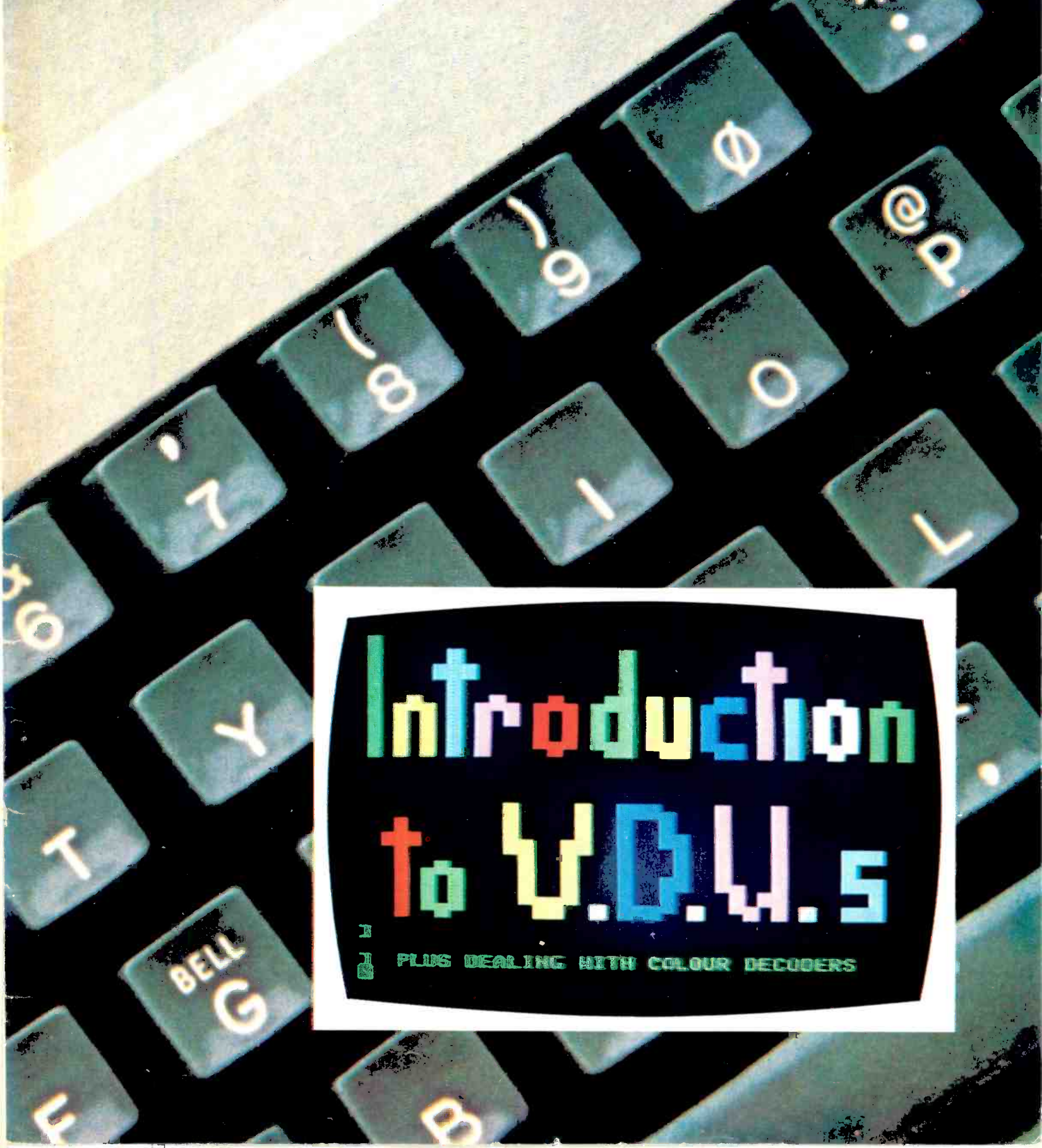
DECEMBER 1979 55p

TELEVISION

SERVICING·VIDEO·CONSTRUCTION·DEVELOPMENTS



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BA100	0.18
BA102	0.10
BA130	0.15
BA154	0.10
BA155	0.20
BA164	0.12
BAX13	0.16
BAX16	0.08
BAY38	0.16
BY206	0.20
IN4148	0.04
BY126	0.20
BY127	0.15
BY133	0.22
BY164	0.50
SKB2/08	1.00
BY238	0.15
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IN4001	0.10
IN4002	0.10
IN4003	0.12
IN4004	0.12
IN4005	0.12
IN4006	0.14
IN4007	o.16
IN5407	0.33
BR100	0.50
BR101	0.60
BRY39	0.60
TIC116ON	1.50
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BYX88C2V7	0.10
BZY88 3VO	0.10
BZY88 3V3	0.10
BZY88 3V6	0.10
BZY88 3V9	0.10
BZY88 4V3	0.10
BZY88 4V7	0.10
BZY88 5V1	0.10
BZY88 5V6	0.10
BZY88 6V2	0.10
BZY88 6V8	0.10
BZY88 7V5	0.10
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BZY88 9V1	0.10
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BZY88 33V	0.10
BZX61 7V5	0.25
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BZX61 36V	0.25
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BZX61 47V	0.25
BZX61 72V	0.25
AC107	0.35
AC127	0.50
AC127/01	0.60
AC128	0.60
AC128/01	0.60
AC141	0.50
AC141K	0.60
AC142	0.40
AC142K	0.60
AC176	0.60
AC176/01	0.60
AC186	0.40
AC187	0.40
AC187K	0.60
AC188	0.40
AC188K	0.60
AD140	1.50
AD142	1.50
AD143	1.50
AD145	1.50
AD149	1.00
AD161/2	1.50
AD162	0.70
AD262	1.50
AF114	0.60
AF115	0.60
AF116	0.60
AF117	0.80
AF118	0.60
AF121	0.60
AF124	0.60
AF125	0.60
AF126	0.60
AF127	0.60
AF139	0.60
AF239	1.00
AL102	3.00
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AU110	3.00
AU113	3.00
AL103	3.00
AY102	3.00
BC107	0.20
BC108	0.20
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BC114	0.15
BC115	0.20
BC116	0.20

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BC119	0.50
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BC238	0.15
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BC328	0.15
BC337	0.15
BC338	0.15
BC547	0.15
BC141-10	0.80
BD115	0.50
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BD132	0.60
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BD134	0.70
BD144	2.50
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BD238	0.50
BD380	0.70
BD441	0.70
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BD538	0.70
BD507	0.70
BD508	0.75
16181	1.20
16182	1.20
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BD710	1.00
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BD379	0.50
BF115	0.60
BF118	0.60
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BFX89	0.50
BFY50	0.50
BFY51	0.50
BFY52	0.50
BFY90	1.20
BF381	0.50
BFR39	0.30
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BFR81	0.30
BFR89	0.50
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MPSU55	1.20
TIP2955	1.30
TIP3055	1.30
TIS90M	0.60
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2N2904	0.50
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2N2905	0.50
2N3053	0.50
2N3703	0.20
2N3705	0.20
2N3710	0.20
2N3055H	0.75
TAA350	0.80
TAA550	0.60
TAA570	1.80
TAA611	1.75
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LLDF 16 Iron Coated Longlife Tip	0.90
LLDF 24 Iron Coated Longlife Tip	0.90
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TELEVISION

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Requests for advice in dealing with servicing problems should be directed to our Queries Service. For details see our regular feature "Your Problems Solved". Send to the address given above (see "correspondence").

this month

65 Leader

66 Teletopics
News, comment and developments.

68 Footnote on the Pye 713/715/717 Chassis *by Harold Peters*
Following Mike Phelan's series, some notes on the evolution of these chassis to assist with stock problems, and a few more tips.

71 ITT's New Remote Control System *by A. J. Edwards*
A concise account of this latest state-of-the-art remote control system which uses infra-red light for transmission with pulse code modulation for the commands. The receiver i.c. has been designed to make the system flexible, so that it can be adapted for use with new developments such as digital synthesized tuning, Prestel, etc.

74 TV Servicing: Beginners Start Here . . . Part 27 *by S. Simon*
This time we tackle the most complex subject yet in the series – the PAL colour decoder, with emphasis on the various things that can be responsible for the no colour symptom.

78 Introduction to VDUs *by Andrew Parr, B.Sc., C.Eng., M.I.E.E.*
The worlds of TV and the computer are coming closer together, with the VDU the meeting point. An account of the way in which computer data is processed for display on the c.r.t. screen, and the ways in which the system can be used for graphics design etc.

83 Equipment Review: The Technalogics PG6RF Pattern Generator *by Roger Bunney*
A new version provides colour bars in addition to monochrome patterns. An add-on unit is also available.

84 Tapez-Les *by Les Lawry-Johns*
After a somewhat surrealistic start, Dennis's GEC colour set brings us down to earth. Troubles then centre around faulty line output transformers – and female logic.

86 Readers' PCB Service

87 Fault Notes *by Robin D. Smith*
More hints and tips worth noting.

88 Vintage TV: The Bush Model TV22 *by Malcolm Burrell*
Renovation of a Bush Model TV22 dating from 1951, with a detailed look at the line output stage.

90 Long-Distance Television *by Roger Bunney*
Reports on DX reception and conditions. This month's beginners' section goes into MS reception.

93 Servicing in the Field, Part 2 *by George Wilding*
This time how to tackle faults on the signals side – weak contrast, no signals, wrong colours etc.

95 Next Month in Television

96 Of TTL and CMOS Gates and Cabbages and Kings . . . Part 2 *by Andrew Parr, B.Sc., C.Eng., M.I.E.E.*
This concluding part deals with the use of CMOS logic devices and the choice between TTL and CMOS.

98 Test Case 204

99 Your Problems Solved

OUR NEXT ISSUE DATED JANUARY WILL BE PUBLISHED ON DECEMBER 17

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AC141	.48	AL102	2.90	BC126	.20*	BC179	.19*	BC547	.14*	BD163	.73
AC142	.40	AL113	2.90	BC135	.20*	BC182L	.14*	BC548	.14*	BD166	.48
AC153	.57	AU103	2.11	BC136	.20*	BC183L	.14*	BC549	.14*	BD181	.77
AC176	.59	AU106	2.69	BC137	.20*	BC184L	.14*	BCX31	.25	BD182	.69
AC187	.38	AU107	2.06	BC139	.39	BC186	.20*	BCX32	.24	BD183	.78
AC188	.38	AU108	2.06	BC140	.39	BC187	.29*	BCX33	.22	BD187	.66
AD149	1.00	AU110	2.90	BC141	.33	BC212L	.15*	BCX34	.27	BD201	.76
AD161	.75	AU111	2.90	BC142	.39	BC213L	.15*	BCX36	.27	BD222	.35
AD162	.75	AU112	2.40	BC143	.39	BC213L	.15*	BCY70	.18*	BD225	.45
AF115	.60	AU113	2.90	BC147	.15*	BC214L	.15*	BCY71	.24	BD232	.47
AF116	.60	AUY10	1.29	BC148	.10*	BC237	.15*	BCY72	.19*	BD233	.47
AF117	.80	BC107	.18*	BC149	.15*	BC238	.14*	BD115	.49	BD234	.45
AF118	.59	BC108	.16*	BC153	.15*	BC239	.12*	BD116	.71	BD237	.58
AF125	.59	BC109	.18*	BC154	.15*	BC307	.14*	BD131	.69	BD238	.50
AF126	.61	BC113	.15*	BC157	.15*	BC327	.15*	BD132	.60	BD435	.78
AF127	.60	BC114	.15*	BC158	.15*	BC337	.14*	BD133	.69	BD437	.75
AF139	.80	BC115	.20*	BC159	.15*	BC338	.14*	BD135	.58	BD509	.58
AF178	1.54	BC116	.20*	BC160	.39	BC384LC	.22	BD136	.58	BD510	.49
AF180	1.60	BC117	.19*	BC170B	.20*	BC461	.27	BD140	.58	BDX32	2.17
AF181	1.61	BC118	.19*	BC171	.15*	BC462	.65	BD144	2.49	BF115	.59
				BC172	.19*	BC463	.65	BD150A	.69	BF121	.21

BF123	.23	BF222	.23	BF450	.42	BU111Y	2.50	R1038	2.10	TIP126	.73
BF154	.20*	BF224	.16*	BF458	1.00	BU126	2.10	R1039	2.10	TIP127	1.12
BF156	.43	BF240	.16*	BF459	1.00	BU204	1.50	R2008	1.60	TIP2955	1.19
BF158	.39	BF241	.15*	BFR41	.32	BU205	1.50	R2009	1.99	TIP3055	1.29
BF160	.59	BF255	.25	BFR52	.33	BU206	1.59	R2010	1.60	TIS43	.40
BF167	.48	BF256	.60	BFR62	.31	BU208	2.50	R2029	1.90	TIS90	.59
BF173	.50	BF257	.49	BFR81	.30	BU208/02	2.99	R2030	1.93	TIS91	.60
BF177	.50	BF258	.49	BFT42	.49	BU326S	2.41	R2265	2.05	TIS92	.59
BF178	.26	BF259	.45	BFW10	.60	BU407	2.80	R2305	.80	ZTX300	.22
BF179	.49	BF262	.49	BFX29	.49	E1222	.39	R2306	.90	ZTX500	.19*
BF180	.49	BF263	.52	BFX84	.49	ME8001	.26	R2540	3.00	40636	1.75
BF181	.59	BF271	.49	BFX85	.43	MJE340	.40	TIP29	.43	2N697	.40
BF182	.60	BF273	.19*	BFX88	.49	MJE520	.45	TIP30	.58	2N2905	.51
BF183	.60	BF274	.24	BFY50	.49	MJE2955	1.49	TIP31	.37	2N3053	.60
BF184	.49	BF324	.43	BFY51	.50	MJE3055	1.29	TIP32	.40	2N3055	.74
BF185	.49	BF336	.43	BFY52	.50	OC28	2.40	TIP33	.61	2N3703	.20
BF194	.15*	BF337	.49	BFY90	1.19	OC35	2.00	TIP34	.74	2N3704	.23
BF195	.14*	BF338	.49	BSY79	.65	OC36	2.10	TIP41	.43	2N3705	.19*
BF196	.14*	BF355	.60	BRY39	.49	OC44	.40	TIP42	.60	2N3706	.19*
BF197	.14*	BF362	.47	BU105/01	1.69	OC45	.43	TIP47	.94	2N3707	.19*
BF198	.14*	BF363	.47	BU105/02	1.64	OC71	.49	TIP112	.90	2N5296	.69
BF199	.14*	BF422	.47	BU108	1.80	OC72	.49	TIP117	1.00	2N5298	.77
BF200	.21	BF423	.51	BU110	3.00	OC76	.37	TIP121	.68	2N5496	.81
										2SC1172Y	2.90

THYRISTORS, SILICON SWITCHES, DIACS

BFT42	.49		
BFT43	.49	BT109	1.20
BR100	.49	BT116	1.24
BR101	.59	BT119	2.49
BRC4443	1.30	BT120	2.49
BRY39	.59	C106D	1.10
BT106	1.50	OT112	1.50
BT108	1.30	TIC46	.80

BRIDGE RECTIFIERS

B40	1.05		
BY164	.60	KBS01	1.40
BY179	.83	WO2	.58
BYW21	1.98	WO4	.54
BYW24	2.50	WO6	1.28
BYW61	3.20	BR1	.52
BYW62	3.20	BR2	.74
BYW64	4.70	BR3	.86
ITT3CD	.60	BR4	.82

DIODES AND RECTIFIERS

AA112	.20*	BA115	.22	BAX16	.08*	BY206	.19*	BYX10	.20*	IN4007	.16*
AA116	.16*	BA145	.16*	BY126	.20*	BY207	.22*	OA47	.18*	IN4148	.06
AA117	.16*	BA155	.20*	BY127	.15*	BY210/400	.40	OA91	.18*	IN4448	.34
AA119	.16*	BA156	.20*	BY133	.22*	BY210/800	.50	IN4001	.10*	IN5401	.24
AA143	.20*	BA202	.18*	BY176	1.64	BY227	.40	IN4002	.10*	IN5404	.32
AA144	.14*	BA219	.18*	BY182	1.03	BY251	.35	IN4003	.12*	IN5408	.42
AY102	2.99	BA316	.40	BY184	.84	BY255	.38	IN4004	.12*	ITT44	.08*
AY106	2.30	BA317	.44	BY187	1.00	BY298	.70	IN4005	.12*	ITT2002	.38
BA102	.35	BAX13	.16*	BY199	.33	BY299	.72	IN4006	.14*		

ZENER DIODES

400Mw BZY88 TYPE	.12*
Values 2.4V - 62V	
1W BZX61 TYPE	.25*
Values 3.3V - 200V	
10W (STUD MOUNTING)	1.30
Values 4.7V - 200V	

INTEGRATED CIRCUITS

BRCM200	3.34	SN72723L	2.20	TBA651	3.00
BRCM300	3.42	SN76003N	2.90	TBA673	2.19
BRC1330	.80	SN76013N	1.90	TBA690	2.85
BTT822	5.21	SN76013ND	1.90	TBA700	1.61
BTT6018	2.97	SN76023N	1.90	TBA720A	2.64
C500	3.67	SN76023ND	1.61	TBA750	2.00
CA270AE	3.80	SN76033N	1.90	TBA800	1.62
CA270BE	3.70	SN76110N	1.90	TBA810AS	2.22
CA505	1.61	SN76226DN	1.96	TBA810S	2.22
CA758E	4.10	SN76227N	1.70	TBA820	1.50
CA920AE	2.66	SN76228N	1.85	TBA890	3.94
CA2121	2.40	SN76530P	1.50	TBA920	3.23
CA3089E	4.46	SN76532N	2.00	TBA940	3.09
CA3090Q	1.96	SN76533N	2.00	TBA9502A	3.07
ETT6016	3.20	SN76544N	2.00	TBA970	4.09
ETTR6016	3.20	SN76546N	2.90	TBA990	2.93
LM1351	2.00	SN76666	1.30	TBA1440G	3.33
LM1370	2.38	TAA350A	2.60	TBA1441	3.33
MC1307P	2.80	TAA550A	.60	TCA270	3.00
MC1310P	2.40	TAA550B	.60	TCA270S	4.09
MC1327AP	3.27	TAA550C	.60	TCA290A	3.23
MC1327P	1.50	TAA570	1.98	TCA420A	2.04
MC1330P	1.00	TAA591	2.77	TCA440	1.98
MC1349P	1.99	TAA611B	2.83	TCA640	2.97
MC1351P	1.98	TAA630S	2.50	TCA650	3.42
MC1352P	1.66	TAA661B	2.83	TCA730	3.22
MC1358P	1.60	TAA700	3.91	TCA750	2.43
MC7724CP	1.60	TBA231	1.29	TCA800	3.12
ML237B	2.80	TBA240A	4.87	TCA820	2.27
SAA570	2.68	TBA325	1.57	TCA830S	2.13
SAA700	4.90	TBA395	3.34	TCA900	3.00
SA560S	3.30	TBA396	2.79	TCA910	2.90
SAS570S	3.30	TBA440C	3.30	TCA940	1.90
SAS580	3.64	TBA440N	3.30	TCE100P	3.54
SAS590	3.64	TBA480	2.20	TDA440	3.33
SAS660	4.20	TBA500	2.63	TDA440N	3.33
SAS670	4.20	TBA510	2.63	TDA1170	3.81
SC9503P	1.60	TBA520	2.00	TDA1412	1.00
SC9504P	1.84	TBA530	2.00	TDA2522	4.18
SC9506P	3.20	TBA540	2.20	TDA2530	2.77
SL437F	7.20	TBA550	2.90	TDA2560	3.63
SL901B	5.40	TBA560C	2.34	TDA2590	2.68
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SL918A	6.99	TBA641A12	2.71	TDA3950	2.57
SN16848N	2.60	TBA641B11	3.99	TMS3848NC	4.37
SN16861NG	2.60	TBA641BX1	3.00	ZTK33A	.72

EHT MULTIPLIER TRAYS

TCE 1400 (5 Stick)	3.80	TCE3000, 3500	7.00
TCE 1500 (3 Stick)	3.80	TCE 4000	7.90
TCE 1500 (5 Stick)	4.30	TCE 8000	3.00
ITT CVC 5,7,8 & 9	6.40	TCE 8500	6.00
ITT CVC 20,30	6.40	TCE 9000	6.90
GEC 2028, 1040	6.40	RR1 Dual Standard CTV	8.00
GEC 2110	6.40	RR1 A823	6.90
GEC 2100	6.40	RR1 A823B	6.90
GEC 2200	6.40	RR1 Z718	4.30
PYE 691,693	5.50	GRUNDIG 5010/6010,8&0	6.40
PYE 731 (4 lead)	6.40	GRUNDIG 3000	6.40
PYE 731 (5 lead)	6.40	KORTING	6.40
PYE 713, 15, 17	6.40	SIEMENS TVK31, 51/2	6.40
PHILIPS 520,540,550	6.40	SABA/TFK/SITA/DORIC	6.40
PHILIPS 550 (long lead)	6.40	TANBERG TV2-2, TVC M6	6.40
PHILIPS G9	6.40	EUROTRAY	6.00
DECCA CS1730,1830	4.00	CONVERSION BRACKET A	.40
DECCA CS2030,2230 etc.	6.40	CONVERSION BRACKET B	.40
DECCA CS1910,2213	6.40	TV18 EHT STICK	1.80
DECCA 80/100/Telpro	6.40		

VARICAP TUNERS, DELAY LINES, CRYSTALS, etc.

ELC 1043-05	7.40
ELC 1043-06	7.40
U321 (Philips G11)	7.61
Delay line DL50	4.50
Delay line DL60	4.30
Luminance Delay Line For TBA560	1.50
Transductor AT4041/37	1.68
Linearity Coil AT4042/02	1.50
Linearity Coil AT4042/04	1.50
Colour Crystal 4.433619 M Hz	2.00
Focus Resistor (Thick Film) 10M, 30M, 47M.	.98

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SERVISOL	.75
FREEZER	.75
AIR SPRAY CLEANER	.75
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SILICONE GREASE	.75
SOLDER MOPS	.63

SOLDER

60/40 18SWG

½ Kilo	6.56
2½ Kilo	31.25

TEST EQUIPMENT

POWER SUPPLY 0-30V 0-1A PS301	48.60
POWER SUPPLY 5-18V 0-2A PS302	48.60
POCKET SIGNAL INJECTOR (Requires U7 Type Battery)	2.28

REPLACEMENT DROPPERS

PHILIPS G8	.59
PHILIPS G8 (47R)	.60
PHILIPS 210	.90
TCE 1500	.90
GEC 2018	.70
RR1 640	.80
TCE 8000A	.90
DECCA 20	1.43
PYE 731	1.00
TCE 1400	1.10
RR1 A823	.90
GEC 2110(41R)	.81
GEC 2110(12R5 + 12R5)	.68
TCE 3500	.85

REPLACEMENT T.V. ELECTROLYTICS

TCE 1400 150+100+100+100+150 • 325v	3.70	RR1 300+300 • 300v	2.60
TCE 1500 150+100+150 • 300v	2.05	RR1 2500+2500 • 30v	1.60
TCE 950 100+300+100+16 • 300v	1.60	RR1 600 • 300v	2.60
TCE 3000/3500 175+100+100 • 350v	2.70	PYE 200+300+100+32 • 350v	3.80
TCE 3000/3500 1000 • 63v	1.06	TCE 150+200+200 • 300v	2.94
TCE 8000 700 • 250v	1.73	K.B. 200+200+200+50 • 300v	3.12
DECCA 400+400 • 350v	3.72	K.B. 200+200+75+25 • 300v	3.04
DECCA 200+200+100 • 300v	2.85	PYE 800 • 250v	2.40
RR1/1TT 200 • 400v	2.20	RR1 470+470 • 250v	2.80
PYE 200+300 • 350v	2.70	GEC 300+300+100+50+150 • 375v	5.40
GEC 200+200+150+50 • 300v	3.00	GEC 1000+2000 • 35v	1.80
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EARTH LEAKAGE CIRCUIT BREAKER FOR PORTABLE APPLIANCES. IDEAL FOR LABS, SCHOOLS, TEST RIGS ETC. THE UNIT TRIPS AND ISOLATES THE APPLIANCE OR CIRCUIT BEFORE ANY DANGEROUS SHOCK CAN OCCUR. CONNECTION IS MADE FROM YOUR APPLIANCE TO THE 13 AMP SOCKET CONTAINED ON THE CIRCUIT BREAKER WHICH IN TURN IS CONNECTED TO THE SUPPLY VIA A MAINS PLUG. £33.20.

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PC900	1.60	PL509	3.40
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PCF80	1.40	PL802	3.00
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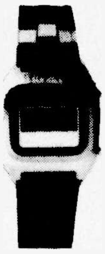
(ANYTIME)

QUARTZ LCD 5 Function



Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins., Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£10.65 Thousands sold!
Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

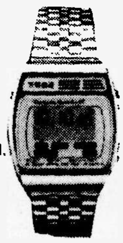
Hours, mins., secs,. month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£12.65

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions



- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags, 22 functions. Constant display of hours and mins., plus optional seconds or date display. AM/PM indication, month, date. Continuous display of day. Stop-watch to 12 hours 59·9 secs., in 1/10 second steps. Split and lap timing modes. Dual time zones. Only 8mm thick. Back-light. Fully adjustable open bracelet.

£22.65

Guaranteed same day dispatch

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags. 22 functions. Solar panel with battery back-up. 6 basic functions. Stop-watch to 12 hours 59·9 secs., in 1/10 sec., steps. Split and lap timing modes. Dual time zones. Alarm. 9mm thick. Back-light. Fully adjustable bracelet.

£27.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up. 6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£13.65

Guaranteed same day despatch.

M9

QUARTZ LCD Ladies Day Watch

Only 25 x 20mm and 6mm thick. Hours, minutes, seconds, day, date, backlight and auto calendar. Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists. State colour preference.

£9.95

Guaranteed same day despatch.

M15

QUARTZ LCD Ladies Fashion Watch

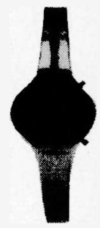
Elegant bracelet in bronze/gold finish or silver colour. Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists. State colour preference.

£14.95

Guaranteed same day despatch

M17

QUARTZ LCD Ladies Cocktail Watch



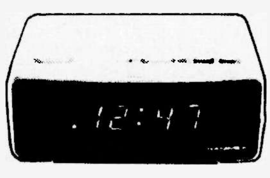
Highly functional watch which also suits those special occasions. Beautifully designed with a very thin bracelet which retains strength as well as elegance. Hours, mins, secs, day, date, backlight and autocalendar. Bracelet fully adjustable to suit slim wrists. State gold or silver finish.

£19.95

Guaranteed same day despatch

M18

HANIMEX Electronic LED Alarm Clock



Features and Specification: Hour minute display. Large LED display with p.m. and alarm on indicator 24 Hours alarm with on off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright 'dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm) Weight 1.43 lbs (0.65 kg). AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

6 Functions plus Alarm: Conference signal, 5 minute snooze alarm. Conference signal sounds 4 secs., before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins., after main alarm and is always preceeded by the conference signal.

£14.95

M60

MACY QUARTZ ANALOGUE

Automatic Calendar Day and Date infinite bracelet. This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21

Metac price breakthrough for an Alarm Chronograph with Dual Time only

£18.95

OUTSTANDING FEATURES

- **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- **CALENDAR FUNCTIONS** include the date and day in each time zone.
- **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show **intermediate (split/lap) time** while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- **ALARM** can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch.

M16

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

Metac Wholesale:

Trade enquiries – send for a complete list of prices for all the goods advertised plus many more not shown also minimum order details.

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Muddling through

"He's a genius with a screwdriver and a bit of string." "It works o.k. if you know which knob to twiddle." That's the sort of thing we tend to admire, isn't it? The person who somehow or other has the knack of getting things to work. There's a belief that this sort of thing contributed more than a little to winning two world wars. If you can extemporize and twiddle effectively the advantages can be enormous, especially in a crucial situation.

Improvisation and practical know-how have served us well, and often seem to be a way of life in the UK's engineering industries. The Yanks are pretty good at it too. Some of their smaller TV stations are said to be kept going by means of string and chewing gum. When things go wrong, you call in Bill or Ed who's got a reputation for being a bit of a genius at this sort of problem. He thinks up a solution and everyone says "what's wrong with that?!" It happens time and time again on the production line, and keeps things moving.

