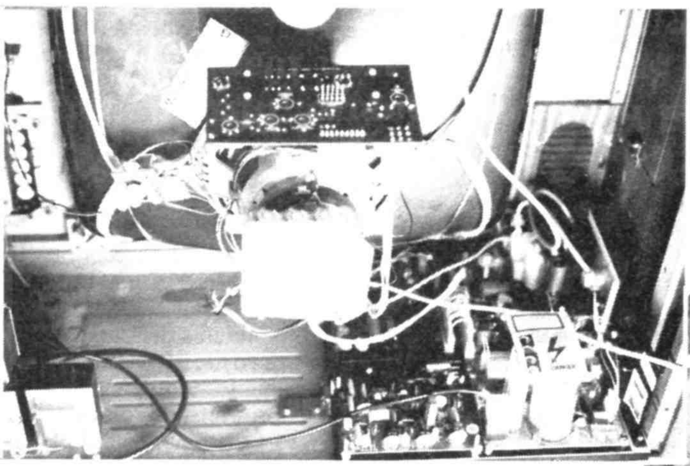


Figure 1: Wiring diagram for connections between components within the RGB monitor.

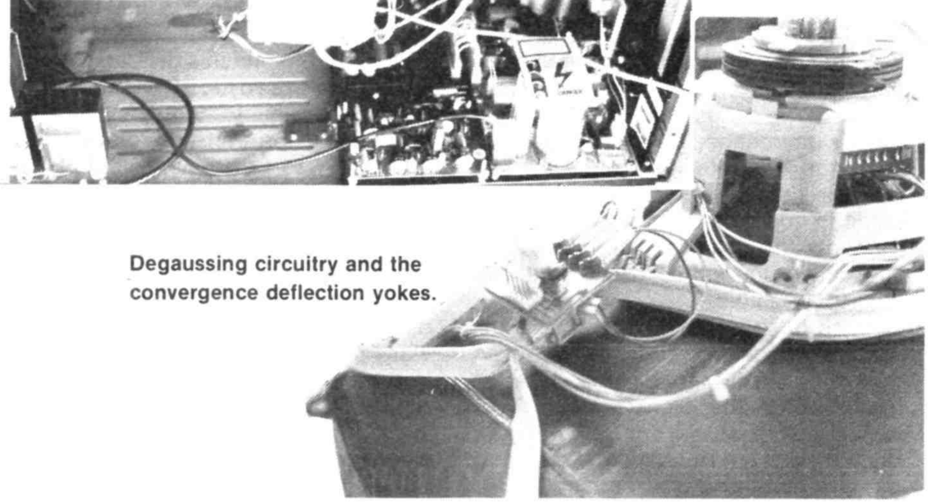
(screwdriver blade that is), the other presets were adjusted in order that the display filled the screen without 'bowing' at the edges. The colour balance also needed attention and together with the aforementioned corrective measures, 'setting up' proved to be quite an arduous and time consuming task. It is sincerely hoped that the particular monitor reviewed was the exception rather than the rule as regards quality control.

Eventually, the picture clarity, size and stability were good enough to allow us to put the completed monitor through its paces.

Comparison of each of the three rasters, with either one or two electron guns switched off, showed remarkable constancy. Using the BBC computer permitted tests of resolution and colour stability. However, before anything significant had been done, it was noticed that the red/blue convergence was not right. Further examination of secondary and tertiary colours revealed quite a serious lack of alignment. Now, to be fair, this could have occurred during transportation, but that would seem to suggest the gun assembly was either loose or could have done with some improvement. Either way, we decided to contact Opus in order to obtain the convergence procedure. Following a helpful phone conversation, the required manual arrived and we managed to reset the offending deflection yokes and purity as well (if you come across similar problems, *get this done by the manufacturers* -the process is lengthy and requires certain pieces of test equipment). Back to the assessment and time to make AB comparisons between ordinary television receivers (probably what the majority of micro-owners are using) and the monitor.



Housing the various boards inside an old TV frame saves time and effort.



Degaussing circuitry and the convergence deflection yokes.

Colours on the monitor are definitely well-balanced (if properly set up!), though this is perhaps an unfair comparison since many TV's give prevalence to certain tints, for better colour balance on skin tones. Something much easier to discern is 'full-frame' stability — judged by running a short program which displays different foreground/background colour combinations. Often television receiver pictures will 'tear' or 'ripple', but the monitor coped admirably; each colour possessed a sharp edge without blurring or intensity variation.

Another problem sometimes encountered with displaying modulated outputs is drift in frequency. Graphic displays on TVs can lose colour and definition, making it necessary to readjust the channel tuning. Not so with the monitor, which retained full colour and resolution at all times.

The final and definitive test for the monitor was retention of clarity in high resolution displays. Disregarding colour, we arranged some fairly demanding displays (software derived), using one of the BBC's high resolution modes. Here the differences from a normal TV were quite startling. Fine lines and closely packed letters, though not perfectly clear, were well defined on the screen — the TV picture being distorted and unstable. High resolution dot displays were distinct almost to the point of coincidence, and the sharpness was constant even with the screen completely covered.

With such glaring advantages over a domestic television, the Ramtek Monitor certainly rates as a worthwhile buy for anyone wishing to obtain superior graphics 'on the screen'. The problems encountered during construction and subsequent operation, though hardly insignificant, must be considered as exceptional and therefore this reviewer can recommend the monitor with only slight reservation. At around £100 the quality and value is unbeatable.

■ R&EW

VIDEO NEWS

Peter Luke confesses to a slight indiscretion this month and has news of a new quarterly video magazine.

AS A LAW abiding citizen and a responsible journalist I have to date resisted the temptation to join the pirate video tape bandwagon. I must be one of the few people in the business who did not see a pirated copy of ET before its London release. I had the chance but quite frankly I was not interested in seeing a poor quality copy of Speilberg's blockbuster. Such a film needs the large screen of a cinema, together with a good quality sound system, if its full impact is to be appreciated.

This month however I did take the opportunity to see a pirated copy of a recent release. In this case, it wasn't a mammoth production and, in the normal course of events I probably would not have got round to seeing it on the big screen. It did however look a fairly interesting film, just the thing to settle down in front of on a wet winter evening.

As may be expected, the quality was dreadful, so bad in fact that it spoilt any enjoyment I might have got from the film. I persevered for half-an-hour or so and then gave up. What I did see however, captivated my interest and a couple of nights later I duly queued up outside my local picture palace and made my contribution to the production costs of the film.

I know of at least one other person who has gone through the same loop at least once before. I'm not saying that this reaction is typical but it's certainly true that in my case, a pirate tape, far from depriving the film industry of much needed cash, it acted as an extended trailer encouraging me to see a film that I would otherwise not have bothered with.

Video A-Z

You may have seen copies of the new magazine Video A-Z on the shelves of your local newsagent. The quarterly publication is well worth buying if you are considering the purchase or rental of a video machine, or indeed if you're interested in any aspect of video.

The magazine features reviews of nearly all the video recorders and cameras available in the UK, no mean task when this means collecting together some 40 or so for review. Each product is reviewed in two pages and all provide information as to a machine's specification as well as an assessment of its quality.

Video A-Z was the first magazine to produce a comprehensive assessment of the quality offered by the various brands of blank tape on the market. We have arranged with video A-Z's Editor to reproduce the survey in next month's **R&EW**. It makes interesting reading and, if you want to make sure you get value for money when you buy blank tape, make sure you read the survey in our April issue.

The next issue of Video A-Z plans to feature a survey of head cleaning tapes — a thorny subject — as well as a comparison of a couple of the new VHS-C portable recorders.

Watch out for the next issue of video A-Z — I don't know what they plan for their next cover but if their last issue is anything to go by, the magazine should be eye catching to say the least. It's a pity that we can't get away with this sort of cover at **R&EW**.

New Cameras

Two new lightweight colour video cameras from Panasonic should be available in the shops by the time you read this.

The Panasonic WV-P30 and WV-P50 hand-held cameras follow closely in the wake of a variety of recently announced Panasonic video products, such as the 100 Series portable system, the 'C' format portable, the first full-feature VHS edit suite and a top-of-the-range auto-focus shoulder-mount camera, the WV-P100.

The WV-P30, weighs only 1.5 kilos and measures 80 (W)⅟₁₅ 212 (H) by 371 (D)mm — including the handle. It uses a 1/2" Saticon pick-up tube to produce sharp pictures with negligible after-image. There is also automatic white balance, and a one-touch red/blue colour balance control to allow colour compensation. The 6:1 zoom lens is controlled by slide system (which also allows simultaneous focusing), and, with a maximum aperture of F1.4, operation is possible in illumination as low as 75 lux. The WV-P30 also has an auto iris control which automatically compensates for different lighting conditions and quickly sets the iris for the proper light level. Even high detail close-ups of subjects such as titles, flowers or insects can be recorded by setting the zoom lens to the 'macro' position.

In the 1" B/W electronic viewfinder compartment there is a series of LED indicators which show record mode, indoor selection and low light alert, as well as low battery warning and auto white balance indication.

At £445.00 (RRP incl. VAT) the new Panasonic WV-P30 offers good value for the creative video producer with a limited budget. For slightly more, however, (£611.00 RRP incl. VAT) the sister camera WV-P50 offers some additional features.

An ultrasonic auto-focus system makes focusing quick, accurate and virtually fool-proof on most subjects, moving or stationary. And when the 'auto focus' is turned off, the auto focus can be manually set. In manual mode the diversified techniques of focus-in, focus-out etc. are all at the total discretion of the cameraman.

As for fade-in/fade-out, the WV-P50 can provide gradual and smooth appearance and disappearance of both sound and vision at the push of a button. A flashing LED above the electronic viewfinder indicates when the fade mode has been selected. A unidirectional boom microphone is a standard feature of the WV-P50, and in addition an external microphone jack is included (also in the WV-P30). In both cameras there is a handy VTR remote jack for the addition of an optional VTR conroller (WV-VR11) which can be attached to the side of the camera. With this accessory, functions such as Rec/Play, Play, Slow, and Cue and Review on the NV-100 portable video recorder are all controllable from the camera, even when filming at a distance from the VTR. ■ R&EW

SOUNDING OFF

By Evan Steadman

How Much Are You Worth?

Riddle me ree this one.

How much would you expect to earn, if you started tomorrow, as a 'major account sales executive' for Acorn Computers here in benighted Blighty?

The answer: £24K + car.

And that ain't for 'the' major account executive, either, Just 'a'.

If you can bear with my lachrymose meanderings a little longer, the whole question of who gets how much — and why — is beginning to fascinate me.

Until recently there was a genus of Gauleiters at Texas Instruments' base in Dallas known as 'Corporate Managers'.

Some eighty souls.

Of whom, at a stroke, 58 have gone to their last chippermat.

The to-be-delivered orders they generated one way and another is fated as being $2,532,000,000.

But TI said they should go.

And they were right (of which more anon).

Next question: guess how many folk Texas have remaindered since May 1981?

'Some 12,500.'

That's **some** 12,500. Dammit, that's, well — that's a lot. And I think TI were right again.

The chap who must have had a lot to do with it, as boss of the semiconductor and consumer end, is a Mr. Sick.

As a parrot, was he? Well, I hope not.

Forgive this fascist line but I have to say — again — that the Dallas cowboys ('Cowboys' is the nick-name for their football team; 'Dallas' is where they shoot Presidents) with the Corp **must** do the lemming cull whenever the margins start looking marginal.

It's a case of those living by the sword, dying by the sword. 'Cos if you blokes want to earn twice as much as your neighbour, you must expect to face twice the danger of a head-topping ceremony.

If you want to live in a fast-moving, free-wheeling, big-talking, grab-and-get it environment — well, somebody somewhere may decide thay can, after all, do without **you**, big mouth, and stuff your efforts into the word-processor.

Which is how TI got to be TI in the first, second and third place. Get it right, you're a good guy. Get the numbers wrong and you're a no-no.

So say 'goodbye" to the car park attendant, Chuck.

How else can the electronics industry, now one of the world's top ten industries — and scheduled to be one of the world's top four "ere we hit 1990 — fly by the seat of its entrepreneurial instincts?

Wanna fight? Go where the action and rewards are.

Oh, I forgot to mention. TI's profits, for the 9 fiscal months ending September 30, were $101,500,000. On sales of $3,219,700,000. Somewhat up from the previous year.

And those redundanced? Don't worry. They went out and set up their own little piece of the action.

Probably in Silicon Valley where they're running out of room for them all. Some of them will win; and hire guys; and fire guys; and become TI's now and again.

Medium is the massage

The TI numbers were clipped from the weekly American Electronics newspaper. It's called 'Electronic News', is as old fashioned as a sense of sin, and was 230 pages long. In full colour.

The biggest UK Weekly, same period, was 40 pages in toto.

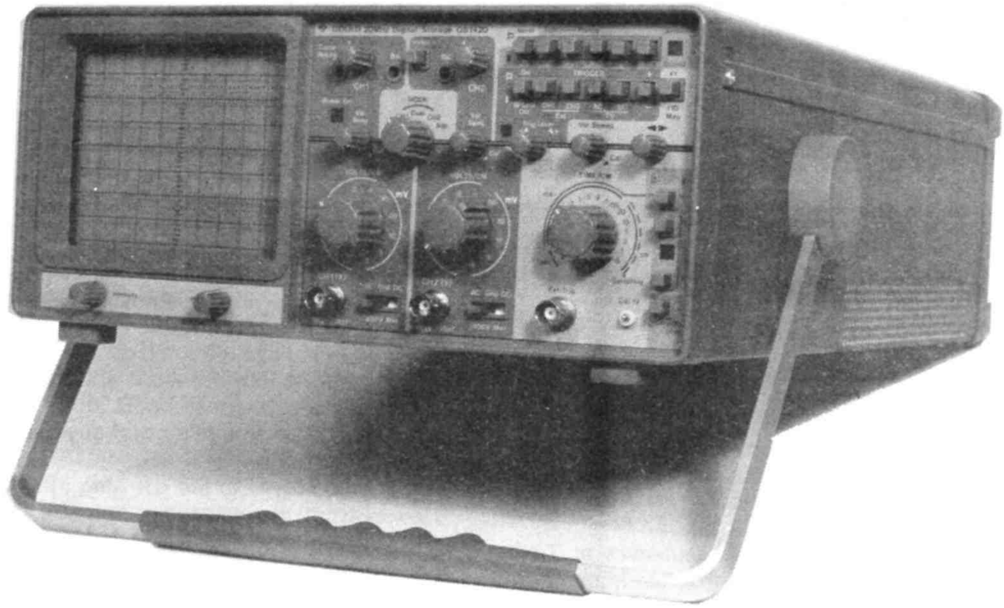
Which might lead you to the view that there's rather more happening, electronics-wise, over the pond than here.

You would be right.

So why stay? Well our beer is better. Our birds are better. And our football is better. And **we've** got Clive Sinclair.

EVENTS: MOBILE RALLIES March '83

February 18th-11th	Exhibitionof New Technology	Parc des Expositions, Brussels	Tel: 02-478 4860
March 13th	Pontefract & DARS Components Fair	Carleton Grange Comm. Centre, Pontefract	P.N. Butterfield G4AAQ Tel: (0977) 791071
March 21st-25th	2nd International Network Planning Symposium	University of Sussex, Brighton	Tel: 01-240 1871
March 27th	White Rose ARS Rally	Leeds University	Richard Hughes G4DZI
April 19th-21st	All Electronics/ECIF Show	Barbican Exhibition Centre, London	Samantha Clarke Tel: (0799) 22612
May 10th-12th	Micro City 1983	Bristol Exhibition Centre	Tel: (0272) 292156
May 29th	East Suffolk Wireless Revival	Civil Service Sportsground, Ipswich Suffolk	Jack Tootill G4IFF, 76, Fircroft Rd, Ipswich Suffolk



OS1420 STORAGE 'SCOPE

Michael Graham assesses Gould's workmanlike digital storage 'scope.

ALTHOUGH THE BASIC design of the oscilloscope has not changed for the past few decades the ingress of modern technology has meant that todays 'scopes are smaller and more reliable than there forebears. Perhaps the most significant advance in the facilities provided by 'scopes in recent years has been the development of a digital storage capability. The Gould OS1420 is part of Gould's 1400 range of 'scopes and offers a 20MHz, dual-trace, digital storage design at a reasonable cost.

The 1420 does not offer the sophistication of MPU control or an IEE interface, but instead concentrates on offering a straightforward, high quality design at a reasonable price.

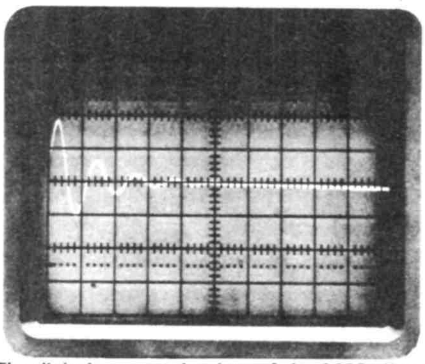
Overview

The majority of front panel controls are exactly the same as those found on a conventional 'scope and indeed, if the specifically digital functions are ignored, the 1420 offers a real time 'scope with a DC to 20 MHz bandwidth offering two identical input channels with a maximum sensitivity of 2mV/cm. The channels may be displayed separately or together and the 'scope has the ability to display the sum or difference of the channels and features X-Y mode operation. The timebase ranges are from 0.005us/cm to 0.25/cm in NORMAL mode. A$\frac{1}{15}$ 10 facility expands the upper limit to 50ns/cm. In NORMAL mode, independent variable sensitivity and separate controls are provided.

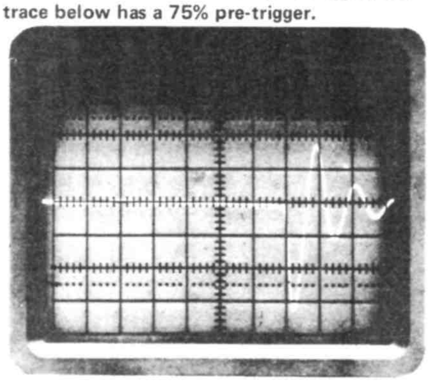
The trigger facilities available are comprehensive, with DC and AC coupling available and a bright-line-free run facility to enable true location in the absence of a trigger. An active TV sync., separator is provided for viewing video waveforms.

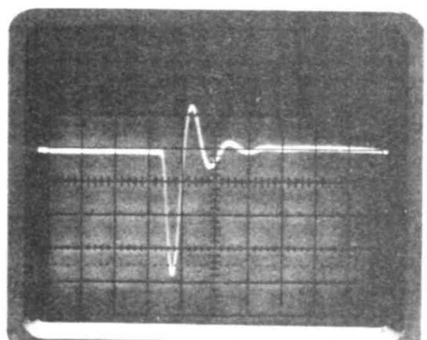
Many additional facilities are provided with the OS1420 such as a plot option fitted as standard, a 1KHz calibrator, a DC coupled Z modulation input and a trace rotation control.

The use of an uncommitted logic array has reduced both the number of components and board area required for the 1420's electronics. This has additional benefits in terms of reliability, power consumption and ease of maintenance.

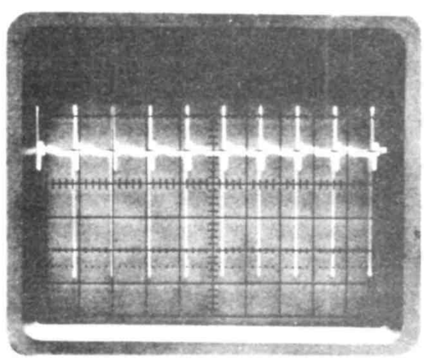


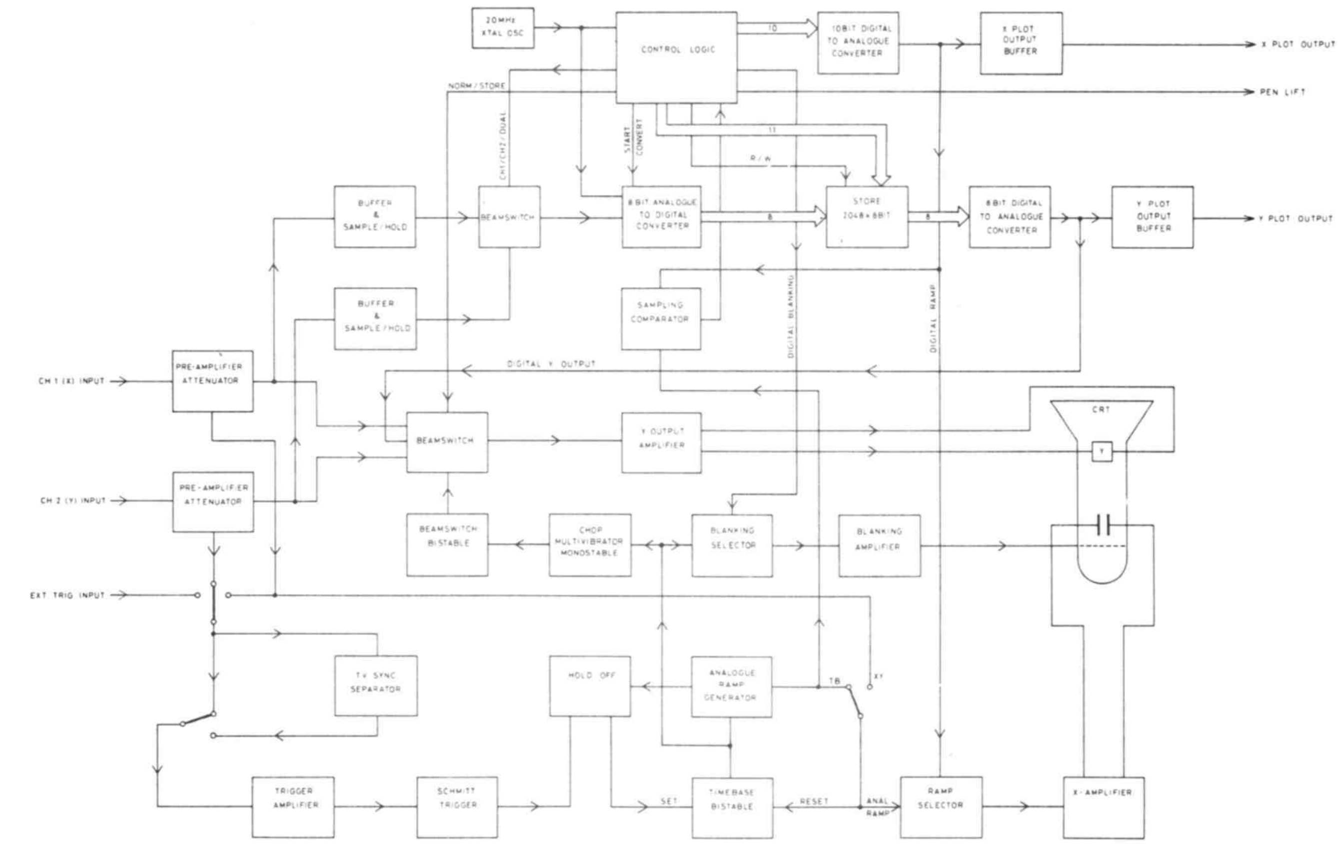
The digital storage circuitry of the 1420 allows the trace to be 'pre-triggered'. The display above shows a trace without pre-trigger, the trace below has a 75% pre-trigger.





These two displays show the 'scope's X10 trace expansion in operation.





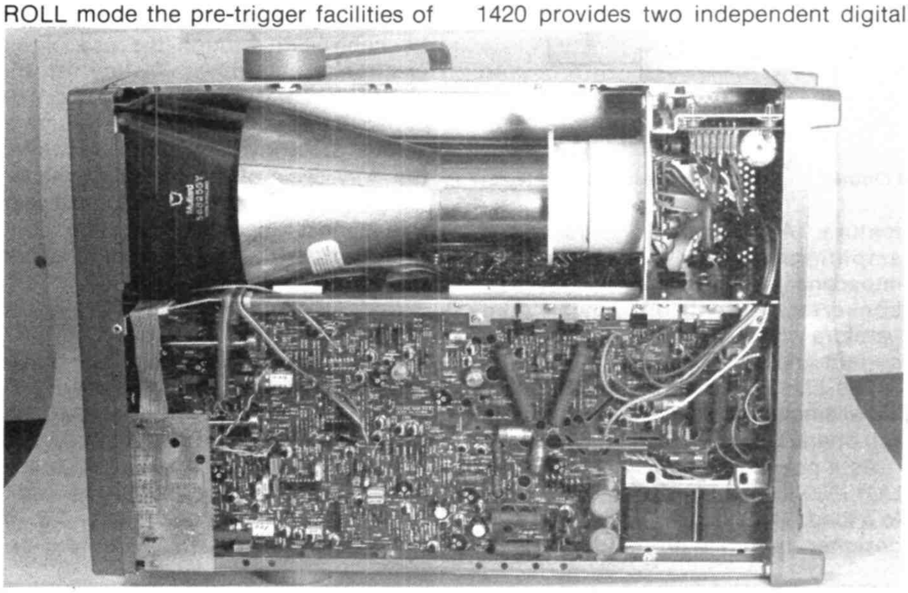
Block Diagram.

Store Mode

The storage mode of the 1420 is selected by means of the NORM/STORE control and the precise mode of the store's operation is decided by the ROLL/-REFRESH button.

In the ROLL mode, incoming data is fed continuously to the store. This results in a trace that appears to be rolling to the left, and is similar in appearance to the view through a 10cm window of a chart recorder trace. In the ROLL mode the pre-trigger facilities of the 'scope can be engaged depending on the position of the two pre-trigger controls, 0%, 25%, 75% or 100% pre-trigger can be selected. The pre-trigger facility is particularly useful for analysing transient or noise signals (for an explanation of the use of digital storage 'scopes in this, and other applications, see Chris Crook's article in November '82's **R&EW**).

A X10 expansion facility allows any part of a stored digital trace to be examined in detail and the fact that the 1420 provides two independent digital stores, means that it is possible to compare two stored signals on the screen — particularly useful when making changes to a circuit during development.



In The Workshop

We let the OS1420 loose in the **R&EW** labs and asked the designers there to put the 'scope through its paces. As a real-time DC — 20MHz 'scope the Gould was well liked. The front panel is well laid out with easily read legending and large controls with a positive action.

As a storage 'scope the 1420 came into its own. An audio project under development in the labs at the time required a series of LF measurements to be undertaken. Using a real time 'scope, the screen flicker evident at low frequencies makes measurement a difficult task. Utilising the storage capability of the 1420, these LF signals could be frozen and, very importantly, the effect of minor circuit changes, investigated using the comparison facility of the 1420.

The standard of construction evident inside the 'scopes case was extremly high. The 'scope is a British product, designed and built, and it is gratifying that quality products such as this scope can still be designed and built in the UK.

■ R&EW

DESIGNERS UPDATE

Michael Graham with another batch of circuits from the manufacturers' data books.

This latest batch of circuits concentrates on audio functional blocks. Selecting two or more of the circuit blocks in the next few pages should enable you to put together a tape player, power amplifier or even a complete audio system. We've also included an interesting power op-amp for good measure.

As we've explained in previous Designer's Updates, the circuits presented here have not been tested by ourselves but reproduced from our collection of device data sheets. For information as to the availability of any of the ICs, contact any distributor with a national semiconductor franchise.

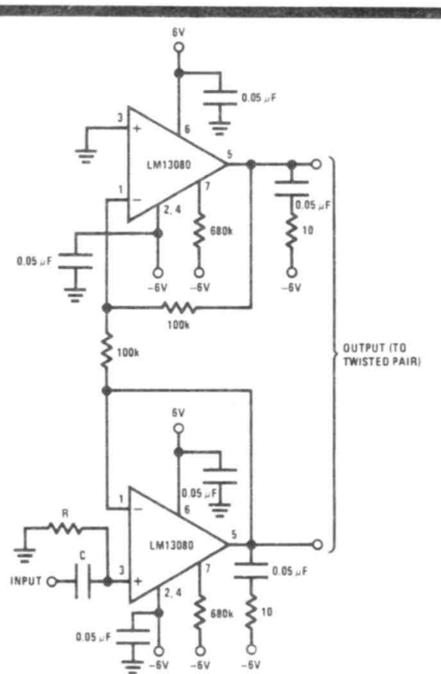


Figure 1: Line Driver, Unbalanced Input to Balanced Output.

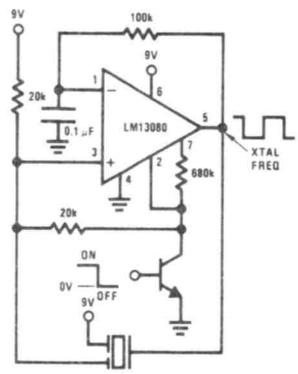


Figure 2: Piezoelectric Alarm.

LM13080 Programmable Power Op Amp — National

The LM13080 is an internally compensated medium power operational amplifier designed for use in those applications requiring load currents of several hundred milliamperes. This amplifier has the added advantage of having an input stage programmed with an external resistor. The user is able to optimize the amplifier performance for each individual application with this feature. Applications include servo amplifiers and drivers, high input impedance audio amplifiers, DC-to-DC converters, precision power comparators which can either sink or source current and motor speed controls.

The LM13080 may be powered from either single or dual power supplies, and will operate from as little as 3V.

As a power operational amplifier, the LM13080 is capable of delivering 0.25A to a load. This feature allows the system designer to fulfill his medium power circuit requirements without having to add external current boost transistors to the output of a standard operational amplifier.

By selecting the proper input stage bias resistor it is possible to tailor the performance of the input stage to meet the needs of any partiuclar system. Trade-offs between input offset voltage, input bias current and gain bandwidth are easily made.

An unusual feature of the LM13080 is an electronic shut-down capability.

Line Driver

The line driver circuit in ***Fig 1*** is able to accept an unbalanced, high impedance input and convert it to a balanced output suitable for driving a low impedance line. this is particularly useful in an environment where magnetically induced hum or noise pickup is a problem.

The outputs of the 2 LM13080's are of opposite polarity; therefore, terminating the line with a balanced load (ie, a differential amplifier or a transformer) will cause common-mode interference pickup to be cancelled.

This circuit will drive a 20 Vp-p signal into a 50Ω load for frequencies up to 10 kHz. Above 10 kHz the output signal is slew rate limited, but the line driver will still supply a 13 Vp-p signal at 20 kHz. the voltage gain of the network is 2, and the low frequency roll-off is determined by:

It can be seen that if the load is connected directly between the outputs of the amplifiers, the line driver becomes a simple bridge amplifier capable of delivering 2W into a 16Ω load.

Piezoelectric Alarm

The piezoelectric alarm shown in ***Fig. 2*** uses a 3-terminal transducer (Gulton 101FB or equivalent) to produce an 80 dB SPL alarm.

The transducer has a feedback terminal which is connected to the non-inverting input of the LM13080, causing oscillation at the resonant frequency of the piezoelectric crystal. The alarm can be controlled through the use of the electronic shut-down feature of the amplifier. The 100k resistor and 0.1 uF capacitor are used to provide a reference voltage at the inverting input and to keep the duty cycle of the crystal oscillation close to 50%. The RC time constant of this feedback network should be much greater than the time constant of the transducer.

Sirens

Two separate circuits for sirens are shown. The first **Fig. 3**, is a 2-state or ON-OFF type siren where the LM13080 oscillates at an audio frequency and drives an 8Ω speaker and the LM339 acts as a switch which controls the audio burst rate. The second siren, ***Fig. 4***, provides a constant audio output but

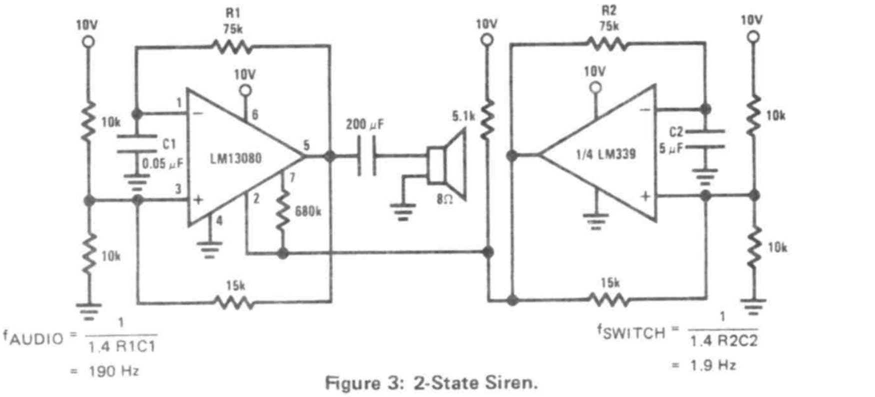


Figure 3: 2-State Siren.

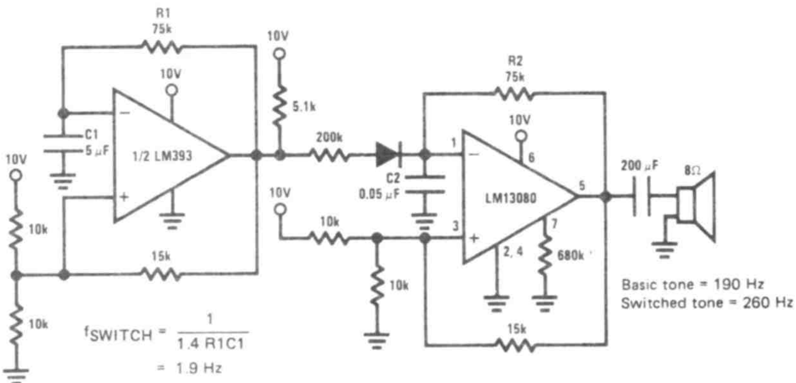


Figure 4: 2-Tone Siren.

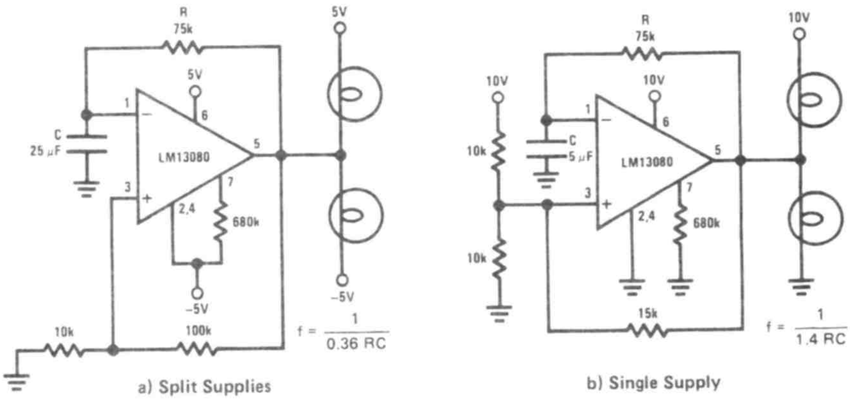


Figure 5: Low Frequency Lamp Flasher/Relay Driver.

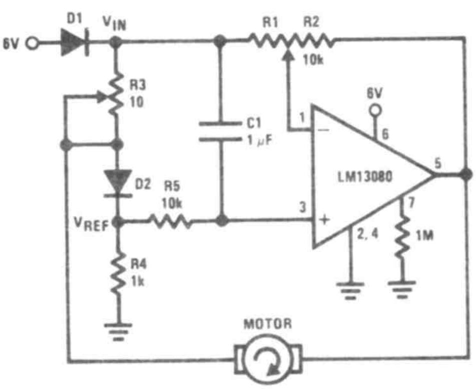


Figure 6: Motor Speed Control.

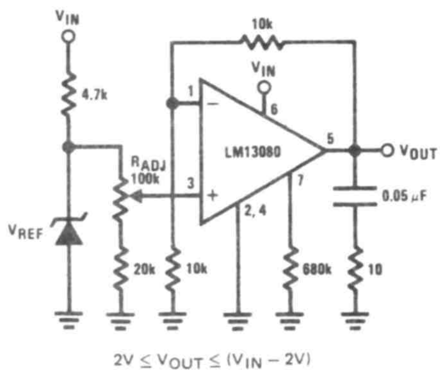


Figure 7: Positive Variable Voltage Regulator.

alternates between 2 separate tones. The LM13080 is set to oscillate at one basic frequency and this frequency is changed by adding a 200 kΩ resistor in parallel with the feedback resistor, R2.

Lamp Flasher — Relay Driver

The LM13080 is easily adaptable to such applications as low frequency warning devices. The output of the oscillator is a squarewave that is used to drive lamps or small relays. As shown in ***Fig. 5***, the circuit alternately flashes 2 incandescent lamps.

Motor Speed Control

The LM13080 can be used to construct a very simple speed control for small motors requiring less than 0.5A start current. This circuit operates by impressing the multiple of a reference voltage across the motor, and then varying the reference by means of quasi-positive feedback to change the voltage across the motor any time the load on the motor changes.

To understand the circuit operation, it is easiest to let the voltage at the cathode of diode D1, ***Fig. 6***, be the input voltage, V_{IN}, to the system. Diode D1 is actually a level shift diode to bring V_{IN} into the common-mode range of the amplifier. A reference voltage is established by the combined voltage drop through the 10Ω potentiometer, R3 and the reference diode. D2 and is applied to the non-inverting input of the LM13080. Resistor R4 is a bias resistor used to keep D2 active. The 10k speed adjust potentiometer is 2 resistors in 1, where section R1 is the input resistance and section R2 is the negative feedback resistance. It can be seen that the voltage impressed across the motor is equal to:

The positive feedback is developed as a change in the voltage across R3 due to the change in the motor current caused by a variation in the motor's load. Resistor R3 is shown as a potentiometer so that the amount of positive feedback can be adjusted for smooth operation of the motor. Capacitor C1 and resistor R5 serve as a filter for the reference voltage at the non-inverting input of the amplifier.

Voltage Regulators

In normal, positive or negative regulator application such as those shown in **Fig. 7** and **Fig. 8**, the LM13080 has 2 major advantages over standard operational amplifiers. The LM13080 has its own on-chip pass device and in addition can either sink or source 250 mA of load current.

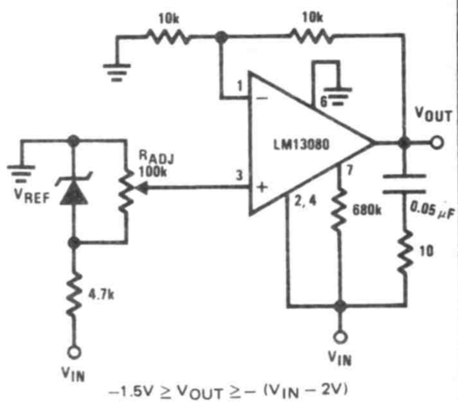


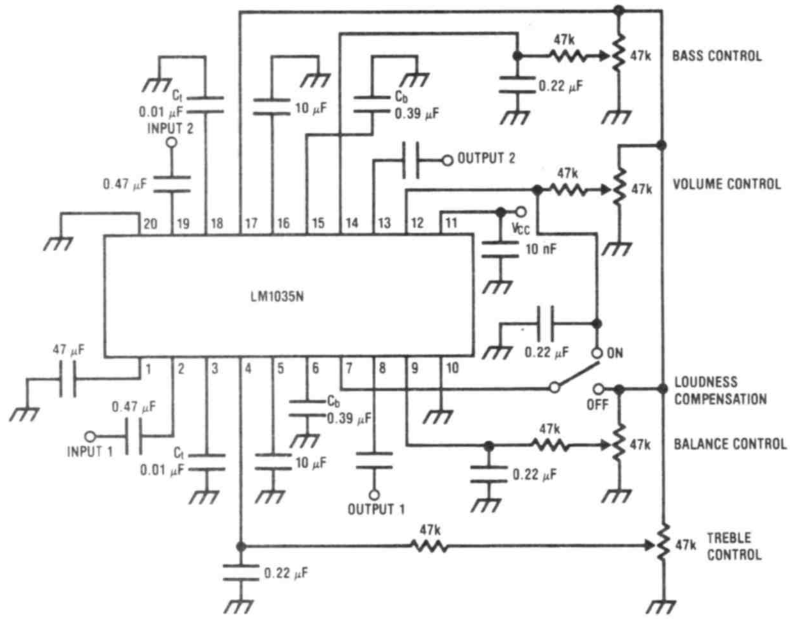
Figure 8: Negative Variable Voltage Regulator.

LM1035 Dual DC Operated Tone/Volume/Balance Circuit — National

The LM1035 is a DC controlled tone (bass/treble), volume and balance circuit for stereo applications in car radio, TV and audio systems. An additional control input allows loudness compensation to be simply effected.

Four control inputs provide control of the bass, treble, balance and volume functions through application of DC voltages from a remote control system or, alternatively, from four potentiometers which may be biased from a zener regulated supply provided on the circuit.

Each tone response is defined by a single capacitor chosen to give the desired characteristic.



Tone Response

The maximum boost and cut can be optimized for individual applications by selection of the appropriate values of C_t (treble) and C_b (bass).

The tone responses are defined by the relationships.

$$\text{Bass Response} = \frac{1 + \dfrac{0.00065(1-a_b)}{j\omega C_b}}{1 + \dfrac{0.00065a_b}{j\omega C_b}}$$

$$\text{Treble Response} = \frac{1 + j\omega 5500(1-a_t)C_t}{1 + j\omega 5500a_tC_t}$$

Where $a_b = a_t = 0$ for maximum bass and treble boost respectively and $a_b = a_t = 1$ for maximum cut.

For the values of C_b and C_t of 0.39uF and 0.01uF as shown in the Application Circuit, 15 dB of boost or cut is obtained at 40 HZ and 16kHz.

Zener Voltage

A zener voltage (pin 17 = 5.4V) is provided which may be used to bias the control potentiometers. Setting a DC level of one half of the zener voltage on the control inputs, pins 4,9 and 14, results in the balanced gain and flat repsonse condition. Typical spread on the zener voltage is ± 100 mV and this must be taken into account if control signals are used which are not referenced to the zener voltage. If this is the case, then they will need to be derived with similar accuracy.

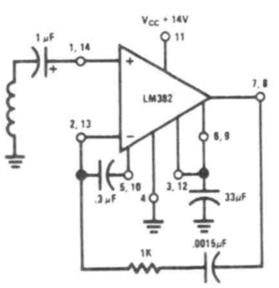
Loudness Compensation

A simple loudness compensation may be effected by applying a DC control voltage to pin 7. This operates on the tone control stages to produce an additional boost limited by the maximum boost defined by C_b and C_t. There is no loudness compensation when pin 7 is connected to pin 17. Pin 7 can be connected to pin 12 to give the loudness compensated volume characteristic as illustrated without the addition of further external components. (Tone settings for flat response. C_b and C_t as given in Application Circuit). Modification to the loudness characteristic is possible by changing the capacitors C_b and C_t for a different basic response or, by a resistor network between pins 7 and 12 for a different threshold and slope.

Signal Handling

The volume control function of the LM1035 is carried out in two stages, controlled by the DC voltage on pin 12, to improve signal handling capability and provide a reduction of output noise level at reduced gain. The first stage is before the tone control processing and provides an initial 15 dB of gain reduction so ensuring that the tone sections are not overdriven by large input levels when operating with a low volume setting. Any combination of tone and volume settings may be used provided the output level does not exceed 2 Vrms, V_{CC} = 12V (1 Vrms, V_{CC} = 8V). At reduced gain (< — 15 dB) the input stage will overload if the input level exceeds 2 Vrms, V_{CC} = 12V (1 Vrms, V_{CC} = 8V). As there is volume control on the input stages, the inputs may be operated with a lower overload margin than would otherwise be acceptable, allowing a possible improvement in signal to noise ratio.

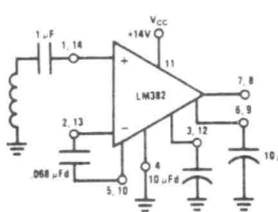
LM382 Low Noise Dual Preamplifier — National



Phono Preamp (RIAA Equalisation)

The LM382 is a dual preamplifier for the amplification of low level signals in applications requiring optimum noise performance. Each of the two amplifiers is completely independent, with individual internal power supply decoupler —regulator, providing 120 dB supply rejection and 60 dB channel separation. Other outstanding features include high gain (100 dB), and wide power bandwidth (75 kHz, 20 Vp-p). The LM382 operates from a single supply across the wide range of 9 to 40V.

A resistor matrix is provided on the chip to allow the user to select a variety of closed loop gain options and frequency response characteristics such as flat-band, NAB or RIAA equalization. The circuit is supplied in the 14 lead dual-in-line package.



Tape Preamp (NAB Equalisation)

LM1897 Low Noise Preamplifier for Tape Playback Systems — National

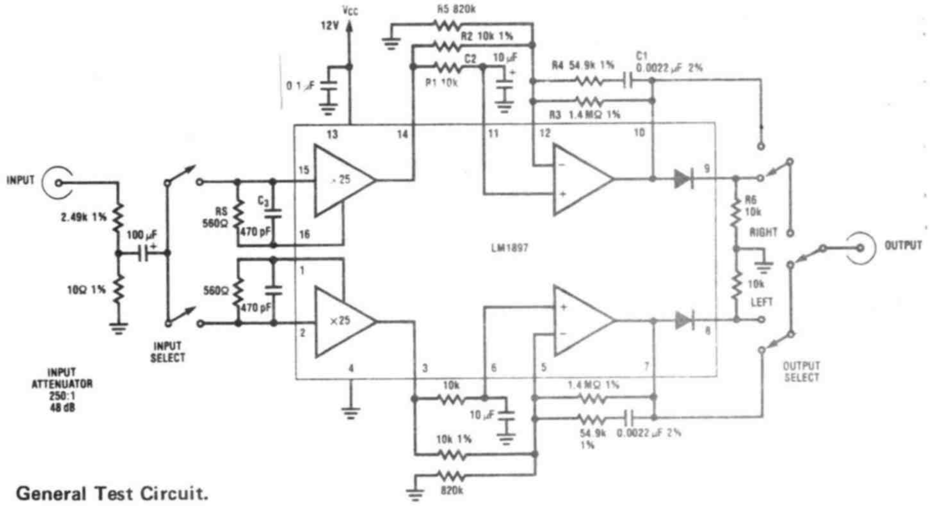
General Description

The LM1897 is a dual high gain preamplifier for applications requiring optimum noise performance. It is an ideal choice for a tape playback amplifier when a combination of low noise, high gain, good power supply rejection, and no power up transients are desired. The application also provides transient-free muting with a single pole grounding switch.

Basic Circuit Approach

The LM1897 IC incorporates a two stage broadband design which minimizes noise, attains overall DC stability and prevents audible transients during turn-on.

The first stage is a direct coupled amplifier with an internal gain of 25V/V (28 dB). Direct coupling to the tape head reduces input source impedance and external component cost by removing the input coupling capacitor. A typical input coupling capacitor of 1uF has a reactance of 1.5kΩ at 100 Hz. The resulting noise due to the amplifier's input noise current can dominate the noise voltage at the output of the playback system. The input of the amplifier is biased from a reference voltage that is temperature compensated to produce a quiescent DC voltage of 2.2V at the output of the first stage. The input stage bias current that flows through the tape head is kept below 2uA in order to prevent any erasure of tape moving past the head. An added advantage of DC biasing is the prevention of large current transients during the charging of coupling capacitors at turn-on and turn-off.

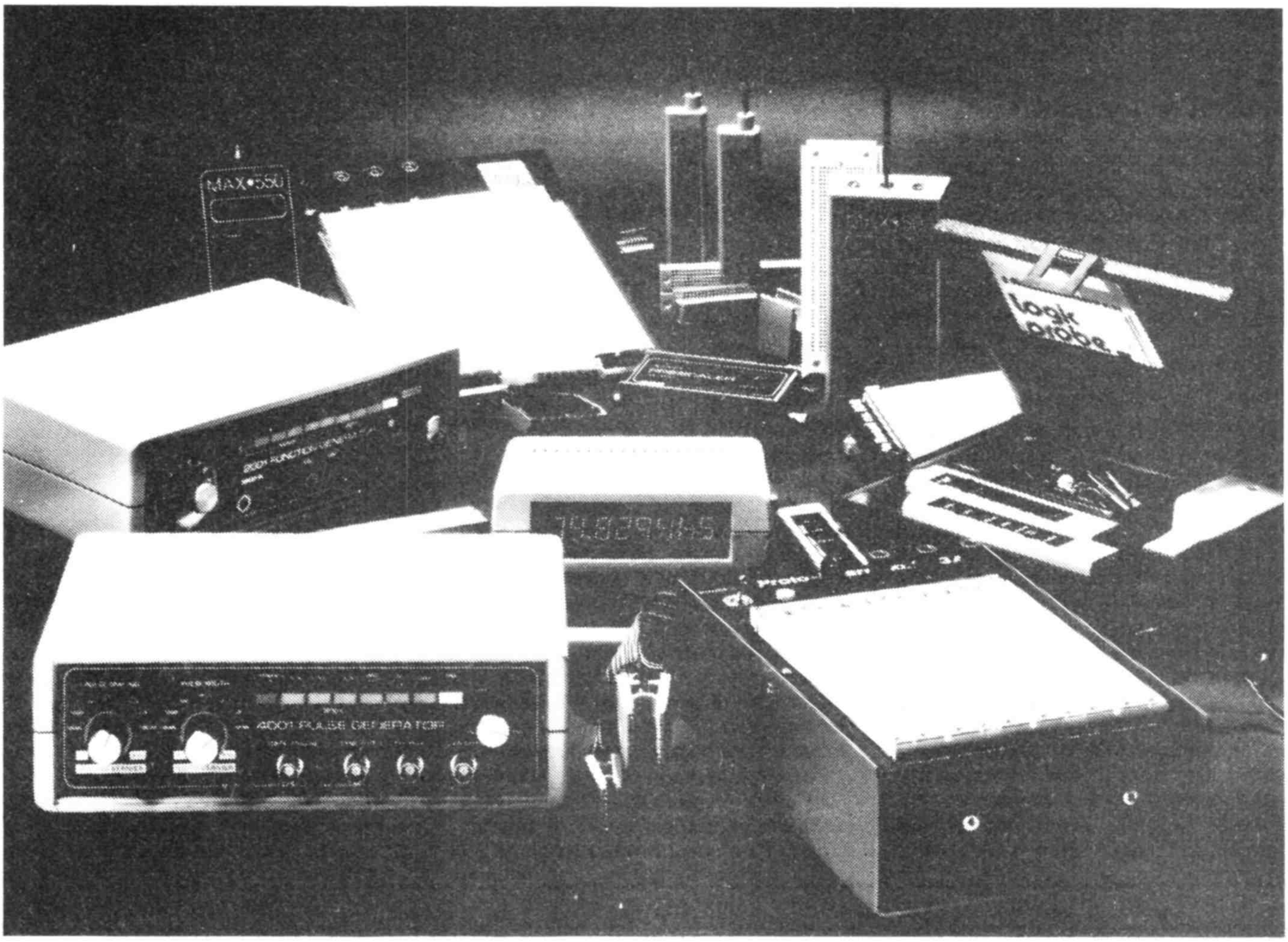


General Test Circuit.

The second stage provides additional gain and proper equalization while preventing audible turn-on transients or "pops". The output (Pin 10) is kept low until C2 charges through R1. When the voltage on C2 gets close to the DC voltage on Pin 14, the output rises exponentially to its final DC value. The result is a transient-free turn-on characteristic.

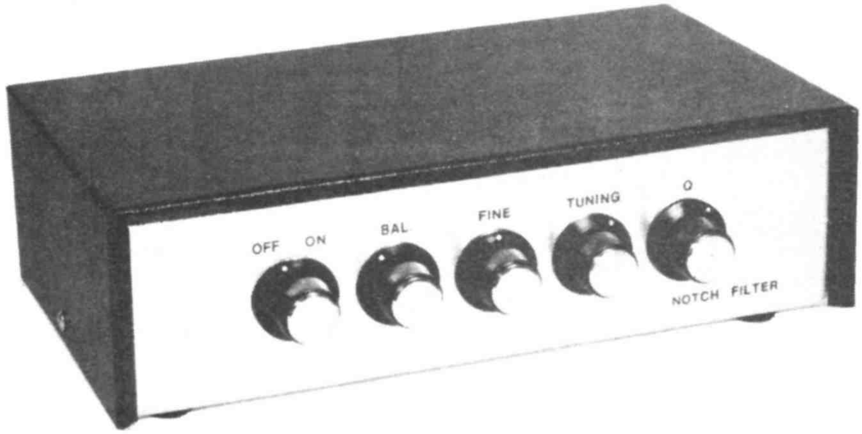
Internal diodes are provided to facilitate electronic diode switching popular in automotive applications.

The general test circuit illustrates the topography of the system. The components determining the overall frequency response are external due to the extreme sensitivity when matching a DIN equalization curve.


MAX•550
4001 PULSE GENERATOR
logic probe
Proto

NOTCH FILTER

A high performance filter, designed by N. V. Hastings, to enhance reception on the short wave bands.



WITH THE REDUCTION in the use of amplitude modulation on the short wave bands, interference due to heterodynes is probably less prevalent now than it was a few years ago. Even so, this type of interference can still present problems and a filter of some kind is a useful aid to the amateur. Many SW receivers are not fitted with a notch filter, but excellent results can be obtained using this audio add-on.

Our notch filter has excellent performance, is easy to use, and covers a frequency range of about 200Hz to 8kHz. The unit will drive most types of headphones or small loudspeakers, with an output of about 500mW RMS into 8 ohms.

Design

The standard configuration for a filter of this type is shown in ***Fig. 3***, where transistor 'Q' is used as a phase splitter. The dual ganged variable resistor (RVA) forms a Wien network in conjunction with CA and CB and, at a certain frequency, the phase shift through the two sections of this network will be identical. The signals are then out-of-phase and cancel out, so RVA is adjusted to balance the levels.

This arrangement can give excellent results in practice, but does have a couple of drawbacks. One is the need to carefully re-adjust RVA each time RVB (the tuning control) is adjusted, to maintain a reasonably high level of notch attenuation. The other is the relatively low Q value of the filter, resulting in a wide range of frequencies being significantly attenuated and a rather odd sounding audio output signal.

The notch filter consists of an input buffer stage, two phase shifters, giving unity gain, and another which varies with frequency from O°-360° (followed by a mixer stage). The phase shifted signals are mixed together and at a certain frequency the two signals will be out-of-phase.

The notch frequency is altered via variable resistors in the phase shifters' RC networks. With constant voltage gain in the shifters, the notch attenuation remains high over the full tuning range without having to readjust the balance control. By making the gain of the amplifier at the filters output variable, it is in fact the Q of the filter that is altered. This feature is very useful since the maximum Q of the circuit may not always be needed, and in some cases it might make the filter difficult to use (mainly where the tuning stability of the short wave receiver is not all one would wish). ***Fig. 1*** shows the response of the filter at minimum and maximum Q with a notch frequency of 1kHz.

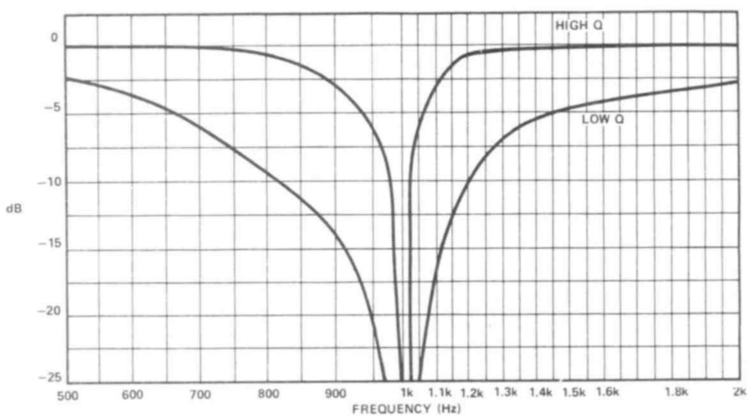


Figure 1: Frequency response of the filter with extreme values for Q (f_0 = 1kHz).

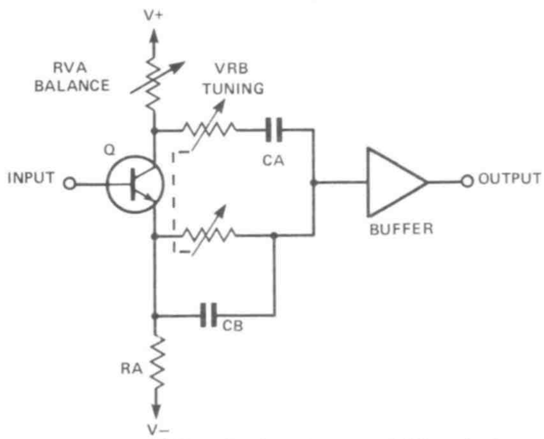


Figure 2: Circuit of an improved filter design.

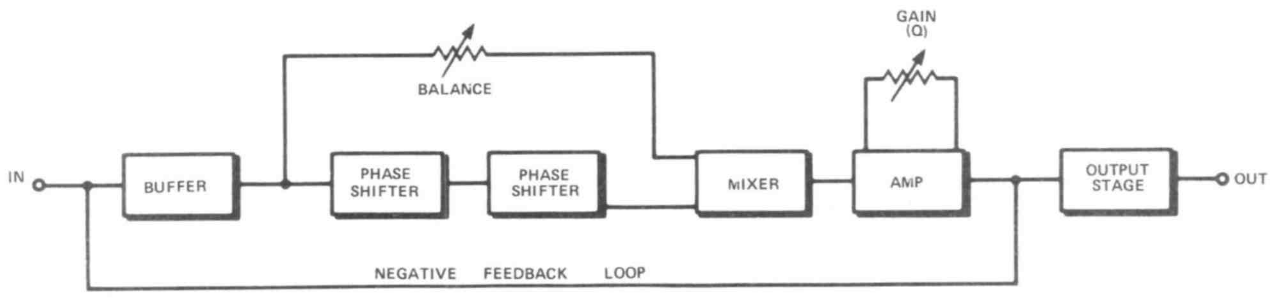
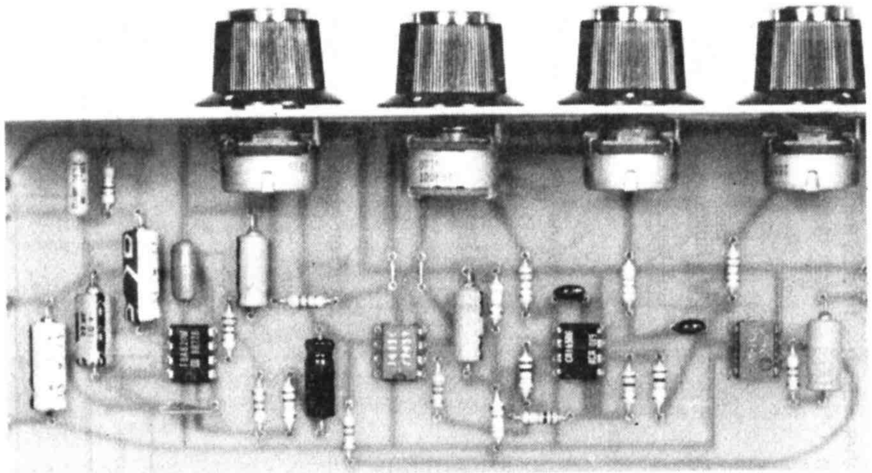


Figure 3: Block diagram of a typical notch filter.

▶



◀ **The filter board mounted inside the case.**

Circuit Description

The circuit diagram of the Notch Filter is shown in ***Fig. 4***. IC1 is a unity gain non-inverting amplifier and both sections of IC2 are used as op-amp phase shifters. RV2 is for tuning, and RV1 is the fine tuning control. The latter is necessary since RV2 covers a fairly wide frequency range.

IC3 is used as the mixer stage. It has a variable voltage gain so that a separate voltage amplifier stage is unnecessary. RV3 is the balance control, which is adjusted to optimise the notch attenuation. The voltage gain of IC3 is determined by a negative feedback network, consisting of RV4, R11 and R13. The gain varies from unity (RV4 at minimum resistance) to a little over 20dB, with R1 and R12 providing overall negative feedback to give unity voltage gain at pass frequencies.

An integrated output stage is used for the PA based on the TBA820M. The output stage does not *need* to provide any significant voltage gain, but discrete feedback resistor R16 produces an inherent gain of about 20dB. A lower level of gain tends to give poor stability, so an input attenuator (R14 and R15) is used to reduce the voltage gain to the required level.

SW1 is the on/off switch which also bypasses the unit in the 'off' position so that it is unnecessary to unplug the filter when it is not needed.

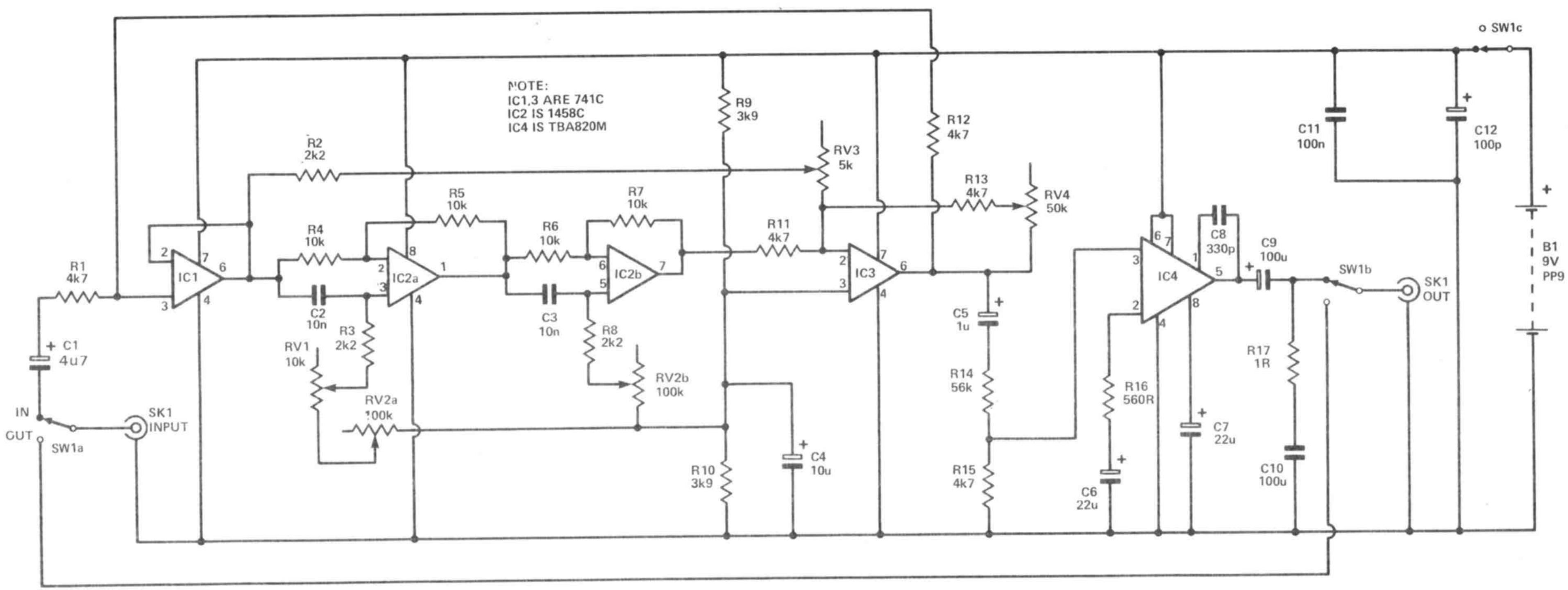


Figure 4: Circuit diagram of the Notch Filter

Construction

All the components fit onto the PCB, except SW1, the two sockets and the battery. ***Fig. 5*** provides details of component orientation and the limited amount of hard-wiring. SW1 is a 3 pole 4 way rotary switch, having an adjustable end stop set for two-way operation.

A large instrument case was used for the prototype filter, but virtually any size will do. Note that the four potentiometers require 7mm diameter mounting holes rather than the more common 10mm size. The printed circuit board is mounted in the case via the potentiometers *only*, although there *are* spaces on the board where fixing bolts could be added.

PARTS LIST

Resistors	
R1,11,12,13,15	4k7
R2,3,8	2k2
R4,5,6,7	10k
R9,10	3k9
R14	56k
R16	560R
R17	1R
Potentiometers	
RV1	10k lin pcm
RV2	100k dual-gang lin pcm
RV3	5k lin pcm
RV4	50k lin pcm
Capacitors	
C1	4u7 50V axial
C2,3	10n mylar
C4	10u 16V axial
C5	1u 50V axial
C6,7	22u 16V axial
C8	330p ceramic
C9,12	100u 16V axial
C10,11	100n polyester
Semiconductors	
IC1,3	741C
IC2	LM1458N
IC4	TBA820M
Miscellaneous	
SW1	4 way 3 pole rotary
B1	9 volt PP9
SK1,2	6.35mm insulated jack socket

PCB, knobs, PP9 connectors, case, connecting lead, pins, wire etc.

Setting Up

The headphone or speaker output of the receiver is coupled to SK1 via a standard jack lead. Start with RV1, RV2 and RV3 at roughly mid-way, and RV4 adjusted almost fully anticlockwise. If the receiver is tuned to an ordinary AM transmission, with the BFO switched on, it should be possible to obtain a heterodyne in the region of 1kHz, and to severely attenuate this by adjusting RV2. By adjusting RV3 and RV1 in turn it should be possible to gradually increase the attenuation until the heterodyne is completely eliminated. If the receiver controls are then adjusted to produce different heterodyne frequencies, it will still be possible, by adjusting RV1 and 2, to obtain a high attenuation.

Varying the frequency of the filter using RV2 will produce clearly audible changes in the audio quality but, if RV4 is advanced, the response of the filter can be further improved. Care is needed though, since with RV4 well advanced the notch becomes so narrow that adjustment of the other three potentiometers is tricky. It is then advisable to back-off RV4 slightly, adjust RV2 to null the interfering signal and advance RV4 to make any final adjustments.

Finally, the unit can double as a way of reducing adjacent channel interference during CW or SSB reception. Here, RV4 is backed-off fully to give minimum Q, and the two tuning controls are adjusted to set the operating frequency of the filter almost at maximum. The result is severe attenuation of signals between 3 and 8kHz.

■ R&EW

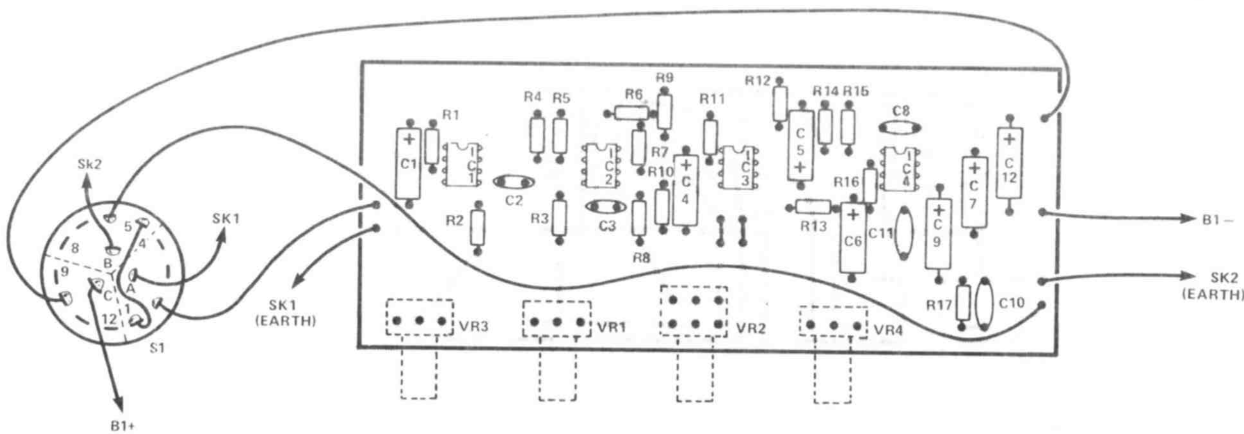


Figure 5: Wiring up the filter board.

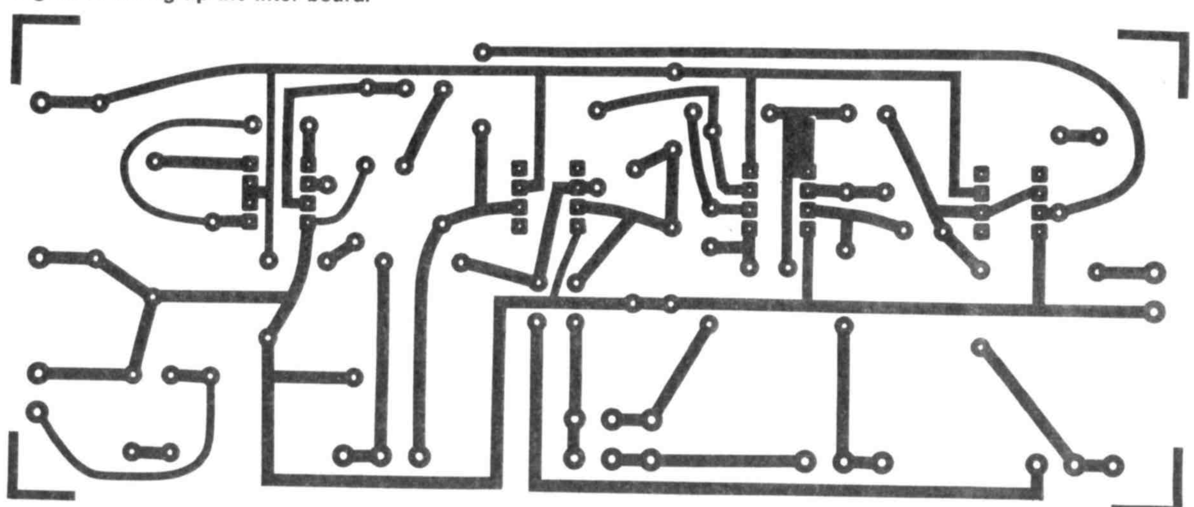


Figure 6: The PCB foil pattern for the Notch Filter.

TELEPHONES EXPLAINED

Stephen C. Taylor BSc AMIEE reveals a little of the much maligned, but essential public telephone network.

The global telephone network has been accurately described as the most complex machine ever made. It is also by far the largest and most expensive. Now, if we are to believe some soothsayers, it is about to become redundant and be swept aside by interactive wideband co-axial cable systems, optical fibres and suchlike.

However, with its 100 years in the making, laying, maintaining and continual updating and with the unparaleled investment in the house-by-house and street-by-street conductor network it must be many years, perhaps a couple of decades, before the technologically advanced wideband systems can achieve comparable market penetration.

Hence, while the digital systems gradually replace or overlay the existing solid copper network to bring hosts of new facilities, in order to meet this decade's needs for universal data exchange between domestic and business users we shall have to rely on Buzby's perch ... or as it is more correctly called — the **Public Switched Telephone Network** (or PSTN).

First the Telephone Line...

To the average user the telephone line is something expensive to trip over in the hallway, speak to a customer on or summon assistance with.

To the average telephone engineer it is a fault-prone, DC to 10kHz, 600 ohm balanced 2-wire transmission line.

To the computer cognoscenti it is often a mystery, of which it is rumoured that even *thinking* about sending data down it is to be breaking the law.

The PSTN is designed mainly for duplex speech communication using telephones incorporaing a carbon microphone, an earphone, a dialling mechanism and a calling device (usually an AC bell). ***Fig. 1*** shows these basic elements developed from the simplest concept to a practical technique.

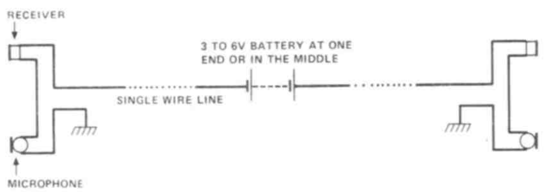


Figure 1(a): Simple series circuit. This is the simplest speech transmission arrangement. The transmission line is unbalanced and therefore prone to interference, crosstalk, 50Hz hum pick-up and earth potential differences.

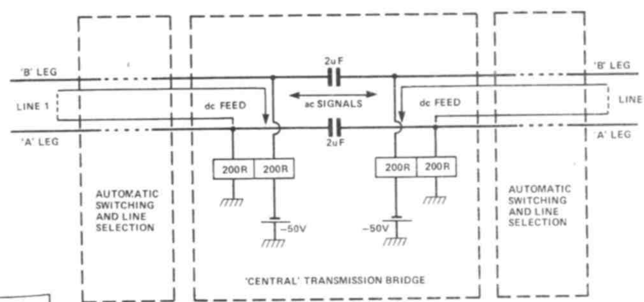


Figure 1(c): The standard form of the transmission 'bridge' uses relays for the inductors. Each relay has two windings so as to maintain AC balance and the two telephone lines are separated by capacitors so that the relays can monitor each line separately.

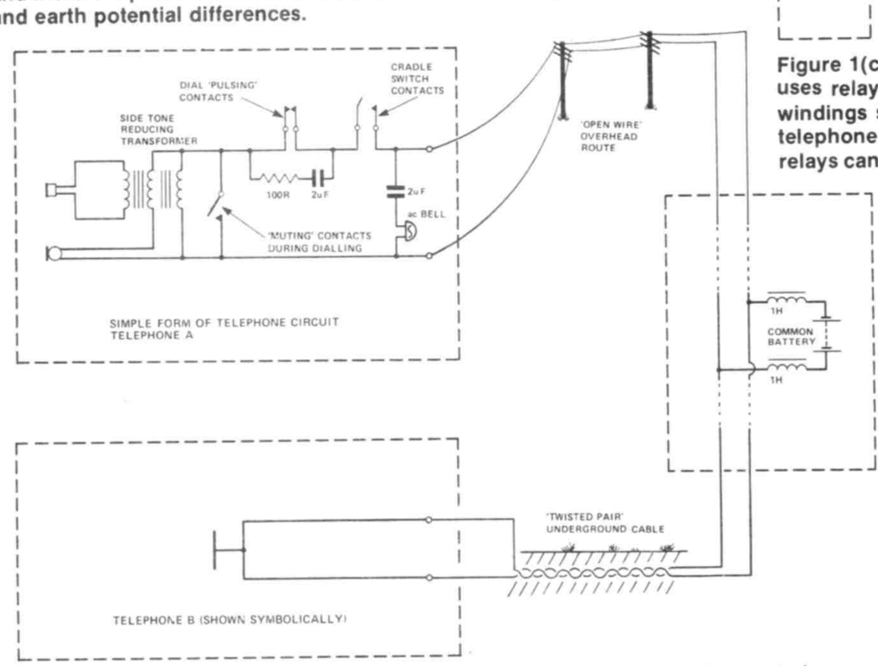


Figure 1(b): A more practical arrangement for energising the lines from the central telephone exchange.

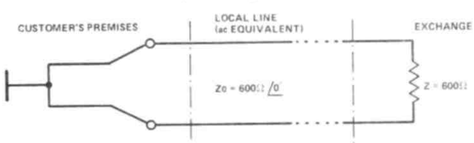


Figure 1(d): For frequencies between 300Hz and 3400Hz the 2- wire telephone line 'looks alike' a terminated 600 ohm balanced pair.

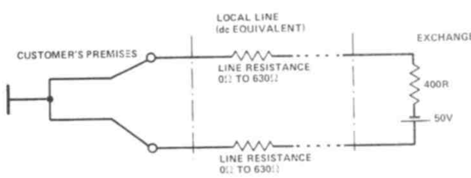


Figure 1(e): For DC the same line looks like a 50 volt DC source having an internal resistance of between 400 ohms and 1660 ohms depending on the length of the line.

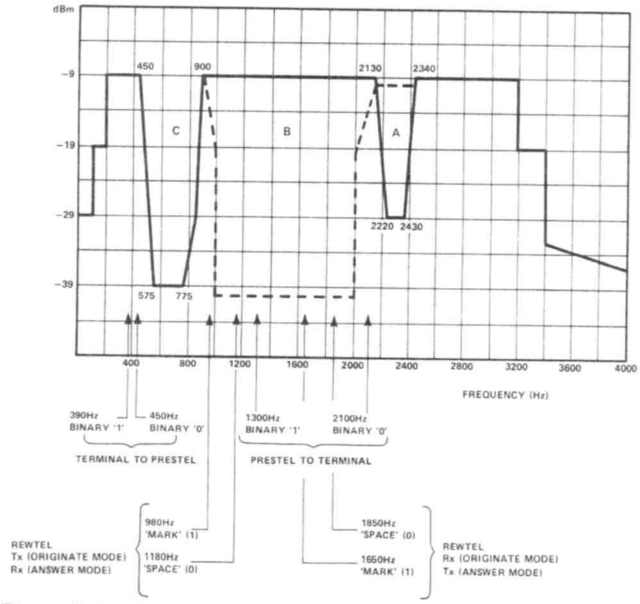


Figure 2: Maximum one-minute-mean power levels of individual spectral components of the output signal from apparatus connected to the PSTN.
Signals are permitted in Area A only if accompanied by signals in Area B at a power level not lower than 12dB below the power level of the signal in Area A.
Signals are permitted in Area C provided that there is no false operation of trunk signalling equipment.

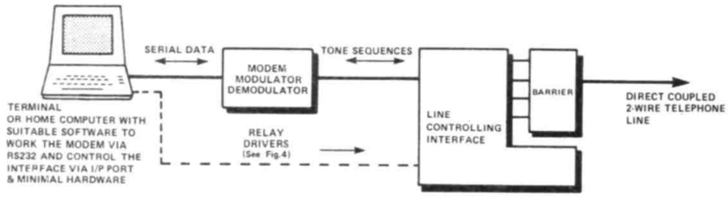


Figure 3(a): Disposition of the Modem, Interface and Barrier. The Barrier section is essential for direct ('hard-wired') connections.