This seems to be something of a way of life in much of the English speaking world's engineering industry, and has given us many advantages. Just think, for example, of the number of inventions and innovations that have arisen from what started off as a piece of bungling! Observation, inspiration and a certain knack: what haven't these achieved!

One can't help wondering however whether the problems of the UK's engineering industries may have something to do with this tradition. Others somehow seem to be able to get their mass production lines tamed and working in a manner that ends up in highly reliable products. Cars, TV sets, VCRs, cameras, and so on and so forth. You don't have to fiddle with them, and no one has to remember at which point a slight tap with a hammer is required. It's all very dispiriting. Lacking that atmosphere of inspired muddling through. And not quite playing the game!

Unfortunately however we live in the era of the consumer. People are no longer amused by the antics of the genius in dirty trousers. They expect things to work first time and go on working. If not, they won't come back for more. They'll buy something from you know where.

Professional engineers – and the engineering institutions – are well aware of these problems of course and are engaged in seeking solutions. It's been suggested for a start that in time only the properly qualified will be able to practise, and that something like the Medical Council will be empowered to strike from the list any engineer found wanting. Such an approach may work, but is likely to be a long term one. It could also beg the question of how you assess the competence of someone working with a fast changing technology.

At a more fundamental level there's the problem of engineering management and the structure of our society – the rigid blue and white collar demarcation and so on. And the problems of communication that arise from all this.

It's been said, rather unkindly perhaps, that the way to get ahead is to be incompetent at doing something. If you're the only one who can't do it very well, you get put in charge so that you do the least damage. Hand him the admin to do and he can't muck things up too much. It's also been said that people rise to their level of incompetence. If someone's obviously good at something, he's a candidate for promotion. Until he lands in a position which he can't manage very well, where he stays.

Perhaps in our free and easy society we'll never get it quite right. The good engineering manager needs to be a man of many skills. He must obviously understand the processes, specifications and requirements of his particular production unit, he must be able to understand the accountant's point of view or they'll all go bust, he must appreciate the marketing side's requirements, and he must be able to handle the personnel problems that inevitably arise. That's a tall order. But without good engineering management, modern mass production plant just won't operate effectively.

There is of course another side to the problem. Growing union power has sometimes coincided with increased reluctance to be adaptable. Just think of all that expensive ENG equipment stored away. It seems to be reinforcing the unfortunate two separate worlds structure of industry.

COVER

Our cover this month shows the Apple II computer's keyboard plus the VDU display. The computer was provided by Strathand Ltd., 44 St. Andrew's Square, Glasgow. Photos by Andrew Parr.

Teletopics

ITT RETRENCHMENT

Retrenchment seems to be the order of the day in the European TV setmaking industry. During the past year or so there have been several major moves in the UK industry, including Thorn's closure of its Bradford plants, with production concentrated at Enfield and Gosport, and the Rank-Toshiba and GEC-Hitachi links. Moves on the continent have included the cessation of TV set production by Tandberg and link ups between Thomson-Brandt-NordMende and Philips-Grundig. Now comes news from ITT of plant closures, with concentration of production in three plants, one each in the UK, France and Germany. ITT say they are at present Europe's third largest TV manufacturer, producing some 700,000 sets a year. Production at ITT's Basildon plant is running at around 200,000 sets a year, and ITT claim to have 10 per cent of the UK market for colour receivers.

The UK ITT plants facing closure are at Kearsley, Lancashire (at the end of March) and Hasting (mid-1980). Kearsley is to be retained as a regional sales, service and distribution centre, but closure of the assembly lines at the two plants will involve the loss of some 900 jobs. Increased production at Basildon is expected to create some 150 extra jobs. The fact is however that with simpler, more compact TV chassis and increased automation a large number of jobs in the industry have been lost.

One area in which ITT plans to expand is in the production of Prestel equipped TV sets and associated equipment. ITT is the first setmaker to start volume production of a 16in. colour set equipped for use with Prestel – Model TXV16. This is priced at £975, though the price is expected to fall to around £825 next year as production builds up. ITT also have a 26in. model, a printer unit which produces in seconds a printed copy of the displayed Prestel page, and both a small and a large, editing keyboard to enable the user to write his own pages. The printer is priced at £550 at present, but should come down to the £400 level. Production is running at 100 sets a week and is expected to build up to over 1,000 a week next year. ITT comment that they were held up until recently by a shortage of i.c.s for Prestel use.

Some facts released recently by Mullard's Economic and Market Research Department help to put the overall world TV production scene into perspective. Total world production of colour sets in 1978 reached 30 million. Of these, 10·2 million were produced in W. Europe, 8·5 million in Japan and 7·75 million in the USA. Production and sales in W. Europe were roughly in balance. Japan exported nearly 3 million sets, and over 2·25 million sets were imported by the USA. Quotas have been imposed by the USA in recent times, so with Japanese setmakers looking for markets elsewhere and the ending of the PAL licensing restrictions this year, combined with market saturation, one can appreciate the jittery state of setmakers in W. Europe.

Even with the current moves towards plant rationalisation, most W. European setmakers remain much smaller than their Japanese competitors. It's interesting that ITT had earlier been considering joining forces with another European setmaker, and had got as far as talks with Thomson-Brandt. Eventually however ITT came to the conclusion that the scale of its combined European operations was sufficient for it to remain independent. As part of the rationalisation plan, the UK, French and German plants will each produce assemblies for use in all sets.

VIDEO DISC MOVES

Philips and Sony have concluded a comprehensive agreement permitting them to use each other's patent rights freely over a wide range of products, including optically (laser) scanned audio and video discs. Up till now, Philips and Sony have been developing laser-scanned disc systems independently. The aim of the agreement is to achieve interchangeability of products.

The Philips/MCA video disc system has been test marketed in two areas (Atlanta and Seattle) in the USA for several months now, and substantial increases in disc prices have been announced following heavy initial losses. Feature film disc prices have been increased from $16 to $25 and other discs from $6 to $16. The price of the player is also to be increased.

In preparation for the European launch of the Philips/MCA video disc system in 1981, discussions are taking place with a view to designating the Mullard Blackburn plant as the European production centre for video discs. It's hoped that pilot production will commence in the second half of 1980. This could involve a multi-million pound investment over a period of five years or so.

Meanwhile BSR, Thorn, Plessey/Garrard, Pioneer, Sharp, Toshiba, General and NEC have all taken out licences with RCA giving them access to RCA's Selectavision video disc system.

MULLARD TV DEVELOPMENTS

Mullard have announced a single-chip PAL decoder i.c., type TDA3560. This 28-pin LSI i.c., in a DIL package, incorporates all the facilities required for processing the chrominance and luminance signals, and provides direct drive to the RGB output stages. We've tried out pre-production samples of the i.c. in the *Television* colour receiver project and obtained excellent results. Details for using the i.c. in a simplified decoder will be published in due course.

Mullard are also to introduce a new low-cost colour TV projection system, called the Empress. The viewing screen has a diagonal measurement of 1·25m (about 4ft.) and the projector employs a Schmidt optical system. The resolution is better than 500 lines. Old-timers will need no introduction to Schmidt optical systems!

EUROPEAN SATELLITE TV

An agreement has been reached between France and W. Germany to bring into operation a jointly run TV satellite service. The satellite launch is expected to be in 1983, with full operation of the system in 1985. Each country is to build an identical satellite, with a third held in reserve, and the total cost of the operation is expected to be around £150 million. The cost of buying and installing a viewer's parabolic aerial is put at about £220.

THORN ACQUIRE REW

Thorn have acquired REW, which operates a number of specialist audio/video shops in the London area. Thorn Television Rentals aims to expand the REW operation, which will play a part in the development of the video side of the business. Thorn opened its first specialist video shop. Vista Video, about a year ago in Nottingham.

IPC VIDEO RELEASES

IPC Video have released in videocassette form two films featuring Joan Collins – *The Stud* and *The Bitch*. The latter is at present running in the West End of London, and this is the first occasion on which a major motion picture has been released in prerecorded videocassette form simultaneously with its general release. A major motion picture? Well, that's what IPC Video call it. In fact it got lousy revues.

TRANSMITTER OPENINGS

The following relay stations are now in operation:
Armitage Bridge (W. Yorkshire) BBC-1 ch. 58, Yorkshire Television ch. 61, BBC-2 ch. 64. Receiving aerial group C/D.
Biddulph (Staffs) Granada ch. 30, BBC-1 ch. 34, BBC-2 ch. 67. Wideband aerials covering Bands IV/V are required.
Carradale (Strathclyde) Scottish Television ch. 41, BBC-2 ch. 44, BBC-1 ch. 51. Receiving aerial group B.
Caversham (Berks) BBC-1 ch. 49, BBC-2 ch. 52, Southern Television ch. 56. Receiving aerial group C/D.
Cragg Vale (W. Yorkshire) BBC-1 ch. 58, Yorkshire Television ch. 61, BBC-2 ch. 64. Receiving aerial group C/D.
Luddenden (W. Yorkshire) BBC-1 ch. 57, Yorkshire Television ch. 60, BBC-2 ch. 63. Receiving aerial group C/D.
Ravenscar (N. Yorkshire) BBC-1 ch. 58, Tyne Tees Television ch. 61, BBC-2 ch. 64. Receiving aerial group C/D.

All the above transmissions are vertically polarised.

In addition, modifications have recentlly been carried out to the BBC/IBA transmitters at the Taff's Well relay station, extending the coverage.

VIDEO DEVELOPMENTS

The main activity on the VCR front remains the extension of playing times. Akai launched a new cassette at the recent Berlin Radio Show, giving four hours' playing time from a standard VHS-format machine. The cassette has a longer length of thinner tape. In the USA, JVC have introduced a dual-speed VHS machine which gives two or six hours' recording time at the flick of a switch. Naturally the slower speed involves some loss of quality. The VCR (Model HR6700U) has a sophisticated programmable timer-tuner unit which allows for up to six recordings over eight channels during a seven-day period. Sharp have also introduced a two-speed VHS VCR – with a programmable timer/tuner having a 49-programme capacity . . . It also has a smart looking LCD clock.

Meanwhile Sony have introduced an updated version of their Betamax VCR. The new Model SL8080 will gradually replace the SL8000. It offers the added features of programme search and cue and review. The latter offers instant playback. The price is expected to be similar to the older machine.

More technical details are available on the two LVR systems previewed recently. The tape speed with the Toshiba system is 6m/sec while BASF use a tape speed of 4m/sec. The BASF cassette has 600m of chromium dioxide tape which takes 2·5 minutes to run through before stopping and reversing. Changeover from one longitudinal track to the next takes 22msec with the Toshiba machine and 100msec with the BASF machine. BASF use a contact winding system to make the high-speed stop-reverse-go process possible: since the back-and-forth shifting is accomplished without entrapping air in the wound tape, BASF say there's no slippage. Toshiba use an endless-tape arrangement, with two spools in the cassette. The BASF VCR produces a stable playback picture on the TV screen half a second after the play push-button is activated. For further details, see *Teletopics* in the last two issues.

BOOK OF AUDIO

A sumptuous book entitled *"Newnes Book of Audio"* has just been published by Butterworths at £4·95 – and a Book of Video is planned. The audio book surveys the current state of audio technology and is aimed at enabling the hi-fi enthusiast to get the best out of his equipment. The book is written by a group of technical authors many of whom will be familiar to readers of this magazine – Gordon King and Vivian Capel for example. There are 120 editorial pages, including a directory of manufacturers and suppliers.

CEEFAX UPDATE

The BBC is now using a new second-generation computer system to control its Ceefax teletext transmissions. The system incorporates three separate computers in a complex configuration, and has been named Selene – after the Greek moon goddess. The new BBC-2 teletext magazine, called Orbit, has been introduced at the same time. Another major innovation is called Polyglot, which takes account of most known accents and combination accents used in foreign languages while remaining completely compatible with existing teletext decoders.

LINK UP WITH THE COMPUTER

The worlds of TV and the computer seem to be getting closer and closer. Thorn and ICL have now joined forces to develop a viewdata system which will enable a viewdata equipped TV set to be linked to an ICL 1900 computer. The system is to be known as Thorn-tel and will enable any sort of display, including graphics, or enquiry system to be set up. The TV set will retain its off-air capability.

Meanwhile, in the US Texas Instruments have made a major breakthrough in getting FCC approval for a home computer that can be linked directly to a conventional TV set. The output from the computer (type T199/4) is fed to an r.f. modulator (type TI900) and thence to the TV set.

SECOND SPTS SEMINAR

The first Satellite Private Terminal Seminar (SPTS), held in Oklahoma City last August, was apparently a great success. It's to be followed by a second seminar in Miami next February. The aim of all this activity, under the guidance of Bob Cooper, is "making low-cost satellite TV happen".

Footnote on the Pye 713/5/7 Chassis

Harold Peters

STOCK faults on these sets were dealt with by Mike Phelan in last month's issue. A problem with these sets is to know the degree of interchangeability there is between early and late models – particularly if you have to carry a minimum stock for repair purposes. First let's identify the chassis.

The 713 is the earliest, with no focus potentiometer on the c.r.t. base panel, rotary controls, a unipotential c.r.t. (see below) and a four-button tuner. Models are the Pye CT200 and Invicta CT7018.

The 715 came during the middle part of the production run. This has a focus potentiometer on the c.r.t. base panel, rotary controls, a four-button tuner and a conventional c.r.t. Models are the Pye CT200/1 and Invicta CT7018/1.

The 717 was the final version. Again there's a focus potentiometer and conventional c.r.t., but this time there are slider controls and a six-button tuner. Models are the Pye CT218, Ekco CT818 and Philips G18C570.

The unipotential tube fitted in the 713 chassis is the A47-342X (470DUB22), which cannot be interchanged with later versions. Unipotential indicates that the focus and first anode electrodes are operated at a similar voltage, which is obtained from D657/C655 in the line timebase. The 715/717 chassis are usually fitted with the conventional A47-343X (470EMB22) tube imported from Toshiba. By conventional, we mean that the focus electrode is operated at about 3·5kV. The degaussing arrangement used with this tube consists of a pair of coils on flat bobbins, mounted on a steel band strapped around the bowl. Towards the end of the production run the tube was replaced by an M.E.C. (Matshushita Electric Corporation) version. This is electrically similar to the Toshiba one but unable physically to carry the steel degaussing strap, which was replaced by two large conventional coils. So although these two tubes are electrically interchangeable and the M.E.C. degaussing fits the Toshiba tube, you may be in trouble if you try to fit the steel band around the M.E.C. tube.

The later type of e.h.t. doubler with five leads can be used in the 713 chassis provided the focus lead is well insulated and tucked out of the way.

The 715/717 series uses a high-impedance brightness control circuit, the 713 chassis a low-impedance brightness circuit. Since half the circuit is on the control panel and the other half on the chroma panel, a wrong combination will give either uncontrollable brightness or uncontrollable dimness . . . The best bet is to stock the later boards (715/717 chassis) coded 20/2. If it's necessary to fit one to an earlier set, straddle R310 (33kΩ) and R483 (47kΩ potentiometer – preset brightness control) with a 10kΩ potentiometer and adjust this for the correct brightness range (see later). In the 713 chassis R310 is 3·9kΩ and R483 4·7kΩ.

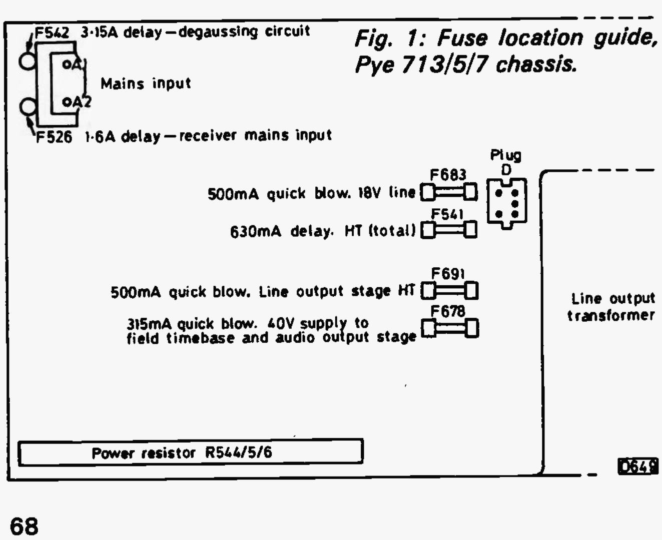

Fig. 1: Fuse location guide, Pye 713/5/7 chassis.

Early on in the production run the design of the TBA560 chrominance/luminance signal processing i.c. was improved – in two stages. The original TBA560 was fitted to boards coded 20, and was soon replaced by the TBA560A on boards coded 20/1. These two devices cannot be interchanged without a lot of work on the peripheral components. Happily the TBA560C, the currently available device, can be fitted in place of the TBA560A with no circuit change and, if you are lucky, without realignment either.

The tuners, i.f. and detector modules are interchangeable with their counterparts in the large-screen 731 and 725 etc. chassis. Towards the end of the run of the large-screen chassis however, the detector module was modified to accept ceramic sound filters in place of coils on the board itself. These detector modules can be recognised by the absence of the "Crystal Palace" trap (L162) at the i.f. end, and are not advised as replacements on the 713 etc. except in dire emergency.

Since the beam limiter (see Fig. 6, page 27 last month) works via the contrast control, it's essential to make sure that the brightness control cannot overload the set by misuse. Hence the inclusion of the preset brightness control R483, which is mounted vertically on the chroma board. To set up, measure the beam current with a meter (AVO 8 etc.) set to 1mA connected across the c.r.t.'s green cathode protection resistor R905 on the tube base panel. Turn off the red and blue guns, using the switches on the convergence panel, and display a test pattern or similar still picture. Adjust R483 for 400 μA with the user brightness control at maximum and the contrast and colour controls at minimum. Then set the beam limiter control R221 on the i.f. panel for 850μA with the brightness, contrast and colour controls turned fully up. Beware of a false reading. The correct one is the first one reached from R221 being fully anti-clockwise. The second, false, reading will result in low l.t. (below 11·5V d.c.).

Fuse blowing (see plan of fuses, Fig. 1) is a common problem, the mains fuse (F526, 1·6A) being a persistent offender, particularly in areas where the mains supply is rough. A useful dodge is to fit a VDR across the set side of the on-off switch. This is effectively open-circuit unless the mains voltage surges to a point where the glow switch would normally trip: it then conducts to clip the peak. This stops the glow switch tripping on mains voltage transients, but leaves the set fully protected against persistent over-voltage due to a fault. A suitable VDR is used in the Philips/Pye G11 chassis (R1307, service code number 116 27041 – or its RS equivalent). The degaussing circuit fuse F542 is not fitted in early sets.

LARGE-SCREEN CHASSIS (731 ETC.)

Mike Phelan reports that he's had to replace R898/R899, the parallel connected resistors in the diac firing circuit in the power supply, on a number of occasions recently. The resistors may look reasonable, but seem to decompose, changing value (82kΩ, later changed to 56kΩ with other power supply modifications). The symptoms can be anything from a jittery picture to low h.t. or a dead set, and may be intermittent. Use a replacement rated at 2W. ■

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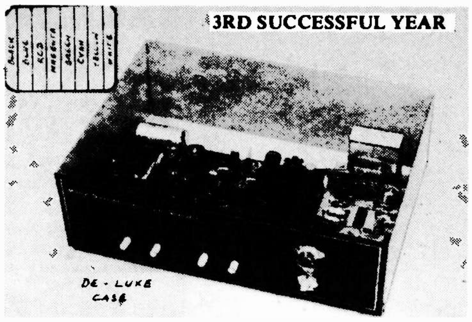

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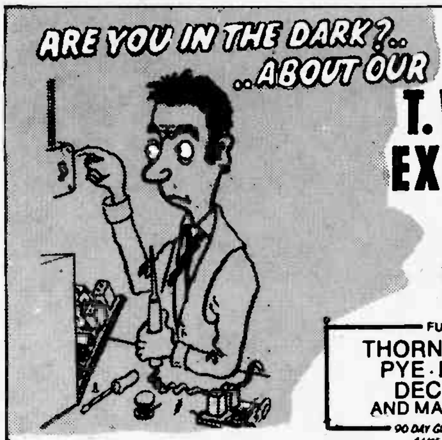

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ITT's New Infra-red Remote Control System

A. J. Edwards*

THE present generation of ultrasonic remote control systems use a band of frequencies of approximately 32-45kHz, the bandwidth being limited by the need to fit it between the harmonics of the line timebase. Because of the Doppler effect, the number of separate control frequencies that can be used within this bandwidth is limited to about 30 – sufficient nevertheless to provide remote channel selection, control of brightness, colour and volume, and operate a teletext system. A number of coding systems have been devised to enable the same or a greater number of commands to be incorporated in the bandwidth using fewer frequencies, but these suffer from problems due to room reflections – if a reflected signal arrives at the TV set at a significantly different time to the main signal, the effect can be misfunction or non-operation of the remote control system. A solution to these problems is to use infra-red instead of ultraviolet frequencies for transmission. Until recently this approach suffered from a cost penalty, but infra-red transducers are now available at a very competitive price.

Pulse Code Modulation

The latest remote control system developed by ITT employs infra-red for the transmission link and pulse-position modulation to code the commands. The principle of pulse-position modulation has been described in these pages before, in connection with the Plessey remote control system (see *Television* November 1978 and April 1979). All that's required is to define two different time intervals between pulses: one interval is taken to be a logic 1 and the other logic 0. This means that the commands are digitally coded, the number of commands of which the system is capable depending on the number of digits used, i.e. the length of the digital "word". The ITT system uses a ten-digit word, for which eleven transmitted pulses are required (since each digit is the interval between two pulses). The use of ten bits gives a possible total of 1,024 commands. Additional pulses are added to provide error protection and other features, the transmitted word actually consisting of 14 pulses.

Fig. 1 shows the details of the transmitted word and the time intervals corresponding to 0 and 1.

Processing the Received Word

The first pulse of the word (the preliminary pulse) sets the a.g.c and clipping levels within the remote control receiver, enabling the system to work over a very much larger range than would otherwise be possible. The SAA1251 receiver i.c. detects this pulse and starts a timing sequence which expects another pulse to arrive one time period (±15%) later. Since such a pulse doesn't arrive, the i.c. rejects the initial pulse as a random event, i.e. it's not taken to be part of the actual command. The second (start) pulse starts a similar timing sequence, the i.c. measuring the time till the arrival of the third pulse. This time is taken to be the nominal period for a 0, and multiples of it as being either a 1 or the end of word bit (the period to the stop pulse). This arrangement corrects for any frequency offset in the oscillator used in the transmitter unit. The receiver unit then uses this measured period to open "windows" for data acceptance.

To reduce susceptibility to noise, the receiver i.c. accepts a received command as valid only if it fulfills the following conditions: (a) The input period is 100μsec (±15%). (b) All pulses arrive within the acceptance windows. (c) No pulses arrive between the acceptance windows. (d) A valid word of 10 data bits (eleven pulses) followed by a stop pulse bit is received. This checking/validation procedure provides a system which is virtually immune to misfunction due to extraneous sources of infra-red light, e.g. the sun, electric fires, lighting and so on.

Transmitter Circuit

Since the system is tolerant of a frequency error of 15%, only one stable reference is required. The obvious place to include this is in the receiver unit, where it can be interfaced with other arrangements, e.g. a frequency synthesizer tuning system. The oscillator used in the transmitter unit is thus a simple *RC* type incorporated within the SAA1250 transmitter i.c. To minimise drain on the battery used in the transmitter unit, the oscillator is powered only when a command is detected by the keyboard input circuit. The circuit of the transmitter unit is shown in Fig. 2.

When the transmitter i.c. detects an input from the keyboard, it starts the oscillator and times out a 20msec delay to allow for keyboard switch bounce. It then transmits the 14-pulse word appropriate to the command requested. If the key is held depressed, the command is retransmitted at 130msec intervals.

Since each word consists of 14 10μsec pulses, the word being repeated at 130msec intervals, the output stage duty cycle is approximately 0·1%. Thus for a peak infra-red LED current of 2A, only 2mA is drawn from the battery. Adding the transmitter output stage current and the i.c. current (approximately 4mA) gives a total active transmitter current of 6mA, which is well within the capability of a 9V layer battery of the PP3 type. The

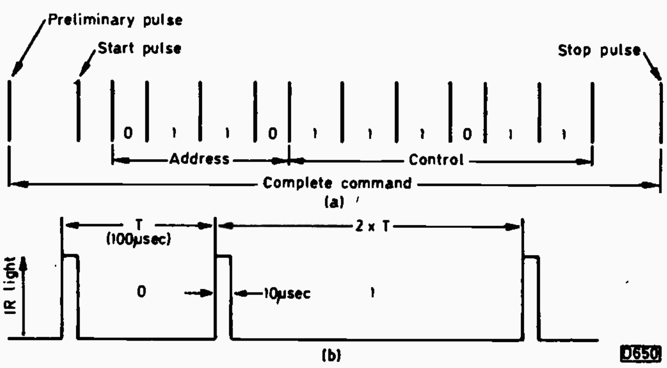


Fig. 1: (a) The transmitted command word. (b) Pulse timing for a 0 and a 1.

**Applications Department, ITT Semiconductors, Foots Cray, Kent.*

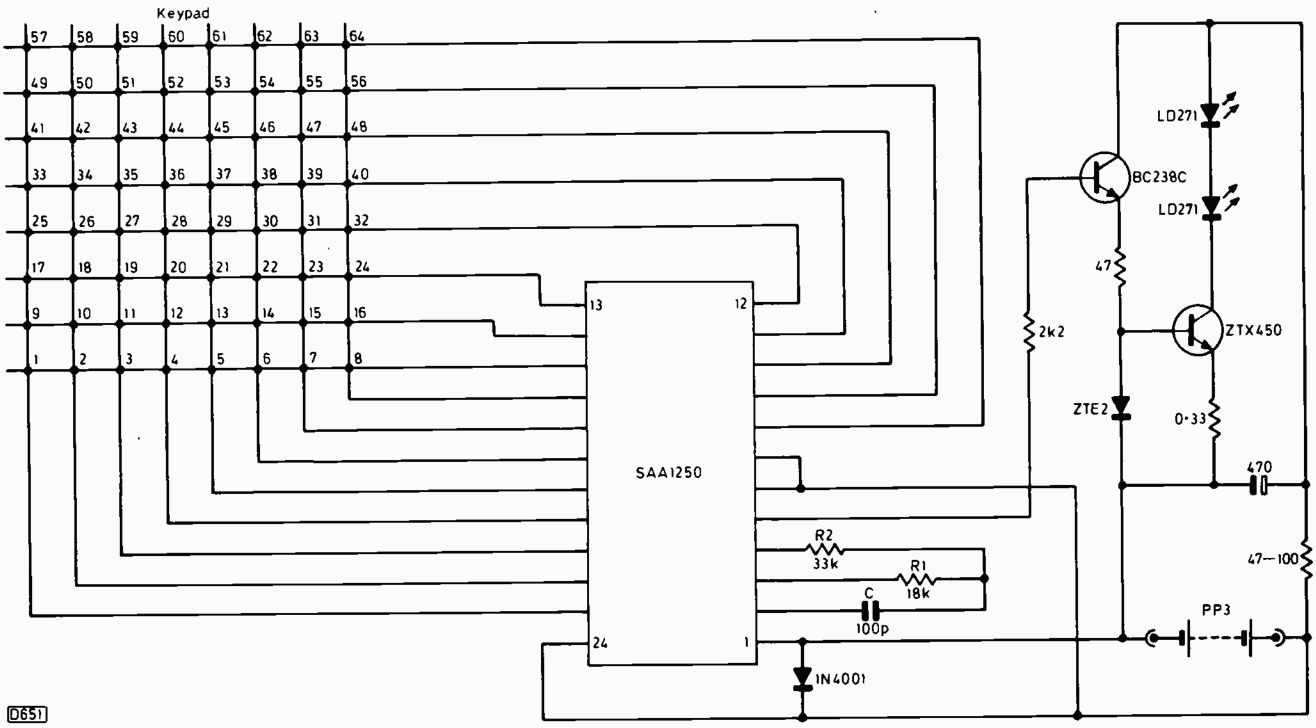


Fig. 2: Typical transmitter circuit. Components R1 and C in the oscillator circuit must be close tolerance types – the combination of R1 and C should have a tolerance of better than 4·5%. R2 may be a 5 or 10% type.

quiescent current consumption is only some 10μA. The battery life should thus be not significantly less than its shelf life.