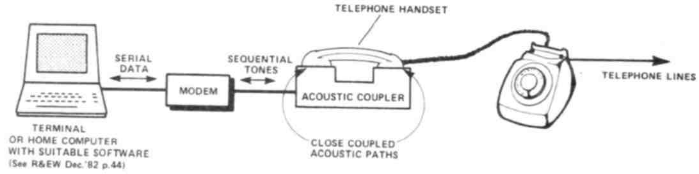


Figure 3(b): When an acoustic coupler is employed the call is set up under 'user control'. There is then no need for the line controlling Interface section, with relay control lines. A good reliable acoustic link is essential to reduce the problems of extraneous room noise and spontaneous variations in the overall channel attenuation.

The 2-wire line must carry:-

a) speech signals to and from the telephone

b) line status signals (phone up — phone down)

c) a few milliamps of microphone energising current

d) dialling information

e) ringing current to ring the bell.

Taking each of these line conditions separately:-

a) The speech signals from the microphone are passed to line via a transformer so as to reduce the sound level in the earphone compared with incoming signals. The incoming signals from the line to the earphone are not attenuated in this way. This low level of feedback makes the line sound 'live'. Too much feedback causes the user to speak more quietly. The simple all-in-series circuit shown in ***Figs. 1(a)*** and ***1(b)*** result in the user whispering to avoid deafening himself.

b) Line status is detected at the telephone exchange by a relay (***Fig. 1(c)***) which operates to the line current. This line current flows only when the handset is lifted, thereby connecting the telephone across the line.

c) The line current (DC) flows through the carbon microphone and is modulated by the speech. Thus the DC component is carrying the signalling information and the AC component is carrying the speech information.

d) From the earliest Strowger days, dialling has been effected by rapidly interrupting (ie 'pulsing') the line current at 10 pulses per second (pps), with a 'break' period of 67ms and a 'make' period of 33ms. The unequal ratio of make and break is to allow for the fact that relays take longer to release than to operate. The relay logic at the telephone exchange can distinguish between, (1) the continuous looped line indicating the off-hook or 'calling' condition, (2) the 10pps dial pulses, (3) the Inter Digit Pause (IDP) between each number dialled and (4) the 'open circuit' line, indicating that it is not in use.

e) Ring current is fed to line from the exchange (if there is no DC line current showing that the line is free). It is derived from a 75 volt 25Hz (and sometimes 16Hz) source. The capacitor in series with the bell prevents the bell 'looping' the line for DC.

Within the so-called 'commercial speech' band of 300Hz to 3.4kHz the telephone line 'looks' like a 2-wire 600 ohm balanced transmission line (***Fig. 1(d)***). At DC the line looks like a 50 volt source with an internal resistance of between 400 ohms and 1660 ohms (***Fig. 1(e)***).

...Then the Exchange

Deeper into the telephone exchange and beyond that the inter-exchange network, things get really complicated with DC, AC and digital **signalling** and with both digital and analogue speech transmission depending on the route, the distance and the traffic density. But for our present purposes we only need to note that this complex network includes: (a) **AC signalling** using single and multiple tones to convey call-status, number dialled, answering conditions etc, and (b) **analogue** signal amplifiers and frequency translation techniques to 'stack' the speech channels (frequency division multiplex) over the long-haul routes.

Some System Subtleties...

1. By applying AGC to the speech signals the transmission equipment can maintain optimum signal-to-noise ratios.

2. By monitoring the SPREAD of frequencies in the typical speech waveform the AC signalling systems can avoid false triggering to the individual harmonics in the speech transmissions.

Hence a loud, sustained, single tone can cause problems such as overload distortion, adjacent channel interference in the FDM systems and false cleardown signals in the AC signalling equipment.

Much of the inland trunk network uses frequencies in the 450 to 900Hz and 2130 to 2430Hz bands. ***Fig 2*** shows the 'forbidden' bands for 'single tone' transmissions.

The PRESTEL signalling frequencies (CCITT V23 Mode A2) are shown in ***Table 1***:-

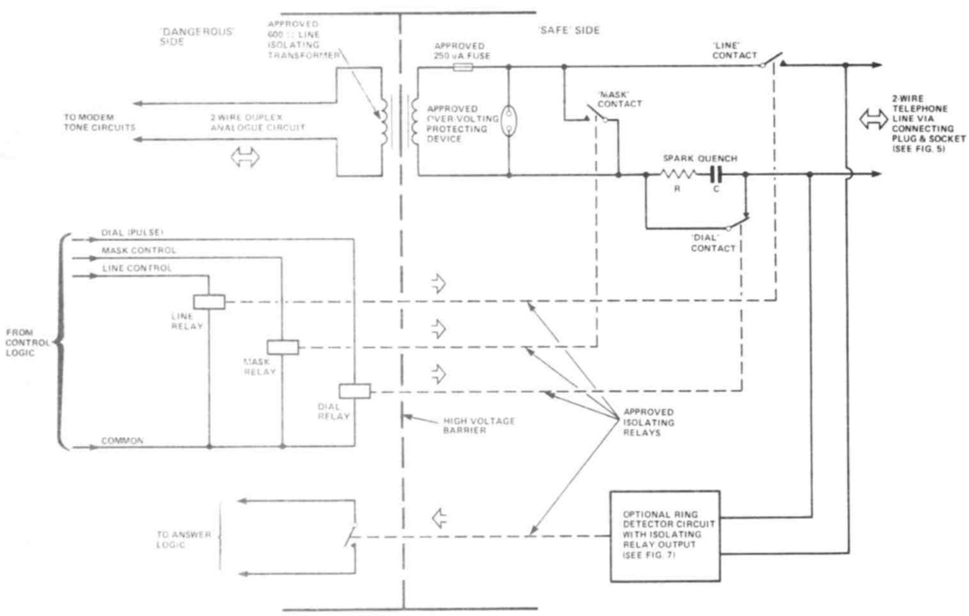


Figure 4(a): A typical Interface circuit showing the relay control of the telephone line.

The PRESTEL signalling frequencies are:-

For terminals to Prestel,

Binary 0... 450 Hz +/- 5 Hz
Binary 1... 390 Hz +/- 5 Hz

at a data rate of 75 bits per sec.

For Prestel to terminals,

Binary 0... 2100 Hz +/- 16 Hz
Binary 1... 1300 Hz +/- 16 Hz

at a data rate of 1200 bits per sec.

The REWTEL (and other computer link) signalling frequencies (CCITT V21) are:-

For "originating" end,

Mark... 980 Hz
Space... 1180 Hz

For "answering" end,

Mark... 1650 Hz
Space... 1850 Hz

both at a data rate of 300 Baud (ie, 300 bits per sec.)

Modems using these V21 frequencies were originally designed for 200 bps operation, but with the wider use of al-electronic terminals in place of the early electromechanical teeprinter-based terminals the modem filter bandwidths were widened during the mid-seventies to allow operation at 300 bps, albeit with reduced noise immunity.

...and Safety

Acknowledging that the first and major use of the PSTN is for telephone traffic, BT, not unnaturally, don't take kindly to anything which disrupts the correct functioning of the system for telephone traffic. Furthermore if the local gourmet telephones the neighbourhood Take-Away and gets only a strange computer-garble, or What's On in New York in Puerto-Rican or a single ear-splitting bang then there are (at least) **three** unhappy parties.

But most of all, if anyone connects mains operated equipment to the low voltage telephone line the consequencies of leakage currents to the telephone engineer, possibly working up to his ankles in water in a flooded footway box, or 30 ft up a rain soaked telephone pole, just don't bear thinking about.

So BT's philosophy on non-telephonic use of their network is very concerned with electrical safety and with maintaining the integrity of the whole network for the majority of (telephone) customers.

Modems, Barriers and Interfaces

Since the PSTN can carry only AC signals from customer to customer then clearly you can't connect your digital 40-way parallel bus, or even your serial RS232 directly to a 2-wire telephone line.

Modems...

The subject of Modems (MODulators-DEModulators) has been dealt with in an article in the February '83 issue of R&EW so for our purposes we need only consider the modem as being a means for converting the outgoing serial digital data into a stream of analogue tones which can be accommodated by the PSTN and for converting an incoming compatible stream of tones into serial data.

The modem generally includes:

1) a **barrier** circuit to ensure adequate electrical isolation between the data source (typically a terminal with a VDU) and the telephone line,

2) signalling **interface** circuitry to seize and hold the telephone line, and to dial to and respond to calls from, the line,

3) tone-to-data and data-to-tone **conversion circuits**.

If the barrier, interface and modem

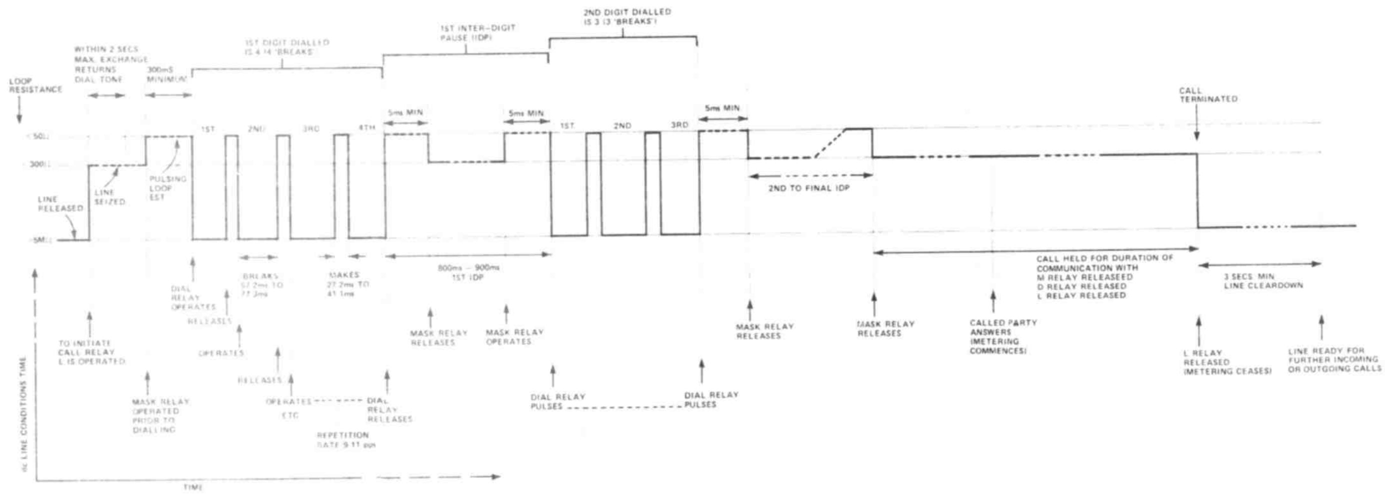


Figure 4(b): Timing sequence for the setting up and cleardown of a call. The relays control only the DC conditions on the line. These conditions must be correctly set up in order to maintain the analogue signal path.

circuits were entirely separate blocks they would be arranged as shown in ***Fig. 3(a)***.

...Barriers...

The barrier is a 2-wire to 2-wire safety 'block'. One way to meet the stringent safety requirements is to use an approved acoustic coupler. This makes the control of the telephone line simple and straightforward.

The call is first set up using an ordinary telephone, then on receipt of the answering tone from the distant terminal, the telephone handset is placed on to the acoustic coupler to complete the analogue signal path to allow the exchange of data.

The sequence of data exchange between the two terminals (i.e. the 'protocol') is determined and controlled by the terminals, the modem being simply a 'non intelligent' link in the communication chain.

Compared with 'hard wired' methods, acoustic couplers (see ***Fig 3(b)***) have some useful advantages.

(1) A portable (or transportable) data terminal can be used at *any* telephone location.

(2) The call is set up and held via the telephone instrument thus avoiding the need for line hold circuitry, busy tone detectors and timer circuitry within the modem. Their disadvantages are that they are generally inefficient, unreliable, noisy and susceptible to any room noise.

...and Interfaces

To correctly interface with the 2-wire line the 'intelligent' terminal needs to control the DC conditions on the line whlst transmitting and receiving the analogue signals (tones). This is most easily achieved using relays and ***Fig. 4*** shows a typical arrangement where three relays and a line transformer simulate the action of parts of a standard telephone instrument, to allow call initiation, dialling, transmission and reception of tones and finally call cleardown.

If an appropriate line transformer and relay types are used, sufficient isolation can be achieved between the modem and the telephone line that the interface can be considered to have an inherent barrier function.

Operation

Referring to ***Fig. 4***, to 'seize' the line, relay (L) must be operated. This places a DC loop onto the line via the transformer winding. The telephone exchange responds by returning dialling tone. The sequence of relay operations produces a form of serial information, hence the timing, shown in *Fig. 4(b)*, is important.

Since the dial pulses must consist of 'breaks' in a short-circuit condition, the masking relay (M) must first be operated. Dialling can then proceed by pulsing the dial relay (D) with the number of 'breaks' representing the digit dialled (1 break = "1", 2 "breaks" = "2", etc. But 10 breaks = "0"!). There is an 800ms pause between each digit. During the pause period the masking relay is released to allow the tone detecting circuits to monitor the line and 'listen' for 'busy", 'number unobtainable' or premature ringing tone. When the last digit has been dialled only the line relay (L) remains operated, to 'hold' the call via the transformer winding. The call is terminated by releasing relay L.

It is worth noting here that the standard BT push button telephones all use digital circuits to convert the keyed-in numbers into Strowger pulse trains which are sent to line as though they were generated by a rotary dial. We do not yet have the American style 'tone dialling' phones.

The enormous cost of installing all the exchange equipment which would be required would be wasted so long as the bulk of the PSTN is based on 10 pps Strowger digital signalling however it will become both practical and economic to go for the full advantages of push-button dialling.

Meanwhile we can use the time saved by rapidly punching out our numbers to appreciate the benefits of LSI silicon technology which have relieved us of the tedium of waiting for the dial to unwind.

But back to the important operational functions of the interface which are:-

1) to provide isolated AC coupling between the tone detecting/generating circuits and the balanced 2-wire line and,

2) to provide correctly sequenced and isolated dc control of the line.

Strictly speaking, the interface function includes all the driving hardware and controlling software 'behind' the transformer and relays.

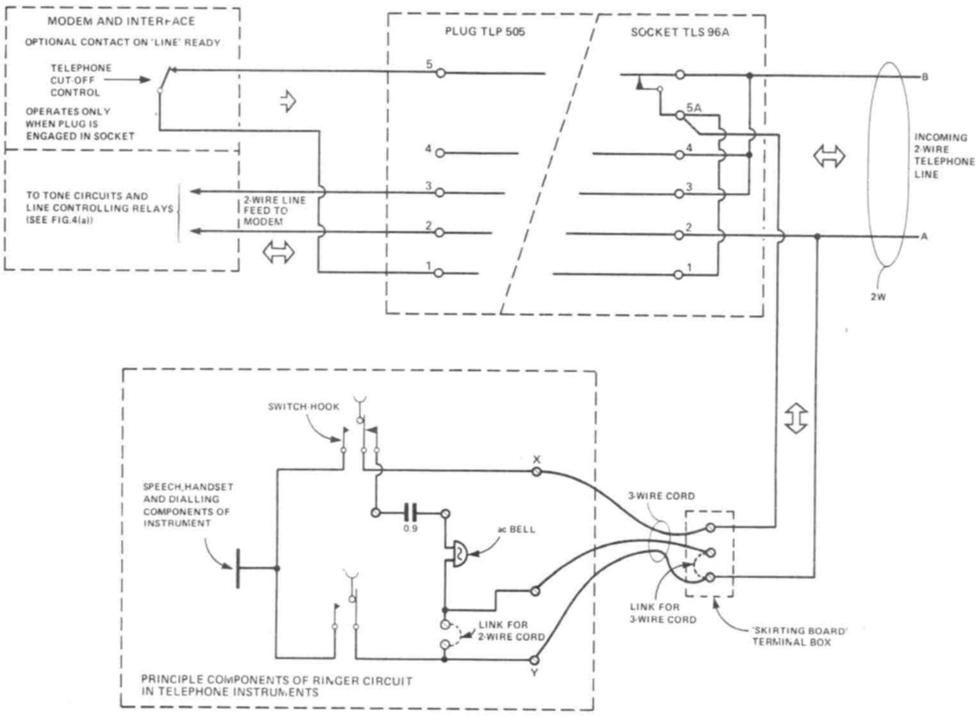


Figure 5: Circuit diagram of the ringer in a typical telephone instrument.

Connection to the Line

For Prestel connections BT will install a 'Jack 96A' in the customer's premises for connecting the approved equipment (which must be fitted with a 'Plug 505') to the telephone line. This is a 5-way plug and socket connection, the wiring of which is shown in ***Fig. 5***. Equivalent plugs and sockets are available as 'TLP 505' and 'TLS 96A' from commercial sources. This form of connection would also be suitable for other connections to the line, although BT have their own approved plug and socket arrangement for multiple outletting. The purpose of the 'break' contact in the socket is to isolate the normal telephone instrument from it's direct connection to the line during 'modem' operation. It is then possible to have the telephone instrument connection under the control of the terminal, via the interface.

If the modem is not designed for 'autodial' operation it need not be equipped with the line controlling relays. It must however still have the isolating line transformer, fuse and voltage dependent protection device(s). With this scheme it would be perfectly practical to first set up the telephone link and then plug in the modem when either: ▶

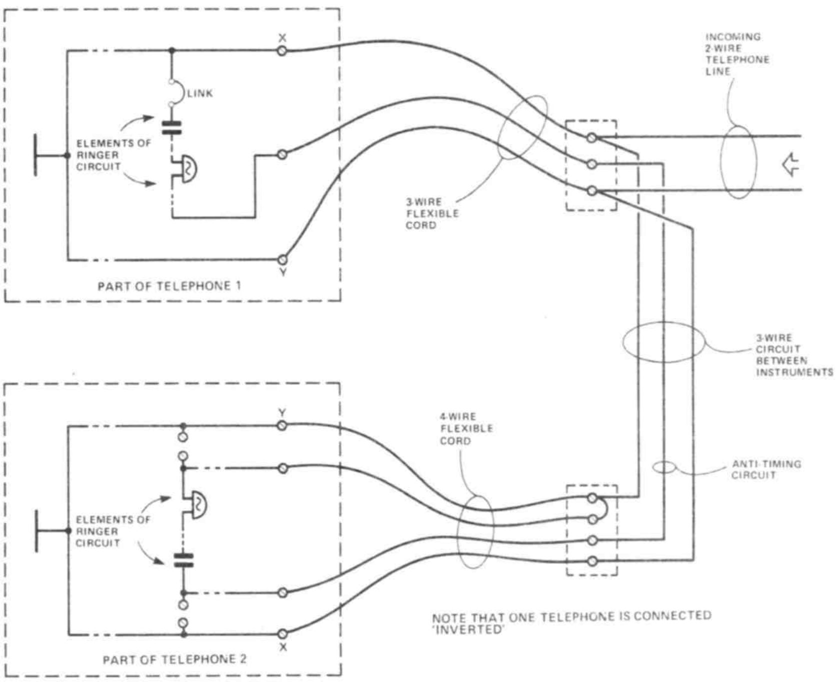


Figure 6: Typical wiring plan for telephone extensions. The 3rd wire (sometimes called 'the shunt wire') forms part of the sometimes quaintly termed 'anti-tinkle' circuit.

a) the answering tone is heard in the 'phone from the distant data centre eg REWTEL or,

b)the 'called' person (who must of course have a modem and some means of receiving/sending data) plugs in a modem at the distant end.

Although *practical*, it is nevertheless *contrary to BT regulations* unless the equipment is type-approved and meets the requirements laid down in BT's Technical Guides No. 26, 30 and other relevant documents.

Extensions

For other connections to the telephone line, including the addition of extension telephones, answering machines and suchlike the usual cause of practical problems is 'bell tinkle' on one telephone while dialling on another. And the usual cause of confusion is the 3- or 4-wire telephone instrument cords (see ***Fig. 5***) and their connection to the 2-wire telephone line. ***Fig. 6*** shows the principle of connecting extensions, the object of which is to disconnect the bell circuits no matter which telephone handset is lifted.

Ringing Detectors

Figure 7 (a) shows an arrangement for detecting the incoming 'ringing current' which normally rings the ac bell. The rectified current is used to operate the safety isolating relay which in turn can be used to initiate the necessary sequence to operate the Line relay. As with an outgoing call this places a DC 'loop' across the line (via the line trans former winding), which 'trips' the ringing supply at the exchange and causes the telephone link to be set up from end to end. The transformer not only provides the DC 'holding' path, it also extends the analogue path to the modem tone circuitry.

If the ringing detector were to be placed directly across the line it would be necessary to ensure that during the normal course of a call, while speaking (or transmitting tones) or during dialling, the detector circuit could not cause shunting problems on the signal path. And of course it is essential to ensure that any circuitry which is connected to the line follows the principle of maintaining the full isolation between the BT 'safe' side (the telephone lines) and the potentially dangerous side. After all, any equipment which includes a CRT with multi-kV of EHT is literally potentially lethal!

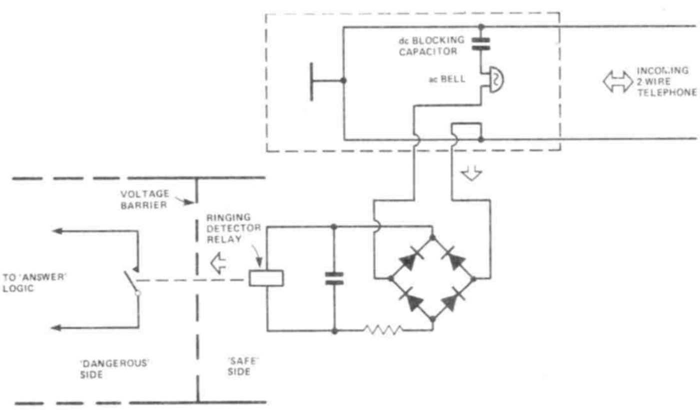


Figure 7(a): Ringing detector circuit. The relay operates to the rectified ringing current. The relay contact can then be used to initiate the automatic all answering sequence.

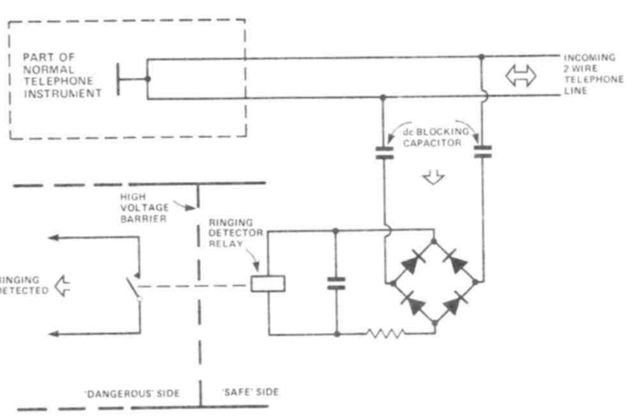


Figure 7(b): If a ringing detector circuit is used, it must not 'bridge' the safety barrier.

Perspective

My old school motto 'Respice Prospice" (Look backward — Look forward), when applied to technological progress, highlights the difficulties and dangers of communications forecasting.

A Look Backward...

A market study ad forecast carried out twelve years ago for the then British Post Office (now BT), categorised those people who would generate data 'traffic' into five groups. Of these, the largest by far was the 'incidental data-collection or enquiry activity ... using a very simple terminal ... existing in large numbers ... but originating or receiving only very small volumes of traffic". Considering that this concept predates the explosive development and growth of the 'home computer' it is a surprisingly accurate definition of today's situation, even though the study was referring only to business telephones!

...And A Look Forward

It will be interesting to see how accurate will be their 1971 forecast of the number of these 'slow-speed (REWTEL & PRESTEL type) originators and receivers of data'. Their forecast figure for December 1983 is only 316,000 with a total for ALL types of terminal (including airlines, banks, computer bureauz, PRESTEL and all the Forum 80s, REWTELS etc.) of only 434,000!

Close Up ...

In the conclusion to an extremely detailed article on Data Communication in the Post Office Electrical Engineers Journal, several points were listed as 'indicated objectives'. Among these points were:-

1)"...develop, adapt and improve the (BT) Datel services up to the limits of the telephone system" and

2)"to provide interim switched ... network facilities for urgently needed services outside the capability of Datel..."

Point 1) above has perhaps been overtaken by technical developments in that the much heralded cables and the much hoped-for optical fibres may make it unnecessary for BT to overload te PSTN with high speed, high density Datel traffic.

Point 2) above has been given a new twist by the "liberalisation" of the telecommunications services. The cost of the professional standards of the Datel services are far beyond the means of ordinary domestic users. However private telephone connections of very low cost modems built to CCITT Recommendations V21 for 300 bits per second (and sometimes acoustically coupled, as in last months **R&EW**) and to V23 Mode A2 for 1200 bps, can provide exactly the service envisaged by both the forecast and article referred to above.

... and Close Down

Which brings us back to the main point of this article.

That is, given an understanding of its basic operation and its limitations, for both the professional users with terminals and the hobbyists with home computers, all of whom wish to communicate economically *today*, with many different people and places, on an ad hoc basis ... there's a lot of useful mileage in telephone cables.

■ R&EW

Mr. Taylor is a freelance communications consultant based in Nickhambrosk, Newmarket, Suffolk.

R&EW Data Brief

A precision rectifier for DC voltmeters

The bargraph display, featured in Data Brief 1, indicates the potential between input and negative rail. However, should an AC signal be fed to the input, negative peaks are clipped and therefore do not register — some kind of rectification is necessary to accommodate both voltage swings in the signal.

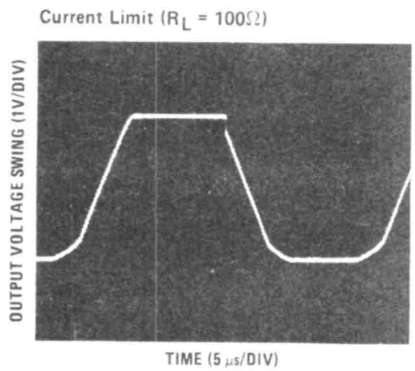
The input impedance of the display driver IC is very high, which means there is a chance of full scale deflections without an input. In order to avoid this, a 56k resistor pulls down the input, followed by a buffer to raise the impedance again. IC1a is configured as a voltage follower with unity gain, to act as this buffer.

IC1b is a precision rectifier (D1 and D2 forming the feedback loop), with IC2b summing the output signals and completing the full wave rectification.

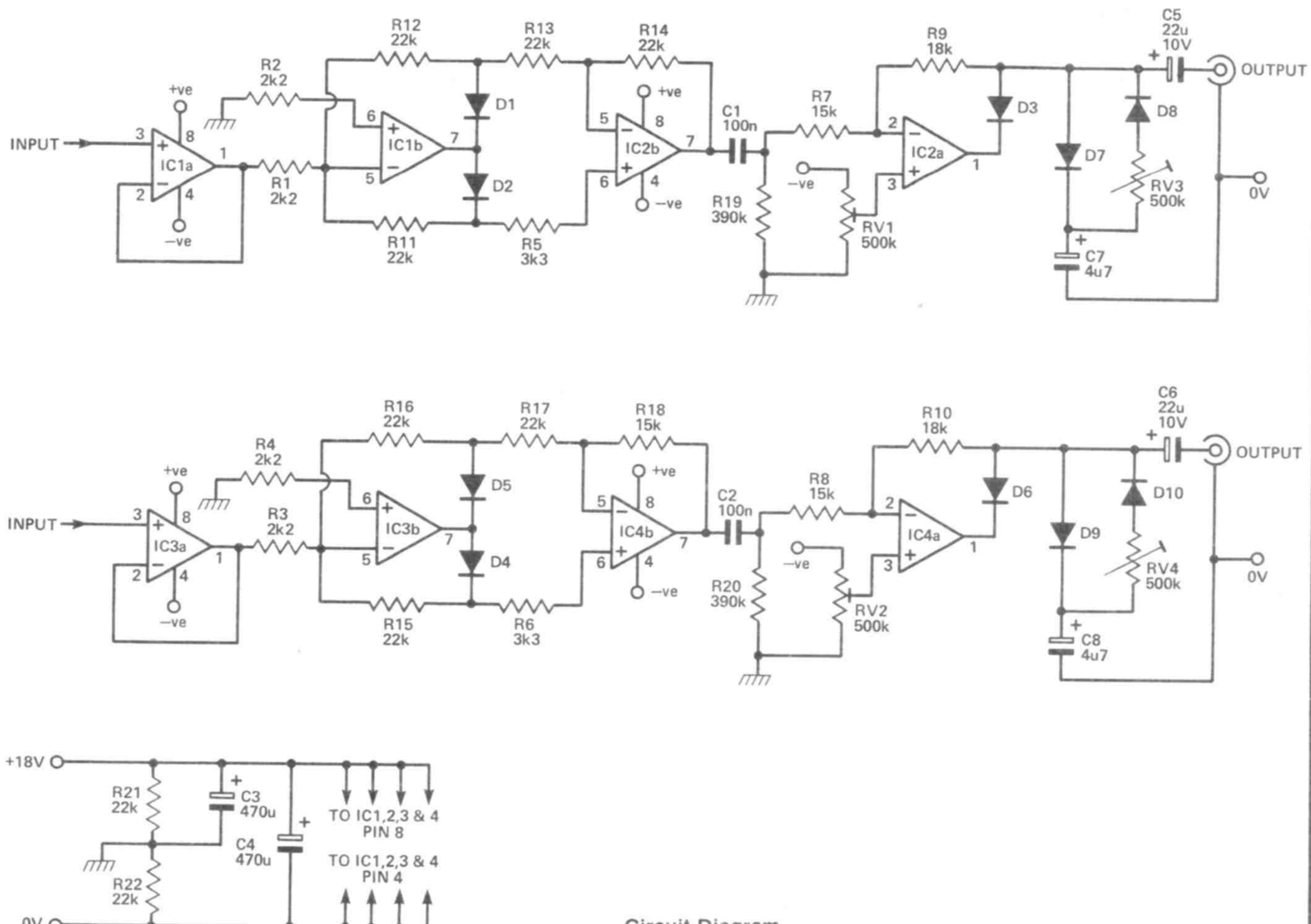
To avoid the signal being displayed summed with half the supply, either V_{DD} has to be doubled and the negative rail of the bargraph connected to a virtual earth or the signal level has to be lowered. The first is easiest but unsatisfactory because of variations in the current drawn by the LEDs. Hence, the spare op-amp (IC2a) is configured as a level shifter or DC restorer.

Since FSD on the bargraph is around three volts, it does not matter that the signal level will be restricted to a maximum of $V_{DD}/2$. With no input, C1 charges to the level of the non-inverting input pin 3. When the input goes positive, D3 is turned on and C1 discharges. When D3 turns off again, C1 remains in a lower state of charge until a negative peak comes along.

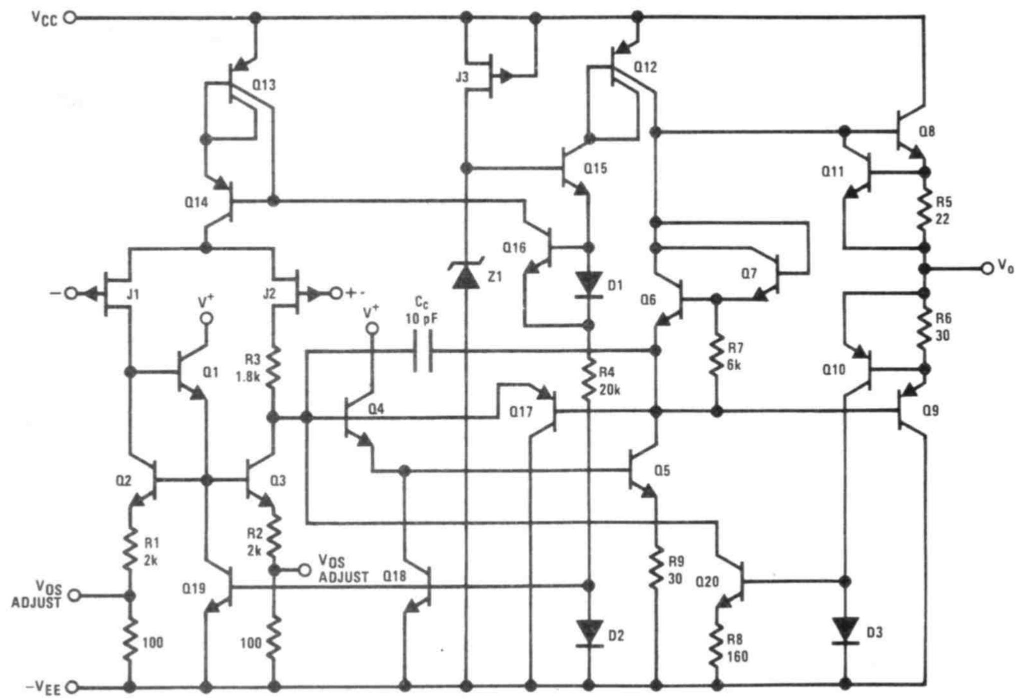
To set RV1, connect the display unit and turn RV1 fully clockwise and RV3 fully anticlockwise. Then rotate RV1 until the display just responds to the signal. Damping is provided by D7 charging C7 and discharging via D8 and RV3.



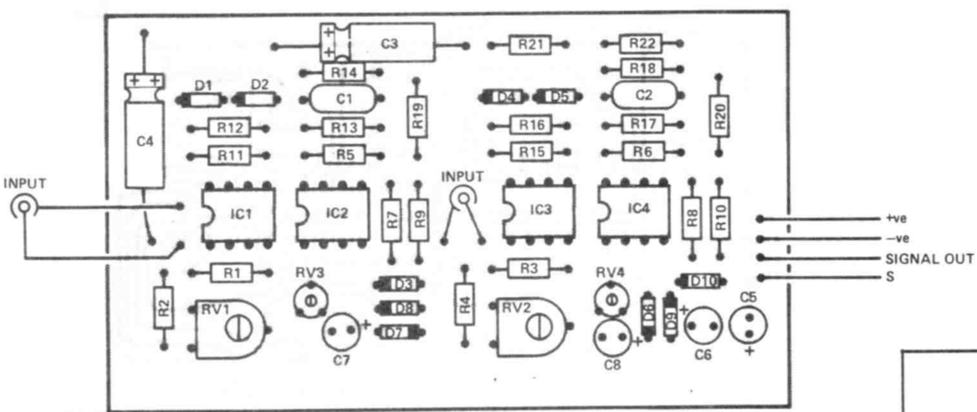
Pulse Response of the Op Amp.



Circuit Diagram.

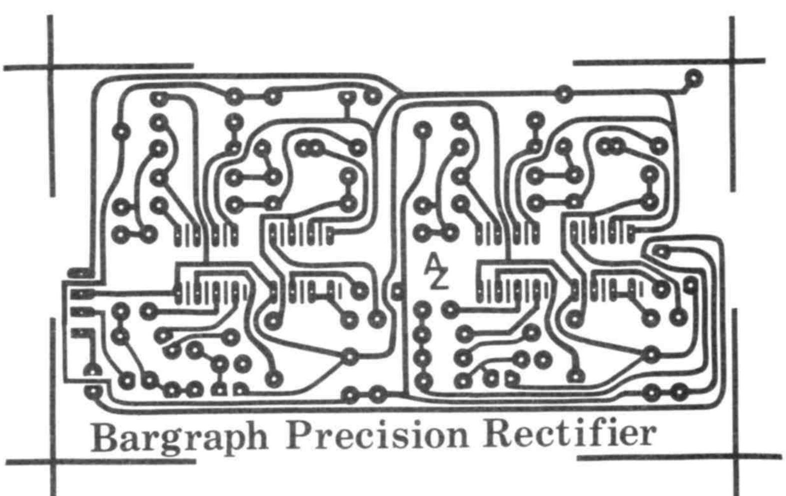


Schematic of the Op Amp.



Component overlay.

PARTS LIST	
Resistors	
R1,2,3,4,	2k2
R5,6	3k3
R7,8	15k
R9,10	18k
R11-18,21,22	22k
Potentiometers	
RV1,2	500k preset 10mm
RV3,4	500k preset 6mm
Capacitors	
C1,2	100n polycarbonate
C3	470u 16V axial
C4	470u 25V axial
C5,6	22u 10V radial
C7,8	4u7 50V radial
Semiconductors	
IC1,2,3,4	LF353
Capacitors	
D1	1N4148

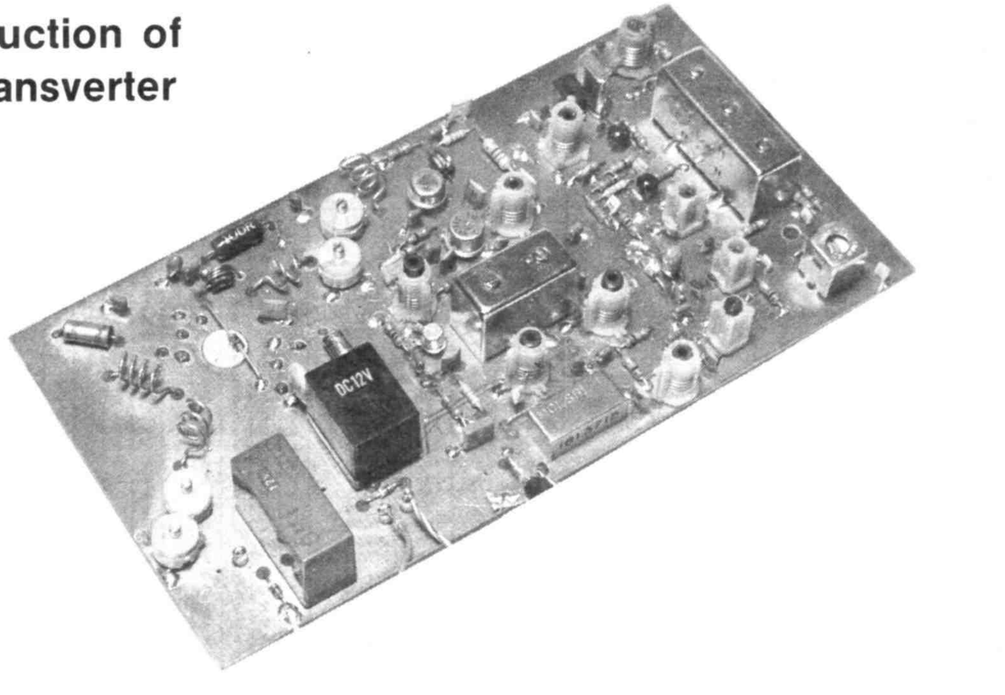


PCB Foil pattern.

■ R&EW

2m TRANSVERTER

The design and construction of a 28MHz to 144MHz transverter by Howard Roberts.



REGULAR READERS WILL recognise that the Rx converter, in this transverter, is the one from November's **R&EW**, this was felt to offer the best design and easiest construction. The Tx converter is, however, of conventional design with a few improvements to enhance the spectral purity at 2m. This is important to combat overcrowding and associated problems.

The transverter needs a 28MHz drive source, not less than +5dBM (4mW) — most Japanese HF transceivers should be satisfactory. A pi-network attenuator is fitted on the transverter board, so that it is possible to attenuate any 28MHz signals above the correct level. This is a very important consideration, as over-driving the mixer will produce many unwanted mixing products (also, no doubt, many complaints when the circuit is in operation on the band!). A table is provided to enable selection of the correct resistors for the pi-network (**Table 1**).

When fully driven, the transverter should produce more than 10W PEP, operating from a +13.8V DC supply (you'll need to be able to measure the RF output power, for alignment).

ATTEN	R4,6	R5
3dB	300R	18R
6dB	150R	39R
10dB	96R	68R
13dB	82R	120R
16dB	68R	150R
20dB	56R	270R

Table 1: Resistor values for the Pi-Attenuator.

Design And Operation

As the operation of the Rx converter was covered in the November issue, we will concentrate on the Tx converter.

The 116MHz output from the oscillator chain is passed through a low-pass filter (L4, C2, C3) into the LO port of SBL1; the level at this point being about +5dBm. The 28MHz signal, from the transceiver, after passing through the pi-attenuator

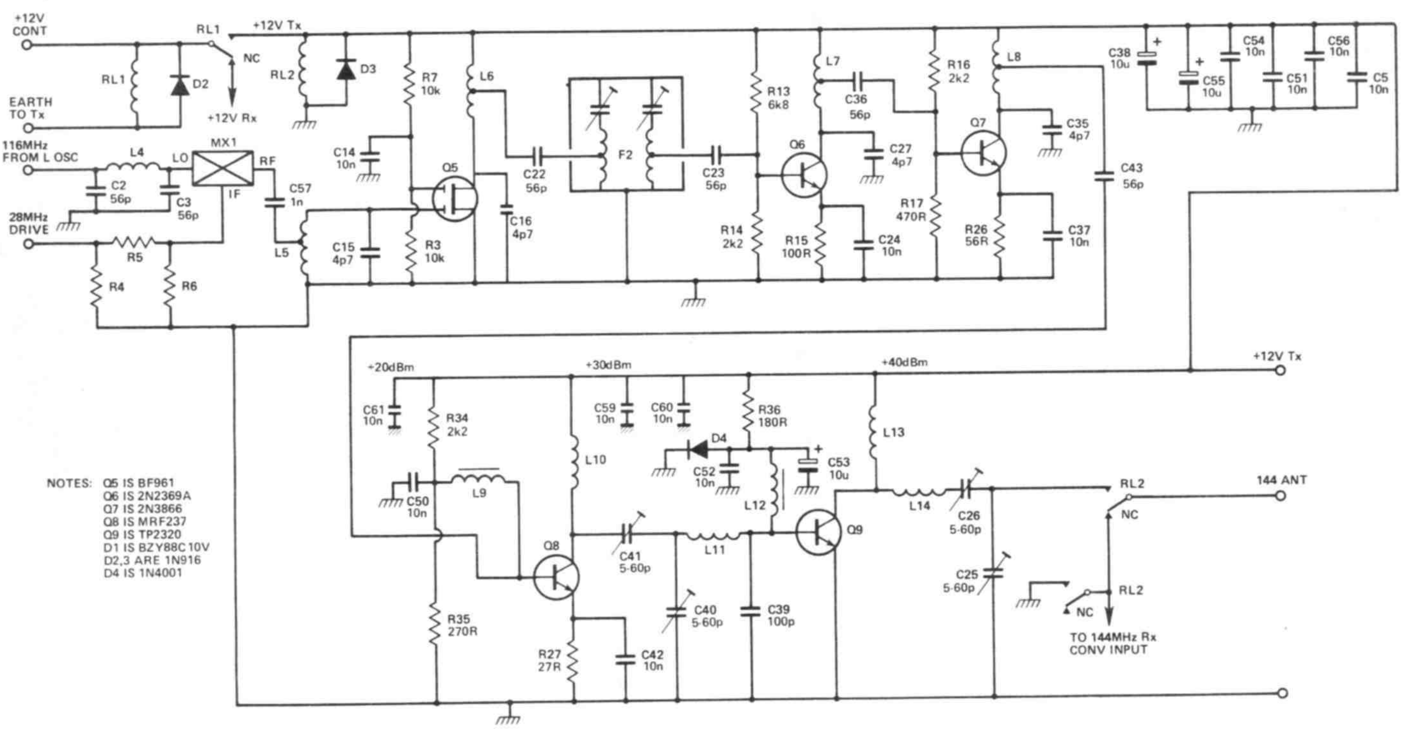


Figure 1: Circuit of the Tx mixer and output stages.

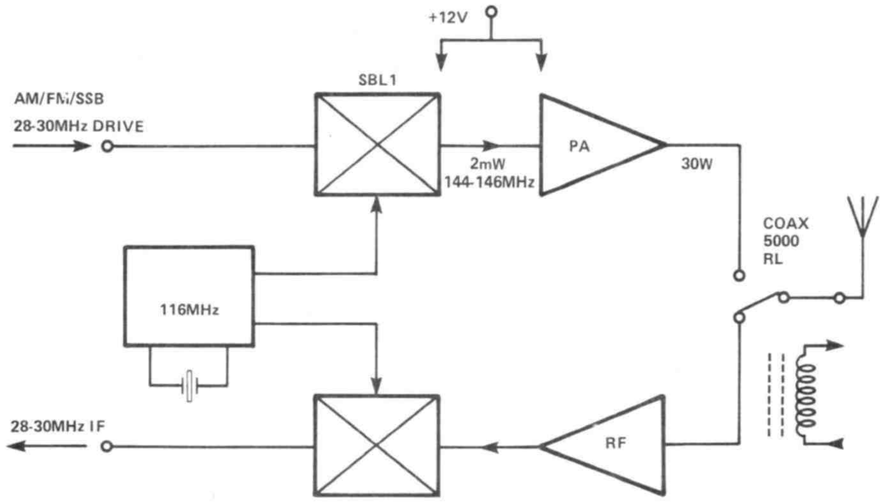


Figure 2: Block diagram of the Transverter.

COIL	TURNS	END
L5	1¾	GND
L6	3¼	12V
L7	3	12V
L8	2¼	12V

Table 2: Winding details for L5-8.

(R4,5 & 6), is fed to the IF port (also at about +5dBm). The 50R output, from the SBL1 mixer, is matched into the gate of Q5 via L5 — the MOSFET giving approx 5dB gain.

The drain of the MOSFET is matched into the 500R input impedance of the helical filter, by L6. The output of the filter is then of low enough impedance to feed directly into Q6. Another stage of amplification follows (Q7) before the 144MHz signal (at about +18dBm) is fed into the driver transistor (Q8). This transistor provides 10dB of gain, so that a signal of about 1W is fed to the output transistor Q9. Biasing of Q9 is performed by R36,C52,C53 and D4. The diode is in direct contact with the output transistor, so that thermal tracking is achieved. The output is passed through L14 to the aerial changeover relay, RL2, and then to the antenna socket. It will be seen that the receiver front end is earthed by the relay when on transmit. This prevents large RF spikes damaging the front end transistor (Q2), when operating into a high VSWR.

If you wish to operate the Rx converter whilst on transmit, then two minor modifications must be performed:

1) Disconnect the coaxial cable, from the Rx contact on the antenna change-over relay RL2. Then connect this cable to the receive-antenna coax.

2) Connect +12V (continuous) to the outer end of R1; which will enable duplex operation.

Construction

A double sided PCB is used to provide good electrical stability and ease of construction. All components, that require an earth connection, should be soldered directly to the earth plane on the topside of the board — the hole being included solely to indicate component positions.

Make the through PCB links that provide earth connections for T3, T4, RL1, RL2, Q9 (emitter), X1 and the source connections of Q2. This is done by passing a length of tinned copper wire through the hole and soldering it on both sides.

There is one lead that must be soldered on both sides of the board. It is the hot end of C13, which forms the +12V (cont) connection to the oscillator chain. Next, solder the 10 pins in place, followed by the helical filters, F1 & F2. The tabs on the cans must be soldered on *both* sides of the board, to create earth connections on the underside.

The BF961 MOSFET should be mounted on the underside of the board. The long leg is soldered to the large earthed pad on the hot end of L6 (when mounted, the printing on the MOSFET should read towards the board).

The remaining components can now be soldered in place, finishing up with the semiconductors. Diode, D4, must make physical contact with the output transistor Q9, and the taps on the inductors should be made with fine tinned copper wire **(Table 2)**.

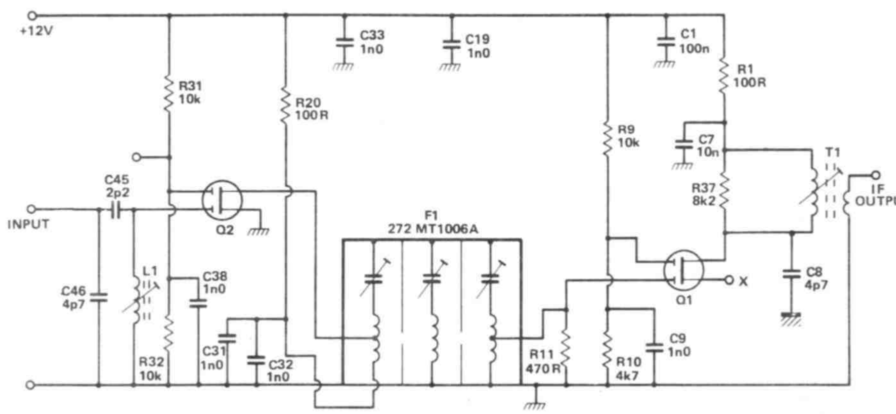


Figure 3: Circuit for the RF and mixer stages.

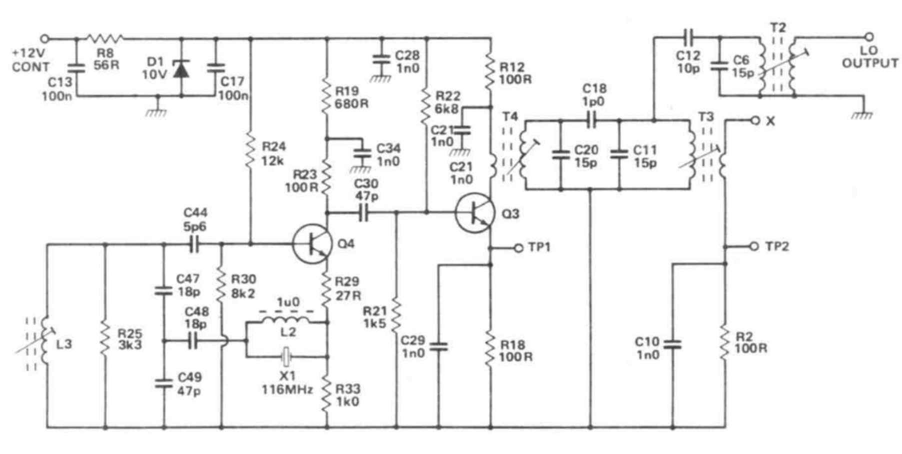


Figure 4: Oscillator and Buffer circuit.

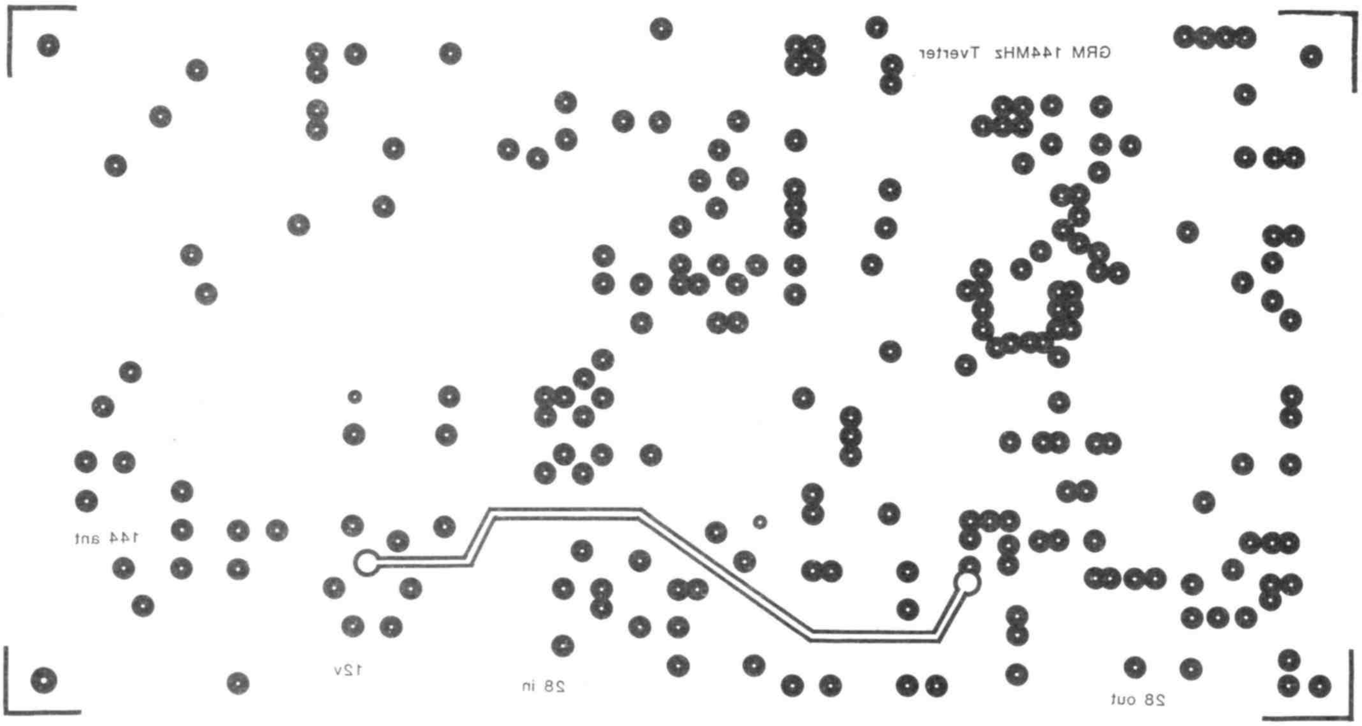
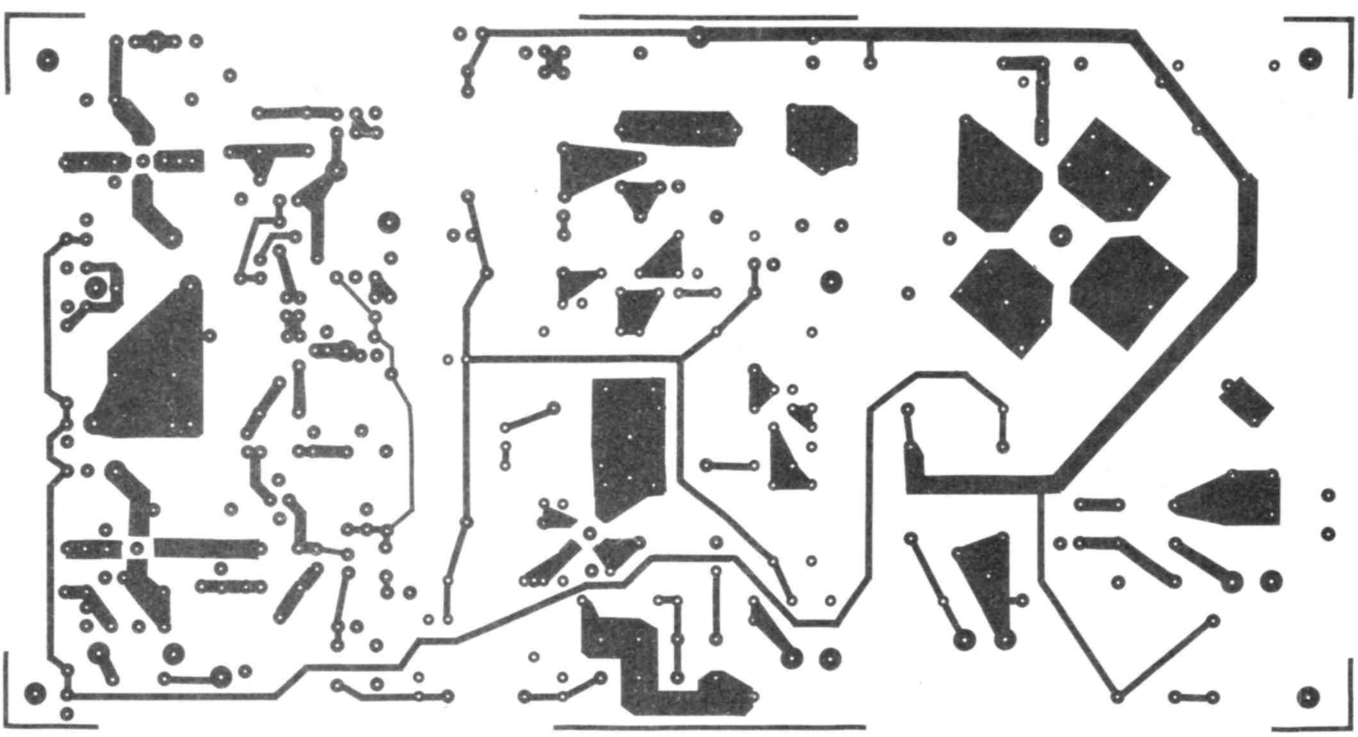


Figure 5: Both sides of the Transverter PCB (the earth plane is uppermost).



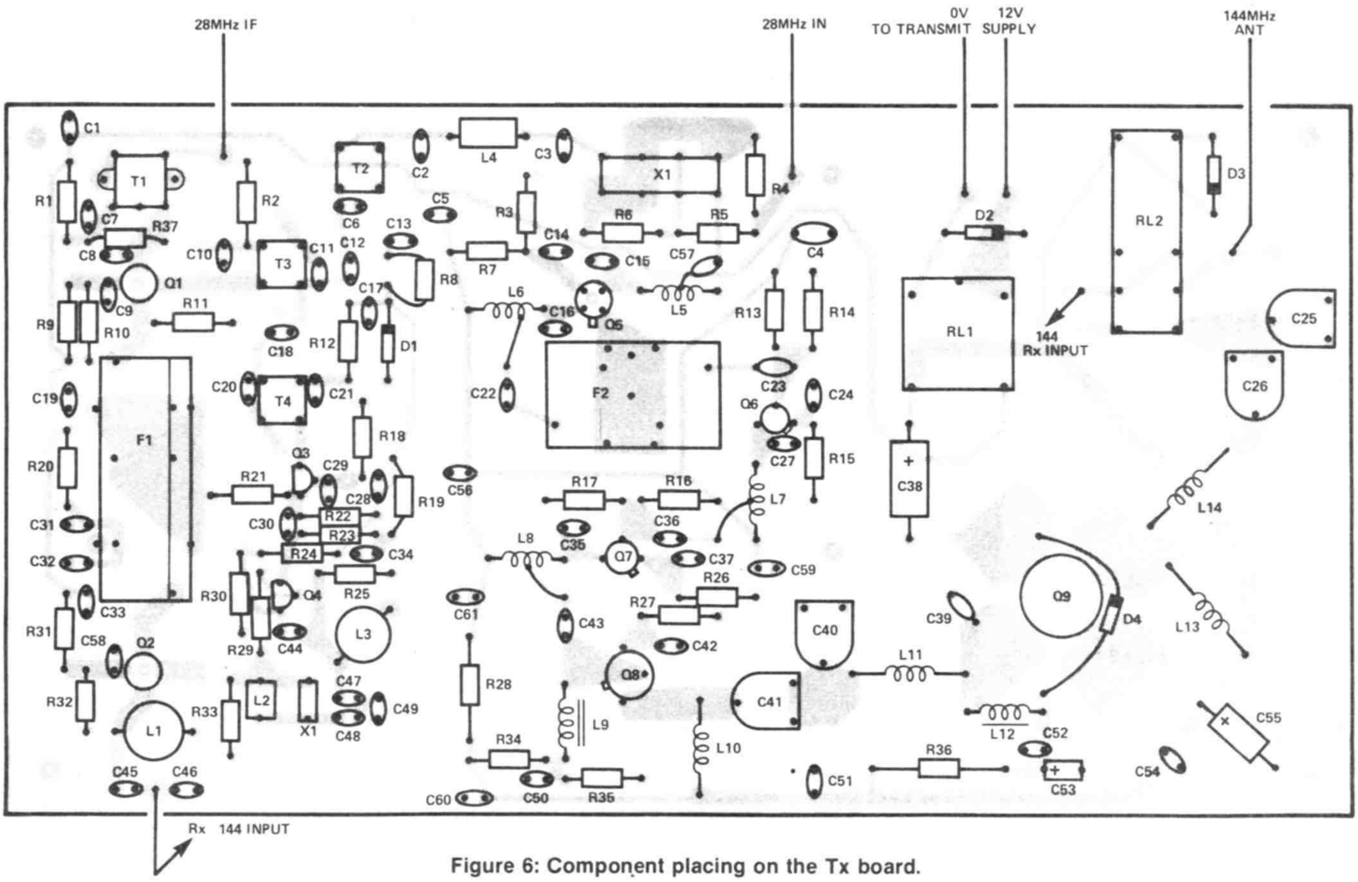


Figure 6: Component placing on the Tx board.

Testing

After initially checking (visually) for any short circuits, switch a +12V *current limited* supply to the transverter (at this stage, the current drawn should only be a few tens of milliamps). Connect a voltmeter between TP1 and ground, on the local oscillator chain, and tune L3 for maximum voltage. Move the meter to TP2 and tune T4 and T3 similarly.

Now, connect an aerial and 28MHz receiver to the board and 2m signals should be heard. Find a signal near the centre of the band and adjust L1 and T1 for maximum signal-to-noise ratio (adjustment of the helical filter is not recommended, unless specialised test equipment is available). Then, remove the aerial and replace it with a 50R load.

To align the transmit converter, a similar procedure is used. Firstly earth the "OV to transmit" pin on the board and check that the current does not exceed 1A. Apply 28MHz drive and measure the voltage across R15. Tune L5 & L6 to achieve a peak of about 0.5V. Now connect the meter across R26 and tune L7 for a maximum. It should be possible to see the supply current increase as the circuit is tuned, and this should also peak on tune.

Finally, connect a power meter to the output of the transverter and tune the output stages for maximum RF into a 50R load. After re-checking the earlier stages, the RF output should be greater than 10W PEP.

If driven correctly, the DC input current should average approx 50% of the peak carrier current, thus avoiding compression and overdriving.

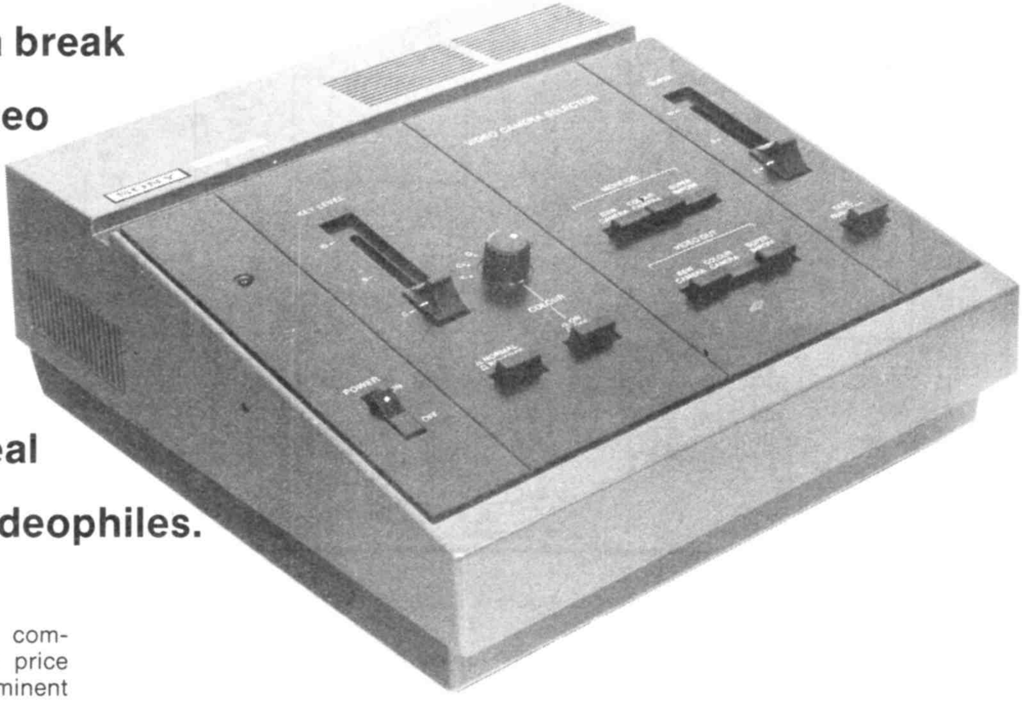
■ R&EW

PARTS LIST

Resistors	
R1,2,12,15,18,20,23	100R
R3,7,9,31,32	10K
R4,5,6	(see text)
R8,26,28	56R
R10	4k7
R11,17	470R
R13,22	6k8
R14,16,34	2k2
R19	680R
R21	1k5
R24	12k
R25	3k3
R27,29	27R
R30,37	8k2
R33	1k
R35	270R
R36	180R
Capacitors	
C1,9,10,19,21,28,29,31-34,57,58	1n
C2,3,22,23,36,43	56p
C4	100n polycarb
C5,7,14,24,37,42,50,51,52,54,56,59,60, 61	10n ceramic
C6,11,20	15p
C8,15,16,27,35,46	4p7
C12	10p
C18	1p
C25,26,40,41	5-60p trimmer
C30,49	47p
C38,55	10u 16V Elect
C39	100p
C44	5p6
C45	2p2
C47,48	18p
C53	10u tant
Semiconductors	
Q1,2	3SK88
Q3,4	BF241 or BF274
Q5	BF961
Q6	2N2369A
Q7	2N3866
Q8	MRF237
Q9	TP2320
D1	BZY88C10V
D2,3	IN4148
D4	1N4001
Miscellaneous	
MX1	SBL1 Mixer
X1	116 MHz crystal
L1	L1 5½+ 518
L2	1uH 7BA choke
L3	3½+ 518
L4-8	4.5t Toko yellow
L9,12	4t 24g single hole FB
L10,13	4t 16g ¼" diam CW
L11	2t 16g ¼" diam CW
L14	3½t 16g ¼" diam CW
T1	154FN 6439
T2,4	MC111 4.25/1.25 +
T3	MC111 4.25/2.25+
RL1	KUIT 12V
RL2	OM1 12V
F1	272MT1006A
F2	272MT2006A

SONY CAMERA SELECTOR

Peter Luke takes a break from reviewing video recorders with this look at a collection of equipment that should appeal to all creative videophiles.



With portable recorder/camera combinations the object of healthy price cutting during late '82 and the imminent arrival of 'half-size' portable recorders there are a large number of people forsaking cine for video and others who are entering the moving picture business for the first time. While a significant number of these video tyros will be content to 'point 'n shoot' and have no desire to get involved in editing their footage, or get involved in other post-production activities, this sort of person will miss out on the pleasure of creative video.

All portable recorders provide some form of editing capability and on many of the more recent machines quite sophisticated insert edits are possible. It's possible therefore to assemble your location footage into a logical order and to impart a bit of pace to any production. The Sony camera selector reviewed here enables extra sophistication, in the form of superimposed captions, to be incorporated in amateur/semi-professional video productions.

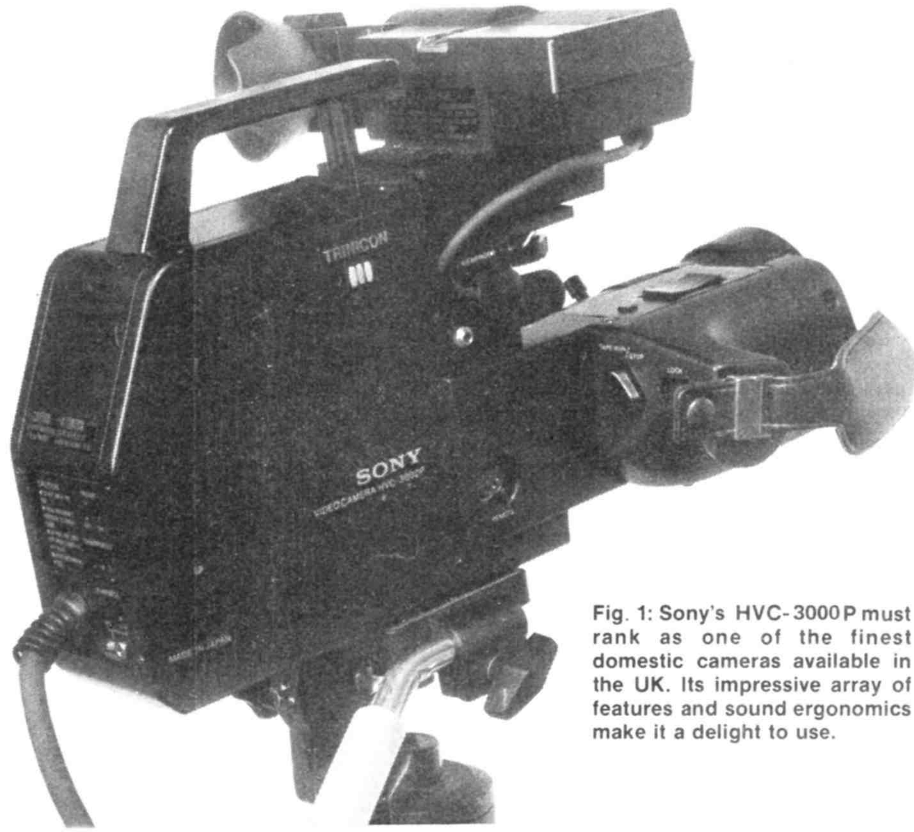


Fig. 1: Sony's HVC-3000P must rank as one of the finest domestic cameras available in the UK. Its impressive array of features and sound ergonomics make it a delight to use.

The Ensemble

The equipment reviewed here consists of the HVS-2000P (the camera selector itself), the HVC-3000P colour camera and the HVM-100CE black and white camera.

Both the colour and black and white cameras are plugged into the camera selector unit via the familiar Sony K type

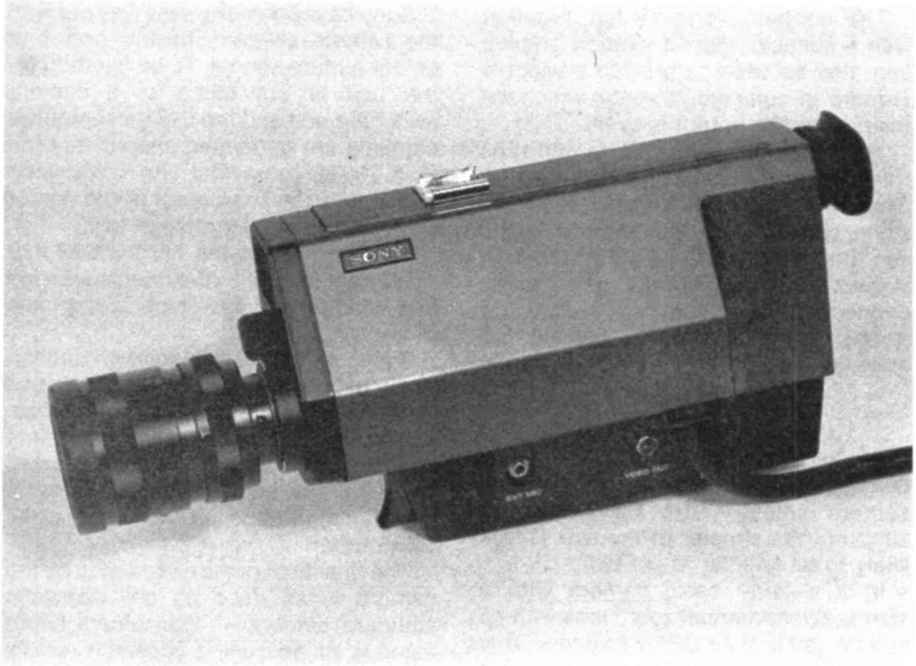


Figure 2:The HVM — 100CE is a B&W camera that is capable of being locked to an external sync. source.

connectors that, in one plug, take care of all video/sound/power lines to and from the cameras. We'll describe the cameras in more detail later and concentrate on the selector unit itself for now.

As the HVS-2000P's title suggests it can be used as a straightforward unit to select either the colour or B&W camera's signals. There are two rows of selector buttons, one marked video out and the other monitor. Depressing the appropriate selector will send either one of the cameras' outputs to the two, BNC type, video output sockets on the rear panel of the unit. The third button in the bank of selector switches engages the superimposition capabilities of the HVS-2000P. The other controls on the selector unit are all concerned with the control of the superimposed caption.

In use, the B&W camera is focused on to the caption board, while the colour camera is arranged to view the 'main' scene. Advancing the 'super' slide will now superimpose the caption onto the main scene. If the caption does not appear or, if the edges of the caption are rather ragged, the 'key level' slide control allows the cleanest possible caption to be obtained.

The straightforward B&W caption thus superimposed can be 'coloured' by switching the colour on/off to on. The rotary switch to the right of the key level control allows the superimposed caption to be set to any one of six colours. The options are yellow, cyan, green, magenta, red and blue.

An additional control associated with the superimposing process is the normal/reverse control. With this control in the normal position the black part of any caption will be superimposed onto the output signal. In the reverse position the white part of the caption will be superimposed on the main picture with the result that the main scene will be largely obscured by a coloured border, the details appearing 'through' the caption logo.

The only remaining front panel control is the tape run/stop button which can remotely control a recorder with a remote pause capability.

Before going on to look at the operation of the unit, we'll cover the in/out connections found on the rear panel. The camera connections and video outputs have already been described. In addition to these there is an audio line out socket (phono). This is permanently connected to the mic of the colour camera (irrespective of the camera selected). The tape run/stop signal appears at a 3.5mm jack socket while another jack marked tally, when connected to a Sony recorder and used in conjunction with the HVC series of cameras, will operate the cameras record tally light.

Cap That

The front cover of the magazine shows the camera selector and two cameras in a typical 'studio' set up. The results produced by the selector unit were difficult to distinguish from the captions seen on professional programme material. In order to get the best results though it is necessary to pay careful attention to the lighting of the caption board and to experiment with the position of the key level control.

During our 'filming' with the set up we found that, in order to get the best effect from the captions, considerable care had to be taken in order that the framing of the main scene and the size/position of the caption were to give a pleasing result.

Apart from the superimposing facility, it is also possible to fade the main cameras output to black/white or to any of the colours that the unit is capable of generating. The colours were all stable and, although fully saturated, gave a pleasant effect over the screen.

Figure 3:The rear panel of the camera selector provides all the video and audio in/out connectors. The Sony K type camera selectors provide all camera connections in one handy plug.

Figure 5: This sequence of photographs shows how a typical caption shot is produced. This picture shows the output of the colour camera.

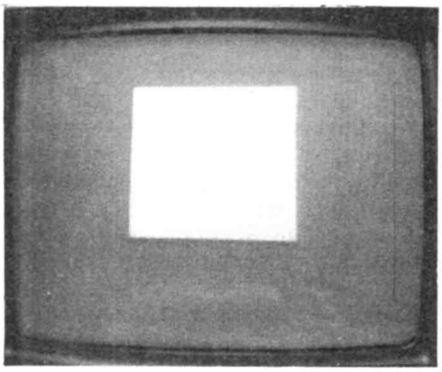


Figure 6: The B&W camera is focused on the caption graphic — in this case a white rectangle on a black background.

Figure 7: With the normal/reverse switch in the normal position, the white part of the caption graphic is superimposed on the main scene.

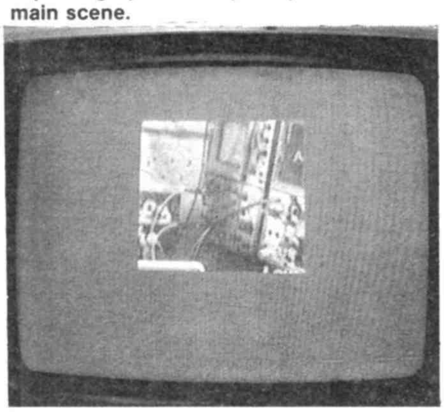


Figure 8: Switching the switch to reverse will 'frame' the main scene with a border.

The normal/reverse switch, together with a suitable shaped caption graphic can also be used to provide a window (square, circular etc.) through which the main camera's output is seen.

The camera selector unit, as well as its role in 'live' work, can equally well be used with a video recorder as the main signal source. Thus captions and effects can be added at the post-production stage. Sony can supply a range of connecting leads that will enable the selector to be used with equipment that does not feature Sony style connectors.

The Cameras

Of the two cameras used with the camera selector the B&W camera, although the simpler of the two, is less likely to be familiar to people.

It is a fairly basic camera with a 16mm/32mm manual zoom lens with an optical, rather than CRT viewfinder. This means that framing of any caption should be done with the aid of a monitor rather than risking any parallax or zoom setting errors.

The most important feature of the HVM-100CE is the fact that it can be switched to operate on an external sync. When operating two or more cameras together it is essential that they are all locked to the same sync. source. If all the cameras are run independently of each other, every time the vision output is switched between cameras, the picture will lose lock for a few seconds as the monitor or recorder attempts to lock to the new signal. With two colour cameras the situation is even more critical, as in this case, for ideal results the colour sub-carriers of the two cameras should be locked to one another.

Sony have taken the easy way out with the camera selector, having only one colour picture source. To be fair though, the unit is not billed as a camera switching unit and the fact that coloured captions are generated, means that the HVS-2000P must lock its colourising circuitry to the sub-carrier of the colour camera's signal — no mean task.

Turning now to the HVC-3000P that must rank as one of the most advanced and delightful to use cameras available in the UK.

Based on Sony's 2/3 inch MF Trinicon Tube its many features include power drive for its 11mm to 70mm F1.4 lens, electronic viewfinder, automatic fade in/fade out function and a sophisticated white balance indicator that produces a display superimposed upon the CRT viewfinder.

The quality of picture produced by the camera is as good as any domestic standard camera — the camera being capable of producing excellent results down to lighting levels as low as 35 lux.

Perhaps the most outstanding feature of the camera however is its ergonomic design. The camera is shaped for shoulder mounted operation and in use all controls fall naturally to hand. The angle of the viewfinder is adjustable over a wide range — useful when the camera is tripod mounted — and the lateral position of the viewfinder assembly is adjustable to suit various users.