Since the transmitter uses a 9V supply, it's convenient to use a couple of infra-red LEDs in a current-driven series configuration, thus reducing the component count and the power consumption. If an operating range of greater than 20m or so is required, more LEDs and more complicated drive circuitry can be employed. The configuration shown allows for falling battery voltage with age and use. This is an important factor since, as the power for the LEDs comes from the 470μF storage capacitor, the first word would otherwise have more power than succeeding words in a continuous command.

Receiver Circuit

In the receiver unit a large-area pin diode such as a BP104 or TIL100, incorporating in its encapsulation a filter compound to reduce sensitivity to visible light, converts the infra-red signals to electrical ones. The photodiode is connected directly to the TEA1009 preamplifier i.c., whose first task is to bias the photodiode so that it always has the same d.c. voltage conditions, thus taking care of the effects of sunlight, room lighting, etc. The following high-gain wideband amplifier in the i.c. is a.c. coupled, via the external 0·01μF capacitor between pins 4 and 5, to the clipping stage, which removes noise and feeds a clean signal to the SAA1251 receiver i.c. The first pulse to arrive from the transmitter is used to reset the photodiode's d.c. conditions, compensating for variations in transmitter range. The first pulse also sets the clipping level within the TEA1009, thus determining the signal-to-noise discriminating level. Hence the importance of the preliminary pulse from the transmitter, without which the system's range of operation would be very much reduced – especially close to the TV set.

The SAA1251 i.c. first carries out the checking/validation procedures previously described. To provide a timing reference, the i.c. incorporates an oscillator which operates with an external crystal. This may be an ordinary 4·43MHz crystal for normal systems, or a 4MHz type where the remote control system is to be integrated with a frequency synthesizer tuning system. The validated data is then processed in various ways. The 1,024 possible commands are split into 16 groups of 64 commands, and any particular receiver i.c. will be looking for only its own 64 commands. This splitting into groups is done by using the first four bits of the transmitted word as an address, and the remaining six bits as the command itself. The receiver i.c. checks the address bits and if these don't correspond to its own programme it doesn't act upon the command (other than to change its format and feed it out on to a serial data bus). If the address is correct for the receiver, the appropriate control action is initiated.

Commands

Ten commands are used for analogue controls. The analogue control outputs from the i.c. are of the usual variable mark-space ratio type. Eight consist of the usual up and down (volume up and down etc.) commands, the other two being sound mute and picture normalise. A further 17 commands are allocated to programme selection: 16 give direct access to a programme via a latched, 4-bit parallel bus, the remaining command providing sequence control, stepping the programme number upwards. In addition, commands have been allocated to switch the receiver on and off, and to set or reset a spare flip-flop whose output can be used to activate a top-cut tone control or any other switched function. Most of these commands can also be fed to the receiver i.c. from a keyboard mounted in the set – thus all is not lost if the transmitter fails to operate.

Remote TV receiver control uses very few of the available 1,024 commands – in fact it doesn't even come close to making full use of a single address. The remote control system is thus capable of being adapted to new developments and technology as these arrive. In this

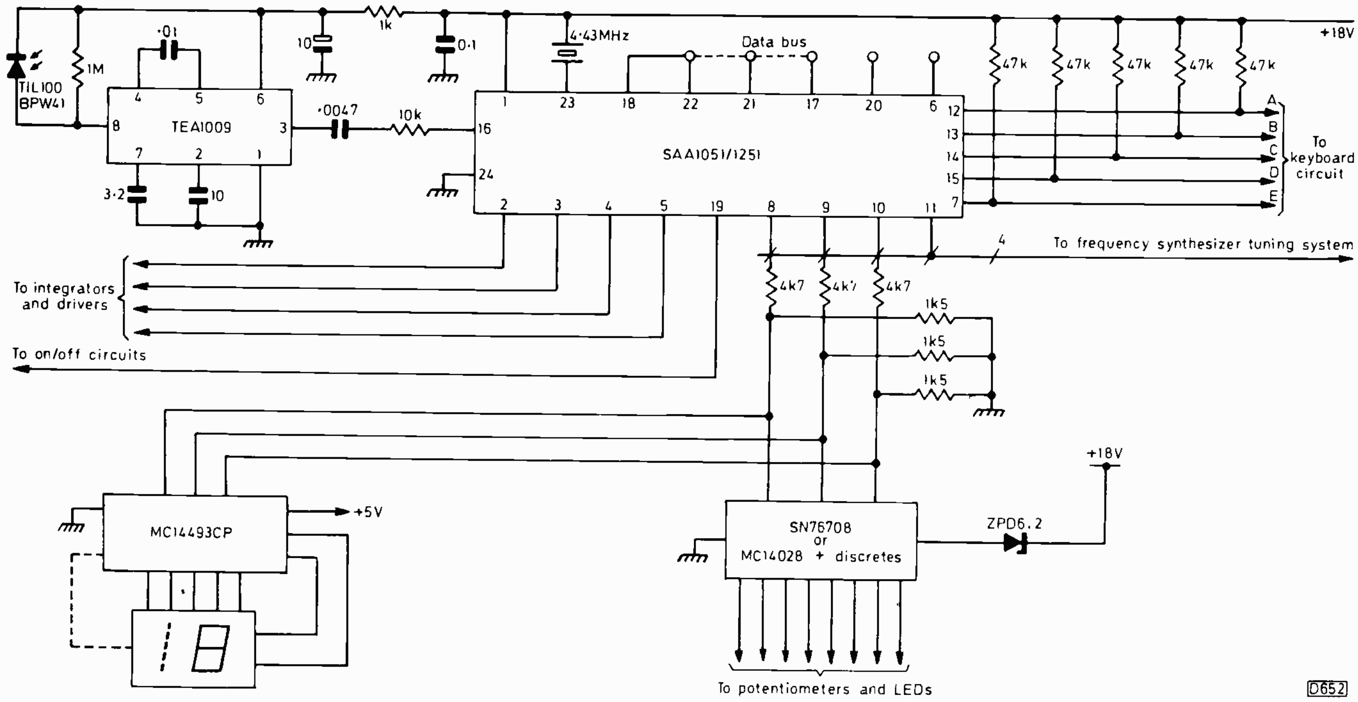


Fig. 3: Typical receiver circuit. The outputs from pins 17 (serial data) and 21/22 (clock pulses) can be used to drive sub-systems. Pin 20 is the output from an additional memory within the i.c., while pin 6 provides an output from the i.c.'s control unit. The SAA1251 can be used in four different operational modes by connecting pin 18 to either pin 1, pin 21, pin 22 or pin 24. In these different modes, the i.c. responds to different addresses in the command word.

connection, an i.c. is being developed to enable the remote control system to be interfaced directly with various other systems, giving remote teletext and viewdata control.

The new ITT remote control system is optimised for use with infra-red radiation as the transmission link. It's thus considerably faster than systems which can be used with either an ultrasonic or an infra-red link, and consumes considerably less power. ■

TV Servicing: Beginners Start Here...

Part 27

S. Simon

TACKLING THE COLOUR DECODER

HAVING discussed tube drive, and the way in which the three beams in a colour tube are controlled by the various assemblies mounted on the tube's neck, we come to the subject of decoders – the way in which the transmitted colour signal is sorted out into its various components and processed. To get to grips with this we need to consider first what's involved in transmitting a colour signal.

Transmitting a Colour Picture

We've seen that a colour picture can be displayed by adding together suitable proportions of the three primary colours red, green and blue. So we could use three cameras, each incorporating a filter so that it's sensitive to only one primary colour, and feed the outputs to three transmitters and three aerials. At the receiving end we could have three aerials, three receivers and a projection system to combine on a screen the outputs from the three tubes (red, blue and green). Fine, but hardly practical. Apart from being expensive, this approach would be wasteful of air space, calling for three channels to provide a single picture.

Right at the start of colour TV, it was decided that the colour transmissions should occupy the same channel bandwidth as the existing monochrome transmissions, and that the colour signal should be added to the monochrome one in such a way that monochrome receivers would continue to function happily, simply ignoring the extra colour information. As we saw in Part 24, we can use a basic monochrome signal, which is more strictly referred to as the luminance (i.e. brightness) signal, for which the abbreviation Y is used, plus three colour-difference signals. The monochrome receiver ignores the colour-difference signals, while the colour receiver uses them to adjust the drives to the colour tube's three guns.

The colour camera must clearly be able to recognise the primary colours and produce primary-colour signals: and so that monochrome viewers are happy, it must also provide a luminance signal. The luminance signal can be simply produced by adding together certain proportions of the primary-colour signals. These are 30% red, 59% green and 11% blue, these proportions corresponding to the characteristics of the human eye. Once this has been done, it's again a simple matter to do a little more signal mixing to get B – Y, R – Y and G – Y.

Since these signals are in set proportions, it's not necessary to transmit them all. Y has to be transmitted for the benefit of monochrome viewers. The transmission of two of the colour-difference signals as well will give us our colour display – the third colour-difference signal can be recreated in the receiver by adding together proportions of the other two. In practice, B – Y and R – Y are transmitted, and G – Y is obtained in the receiver by matrixing as it's called.

Some other facts assist in the bandwidth economy drive. The human eye is sensitive to brightness detail but not to fine colour detail. So we don't need the full monochrome vision bandwidth (5MHz for the UK 625-line system) for our colour-difference signals. We can chop them down to 1MHz (double-sideband) and modulate them on to a suppressed subcarrier placed somewhere towards the higher frequency end of the monochrome channel bandwidth.

Why a "suppressed subcarrier"? It's not our purpose to go into transmitter details here, but briefly by using the suppressed subcarrier technique there's no extra colour signal at all when no colour is present in the scene, thus minimising possible interference to the monochrome picture.

Just one subcarrier for two signals (R – Y and B – Y)? Yes. Again we can't go into transmission theory, but if we arrange that the two signals are in quadrature with one another, i.e. there's a 90° phase difference between them, a single subcarrier will suffice – the technique is known as quadrature/amplitude modulation (QAM).

So we've got one suppressed subcarrier carrying two relatively narrow-band colour-difference signals (the chrominance signal for short). We've still got to fit it into the monochrome channel bandwidth. Due to the line structure of the picture, there are unused gaps, at regular intervals, in the monochrome channel bandwidth. If we select our colour subcarrier frequency carefully, the chrominance signal will fit into these gaps. Hence the rather surprising looking chrominance subcarrier frequency of 4.43361875MHz (4.43MHz for short). This is related to the line frequency (15.625kHz), and is chosen to minimise interference effects on monochrome receivers by cancelling to some extent on a line-by-line basis.

The Complete Colour Signal

What have we got so far then? A luminance signal which corresponds to the monochrome vision signal, a sound signal and sync pulses of course as usual, plus a chrominance signal (when colour is present) which consists of two colour-difference signals combined through a quadrature modulation process and inserted into the luminance channel bandwidth, towards the h.f. end. Is anything else needed? There's one more complication. The use of a suppressed subcarrier means that an oscillator, operating at the subcarrier frequency, is required in the receiver to assist with the chrominance demodulation process. It's vital that this oscillator is synchronised with the transmitter's subcarrier oscillator, and for this purpose a burst (six cycles) of oscillation at the subcarrier frequency is transmitted during the back porch period, immediately following the line sync pulse, when otherwise there's no video information being transmitted. For obvious reasons, this is called the burst. Remember that it's present for a brief interval only, during the line flyback period, and that it's present only when a colour picture is being transmitted.

Returning to our colour receiver, the job of the decoder is to sort this lot out, producing from the burst and the chrominance signals three separate colour-difference signals. Always assuming that the picture being transmitted is a colour one of course: with no colour there are no colour-difference signals and the colour tube is driven as if it was a monchrome one.

Enter PAL

Before we take a look at a typical decoder arrangement, one extra complication has to be considered – PAL. The problem with the use of QAM is that any spurious signal phase shifts will cause incorrect colours. This is obviously a serious matter. The PAL technique, used for the UK, most W. European and many other colour services, was devised to overcome this problem. The technique consists of inverting the polarity of one of the colour-difference signals (in practice R – Y) on alternate picture lines: the use of a line duration delay line (the chrominance delay line) plus summing networks in the receiver than makes it possible to cancel out the effects of phase shifts (this is not a 100% accurate technical account of what actually happens, but we've got to keep the theory as simple as possible). This adds to the complexity of the decoder of course: a PAL decoder must have a delay line, a summing network, a switch to re-invert the polarity of the R – Y signal – and a means of synchronising this switching with that carried out at the transmitter.

Operation of the Decoder

Right, now let's turn to the decoder. The best way of seeing what takes place here is to use a block diagram (Fig. 1). We'll start with the i.f. signal, which incorporates the luminance and chrominance signals (also the sound signal, but we're not concerned with that here). This is applied to one or more detectors to give us a video frequency signal. Only one detector is necessary, but an extra one is often used to make it easier to filter out the components of the composite signal, and also to minimise the generation of beat frequencies which can cause patterning (e.g. mixing the 6MHz sound signal and the 4.43MHz colour signal can produce a spurious output at 6 – 4.43 = 1.57MHz).

The next step is to separate the luminance and chrominance components of the composite video signal. Fortunately this doesn't have to be a 100% process, and some simple filtering suffices. A notch filter tuned to the chrominance subcarrier frequency (4.43MHz) will effectively remove the chrominance from the luminance channel, which is shown across the top in Fig. 1, while a high-pass filter will ensure that the main signal component passed to the colour decoder consists of the chrominance signal.

The Luminance Channel

The luminance channel is a simple enough affair consisting, in addition to the filter, of amplification as necessary and the luminance delay line. The latter is required to keep the luminance and chrominance signals in step since, as we pointed out in Part 25, the chrominance signal takes longer to pass through its narrower bandwidth circuitry than the luminance signal takes to pass through its wider bandwidth circuitry. We can forget about the luminance signal then, noting simply that at some later stage it must be added to the colour-difference signals in order to get the primary-colour signals required to give us the actual colour picture.

Burst Gating and Blanking

Turning to the decoder proper, the first obvious thing required is amplification of the chrominance signal. At an early stage, the burst signal must be separated out. It's not required in the chrominance/colour-difference signal path, where it could interfere with any clamping arrangements used in the output stages, so it's simply blanked out. Conversely, the chrominance signal is not wanted in the burst channel, where it would interfere with synchronisation of the reference oscillator. So a simple gate is used to allow the burst signal only through to its own detector.

The Burst Channel

Let's stay with the burst signal for a minute or two since there are some important points to be made here. First, while the amplitude of the chrominance signal will be varying as the colour-difference signals vary, its phase also varying as a result of the QAM process, the amplitude of the burst signal will be constant – except for changes due to variations in signal strength. This provides us with a convenient method of applying a.g.c. – or automatic chrominance control (a.c.c.) as it's generally called. We can use a simple half-wave rectifier to detect the amplitude of the burst signal, and use this to control the gain of the first chrominance amplifier. The amplitude of both the burst and the chrominance signals will be stabilised as a result.

Secondly, the burst signal is used to synchronise the frequency and phase of the decoder's reference oscillator. The process employed is very similar to flywheel line sync: the burst detector compares the phase of the bursts and the signal from the reference oscillator, and produces a control signal to pull the reference oscillator into lock. For this to be effective, it's vital that no chrominance signal, with its phase variations, gets through to the burst detector. So the shape and timing of the pulse used to open the burst gate are important. In many decoders there are controls to adjust this, and incorrect setting will result in colour faults. It's also vital for the pulses to be present. These are obtained from the line timebase (usually – the sync pulses themselves can alternatively be used to generate the gating pulse), since the gating has to done at line frequency. No gating pulses equals no burst input to the burst detector and no output from it. Since the colour-killer works off the burst detector output, via the d.c. amplifier (if present) and the ident amplifier, no gating pulses will also mean no colour. So for the no colour fault you might have to check back to the line timebase: in the Thorn 8000 chassis for example the 33kΩ pulse feed resistor R404 often goes open-circuit to cause this trouble. We'll get back to the colour-killer in a moment. First it's necessary to say something about the phase of the bursts.

Since it's unmodulated, the burst's amplitude remains constant – except for variations due to signal strength changes. You might think its phase remains constant too, especially as it's used to synchronise the phase of the reference oscillator. In fact, due to the PAL switching at the transmitter, the phase of the burst varies by ± 45° line-by-line. This doesn't affect the reference oscillator synchronisation, due to the long time-constant of the filtering components used. There is nevertheless an output from the burst detector at line frequency due to the PAL switching. This is called the "burst ripple". It's amplified by the ident amplifier and used to control the line-by-line switching of the PAL switch.

The Colour Killer

When the transmitted signal is a monochrome one, no burst is included. This provides us with a simple means of identifying whether or not the signal is a colour one. Why should this be necessary? Simply because if the chroma channel is left operative during a monochrome transmission, coloured noise could mar the colour set's monochrome display. So we want to switch the chrominance channel off on monochrome and switch it on with colour. We can do this quite simply by noting whether the burst is present, rectifying it and using the resultant d.c. potential to forward bias one of the chrominance amplifier transistors. In practice it's easier to rectify the ident amplifier's output instead – with no burst there's no ident so the effect is the same, but we can get a larger d.c. output by rectifying the ident signal.

Chrominance Signal Demodulation

Let's assume then that the burst signal is reaching the burst detector, and that the control loop is holding the reference oscillator in phase and frequency synchronisation with the transmitter's subcarrier oscillator. What do we do with the reference oscillator's output?

Synchronous detectors are used to demodulate the R – Y and B – Y signals. This means that the detectors are timed – they are not simple half-wave rectifiers. The reference oscillator output is used to do the timing. As we've seen, the two transmitted colour-difference signals are modulated on to the suppressed subcarrier in quadrature. So a quadrature (90°) shift is required in the feed from the reference oscillator to one of the colour demodulators. This is usually to be found in the feed to the B – Y detector.

PAL Switch

The effect of the PAL switching can be reverted by inverting the R – Y signal feed to the R – Y detector or alternately inverting the reference signal feed to the R – Y detector line-by-line. In our block diagram the reference signal feed is shown passing through the PAL switch. The latter is driven by more pulses from the line timebase, with the output from the ident stage used to synchronise the switching.

The demodulated R – Y and B – Y signals are fed to the various matrixes shown, so that at the end of the chain we get the required R, G and B signals – or three colour-difference signals if the set uses colour-difference tube drive.

The Chrominance Channel

Now let's backtrack down the chrominance channel. We left the chrominance signal at the point where the burst signal had been blanked out. It's usual to provide a user colour control which operates at some point in the chrominance channel. Colour-killing we've already dealt with, so the only point left is the chrominance delay line and the add/subtract networks.

Delay Line Circuit

Since the delay time of the chrominance delay line is exactly one line, we can feed the chrominance signals from successive lines to the add/subtract network. Due to the line-by-line inversion of the R – Y signal, we get separated B – Y and R – Y outputs from the network and also cancellation of spurious phase shift effects. We're simplifying somewhat, but the purpose of these articles is not to provide precise theoretical explanations but to provide enough information to enable fault conditions to be understood.

The important thing from a fault point of view is that the amplitude and phase of the direct and the delayed signals fed to the add/subtract network must be identical, otherwise the addition and subtraction will be incorrect and the effect will be blinds on the display – since there will be errors in the outputs on a line-by-line basis. Controls are usually provided to enable the amplitude and phase of the inputs to the add/subtract network to be set up correctly.

This is one form of blinds. Another and more severe form occurs should the PAL switch stall, due say to the absence of the triggering pulse or, more likely, a defective transistor in the bistable circuit used as the active part of the switch. If for some reason the PAL switch is operating in the wrong phase, the result will be green faces.

Decoder Faults

When it comes to decoder faults, generalisation is hampered by the very wide divergence in the circuitry used in different decoders. Certain faults do apply in general, for example blinds due to incorrect alignment of the circuitry around the chrominance delay line, also troubles due to

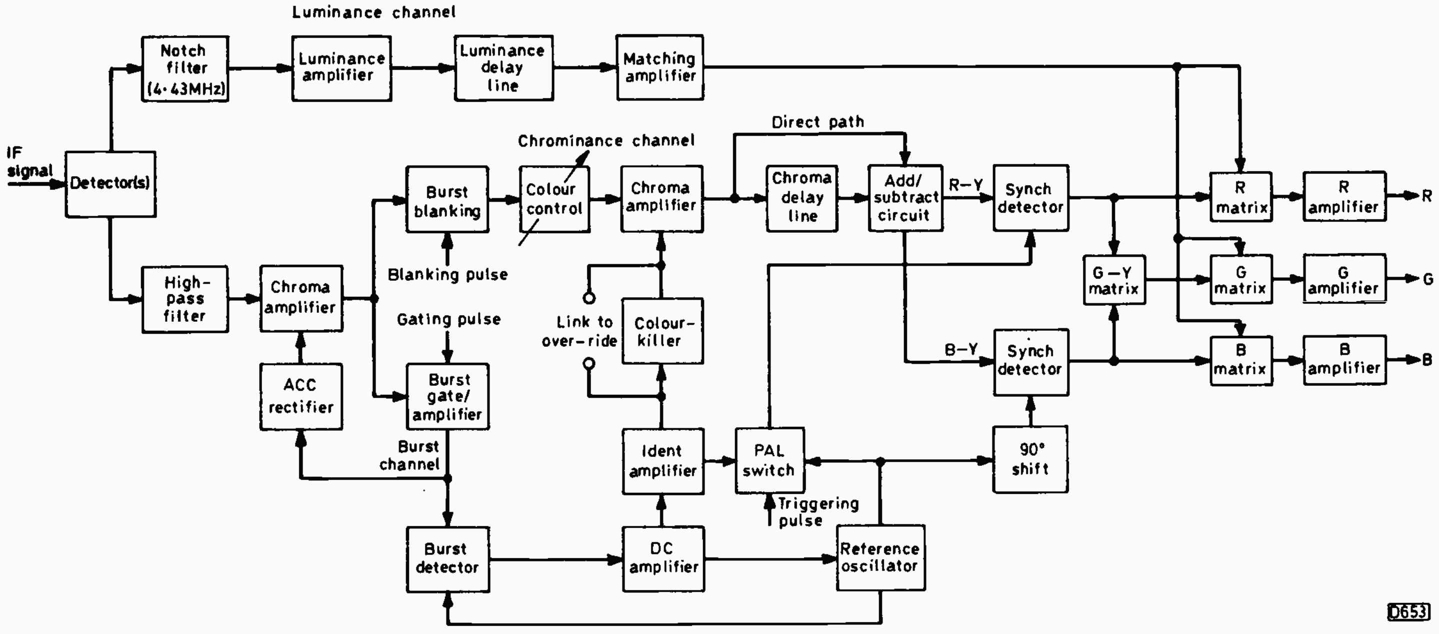


Fig. 1: Block diagram of a typical discrete component decoder.

incorrect burst gating. In some sets you get incorrect timing of the PAL switch, giving a vertical band of incorrect colour down one or other side of the screen. Probably the most common fault however is no or intermittent colour. What do you do?

Remember for a moment that the R – Y, the B – Y and the burst detectors are all of the synchronous type. This means that both inputs must be present in order to obtain an output. Furthermore the reference oscillator must be operating at the correct frequency. So no colour could be due to no output from the reference oscillator, no burst signal, failure of the colour-killer circuit to switch the chrominance channel on, or failure of the signal to get through the chrominance channel. Quite a lot of things to check you might think. In practice a single check tells you quite a lot. It's always possible to over-ride the colour-killer, thereby switching on the chrominance channel. Doing this will produce one of three results: (a) correct colour; (b) still no colour; (c) unsynchronised colour (bands of incorrect colour across the screen). Let's take these in turn.

Correct colour means that the colour killer is not working or there's insufficient output from the ident amplifier (low gain here may be due to mistuning or faulty decoupling): you've proved that the reference oscillator, the burst and the chrominance channels are all operative.

Still no colour means that there are still a number of things to check – the presence of burst gating pulses, that the reference oscillator is working, and that the burst and chrominance channels are operative. A scope is often essential when confronted with this situation. Note however that if the ident stage is operative, the burst channel and reference oscillator must be in order.

Unsynchronised colour means that the reference oscillator is working at the wrong frequency. There's usually a set oscillator frequency control. If adjusting this doesn't improve matters, check the burst detector (unbalanced diodes?), the d.c. amplifier (leaky transistor?) and the reference oscillator circuit (faulty capacitors?).

Reliability

There may seem a lot that can go wrong in the decoder. Most decoders are pretty reliable however – since except for a very few early ones they use transistor and/or i.c. circuitry, thus operating at low voltages and with little heat dissipation. Faults that are particularly difficult to trace are likely to be due to print defects or dry-joints.

Convergence and Degaussing

Finally, there are one or two points still to be made on the subject of convergence circuitry (see last month).

In dealing with dynamic convergence circuitry we made the point that the energy used is derived from the timebases. This is something that can be overlooked, and sometimes fools even the experienced. What we are getting at is that partial or complete collapse of the line or field scan can be the result of a fault somewhere in the convergence circuitry.

Take the Rank A823 solid-state chassis for example. In the event of line or field collapse on this chassis one does not immediately leap to the relevant timebase, looking for defective transistors, transformers etc. – in fact changing the line output transistors in this chassis is no joke. In the event of line collapse, showing up as severe lack of width, it's much easier to check up on something else. That something else is the R/G horizontal tilt control 7RV3 (a 7Ω preset), which may not be the obvious thing to check. It's the second potentiometer from the left at the top when the convergence panel is swung up in the operating position, viewed from the rear. The wiper of this control is the earth return path for the line scan current you see.

A similar state of affairs can occur with the field scan, where almost total collapse may well be due to a defective control (6RV2, 5Ω, vertical scan balance) or a poor connection to the pincushion phase control 6L20. These two components are on the scan control panel – the small subpanel on the upper right side, carrying the shift controls etc.

One more little hint. Whilst the degaussing coils are arranged around the bowl of the tube, the associated components may be elsewhere. On this Rank chassis for example they are mounted on the power supply panel. There's a black plug which connects to a socket on the power board: it supplies the tube heaters and the degaussing coils. If this plug is left disconnected (say after removing and refitting the decoder panel) a cloud of smoke will arise from a resistor (8R5, 680Ω) on the power supply panel when the set is switched on – because the degaussing coils are not connected, leaving this poor little resistor across the mains input.

Introduction to VDUs

Andrew Parr, B.Sc., C.Eng., M.I.E.E.

ONE of the interesting side effects of the wider use of integrated circuits is the blurring of the traditional dividing lines between various electronics subjects. A striking example of this is the Visual Display Unit, which neatly straddles many electronic disciplines.

A visual display unit (or VDU as we shall call it) is a device primarily designed to display data from a computer, but the techniques involved are used in many other areas like teletext and communications. To the user, a VDU is a c.r.t. on which data is displayed: it can be considered as a replacement for a computer print out where a permanent copy is not required.

The essential components of a VDU are shown in Fig. 1. Let's assume that our VDU is to display 24 rows of characters, each row containing 72 characters (a common standard). Incidentally we shall refer to "rows" of characters to avoid confusion with TV lines. Data from the computer must be stored prior to its display, so the VDU's store must be able to hold 24 × 72 characters = 1728 locations. Each character is sent from the computer as an 8-bit code, so the store consists of 1728 locations each capable of holding 1 byte (1 byte = 8 bits). As we shall see later, it's convenient to consider the store as being arranged in the same manner as the display, and to have each location addressed by an X address determining the character position in a row, and a Y address determining the row (see Fig. 2). The location 57, 18 thus refers to the 57th character along the 18th row.

Having got the data from the computer to the store, we must now display it. This is done by the block labelled the display logic, in conjunction with the TV monitor. There have been many ingenious schemes for displaying characters on a c.r.t., some of the more interesting ones being described below. The majority of VDUs nowadays use a perfectly ordinary CCTV monitor. The signal used to drive the c.r.t. in these VDUs is thus a normal composite video signal, and this technique is known as a raster-scan VDU.

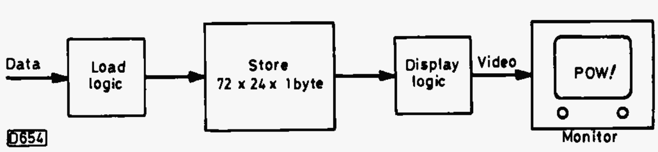


Fig. 1: Basic VDU block diagram.