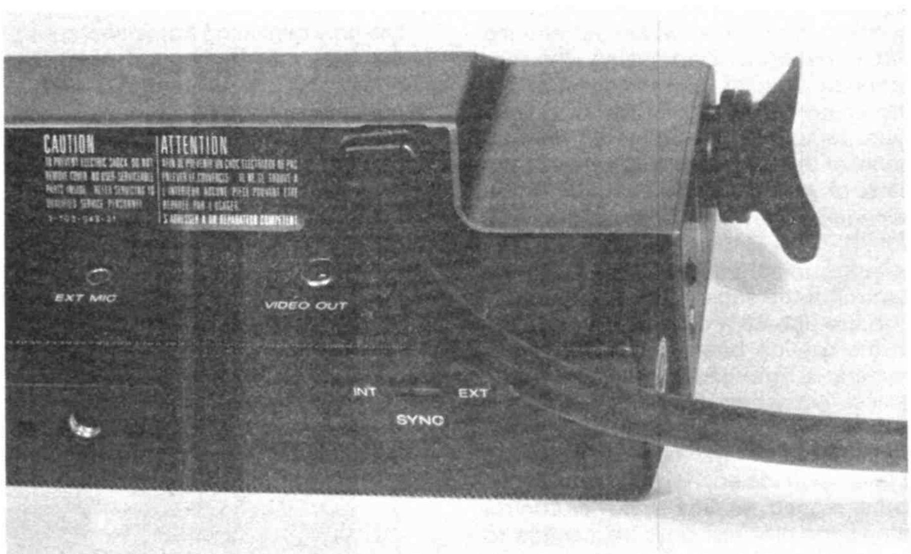


Figure 4:Detail of the base of the HVM-100CE showing the all important sync selector switch.

Caption Competition

At least one other manufacturer makes a similar unit to the Sony but it would have to be very good in order to match the quality and versatility of the Sony system described here.

■ R&EW

This month, Ray Marston looks at sophisticated CMOS 'UP' and 'UP/DOWN' counter/dividers.

Data File

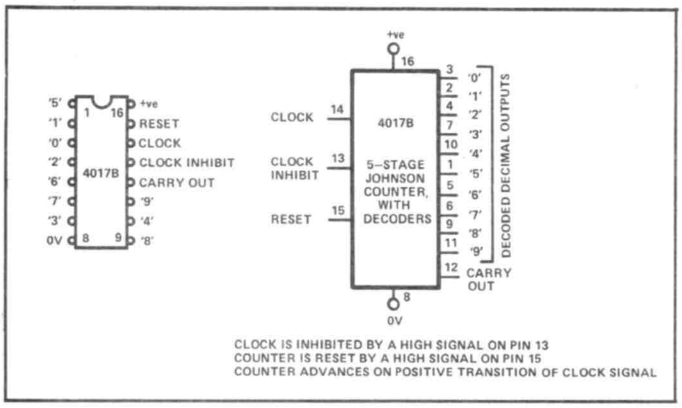


Figure 1: Outline and functional diagram of the 4017B Decade counter.

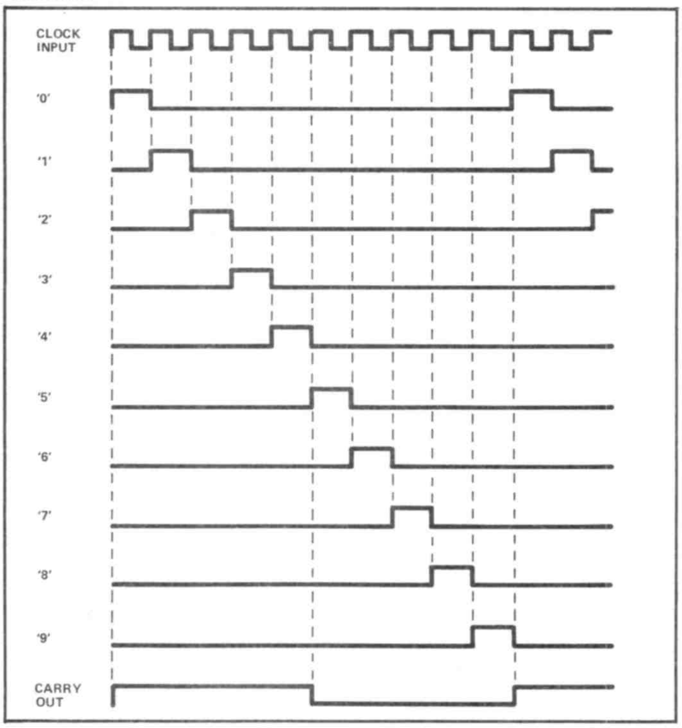


Figure 2: Waveform timing diagram of the 4017B, with its RESET and CLOCK INHIBIT terminals grounded.

IN THE LAST EDITION of 'Data File' we looked in detail at CMOS 'D' and JK flip-flops, and showed how they can be used to make a variety of counting/dividing circuits, etc. We now continue this theme by looking at sophisticated CMOS 'UP' and 'UP/DOWN' counter/dividers.

The 4017B Decade Counter

The 4017B is a 5-stage synchronous walking-ring or 'Johnson' decade counter with ten fully-decoded outputs that switch high sequentially on the arrival of each new clock pulse, only one output being high at any moment of time. Each output is capable of sinking or sourcing a current of up to several milliamps.

Figure 1 shows the outline and functional diagram of the 4017B, and ***Fig 2*** shows the basic timing diagram of the device, which has CLOCK, RESET and INHIBIT input terminals and ten DECODED and one CARRY output terminals.

The counters are advanced one step at each positive transition of the CLOCK input signal when the CLOCK INHIBIT and RESET terminals are both low. Nine of the ten decoded outputs are low, with the remaining output high, at any given time. The outputs go high sequentially, in phase with the CLOCK signal, with the selected output remaining high for one full clock cycle. An additional CARRY OUT signal completes one cycle for every ten CLOCK input cycles, and can be used to ripple-clock additional 4017s in multi-decade counting circuits.

The 4017 counting cycle can be inhibited by setting the CLOCK INHIBIT terminal high. A high signal on the RESET terminal clears the counters to zero and sets the decoded 'O' output terminal high. In use, all unused inputs of the IC must be tied low or high, as appropriate. The IC has a built-in Schmitt trigger on its CLOCK input line, and is thus not fussy about clock-signal rise and fall times.

4017B Applications

Figures 3 to ***6*** show some basic ways of using the 4017 in counting applications. In ***Fig. 3*** the IC is connected as a decade counter/divider, in which the output frequency is 1/10th of the input clock frequency. Here, the RESET and INHIBIT terminals are grounded and the output is taken from the CARRY OUT terminal, the 'decoded' outputs being ignored.

Figure 4 shows how three decade dividers of the ***Fig. 3*** type can be cascaded to make a 3-decade divider that generates

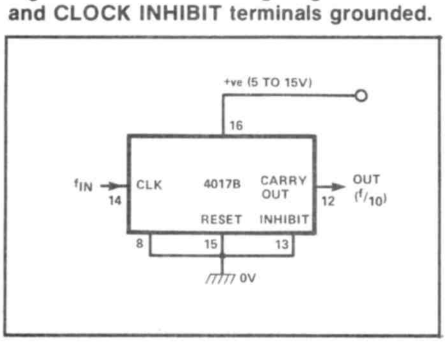


Figure 3: 4017B connected as a decade counter/divider.

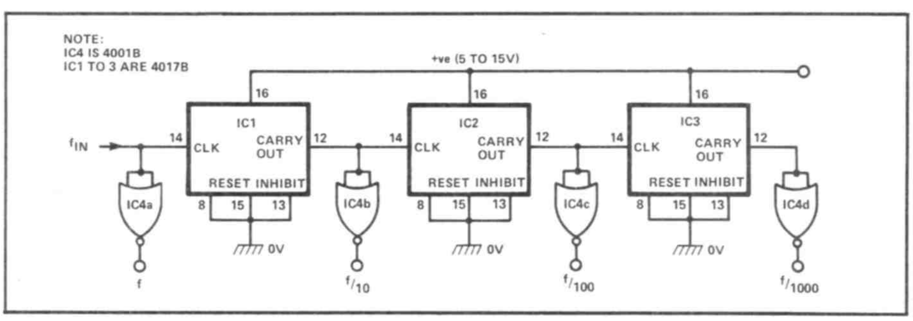


Figure 4: Any number of 4017B's can be cascaded to make a multi-decade divider. If the outputs are externally loaded, they should be buffered, as shown here. ▶

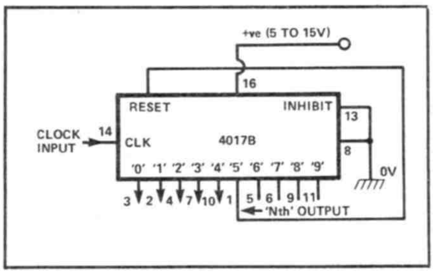


Figure 5: Simple method of connecting the 4017B as a divide-by- N (N = 2 to 9) counter with 'N' decoded outputs. The circuit is shown set for divide-by-5 operation.

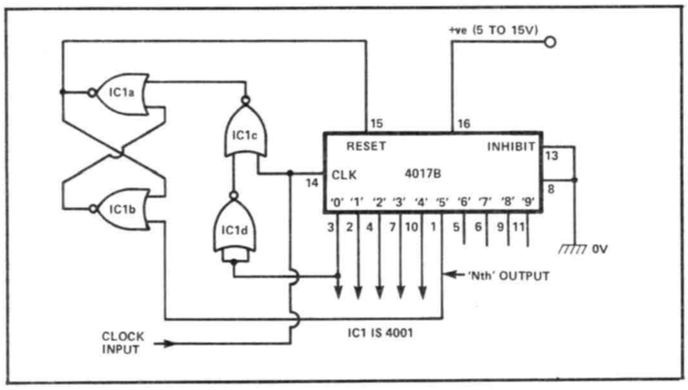
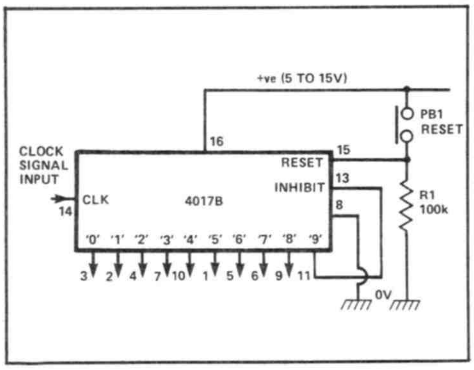


Figure 6: Alternative method of connecting the 4017B as a divide-by-N counter. The circuit is shown set for divide-by-5 operation.



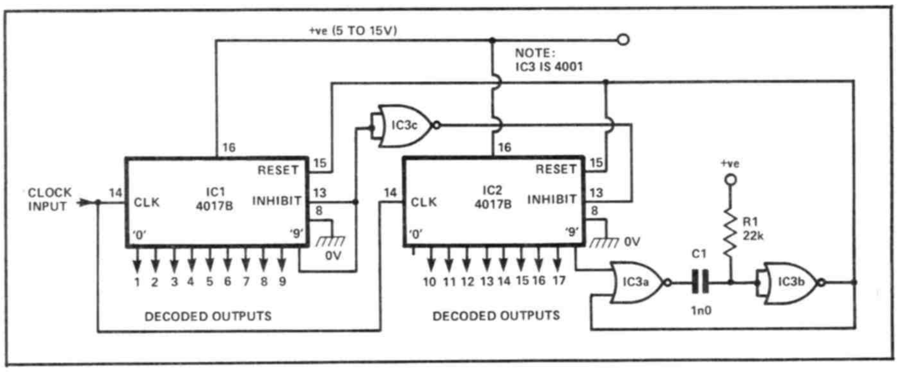


Figure 7: Method of connecting the 4017B for sequence-and-stop action.

Figure 8: A 10- to 17-stage counter/decoder, set for divide-by-17 operation.

outputs of 1/10th, 1/100th and 1/1000th of the clock frequency; the CARRY OUT signal of each counter is used to provide the CLOCK signal to the following stage. Note in this particular circuit that the four outputs are buffered via CMOS inverters (made from 4001 gates, etc), to ensure that output loading does not degrade the rise times of the clock signals. Thus, if the clock input signal is derived from a 1 MHz crystal oscillator, the circuit can be used as a laboratory frequency standard, providing frequencies of 1 MHz, 100 kHz, 10 kHz and 1 kHz.

Figure 5 shows a method of connecting the 4017B as a divide-by-N counter (N = any whole number from 2 to 9) with N decoded outputs. Here, the 'Nth' decoded output is simply shorted to the RESET terminal, so that the counter resets to zero on the arrival of the 'Nth' clock pulse. In the diagram, the circuit is set for divide-by-five operation.

Figure 6 shows a slightly more sophisticated version of the divide-by-N counter, in which logic gates control the RESET operation via the IC1a-IC1b flip-flop. The operation here is such that the RESET command is given on the arrival of the 'Nth' clock pulse and is maintained while the clock pulse remains high, but is removed automatically when the clock pulse goes low again.

The most important feature of the 4017B is the fact that it provides up to ten fully decoded outputs, making the IC ideal for use in a whole range of 'sequencer' applications in which the outputs are used to drive LED displays, relays, sound generators, etc. ***Figs. 7*** and ***8*** show ways of extending the usefulness of the IC in such applications.

Figure 7 shows how to connect the IC so that it stops operating after completing a pre-determined counting sequence. In the diagram the counter is set to stop when its CLOCK INHIBIT terminal is driven high by the '9' output, but the counter can in fact be inhibited via any one of the 4017's decoded output terminals. The count sequence can be restarted by pressing the RESET button PB1.

Finally, ***Fig. 8*** shows how a pair of 4017s can be connected to give up to seventeen stages of fully decoded counting. The CLOCK input signal is fed to both ICs, but when the count is below 9 the '9' output of IC1 is low and causes the CLOCK INHIBIT terminal of IC2 to be set high via IC3c, so IC2 is not influenced by the clock signals. When the 9th clock pulse arrives the '9' output of IC1 goes high and inhibits IC1 from further clocking action; simultaneously, the CLOCK INHIBIT terminal of IC2 is driven low via IC3c, enabling IC2 to respond to subsequent clock signals. Eventually, on the arrival of the 17th clock pulse, the '9' output of IC2 goes momentarily high and triggers the IC3a-IC3b 15uS monostable, which resets both counters to their '0' states. The counting sequence then repeats.

Note that the '9' output of IC1 and the '0' and '9' outputs of IC2 are lost in the counting action, so the circuit gives a maximum of 17 usable counter/decoder stages. The circuit can be made to count by any number in the range 10 to 17 by connecting the 'free' input terminal of IC3a to the appropriate output terminal of IC2.

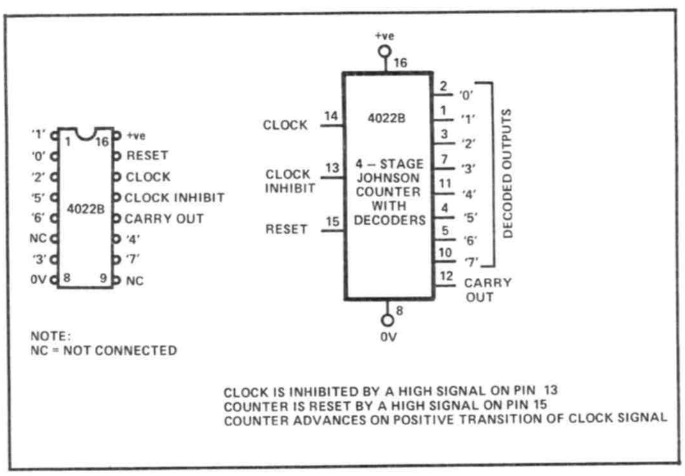


Figure 9: Outline and functional diagram of the 4022B Octal counter.

The 4022B Octal Counter

The 4022B can be regarded as an octal (divide-by-8) 'brother' of the 4017B. It is a 4-stage walking-ring synchronous counter with eight fully decoded outputs, so arranged that they go high sequentially. ***Figure 9*** shows the outline and functional diagram of the device. For normal octal counting, the RESET and INHIBIT terminals are tied low; the CARRY OUT signal completes one cycle for every eight input clock cycles. The IC has a built-in Schmitt trigger on its CLOCK input line, and is thus not fussy about clock-signal rise and fall times.

Synchronous 'UP' Counters

Synchronous 'up' counters are normally used in fairly simple applications in which it is necessary to merely count a number of input pulses, or divide them by a fixed ratio, and (perhaps) then display the results on a 7-segment LED or LCD readout unit.

Three basic families of CMOS 'up' counters are readily available, to suit virtually all possible needs. The oldest family are the 4026 and 4033 types, which are decade counters with built-in decoders that give 7-segment display outputs that can directly drive sensitive LED displays. Another family of devices are the 4518 and 4520 'duals', which house two counters in each 16-pin package. The 4518 is a dual decade counter with BCD outputs, and the 4520 is a dual hexadecimal (divide-by-16) counter with a 4-bit binary output. The outputs of these ICs must be decoded externally if they are to be used to drive 7-segment displays, etc.

The third family of 'up' counters are the 40160 to 40163 range of presettable counters, which can be made to reset to (or start to count from) either zero or to any 4-bit number that is fed into a set of four PRESET ('JAM') pins. The 40160 and 40162 are decade dividers, and the 40161 and 40163 are binary dividers.

Let's now look in detail at each of these three families of 'UP' counters, starting with the 4026 and 4033 types.

4026B And 4033B Counters

The 4026B and the 4033B are synchronous 'UP' counters that incorporate decoding circuitry that gives a 7-segment output suitable for directly driving a sensitive 7-segment common-cathode LED display; the output drive currents are limited to only a few mA. Both ICs have CLOCK, CLOCK INHIBIT and RESET input terminals, and a CARRY OUT output terminal that completes one cycle for every ten input clock cycles and can be used to clock following decades in a counting chain. The counters advance on the positive transition of the input clock cycle.

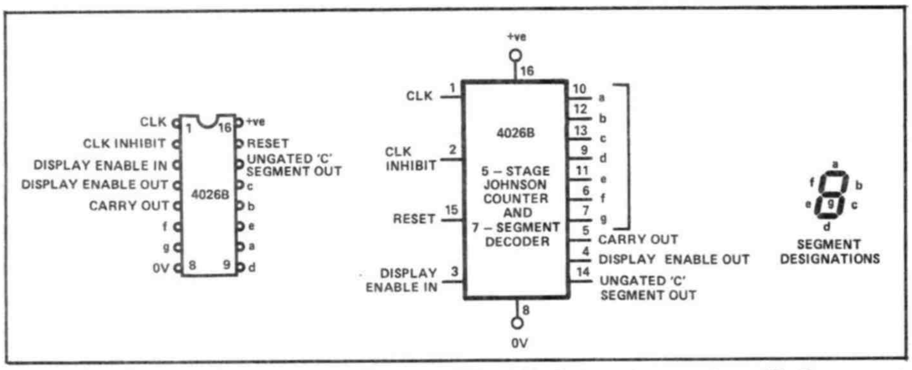


Figure 10: Outline and functional diagram of the 4026B decade counter with 7-segment display driver and DISPLAY ENABLE control.

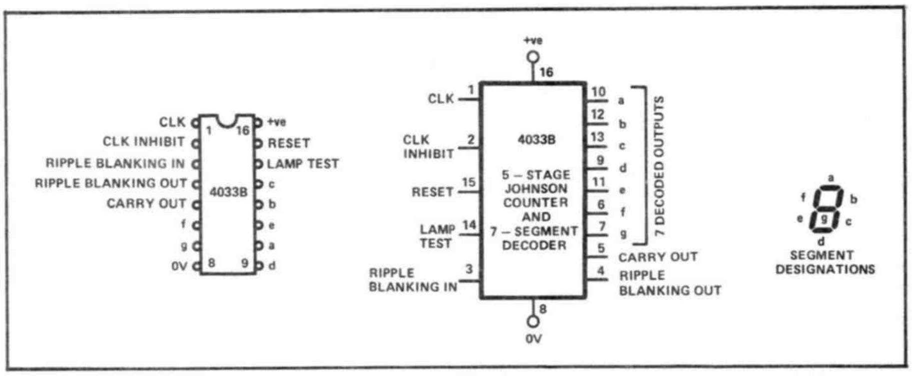


Figure 11: Outline and functional diagram of the 4033B decade counter with 7-segment display driver and RIPPLE BLANKING facility.

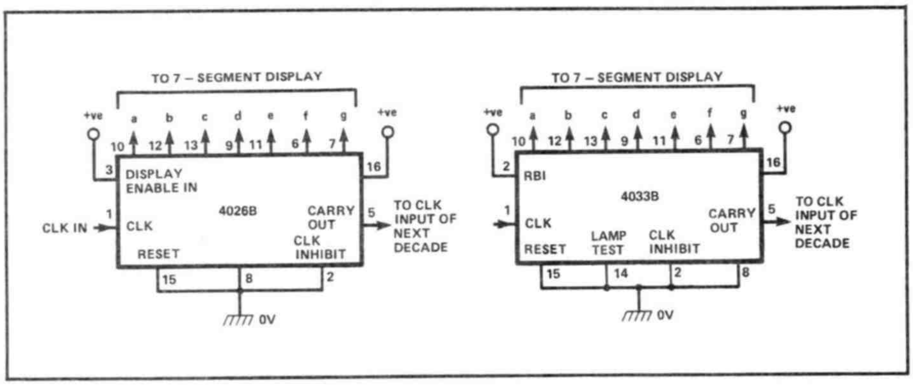


Figure 12: Methods of connecting the 4026B and 4033B for normal decade dividing/ display operation. In the case of the 4033B, the RBI connection does not give suppression of display zeros.

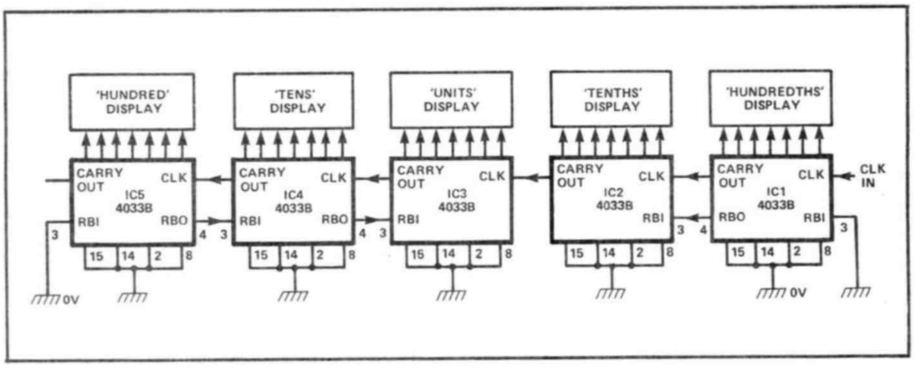


Figure 13: Method of connecting the RBI (RIPPLE BLANKING IN) and RBO (RIPPLE BLANKING OUT) of the 4033B to give leading and trailing zero suppression in a multi-decade display so that, for example, the count '009-90' is displayed as '9-9'.

Figure 10 shows the outline and functional diagram of the 4026B. This IC features DISPLAY ENABLE input and output terminals, which enable the entire display to be blanked. Normally, the DISPLAY ENABLE IN pin is held high; the display blanks (but the IC continues to count) when this pin is pulled low. The IC also has an UNGATED 'C' SEGMENT output terminal, which can be used with external logic to make the IC count by numbers other than 10.

Figure 11 shows the outline and functional diagram of the 4033B. This IC features RIPPLE BLANKING input and output terminals, which can be used to automatically blank leading and trailing zeros in multi-decade applications; the 'O' display blanks automatically when the RIPPLE BLANKING INPUT pin is held low. The IC also features a LAMP TEST pin, which is normally held low but which drives all seven decoded outputs high when the input pin is taken high.

Figure 12 shows how to connect the 4026B and the 4033B for simple decade counter/display operation. In both cases, the RESET and CLOCK INHIBIT terminals are tied low. In the case of the 4026B, the DISPLAY ENABLE INPUT MUST be tied high if the display is to be illuminated. In the case of the 4033B, the RIPPLE BLANKING INPUT terminal must be tied high if the display is required to give normal operation, or must be tied low if it is required to give 'zero' suppression. Note in both circuits that, if multi-decade counting is to be used, the CARRY OUT of one stage must be used to provide the CLOCK input signal of the next stage.

Finally, *Fig. 13* shows how to interconnect several 4033B s to give automatic suppression of leading and trailing zeros so that, for example, the count 009.90 will actually be displayed as '9-9'. To get leading zero suppression (on the integer side) the RBI (pin 3) terminal of the 'Most Significant Digit' (MSD) counter must be tied low, and its RBO (pin 4) terminal must be taken to the RBI terminal of the next MSD counter, and so on down to the UNITS counter. To get trailing zero suppression (on the fraction side of the display) the RBI of the 'Least Significant Bit' (LSB) must be tied low, and its RBO terminal must be taken to the RBI terminal of the next LSB counter, and so on, to the first counter in the 'fractions' chain.

When contemplating use of the 4026B or the 4033B, note that these IC s do NOT incorporate DATA latches; consequently, the displays tend to 'blur' when the IC s are actually going through a counting cycle.

4518B And 4520B Counters

The 4518B and 4520B are dual 'up' counters with binary-coded outputs. The 4518 is a dual decade counter with BCD outputs, and the 4520 is a dual hexadecimal (divide-by-16) counter with 4-bit binary outputs. The IC s have identical outlines and functional diagrams, as shown in *Fig. 14*.

An unusual feature of these counters is that they can be clocked on either the positive or the negative edge of the clock signal. For positive-edge clocking, feed the clock to the CLK terminal and tie the ENABLE terminal high. For negative-edge clocking, feed the clock to the ENABLE terminal and tie the CLK terminal low. The counters are cleared by a high level on their RESET pins, and clear asynchronously.

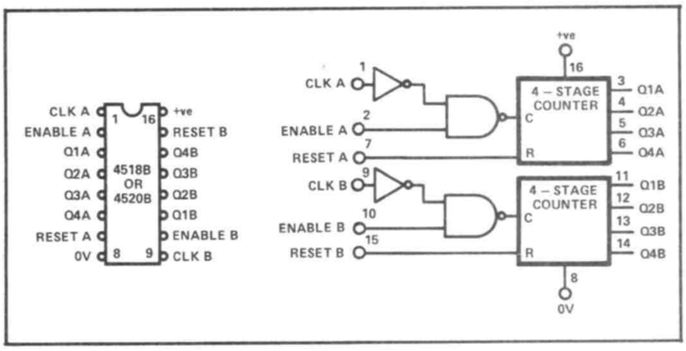


Figure 14: Outline and functional diagrams of the 4518B (decade) and 4520B (binary) dual counters.

Note that these counters do not have a 'CARRY' output; to cascade counter stages, the negative-edge clocking feature must be utilized, as shown in *Fig. 15*. Here, the Q4 output of each counter is fed to the ENABLE input of the following stage, which must have its CLK terminal tied low.

40160B To 40163B Counters

This range of counters are 'presettable' types, in which the 4-bit output can be made to agree with a 4-bit code set up on four PRESET pins, regardless of other conditions. This facility is useful, for example, in producing a count/display system that will repeatedly count from 1-to-'x', rather than from 0-to-'x' as in a non-programmable counter.

The 40160B to 40163B range of IC s have identical outlines and functional diagrams, as shown in *Fig. 16*, but differ in their methods of counting and clearing. The 40160 and the 40162 are both decade counters with BCD outputs, but the 40160 has an asynchronous CLEAR action, while the 40162 has a synchronous CLEAR action. The 40161 and 40163 are both hexadecimal counters with 4-bit outputs, but the CLEAR action of the 40161 is asynchronous, while that of the 40163 is synchronous.

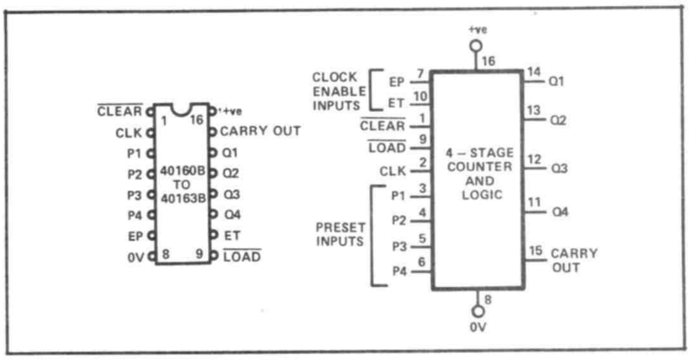


Figure 16: Outline and functional diagrams of the 40160B to 40163B range of programmable 4-bit counters.

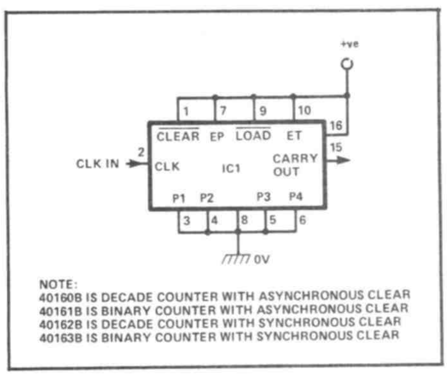


Figure 17: Method of connecting the 40160B to 40163B range of ICs for 'normal' counter operation.

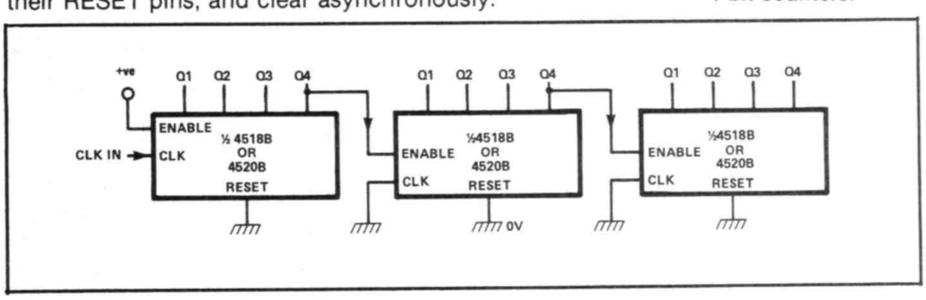


Figure 15: Methods of cascading 4518B or 4520B counters for ripple operation.

Thus, a low level at the CLEAR terminal of the 40160 or 40161 'asynchronous' types immediately sets all four outputs low, regardless of the states of the CLOCK, LOAD, or ENABLE inputs, but in the case of the 40162 or 40163 'synchronous' types a low level on the CLEAR terminal sets the outputs low only on the arrival of the NEXT positive clock edge. Note that a low level on the LOAD terminal disables the counters and causes the outputs to agree with the PRESET (P) data on the arrival of the NEXT clock pulse, regardless of the states of the ENABLE inputs.

The counters have two clock ENABLE pins (EP and ET), which must be tied high for normal counting operation. These pins are available to facilitate an internal carry look-ahead feature that is useful in fast counting applications. ***Fig. 17*** shows how to connect the IC s for use as 'normal' counters.

Synchronous 'Up/Down' Counters

Synchronous 'up/down' counters are devices that can be made to count in either direction, either by using a single clock input in conjunction with a 'DIRECTION' control, or by using two separate clock signals, with one controlling the 'up' counting and the other controlling the 'down' count. Up/down counters are very versatile devices. They can be used in the 'fixed' mode as conventional 'up' counter/display units or as 'count-down' counter/display devices. In the active mode, they can be used as 'difference' or 'add/subtract' counters or as bidirectional counter/display units, etc.

Three basic types or families of CMOS up/down counters are readily available. All of them are versatile 'presettable' types, giving undecoded 4-bit binary or BCD outputs which can be forced to agree with a 4-bit binary number set on four 'JAM' or PRESET terminals.

The oldest type of CMOS up/down counter is the 4029B. This device uses a single clock signal, with count direction controlled via an UP/DOWN terminal. The IC can act as either a decade (BCD output) counter, or as a binary (4-bit binary output) counter, depending on the setting of a BINARY/DECADE select terminal.

The 4510B and 4516B family of up/down counters also use a single clock signal, with count direction controlled via an UP/DOWN terminal, but in this case the count scale is fixed. The 4510B is a decade counter with BCD outputs, and the 4516B is a binary counter with a 4-bit binary output.

Finally, the 40192B and 40193B family of up/down counters use separate clocks to give the 'up' and the 'down' counting action. The 40192B is a decade counter with BCD outputs, and the 40193B is a binary counter.

Let's now look in detail at each of these three sets of up/down counters, starting with the 4029B type.

The 4029B Up/Down Counter

Figure 18 shows the outline and functional diagram of this versatile 'presettable' IC; a high PRESET ENABLE signal forces the outputs to immediately (asynchronously) agree with the binary code set on the JAM inputs. The IC acts as a binary counter when the BINARY/DECADE input terminal is high, or as a decade counter (with BCD outputs) when the terminal is low. The IC counts 'up' when the UP/DOWN input terminal is high, or 'down' when the terminal is low; note,

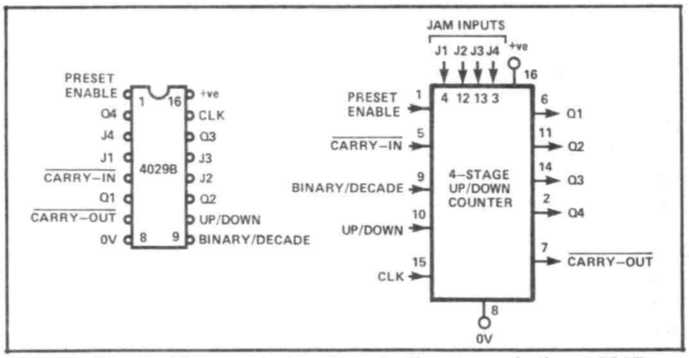


Figure 18: Outline and functional diagram of the 4029B presettable UP/DOWN counter.

however, that the UP/DOWN control must ONLY BE CHANGED WHEN THE CLOCK SIGNAL IS POSITIVE.

The 4029B terminal marked CARRY-IN is actually a clock disabling terminal, and is held low for normal clocking operation. When CARRY-IN and PRESET ENABLE are low, the counter shifts (UP or DOWN) one count on each positive transition of the clock signal. The CARRY-OUT terminal of the IC is normally high and goes low only when the counter reaches its maximum count in the UP mode or its minimum count in the DOWN mode (provided that the CARRY-IN signal is low).

The actions of the CARRY-IN and CARRY-OUT terminals of the 4029B are designed to facilitate fully-synchronous action in multi-decade counting applications, as shown in ***Fig. 19***. Here, all IC s are clocked in parallel, and the CARRY-OUT terminal of each counter is used to enable the following one (at a '1/10th of' rate) via its CARRY-IN terminal.

Numbers of 4029B s can also be cascaded and clocked in the asynchronous 'ripple' mode by using the connections shown in ***Fig. 20***, but in this case the 'Q' outputs of different counters will not be glitch-free when decoded. Note in this diagram that the CLK and CARRY-IN terminals are joined together on each IC, to ensure that false counting will not occur if the UP/DOWN input is changed during a terminal count.

Finally, ***Fig. 21*** shows a simple circuit that can be used to convert the 4029B into a 'dual clock' up/down counter, in which clock signals on the 'up' terminal give 'up'-clocking, and clock signals on the 'down' terminal give 'down'-clocking. The counter shifts (UP or DOWN) on the positive transition of either

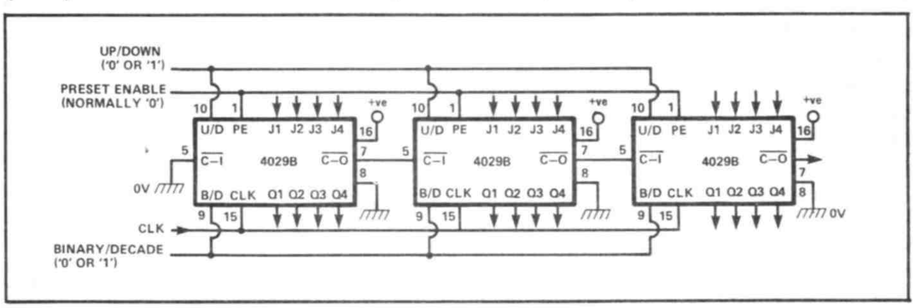


Figure 19: Method of cascading 4029Bs for synchronous 'parallel' clocking.

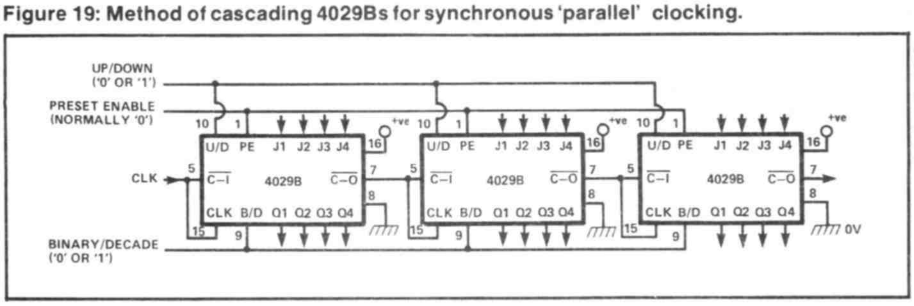


Figure 20: Method of cascading 4029Bs for asynchronous 'ripple' clocking.

clock signal. Note when using this circuit that only one clock terminal can be used at a time, and that the unused terminal must be held high.

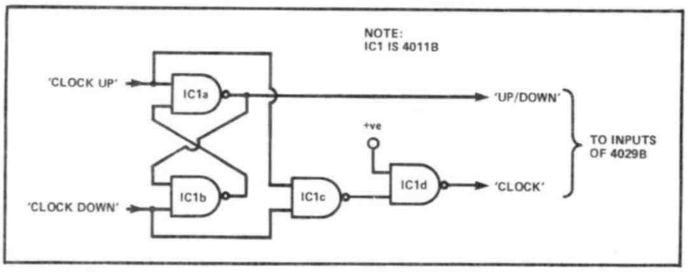


Figure 21: Simple circuit for converting the 4029B to a 'dual clock' UP/DOWN counter.

4510B And 4516B Up/Down Counters.

The 4510B and 4516B are presettable up/down counters; the 4510B is a decade counter with BCD outputs, and the 4516B is a binary (hexadecimal) counter. The IC s have identical outlines and functional diagrams, as shown in ***Fig. 22***. These counters have a RESET terminal which enables all outputs to be set low (cleared) by applying a high level on the RESET line; the outputs can be made to agree with a binary code on the PRESET (P) terminals by applying a high level on the PRESET ENABLE line. The IC counts 'up' when the UP/DOWN terminal is high, and 'down' when the terminal is low; the UP/DOWN input must only change when the CLOCK signal is high

The CARRY-IN terminal is actually a clock disabling terminal, and is held low for normal operation. When CARRY-IN (and RESET and PRESET ENABLE) is low, the counter shifts one count on each positive transition of the clock. The CARRY-OUT terminal is normally high and goes low only when the counter reaches its maximum count in the UP mode or its minimum count in the DOWN mode (provided that the CARRY-IN terminal is low).

Numbers of 4510B s or 4516B s can be cascaded and clocked in parallel to give fully-synchronous action by using the connections shown in ***Fig. 23***, or can be cascaded in the asynchronous 'ripple' mode by using the connections shown in ***Fig. 24***, which ensure counting validity even if the UP/DOWN input is changed during a terminal count.