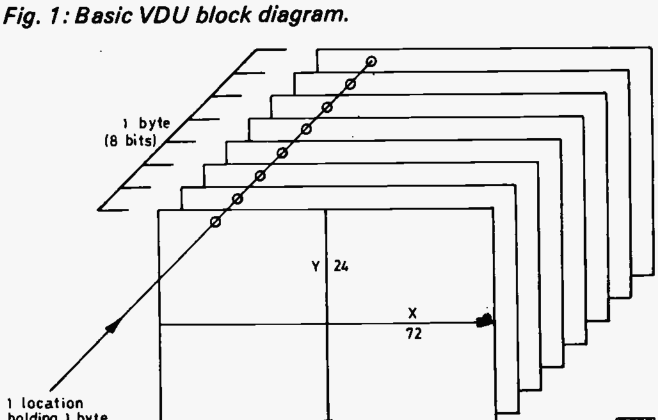


Fig. 2: Representation of a VDU's data store.

Historical Diversion

Early VDUs used deflection plates to move the electron beam of the c.r.t. and thus trace out the display. By the use of the tube's blanking grid, the electron beam could be turned off between letters. Two techniques using this method are shown in Fig. 3.

Fig. 3(a) uses the beam to trace out the letter, the control logic producing tortuous voltages to drive the X and Y deflection plates so that the required shape is drawn out. Fig. 3(b) shows a method using a small raster at each character position, with correctly timed bright-up pulses being used to produce the characters. This technique is similar to that employed by the raster-scan VDUs used today, but requires a specially designed display unit.

These early VDUs were about the size of a large filing cabinet, and cost about ten times as much as a computer printer. So early VDUs were considered a luxury and something of a status symbol. Today however a VDU using a few i.c.p.s can be built for a fraction of the cost of a printer. It's now considered a luxury to have a printer, and VDUs are supplied wherever possible.

Raster-scan VDUs

The vast majority of modern VDUs employ a normal CCTV monitor. The display appears as a white character on a black background (or vice versa). The video signal fed to the c.r.t. therefore consists of white pulses at the correct points along each TV line. Fig. 4 shows a typical display and the corresponding pulses.

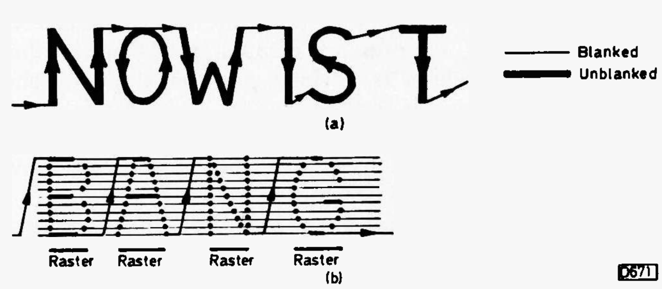


Fig. 3: Early VDU schemes.

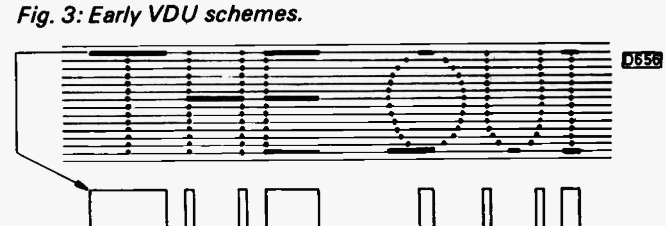


Fig. 4: Raster-scan VDU display, with the corresponding video pulse waveform.

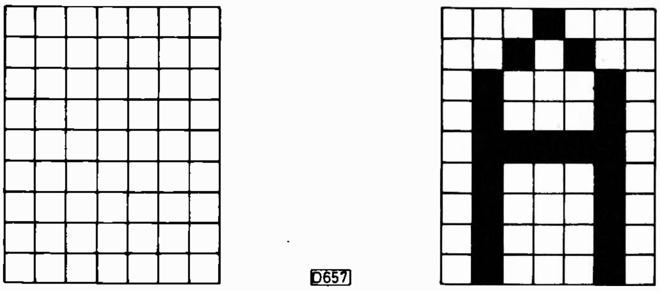


Fig. 5: Seven by nine dot matrix, showing how the letter A is formed.

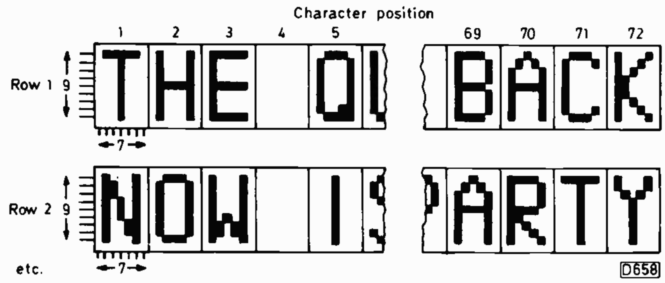


Fig. 6: Character cells.

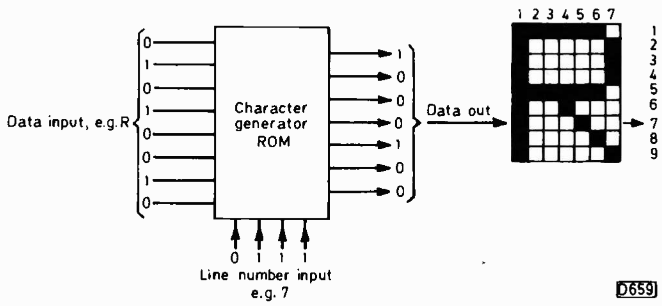


Fig. 7: Operation of a character generator ROM.

To standardise the display, each character cell is broken down into a matrix of dots. Common arrangements are 7 × 10, 7 × 9, and 5 × 7. Each line of the matrix corresponds to a line of the TV raster (for larger characters, each dot can be repeated for several successive TV lines). Fig. 5 shows a matrix block of 7 × 9 dots, and the dot pattern for a letter A.

A row of characters consists of a row of character cells as shown in Fig. 6. Each cell corresponds to one location in the VDU's store. Each row of characters will be traced out one line at a time, so we get:

line 1	character 1	row 1
line 1	character 2	row 1 etc. to
line 1	character 72	row 1
line 2	character 1	row 1
line 2	character 2	row 1 etc. to
line 9	character 72	row 1, then
line 1	character 1	row 2 etc.

and so on for all rows.

The characters are stored in the VDU's store in the form of an 8-bit logic word, and are converted to the dot matrix by a special ROM (read-only memory) i.c. called a character generator. Ideally, this would give us all 63 dots of a character cell at once when presented with an 8-bit code. Unfortunately pin considerations make this impossible (40-pin i.c.p.s being the largest readily available). We don't require all 63 dots at once however. As we saw above, we draw one line of a character at a time. All we require from the ROM therefore is the data for one line.

A logic diagram of a typical ROM is shown in Fig 7. There are two inputs: an 8-bit data input representing the character required, and a 4-bit input telling the ROM which line we want. The seven outputs give us the 7 dots for the selected line of the selected character.

Suppose we are displaying the letter R, and that we are drawing the 7th line. Our inputs are the data for R,

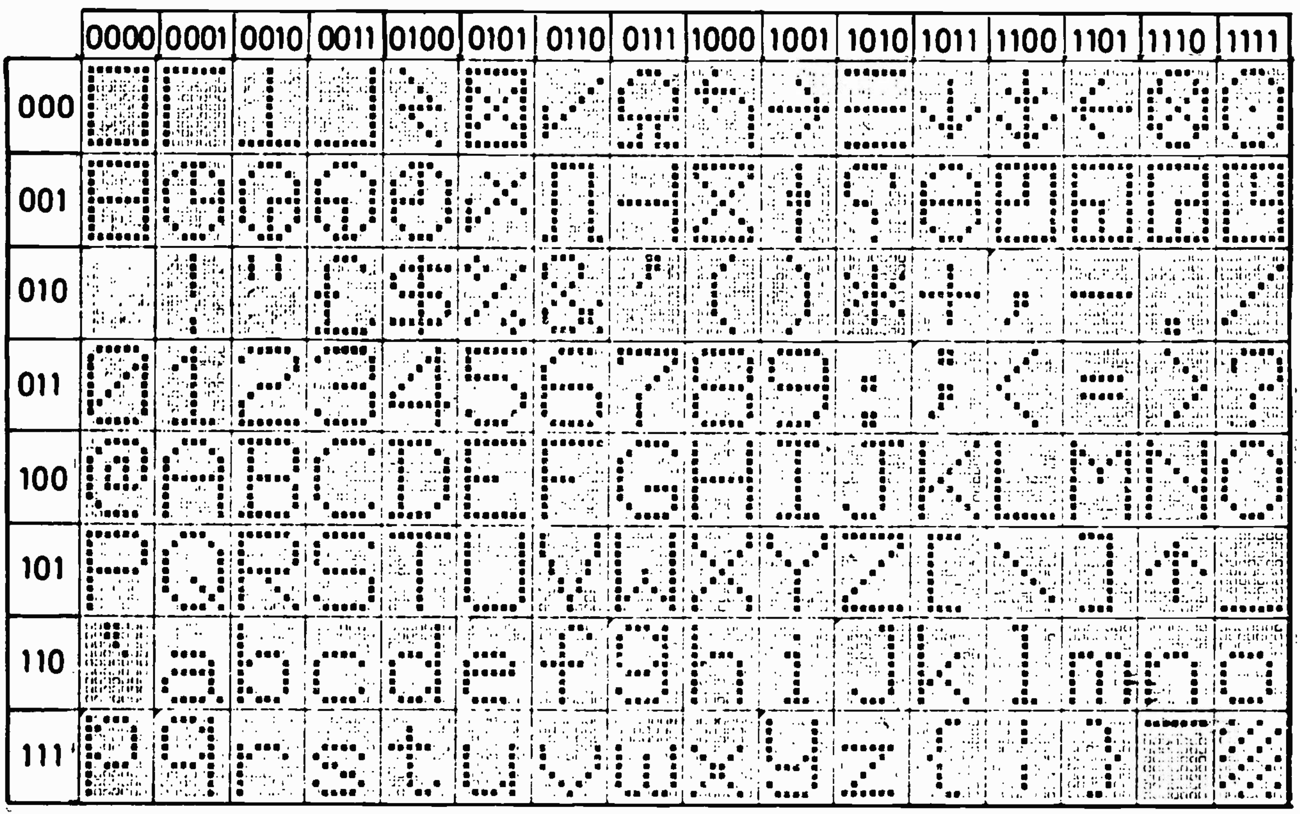


Fig. 8: The MCM6576 character generator ROM's character set.

"01010010", and our line, which is 7, "0111". The ROM gives us 1000100 which is the dot pattern for the seventh line of letter R. To summarise: we provide the ROM with the data and the line number; it gives us the seven dots for that line.

A typical character generator ROM is the MCM6576, whose character set is shown in Fig. 8. This ROM uses a 7-bit data input (ignoring parity) giving 128 characters. The most significant three bits are obtained from the vertical column at the left-hand side of the array, and the least significant four bits from the horizontal row at the top. The code for 6 is thus 0110110 (or 36 in hexadecimal).

At this point we must remember that a TV picture is time related. The position of any point on the screen is defined by its line number and by its time from the line sync pulse. The seven dots from the ROM need to be scanned in sequence to turn them into a video signal. This is done by loading them into a shift register at the start of the character, then shifting them out at the correct rate (see Fig. 9). Having converted the seven dots for one line of one character into video, we now move on to the next character and repeat the operation. At the end of the line we start again. This is achieved by a simple, if somewhat lengthly, timing chain.

We have already described how the data is held in a store with an X address (corresponding to the character position) and a Y address (corresponding to the character row). The timing chain has to provide: (a) An X address to the store. (b) A Y address to the store. (c) A lines number to the character generator ROM. (d) The load and shift (clock) pulses for the shift register in Fig. 9.

The basis of a VDU timing chain is shown in Fig. 10. We shall assume that the VDU displays 24 rows of 74 characters per row, and uses a 7 × 9 dot matrix.

The chain starts with a clock generator. The clock pulses go to a sync pulse generator, and also to the shift register to convert the ROM data to a video signal. After seven clock pulses we move on to the next character in the row, so we have a divide-by-seven counter. This controls the loading of the shift register, and steps the X address counter. The displayed character is thus stepped on after each seven dots.

When we come to the end of the line, we step on the line number counter. This counts up to nine to provide the line number to the ROM. When all nine lines have been displayed, we step the Y counter, and start again at line 1, character 1 on the next character row.

We now have the correct video coming out of the shift register, and all that remains is to add the sync pulses and provide a buffer amplifier to drive into a 75Ω line.

Fig. 10 is somewhat simplified, ignoring details such as blanking periods and the gap between rows. All raster-scan VDUs use the same basic arrangement however. Not surprisingly, special i.c.p.s called c.r.t. controllers have been developed for the implementation of the timing chain and control.

Loading the Store

We have seen how we can convert the data in an X, Y addressed store into a VDU display. To be of any use however, we must be able to load the data into the store in the first place. This falls naturally into two parts: data transmission from the computer to the VDU, and the internal arrangement of the store itself. We will deal with the latter first.

Data from the computer is normally loaded into the store in one of two ways. The first is called scroll mode. In this mode, the data is loaded along the bottom row of the VDU (i.e. row 24), and when the computer sends a "new row"

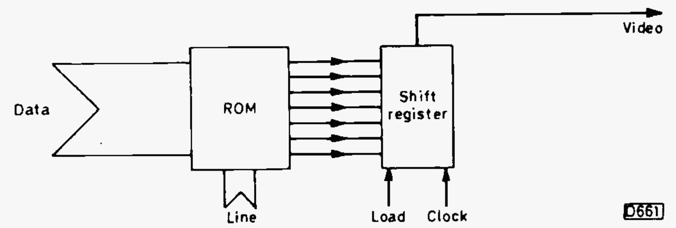


Fig. 9: Use of a shift register to convert the ROM's output to a serial video signal.

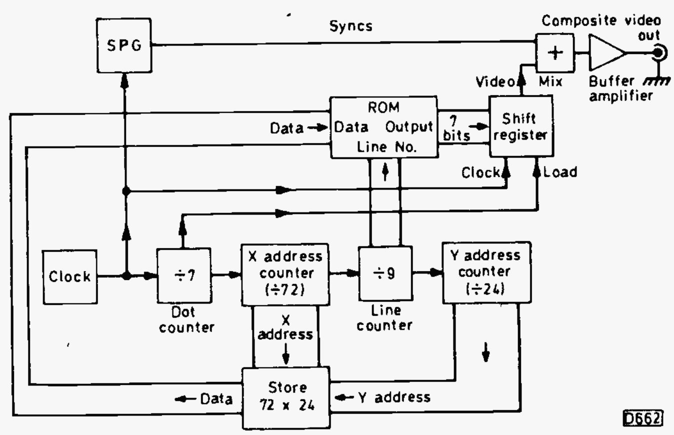


Fig. 10: Detailed VDU block diagram.

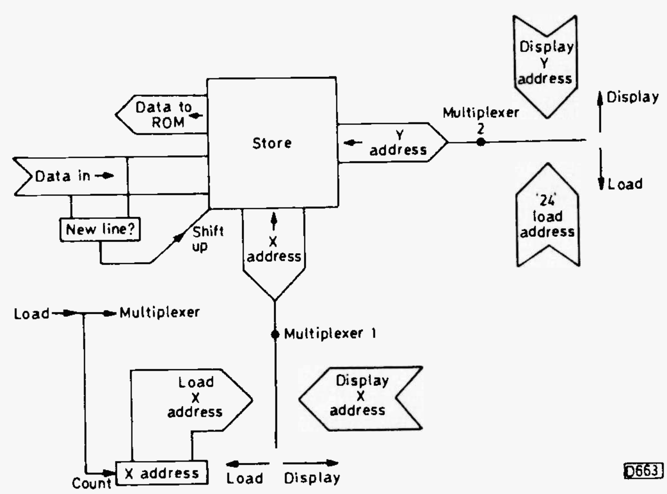


Fig. 11: Logic for scroll-mode operation.

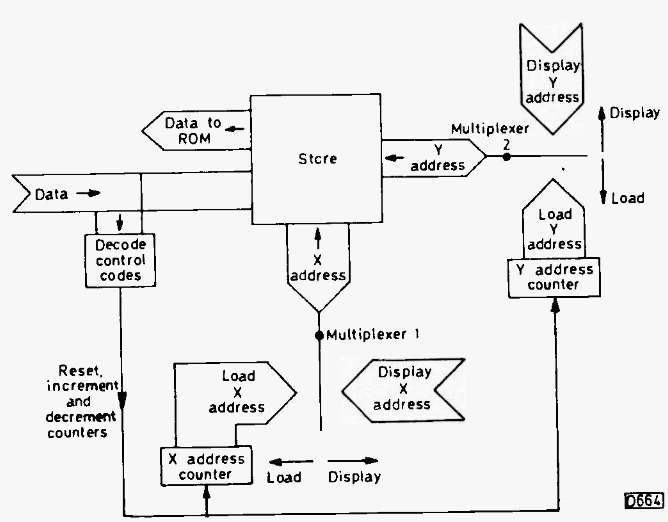


Fig. 12: Logic for page-mode operation.

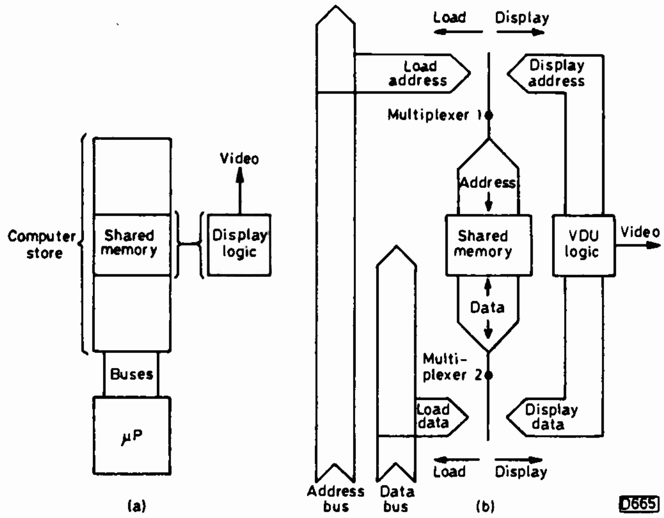


Fig. 13: (a) Basic memory-mapped VDU arrangement. (b) Detailed block diagram of a memory-mapped VDU.

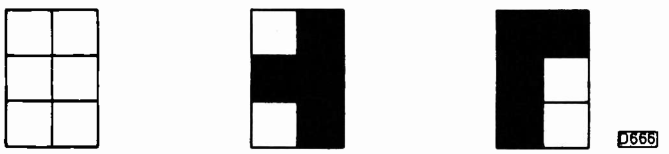


Fig. 14: Graphics character cell.

signal all rows move up by one (i.e. row 24 goes to row 23 and so on, row 1 now being last). The screen thus resembles a sheet of paper scrolling up from a typewriter. Hence the name.

The logic required to achieve this is quite simple (see Fig. 11). Two multiplexers select the X and Y addresses from the timing chain except when data is being loaded. When data is sent to the store, the multiplexers change the X and Y addresses to the load logic. The Y address is simply "24"; the X address is a counter incremented each time a character is loaded. The incoming data is checked to see if it means "new row". If it does, the logic shifts all the store data up by one row and resets the X address counter to the first character position again.

Scroll mode is very easy for a programmer to control, but has many limitations. It cannot be used for example to display fast changing data, or to construct mimic diagrams. Greater versatility is given by the operating mode called page mode.

In page mode, a single character can be written in any position on the screen. The current writing location is defined by the X, Y coordinates of a cursor, and control codes are used to move the cursor. The control codes commonly provided are:

Cursor home	(i.e. X = 1, Y = 1, top left of screen)
Cursor up	(decrement Y)
Cursor down	(increment Y)
Cursor left	(decrement X)
Cursor right	(increment X)
Cursor return to start of row	(i.e. X = 1, Y unchanged)
Cursor at	(X, Y)

In the absence of any cursor control, the cursor continues normal movement by incrementing X after each character is loaded. Using cursor control, static displays are provided, and individual bits of data can be changed without affecting the rest of the screen.

The logic required to achieve page mode is, of necessity, more complex than for scroll mode. The basis is shown in Fig. 12. We now have two counters for load purposes: one for the X address and one for the Y address. These are selected by the two multiplexers when data is to be loaded into the store. Control codes are decoded and used to increment, decrement and reset the X and Y counters.

In both the scroll mode and page mode it will be noticed that there is a clash of interests between the timing chain reading from the store and the load logic writing into the store. The load logic always wins, and the brief flicker on the screen is not normally noticed unless data is being loaded continuously. Careful use of buffer registers in the design can reduce the flicker considerably. Commercial VDUs will usually operate in both the scroll and page mode, selection being done by special control codes.

If the VDU is an integral part of a computer system, a simple technique called a "memory-mapped VDU" can be used. The VDU data store is part of the store of the computer, as shown in Fig. 13(a), and the computer has access to each location by the normal fetch, store instructions.

The arrangement is shown in more detail in Fig. 13(b). The VDU display logic produces video in a similar manner to Fig. 10, but when the computer wishes to have access to the store the address and data multiplexers change over to the computer address and data bus lines. When the transfer of data is complete, the multiplexers switch back to the VDU display logic.

Memory-mapped VDUs are inherently a form of page mode, since each location can be changed independently. Programs to drive memory-mapped VDUs are simple to write, as each position on the screen corresponds to a store location. The computer can also read back data from the store, which can be useful in some programs. Unfortunately the address and data buses in a computer need to be quite short, and a memory-mapped VDU can only be implemented as an integral part of a computer.

Graphics

VDUs are widely used for mimic diagrams and games. In these applications the VDU must be able to draw rudimentary pictures in addition to the normal alphanumeric symbols.

Simple low-resolution graphics can be obtained by using the dot matrix to form various block shapes which can be assembled as required. A common arrangement is the normal character cell split into the six blocks shown in Fig. 14. These are normally taller than the alphanumeric symbols, bridging the gap between rows to allow large solid areas to be drawn. Teletext uses low-resolution graphics to good effect for titles and illustrations.

High-resolution graphics are used where fine details are required. Examples are graphs and some games. In high-resolution graphics, each and every dot in the character block can be selected by the program. One common technique is to have several 8-bit data codes reserved for "user defined" displays, allowing the program to define a particular character. This approach is very userful if you want a stagecoach and cacti for a cowboy game. A second common approach is to increase the range of the addressing, so that each and every dot can be addressed and given the state "1" for on or "0" for off. A typical high resolution VDU would allow addressing of 500 × 200 individual dots.

Programming for high-resolution graphics is obviously more complex, but the results are very impressive. Often "intelligent" VDUs employ an internal microprocessor to provide functions like "draw a line from 256, 18 to 40, 187", or "draw a circle centre 48, 42 radius 18". The internal microprocessor works out the relevant dots to be illuminated.

Colour

Colour adds a new dimension to VDU displays, and is especially useful where attention needs to be drawn to part of the screen. Colour VDUs employ a three gun c.r.t. similar to domestic TV sets, giving a choice of eight colours: red, green, blue, yellow, cyan, magenta, black, white. Conveniently, eight colours can be represented by three binary bits.

The simplest means of programming a colour VDU is to do colour changes by control codes. A control code will appear as a black on the screen, so colours can be changed at each space between words or at gaps in graphics. Teletext uses this technique to define colours, but it has several limitations. It's not possible to use different colours within a word, and normally the background colour is fixed. In graphics, the colour control code will appear as a gap between different colours. Teletext uses the "hold" control code to maintain colours over control codes, but this is a bit laborious.

Greater versatility can be obtained by increasing the length of the data word to two bytes. The first byte defines the character or graphics symbol as before. The second byte is split into two 4-bit nibbles. One defines the character colour, the other the background colour. There are now no restrictions on the colours, and each letter in a word can have a different colour background. The one disadvantage of this technique is that the data store needs to be double the size (X by Y by two bytes), with a corresponding cost penalty.

Colour VDUs normally use commercial colour monitors. PAL encoders and decoders are used where long cable runs are necessary between the VDU logic and the monitor, but it is normally prefered to run separate RGB and sync signals rather than composite video. Very rarely, domestic u.h.f. receivers are used, but the results are somewhat inferior to direct video drive. The setting of the convergence on a colour VDU monitor is very important, as the crisp edges of VDU signals readily show any convergence errors.

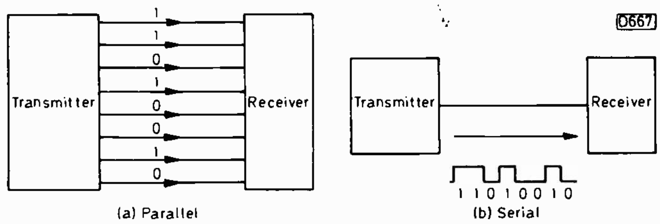


Fig. 15: Parallel and serial data transmission.

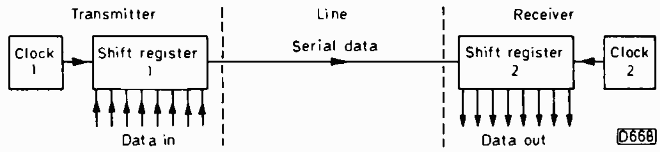


Fig. 16: Parallel to serial conversion.

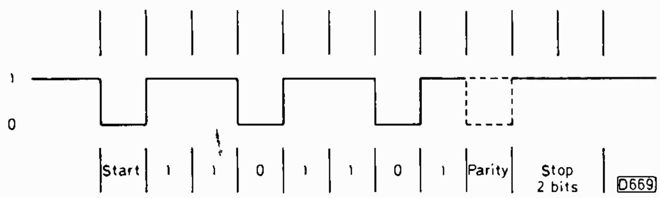


Fig. 17: Serial data format.

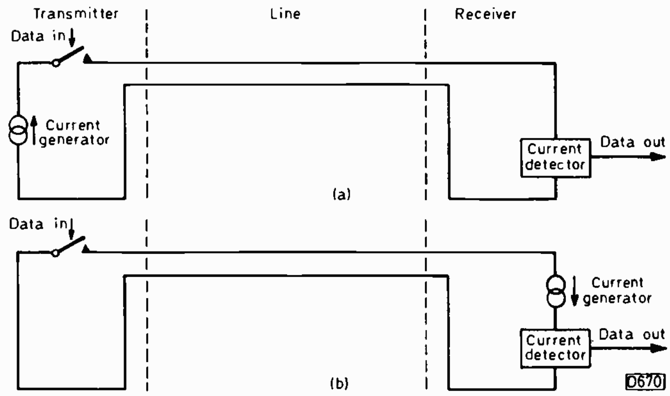


Fig. 18: The 20mA current loop system. (a) With active transmitter and passive receiver. (b) Passive transmitter and active receiver.

Data Transmission

The final problem is the transmission of the data from the computer to the VDU. A character is represented by 8 bits, so we can send the data along 8 lines (called parallel transmission) or by an 8-bit pulse train on one line (called serial transmission). These two techniques are summarised in Fig. 15.

Parallel transmission is faster than serial transmission, but is obviously more expensive as eight times as many cores and eight times the electronics are needed. As economics govern most things, serial transmission is almost used universally used.

Computers and VDUs operate internally in parallel however, so at each end of a serial link we need a device to convert from parallel to serial and vice versa. In its simplest form this consists of the shift registers shown in Fig. 16. Data is loaded into SR1, then clock 1 shifts it on to the line one bit at a time. Clock 2 loads the data into SR2, where it's available for reading in parallel. Special i.c.p.s are available for this conversion, quaintly called UARTs (Universal Asynchronous Receiver/Transmitters).

The data format is shown in Fig. 17. In the quiescent state, the line is at a 1. The first bit is a 0 start bit, followed by seven data bits and one parity bit. Two stop bits indicate the end of the character.

If the link is to work correctly, clocks 1 and 2 must match, although the data format does provide a certain amount of synchronisation. The speed of transmission is measured in "Baud", where one Baud is one bit per second. A computer teletype operates at 110 Baud. Since one character takes 11 bits, including the start and stop bits, a teletype will print 10 characters per second. Most VDUs operate at 1200 Baud.

There are three standards used to define signal levels on a serial link. The most common is the 20mA current loop summarised in Fig. 18(a). The data is carried as current pulses, 20mA representing a 1 and 0mA a 0 (and the start bit). Because it's a current loop, this system provides excellent noise immunity.

Unfortunately, no one has ever made the 20mA current loop official, so inconsistencies exist between different equipment. In particular, no one has stated specifically at which end of the line the 20mA is generated. Fig. 18(a) has an active transmitter and passive receiver; Fig. 18(b) has a passive transmitter and active receiver. Little communication can take place if the transmitter and receiver types do not match!

The second and third standards are almost identical. V24 is a European standard and RS232 an American standard. These use voltages rather than current, and represent a 1 by a negative voltage and a 0 by a positive voltage:

	V24	RS232
Binary 1	−3V to −15V	−6V to −15V
Binary 0	+3V to +15V	+6V to +15V

In general, V24 and RS232 devices are compatible. I.c.p.s are available which convert direct from TTL and CMOS signals to V24/RS232 standards.

Uses

VDUs are mainly employed as computer output terminals. They are very versatile devices however, and the two examples below illustrate other uses.

Word processors are a current boom industry. Text for correspondence, forms or literature is typed on to a VDU screen. Errors can be corrected, standard phrases inserted, and modifications carried out on the screen. When the text is correct it's printed out on a normal printer. In addition, copies of the text can be stored on magnetic tape or disc for future use.

VDUs can also be used as part of a creative design procedure. Computer Aided Design (CAD) was originally developed in the American aircraft industry, but is now appearing in many drawing offices. Very high-resolution VDUs using techniques similar to Fig. 13(a) are used, in conjunction with special keyboards and light pens, to produce engineering drawings. The drawings are stored in coordinate form, and can be enlarged, sectioned and rotated in any place. Completed drawings can be fed out to X, Y plotters for hard copy, or direct to numerically controlled machine tools. Management of drawings is simplified, because all masters are kept on computer discs. To give an idea of the size of the problem, a medium sized engineering works may utilise over 1,000,000 engineering drawings including revisions.

An example of what can be achieved by high-resolution graphics – a computerised dollar bill.

Acknowledgement

The author would like to thank Strathand Ltd., 44 St. Andrews Square, Glasgow for their assistance and for the use of the Apple II computer used in the illustrations in this article.

Equipment Review: Technalogics PG6RF Pattern Generator

Roger Bunney

LAST January I reviewed the Technalogics PG6RF pattern generator. This provides grey scale, peak white raster, vertical line, horizontal line, dot and crosshatch patterns. I recommended it as excellent value in view of the useful patterns it provides, its low consumption of only 6mA from a PP3 battery, and its competitive price. Some while later a printed board add-on unit providing colour bars became available. This is powered from an additional 6V source, and interfaces with the PG6RF main board via ten wires from one of the i.c.s and an additional single connection between two points on the respective boards. It fits neatly into the Vero box which houses the unit. I've recently added one of these boards to the basic unit and tried it out.

Construction is simplicity itself, though care must be taken when soldering the 17·734MHz crystal into circuit to avoid overheating the leadout wires. If the C6 (as it's called) is being built as an add-on unit to an existing PG6RF pattern generator, the IC10 pad on the unit will require ten wire connections to link it to IC4 on the main PG6 board, also a further wire between pin 10 of IC9 and the emitter of Tr1. The original on-off switch is replaced with a two-pole two-way (centre off) switch. This is rotated through 90°, giving a centre off position, the original patterns to one side, and coded PAL colour bars with the switch in the other position and the pattern selector switch set to the grey-scale position. Mechanical fixing involves drilling four holes in the PG6 board to match the corresponding holes in the C6 board: one-inch pillars are provided to give adequate spacing. Take care to match the C6 access holes for VR1 and VR2 on the PG6 board.

Alignment is also a simple matter. A small trimmer TC1 is adjusted for the 4·43MHz colour subcarrier at a given point, using a scope, or alternatively for locked colour bars of maximum saturation displayed on a colour set's screen.

If the complete CPG6RF kit is obtained, construction is similar except that IC4 is mounted in position IC10 on the C6 board, sixteen wires being used to link the two positions.

The colours provided are the standard white, yellow, cyan, green, magenta, red, blue and black. The separate 6V power source referred to above is provided by an integral four HP7 "pen cell" plastic container. Some 20mA is drawn from this. The r.f. output is similar to that described in the previous review.

As a kit, the C6 add-on unit costs £18·99 inclusive of VAT – the complete CPG6RF costs £42·55 in kit form. Versions with a v.h.f. output are available for use in overseas countries using systems B and I.

For the serviceman, one improvement that could be made would be to fit an instrument case handle on the upper cover of the ABS Vero box to make the unit easier to carry around.

The price of the C6 and the CPG6RF, the weight, size and appearance, make it an attractive and versatile piece of test equipment which I can fully recommend. Certainly the technical performance is unmatched at this sort of price. ■

Tapez-Les*

Les Lawry-Johns

FIRST we have to apologise for the error of location, or more exactly name, of the place mentioned in the unlikely tale related in the September issue. For those of you who spotted it (and several did) I merely claim a lapse of memory occasioned by old age, plus a little bit of a coincidence. For those of you who didn't spot the mistake, it doesn't really matter that Fayid is actually down in the canal zone. The rest of the story was true or nearly true. Well, not really, but it could have been . . . I think.

A Flight to the East

I mean, look at the time we went well east of Suez, so far east in fact that we nearly went west, Fred flying the Tomahawk, Reg the Kittyhawk and me the Shitehawk. We didn't know where we were in fact, because we'd been troubled by wind of late. Fred thought we were somewhere in Burma, Reg reckoned we were in Rangoon, and I thought they were both right but we were still troubled by the wind which was ruining our war effort.

Fred said that he'd heard of a wall up north which would give us protection, and as soon as he'd said this a little man appeared with a little round hat which had a length of plaited rope hanging from the back of it. His hands were tucked up his sleeves.

"Ah . . ." he said. "My name is . . . ah . . . Sung Set Song." There was something in the way he hesitated with the "ah" that made me feel even more uneasy, what with the wind and all. If he could help us however it would do no harm to listen.

"Centuries ago, ah, my people built great wall to keep out the wind. We came across it some time ago during our long march south, and as soon as we crossed it the wind troubled us no more."

Fred did not doubt him as I did. "Tell us where it is, and Reg will write it down on rice paper."

Sung Set Song said "Go north young man. Fly fast over the flied lice fields until you cross the boulder where you will find many more boulders and this is the great wall that the north wind cannot pass. You will be safe there and the wind will wane".

Reg wrote rapidly on the rice paper so that the precious directions would not be lost. Little did he know then that it wasn't rice paper he was writing on.

I'd heard rumours in Rangoon that a Japanese ex kamikaze pilot who couldn't be killed even by himself was posing as a charming Chinese, luring our lads and their Hawks to destruction.

This wasn't Sung Set Song. This was Muchashita the gentleman Jap. He was after my Shitehawk and that was why the paper was perforated. I didn't hesitate. I whipped out my weapon and shook it violently at him.

"You're not Sung Set Song," I screamed. "You are Muchashita the kamikaze killer and I claim the £5 prize for having unmasked you." I hit him with my Hampton and he crumbled to the ground with a faint "Ha" as his cranium cracked under the mighty blow.

Fred hit him with his rhythm stick for good measure, while Reg was rummaging around for his rifle.

"Good God" said Fred. "How did you rumble the rascal?"

"Elementary. Had we flown fast to the wall we would have been whipped away by the wild wind. If you'd looked carefully at the paper Reg was writing on, you would have seen that the wall was full of holes. Please pay more attention in future and do not be fooled by funny fakirs."

This was the end of our far eastern adventures, and if anyone wants to write in and correct the facts they are a better man than I am. Oh yes, we also sung a song on the way home.

In the street of a thousand "Ah so's."
By the sign of the swinging twit
Lived a slant eyed chinese maiden
By the name of Hu Flung Slit.

Enter Dennis

This should really be entitled "let the heartache begin", because until Dennis brought in that GEC 2121 I didn't know what heartache was. On a Saturday, just to make things worse. Well it looked innocent enough at first: a blown 3·15A mains supply fuse. Naturally we checked the filter capacitors and then headed straight for the thyristor rectifier. No joy. "We're not to blame" they shouted.

With some trepidation, we took the top screen off the line output stage. Both the small 4·7kΩ resistors R609/R611 (see Fig. 1) were blackened, and at the same time we noticed that the rear wirewound spring resistor was sprung – R601 to the 12V line. Now the fact that one or the other of these thermal cutouts is found sprung does not necessarily mean that there is a short in the circuit it supplies. More often it means that the associated zener diode has been asked to zener too much (you see).

This can happen in particular if the 40V supply rises much above the correct 40V. This supply is provided by D601/C601, and a small 47V zener diode (D51) is

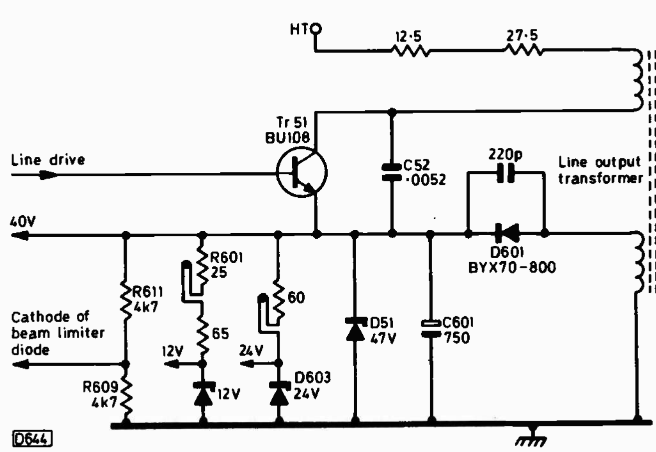


Fig. 1: Line output transistor circuit, GEC C2110 series. The transistor sits on a 40V line produced by D601/C601. 12 and 24V supplies are derived from the 40V line via droppers and zener diodes. D603 is often responsible for no sound or distorted sound.

**Which is French for hit 'em, in case like me you didn't know – Editor.*

connected across the supply to prevent it rising above 47V – it's designed to short out, which is why it is not of a more manly type. When it's found shorted (as we found it) one tiptoes around a bit. Whilst the makers say that failure of D51 can be due to C601 becoming open-circuit, we're more inclined to look closely at the line output transistor since a collector to emitter short here will slap a sizeable chunk of h.t. straight on to the poor little zener. Sure enough, the BU108 was short-circuit.

A new one was fitted, after a struggle, at which point Dennis departed to do some shopping: he said he'd call back in an hour or so. The agony then started.

We thought we were being careful, unhitching the tripler and checking the lines before chancing mains application. All seemed well, so we connected a meter across the fuse holder and switched on. The meter swung across to over 3A, and instead of falling started to rise. We hurriedly removed the prod and carefully rechecked the h.t. line and the line output stage. The new little zener was short-circuit, but the new BU108 seemed o.k.

We next decided to chase the cause of the burnt 4·7kΩ resistors on the top of the transformer, though we were inclined to think that this was a legacy from some previous incident. The resistors read right, but we thought we'd change them and check the circuit with them out. There appeared to be a resistance reading where there shouldn't be one, and step by faltering step took us to the line output transformer winding – which had a leak to the core. "Oh dear" we said, "fancy that. Dennis will be pleased."

We had a replacement transformer in stock, and after a tussle it went in. I still don't like double-sided print, and will tell Arnold one of these days when and if I tie up alongside him. So the transformer was fitted and we decided that it would be better to fit a 3·15A supply fuse and stick a voltmeter on the emitter of the BU108 instead of a new zener. We crossed our fingers and eyes and switched on. The meter said 40V, and the sound came up normally. "Oh goody" we said. "Now we can hook up the tripler."

So we did that and fitted a little zener. This was a bad mistake. There was a hum and the zener burnt out. The tripler was faulty after all, the new BU108 was no longer new.

Dennis appeared with his shopping and his wife. "Not finished it yet?"

I looked sick. "I hope you've got plenty of money left after your shopping." He looked sick.

I told him the sorry tale. The tripler felt sick and this made the output transformer and the output transistor feel sick which made the zener and fuse fail and now I'd just lost another transistor and zener so I felt sick. While this was happening other sick sets were coming in, and I felt like volunteering to become a kamikaze pilot and end it all in one reckless dive. Actually I didn't, which is why I'm sitting here tapping away on this typewriter. We'll draw a veil over the rest of that day's happenings.

Female Logic

Monday dawned dull and drizzly, and whatever good spirits we started with swiftly vanished.

"Our set is too big to bring in. Can you call? It's probably only a fuse." Since they also said it was a 26in. Philips colour set (G8) I was inclined to believe this, but it still seemed a long way to go (several miles) to replace a fuse – at my age. Anyway we set out with our box of fuses etc.

On the way we had to negotiate a roundabout. As there was nothing coming from the right I proceeded around it. A car appeared from an entry on the left, straight across my path. I had to brake hard and so did the other vehicle – a car driven by a middle aged lady. She looked at me indignantly.

"I nearly hit you. Why can't you drive more carefully?" I thought this a little bit much, since she should have given way.

"It was your place to give way – to traffic coming from the right" I pointed out.

"Normally yes" she snapped. "But certainly not to an old vehicle like yours. Mine is much newer and you should have given way to me."

I'm always defeated by feminine logic, and this was about the most logical thing I'd ever heard.

"Very sorry ma'am" I said, touching my forehead as I didn't have a hat to raise. "It won't happen again. *I'll smash straight into you next time*!"

So on we went, bawling and shouting obscenities at all and sundry until we finally arrived at Lower Higham.

I rang the bell of number nineteen and waited . . . and waited.

Finally a cheerful lady appeared from around the side of the house. "I'm round the back dear, so I didn't hear you round the front."

That's the second one I thought, but meekly followed her around the back and through the kitchen.

The set was in a room leading off the hall, and the hall was cluttered up with bits of central heating gear. This meant I'd be hard put to it to take the set away if I had to. The size of the set was another good reason.

Off came the back and we went straight behind the left side plug cover to the 3·15A fuse. It was intact, and our spirits sank a bit. With the mains switched on the tube heaters lit up and the voltage appeared at the fuses on the power board. This meant that in all probability the 800mA fuse on the right side line scan board was open-circuit. It was.

I removed the screening cover from the line output transformer and put the ammeter across the fuse holder. It read 2A and there was a spark inside the transformer winding. This was as expected and feared, since the one thing I hadn't brought along was a line output transformer. Fool.

I weighed up the alternatives and made the wrong decision. "You need a transformer. I'll have to go back to the shop to get one. Won't be long – I hope."

I was. All sorts of things needed sorting out, but I finally arrived back at Upper Lowham or somewhere, anyway at number nineteen. Round the back and through the kitchen. Hubby had arrived home by this time.

"Transformer eh? Thought it might be. Mind if I watch you fit it?" So we settled down to replace the transformer. Out with the panel and lay it on a newspaper to save the carpet from the droppings of my soldering gun. Make a note of the connections as my memory is feeble. I can still remember some things though. Like it's 1969.

It didn't take long to fit the new transformer, but it was one of those without the tripler nipple. The nipple is easy to remove from the original, so off it came and was swiftly plonked on with no trouble (I thought) and securely soldered into place. Refit the panel, check that all plugs are in position except the tripler (oh no, not again), stick in the 800mA fuse and switch on. The sound came on for a split second and then plonk, the fuse blew. Once again I felt sick.

The tripler wasn't connected so that was out. I'd also checked the line output transistors, the transductor etc.

Investigation showed that one of the line output transistors was short-circuit but not the other. Rummage in box to find another BU205, thinking why, why, why? Out came the faulty transistor and in went the new one. Check around with the ohmmeter, and get some funny readings as the emitter of the other transistor was correctly connected to chassis but so was its collector, which suggested that it was short-circuit. I'd only just checked it when the heatsinks were off however and it read right then. A shorted tuning capacitor? No.

Just as I was about to die, I looked at the top line drive panel and there on the top right was a thin sliver of solder from the chassis screw to the 1Ω base resistor. I felt a bit awkward.

"Some clumsy bugger has let some solder fall on the panel where it shouldn't be."

"Yes, I saw it drop when you were soldering on that nipple. I thought you saw it too and it didn't matter." Funny how some people are good at things and others never quite get the hang of it.

With the short cleared, the tripler could be connected and a picture displayed. A pretty grim picture it was too.

"We've never had good colour on this set. The other people said there was nothing that could be done."

I couldn't quite understand this, since the tube seemed quite good. Resetting the drive controls and the first anode presets restored a very reasonable grey scale, and a touch on the convergence made an immense improvement. When the colour was turned up, faces looked like faces and not like burnt toast.

So the job was wrapped up, and we regained a little of our shattered confidence – until we looked at the picture again and found that the red had dropped out. Out tools, off back (again), and check the colour drives. Horrible dry-joint on the red amplifier base. Resolder and recheck. Wrap up (again) and get out quick.

Back at the Ranch

"You've been a long time. I don't know: it seems to take you longer and longer to do these outside jobs lately. Are they all that hard to sort out?"

"I don't know either. I never seem to do anything right first time."

"Perhaps it's your age. Can't you take some of that stuff that fortifies the over fifties?"

"I do. Sometimes I take whisky, sometimes brandy. Both fortify me. What does fortify mean anyway?"

"How do I know? You'd better get on with mum's set though. If she doesn't have her telly tonight she'll go barmy."

Oh! I do love my mother in law . . .

Fault Notes

Robin D. Smith

A Sizzling Rank A823 Chassis

The customer's complaint about a Bush colour set fitted with the A823 chassis was that he could hear a nasty "sizzling" noise coming from the back, though the sound and vision seemed to be normal. We ran the set for about half an hour, and found that there was arcing around the line output stage. The tripler was discovered to be literally melting away, the "yellow gunge" leaking on to the main chassis. I've had many faulty triplers, but never seen one like this.

After cleaning away the mess and replacing the tripler, we obtained very good results for a set some six years old. While soak testing however I noticed that there was an intermittent single jagged line from the top to the bottom running down the left-hand side of the screen, together with misplaced blue field convergence and what appeared to be desaturated colour (every other line missing). This was eventually traced to pin 3 of plug/socket 7Z1 on the convergence loom being open-circuit. The set ran perfectly after repairing this, and the customer was amazed to see the state of the tripler. He'd not noticed the other fault, which could have been created accidentally while we were replacing the tripler.

A cautionary note on this chassis incidentally. If you find a faulty line driver transistor (5VT12, BD131 – 5VT7 on the earlier A802 panel) it's advisable to check that the associated driver transformer damping components are in order. The 0·22μF capacitor (5C40/5C25 depending on panel) tends to go short-circuit, while the 22Ω resistor (5R54/5R35) goes open-circuit. These components are mounted very close together, the heat from the resistor tending to discolour the capacitor – this probably helps to shorten its life.

Tripping: ITT CVC45/1 Chassis

A new ITT set fitted with the CVC45/1 chassis kept tripping. Now this is a fairly recent chassis, and as we've had little experience of it to date we decided to consult the Technical Liaison Officer at ITT. To determine whether the fault is in the power supply or the line output stage, the procedure is to remove plug S, thus disconnecting the h.t. feed to the line output stage. Then check whether the 127V h.t. is present across pins 4 and 7 of plug R on the switch-mode power supply control panel. If so, the power supply is in order. The next thing to do is to disconnect the tripler and reconnect plug S. On doing this the tripping stopped, a new tripler restoring normal results.

GEC C2110 Series

We've mentioned various faults on the GEC C2110 series chassis in previous articles. Here are three more points worth noting:

(1) If the colour seems to be slightly desaturated, with the appearance that every other line is not the correct colour, slightly adjust the delay line circuit phase control L204 for correct colours on a test pattern. It's mounted on the chrominance/luminance panel PC446. I don't bother with test equipment for this adjustment, relying on my eyes and experience. This decoder is very reliable, and further adjustments are not usually required.

(2) Field flyback lines with a poor looking tube is usually due simply to the first anode controls P508/509/510 being set too high. Just turn them down equally, and the problem should disappear. If necessary check the series feed resistors R507 and R506.

(3) An interesting fault came our way recently. The h.t. voltage was approximately 170V instead of 190V, while the 40V l.t. was correspondingly low. This turned out to be due to the diac D701 on the power supply panel failing to trigger the thyristor at the correct point.

Thorn 3500 Chassis: Fast Tripping

A Thorn colour receiver fitted with the 3500 chassis came to us with the symptom no results, the overload cut-out tripping very fast. It didn't take long to discover that both diodes (W603/4) in the 30V supply rectifier circuit were short-circuit, but after replacing these the trip was still operating. Fitting a replacement power supply panel proved that the cause of the trouble was in the power supply, and after many checks we discovered that the mains transformer T601 had shorting turns.

GEC Hybrid Colour Chassis

The trouble with a hybrid GEC colour set was varying tube drive outputs, giving all sorts of different colours. The output panel had had a lot of work done on it by previous "engineers", and as the faults would appear with just the slightest tap of the output valves I decided that the best course would be to change the valve bases. Removing these from the the double-sided print is not the easiest of jobs, but we eventually managed to replace them without damaging any of the print.

After tidying up various solder joints and replacing R416 (18kΩ) which feeds the screen grids of the three PCL84s and had fallen in value, the panel was replaced and the set switched on. The result was that the 220Ω HT2 smoothing resistor R64 on the power supply blew up, emitting a nasty pong. All connections were double checked, and after fitting a new resistor we switched on again. Another nasty bang, and R64 bit the dust once more. What was happening? There must be a short somewhere that was not there before. A careful look round revealed a three-inch length of solder that some idiot (not me!) had dropped on one of the other panels – it was tracking across between h.t. and chassis. After getting rid of this and fitting yet another R64 we had the set working very well, with no more colour flashing.

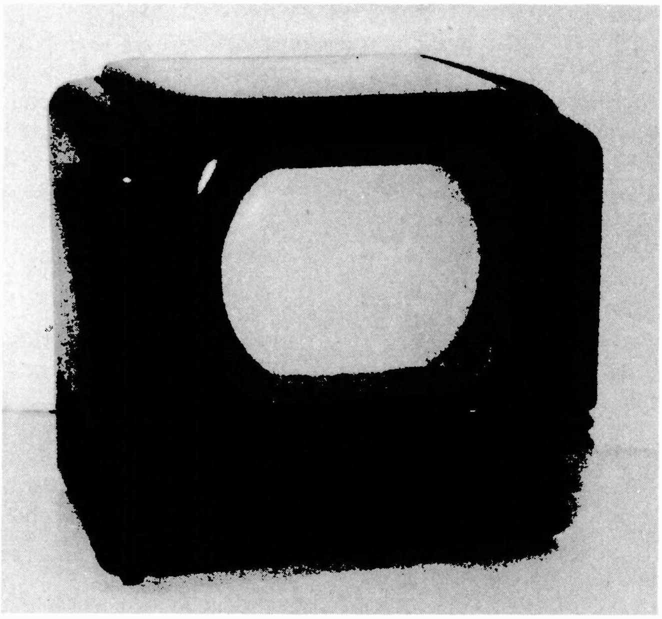
ITT CVC25 Chassis

For personal viewing I've recently changed to an ITT Model CVC25: after all, it's one of my perks to have a new set occasionally. The articles on the chassis by E. Trundle earlier this year were most informative. I've had many of the faults described, but only on earlier production sets. Anyway, the new set performed well until three weeks ago, when chronic pincushion distortion at the sides appeared. As I've mentioned before, one's own set tends to receive attention last and it was only while watching "One Million Years BC" that I decided enough was enough – no prizes for guessing why! It turned out that the pincushion preset control R901 (470Ω) on the EW modulator panel was open-circuit. Roll on the re-run on "One Million Years BC"...

Vintage TV: The Bush Model TV22

Malcolm Burrell

THE start of post-war TV in the UK came with the reopening of the Alexandra Palace transmitter, serving the London area, in 1946. The only channel then in use was what is now known as channel B1, and under favourable conditions pictures from the 17kW e.r.p. transmitter could be received over a radius of 50 miles from London. TV came to the midlands in 1949, to the north in 1951 and, by 1952, had arrived in Scotland and Wales. This brought all five Band I channels into operation.



The renovated Bush Model TV22, dating from 1951.

At the start, most TV sets were of the t.r.f. type, with a complete vision and sound front-end tuned specifically to one channel. This complicated attempts at mass production, and necessitated expensive modification when a set was taken to a different part of the country. The obvious need was for five-channel receivers.

Years before the man with the gong had converted his cinemas into bingo halls and got into TV set manufacture, Bush Radio Ltd. with its Christmas tree trade mark was an independent producer of TV sets and other receiving equipment (the name comes from Shepherd's Bush in W. London incidentally). Amongst the TV receivers they'd been producing was a t.r.f. set bristling with red metal-clad valves of the EF50 variety, using a compact a.c./d.c. chassis. One of the cheaper models (the TV12) introduced a distinctive break with tradition in using a Bakelite instead of a wood cabinet. The result was a light, streamlined set which, with its nine inch tube, didn't dominate the living rooms of the early 1950s in the way that other monsters tended to do. It still needed development however.

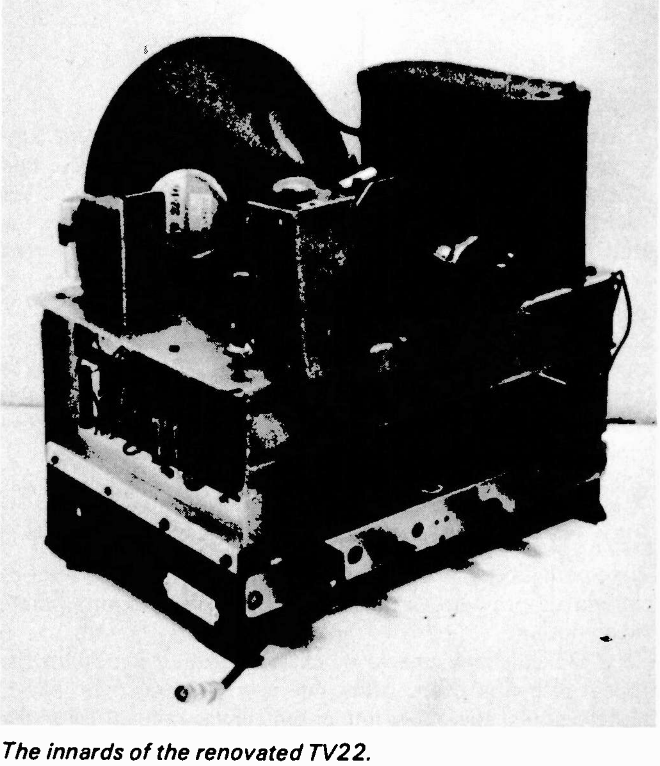
In February 1951, Messrs. Asbury, Wright and Lloyd of Bush presented a paper to the then Television Society (the Royal came later) describing their new baby. Most sets with nine inch, round screen c.r.t.s had hitherto used only a limited part of the screen, to get an almost rectangular picture about 7½in. wide. The Bush TV22 however used a "Double-D" mask, i.e. one with curved sides, giving an 8¼in. line scan. The e.h.t. was increased (to 8kV) to give a brighter picture, line timebase radiation was reduced by the use of elaborate screening, sound quality was improved, and the receiver section was able to cover the entire band of five channels. The aim was to do all this at lower cost than previously. (The initial release date of the TV22 had been June 1950 incidentally.)

Restoration

I've recently been working on the restoration of a Bush TV22 dating from 1951 – see the accompanying photos. The main chassis holds the sync separator, power supply, timebases, sound output stage and the c.r.t., the receiver section being in the removable lower deck. All the original capacitors, which were wax covered and had become rather leaky, had to be replaced. With some difficulty, a new tube had been obtained and fitted some years before, and the rubber mask, which had become hard and brittle, had been reinforced with car body filler. The Bakelite cabinet was cleaned with rubbing compound and then re-polished, the final outcome being quite a nice little set.

The original version of the receiver unit used B7G valves of the EF91 (pentode) and EB91 (double diode) variety. This was the type initially fitted in the set, though the original receiver unit had disappeared some years ago – it was a wonderful chassis for use in constructing amplifiers . . . I managed to obtain one of the later versions, using EF80 valves, as a replacement.