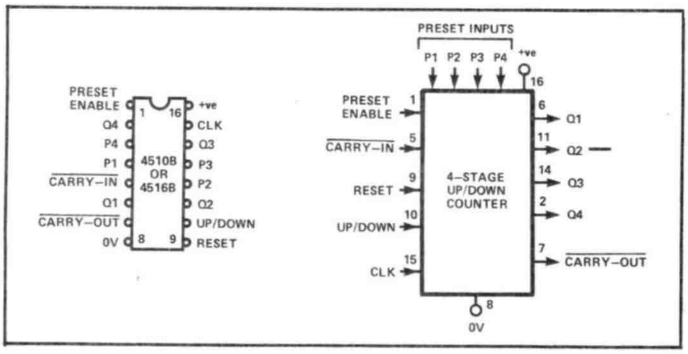


Figure 22: Outline and functional diagram of the 4510B (decade) and 4516B (binary) UP/DOWN counters.

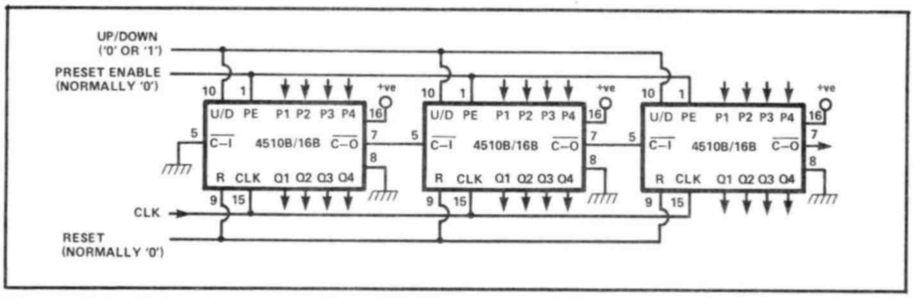


Figure 23: Method of cascading 4510B or 4516B ICs for synchronous 'parallel' clocking.

40192B And 40193B UP/DOWN Counters

The 40192B and 40193B are presettable, dual-clock up/down counters; the 40192B is a decade counter with BCD outputs, and the 40193B is a hexadecimal counter. The IC s have identical outlines and functional diagrams, as shown in ***Fig. 25***. A 'high' on the RESET terminal asynchronously sets all four outputs to zero. A 'low' on the PRESET ENABLE terminal asynchronously sets the outputs to the values set on teh four JAM (J) input terminals.

The counters have two CLOCK input lines, one controlling the UP count and the other controlling the DOWN count. Only one clock input terminal must be used at a time, and the unused input must be tied high. The counter shifts one count (UP or DOWN) on each positive transition of the 'used' clock line.

The CARRY and BORROW output signals of the counters are normally high, but the CARRY signal goes low one-half clock cycle after the counter reaches its maximum count in the UP mode, and the BORROW output goes low one-half clock cycle after the counter reaches its minimum count in the DOWN mode.

■ R&EW

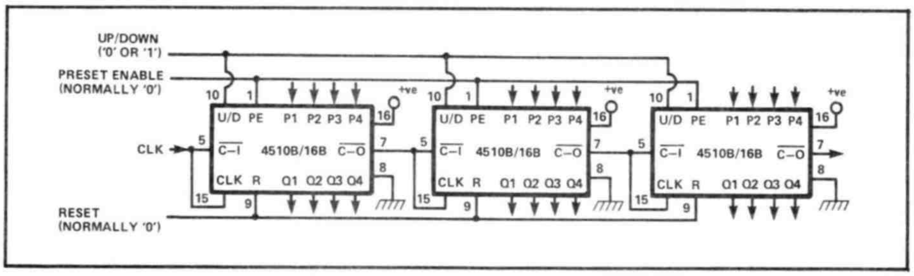


Figure 24: Method of cascading 4510B or 4516B ICs for asynchronous 'ripple' clocking.

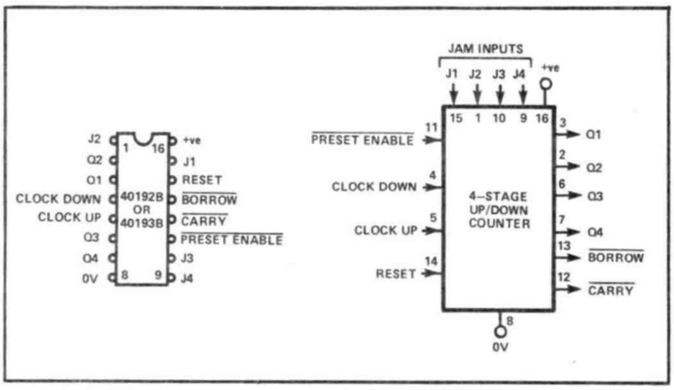


Figure 25: Outline and functional diagram of the 40192B (decade) and 40193B (binary) dual-clock UP/DOWN counters.

NOTES FROM THE PAST

With channel four still in its infancy it's interesting to note Centre Tap's views on the early days of the launch of ITV.

Now that ITV is in its second year, perhaps those who not only opposed it bitterly but also foretold an early failure are feeling a bit foolish. Fortunately for them the public have short memories for such things. Certainly, an impressive number of advertisers are buying more space, and the proportion of viewers who have a choice is now nearing a ratio of 7 to 3 in favour of ITV.

We already know the answers to questions such as "Do the public want ITV?" and "Will the BBC programmes improve as a result of competition?" to be a couple of yes's. As a consequence it is the turn of the BBC itself to find the answer to a question that is becoming increasingly important. It is, "What do we do next?" The choice is either to spend more money to recapture the Light programme audiences, or to concentrate on the more serious viewers. What would you do, chums?

Wot — No Moral?

No doubt many readers were amused by the recently reported story of the man who, fed up with his broken-down TV after having repeatedly sent it back for repair, took it back to the dealers and heaved it through the window. Although I am generally credited with a fair amount of patience, I have a sneaking feeling that we poor humans should be treated with greater understanding when driven by exasperation to take desperate measures. However, the magistrate seemed to take a dim view of the affair, and it must be admitted it wouldn't do for us all to yield to our primitive instincts even if we are unlucky enough to buy a hoo-doo tv.

Unfortunately, the knowledge that to get redress by legal means may be a costly, hard-to-prove, time-wasting and an even chancy business, tends to heighten one's anger. So whether you have actually been stung, or you merely imagine it, experience once again teaches that it's much cheaper to grin and bear it.

Tuppence Coloured

Last month it was only possible to fringe on the vexed question of colour TV when I expressed the view that it would be a long time before a regular service would be in operation in Great Britain. The two obvious difficulties, band-width and high cost, are not the only restricting factors. Public demand has also to be considered. Sure, they would like it as a novelty but would they go to the extra expense — and the risk of trouble? In the United States where a 4-hour daily programme has been on tap for some time, it was quickly discovered that everyone who was supposed to be so eagerly awaiting colour, developed a very marked sales resistance. As the growth of both sound radio and monochrome TV closely followed American trends it is not unreasonable to expect the same tendency will be repeated here.

Colour TV would be easily possible in a few weeks but even its most ardent supporter must admit that it is still insufficiently developed. To-day's production cost for a receiver would be in the region of £500 and few would be prepared to readily put down a sum of that order. Even quantity production is unlikely to reduce that figure to £350 very quickly, especially in the face of probable slow sales.

Assuming that there are no new basic developments and that the system to be used is fundamentally that which could be put into service to-day, what will the viewer get for his £500? The answer, I am afraid, is a highly complicated box of tricks, very bulky, and which for satisfactory reception would require him to be continually jumping up to twiddle the knobs. Granted a few people might enjoy that sort of thing the type that love doing the projection in home movie shows! I had a cousin a few years older than myself who was a born twiddler. When we were kids the electric gramophone motor was unknown and whenever anyone decided to play a few records, it was high delight to sit beside the motor, slowly and silently winding it so that the family could sit and enjoy a non-stop performance. When he wasn't winding he was getting a new needle and the next record lined up for a lightning change. I am sure he and his kind would simply love monitoring a colour tv but even they might jib at paying £500 for it.

The average viewer, however, is liable to soon get fed up with a receiver requiring constant adjustment especially as the colour, still rather garish, would add little to many of the programmes. Undoubtedly the advertisers would like it. Their products, packaged in gay and attractively coloured wrappers to which skilful lighting might add further appeal and brilliance, would become positively irresistible.

Much of the success of *R.C.* can be attributed to its close contact with its readers. Both the Staff and the contributors enjoy the hobby themselves for its own sake, unlike the apparently aloof desk-type editorship which can only remotely share what the readers feel. Less still can it be alive to the changing trends of specialised interestes. While *R.C.* does in some measure help to mould the constructor's tastes, to an even greater extent it serves to canalise the trend of the radio hobbyist's interest. From my own recent stocktaking of home constructional enthusiasm, pride of place must be given to the transistor. Having so wide a range of application, comparatively inexpensive and ideally suited to fresh experimental uses, this is perhaps unsurprising. What did surprise me, however, was the width of the second present-day interest — disc gramophone reproduction.

Those whose tastes lie in this direction have in recent years had numerous quality amplifiers described in our pages, plus an expanding choice of microgroove recordings. Recently, too, there have been a number of 3 and 4-speed turntables available at moderate and, more recently, even "bargain" prices.

Among radio enthusiasts in the last few months I have noted that there has been much discussion over long-play records, the best speed for high-quality microgroove recording and the future development of the 16 r.p.m. record. The latter, in this country, are still limited to Talking Books for the Blind.

Until recently I was inclined to take a simplified view of the record-buying public, feeling that the 15 to 30-year-old group bought the crooning, dance music, jazz and rock and roll 78 r.p.m. discs, while those of mature years and tastes (usually) with more money to spend) invested in the long-playing records of operatic and more serious music. This may well be true of the radio minded, but it is certainly a long way out when it comes to the record buying public generally. Some 70,000,000 discs were sold last year — a big jump on recent years almost suggesting a swing back to the gramophone boom years. The best-selling records were those of the crooners and dance bands, bought presumably by those with little to spend and who spend it a little at a time! They bought well over 90% of the records sold. Those with more money to spend and more time to listen hardly bought enough to make it a worthwhile business, if it were not for the fact that these records sell over a vastly longer period.

DX-TV

Reception Reports

Compiled by
Keith Hamer & Garry Smith

THE MOST STRIKING feature of November 1982 was the lack of F2 activity in Band I. The long awaited return of F2 conditions didn't materialise as anticipated, this being a sad indication that the golden years of F2 reception have now passed. Fortunately, DX reception by other modes of propagation occurred most days although it was a struggle to receive signals even by meteor shower(MS) reflection at times. There were a few instances of Sporadic-E DX, notably on the 14th, 25th and 30th. Intense Auroral activity occurred on the 24th during the late afternoon with channels E2 through to R10 being affected. To round off the month the widespread foggy conditions in the UK produced enhanced reception from distant IBA and BBC transmitters. As the high pressure system progressed eastwards, signals from the Low Countries and East Germany were received.

The first Sporadic-E opening of any note was on the 14th when a nature programme from the USSR (TSS) was seen on channel R1 from 0920 GMT onwards. A lunch-time opening on the 19th produced the Spanish (RTVE) test pattern with several "floaters" radiating programmes on channel E3. Spanish transmitters often go regional around this time causing confusion, especially for the newcomer to DX-TV. Signals from the east were seen again on channel R1 via Sporadic-E, but despite strong video being present the programmes could not be identified.

An interesting opening occurred on the 30th during the late afternoon when a subtitled programme appeared on channel E3. This was from the south-east and the subtitling suggests Yugoslavia(JRT). A different transmission, possibly of Italian origin, was noted on channel E4/IB.

Meteor shower activity was particularly good on the 14th with signals occasionally appearing in Band III on channel E5/R6(175.25MHz). Reception consisted of programme material, of course, just to make identification impossible! During the rest of November, countries positively identified via MS included Spain, Denmark (DR), Czechoslovakia (CST), Austria (ORF), Norway (NRK), Switzerland (+PTT) and Sweden (SR). Spain was a regular visitor via MS every Sunday morning during the month, on test pattern between 0830 and 0900 GMT. After 0900 positive identification would have been difficult due to programmes being broadcast.

The tropospheric opening at the end of the month wasn't exactly spectacular although goodies such as East Germany on channels E6 and E34 (DDR:F first and second networks respectively) were noted with strong video but, unfortunately, no programmes at the time. Signals from the Television de France (TDF) transmitter at Dunkirk were in evidence on channels E39,E42 and E45 for most of the evening on the 30th but, strangely, there was no sign of reception from Belgium (BRT/RTB:F). Colour pictures were resolved from many West German outlets throughout Band III and UHF during the evening with programmes such as "Tagesthemen" and "Arena" being shown towards close-down time. The sighting of an "NDR" (Norddeutscher Rundfunk) caption on channels E10 and E11 shortly after 2200 GMT suggests that the programmes were regional broadcasts.

Italian Pirates

During recent intense Sporadic-E openings, many television DX-ers have noticed the presence of Italian pirate radio transmissions between the 50 and 60 MHz portion of Band I. Since special radio receivers would be necessary in order to cover these frequencies it seems unlikely that these are normal domestic broadcasts. So why are they there? Two suggestions have been offered. The first concerns spurious radiation from the transmitter on these frequencies, but this is difficult to prove because nobody has reported simultaneous reception in the FM band. Provided that the Sporadic-E MUF rises sufficiently, we could discover whether these are harmonically related. The second suggestion seems more feasible however. Many of the pirate radio transmitters are located outside the main cities, away from the studios, and some form of link would be necessary. It is likely to be a radio link and these could be using frequencies within the Band 1 spectrum.

Service Information

Greece: A Band I transmitter on channel E4 is now in service and operated by EPT. It is located at Saitos Achaia with an ERP of 200 watts.

Hungary: Magyar Televizio's first network (MTV-1) transmits from 0800 until 1230 and from 1400 until 2300 Tuesday to Sunday. The second network, although unlikely to be received in the UK, transmits from 2000 until 2230 on Tuesday, Wednesday, Friday and Sunday but from 1400 until 2300 on Thursday and Saturday. There are no transmissions at all on either network on Monday. Why don't the BBC and IBA try this? Channel 4 could stay off the air altogether!

France: Telediffusion de France are to commence a fourth television network soon, called "CANAL PLUS", in Bands I and III. At present the obsolescent 819-line system is still used for the 1st network programmes (TF 1). It is also duplicated on UHF using 625 lines, so Band I transmissions are to be rapidly phased out. The new network will use system L, that is, 625 lines, scanning, positive vision modulation, AM sound with 6.5MHz sound and vision spacing. SECAM colour will be used and 60% of the population should be able to receive it by mid-1983.

West Germany: Westdeutscher Rundfunk (WDR) have recently installed a 50kW transmitter operating on channel E50 at Ederkopf, about 55 miles east of Cologne. The FuBK electronic test card carries the inscription "WDR 1 EK50".

Nigeria: The Nigerian state of Ondo is being equipped with UHF transmitters, initially at the state capital, Akure. The outlets will operate in Band IV.

Our thanks go to our Dutch correspondent Gosta van der Linden

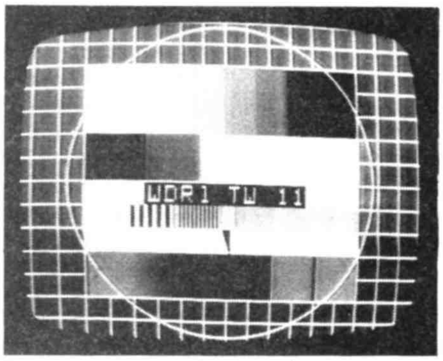


Figure 1: Westdeutscher Rundfunk FuBK test card from the Teutoburger Wald transmitter on channel E11.

Figure 2: France-Regions 3 identification caption (regional transmission).

(Rotterdam), Roger Bunney (Romsey, Hants) and GEC Limited (London) for supplying the above information.

Reception Reports

There's bad news for pop fans. Ray Davies (Happisburgh, Norfolk) has advised us that the Dutch NOS-1 and 2 television services no longer radiate the Radio One-style sound of the NOS 3rd radio network during test transmissions. The more sombre 1st network in now radiated.

Andrew Webster (Billinge, near Wigan) has been in touch and following the installation of a Jaybeam 11-element wideband Astrabeam Band III array he is now able to receive better quality signals from the Radio Telefis Eireann (RTE) transmitter at Dublin on channel IH. On UHF, Television South's transmissions from Hannington on channel 42 can be received on a daily basis. He has also noted an IBA "Channel 4" programme on channel 29 from the Stockland Hill transmitter which can now be received daily at a distance of some 200 miles. Andrew is also experiencing problems with intermittent interference caused by an arcing fault on a nearby CEGB power line. Although Band I frequencies are his main concern, the domestic FM transmissions are similarly affected. British Telecom have investigated the complaint but so far the problem remains . . .

After seeing the Swedish PM5544 test card, Graham Angel (Sheffield) has commented that his channel E8 reception during a recent tropospheric opening was "the best yet for clarity and colour". Many West German stations were received (some in colour) throughout Band III and as high as UHF channel E57. Graham has queried a PM5544 test card seen on around channel E3 without identification. Since it had a very dark background compared with a standard PM5544 it must have been Televizja Polska (TVP-1 Poland) on channel R2 (59.25MHz).

Brian Renforth has sent us an interesting letter from his new location in Torquay. He began DX-ing in 1974 when he discovered, by accident, that Yorkshire Television from the Emley Moor transmitter could be received at his South Durham home. Further experiments revealed that even the mildest tropospheric lifts guaranteed West German television signals, using nothing more than an Ultra colour receiver (Thorn 3500 series) and a group A six-element aerial directed at his local transmitter, Bilsdale. He later acquired a multi-element array, the Fuba XC343D. This was fed into a Thorn 1500 monochrome receiver resulting in dramatically improved tropospheric reception on UHF. For VHF he obtained a Thorn dual-standard mono receiver (1400 series) and following successful renovation it was converted for 625-line VHF reception. Apparently it is very easy to do on this model; simply move the lead from tag 43 to tag 44 and disconnect the middle (grey) lead on the system switch control at the turret tuner. Brian has positively identified at least 20 countries in Band I during the 1982 Sporadic-E season. Two "exotic" signals were noted early in the season. On May 23rd between 1818 and 1830 BST a Nigerian (NTA) broadcast was seen which consisted of a hospital drama programme made by the old UK network, ATV. It was followed by captions, programme details and coloured dancers. On June 5th a programme showing coloured people was noted on channel E2 from 1915 BST but heavy interference from Spanish and Portuguese (RTP) transmitters using the same frequency made identification difficult. On July 11th a strange Sporadic-E opening occurred in which signals from inside the UK were resolved from a BBC-1 405-line transmitter located in Scotland. At the same time, the Icelandic (RUV) test card was being received on channel E4.

From Meyerspark, South Africa, F. Anderson has written detailing F2-layer successes during early 1982. Stations were received between 41.25MHz (French television sound) and 49.75MHz (USSR video) during the day, with signal strengths approaching 200uV. He concludes that the propagation mode was invariably double-hop F2. After 1900 local time, Trans-Equatorial skip(TE) would occur allowing reception on frequencies as high as the 2-metre band. Occasionally, signals on 432 MHz were resolved between countries located at an optimum distance north and south of the geomagnetic equator as Zimbabwe and Cyprus.

On November 2nd an incredibly short Aurora was noted by Cyril Willis (Little Downham, Cambs) who writes, "It lasted only ten minutes — very weak then very strong and that was it!". Channels affected were E2,E3,E4 and American channels A3 and A4.

Clive Athowe (Blofield, Norfolk) also noted the Band III meteor shower activity on the 14th and in Band I on channel R2 he saw a colour test pattern from Russia (actually from the transmitter located at Tallin) with the identification "EESTI TV". During a Sporadic-E opening on the morning of the 18th, on channel R1 the Russian monochrome "0249" test card was observed followed by an electronically generated type prior to the programme opening sequence at 1130 GMT. Other Sporadic-E successes during November consisted mainly of USSR and Spanish signals on all Band I channels. While checking the FM radio band between 1900 and 2030 GMT on the 19th, a stereo music programme emanating from a southerly direction was heard on 107.40 MHz. There were no announcements or time checks to assist identification. Perhaps it's another UK pirate. Can anyone clear up this mystery?

Finally, Dave Lauder, editor of the DX-TV RX Group Newsletter (see last month's column for details), has designed a spectrum analyser for long-distance television work. It is based on the "Poor Man's Spectrum Analyser" described in a recent issue of 'Rad Com'. Dave's system is different since a television is used as the display device rather than an oscilloscope as in the original design. Although the analyser used a standard varicap tuner a narrowband IF strip at around 36MHz was required which posed something of a problem. This was eventually overcome by down-converting the IF output of the tuner to 10.70MHz to enable a standard FM broadcast IF strip to be employed. Improvements in gain and selectivity are planned although results achieved so far are interesting. There are provisions for manual control over the tuning to enable a particular "blip" to be selected and then listened to in order to ascertain whether it is a sound or vision carrier. The tuning control can be calibrated in frequency for the unit to be used as a monitor receiver for a spot frequency. By feeding the audio output of the monitor into a stereo decoder a very effective DX signal alarm can be made. The decoder is retuned to detect a 15.625kHz "pilot tone" which in this case would be the television line sync frequency. The stereo indicator output of the decoder could be made to operate a bistable or a latching relay to drive an audible warning device.

Figure 3: "Antenne-2" (France) clock and identification caption.

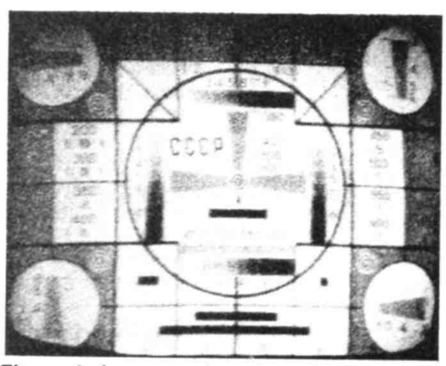


Figure 4: An unusual version of the Russian "0249" monoscopic test card — note the "CCCP" identification.

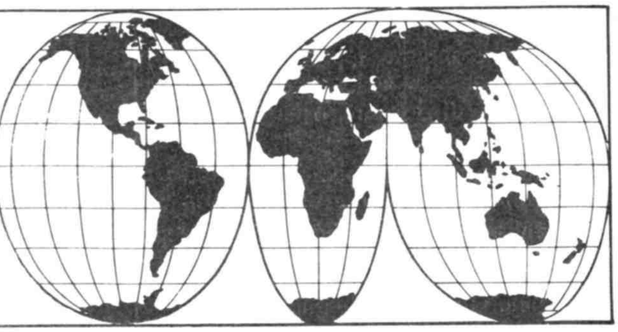
Photos 2,3 and 4 by courtesy of Clive Athowe.

■ R&EW

SHORT WAVE NEWS FOR DX LISTENERS

Frank A. Baldwin

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



NOW THAT WE are in the midst of the season for the best possible chance of hearing transmissions emanating from the Far East, some further details are given here as an aid to interested readers.

Having a try for the following Chinese local stations is one way of commencing your "Dxpedition' this month. On **4865** there is the relatively easy to log Gansu PBS, Lanzhou which indentifies as "Gansu Jen Min Kwang Po Tien Tai". The opening session is at 2140 and it closes as 1600, listen just prior to these times or, under favourable conditions from 1330 to 1400 when they feature an English language lesson.

On **4883** you could pull in Beijing (Peking) around 1530 when it is broadcasting the Foreign Service in Russian (scheduled from 1500 to 1600). It opens at 2200. On **4905** there is Beijing with the Home Service 1 opening at 2000 and closing at 1735 but this one is seasonal, operating here from November through to May inclusive.

Tune to **4925** and you could listen to Heilongjiang PBS, Haerbin (Harbin) which relays Beijing 1, commencing at 2040 (May to October from 2000) and closes at 1530. It has an English language lesson at 2115 to 2145 and from 1310 to 1340. Further up the band there is Hunan PBS on **4990**, it identifies as "Hunan JMKPTT" (as above) and operates from 2100 through to 1620.

A visit to the **4975** channel could produce signals from Fujian PBS, Fuzhou, featuring programmes in the Fujian 1 Service and also relays of Beijing 1 from 2050 to 1600 and following this with a transmission to Taiwan from 1600 to 1810. Next, go up to **5010** at which point on the dial you may be fortunate in logging Guangxi PBS, Nanning, this one opening at 2130 and closing at 1500.

Further up the band there is **5020** on which operates Jiangxi PBS, Nanchang, it opens earlier than the others — at 2000 in fact and closes at 2400 with this particular transmission but opens again at 0855 and closes at 1500.

Tune to **5040** just prior to 2200, at which time Fujian PBS, Fuzhou, opens with the Fujian 1 Service. It closes at 1600. Some 20kHz further up the band you may be able to note Xinjiang PBS, Urumqi, it opens at 2330 and closes at this time of the year at 1700 although it does relay the Beijing Foreign Service in Russian from 1800 to 2055 — accompanied by a jamming overlay from Moscow 2! **5060** is the channel.

Should you fancy to try for some more Malaysian transmitters (see last issue for the first instalment) set your pointer at **4950** which is another channel for Radio Malaysia, Kuching, Sarawak. It opens the proceedings at 2230 and is on the air until 2400, signing-on again at 1000 and closing at 1600, the languages being English and Chinese. Radio Malaysia, Penang is to be found on ***4985*** operating in English and local vernaculars. It opens at 2230 and finally closes at 1630. Like many of these Far Eastern stations, this one has several operating periods, ie 2230 to 0130, 0530 to 0630, and 0930 to 1630 but to make matters easier for readers I have in the main simply mentioned the initial opening and the final closing times, these probably offering the best chance of reception for U.K. enthusiasts.

The **5005** channel presents us with an opportunity to log another Radio Malaysia Sarawak transmitter, this one being based at Sibu. It opens at 2200 and finally closes at 1500, the first transmission lasting just one hour except for Saturdays when it signs-off at 0200. Sarawak is again evident on **5030**, the station at Kuching operating here from 2200 with the final closing at 1500.

Then there is Burma in the shape of BBS Rangoon on **5040** which radiates the Home Service in Burmese from 0930 to 1430 and is in English from 1430 to 1600 and all with a power of 50kW. Or Singapore on **5010** and in parallel on **5052**. I find the latter channel to be the best on most occasions, the language used is English this making station identification an easy matter. The schedule is from 2230 through to 1630 on this last mentioned frequency.

With a little luck, North Korea may be coming through on **4771** although in fact Pyongyang is listed on **4770**. This one operates the Foreign Service in Korean and is sometimes logged here just prior to the closing time of 1555.

The next instalment will deal with some difficult to log transmitters based in the Far East.

Amateur Bands

A few sessions on these bands brought some changes from roving over the various broadcast channels. Top Band provided some thrills and spills as far as I was concerned. Always a favourite haunt of mine, the 160 metre portion of the dial more often than not provides much of interest when using, as usual, the CW mode. Dx being relative to the band in use, any signal over 200 miles distant from the reception point is generally considered to be in that category.

Top Band (1800-2000kHz)

Listening intently for the dots and dashes the following were resolved. From Germany there were DJ8FW, DK2ZM/A, DK4FM, DK8SV, DL300K whilst France was represented by F30A, F6BWO, F9KP (a regular on the band), F9YZ (so is he), then from Bonnie Scotland we heard GM4IPS, Wales being logged via signals from GW3YDX and GW4BRS.

Switzerland put in an appearance with HB9AJU and HB9BG whilst from Norway there was LA0BS pounding away into Central Europe. Then we have OE5KE and OE9JKH from Austria, OK1DWF, OL2VAG, OL4BET, OL4BDY and OL8CMP from Czechoslavakia, OZ1DX from Demark, RA3ZGM from the USSR, SM4FPD and SM5YS from Sweden. SP1ADM from Poland, UA1AFZ and UB5MPE from the USSR, UP2BEW from Lithuania, UQ2GFU from Latvia, YU3NP from Yugoslavia with ZB2EO bringing up the rear.

Three late log entries since typing the above were EA3AQS from Spain, EZ6AED from I don't know where and LZ2SC from Bulgaria.

All in all, quite a good month on Top Band.

40 metres (7000-7100kHz)

If you can stand all the hassle then forty metres is the band for you. Amid the welter of CW and broadcast QRM one can occasionally sort out some moderate Dx — which is just about all I managed on this occasion.

CO8AC putting in a fair signal from Cuba — but at 0400, PS8AKL and PY7COT from Brazil both working into Europe, SV2QV from Greece vainly calling CQ, UA9MFB in Asiatic USSR, UB5BAX and UB5BIC from the Ukraine, UD6DLL from Azerbaijan, UT5HP also from the Ukraine, VE3II being the only Canadian logged and, last but not least, W4SU from the States.

Nothing very startling but it was the best I could do.

20 metres (1400-14350kHz)

Three short but intensive forays on this band just produced the following — conditions must have been bad!

Commencing with CE3WD in Chile we proceed to FG8CC in Guadeloupe, HK3BBJ in Colombia, KL7JP in Alaska, LU5BB and LU8FE in Argentina, PY1EMM, PY5MM, PY5BI and PY7AMF in Brazil, VK2ZC and VK5AK in Australia, VP9DR in Bermuda, YV1AD in Venezuela, 5B4LY in Cyprus and 9K2DX in Kuwait. An oddity, at least to me, was KP2G.

15 metres (2100-21450kHz)

Several sessions on this part of the dial resulted in FM7CT from Martinique, HK2DP in Colombia, JA1ATF, JA3YKC (rattling away at something like 25 wpm) and JA7AS in Japan, PY2GTL in Brazil, UF6FFF in Geogia, USSR, VP9AM in Bermuda and lastly ZS6CS in South Africa. Oddities? Yes, what about Z2JT or 4N4MW?

All of that just about wraps up the Amateur Band scene for this occasion.

Around The Dial

In which are presented some recent loggings which will act as guides to those exploring the short wave bands as short wave listeners and for those who aspire to the rating of Dxer. A start is made with -

Indonesia

RRI (Radio Republik Indonesia) Medan on **4764** at 1535, OM with a talk in Indonesian. This Sumatran-based transmitter is on the air from 2300 to 0300 and from 0900 to 1700 with a power of 50kW and is therefore a relatively easy Indonesian to log.

RRI Bukittinggi on **4910** at 1550, YL with a newscast in Indonesian, several mentions of Bandung. Bukittinggi operates from 2300 to 0300, from 0500 to 0715 and from 0930 through to 1600. The power is just 1kW.

RRI Yogyakarta on a measured **5046** at 1559, Om and YL alternate with announcements in Indonesian. This Java based transmitter is on the air from 2300 to 0300, 0455 to 0800 and from 0955 to 1700. The power is 20kW.

RRI Banda Aceh on **4955** at 1541, OM with a song in Indonesian, gamelan music. The schedule of this one is from 2300 to 0100 (Sunday until 0600) and from 1100 to 1600. Sumatra based, it has a power of 10kW and the local time is GMT +7 hours.

RRI Jambi on a measured **4927** at 1543, OM with announcements in Indonesian. Jambi is scheduled from 2200 to 0600 and from 1100 to 1600. Sited in Sumatra the power is 7.5kW and is also GMT +7 hours.

India

1AIR (All India Radio) Hyderabad on **4800** at 1542, OM with a newscast in English Hyderabad is sheduled from 0025 to 0215 and from 1200 (March to April from 1130) to 1740. English newscasts are timed at 1230 and 1530, the power being 10kW.

AIR Calcutta on **4820** at 1545, YL with songs in Hindi during the scheduled 1230 to 1740 transmission. Also on the air from 0025 to 0215, the power is 10kW.

AIR Bombay on **4840** at 1547, OM with a song in vernacular complete with local orchestral backing. Bombay is timed from 0025 to 0430 and from 1230 to 1730. English newscasts are at 1530 and 1730 in English.

Pakistan

PBC Islamabad on **5060** at 0203, YL with a talk in vernacular in the Regional Service timed on this channel from 0045 (December to March from 0130) to 0230 (September to October to 0210 and from 1400) 1600 (November to February from 1630) to 1800. The power is 100kW, the schedule being seasonally based and complicated — as shown.

Colombia

Radio Cinco, Villvicencio on **5040** at 0525, OM with announcements and promos in Spanish, OM with a pop love song. Radio Cinco operates around the clock, is part of the Caracol Network and has a power of 3kW. Villvicencio is a town set in the foothills of the Andes in Eastern Colombia.

Radio Caracol, Neiva on **4945** at 0521, YL with a pop song in Spanish. Formerly Radio Colosal, this one operates on a 24-hour schedule, the power being 2.5kW.

Radio Super, Medillin on **4875** at 0518, OM with station identification in Spanish, guitar music. Radio Super has a power of 2kW and also operates around the clock.

Radio Surcolombiana, Neiva on **5010** at 0232, OM with folk songs in Spanish followed by announcements and promos. The power is 2.5kW.

Bolivia

Radio Abaroa, Riberalta on **4730** at 0238, YL with Spanish songs complete with guitar backing. This one is on the air from 1000 to 0400 and the power is just 0.5kW. The frequency is likely to vary slightly from that shown.

Radio Nueva America, La Paz on **4797** at 0246, OM with a talk in Spanish on internal events, several place names being mentioned. With a power of 10kW, Radio Nueva America is on the air from 1000 to 0400 but is not an easy one to log owing to the close proximity of La Voz de los Caras in Ecuador operating on **4795**. A selective receiver is required to sort these two transmissions.

Radio Frontera, Yacuiba on **4805** at 0155. OM with a speech all about local politics, OM with a clear station identification at 0200. Radio Frontera operates from 1100 to 0400 and has a power of 1kW.

Ecuador

La Voz de los Caras, Bahia de Caraques on **4795** at 0240, OM with announcements and a programme of local pops during the schedule 1100 to 0430. The power is 5kW.

Radio Nacional Espejo, Quito on **4680** at 0312, OM with a newscast of Latin American events — in Spanish of course. This one operates around the clock and has a power of 5kW.

CRE Guayaquil on a measured **4656** at 0314, pop songs, local-style dance music interspersed with many announcements, promos etc. The schedule is from 0900 (Sunday from 1100) to 0500 but the closing time is variable, the power being 10kW.

Thailand

Bangkok on **4830** at 1546, OM with a talk in Thai. Radio Thailand is on this channel from 2245 to 0700 and from 1000 to 1630 with a power of 10kW.

Burma

BBS Rangon on **5040** at 1558, YL with a pop song in English. This was a transmision in the Home Service which is on the air from 0930 to 1430 in Burmese and from 1430 to 1600 in English. The power is 50kW.

Nepal

Radio Nepal on **5005** at 1537, OM with a song in Nepali, the schedule being from 0020 to 0350 (Sunday until 0450) from 0730 to 1050 and from 1150 to 1720, the power being 5kW.

China

Xinjiang PBS, Urumqi on 4735 at 1809, YL with the Russian transmission, timed from 1800 to 2100, this being a relay of the Radio Peking programme in that language. Urumqi carries programmes in the Home Service including those in Uigher and some relays of Radio Peking from 2230 to 0200 and from 1045 to 1730.

Radio Peking on **11600** at 1455, YL with songs in Chinese during the English Service directed to South Asia, which may be heard on this channel from 1400 to 1500.

Radio Peking on **11695** at 1450, YL with songs and local-style orchestral music in the Cambodian transmission, times from 1400 to 1500.

Radio Peking on **8566** at 1444, YL with announcements during the Kazakh programme in the Domestic Minorities Service, this language being featured from 1400 to 1455. Also logged in parallel on **5440**.

Radio Peking on **5320** at 2120, OM with instructions for physical exercises set to music in a Home Service 1 transmission, on this frequency from 2000 to 0030 and from 1100 to 1735 — all in Chinese.

Yunnan PBS on **4760** at 2320, YL with songs in Chinese, YL announcer. This is Yunnan 1 with both local and Radio Peking programmes, operating from 2150 to 0600 (Tuesday and Sunday until 0800) and from 0920 through to 1600.

North Korea

Pyongyang on **11985** at 0719, YL with station identification in English and news comment — all about nuclear weapons — in the English transmission for Europe, timed from 0600 to 0750.

Venezuela

Radio Tachira, San Cristobal on **4830** at 0202, OM's with a discussion in Spanish about the oil and fiscal matters. The schedule is from 1000 to 0500 and the power is 10kW.

Radio Maturin on **5040** at 0206, OM with promos in Spanish then into a programme of Latin American style music. Radio Maturin is on the air from 0900 to 0400 and the power is 10kW.

Chile

Radio Nacional de Chile, "La Voz de Chile" Santiago on **9550** at 2300, OM with a sporting commentary in Spanish. The schedule is from 1000 to 1510 and from 1810 to 0350.

Clandestine

From time to time I make mention of the so-called clandestine stations in these columns, it being to my knowledge that some readers are very interested in these transmissions. Some of the clandestines recently logged are listed here.

"Voice of the Libyan People" on **12645** at 2055, OM with identification in Arabic, trumpet fanfares and sign-off.

"Voice of the Sudanese Popular Revolution" on **17940** at 1420, OM with a talk in Arabic with many mentions of the Sudan (Sudaniya) and a few of Palestine for good measure.

"Radio Venceremos" on **6852** at 0304, OM with news from the combattant forces in E1 Salvador, this being followed by some military music then YL with news of events in Costa Rica and other South American countries. All in Spanish of course. A few nights later however, this one was logged on **6842** presumably to dodge the jammer.

"Voice of Irans" on **11640** at 1948, YL in Persian — more of a tirade than a talk! This one supports the former Premier Bakhtiar.

Kenya

Nairobi on **4915** at 0540, YL with a talk in Swahili. Good signal strengths from the African continent can often be apparent in the early mornings. This talk was in the National Service — all in Swahili — which operates from 0255 (Sunday from 0330) to 0630 and from 1330 to 2005 (Saturday until 2115). The power is 100kW.

Nairobi on **4934** at 1844, typical local-style music in the North Eastern and Coastal Service operating here from 0250 to 0630 and from 1420 to 2010. The power is 20kW.

DX Feat

Although I do not record Medium Wave events in these columns, I make this one exception if only to bring to the attention of readers the possibilities of this band.

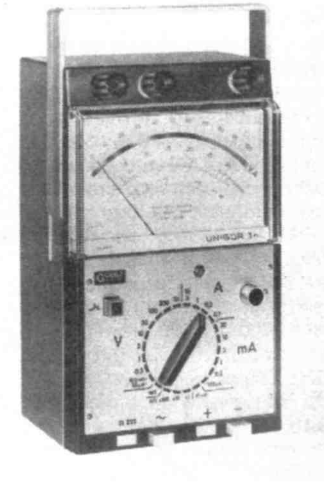
Reader Ian Anderson of Lerwick in Shetland wrote informing me that he had logged Radio Dieciocho de Mayo ("Radio 18th May") in Capinota, a small town located south-east of La Paz in Bolivia. The power is listed at just 250 watts and on a good night for Latin American reception the signal strength recorded was S9 on a 'graveyard' frequency of many other LA small local stations. Congratulations Ian and thanks for your letter.