The aerial input is connected by way of screw terminals. The signal is coupled via tuned circuits to an r.f. amplifier stage, and is then taken to a single pentode oscillator/mixer



The innards of the renovated TV22.

stage. The oscillator coil's core is brought out to a spring-loaded knob at the rear, labelled "tuning for maximum sound". The r.f. cores are also accessible, to a trimming tool, at the rear, and are adjusted for the best picture. The i.f.s are 19·5MHz sound and 16MHz vision (perhaps we should say 19·5Mc/s and 16Mc/s). Two further EF80s provide vision i.f. amplification, followed by an EB91 detector/noise limiter and then an EF80 as the video output stage. There are also two EF80 sound i.f. amplifiers, the sound signal being tapped from the anode circuit of the first vision/sound EF80 i.f. amplifier. Another EB91 provides sound detection and interference limiting. There was no a.g.c. in those days. Instead, the contrast control simultaneously varies the gain of the r.f. and first i.f. amplifier stages – the two cathodes are returned to chassis via a common 7kΩ potentiometer.

On the main deck, a large octal based valve (PL33) produces about 1W of audio, which is fed to the chassis mounted elliptical loudspeaker. An ECL80 is used for the field blocking oscillator and output stages, a further ECL80 acting as sync separator and part line oscillator. The other part of the line oscillator is the line output stage itself, since there is flyback pulse feedback from a tap on the line output transformer to the line oscillator triode, the two stages acting together as a multivibrator. The line output valve is a PL38, and the overwinding on the line output transformer, which is wound on a laminated iron core, feeds a little EY51 e.h.t. rectifier (it reappeared years later as the focus rectifier in some early colour sets). The final valve is a PZ30, one half of which acts as the h.t. rectifier while the other half is used as the boost diode. The h.t. is 190V, the boost rail, which is developed across a 2μF electrolytic capacitor, being 280V. A 300V supply is used for the c.r.t.'s first anode. This is obtained by using a Metrosil (an early form of v.d.r.) to rectify line flyback pulses. See Fig. 1.

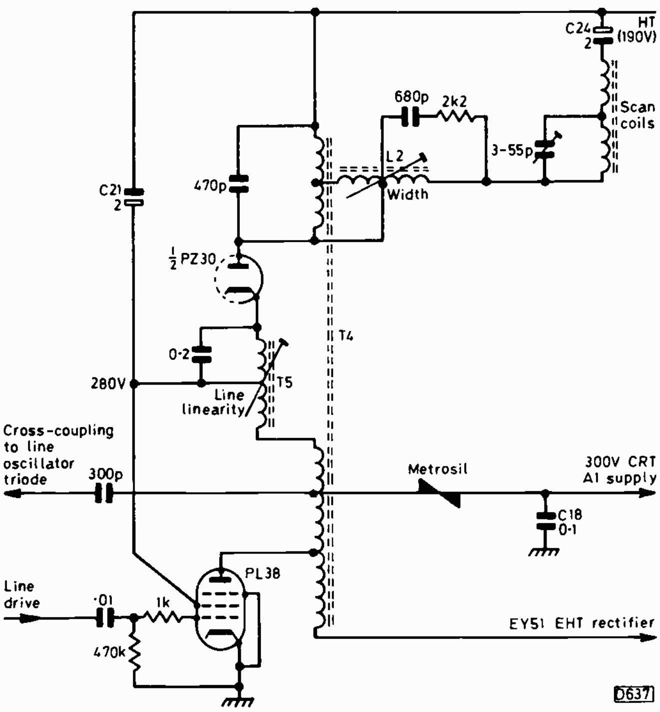


Fig. 1: The line output stage circuit used in the Bush TV22. There are one or two unusual features. First, the boost diode (half a PZ30) and the line linearity transformer T5 are inserted between sections of the line output transformer's primary winding. The line linearity transformer is in series with the cathode of the boost diode, serving to compensate for the diode's non-linear characteristic. The width control L2 is designed to present a constant load so that the e.h.t. does not vary when the width is adjusted. No scan correction is required with the narrow deflection angle (60°): C24 is simply a d.c. block. A 280V boost supply is developed across the boost capacitor C21. The Metrosil rectifies line flyback pulses to produce a 300V supply for the c.r.t.'s first anode across C18.

Once set up, these receivers would operate for years, requiring only minimal adjustment of the front mounted brightness and volume/on-off controls, and the coin-operated preset line and field hold controls. It's a tricky set to get working correctly after tube replacement however, due to the interaction between the ion trap magnet, which has to be set for maximum brightness in order to avoid screen damage, and the combined focus magnet/picture centring assembly, where rather clumsy screwdriver adjustments move the picture laterally or longitudinally. Centring the picture affects the focus, and once you've reset that the ion trap will have to be readjusted – an almost endless sequence of events.

The ion trap magnet looks rather like a blue lateral convergence assembly, though it's simply a small permanent magnet. The MW22-16 c.r.t. used in the TV22 was one of the first to feature a "bent gun", the heater, cathode and grid being aligned so as to fire the electrons at the side of the tube neck. The ion trap is used to bend the electron beam back towards the screen. The idea is that the ions, being heavier, continue on their collision course with the neck and thus don't discolour the tube phosphor. The advent of aluminised screens minimised the problem of ion burn. Many early aluminised tubes also featured ion traps, but these were phased out with the coming of slimline tubes.

Performance

There's no flyback blanking on the TV22, so it's necessary to allow for this when setting the brightness and contrast controls. The set will just resolve 2·5MHz when correctly tuned on a strong signal. Under adverse conditions it can still produce a slightly noisy picture when dual-standard sets some twenty years its junior are having trouble. The picture brightness does not match up to modern standards – it's definitely not a set for viewing under high ambient light conditions. Also, one's tendency to turn up the brightness on contrasty scenes stretches the limits of the line output stage, resulting in poor e.h.t. regulation and varying focus. The collection of hot valves housed in the line output stage screen does not, miraculously, seem to cause any trouble, though one can almost fry eggs on top of the Bakelite cabinet on that side after several hours' viewing.

Some History

By the Coronation year (1953) the TV22 was selling for £36.2s.6d. plus the dreaded purchase tax. Bush had made a breakthrough with this design, and for its time the set was extremely good value for money. The chassis was also used in wooden cabinet 12in. models, but what most of us will remember with affection is the little brown plastic box. Even after production of the TV22 ceased, the style returned briefly in about 1956 in the budget version of the TV53 thirteen channel series, which will jog many hearts involved in DX-TV: the set concerned was the TV62, whose similar Bakelite case housed a 14in. tube and a rather different chassis.

Many have said that the Coronation put TV on the map. This is indeed true, but one wonders how many people would not have been able to afford to see it had the TV22 not been around? ■

Long-distance Television

Roger Bunney

TV signals via all four modes of long-distance signal propagation – F2, Sporadic E, tropospheric and MS – were received here at Romsey during September. The SpE reception was as follows:

1/9/79 An unidentified programme on ch. R1.
2/9/79 RTVE (Spain) channels E2 and 3.
3/9/79 RTVE E2; RAI (Italy) IB.
6/9/79 RTVE E2.
18/9/79 A good late morning opening, with TVP (Poland) R1 and 2, CST (Czechoslovakia) R1, and SR (Sweden) E2.

There were three main periods of improved tropospheric activity. The E. German Brocken ch. E6 transmitter was received via tropospheric ducting all morning on the 5th. More general reception from DFF (E. Germany) was present on the 11th, with ch. E5, 6 and 11 signals and also W. German signals at both v.h.f. and u.h.f. On the 16th, Hugh Cocks phoned to report that conditions were good with several Swiss channels including E4. This ducting continued into the following day, when more German signals were received here.

There were also improved F2 conditions during the month. The 2kHz whistle at 46·15MHz, usually indicative of the presence of African Band I signals during the early evening, was very strong on the 10/11th, and a weak Rhodesian ch. E2 signal was received here on the 10th. The m.u.f. started to rise quite considerably after the 20th. Hugh reported South American signals at up to 45MHz, and I've heard various signals here during the early/mid afternoon period at up to around 40MHz. There were African signals (which I just missed) again on the 23rd – Hugh reported two, one of which was a football match which was present for nearly two hours. An interesting logging on the 27th, from about 1755, consisted of a frequency grating (I assume via F2) from a southerly direction. The transmitter itself seemed to be in trouble, with flashing, loss of video and other problems. The signal faded away after 1820, with no identification.

There was the usual daily MS reception, and as I write this towards the end of the month a slow-moving high-pressure system is giving the promise of another spell of enhanced tropospheric reception. Altogether an interesting and varied month.

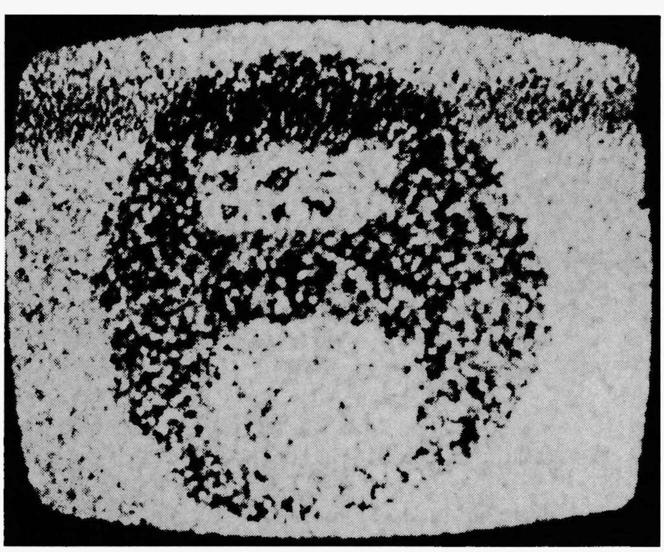
Several clues have come in concerning earlier reception queries. The new identification that several enthusiasts have noted on the DFF (E. German) test pattern is "DFF1 Radio DDR1": Mike Allmark (Leeds) logged this on August 6th. The weak signals noted between chs. E2 and R1 (at approximately 49MHz) are thought to be from a JRT (Yugoslavian) relay – I saw this signal on June 21st, with the Fubk test pattern. Kevin Jackson wrote to the Yugoslavian authorities querying reception of a ch. E3 outlet: apparently this was from a 25W relay at Pisvir, the only E3 outlet in the TV Sarajevo network. Well done Kevin!

Dave Palmer (Lowestoft) has received a ch. R2 news caption containing lettering not unlike Greek text. Can this be Bulgaria? Last month I reported reception of fluttery signals on August 12th: Kevin Jackson, using crossed Band I dipoles, noted MS signals on the 12th/13th including several Band III signals from ORF (Austria), NRK (Norway), DFF and TVP.

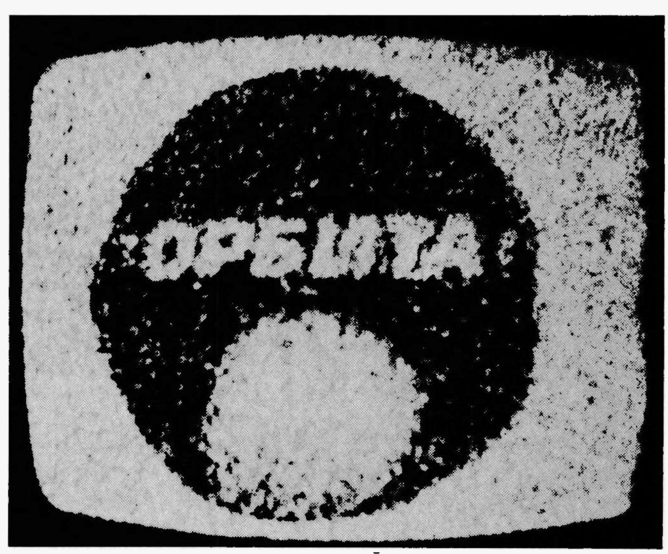
Two Dutch DXers received the RTA (Algerian) ch. E5 (Band III) signals previously mentioned – on June 28th. Ryn Muntjewerff's reception was clearest, there being greater interference farther south in Holland. At Hillegon RAI ch. D was received instead. Regarding the suspected reception of Gabon, reported last month, apparently RTVE ch. E3 was being watched at the time, when for about 45 seconds the test card came up over RTVE. The signal was recorded on a VCR and subsequent study suggests that "RTG" (i.e. Radio Television Gabonaise) is present at the top of the card. Rhodesia was received later on the same afternoon.

EBU Transmitter List

The latest EBU transmitter list, which includes all transmitters down to even milliwatt outlets and is up-dated with bi-monthly supplements, is now available. It's the most accurate list available, and most useful for DXers. The cost



The Russian Stat-T satellite received in South Africa by Ian Roberts. Signal/noise ratio some 15dB.



Improved reception of the Stat-T satellite, with 23dB signal/noise ratio. Display on 9 in. c.r.t., with slope detection.

is 450 Belgian Francs, and payment can be made via a Banker's draft to the European Broadcasting Union, Technical Centre, 32 Avenue Albert Lancaster, B-1180, Bruxelles, Belgium.

VCR Operation

I've been giving thought to the advantages of using a VCR for DX-TV work – as noted above, it proved helpful with the suspected Gabon reception. Two enthusiasts have written to us on this subject recently. James Burton-Stewart (North Bucks) has been using a Sony Betamax machine which seems to work well on weak signals. Good results have also been obtained feeding the machine from an up-converter. It's interesting that an unstable French signal could be played back with better sync.

John Neary (Dukinfield) had the loan of a Ferguson VHS VCR to record examples of DX-TV signals for a lecture. He recorded some three hours of SpE signals altogether, which provided an impressive demonstration. He used a four-element wideband Band I aerial plus amplifier, feeding the machine via a Labgear up-converter, with a Panasonic 14in. colour set to monitor the reception. The results were very good, and the freeze frame facility was a decided advantage.

If anyone else has experience of using a VCR to record DX signals, particularly weak, fluctuating ones or SpE signals with extremes of signal strength, I'd be interested to hear from them.

Satellite Reception

Ian Roberts (S. Africa) has been receiving video signals from the Russian Stat-T satellite, at 714MHz, and has sent in some photographs of his results. A standard TV set and a five foot dish with three-element horizontal pick-up are being used, initially with a three-transistor (BFW92) preamplifier giving a gain of 34dB. The first shot shows earlier reception, with a signal-to-noise figure of 15dB. A rebuilt head amplifier and a receiver-side amplifier, plus an extra i.f. preamplifier in the set, gave considerable improvement – a signal/noise figure of approximately 23dB was achieved. A narrow-band preamplifier using a couple of BF679 transistors is to be tried and should give an improved noise performance: a PLL to detect the f.m. video, using an NE561B i.c., is also being considered.

The programme times are 1100-1700 (S. African time). It seems that there's reduced signal strength towards the end of the transmissions, possibly due to the satellite receiving less solar power as a result of reduced sunlight. Ian comments that the sign-off is abrupt, with no test card following it. Congratulations to Ian on this achievement! Unfortunately for us, Stat-T is over the UK horizon – we'd have to go as far east as Greece for line of sight.

From our Correspondents . . .

Chris Wilson (Potters Bar) has just returned from a holiday in Czechoslovakia and comments that two out of three aerials there look as if they are home made. He's starting on a programme of experimental work with sync separators etc. for DX. The notch filter circuit he kindly sent in (see Fig. 1) uses a couple of varicap diodes and can thus be employed as a masthead unit.

Michael Pettigrew (Wicklow, Eire) is experiencing trouble with interference from r.f. welding equipment, strangely at u.h.f., where it drifts over much of the band. V.H.F. is clear, and Michael has had a most satisfactory DX season, including reception of Rhodesia.

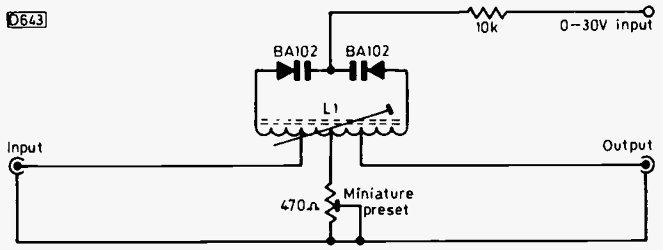


Fig. 1: Varicap tuned notch filter for use in Band I. Coil L consists of nine turns of 26 s.w.g. enamelled wire wound on a ¼in. former, tapped at turns 4, 5 and 6.

Finally, a word of warning from Arthur Milliken (Wigan). He left the aerial connected to his National Panasonic TV set during a thunderstorm, with the result that the front end was damaged. So don't leave the aerial connected during thundery conditions, especially if the tuner is a transistor type.

DX-TV for the Beginner – 4

Distant TV signals, say upwards of 600 miles, are present briefly every day of the year, being received on all channels in Band I and at times in Band III. We're not talking now of SpE signals, but of those propagated via MS (meteor shower/scatter) reflection. The reflection still occurs within the E layer, but the mechanism is different.

Throughout the day and night, the Earth is bombarded with particles from space, a few of these very large but the vast majority small. These small particles, perhaps the size of a pebble or less, burn up on entering the layers around the Earth, leaving a fiery trail which can often be seen. More importantly for us, the electron density of this ionised trail is sufficient to reflect incident v.h.f. signals. The meteorite burns up quickly, and its trail is equally short lived, so that MS signals are relatively weak and of short duration. As the reflection occurs in the E layer however it means that the reflection will be over a similar distance to SpE propagation, i.e. 600-1,300 miles or so. MS signals can sometimes be strong, but the average daily quota will be of low strength and of only a few seconds duration.

It follows from this that the receiving system must be of high gain if the average MS signals are to be resolved. A high-gain aerial however will have a directional characteristic, and won't be much use if one is awaiting random MS signals. Better therefore to use an aerial with a relatively wide forward pickup lobe, since this will gather such random signals over a wide arc. I personally favour the use of a two-element array facing east, since this will give coverage from Scandinavia in the north east to Yugoslavia in the south east. Alternatively one could use an omnidirectional aerial consisting of wideband dipoles mounted at right angles to each other, horizontally, connected via a wideband combiner such as the Antiference CS100 or Labgear CM6011/OS to a single down lead.

Band I MS reception is particularly rewarding for me, since it allows daily reception of sorts from a great many countries, and one can normally expect to receive specific transmitters. I've found for example that the East German ch. E4 signal with its characteristic test pattern can be expected daily here. With the PM5544 test pattern being used by so many transmitters these days, weak MS signal pings can be difficult if not impossible to identify. MS reception can occur at any time during the 24-hour period – subject to transmitters being in operation – but there's a tendency for early morning MS to be superior in the number and strength of the signal pings.

In addition to random MS, there are also regular meteor showers that generally arrive at certain dates and times which can be calculated. The major showers are listed in the various Astronomical year books and occur as follows:

Quadrantids	Early January.
Lyrids	Mid April.
May Aquarids	Early May.
Perseids	End July/mid August.*
Orionids	Mid/late October.*
Taurids	Early November.
Leonids	Mid November.*
Geminids	Early/mid December.*

*These showers often produce spectacular results.

If a major shower is particularly intense, reception can be quite dramatic with signals lasting for perhaps a minute or so. With a large number of reflected signals however, several fluctuating signals may be seen simultaneously.

Our comments so far refer to Band I. If a meteor trail is particularly intense, Band III signals may be seen. These may be of equal strength to Band I signals and at times rather more stable and slower fading. The best channels for Band III MS reception are E5, R6 and E6. A higher-gain array is necessary for Band III reception, and one must accept the fact that signals arriving "off beam" will be lost. MS signal pings in Band III are much rarer than in Band I however, so that the Band III MS DXer must sit and wait for much longer periods.

Aerial amplifiers are essential for MS reception, with a gain of say 15dB in Band I and 30dB in Band III.

My first experiences of MS reception were at my parents' house, where a 19in., 405-line Sobell receiver was used for reception of BBC-south on ch. B3. When the Rowridge transmitter closed at the end of "The Queen", I found that it was often possible to see and hear pings of the Scottish late news if the receiver was left on!

On a memorable occasion some years later, the Russian 0249 pattern suddenly appeared for some five seconds, with a further ping lasting some four seconds ten minutes afterwards, while I was watching ch. E5/R6. MS is about the only way in which Russian Band III signals are going to arrive at my valley location in Hampshire, only some 75ft. a.s.l.!

For MS work the receiver must of course have high gain. Of more importance perhaps is that it should have efficient sync performance – since MS signals last for only a second or so, rapid line and field locking are essential. Another requirement is to minimise noise. One of the simplest means of achieving maximum gain with minimum noise is to restrict the i.f. bandwidth – there's also the added benefit of improved selectivity.

It's quite easy to reduce the i.f. bandwidth by interposing one of the inexpensive vision selectivity modules from the Philips G8 chassis in the feed from the tuner to the i.f. strip. This small single-transistor unit has four tuned circuits which can be peaked by tuning to a weak signal and setting the cores for maximum gain. Connection details for this unit were given in Hugh Cocks' recent article on receiving French TV. The unit is usually available from Manor Supplies – send s.a.e. for details.

With older chassis, careful increase in the values of coupling components in the sync circuits can often give considerable improvement.

A word of warning however. Unless you're knowledgeable about TV receiver electronics, the rear cover should be left in place – there are dangerous high voltages around.

Servicing in the Field

Part 2

George Wilding

LAST month's article outlined the best approach to diagnosing TV power supply and timebase faults quickly in the customer's home: this time let's consider faults in the signal amplifying stages, from the tuner right up to the tube.

Weak Signals

One of the more common complaints with all types of set is a weak, grainy picture. The problem may simply be due to an inadequate, misaligned or damaged aerial of course, but assuming that the coaxial connections are in order, that there's no dodgy plug and socket combination on the skirting behind the sideboard, and that a sensitivity or a.g.c. preset control isn't misadjusted, the first suspect must be the r.f. amplifier. Make sure that wobbling the coaxial plug in its socket doesn't reveal a fault in the latter– many sockets are of the printed circuit type, and frequently develop a hairline crack in the print connection to the centre pin or even to the surround. Aerial isolating capacitors hardly ever give trouble, but when sockets are pushed into holders on cabinet backs, as in many Rank models, the coaxial lead can be pulled away from its termination at either end.

If you're at all suspicious about the aerial, first try with only the inner lead connected to the set: improved results are a sure indication of aerial trouble. To convince the customer, which is not always an easy task, show the results obtained with a set-top aerial – or even the meter lead. In my area, which is not too far from the local transmitter, I can get fair results when holding a meter lead in the right position. If the results from the aerial are little if any better, you've made your point.

Transistor r.f. amplifiers don't give much trouble, though the transistor may be damaged by lightning.

No Signals

Complete loss of vision and sound, but with car and other interference getting through, is due to failure of the local oscillator or mixer: the bandwidth of such interference is so wide that it can break into the i.f. section and get amplified there. It's sometimes found that the tuner will provide an output on the higher frequency channels only: this is usually due to the oscillator itself, whether a valve or a transistor.

Complete loss of vision and sound, but without any interference present, is usually due to a fault in the i.f. circuit or to loss of the supply to the i.f. strip or the tuner. A condition that can be misleading is when the vision signal does not get through the i.f. strip though the sound signal does – at reduced level.

If the i.f. strip uses valves, look for burnt out resistors, especially around frame-grid pentodes of the EF183/4 type. These tend to develop control grid-screen grid shorts, as a result of which excessive current flows through the screen grid feed and cathode bias resistors. Next try new valves. If this doesn't restore the output, check the detector diode. This will be found in the final i.f. transformer can, but can usually be checked by making resistance checks in both directions across appropriate coil tags and chassis, or at the signal feed points to the next stage. Such readings will be affected by associated components, but if you get a marked resistance variation between readings the diode can be considered operational – after all, we're looking for complete loss of signals, not reduced contrast and sound levels. Detector diodes in sets using transistor i.f./video circuitry very rarely break down. What does kill a detector diode is a sparkover in a d.c. coupled video output valve – particularly where a PCL84 is used in the video output stage.

Complete loss of output – or possibly no vision, reduced sound output – from a transistor i.f. strip is also quite rare and, when encountered, is generally due to failure of one particular transistor. Note however that the defective transistor may be in the a.g.c. circuit rather than being one of the i.f. amplifier transistors. Should the controlled stage(s) in the i.f. strip saturate as a result of a fault in the a.g.c. circuit, they won't be able to respond to the signal input.

If you have the circuit or are familiar with the particular chassis, it's a simple matter to check the transistor voltages. Even if you don't have the circuit, voltage checks should clearly indicate which stage is faulty. With an npn transistor for example the emitter voltage should be several volts at most, the base voltage 0·5-0·6V higher, and the collector voltage, depending on the value of decoupling resistor used, something approaching the supply rail potential. To check whether an i.f. transistor is operational, temporarily short its base to chassis (assuming that the emitter is connected to chassis rather than, as in a few early designs, being returned to the supply line): the emitter voltage should then disappear and the collector voltage rise. If the transistor gives these normal indications of d.c. amplification, it can be taken to be operational.

Note however that you may find the transistor(s) to which a.g.c. is applied saturated as a result of an a.g.c. fault – indicated by the base, emitter and collector voltages being almost the same, with a reading of only a fraction of a volt between the collector and emitter. This is generally due to a defective a.g.c. amplifier stage, as a result of which excessive forward bias is applied to the controlled stage(s).

This fault can and does occur in chassis such as the Thorn 1500, where (see Fig. 1) an npn a.g.c. amplifier transistor is a held saturated under no signal conditions. Apart from causing the controlled stage(s) to saturate, failure of the a.g.c. circuit to work normally can result in faults such as cross-modulation when a strong signal is present.

Lack of Contrast

Weak contrast is seldom due to a fault in a transistor i.f. strip. Valve i.f. strips often produce this fault however – due to failure of the contrast control to reduce the negative a.g.c. voltage sufficiently when fully advanced, usually because of an increased value resistor in the contrast control circuit. A simple check for this is to short the a.g.c. line to chassis. If the gain increases markedly, the contrast control circuit is implicated. A less common cause of this trouble is when the a.g.c. clamp diode goes open-circuit. As a result, the normal contrast range is covered by only a fraction of the contrast control's movement, the picture

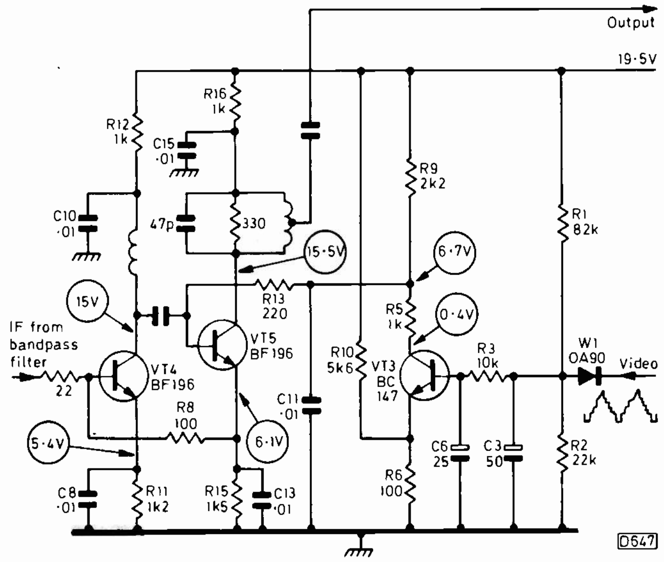


Fig. 1: A.G.C. is applied to the first two i.f. transistors (VT4/5) in the Thorn 1500 chassis. W1 is the a.g.c. detector, which rectifies the negative-going sync pulse tips, and VT3 the a.g.c. amplifier. If VT3 goes open-circuit, VT4 and VT5 will be driven to saturation, giving the no signals symptom.

becoming unstable and badly blurred with the control turned up beyond this point.

Should shorting a valve a.g.c. line fail to restore normal contrast, the next step must of course be to try new valves. Check any discoloured resistors, which will almost certainly have changed value.

Weak contrast can also be the result of a video circuit fault – a defective valve (especially the PFL200), a defective electrolytic capacitor, or a changed value resistor (particularly in a pentode video output stage). It's important to note all symptoms, since a dried up electrolytic in a video circuit will affect the lower frequencies more noticeably. There could therefore be streaking across the picture following large black or white areas, with probably impaired field lock. In fact, inability to stop the picture rolling may well be the customer's only complaint, since with the capacitor drying up gradually, over a period of months, the picture quality deterioration may have gone unnoticed.

It never fails to astonish one how poor a monochrome or colour picture can become before the user decides that something must be done about it. In most cases for example you will find that after restoring a dead colour set to life the picture is tinted one way or another, the height is excessive, or the focus and/or convergence are well away from optimum. The brightness and saturation may also be set too high.

Called to see a colour set fitted with the Thorn 3000 chassis recently – an aerial extension lead was required – I found that there was hardly any blue in the picture, due to leakage across the tube's blue gun first anode switch. These switches often give trouble in older 3000s, pulling down the relevant first anode voltage and thus reducing that gun's output. The customer was aware that the colour wasn't very good, but said what she mainly noticed was that old monochrome films were a "funny colour" instead of black and white.

In most cases, on turning down the colour control to show what should be a monochrome picture you'll find, to the customer's surprise, that it's pinkish or blueish – excessive green seems to be more often noticed.

Returning to electrolytics, check any miniature wire-ended types that are mounted close to high temperature components or valves. With canister types, look for signs of end cap swelling or slight white deposits around the rims of soldering tags. Whilst in valve circuits an equivalent can be stabbed across a suspect, this should not be done in a transistor circuit with the set switched on since the initial heavy charging current could damage the transistor's base-emitter junction. If a capacitor is at all suspect, it's best to change it.

Apart from electrolytics, video circuits normally include small-value compensating capacitors across the transistor emitter or valve cathode bias resistor. If one of these goes open-circuit or becomes dry-jointed, the effect is most noticeable as a reduction in the stage's h.f. response. It's important to use correct value replacements, otherwise the definition is likely to be impaired or a form of ringing instigated. This is especially so when peaking coils are present in the circuit.

As well as affecting stage gain, changed value resistors sometimes restrict the normal brightness range. Furthermore, incorrect biasing of a video output pentode or transistor will result in high-amplitude sections of the signal being handled on a non-linear section of the characteristic – towards cut-off. The sync pulses will be cramped therefore, while there will be great difficulty in separating the two darkest sections of the test card grey scale. Especially in older receivers using an output pentode, take a look at the biasing resistor(s) if the tonal range towards black is poor and the sync performance is below par.

Low Brightness

In colour and monochrome sets of all types, it's often found that the required brightness level is not obtained even with the brightness control set to maximum. Since brightness control is affected in so many different ways, it's difficult to generalise about this. The place to start of course is at the tube base, to find out which voltage(s) is/are incorrect, tracing back as necessary. In hybrid colour sets using colour-difference drive, replacing the PL802 luminance output valve will generally restore correct brightness range. The same principle holds for a monochrome set using a d.c. coupled video output valve of course. In colour sets there may well be an incorrectly adjusted preset brightness or beam limiter control.

Concentrating on monochrome sets, failure to obtain a peak white raster will be the result of one or other of four fault conditions: (a) insufficient c.r.t. first anode voltage; (b) excessive cathode voltage; (c) insufficient grid voltage; (d) an open-circuit beam limiter diode in the feed to the cathode

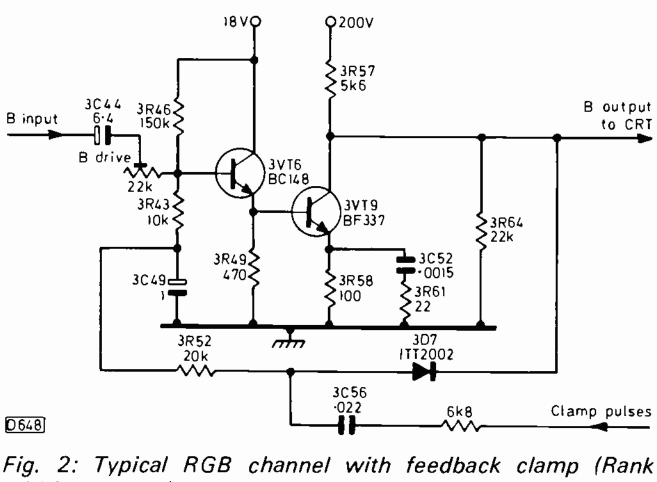


Fig. 2: Typical RGB channel with feedback clamp (Rank A823A chassis). Defective transistors or a clamp circuit fault will result in incorrect colours. With no clamp pulses there'll be excessive brightness.

– this one is very rare however. Without the manual, and without knowing what the correct voltage figures are, what's the best course of action?

First, short-circuit the tube's grid and cathode with the blade of a screwdriver. You've now removed all bias from the tube, and if this results in a peak white raster the first anode voltage is adequate. If this shorting action doesn't increase the brightness level, the tube's biasing is likely to be in order and the first anode voltage low. In this event, snip one of the leads to the first anode decoupling capacitor – even a small leak in this will reduce the first anode voltage enormously, since it's obtained from a high-voltage point. If this restores full brightness, the fault is located: it's always worth checking the associated feed resistor however, since the extra current drain may have increased its value. Alternatively, the capacitor may be in order, the resistor having simply changed value. If in any doubt about this, shunt the meter on a medium- or high-voltage range across the suspect resistor. If the brightness level increases, it can be safely assumed that the resistor is above its correct value. One way or another then, the possibility of low first anode voltage can be quickly checked.

Incidentally, we suggested snipping one of the decoupling capacitor's leads. It's best to snip the leads of suspect components rather than endeavouring to unsolder and free a lead. It's far quicker, much less likely to damage the component, and a solder blob quickly puts matters right.

Having established that the first anode voltage is adequate, how do you discover whether the tube's cathode voltage is high or its grid voltage low? With a d.c. coupled output pentode, the odds are that the valve is low emission. To check whether the valve is d.c. coupled, partly withdraw it from its holder, when moving it to one side or the other will momentarily put it out of action. If this blacks the screen out, the valve is d.c. coupled. Assuming that the valve itself is in order, its high anode voltage could be due to low screen grid voltage or high cathode voltage. If you don't know what these voltages should be, inspect the appropriate resistors. If at all discoloured, check their resistance value. A particularly common offender in older valve receivers is the resistor sometimes used to stabilise the output valve's biasing – connected from the h.t. rail or the screen grid to the cathode. This is likely to affect the sync as well, since it alters the biasing when it changes value (going low).

Where the resistors in the output stage – whether valve or transistor – are of the correct value, attention will have to be turned to the tube's grid circuit.

Wrong Colours

Excessive or inadequate red/green/blue in a colour set calls for a similar approach. Check the c.r.t. base voltages to find out which one differs from the others. Say you've a Thorn 3000 set with insufficient blue. If the blue first anode voltage is lower than the red and green first anode voltages, you've found the basic cause of the trouble. As mentioned earlier, check the switch, then as necessary the decoupling capacitor and the preset control and its series resistor. If the first anode voltages are all much the same, find out which cathode/grid voltage differs from the others.

With RGB tube drive, it may be necessary to check back from the output transistor to its driver, since these are d.c. coupled. In some chassis, such as the Rank A823, the Decca series 10, the ITT CVC5 and the Thorn 3000, there's a feedback clamp (see Fig. 2) which may need to be checked. If the diode goes open- or short-circuit, there's an excess of the colour concerned: if the feedback resistor goes open-circuit, again there'll be excessive red, green or blue.

next month in TELEVISION

SPECIAL VIDEO ISSUE

This month we seem to have been on something of a computer kick. So as another change we thought that next month we'd turn to the video side of things.

- **CAMERAS**

. . . for the domestic video user are becoming cheaper. David Matthewson takes a look at the current types on offer, what they can do and how they do it.

- **PROJECTS**

A neat all-purpose approach to monitor/receiver adaptation, devised by Steve Beeching, with specific details on adapting the Sony KV2000UB colour receiver for the purpose.

John de Rivaz shows how to salvage an old N1500 for use as a rewind machine. Andrew Parr provides a neat design for a portable CCTV test box to simplify the testing of CCTV installations. And Ian Pawson describes a d.c.-d.c. converter to enable the 12V "Dryfit" type lead-acid batteries used in portable video recorders to be recharged from a car battery.

- **REVIEWS**

A visit to the Video Tradex Exhibition and a look at Hitachi's VHS VCR.

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Andrew Parr, B.Sc., C.Eng., M.I.E.E.

CMOS LOGIC

TTL was so successful that it had the logic market to itself for five years – and five years is a long time in electronics! In the early 1970s however a new logic system started to appear. It was called CMOS (complementary metal oxide semiconductor, i.e. using insulated-gate field effect transistor technology) and was heralded as the perfect system. It would work on any supply from 3V to 15V, and use very little power. The power supplies required for TTL had to be stabilised and able to provide a current measured in amps: those for CMOS could be crude and had to provide only milliamps, even for very large systems. Noise immunities of 6V were quoted, and easy designs with fan-outs of 50.

My first encounter with CMOS was in 1973, when a CMOS automation scheme was delivered to one of the works in a certain nationalised industry which employs me. Like many other users of CMOS, my first experiences were not encouraging. CMOS has a very high input impedance – several tens of Megohms, and one thing you must not do with it is to apply inputs to the gates when the power supply is not present. The human body gets charged to several kV, through friction with cloths. This charge normally causes no problems, since it discharges quickly through low-impedance routes to earth in a circuit. With CMOS however there are no such low-impedance routes, and we found that whenever we picked up a board zap went a couple of gates. A situation in which we could not rely on spare boards was obviously not acceptable, and we modified the whole system by adding 100kΩ resistors to 0V at each vulnerable gate input. At one stage we were calling CMOS "TTL with a death wish", and one engineer put a sign on the logic panel saying "this system will self-destruct in three weeks". All very sad.

As was to be expected, CMOS got a bad press and a bad reputation in many industries. In a very short time however the semiconductor industry had revamped CMOS, and the B series came out. This will operate with a supply of up to 20V but, more importantly, protection has been added to the inputs, allowing it to be treated like any other component (well, almost). The Motorola version was manufactured near my home in Scotland, and the plant came to be known locally as the McMOS factory. Someone must have heard, because that became the trade name!

Basic Circuits

As already mentioned, the basis of CMOS is the field effect transistor – the enhancement type of insulated-gate f.e.t. (IGFET). Fig. 1(a) shows a simple IGFET transistor circuit. When the gate voltage is low, a p-channel IGFET presents an almost infinite impedance between its source and drain: when the gate voltage is high, the source-drain impedance is low. The IGFET can thus be regarded as a perfect switch, and can be represented as shown in Fig. 1(b). This simple circuit is an inverter, giving a 0 output for a 1 input and vice versa. It should be emphasised that the gate input is a voltage input, and the input impedance is several Megohms.

Given a perfect switch, it's easy to make logic gates. Fig. 2 shows NOR and NAND gates using MOS transistors, and their switch equivalents. The circuits shown so far have one disadvantage however. When the output is at 1, the circuit draws negligible current: when the output is at 0, current flows through the pull-up resistor. An ideal logic element should draw the same current in both states, in order to minimise power supply noise.

Fig. 3(a) shows the basic CMOS inverter stage. This time the p-type IGFET occupies the pull-up resistor position and is arranged in a totem-pole configuration with an n-type IGFET (hence complementary MOS). This gives the normally open/normally closed switch arrangement shown in Fig. 3(b). The current drawn by the logic gate itself is now negligible, the only current drawn from the supply being that taken by the output load. If this is another gate input, the load will also be negligible and we have a gate operating on a microamp.

For reasons that are not relevant here, it's easier to achieve high chip densities using CMOS. Thus LSI chips such as microprocessors and large RAMs tend to use CMOS technology.

With its early teething troubles sorted out, CMOS seems set for a healthy future.

Use of CMOS

In some respects CMOS is very easy to use. Unlike TTL, it can be run on any supply from 3V to 18V (15V for A series devices). The current drawn is negligible, and the simple power supply circuit shown in Fig. 4 will operate quite a large logic system. Again unlike TTL, it's relatively immune to supply noise.

In the static condition, CMOS draws little current. As it switches, the charging and discharging of stray capacitance causes current pulses on the supply. As the logic gets busier the current rises, until at around 1MHz CMOS is drawing much the same current as an equivalent TTL assembly. CMOS is thus best suited for low-speed logic applications. At the time of writing CMOS will operate only up to 5MHz, so it cannot match Schottky TTL (yet!).

On paper the noise immunity of CMOS is around 45% of the supply. The transfer characteristic is shown in Fig. 5, and it can be seen that it's tidier than TTL. In my experience of using TTL and CMOS in the electrically noisy environment of a steelworks however, TTL seems to give less problems than CMOS. I've not managed to decide exactly why this is so, but I think it's connected with the input impedance of the gates. It would seem easier to move 1MΩ by 6V than 4kΩ by 0·4Volts against a gate's will. There's room for research here into what makes a gate have good noise immunity.

Compared with its early days, CMOS is now quite idiot proof, and circuits no longer need to be assembled in operating theatres with technicians in earthed aluminium space suits. There are however a few precautions that should be taken.

CMOS is (or should be) supplied in conducting foam to protect the chip from static. The chip should be left in the foam until needed, and the CMOS chips should be the last thing to be placed in the circuit. The use of i.c. sockets is strongly recommended for the mercenary reason that most suppliers will not replace chips that have been soldered in place. If the chips are soldered in, the soldering iron bit must be earthed. When handling CMOS I usually earth

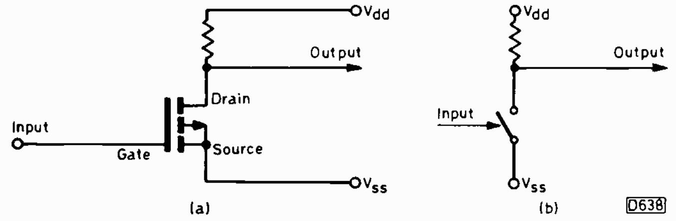


Fig. 1: (a) MOS field effect transistor inverter stage. (b) Equivalent switch circuit.

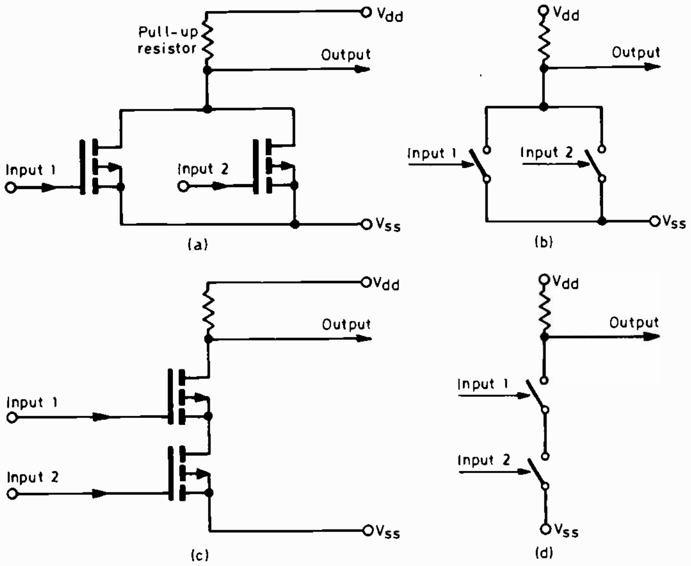


Fig. 2: (a) MOS NOR gate. (b) Switch equivalent. (c) MOS NAND gate. (d) switch equivalent.

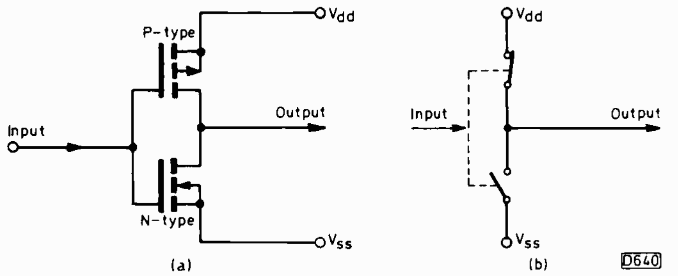


Fig. 3: (a) CMOS inverter stage. (b) Switch equivalent.

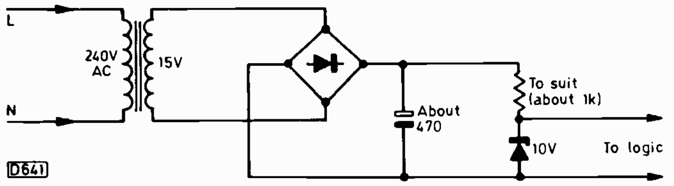
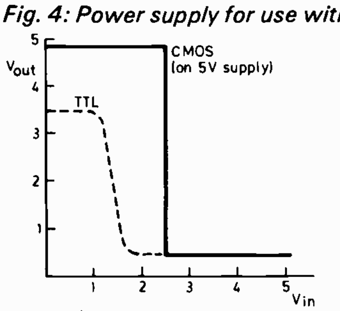


Fig. 4: Power supply for use with CMOS circuitry.



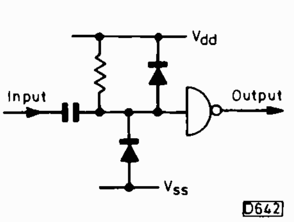


Fig. 5 (left): CMOS transfer characteristic.
Fig. 6 (right): Protection with clamp diodes.

myself by wrapping an earthed wire around my watch strap. I don't think this is really essential, as I have changed CMOS on site without bother, but at the bench the trouble is minimal.

Unlike TTL, the 1 and 0 logic levels are not fixed by the saturation voltage of a transistor. In an "on" state, the outputs look like a 500Ω resistor connected to the relevant supply rail. The output voltage thus rises (or falls) by about 1V for every 2mA of current sunk (or sourced) by the output.

The permissible load is thus fixed by two factors. The first is how far you can permit the output to be degraded in your particular application. If you're interfacing to some transistors and also some logic, you will be able to draw only a mA or so without adversely affecting the noise immunity. If you are driving only gate loads however you can draw several mA.

The second constraint is the power dissipation. If you load several mA on to an output, the dissipation will rise (given by I^2R). The total device dissipation must not exceed 200mW. Some quick sums will show that the device can withstand a short on any output to any rail: this is not recommended however.

There are a few essential "don'ts" for CMOS.

Don't apply voltage to an input if the supplies are not present. This is certain death.

Don't leave unused inputs floating. The high input impedance guarantees that they will pick up some noise and cause interesting results. Tie them to another used input or a supply rail (which rail will depend on the gate function).

Don't take any input to a source more positive than the supply, or more negative than 0V. This can easily occur with capacitive coupling to give edge triggering, so in this case use clamp diodes as shown in Fig. 6.

The labelling of CMOS is not quite as logical as TTL. All chips have a code in the range 4000, so a typical code might be:

(a) Manufacturer. CD is RCA, MC is Motorola.
(b) Type of device. 4012 is a dual-input NAND gate.
(c) Series – A or B.
(d) Packaging. E is the common dual-in-line plastic package.

A typical device type number therefore is CD4012BE.

TTL OR CMOS – THE CHOICE

At the end of the day, which logic system best suits your need? Let's start with the cases where you have little or no choice.

If your logic is to be run on batteries, use CMOS – provided its slightly lower speed is acceptable. If you're out for high speed on batteries I would rethink your scheme – even low-power Schottky is really high power as far as a PP3 battery is concerned.

If you're using complex LSI chips like microprocessors and large memories, again use CMOS. You have no choice, as TTL technology is limited to MSI.

If you're out for speed, use TTL. It's more predictable and can go ten times as fast as CMOS. As speed rises, CMOS loses its low power consumption advantage anyway.

If your system is likely to be abused by non-technical people, use TTL. The industry I work in has some of the worst conditions, and I've seen TTL operating under dust layers where you could not make out the chips. I've also seen TTL survive 24V on the 5V rail for a few seconds. It carried Apollo to the moon, and that's good enough for me!

For the average logic system there's little to choose and it's largely a matter of personal preference. If you've detected a slight pro-TTL bias you are correct – but this is mainly due to my experience. There's honestly little difference nowadays. The future however would seem to lie with CMOS. As industry calls for even more complex chips which only CMOS can provide, it seems likely that TTL will lose its present supremacy.■

TEST CASE

204

Each month we provide an interesting case of television servicing to exercise your ingenuity. These are not trick questions but are based on actual practical faults.

A fairly early and well used Decca colour set fitted with the 10 series Bradford chassis was brought into the workshop with the complaints of colour smearing accompanied by a drift towards a yellowish tinge after the set had been on for a time. The set had given no previous trouble at all, and the sound was still good.

A Philips PM5519 pattern generator was connected to the set, and with a white raster there was certainly more than a mere trace of grey-scale imbalance. On decreasing the brightness control setting, a yellowish shade was noted. We switched over to colour bars, and found that the transitions between the colours were a trifle hazy: after a while there was a slight flickering effect on some of the colours.

The chassis employs a discrete component decoder, with RGB drive to the c.r.t. cathodes. Each RGB channel consists of a driver and output transistor, with the input signal fed in via a 5μF electrolytic capacitor and a feedback clamp circuit to stabilise the black level. A 2kΩ preset control is included in the collector circuit of each output transistor for grey-scale setting up purposes. We've had trouble with these presets before, in the form of varying resistance between the wiper and track, so we decided to work in some cleaning fluid and then set up the grey scale. All went well until we came to adjust the blue drive control VR241: to get anywhere near Illuminant D, the preset control had to be at one end of its travel. Ohmmeter checks were carried out, revealing that the presets themselves had responded to the cleaning treatment and that their values were correct.

Since the outputs are d.c. coupled to the c.r.t. cathodes, we next checked the values of the resistors in the blue output stage. There were no problems here, so the two transistors in the blue channel were replaced. Once more it was impossible to achieve an acceptable grey scale however, and at this point we found that the setting of VR241 tended to be unstable, the degree of grey-scale error apparently changing as the control was rotated.

Which important component had been overlooked? See next month for the solution and a further item in the series.

SOLUTION TO TEST CASE 203
– page 45 last month –

Being associated with an acoustics engineer, we decided to seek his views on the problem of the ringing Decca set mentioned last month. He set up some very expensive looking equipment in the young couple's home, with a microphone at the place where they normally view (about 9ft. from the set), and came up with some startling results as shown in the accompanying spectrogram (Fig. 1).

The top horizontal line, at 0dB, refers to a 60dB sound pressure level (SPL). The vertical scale corresponds to 10dB per main division, and the horizontal scale to 5kHz per main division. The microphone was thus picking up a 15,625Hz line frequency component at a SPL of no less than 60dB (this is about the average level at which the sound of a TV set normally operates!), a second harmonic component of 32,250Hz at a SPL of 37dB, and a third harmonic component of 46,875Hz at a SPL of 32dB. By extending the horizontal scale, other harmonics of diminishing amplitude were also detected!

My old ears and those of our senior technician and, indeed, the acoustics engineer failed to respond to these upper-frequency sound components, but those of the married pair of significantly younger years were very sensitive to the shrill sounds, which were obviously causing them distress.

Having invested in some expensive research, we decided to see how other sets fared in this respect. We found that all receivers radiate the line timebase fundamental frequency plus harmonics, but at differing levels – mostly about 10dB below the Decca set. The cause is basically magnetostriction in the core of the line output transformer and the scanning yoke. After a good deal of experimentation (we made no money out of this deal!), we found that the intensity of the radiation from the Decca set could be reduced by using capacitors different from those we had earlier replaced in the line output stage. We eventually managed to reduce the radiation level by about 10dB, and although the couple could still vaguely detect the line whistle it was no longer distressing to them – and no worse than that from most other sets.

It seems nevertheless very wrong to me that sets should produce such a high whistle level which is "tolerable" only because the average viewer's ears are unable to detect it. If it was at a lower frequency, it would certainly be classified as well within the range of annoyance and steps would have to be taken by designers to mute it!

Judged from a few sample receivers of different makes, the average level of the 15,625Hz component is around 50dB (corresponding to about speech conversation level). This is affected by microphone positioning, the set's position in the room and the room's acoustic properties. Hard, undamped walls for example tend to reflect the whistle and "amplify" it.

Regarding the reduction in level achieved by changing the capacitors, we can conclude only that some capacitors "whistle" more than others, depending upon their electrostatic-mechanical properties!

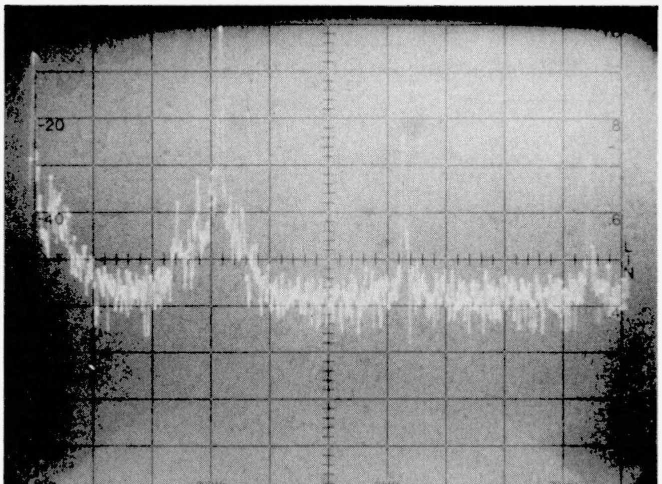


Fig. 1: Spectrogram of the line frequency ringing produced by the Decca CTV25 mentioned in test case 203. The set up used to obtain this included a B & K 2209 sound pressure meter fed via a third-octave filter and a Hewlett Packard 1616 spectrum analyser switched to the 100Hz filter.

Your PROBLEMS solved

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THORN 1500 CHASSIS

There's an unusual fault on this set – the picture expands at the top and bottom. I've tried turning down the height control, but the picture keeps expanding. The picture does not disappear when the brightness is turned up, so I assume that the e.h.t. is o.k.

If the picture is narrow and expands vertically at high brightness levels, the line output valve and transformer are suspect. If the height is unaffected by the brightness control setting and the vertical scan is, as far as can be seen, linear, the height stabilising VDR Z1 (00E5-100/001) and the height control are suspect. If however the field linearity is poor, the chances are that the linearity feedback path has become high resistance or maybe open-circuit – check C81, the top linearity control R104 and R100.

ITT VC51 CHASSIS

The sound is o.k. but the picture sometimes doesn't appear, due to lack of line drive (line output valve overheating). The difficulty is that when a voltage reading is taken at pin 1 (triode anode) of the PCF802 line oscillator valve the line timebase suddenly starts to run, the picture then appearing. When the fault is present there seems to be no voltage at pin 6 (pentode anode) of the PCF802 – there should be 130V here. The 47kΩ load resistor then has no voltage at one side, but when the test probe is applied to the other side the line timebase suddenly starts up, with a picture a few seconds later. The load resistor has been replaced without alterating the situation and I'm now stumped.

This problem often causes confusion. It's almost always due to the polystyrene feedback capacitor C121 (800pF) in the line oscillator stage. Replace with an 820pF silver mica type. On very rare occasions the electrolytic capacitor that smooths the supply to the line oscillator can cause the same trouble. This is C110 (16μF).

THORN 1591 CHASSIS

The trouble is that the raster is an inch in at each side. The voltages seem o.k., the l.t. line being set correctly at 11·6V. A new line output transistor cured the fault temporarily, but five hours later the raster was narrow again.

The trouble could well be due to the boost diode W11 going high resistance. A fast-acting type must be used, the MR854 being suitable. If replacing this doesn't cure the fault, check for leakage in W13, W14, C110, C111 – this would load the line output stage.

THORN 3500 CHASSIS

The e.h.t. tripler has been replaced – the previous one was faulty – but the brightness is low when set up as prescribed in the manual. A reasonably bright picture (a rather hazy glare rather than proper brightness) can be obtained by adjusting the beam limiter control for 2·5V instead of 1·3V across the beam current sensing resistor R907, which is correct in value incidentally. Also the size of the picture is inclined to alter at extreme contrast control settings.

Everything points to excessive current demand in the line output stage due to heavy damping. In view of the fact that the original tripler failed, it's likely that the e.h.t. transformer T503 or, less likely, the scan transformer T504 has shorting turns. First however eliminate from suspicion the choke (L504) in the shift circuit. This can be done by removing it to see whether the operation of the set then returns to normal.

RANK A823 CHASSIS

The problem with this set is black bands across the picture following anything white. The problem is present on both colour and monochrome. The grey scale is o.k. and the convergence good.

The effect is present to some degree on most colour sets, due to slightly inadequate video signal clamping. It's usually aggravated by grid current in an ageing tube. If the 18V decoder supply stabilising zener diode 8D1 and the h.t. smoothing electrolytic 8C10 (600μF) on the power supply board are in order, we suspect that the root of the trouble is a gassy c.r.t.