NEW PRODUCTS

Accurate Analogue

House of Instruments announce the availability of the Unigor 3n, which features 52 measuring ranges ideal for light current engineering and electronics, radio, TV and other communications. When matched with its major competitors, the features of particular interest are: one rotary switch for 52 measuring ranges — nearly 32k ohms/volt sensitivity — better than 0.5 percent accuracy — frequency response up to 50kHz — 0 to 500 ohms low resistance range and 50M ohms high range.

AC and DC voltage ranges are from 100mV full scale to 1000V, while current ranges are 100 microamps to 10 amps full scale. A range of optional accessories are available including a strong leather carry-case. The meter is supplied with test leads, test prods, spare fuses, battery and instruction manual and measures 128 × 205 × 100mm. It is fully guaranteed for 1 full year and costs £100.

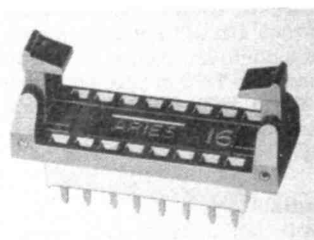


House of Instruments,
Clifton Chambers,
62 High Street,
SAFFRON WALDEN,
Essex CB10 1EE.

Socket And See

A low-profile IC socket, which locks the device into position and also provides an ejecting action when the device has to be withdrawn, has just been introduced by Aries Electronics of Witham, Essex. The Eject-A-Dip socket is available in 14, 16 and 24 pin configurations. It incorporates a pivoting arm at each end, which lock the device into the socket. When the arms are pushed outward to release the device they provide a lever action which ejects the integrated circuit from the socket without damaging the legs.

The socket has gold or tin-plated, phosphor-bronze contacts, designed to take both round or flat pins.



Aries Electronics,
Unit E,
Metrostore House,
Eastways Industrial Estate,
WITHAM,
Essex

Minis From Quiller

A new miniature audio indicator, from American buzzer manufacturers 'Projects Unlimited', is available from sole UK agents Quiller Components.

Measuring only 14mm high with 16mm diameter, the AT-01 series of electro-acoustic transducers is intended for PCB mounting and suitable for wave soldering. Three voltages are offered : 1-3V, 4-9V and 16-18V with a sound output of approximately 70dBA at 8" (2.1kHz).

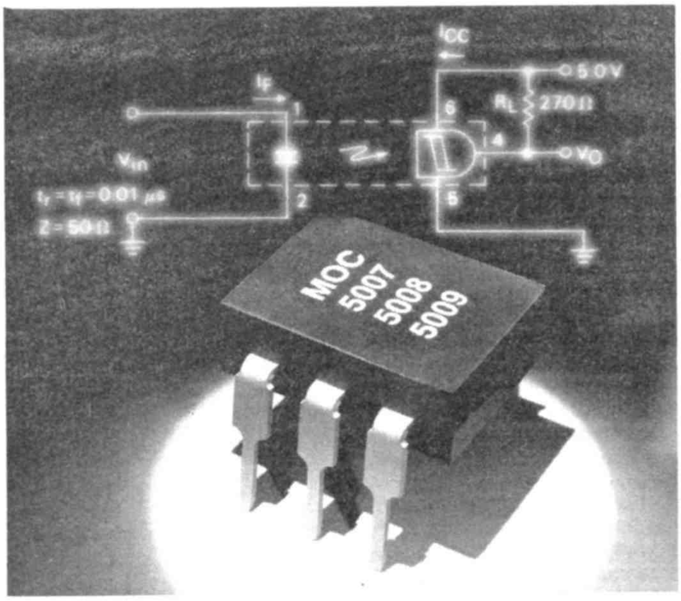
The AT-01 contains no electronics and transforms AC voltages to sound pressure waves. Typical applications include electronic games, computer terminals and warning devices for portable equipment.

Quiller Components Ltd.,
85 Stanley Road,
BOURNEMOUTH,
Hants BH1 4SD.

Isolation For Schmitt

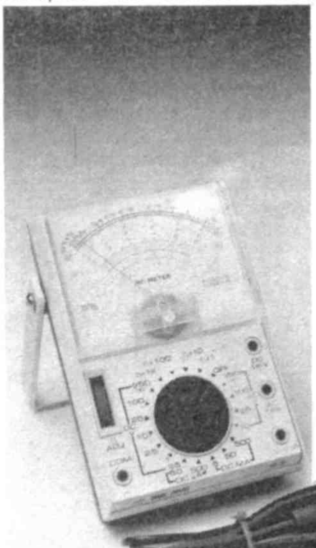
Motorola has announced a range of infra-red optocouplers with Schmitt-Trigger output. By providing a digital output without the use of comparators or other off-chip wave shape circuitry, they are particularly well suited for interfacing computer terminals to peripheral equipment, as well as for digital control of power supplies, motors and other servo applications.

The series of five gallium arsenide couplers feature guaranteed switching time of under 4us, making them suitable for high-speed logic interfacing.



Hi Buzz

The HM 102BZ is the latest addition to the House of Instruments range of analogue multimeters, based on the popular and accepted HM 101/102 series.



New features include an audible tone for quicker and easier continuity checks, an extra coloured meter scale offering rapid indication for external battery testing and full 10A current capability.

Other facilities include: 20,000 ohms/volt sensitivity, full DCV, ACV, DC1 and Ohms ranges and a dB scale with mirror arc to reduce parallax errors. A carrying handle can also be used as a tilt stand for bench use.

All models are good value for money with a host of general purpose applications. Housed in high impact resistant cases they come complete with test leads, battery and handbook. Prices (excluding p&p and VAT) are £5.75 for the 101R, £11.50 for the 102R and £13.00 for the 102BZ.

House of Instruments,
62 High Street,
SAFFRON WALDEN,
Essex CB10 IEE.

NEW PRODUCTS

Portable Forces

Frank Cody Electronics limited of Staines, Middlesex are pleased to announce that they have been appointed the exclusive UK distributors for the Force range of VHF and UHF hand portables. The range consists of 8 model variations covering many frequencies. The VHF and UHF models now available include the following:

VHF — 2 to 5 watts RF Power Output. 2 to 6 Channel capability on 148-174MHz.

UHF — 2 to 4 watts RF Power Output. 2 to 4 Channel capability on 450-470MHz.

One of the unique features of the Force Portables is the capacity for multi-channel operation combined with simultaneous CTCSS and 5 tone signalling. The signalling options available include CTCSS and/or 5 tone, CCIR/ZVEI or touch tone. The CTCSS tone control squelch is mounted on the main board to save valuable option space at the bottom of the radio.

A full range of accessories are available, which include speaker microphones with built-in antennae and surveillance kits. Also available is a multi-unit charger, a leather carrying case, headsets and a vehicle conversion charger which enables the portable to be used as a mobile unit. The vehicle charger is supplied complete with a mobile microphone, external speaker, mounting hardware and antenna connector.

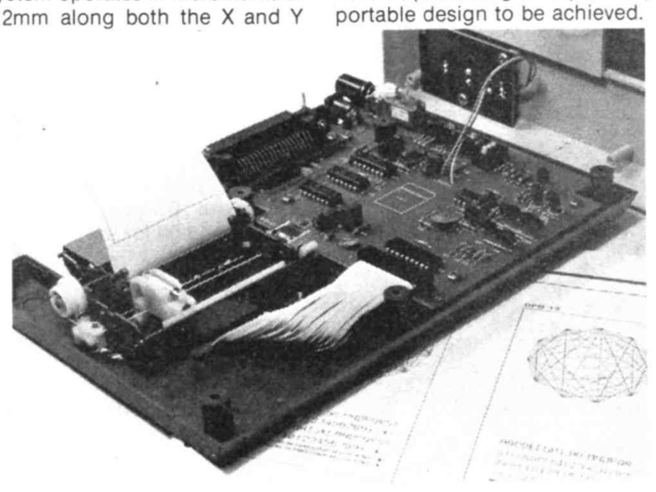
Frank Cody Electronics Ltd.,
Star House,
Gresham Road,
STAINES
Middlesex TW18 2AN.

Plotters In Colour

Ambit International are supplying and supporting a range of miniature low-cost drum plotter mechanisms, with 2" and 4" carriages. These unique printer plotters use 4 ballpoint cartridges in a rotating head to provide red, green, blue and black output onto plain roll fed paper. Power consumption averages at around 170mA at 5V, when plotting is in progress.

The step motor positioning system operates in increments of 0.2mm along both the X and Y axes, at a maximum rate of 260 steps per second, and may be driven from a custom MCU that provides a Centronics parallel interface (or a 600 baud RS232 serial interface), making the system compatible with virtually any microcomputer on the market.

The LSI driver also contains a complete character set and is supplied with all necessary information to allow programming from BASIC. The device is available in either NMOS or CMOS, permitting a fully battery portable design to be achieved.



Computing Digits

The model DMM 1905a from Thurlby Electronics is a 5½ digit general purpose bench multimeter, with extensive calculating and data-storage facilities.

Based around a 6502 microprocessor, the meter uses 8K bytes of program storage ROM, of which about 3K is used to control the A to D converter display and keyboard and the remaining 5K providing calculating functions and programmable data storage.

Unlike most 5½ digit DMMs, which tend to be volt — ohm meters only, the 1905a has a full complement of AC functions and current ranges as standard. More importantly, the 1905a costs under £300, which puts it in the same price bracket as conventional 4½ digit DMMs that lack it's high resolution, sensitivity and calculating power.

The 31 ranges provided cover DC voltage from 1uV to 1100 volts, AC voltage from 10uV to 750V, resistance from 1M to 21M, DC current from 1nA to 5 amps and AC current from 10nA to 5 amps. Basic accuracy (DCV) is 0.015% guaranteed for 1 year. The two lower voltages ranges can be selected at either 10M input impedance or 10,000M to avoid loading errors when measuring high impedance circuitry.

Access to the meter's intelligent capabilities is achieved through it's built-in 20 key pad. Examples of the intelligent functions include linear scaling with offset (Ax+b), a 'delta-percent' function, which enables the percentage deviation from an entered nominal to be displayed to a resolution of 0.001% (up to ±400%). Since each of the programs can be operated simultaneously with others, it is possible to measure an electrical output, scale and offset it to achieve the required engineering units, calculate the percentage deviation from the required nominal, and set maximum and minimum limits for that deviation. The 1905a can thus act as a simple stand-alone test system providing the user with information in a directly relevant format.

Other intelligent functions include dB calculation, general logarithmic calculation, single key automatic nulling or change of zero reference, and discontinuous averaging of measurement data. The meter can also store up to 100 readings in memory which can be later recalled to the display.

The Thurlby 1905a is designed and built in Britain and costs £298 + VAT.

Thurlby Electronics Ltd.,
Coach Mews,
ST. IVES.
Cambs. PE17 4BN.

How Low Can You Get?

There are many occasions in process control and data acquisition systems when it is necessary to capture and digitise low-level analogue signals. The 16-channel SDM 854 hybrid data acquisition system will perform this task easily. It accepts input voltages in the range 0 to 10V and only requires a precision instrumentation amplifier to amplify the output of the sensors (the INA 101 from Burr-Brown is ideally suited). The amplifier is connected between the multiplexer and the sample/hold amplifier that form an integral part of the SDM 854.

Burr-Brown International Ltd.,
Cassiobury House,
11-19 Station Road,
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Herts WD1 1EA.

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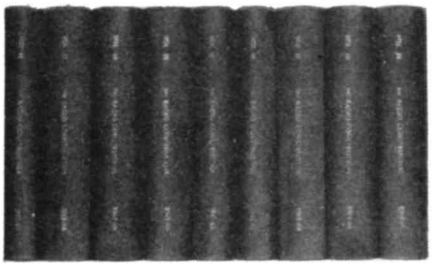

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THE LAST WORD.

Gary Evans with . . .

The R&EW offices, like the magazine itself, are packed with hi-tech goodies. Amongst this cornucopia of technological marvels, we have for a year or so numbered two photocopiers. One of these is a basic, no frills copier that simply never breaks down — boring but reliable. The other is a versatile machine that amongst many tricks, can enlarge and reduce original documents. This piece of junk was forever breaking down though.

We've just acquired a new model to replace the later copier and in view of the frustration caused by its predecessor, it's not surprising that the new arrival has been greeted with the same degree of joy as that shown by the nation upon the arrival of Prince William.

The new machine must be MPU based as it is blessed with a multi-pad touch-sensitive keyboard and an array of indicator lights that are wont to flash in various permutations and combinations during the machine's operation. It's rumoured that some members of staff were sent on an intensive machine acclimatisation course — what ever happened to the idea that MPUs would make machines easier to use.

The new machine, unlike its predecessor, simply does not jam. By some ingenious system, a paper misfeed is nipped in the bud — before the paper can be sucked into the bowels of the machine.

Although the new copier does not jam, it cannot be said to be faultless in operation, instead of jamming however, it simply shuts down and displays one of a series of error messages. So far I've managed to provoke two such anouncements.

The first was PI, which I took to mean Paper Interupt, and took appropriate action.

The second was PO which I took to mean . . . well suffice it to say I left the machine to its own devices, muttering a few choice words under my breath, as I went in search of the simpler, but reliable, machine.

Shocking News

During a recent end of year clear out a rather old press release from the Electricity Council came to light. It was put out at the height of the CB craze in '82 and, as it contains important pointers as to the intelligence level of the average CB'er, we thought you'd like to see it even at this late stage.

CB and amateur radio enthusiasts are warned not to endanger their own lives and the lives of others by putting up aerials too near overhead lines.

Tall 'whip' aerials present a special hazard but extreme care should be taken with all aerials. Safety clearances from electrical equipment, especially overhead lines, vary considerably and depend on such factors as the voltage of the equipment, ground contours, aerials height, wind strength and air temperature. An aerial does not even have to touch a power line to conduct electricity, as it can, through a spark, jump gaps.

If an aerial is to be erected within a distance of three times the overall aerial height from overhead electrical equipment, there is potential danger, so contact the Electricity board for their free advice if there is any doubt. Also remember that any permanently sited aerial of more than three metres will require planning permission from the local authority.

It is not only aerials that can be dangerous if used too close to overhead power lines. Aluminium ladders, tent poles and sailing dinghy masts, kites line-controlled model aeroplanes and fishing rods and lines all need careful handling to avoid a tragic accident.

White's Dept

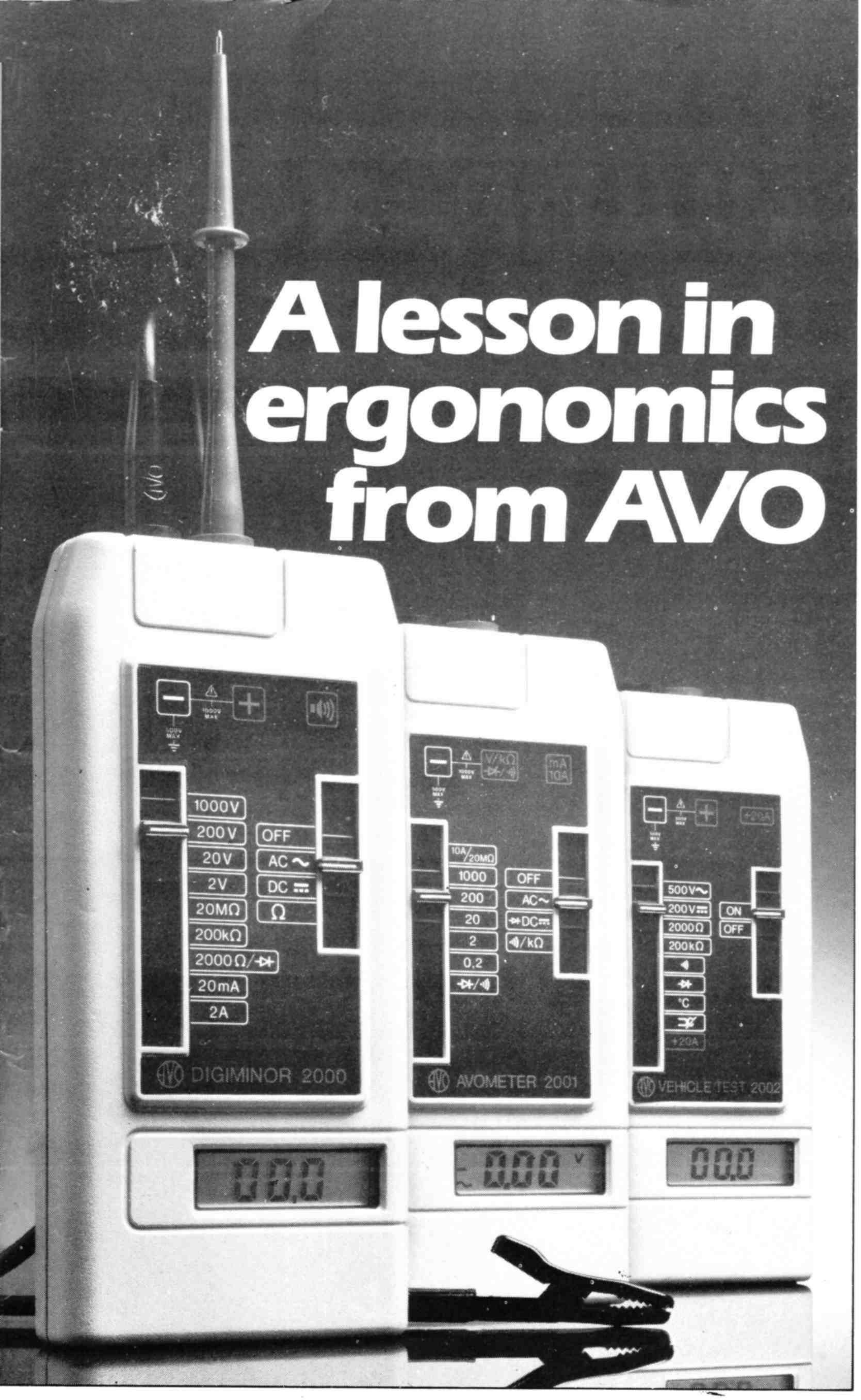
John White, **R&EW's** Advertisement Manager, has been feeling left out of things recently. After the story of Paul Coster's car — that saga continues incidentally, the written off vehicle being involved in another accident after being written off! — Mr White felt that he too deserved a mention.

A story concerning said Advertisement Manager came to light the other day but, unfortunately, cannot be printed for fear of harming the innocent. We'll just say that Mr White's pay cheque will be adjusted accordingly.

Advertisers' Index

PLEASE NOTE: For a variety of reasons we have found it necessary to discontinue our prepaid reader response card and book order forms. We hope that those of you who have used this service in the past will not miss this facility too much.

Subscribers will still be able to make use of a similar system which will be included in future editions of News Brief.



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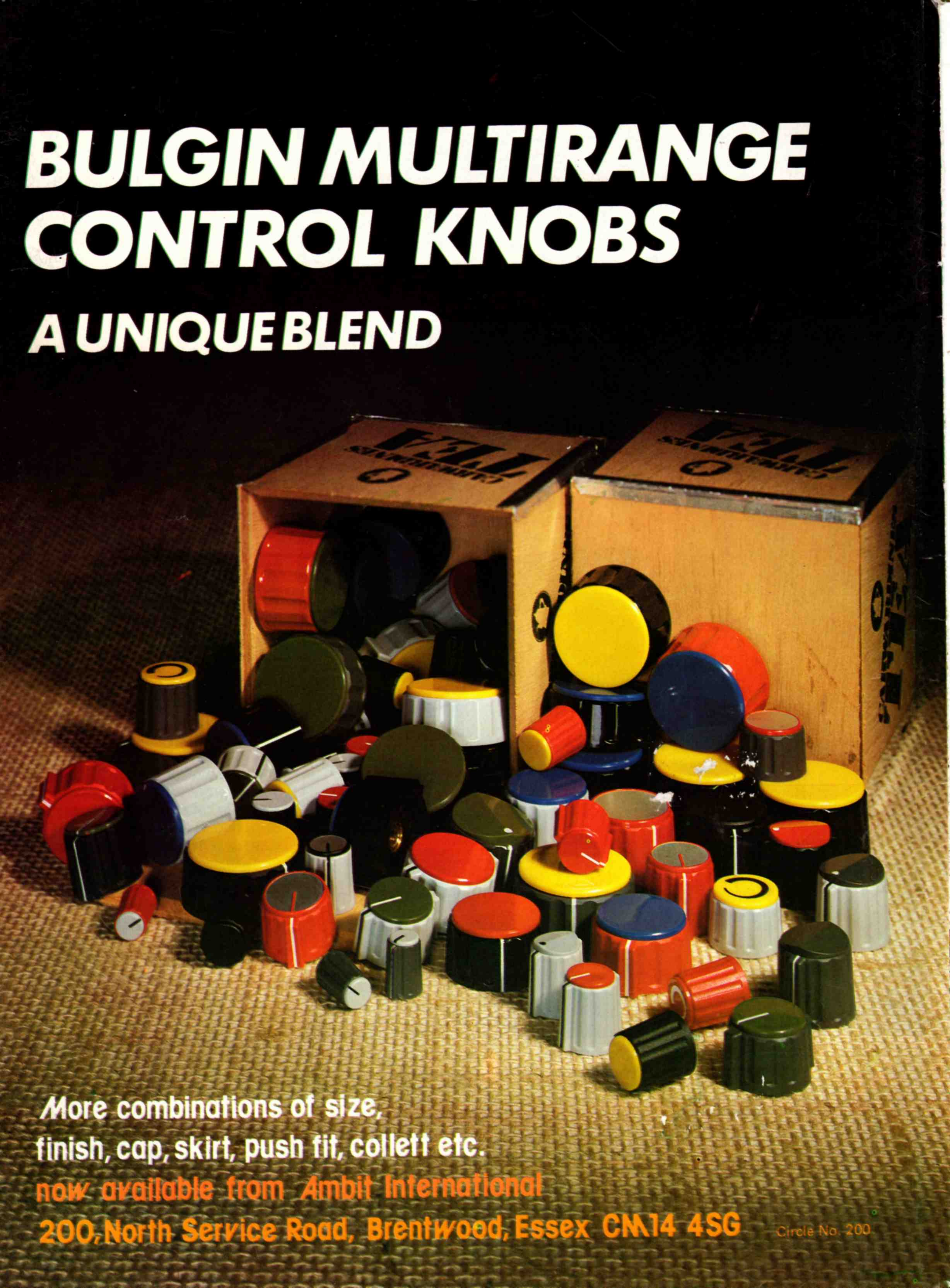
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Lesson 1

Z8000 Course

BASIC ARCHITECTURE

OUTLINE

The Z8000 is a microprocessor capable of a variety of applications formerly only achievable with mini- or large computers. Just as the development of minicomputers vastly improved the performance-to-cost ratio of computing, the Z8000 represents a further, equally significant step; it brings low-cost, high-powered computing closer to where it is needed and is directly usable in advanced system designs. The Z8000 opens new possibilities for applying computing power to the solution of problems, because its features extend beyond those of earlier microprocessors and of some minicomputers as well. In fact, the Z8000 incorporates, in one LSI circuit, features that presently are found only in large-scale computers.

The Z8000 is the first member of a *family* of processors, intelligent peripherals and support devices, all communicating via a hierarchical logical structure called the *Z-Bus*. This organization of inter-device control and signalling imposes a coherent communications structure that can be extended upward to the system level. It is important to view the Z-Bus as a family of structures capable of handling the simple tasks of I/O transactions as well as the more complex needs of large-scale *memory management*. In reality, therefore, the Z-Bus is more than a logical concept; it is a definition that extends in detail down to the level of signal amplitude and timing, and it is a fundamental subject in any discussion of the Z8000.

PHYSICAL CHARACTERISTICS

The Z8000 is a *single-voltage* MOS integrated circuit measuring slightly more than ¼ inch on a side and containing the equivalent of more than 18,000 transistors. It is a microprocessor, and not a microcomputer, because it contains only register, instruction and control circuitry; all memory for program and data storage must be addressed externally. In addition, its design relies primarily on dedicated logic, instead of microcode, to execute instructions. This results in a somewhat smaller physical size for the Z8000 chip as well as improved manufacturability and speed.

Two Versions: Z8001 and Z8002

The Z8000 is manufactured in two versions: The *48-pin Z8001* and the *40-pin Z8002,* which *differ only in the manner and range of memory addressing.* Physically, the two chips are identical, with a 49th bonding pad used to configure the desired product via internal logic. While the Z8002 can address up to six distinct, external memory spaces of 64 K (65,536) bytes each, the Z8001 can address six spaces consisting of 128 segments that are each 64 K in size. In fact, a Z8001 program can directly address, in this way, 48M bytes. Except for this feature, called *memory segmentation,* the Z8001 and Z8002 are functionally identical. In particular, both make use of a multiplexed address and data bus that conforms to the Z-Bus definition by providing strobed address and data transfers between the Z8000 and external devices.

From the standpoint of external data transfers and elementary addressing, the Z8000 is a *16-bit* device. In a typical transfer, an address is emitted on AD15 through AD0 (and SN 6:0 for the Z8001); external devices are signalled of its validity by an *address strobe* ($\overline{AS}$). At a later time, during both writing or reading of data, a *data strobe* ($\overline{DS}$) is generated to signal that written data is valid or that read data may be placed on the bus by the external device. The $\overline{WAIT}$ input will allow slower external devices to stretch $\overline{DS}$ for as many clock cycles as necessary to receive or assemble the data. In any case, a 16-bit address directs a 16-bit data transfer that is essentially independent of the processor's clock and is thus asynchronous.

Control Signals

Several control signals other than $\overline{AS}$ and $\overline{DS}$ are provided. $\overline{MREQ}$ allows the designer to segregate memory from other devices thereby providing two 64K address spaces. READ/$\overline{WRITE}$ controls the direction of data transfers, while BYTE/$\overline{WORD}$ indicates their size, when relevant. (The bar over a signal designation means that the signal is in its true, or active, state when the signal is low, or at nearly ground potential.)

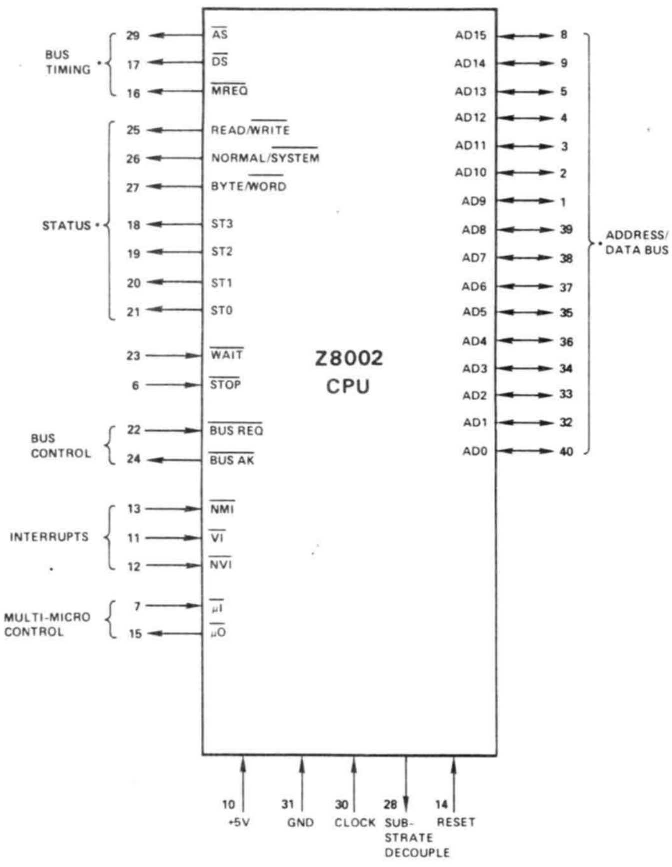


Figure 2
Z8000 Pin Functions

Some of the signals emitted by a Z8000 provide details of the processor's running *status*, and some of these may or may not be used in a given application. The *NORMAL/$\overline{SYSTEM}$* line and the ST (status) lines have optional uses.

NORMAL/$\overline{SYSTEM}$ can be used to create *two distinct memory spaces,* for example. The *System Mode* of operation in a Z8000 is the most general, unprotected mode in which all the features of the processor are available to the running program. *Normal Mode* is more like the "user" mode on a timesharing system, in which the running program is isolated from potentially dangerous activities, such as changing system parameters. Thus a memory system that makes use of the NORMAL/$\overline{SYSTEM}$ signal can implement protection features that prevent individual processes from disrupting the overall operating system.

ST3:ST0	MEANING
0000	INTERNAL OPERATION
0001	MEMORY REFRESH ACTIVE
0010	I/O REFERENCE
0011	SPECIAL I/O REFERENCE
0100	SEGMENT TRAP ACKNOWLEDGE
0101	NONMASKABLE – INTERRUPT ACKNOWLEDGE
0110	NONVECTORED – INTERRUPT ACKNOWLEDGE
0111	VECTORED – INTERRUPT ACKNOWLEDGE
1000	DATA MEMORY REQUEST
1001	STACK MEMORY REQUEST
1010	DATA MEMORY (EPU)
1011	STACK MEMORY (EPU)
1100	INSTRUCTION FETCH, NTH WORD (CODE MEMORY)
1101	INSTRUCTION FETCH, FIRST WORD (CODE MEMORY)
1110	EPU TRANSFER
1111	RESERVED

Figure 3
The ST Outputs

Status Outputs

The four *ST Outputs* are intended to be decoded by the designer's hardware to allow, for instance, a memory controller to sense memory refresh accesses and/or to segregate program, data and stack memory areas. The latter, when combined with use of the NORMAL/$\overline{SYSTEM}$ output, allows physical memory to be divided into six regions: normal program, data, and stack; and system program, data, and stack.

The ST codes also signal I/O accesses to Z-Bus peripherals and special CPU support devices (like the Z8010 memory-management unit), thereby further expanding the I/O address space.

Interrupts

Interrupt acknowledgement is also provided to peripherals via the ST lines. Z-Bus devices thus obey a very simple and efficient protocol for interrupt processing: assert an interrupt until its acknowledge code is emitted, and terminate interrupt handling when a specific completion code is received from the service software. software.

The Z8000, in fact, accepts three types of *interrupt request:* Nonmaskable (NMI), Nonvectored (NVI), and Vectored (VI). NMI requests are edge triggered and may not be disabled (masked) by software. Both NMI and NVI requests automatically select unique service routines, as defined by system software. Acknowledged VI requests are more flexible because the peripheral supplies a *vector* (byte) that the Z8000 uses to select one of many possible service routines defined, again, by software.

Bus Control

As a Z-Bus processor, the Z8000 allows the bus to be shared with other devices that operate independently of the CPU. The $\overline{BUSRQ}$ input allows another device to ask for use of the sharable lines (denoted by *) and to be granted such a *bus request* via the $\overline{BUSAK}$ output. Later, when the external device signals it is done by releasing $\overline{BUSRQ}$, the Z8000 reassumes its normal status as *Bus Master* and continues program execution wherever it was frozen, perhaps even in the midst of an instruction. BUSAK can be incorporated into a priority-resolution daisy-chain for several external devices.

Multi-Micro Control

The Micro-In ($\overline{\mu I}$) and Micro-Out ($\overline{\mu O}$) lines, in conjunction with special Z8000 instructions, allow a more general form of *resource sharing* among *multiple Z8000's*. $\overline{\mu I}$ is multiplexed by $\overline{\mu O}$ acting on external hardware and indicates to software the availability of the sharable resource. Then, when software requests the resource via $\overline{\mu O}$, $\overline{\mu I}$ senses acknowledgement. This allows a priority scheme to resolve the winner in simultaneous requests from competing CPU's.

STOP Input

For special purposes, external devices can control the execution of a Z8000 program by activating the $\overline{STOP}$ input. This freezes the next instruction without the loss of memory refresh that occurs in bus requests but the Z8000 does not relinquish the bus unless so requested. $\overline{STOP}$ is also used to synchronize the interactions of a Z8000 and extended-processor units (EPU's), which can, for example, perform floating point operations.

RESET Input

Any processor must begin operation from a power-on or other restart condition in an organized way. The $\overline{RESET}$ input causes the Z8000 to clear itself completely (even of interrupt and bus requests) and fetch from memory location 2 all the information necessary to begin system-software execution.

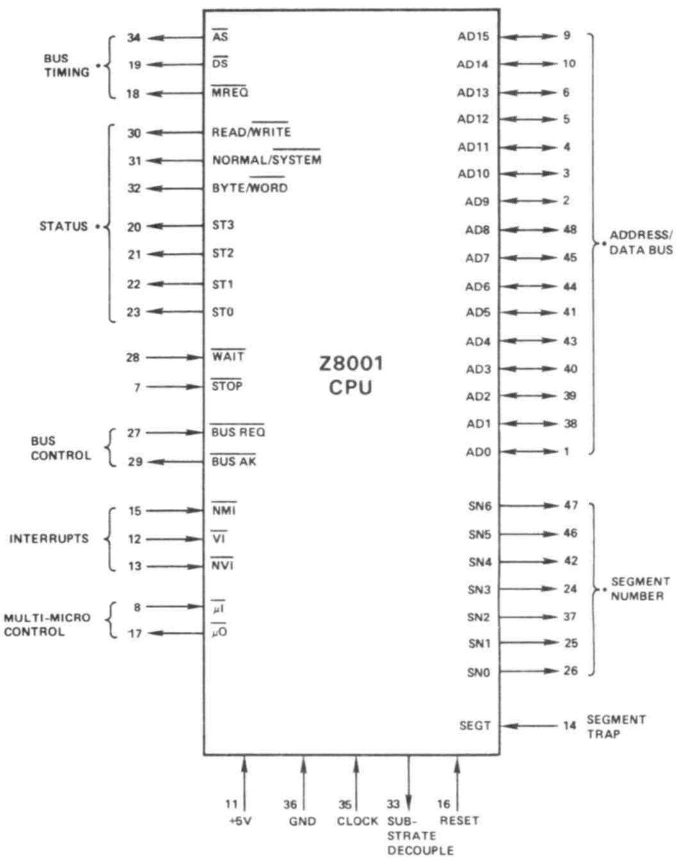


Figure 4
Z8001 Pin Functions

Z8001 Memory Addressing

The Z8001 adds the ability to address memory in 128, 64K segments using the SN (segment number) outputs. The bit pattern on these lines is the upper portion of a *segmented address* in the Z8001, and is distinct from the lower portion: the 16-bit offset on the AD lines. Address arithmetic operation on the offset portion of a segmented address cannot affect the segment number portion; it must be modified explicitly and distinctly.

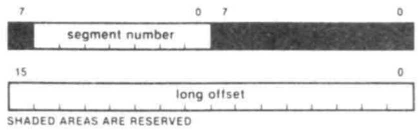


Figure 5
A Segmented Address

The SN outputs may thus be used by memory control circuitry in very simple ways to directly access physical memory, or using memory management hardware, allocate and otherwise manage the memory space available to the programmer.

The *SEGT Input* is intended for those applications in which memory-management hardware can *trap* certain types of access, for example, to enforce a separation of system-mode and normal-mode programs. Asserting SEGT activates an acknowledge cycle, as does an interrupt, and causes a *trap handling routine* defined by software to be run. This routine would implement such features of memory management as allocation and illegal-access recovery.

Power and Clock

The Z8000 makes relatively simple demands of more mundane connections, such as power and clock. Only a single, *five-volt power source* and a single-phase clock are needed. The *clock waveform* must meet risetime, falltime, and symmetry specifications similar to those for a Z80. The use of a driver circuit is recommended.

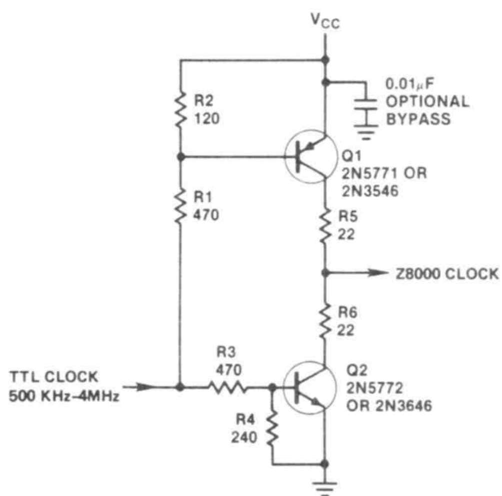


Figure 6
Clock Driver Circuit

The active drive circuitry guarantees proper high/low levels and rise-times. Clock *symmetry* requirements preclude maintaining a high or low for more than two microseconds. This is unlike the Z80, which allows high clock forever. In fact, no individual clock cycle provided to a Z8000 should be longer than two microseconds.

REGISTER STRUCTURE

The Z8000's architecture provides a very regular *register structure* for manipulating byte (8-bit), word (16-bit), and long-word (32-bit) values. Certain special instructions also access bits in bytes or words, and nibbles (4-bits) in bytes.

The Z8001 and Z8002 differ slightly because of the availability of both segmented and nonsegmented addresses in the Z8001.

In either processor there are sixteen 8-bit, sixteen 16-bit, eight 32-bit and four 64-bit registers available to the programmer. The quadruple registers, however, are only used in certain instructions (MULT for instance). Some other instructions treat the byte registers as two binary-coded-decimal (BCD) digits each. Furthermore, any word or long registers (except R0 and RR0) may be used as *stack pointers* and manipulated with PUSH and POP instructions. This degree of flexibility greatly simplifies the programmer's tasks.

Other special registers also appear in the Z8000. By default, R15 and RR14 are the *stack pointers* used by the Z8002 and Z8001 respectively, when executing CALL and RETurn instructions, and when processing interrupts and traps. RR14 is the default stack pointer in a Z8001, and then only when *segmented-addressing mode* is active. In either processor, system and normal stacks are separated by having two pointers; the appropriate one is automatically enabled according to the mode of operation (system or normal).

The environment of a running Z8000 program is defined by two additional registers: the *Program Counter* (PC), which in the Z8001 may contain a segmented address; and the *Flag-and Control Word* (FCW) whose left half contains bits that set the mode of operation of the processor (system/normal, segmented/nonsegmented) and enable or disable NVI's and VI's. Bit 13 of the FCW (the bit following S/N) is only non-zero in Z8000's with extended architecture. In these it enables external extended processors or co-processors (say, for floating-point computations) to interact with the Z8000 over the Z-Bus and via the $\overline{STOP}$ input during execution of special instructions. In early Z8000's, or when such slave activities are not to occur, this bit must be zero and any related instructions become illegal (unimplemented). The upper half of the FCW is accessible only to programs running in system mode; this protects the integrity of an operating system from user (normal-mode) processes.