ITT VC200 CHASSIS

The trouble is that R162 has burnt out and the value cannot be read. Please let me know the value and the reason for the fault.

R162 is a 1·5kΩ resistor rated at 2W. It's connected across the line linearity coil L63 to provide damping, and probably burnt out because the coil is open-circuit. We usually fit a 4W RS Components wirewound resistor in this position.

PYE 725 CHASSIS

The set has been correctly set up for 185V h.t., but the picture starts to pulsate after fifteen minutes from cold. In case the over-voltage circuit had altered slightly, the setting up was readjusted and a meter was then left across the 185V line. After fifteen minutes, the line started to rise to over 200V, when the set was switched off to avoid damage. The three presets RV916, RV917 and RV879 had no effect on the rising voltage. What's the cause of this rising voltage?

The usual cause of this trouble is that the thyristor mains rectifier D888 is going into the diode mode when warm. Replacement should cure the trouble – use a 2N4444 or OT112.

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TELEVISION DEC. 1979

B & O 3400 CHASSIS

There's a colour fault on this set. Complete loss of colour may last for a full evening, then return the following day – usually about five minutes after switching on.

There are many possible causes of no colour on this chassis, but by far the most common one is failure of one of the high-voltage transistors in the decoder. You may find BF110 or BF178 types fitted – the latter should be used for replacements. The transistors to check are 4TR13 and 4TR6/7/8. The faulty transistor will be betrayed by the following voltage readings: collector at the 60V supply line voltage, emitter voltage zero, base voltage high.

ITT CVC2 CHASSIS

There's quite a good picture except that verticals, i.e. factory chimneys, are bent and captions pull. This condition can be cured by reducing the brightness until the picture is too dark for normal viewing. The setting of the beam limiter, the connections to the tube coating, and most of the components in the line output stage have been checked.

We suggest you first check the components that affect the biasing of the sync stages – Rf38 and Rf40 which bias the base of the sync separator, Rf44 which biases the base of the sync pulse amplifier, and Cf27 which smooths the supply to these stages. Rh50 which feeds the flyback pulses to the flywheel sync circuit is worth checking, also the flywheel sync diodes Dh1/2 and Ch20 which smooths the supply to the line oscillator.

PYE 691 CHASSIS

Shortly after the picture appears, the brightness increases. Two or three minutes later the picture slowly returns to normal brightness, but a convex margin appears on the left-hand side of the raster with some vertical stretching when the picture contains much blue. The performance is otherwise well up to standard.

The PL509 line output valve or the PY500 boost diode may be ageing – both may need replacement. Alternatively, suspect the beam current limiter control of having altered. To adjust this according to the book is involved. If you note the present position however and move it slightly either way no harm will befall. Try for a position giving less width variation with a dimmer picture.

VARIABLE SUPPLY

I'd like to be able to apply a variable input voltage to a set which keeps on blowing its fuses – not the mains fuse – with the aim of supplying enough voltage at low current to be able to test various parts of the set without the fuses popping off. Any ideas?

Any variable autotransformer (variac) will do provided it's capable of supplying 2A (500W) or more – the higher the current rating the better. If you're lucky you may find a surplus one at around £15 or so. There are a couple of transformers in the RS range. It's a good idea to incorporate an RS type moving-iron ammeter and voltmeter, and provide fuse protection. Ensure that in use the common variac terminal is connected to mains neutral.

GRUNDIG 5010

The set worked o.k. after replacing the TA16090 scan thyristor, but after three days R546 (220kΩ) in the feed to the c.r.t. first anode presets burnt out. This was replaced, but as soon as the e.h.t. starts to develop it immediately burns out.

When the scan thyristor is replaced it's as well to renew the components in its gate circuit – C515/L515/R515. These are very inaccessibly mounted midway down the main board, near the heatsink. Otherwise the e.h.t. can rise to over 30kV, taking the first anode voltage up with it and usually producing picture foldover. If this doesn't cure the problem, it will be necessary to check the components in the width regulator circuit. When things have returned to normal, check the three presets themselves as they usually suffer along with R546 – if in doubt, replace all three.

THORN 1400 CHASSIS

The picture is quite stable when the set is first switched on, with good contrast etc. Within about three minutes however the picture develops a judder, flickering up and down. If the height is reduced by about an inch, the top and bottom of the picture become stable, but as soon as the height is restored the judder recommences

The first suspect must be the field timebase valve (PCL805) itself. If a new one doesn't cure the fault, check the height control and the two resistors in series with it (R103 and R133), also C104 (1μF) which decouples R133. The two 18kΩ resistors R113/4 in the cross-coupling network are also suspect.

RANK A823 CHASSIS

This set works correctly for the first two hours after switching on, then simultaneously looses brightness and colour, with picture ballooning. The fault seems to be temperature dependent, with a long cool down period before normal viewing is restored. With the fault present the e.h.t. drops to about 10kV, with a noticeably reduced spark at the tripler input. The first anode supply is also reduced, but the h.t. remains unchanged. I suspect the tripler.

The tripler could be responsible, but only if the h.t. and flyback voltages are equally distributed between the two line output transistors during the fault. We say this because this fault is commonly due to one half of the line output stage becoming short-circuit, as a result of failure of one of the BU105 line output transistors or one of the 0·0047μF flyback tuning capacitors 6C5/6. If 6R6 and 6C4 are present, they should be removed when carrying out the repair. Be sure to rebalance the stage with 6L4/5 as described in the manual.

PYE 569 CHASSIS

The trouble is very loud intercarrier buzz on sound – the picture is perfect. I've tried adjusting the quadrature coil L11 and replaced the TAA570 intercarrier sound i.c., but the fault remains.

The usual cause of this trouble is L11's tuning capacitor C43 (100pF) going faulty. The capacitor is inside the can, but an external replacement will do.

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Fit our **C.R.T. Isolating Transformer.** Ideal for HTR./Cath. Shorts. 200-220-240 inputs. 750-900 MA outputs with thermal cutout. Made for **Thorn 4000** C.T.V. but works O.K. on other sets.
£2.00 each 3 for £5.00

MISCELLANEOUS

Philips G8 Tube Base Panels Complete, but PCB's cracked, ok for spares. Focus, base, leads, plugs etc.	2 for £1
Bush CTV 25 Quadrupler Remo type Q25B. equiv. to ITT. TU25 3QK. with mounting brackets.	**£4.25 each. 3 for £10**
GEC single standard, hybrid chassis. convergence panel. Brand new, complete with plugs and leads	£2.50
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ITT Featherlight Super. Side Chassis, with controls, V. Cap Tuning Panel, Regulator, P/Button Switches, Bridge Rec. etc., etc.	£3.50
I.C. for above	£1.00

SPECIAL OFFER
GEC transistor rotary tuners with slow drive, AE Skt. and leads **2010** Series £1.50

KB VC3 VHF tuner with valves	£1.50
KB VC3 transistor tuner "UHF"	£1.50
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ITT CVC5 power panel. New but five resistors never fitted	£1.50
Pye 697 line and power panels, damaged or some bits missing but invaluable for spares	£2.00
Pye mono mains droppers with fusible link. 147Ω + 260Ω	50p 3 for £1.00
69Ω+161Ω	50p 3 for £1.00
Decca "Bradford" C.T.V. triplers 25KV	£3.00 each 4 for £10
Portable TV EHT Sticks "Siemans TV 18 KV". Fit most portables	50p each 3 for £1.00
Pye 18" CT200 V. Cap P/B Assembly with leads and plug	£2.50
EMO. On/off switch	£1.00
G.E.C. S/S Hybrid Focus Assembly with lead	£1.50
2 × Coax Sockets on plates suitable for various Continental T.V.s	50p
1·9 Amp T.V. Cutouts Suitable for DECCA and THORN sets.	**60p each. 3 for £1.50**

White Ceramic TV Resistors
20Ω 16W, 180Ω 11W, 13Ω 11W.
10 of any one type £1.20
10 of each type £3.00

2·2k fusible, vertical mounting **Screen Feed** resistors 9 watt	8 for £1.00
0·47Ω ½ watt emitter resistors	40 for £1.00
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4,500µF 35V	cans 80p each
R.B.M. 100µF + 32µF + 32µF 300V	50p each
Avoid Lethal Shocks Buy our specially designed **EHT Probe,** removes high voltage charges from tubes, caps, etc. Heavily insulated with lead and earth connector	**60p** each
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C.T.V. Tube bases	5 for £1.00
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Rediffusion/Doric Mk 13 5 stick **Triplers** can be modified for other sets	£1.00
Portable T.V. Batt. Leads with Croc Clips and flat 2 pin socket Fits BRC sets	£1.50
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Transmitter and receiver. 40 kHz 14 mm diam. **£4.25 pair**

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2¼" Round 8Ω	70p
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ZENERS

400MW. 4·3V, 4·7, 6·8, 7·5, 30V		10 of one type 80p 10 of each type £3.00
1·3W. 12V, 13V, 18V,		10 of one type £1.00 10 of each type £2.50
DIACS	BR100	6 for £1.00
STABILIZERS		
TAA550		4 for £1.00
GEN. PURPOSE DIODES		
IN4000	30 for £1.00 IN4003/10D2	20 for £1.00
IN4002	25 for £1.00 IN4148	20 for £1.00

PROTECT YOUR PROPERTY
Buy a "SENTINEL" **Smoke and Gas Detector.** Uses TGS105 plug in sensor, housed in 3½" diameter diecast box. 24V. Convertible to 12V. Will activate lamp or relay.
With Data and Circuit **£16.95**
Suitable 24V Relay **£1.00**

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Our Transistor Packs are even better than before! **100 NEW AND MARKED TRANSISTORS** including BC238, ME0412, BF274, BC148, BC182L, BC338 and, or other similar types. A random analysis of these packs yeilded between 98 and 106 transistors of 17 to 20 different types with our average total retail value of £14 – £16. **OUR PRICE ONLY £4.95**
200 transistors as above but including BD131, 2N3055, AC128, BFY50, BC154, BF394, BC184L, etc.
ONLY £9.95

BY476 (BY176) **18kV. 2·5Ma EHT REC** 60p each 3 for £1.50

De Luxe Fibre Glass Printed Circuit Etching kits
Includes 150 sq. ins. copper clad F/G. board. 1 lb ferric chloride 1 dalo etch resist pen. Abrasive cleaner. Etch tray plus instructions.
Special Price £4.95.
1 lb F.E. C1 To mil. spec. **£1.25**
5 lb FE. C1. To mil. spec. **£5.00**
150 sq. in. **Single sided** board **£2.00**
150 sq. in. **Double sided** board **£3.00**

500 Watt Dimmer Switch
Toroidal mains suppression, fused with satin aluminium knob, white.
ONLY £3.45.

Send **40p P. & P.** on all above items; send Cheque or P.O. with order to:–

SENTINEL SUPPLY
DEPT. TV
149a Brookmill Rd., Deptford, London SE8
(Mail Order address only. Callers by appointment)
Trade enquiries for quantity welcome.
Surplus stocks purchased for cash.

General Electric Company (U.S.A.)* Professional Large Screen TV Projection

The new look in TV Production.

You get new dimensions of viewer impact and operating flexibility with a rear-projection background for news-weather-sports and special effects using a General Electric (U.S.A.) Professional Large Screen Color TV Projector.

The projected background visually displays virtually any signal from a video source, and eliminates production restrictions and video problems possible with electronic backgrounds.

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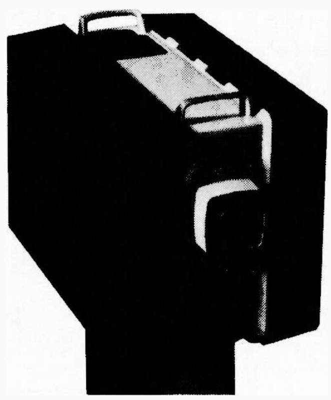

Join the major U.S. TV network and local stations in the U.S. (shown above, WTMJ-TV) and other countries which have put this versatile new production approach to work. For application data, telephone J.P. Gundersen, (U.S.) 315-456-2562. Or write: VDEO, General Electric Company (U.S.A.), Electronics Park 6-206, Syracuse, NY 13221. U.S.A.

GE (U.S.A.) Professional Large Screen Television Projector Specifications

Model	Light Output in Lumens: Open Gate, Min.	Modulated, Min.	Modulated, Typ.	Resolution** in Lines per Picture Height: Min. Horiz.	Min. Vert.	Input Power Req.: Watts	Volt-Amps.	Scan Standards****	Video Input***
COLOR PROJECTORS									
PJ 5000	550	220	280	750	300	1200	1600	525 li./60 fps; 625 li./50 fps	(1)
PJ 5050	1250	500	650	750	300	1600	2150	525 li./60 fps; 625 li./50 fps	(1)
PJ 5800	550	200	280	750	600	1200	1600	875 lines, 60 fps	(2)
PJ 5850	1250	500	650	750	600	1600	2150	875 lines, 60 fps	(2)
PJ 5100	550	200	280	750	650	1200	1600	1023 lines, 60 fps	(2)
PJ 5150	1250	500	650	750	650	1600	2150	1023 lines, 60 fps	(2)
MONOCHROME PROJECTORS									
PJ 7000	1000	600	750	800	400	1000	1350	525 li./60 fps; 625 li./50 fps	(3)
PJ 7050	1700	1000	1250	800	400	1000	1350	525 li./60 fps; 625 li./50 fps	(3)
PJ 7055	3300	2000	2400	800	400	1500	2000	525 li./60 fps; 625 li./50 fps	(3)
PJ 7800	1000	600	750	800	650	1000	1350	875 lines, 60 fps	(3)
PJ 7850	1700	1000	1250	800	650	1000	1350	875 lines, 60 fps	(3)
PJ 7855	3300	2000	2400	800	650	1500	2000	875 lines, 60 fps	(3)
PJ 7100	1000	600	750	800	750	1000	1350	1023 lines, 60 fps	(3)
PJ 7150	1700	1000	1250	800	750	1000	1350	1023 lines, 60 fps	(3)
PJ 7155	3300	2000	2400	800	750	1500	2000	1023 lines, 60 fps	(3)

Line Power, All Projectors: 117 or 240 v., ±10%, 50/60 Hz

**Resolution measurements made with wide-band video input.

***Video Input Key: (1) NTSC or RGB. (2) RGB. (3) Wide-Band.

****For use at other scanning rates, contact General Electric (U.S.A.) (VDEO) for special application/model information.

GENERAL ELECTRIC

U.S.A.

***Not connected with the English Company of a similar name.**

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HIGH QUALITY COLOUR AND MONO-CHROME REPLACEMENT TUBES AT COMPETITIVE PRICES.

- ★ Complete New Gun fitted to every Tube.
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- ★ Every Tube Electrically Tested.
- ★ Every Tube Picture Tested.
- ★ Supplier to Major Rental Companies.

19", 20"	£22
22"	£25
25", 26"	£28

11-29, Fashion Street, London E1

Ring Standerd T.V. Tube Reguner
Tel. 01-247 3097

VIEW WELL WITH WELLVIEW TV TUBE REBUILDS

Exchange Mono

	our price	+VAT 15%	total price
CME 1601-1602	£9·30	£1·39	£10·69
A44/120WR	£9·30	£1·39	£10·69
A50/120WR	£9·30	£1·39	£10·69
AW59/23W	£11·00	£1·65	£12·65
A61/120WR	£11·00	£1·65	£12·65

NEW MONO TUBES
20" = £15.80 inc. VAT 24" = £17.20 inc. VAT

Exchange Colour

	our price	+VAT 15%	total price
A44/270X-271X	£27·00	£4·05	£31·05
A47/342X-343X	£27·00	£4·05	£31·05
A49/120X	£27·00	£4·05	£31·05
A51/110X	£27·00	£4·05	£31·05
A55/14X	£32·00	£4·80	£36·80
A56/120X	£32·00	£4·80	£36·80
A63/120X	£36·00	£5·40	£41·40
A66/120X	£36·00	£5·40	£41·40
A67/120X	£36·00	£5·40	£41·40
A67/200X	£36·00	£5·40	£41·40

18 month full guarantee (Established ten years).

Send cash or cheque together with old tube with your order.
Carriage=£4·50 including VAT

ALSO YOUR VALVE SUPPLIER NEW AND BOXED
(inclusive of VAT)

DY802=74p	ECC82=64p	EF183=78p
EF184=64p	PCC89=72p	PCF802=98p
PCL82=78p	PCL84=92p	PCL805=97p
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PL509=£2·82	PL519=£2·92	PY88=70p
PY800=70p		PY500A=£1·52

Postage and Packing 10p per valve. All orders over £10 Free of charge.

WELLVIEW TUBES LTD.,
Unit 7, KING ROAD,
CHARFLEET INDUSTRIAL ESTATE,
CANVEY ISLAND,
ESSEX
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TELEVISION TUBE SHOP

NEW TUBES AT CUT PRICES

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	Price £	VAT £ 12½%
A28-14W	18.95	2.37
A31-19W/20W	19.95	2.49
A31-120W/300W	17.95	2.24
A31-410W/510W	17.95	2.24
A34-100W	18.50	2.31
A38-160W	17.50	2.19
A44-120W	18.75	2.34
A50-120W	17.95	2.24
A59-23W	18.95	2.37
A61-120W	18.95	2.37

U.S.A./JAP. TYPE Nos.

9AGP4	19.50	2.44
190AB4/C4	17.50	2.19
230ADB4	28.50	3.56
230DB4/CT468	24.00	3.00
240AB4A	17.95	2.24
CT507	17.95	2.24
CT512	27.50	3.44
310DGB4/DMB4	23.00	2.88
310EUB4	19.95	2.49
310EYB4	18.75	2.34
310FDB4	19.95	2.49
310FXB4	17.50	2.19
310GNB4A	23.50	2.94
310HCB4	23.50	2.94
340AB4	19.50	2.44
340AYB4	25.25	3.15
340Rb4/CB4	24.50	3.06
340AHB4	24.50	3.06

Some Rebuilt Japanese & European Types Available at £14.00 + VAT £1.75

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(New & Colourex)

12VARP22	62.50	7.81
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A47-342X	69.50	8.89
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A49-191X	59.50	7.44
A51-220X	64.00	8.00
A56-120X	69.50	8.89
A63-120X	69.50	8.89
A66-120X	75.00	9.37
A66-140X/410X	70.50	8.81
A67-120X	82.00	10.25
A67-140X/200X	69.50	8.89
A67-150X	75.00	9.37

ALL TUBES TESTED BEFORE DESPATCH & GUARANTEED FOR 12 MONTHS! 4 YEAR GUARANTEES AVAILABLE ON MOST TYPES

CARRIAGE
Mono £3.00 Colour £4.00
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EMO – EUROSONIC – GRUNDIG – TELETON + ALL BRITISH MAKES ETC., ETC. ● ALL SPARES READILY AVAILABLE ● REBUILT TUBES

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Almost any TV Component supplied by return "off the shelf" e.g. LOPTX – EHT trays – droppers – OSC coils – switches – cans – smoothers – I.C.'s. etc., etc.
NEW – COMBI LOPTX NOW AVAILABLE.

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IF YOU NEED SPARES FAST – RING NOW!

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ADVERTISERS

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The prepaid rate for classified advertisements is 21p per word (minimum 12 words), box number 60p extra. Semi-display setting £4.00 per single column centimetre (minimum 2·5 cms) All cheques, postal orders etc., to be made payable to Television, and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Television, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

Publishers Announcement

Due to increases which may have taken effect since this issue went to press, we strongly advise readers to check with advertisers the prices shown, and availability of goods, before purchasing.

SETS & COMPONENTS

COLOUR TV's
Many working for disposal, trade only.
All sizes and makes available.
Mono sets also available.
Ingertone (London)
24 Dames Road, Forest Gate,
London E7. Tel: 01-555 5569
Ingertone (Bristol)
28 St. Thomas St., Bristol 1.
Tel: 0272 211179

MAINS DROPPERS AND CAN CONDENSERS

Philips G8 47Ω	43p
Philips G8 2-2-68Ω	63p
Philips 210 118-148-LoopΩ	63p
Philips 210 30-125-2K85Ω	74p
Philips GT23 6-124-84Ω	74p
Thorn 3500	74p
Thorn 1500 350-20-148-1500-317Ω	90p
Thorn 1400	80p
Thorn 8000 56-1K-47-12Ω	90p
Pye 725 27-56Ω	63p
R.B.M. TV161 250-14-156Ω	70p
GEC 2010 8-15-17-70-63-188Ω	90p

2010 Covers 2013 2014 2017 & Sobell 1010 10A 13 & 1014
Bush TV165-166-171-175-176-178 70p
Murphy V1910-1913-1914-2014-2310-2311-2312 2314 70p
Bush A823 68-56Ω 90p

TV Condensers:	− 200 + 200 ± 100 mfd 300V	45p each
	150–100–100–100–150M 325V	£2.00
	150–150–100M 300V	£1.60
	175M 400V 100–100M 350V	£2.05
	400–400M 350V	£2.65

All	2500–2500m 30V	80p	2500–2500m 63V	£1.45
Can	4700m 25V	85p	1000m 63V	63p
Cond	2200m 40V	65p	PL802T Special	£3.50
	BDX32	£1.98	100–300–100–16m 300V	£1.70

Post Free, Cash with order, VAT paid.
Durham Supplies
367 Kensington Street, Bradford 8, West Yorkshire

C.T.V. Panels Ect lists S.A.E. No Callers. Sole, 37 Stanley St., Ormskirk, Lancs. L39 2DH.

COLOUR PANEL EXCHANGE SERVICE
BRC 3000 – 3500 8000 – 8500
Philips G8 and GEC 2110 series.

Free delivery in London area on Exchange Panels. Large stock of BRC 3500 series spares. New and S/H BRC Panels for sale. Immediate exchange on repairable panels.

Catalogue available on request.
KAY JAY TV SERVICE
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ANY 1–20p, 5–80p, 10–£1.25, 50–£5.50

ECC82, ECH84, EH90, PFL200, EF80, EF183, EF184, PCF80, PCF802, PCL82, PCL84, PCL85/805, PY81, PY800, PY88, PL36, PL504, 6F28, 30PL14.

COLOUR VALVES 60p EACH
PY500/A, PL508, PL509, PL519.
~~Postage & Packing 30p, no VAT~~

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9 Mandeville Terrace, Hawkshaw, Via Bury, Lancs.

LOOK!
THORN 3000/3500 TRIPLERS
High Quality Silicon Replacement Units
One Year Guarantee; Same Day Despatch
ONLY £3·95 inc. P.P. Add 59p V.A.T.
Quotes for larger quantities on request.
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RECONDITIONED Pye Hybrid Colour TV's, to the following spec: New regunned tube (2 year Gtee.) Solid state CDA panel, new boost caps, new tower valves, new thermistors, etc, trade price £149 including VAT. CASTLEGATE TV, 64 Castlegate, Grantham, Lincs. Tel: 0476 66869.

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Rebuilt with new electron gun, to British Standard. High temperature pumping.
Here is what you pay.

17-18-19 inch	**£29.00**
20 inch	**£30.00**
22 inch	**£32.00**
25 inch	**£34.00**
26 inch	**£38.00**

Guarantee 2 years.
Exchange basis.
Prices negotiable for contracts.
Old Colour tubes purchased.
Carriage £5·00.
TELESTAR TUBES
575c Moseley Road, Birmingham B12 9BS.
Tel: 021-440 5712.

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20 AX & P.I.L. TUBE

Colour Tubes	from **£25**
20 AX all sizes	from **£25**
Toshiba P.I.L. All Sizes	from **£25**
S/S COLOUR SETS	from **£60**
S/S & D/S MONO	from **£5**

RING: JEFFRIES 01-845 2036

S/S Colour **£30**, Mono Push Button **£3**. Plus VAT. Phone Southend 559895. Any time.

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12 months guarantee

Colour tubes supplied on a 'glass for glass' basis
Callers ring to arrange to bring your glass for on the spot exchange from our stocks
Lancashire/W. Yorks. deliveries by arrangement
Carriage costs per tube: Portables £1·[illegible]; Mono £3·[illegible]; Colour £4·[illegible]; incl. VAT

REBUILT MONO

A28-14W	11" (Pencil)	£14
A31-410W	12"	£14
A31-120W	12" (Pencil)	£14
A31-18W	12"	£14
A34-100W	14" (Pencil)	£14
A38-160W	15" (Pencil)	£14
A44-120WR	17"	£14
A59-23W	23"	£14
A50-120WR	20"	£11
A61-120WR	24"	£11

Glass is required for portable rebuilt mono please.

REBUILT COLOUR

17" 18" 19" 20"	£28
22"	£30
25" 26"	£34
26" 110°	£36

NEW MONO

A31/510 12" Replaces A31/120 A31/410	Mullard 2 year warranty	£17
A34/510 14" Replaces A34/100		£18·50
A50/120WR 20"		£12
A61/120WR 24"		£13·50

All tube prices subject to 15% VAT

NEW MULLARD COLOUREX TUBES
ALL SIZES IN STOCK
SEND S.A.E. FOR PRICE LIST
NEW VALVES
Valve prices include 15% VAT

Type	Price	Type	Price	Type	Price	Type	Price
30FL1/2	£1.28	EF184	63p	PCC85	62p	PL36	92p
DY802	89p	EH90	77p	PCC89	87p	PL81	52p
DY86/7	80p	EL34	£1.84	PCC189	87p	PL84	87p
ECC81	53p	EL84	52p	PCF80	83p	PL95	£1.02
ECC82/3	63p	EL509	£2.55	PCF86	87p	PL504	£1.38
ECC85	51p	EY86/87	52p	PCF200	£1.83	PL508	£1.60
ECC88	74p	EY500A	£1.53	PCF801	81p	PL509	£2.81
ECF80	87p	EZ80	51p	PCF802	83p	PL519	£3.07
ECF82	87p	EZ81	51p	PCF805	£1.89	PL802	£2.00
ECH81	58p	GY501	£1.43	PCF806	71p	PY81	70p
ECH84	£1.02	GZ34	£1.78	PCF808	£1.74	PY88	83p
ECL80	82p	KT66	£3.58	PCH200	£1.23	PY500A	£1.63
ECL82	82p	PC86	77p	PCL82	75p	PY800/1	70p
ECL86	77p	PC88	77p	PCL84	83p	UCH81	87p
ECF86	83p	PC92	85p	PCL805/85	87p	UCL82	77p
EF80	41p	PC97	77p	PCL86	87p	UCL83	£1.02
EF85	41p	PC900	77p	PD500	£3.37	UL84	£1.02
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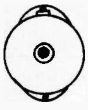

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(New) £3.50

G8 PHILLIPS £3.50

UHF Varicap replacement

NEW VHF/UHF on panel
ELC2060 £4.50

Phillips T/Units UHF
New £2.00

VHF/UHF AEG £2.50

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Removed from new panels

VHF Varicap Units
NSF AEG removed from
Print Panels £1.00
New 49.00 21.900MHz

VHF Varicap (NSF) AEG
New 49.00 21.900MHz £2.00

4 Push Button T/Units
UHF MULLARD £2.00

AE Isolating Sockets UHF
& Lead
PYE & THORN ITT 35p

DECCA 1730 Doubler £1.00

Transistor UHF Units with
AE Socket and leads
GEC 2000 Rotary type
NEW £2.00

7 button Varicap tuning heads
Variable Resistor with Fascia
Plate 7 Lamps £3.00

PYE 6 push button unit for
Varicap Tuning £2.50

4 push button unit (for
Varicap Tuning) 20K
New 50p

DECCA Bradford Tuner
5 Button New £2.75

BB 105 UHF
BB 103 VHF
BA 182
Varicap diodes 5p each

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3 amp Diodes 300V 10p
3 amp Diodes 100V 7p
1 amp Bridges 100V 20p
1 amp 400V 20p
3 amp Bridge 25p
W005M Bridge 15p

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Wire ends 25p

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BT 106 95p
BT 116 95p
BT 119 95p
BT 109 70p
BT 146 750V 25p

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2N6399A 30p

Thyristors 8A/400V
52600D 30p

Y827 Diodes 30p

Bridge Rec
B30C 600A6 12p
B30C 500 12p

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BC148B BF198
BC149C BF274
BC195 BSY79
BC108 BC327
BC107 BC213LA
BF594 BC212LT
BC158 BF195
2N2222 BC182L
2N390 BF594
2N4355 BC183
T1591 BC238A
2SK30A BC454
BC455
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TIS90 15p

SENDZ COMPONENTS

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