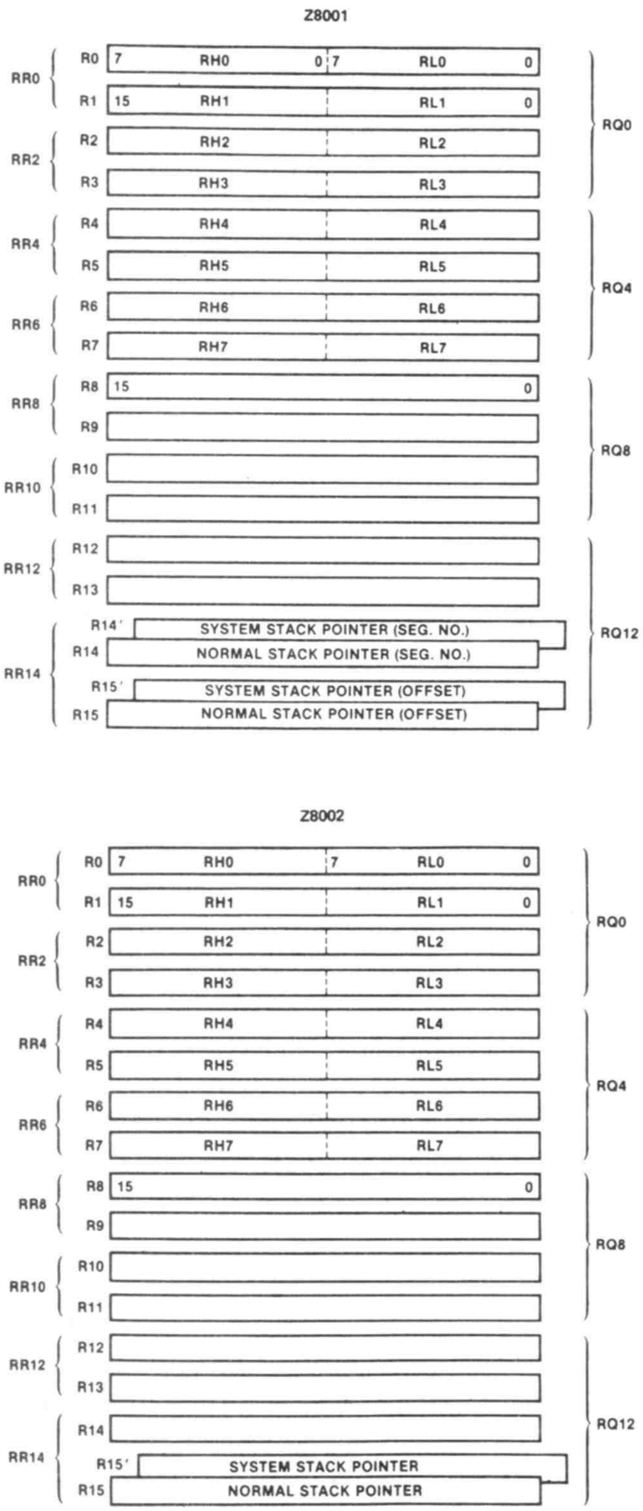


Figure 7
Z8000 Register Structure

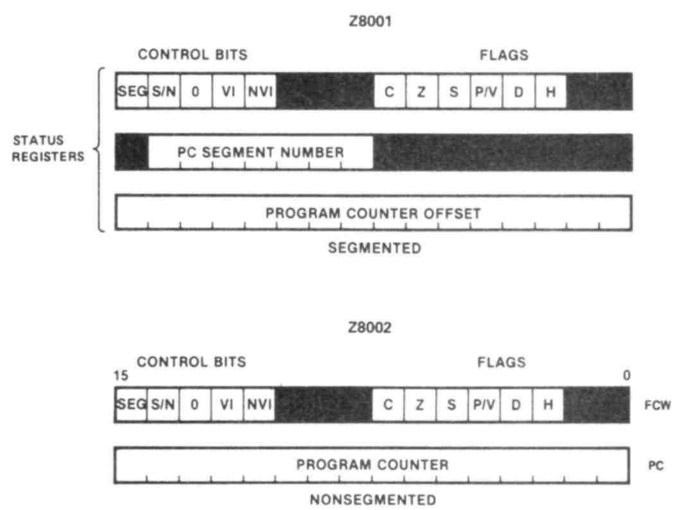


Figure 8
Program Status Registers

The right half of the FCW contains flags that may be used by any program to make *conditional jumps* or other control decisions. These flags are set or reset depending on the result of preceding instructions. SUBtract will, for instance, set, the Zero flag if the two subtracted operands are equal. The Z8000 also provides instructions for manipulating all flags at will.

Potential future environments (FCWs and PCs) for the Z8000 are pointed to by another special register: the *Program Status-Area Pointer* (PSAP). Part of the system initialization software must allocate a table in memory that contains all the FCW and PC values needed for each of the possible internal and external events (or exceptions), such as: illegal instruction, segmentation trap, NMI, etc. The system software must then load

PSAP with the starting address of this table before any such event can be processed.

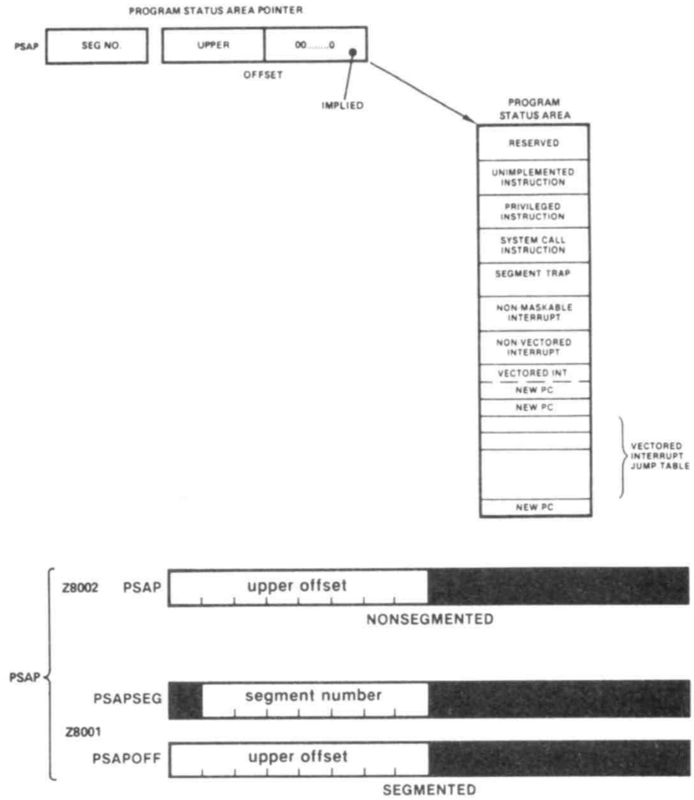


Figure 9
The PSAP

In the Z8002 there is no PSAP segment register, just as there is no PC segment. Because only the upper half of an address appears in the 16-bit portion of the PSAP, the *status area* table must begin on address boundaries that are multiples of 256. Like the control bits in the FCW, the PSAP may be accessed only when running in system mode. The status area must, furthermore, be in program memory, if such a distinction is made by the memory controller.

The last special register available to the Z8000 programmer is the *REFRESH Register*. The Z8000 has been

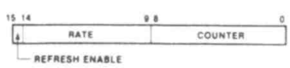


Figure 10
REFRESH Register

designed to provide dynamic-memory-refreshing, row-address outputs on an *estimated-demand* basis. The programmer loads the rate portion of REFRESH with a value which guarantees that the interval between refreshes is not too long. Then the programmer sets the enable bit. The Z8000 decrements the rate value every four clock cycles. When it reaches zero, the original rate value is reloaded and the 9-bit row-counter value is emitted on AD8:1 soon thereafter (A0 is actually unused). The row counter is then incremented; the whole process takes exactly three clock cycles. Up to 256 rows may be refreshed. Immediate reloading of the rate value guarantees no precession of REFRESH activity due to timing constraints. REFRESH is disabled on RESET and need only be enabled if dynamic memory is used in the system design. REFRESH is *virtually transparent* to the operation of a program.

ADDRESSING MODES

Data may be addressed in Z8000 systems in *eight* basic ways. Addressing modes are explicitly specified or implied by the software instruction used.

Immediate Mode

The data for an operand may be part of an instruction itself, as in *Immediate Mode* (IM) addressing:

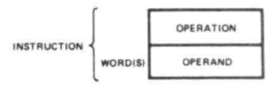


Figure 11
IM Addressing Mode

The operand is *always* one or two words, depending on whether a byte, word or long word is the operand. In the case of a byte, the immediate value is assumed to be duplicated in both halves of the word.

Register Mode

Register Mode (R) requires that the instruction carry the name of a byte, word, long-word, or quadruple register into which the operand is to be written or from which it is to be read:

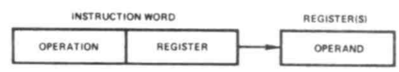


Figure 12
R Mode

Except for fetching the instruction, no memory access is needed.

Direct Access

Direct Access (DA) mode allows the instruction to carry with it the address of the operand in memory. A Z8001 segmented address usually requires two words, while nonsegmented addresses require one:

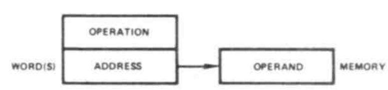


Figure 13
DA Mode

A special form of segmented address called *short-offset* can be used only in Direct Access and Indexed modes where the address is part of the instruction:

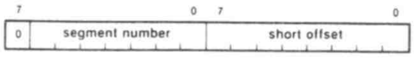


Figure 14
Short-offset Segmented Address

The leftmost bit of the first address word fetched by the instruction thus indicates whether the segmented address contains one or two words:

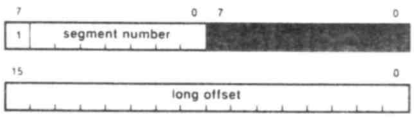


Figure 15
Normal Segmented Address

The IM, R and DA modes all require that the operand's address be known *before* the program runs. Several more modes of addressing are available, however, that allow runtime computation of addresses and/or displacements in registers. The *zero registers* (R0, RR0 etc.) may *not* be used, just as they may not be stack pointers.

Indirect Register

Indirect Register (IR) mode assumes the operand's address will be placed at runtime in a register whose name is mentioned in the instruction at assembly time:

Figure 16
IR Mode

Indexed Mode

Indexed (X) mode allows the program to calculate a *displacement* from a fixed base address:

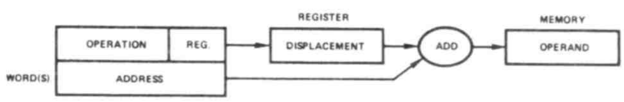


Figure 17
X Mode

This mode is useful when a table at a known, fixed location must be entered (indexed) at varying points.

Base Mode

Base (BA) mode is the reflection of X mode because the *base address* rather than the displacement is calculated at runtime:

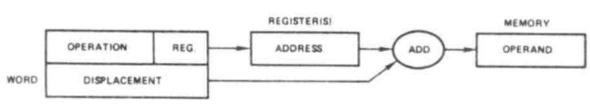


Figure 18
BA Mode

This is useful for accessing identical portions of different instances of a data structure.

Base Indexed Mode

Base Indexed (BX) mode is the most general method of addressing. It combines BA and X modes to allow the creation of fully *relocatable, reentrant* code:

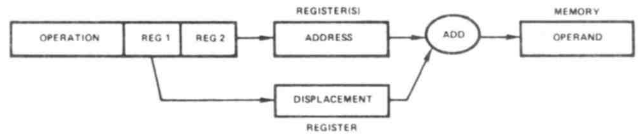


Figure 19
BX Mode

"Relocatable" means that the program can be moved to a different region of memory and still work. "Reentrant" means that the code and data can be separated, thus having one set of code serve many distinct processes with distinct data.

Relative Mode

The final addressing mode available to the Z8000 programmer is *relative* (RA) mode. The program counter is always used as the base to which (or from which) a signed, two's-complement displacement is added (or subtracted depending on the particular instruction):

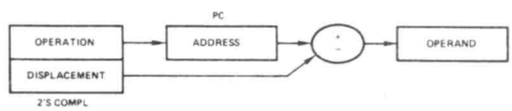


Figure 20
RA Mode

RA mode always accesses memory with the ST lines indicating IFn, (instruction fetch); hence it always uses *program memory,* if memory hardware makes such a distinction. The PC value *after* instruction fetch is used in the calculation (it points to the next instruction), and the displacement is , in fact, doubled before being used. An assembler must, therefore, halve the displacements it calculates before incorporating them into object code. This saves space and, because the Z8000 is a word-organized machine, it guarantees that the calculated address will still point to a word boundary when relative jumps and subroutine calls are executed.

Runtime vs. Assembly Time

The distinction between runtime (execution) and assembly time is more than philosophical; every programmer must fully understand it to make the best practical use of a machine's instructions. In nearly every programming effort, some values (data or addresses) are known and fixed before the program is assembled (or compiled). These values might be changed by the programmer when he or she assembles the program again, but the essential fact is that, as far as the assembler is concerned, they are constraints. Each will appear somewhere in the memory image of the resultant program, as part of an instruction (as immediate data or an address) or will be preloaded into a memory cell as an initial value for the program's computations.

Because most systems distinguish program memory areas from data areas, immediate data and addresses contained in instructions are fixed while the program runs. Allowing a program to modify its own instructions by writing on program areas is generally considered dangerous because such a program is no longer time invariant. Data memory is, of course, usually read/write, and preloaded constants might well disappear as execution proceeds. In any case, all immediate data, addresses and preloaded values fall into the category of *assembly-time constants*, whose values the programmer determines before the program ever runs. Most assemblers/compilers allow their users to define such values and enter them into algebraic expressions which are themselves evaluated at assembly time to produce runtime constants. These features are very useful for defining parameter values that might occasionally change from one version of a program to another. The program must, or course, be reassembled each time the values change, because the program's instructions themselves must change.

In Z8000 instructions, assembly constants appear as immediate values (IM mode), addresses (DA or X mode), or displacements (BA or RA mode). Register names (used in R, IR, X, BA, BX and RA modes) can also be considered assembly constants because the particular registers used are chosen before assembly. In some assemblers, register names can be defined as constant character strings (names) of the programmer's choice.

If a programmer only manipulates values known at assembly time, it can at most be a data path (say from memory to I/O) and not a data processor. The full power of a computer is attained only when it performs *runtime computations* and makes decisions about what to execute next, based on such computations. In the Z8000, values in registers can be used as data or pointers to data (all modes but IM), or as pointers to other instructions (IR, DA, X and RA modes; BA and BX being reserved for data only). Thus data location and execution sequencing can vary dynamically, and apparently unpredictably, as a program runs. But if the programmer has produced a correct program, execution and data transfers will ultimately achieve the intended result, however unpredictable they seem to be. The programmer's task has been made less demanding to the extent that the processor has powerful instructions and addressing.

Z8000 Addressing Modes: Further Discussion

The Z8000's addressing modes provide considerable flexiblity in operand accessing. While the applicaton of immediate, direct, register and relative modes is generally obvious, indirect (IR) and its extensions, X, BA and BX deserve some more discussion.

Indirect Register (IR) mode is the simplest of a family of addressing modes which allow a program to calculate the location of some data or the next instruction as the program runs. In IR mode a value produced by arbitrarily complex computations may be placed in a register or register pair (Z8001) and used as the address of (pointer to) some data or instructions. This is obviously a necessary, primitive mode of addressing needed in any program that does useful computations. It allows the program to move its attention around dynamically in memory (or I/O) according to computed needs, not just according to rigid, assembly-time definitions. IR mode can, therefore, be used to index dynamically into any form of data structure located anywhere in addressable storage (or I/O). It also conserves instruction size, since no address need be assembled.

Indexed (X) mode is a simple extension of IR mode. It allows the programmer to specify a base address for some memory area table at assembly time and to have the program compute a displacement index into that area which changes dynamically as the program runs. This is useful for accessing operands in arrays or other lists of data.

Base (BA) mode is the logical reflection of X mode. It allows the displacement to be assembled as a constant in the instruction, while the base address of the target area is computed later, in a register, when the program runs. This is useful for accessing, for example, the Nth item in each of several areas that start at different addresses. The areas, of course, all have similar structure, so it is appropriate to define one constant to represent the displacements of all similar items from the base addresses of their areas. Parameter accessing in stacks is one such application. Depending on addressing mode (segmented or nonsegmented) and the assembled size of the displacement, BA mode can save instruction space.

Base-Index (BX) mode in the Z8000 combines the dynamic features of X and BA modes to allow both the index into a table and the table's base address to be calculated at runtime. For more sophisticated purposes, this can allow multiple sets of data/program to be selected and indexed into — for instance, as might be done when more than one job is to be accessed by a time-sharing system. BX mode consumes no address space in assembled instructions.

All forms of addressing that allow an address to be computed at runtime (IR, X, BA, BX and RA modes) effectively allow code and data to be *relocated,* or placed at variable starting addresses in memory as the program runs. RA and X mode restrict the range of such relocations to the sizes of displacements in instructions. RA, of course, always uses the program counter as the base address. IR, BA and BX modes, however, allow quite arbitrary relocations because the base resides in a register.

It is up to the programmer to make practical use of all these modes. Instructions may, of course, need to access more than one operand during execution and so might use any of the above addressing modes more than once and in combination. However, not all addressing modes may be used by all instructions. This will be clarified when the instruction set is covered in a later lesson.

SYSTEM CONSIDERATIONS

Memory Addressing

To review: a Z8002 (or a Z8001 with the SEG bit off) emits a 16-bit address and a low on the $\overline{AS}$ output. The memory hardware then reads this address when $\overline{AS}$ goes high to locate the appropriate memory cell. In the Z8001 with SEG on, that 16-bit address (offset) simply identifies a cell in the segment whose number was emitted earlier on the SN outputs. In fact, all transactions between memory and the Z8000 are for word size, so for each 16-bit address, only the upper 15 bits are meaningful to memory decoder circuitry. This means that all instructions are multiples of words, not bytes, and reside at even addresses.

$\overline{AS}$ is not used to sample the segment number because it is made available earlier to ease the task of memory-management devices. However, $\overline{AS}$ going high should be used to sample all status outputs like READ/$\overline{WRITE}$ and ST3:0. This is then used, for instance, to establish bus direction.

Once external hardware has established the desired memory cell and the direction of access, it can wait for $\overline{DS}$ to be emitted by the CPU. On a read cycle, memory hardware will latch the addressed cell's data onto the bus and hold it until $\overline{DS}$ goes high. On a write cycle, $\overline{DS}$ going high will be used to sample the incoming data for the cell, just as $\overline{AS}$ was used to get the address. If necessary, the hardware can delay $\overline{DS}$ from going high by pulling down on the $\overline{WAIT}$ line to the Z8000.

Because Zilog used instruction-execution frequencies in typical programs to optimize instruction size and timing, the Z8000 makes very efficient use of the bus. The multiplexed, asynchronous nature of the bus is an advantage to the hardware designer.

In the Z8001, a system-mode program may choose to use segmented or nonsegmented addressing. It can, in fact, exploit the feature that the previous SN outputs remain latched when switching to nonsegmented mode. This shortens the addresses needed to access the current segment.

Two very important features of the Z8000 are

1) its representation of program environments by the status registers, FCW and PC; and

2) its ability to save and reload these to *switch environments* (say, for interrupt handling) and then to restore them when such exception-processing is complete. Status saving is always done using the *system stack* because the Z8000 always enters system mode when an exception occurs. Furthermore, in the Z8001, exceptions *always* invoke segmented mode for accessing the new status-register values pointed to by PSAP. The new FCW may, of course, set nonsegmented mode, but the status area *must* be formatted to contain segmented addresses for all PC values:

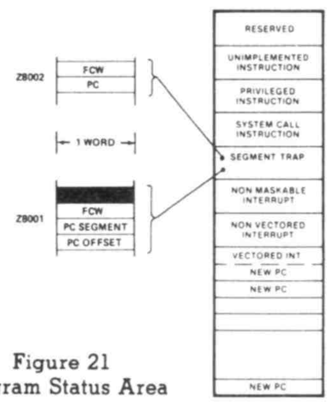


Figure 21
Program Status Area

In addition, the status area is read with ST outputs indicating IFn and so resides in program, not data/stack memory.

The old status, saved on the system stack when an exception is acknowledged, is accompanied by a word that indicates something about the exception. This *"reason"* (or identifier) is thus available to the processing routine in making its decisions about handling the exception:

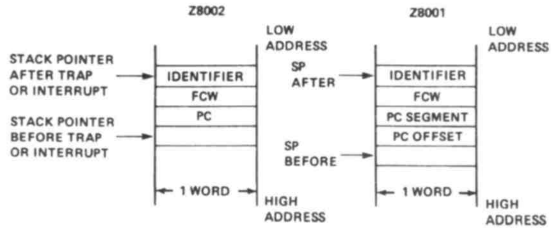


Figure 22
Saving Program Status During
An Interrupt or a Trap

For instance, in the case of a vectored interrupt, the vector returned by the peripheral is in the identifier word.

Initialization Requirements

The Initialization of any Z8000 system thus requires at least that:

(1) A program-status area be established and properly loaded;
(2) The PSAP register be loaded to point to that area;
(3) The system stack area be allocated, along with any user (normal-mode) stack;
(4) The default (system and normal) stack pointers be loaded appropriately;
(5) Any needed interrupt/trap service routines be loaded into memory;
(6) Appropriate interrupt/trap initialization to external devices be done; and
(7) Interrupts be enabled as needed.

If dynamic memory is used (without its own refresh circuitry), then the REFRESH register must also be set up.

All of this can only be done with the Z8000 operating in system mode and this is what *must* be done upon receiving a RESET input. A RESET low for five clock cycles brings the Z8000 into a special mode of operation; it enters system mode and fetches, from program memory, location 2, an FCW and PC that are established in permanent memory. In the Z8001, segmented mode is entered upon RESET, and segment zero is selected so this firmware must be formatted accordingly:

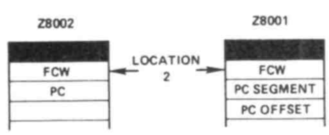


Figure 23
Loading Program Status
from a RESET

RESET is, therefore, handled like exception processing in either processor except that a dedicated area in memory is used as the new status source. This first PC must, of course, point into executable code, typically also in firmware.

With these architectural capabilities, the Z8000 provides extraordinary support for system designs ranging from dedicated controllers to multiprocessing, memory-managing systems, complete with slave processors.

Quiz for Lesson 1

QUESTIONS

1. While the Z8000 has many features which set it apart from older generation microprocessors, in a certain sense, it can be considered a very "regular" machine. The Z8000 is "regular" in its:
____ A. Register architecture
____ B. Address architecture
____ C. Internal memory segmentation
____ D. Microcoding

2. Which output from the processor can be used to create two separate memory spaces?
____ A. The $\overline{MREQ}$ output
____ B. The Normal/System (N/$\overline{S}$) output
____ C. The $\overline{SN6}$:O outputs
____ D. The $\overline{AS}$ output

3. The major difference between the Z8001 and the Z8002 is that the Z8001:
____ A. Contains more circuitry
____ B. Is faster
____ C. Addresses more memory
____ D. Can distinguish more types of memory and I/O spaces

4. The Z8000 allows the programmer to compute instruction operand addresses at runtime using:
____ A. Immediate Mode (IM)
____ B. Direct Access (DA) mode
____ C. Base Indexed (BX) mode
____ D. Register (R) mode

5. In addition to program loading and I/O device initialization, proper Z8000 initialization after RESET *always* requires:
____ A. Loading the FCW and PC
____ B. Loading system and normal stack pointers
____ C. Loading the PSAP and REFRESH
____ D. None of the above

6. Programs written for the Z8002 can always be run on a Z8001 in nonsegmented mode:
____ A. With no modification
____ B. If RR14 and PSAP are formulated to use segmented addresses
____ C. If all status areas and interrupt routines are formulated to use segmented addresses
____ D. If RR14, PSAP, all status areas and interrupt routines are formulated to use segmented addresses

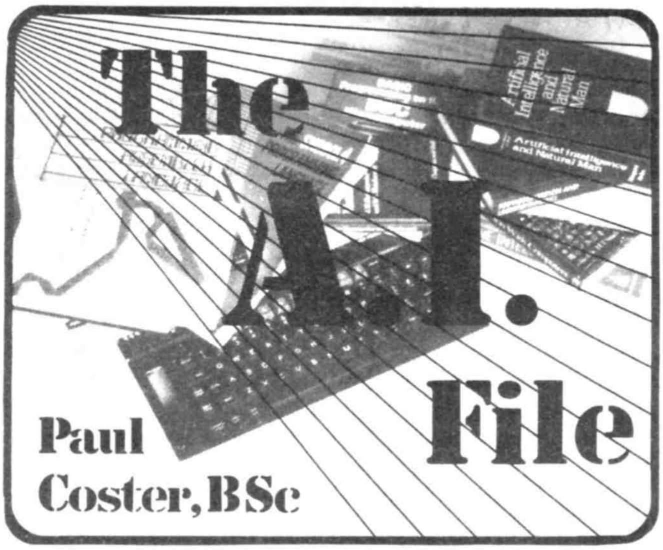
7. The Status (ST) outputs can be used to:
____ A. Segregate program, data and stack memory areas
____ B. Prevent individual processes from disrupting the overall operating system
____ C. Allow the Z8000 to share the bus with other devices
____ D. None of the above

8. Of the three types of interrupt requests accepted by the Z8000 – Nonmaskable (NMI), Nonvectored (NVI) and Vectored (VI) – which, if any, would be considered the most flexible?
____ A. Nonmaskable
____ B. Nonvectored
____ C. Vectored
____ D. Since each serves a distinct function, none can be considered more flexible than another.

9. When the REFRESH register of the Z8000 is used to provide dynamic-memory-refreshing, row-address outputs on an estimated-demand basis, which of the following statements is *not* true?
____ A. The programmer must load the rate portion of REFRESH with a value which guarantees that the interval beteen refreshes will not be too long.
____ B. The Z8000 decrements the rate value every four clock cycles
____ C. When the rate value reaches zero, the original rate value is reloaded
____ D. Up to 128 rows may be refreshed.

10. All of the following forms of addressing in the Z8000 allow an address to be computed at runtime. However, only one allows both an index into a table as well as the table's base address to be calculated at runtime. Which is it?
____ A. Base Mode (BA)
____ B. Index Mode (X)
____ C. Base Index Mode (BX)
____ D. Relative Mode (RA)

We shall be running a competition in conjunction with this series. A leading Zilog distributor has agreed to donate a complete Z8000 development system as the first prize.
The winner will be the reader that most accurately answers the questions that will appear at the end of each part of the series. Don't send the answers to this month's questions yet, but wait until further announcements are made in R&EW.



An exciting new series, compiled by our intrepid Assistant Editor to provide an insight into developments within the field of Artificial Intelligence. Part 1 introduces some basic (and BASIC) principles and previews some of the topics to appear in future issues.

DESPITE REPEATED attempts by various bodies to persuade the manufacturers of microcomputers to incorporate or support a much wider range of software than at present, little progress has been made. Apart from a few notable exceptions (eg, Jupiter Ace), most micros only possess resident BASIC, Assembler and some crude system routines. Even those machines capable of supporting the more structured or specialised languages are limited to a fraction of what's available on mainframes. This sad state of affairs has meant that many areas within computing were beyond the reach of home computer enthusiasts. One is Artificial Intelligence, with its profusion of weird and wonderful 'languages', concepts, theories and techniques, probably unknown to the majority of the micro fraternity. Hence we conceived The AI File to redress the balance and provide what might be termed 'a microphiles guide' to intelligent machines.

Having explained the rationale behind the series, you may still be wondering exactly what is encompassed — or more probably, meant — by the term Artificial Intelligence. Surely it's a contradiction in terms to speak of a *human* attribute being possessed by a machine — a *human* creation? Well, perhaps the best way to answer this question and avoid confusion, is by way of an analogy. If you've ever played one of the *better* computer games, where the machine is 'the other player', chances are you were unaware of any deficiencies in your opponents 'intellect' *within that game structure*. Indeed, machines exist which consistently beat grand masters at certain games, in this case checkers (an Americanism for draughts); though the same cannot (yet) be said about chess.

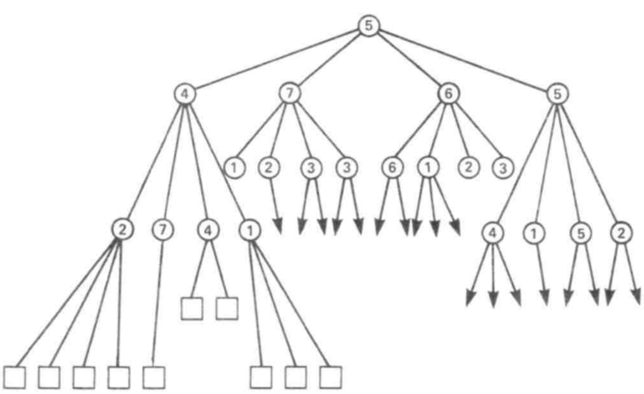


Figure 1: Hierarchical structure typical to many 'intelligent' game playing programs.

The point is, it's sufficient (for our purposes) to be interested *purely* in the ways machines can be made to respond or behave intelligently, rather than whether the machine *has* intelligence — artificial or otherwise.

Throughout the series, it is hoped that the examples given will serve to justify the approach taken. Your comments, suggestions and software ideas are also invited for possible inclusion, but remember — no SAE, no comment!

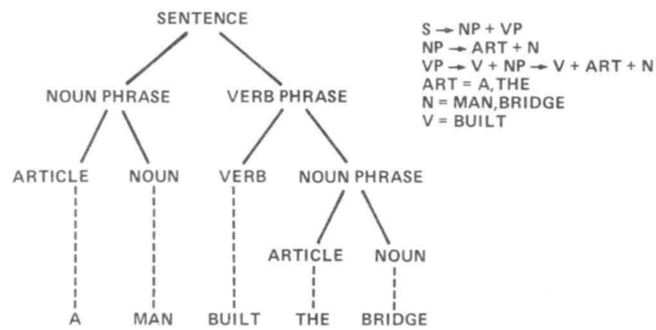


Figure 2: Using a hierarchical system to represent sentences — Rewrite Rules for Phrase Structure Grammar.

Fun And Games With Trees

Since we've already established the relevance of game playing, especially strategy planning, to the study of AI, it is advantageous to begin by extending this example to exemplify 'Multiple-step Tasks' — tasks which require several 'operators' to complete — in general. When there is a choice of possible outcomes, as with games, and with varying levels of success dependent on *potential* moves, a hierarchical representation is used to simplify 'strategy determination'. The type and complexity of the 'tree' depends upon the task, but ***Fig. 1*** shows a typical arrangement By evaluating risks and benefits through a process akin to equating probabilities, a 'mechanical' game (task) plan evolves. At each level, choices are assessed utilising information about results from other levels.

Later in the series we will look at this technique in more detail and introduce related procedures such as alpha-beta minimaxing. For the present, it is sufficient to note the importance of hierarchical structures for representing 'steps to a goal'. Those of you with programming experience will, no

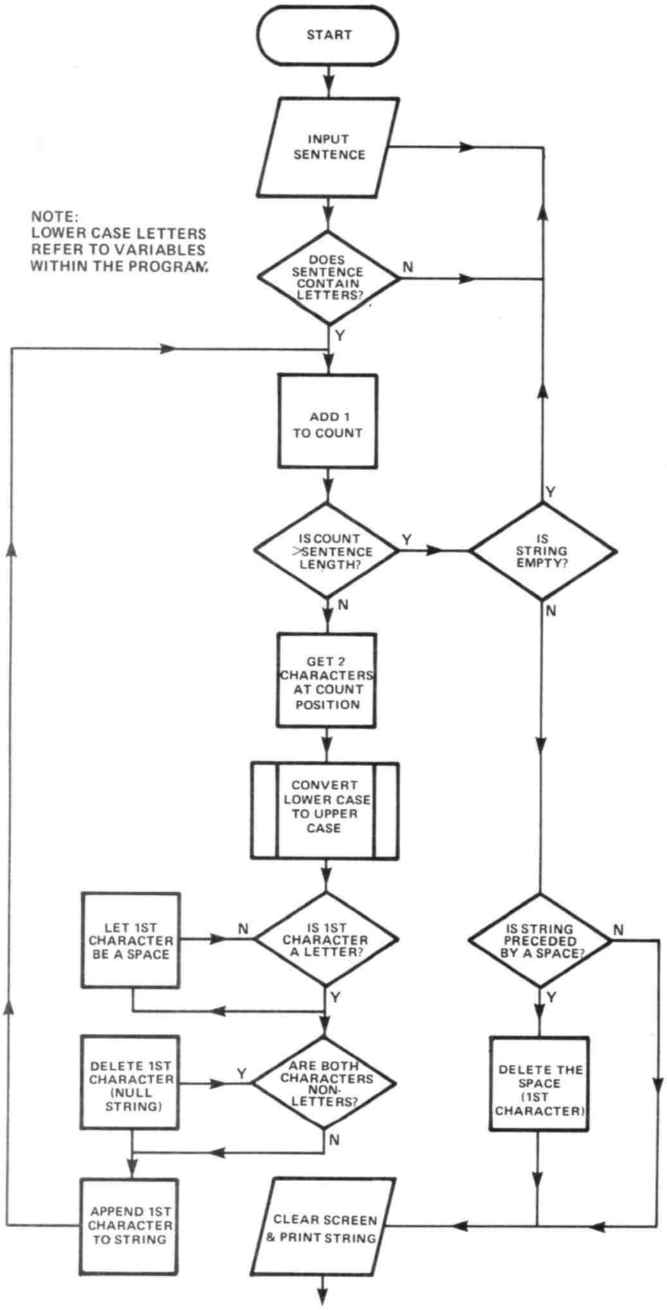


Figure 3: Flowchart for the sentence processing routine.

doubt, have recognised similarities between these methods and program debugging. This is no accident, since both share a common root — their algorithmic base.

A Parsing Phrase

Another use for tree diagrams is in the representation of language — a prerequisite to understanding language — though that's not to say a hierarchical system is the most efficient structure. Nor is it suggested that such representations are solely the result of dedicated AI research. Psychologists and linguists were working on similar problems many years earlier and the inception of computers merely presented a concrete way of checking the various theoretical proposals. ***Figure 2*** shows the example of how a simple sentence can be broken down into its constituent parts using one such proposal — Rewrite Rules. The process of breaking down phrases into their grammatical constituents is called parsing, and is an essential part of any system which is to understand language. One of the aims of this series is to develop, at least in part, a program to 'converse' with its programmer, and an important routine within that program will be the sentence parser.

REWPROG — Cleaning Up The Act

Before any deep analysis can be performed on an input string, some form of formatting is required .The flowchart of ***Fig. 3*** refers to an input editing routine, coded in BASIC (***Fig. 4***) and implemented on the BBC micro, as the first stage in our conversational program: REWPROG. However, prior to examining the routine in detail, a word concerning our choice of language and computer.

Despite the authors preference for a high level language with some decent string processing facilities (eg, SNOBOL4), it was reasoned that since most people are familiar with BASIC, a compromise was called for. Hence, wherever possible, source listings are presented in BASIC.

As regards the BBC micro, selection was more a matter of what was to hand rather than any particular attribute of the BBC; though you'd be hard pressed to find a better machine at the price. The model B is powerful and well conceived, with a host of exciting features which make it an invaluable tool for most applications (all it lacks is a SNOBOL interpreter!).

Bearing in mind the final requirement, a prime concern throughout the development of the editing routine was to make it as foolproof as possible. Not as easy as it sounds, since every condition — no input, spaces only, no letters, lower case entries, mixing spaces with punctuation — has to be anticipated and coped with. The final listing (***Fig. 4***) makes no claim to being the most efficient, but merely performs the required task — accepting single line inputs (up to 255 characters), removing unwanted punctuation, converting lower to upper case, deleting non-letters and printing words (uninterrupted letter sequences) with single spaces between them. For those not familiar with the BASIC language, we will be looking at its string processing functions next month. All that's required here is to recognise the various steps involved in the routine (refer back to the flowchart in ***Fig. 3***).

```
10  DIM SENT$(255),NST$(255)
20  INPUTLINE SENT$
30  IF LEN(SENT)<1 GOTO 20
40  FOR I%=1 TO LEN(SENT$)
50  CH1$=FNcaps(MID$(SENT$,I%,1))
60  CH2$=FNcaps(MID$(SENT$,I%+1,1))
70  IF ASC(CH1$)>90 OR ASC(CH1$)<65 THEN CH1$=" "
80  IF CH1$=" " AND (ASC(CH2$)>90 OR ASC(CH2$)<65)
     THEN CH1$=""
90  NST$=NST$+CH1$
100 NEXT I%
110 IF NST$=" " OR NST="" GOTO 20
120 IF LEFT$(NST$,1)=" " THEN NST$=RIGHT$(NST$,LEN
    (NST$)-1)
130 CLS
140 PRINT
150 PRINT NST$
160 PRINT
170 END
180 DEF FNcaps(CH$)
190 IF ASC(CH$)>96 AND ASC(CH$)<123 THEN CH$=CHR$(
    ASC(CH$)-32)
200 =CH$
```

Figure 4: Source listing of the final program segment.

Best Of The Rest

With the first segment of our conversational program complete, we decided to finish this month with a brief summary of selected delights to come. Though it is not intended to cover every topic connected with AI, even confining the series to programs which accept and respond to a verbal input provides plenty of scope for discussion. There are programs which simulate paranoia, others able to identify and map out objects from photographs and the famous ELIZA, that's so convincing it's difficult to distinguish from human conversation. A more practical program, called SOPHIE, is especially interesting since it can analyse circuit diagrams, compute voltage and current and answer a range of questions from wide protocols.

There are also a collection of programs (with extensive information bases) that are 'domain specific'. These respond 'intelligently' to quite complex questions about their own particular 'world' — usually an abstract representation, such as the 'blocks world' manipulated by SHRDLU (***Fig. 5***).

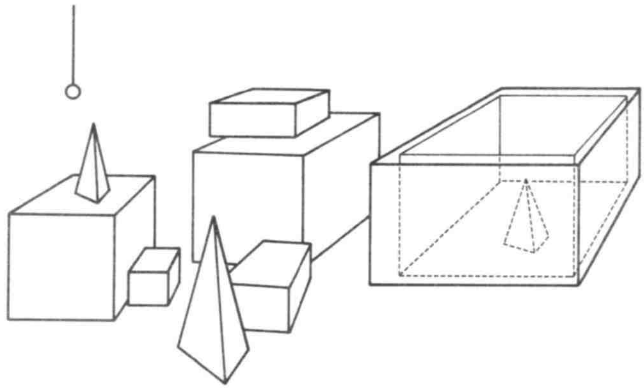


Figure 5: The kind of 'blocks world' in which SHRDLU operates.

Clearly Artificial Intelligence should be viewed as a steadily growing science, with wide-ranging implications for the fields of electronics and computing. So, our efforts will be aimed at keeping abreast of the latest advances and reporting them to **R&EW** readers. And finally...

Bits And Pieces

Every month we'll present a short piece of software to dazzle your friends with. If you have any innovations feel free to send them in. For our part we'll be equally uninhibited about discarding those that don't quite make the grade. This month a prime example — *Graphics On Display*.

```
10  MODE2
20  VDU23;8202;0;0;0
30  CLS
40  FOR I%=1 TO 20
50  N1=RND(1)*1023
60  N2=RND(1)*1279
70  PLOT85,N2,N1
80  GCOL3,RND(1)*7+1
90  NEXT I%
100 FOR J=1 TO 5000:NEXT J
110 GOTO 30
```

Figure 6: Program listing for the random triangle display.