NOVEMBER 1978 Australia 85c; Malaysia $2.50; New Zealand 85c 50p

TELEVISION

SERVICING·VIDEO·CONSTRUCTION·DEVELOPMENTS

Eliminating Ghosts

Thorn 9000 Chassis Faults

Channel Display using LEDS

PHD COMPONENTS

RADIO & TV COMPONENT DISTRIBUTORS
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JEFFRIES RD ENFIELD MIDDX
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ALL COMPONENTS PRICED EACH (INCLUSIVE OF VAT AT 12½%)
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CAPACITORS

Description	
DECCA 400-400/350V	3.25
GEC 2000 200-200-150-50/350V	1.90
GEC 1000-2000/35	1.85
GEC/G8 600/300V	1.83
GEC/G8 600/250V	1.55
RRI 600/300V	1.83
PYE 631 200-300/350	2.69
PYE 169 1000-1000/40	0.85
RRI 823 2500-2500/30	1.03
RRI 300-300/300	2.47
ITT/KB 200-200-75-25	2.86
TCE 950 100-300-100-16/275	1.83
TCE 400 150-100-100-100-15	3.51
TCE 1500 150 x 150 x 100	1.99
TCE 3000/3500 175-100-100	2.16
TCE 3000/3500 1000/70V	0.65
TCE 3000/3500 220/100	0.47
TCE 8000/8500 2500/2500/63	1.41
TCE 8000/8500 700/800	0.93
TCE 8000/8500 400/350	0.93
300-300/350	2.82
100-200/275	1.41
100-200-60/275	1.41
200-200-400/350	3.05
200-200-100-32/350	1.41
125-300-100/350	1.41
300-200-100/300	1.41
2000-2000/40	0.70
300-300-100-32	1.41
300-300-100-50	1.41
220-100-47-22/340	1.41
200-100-100-150/350	1.41

DROPPERS

Dropper TCE 1400	1.06
Dropper TCE 1500	0.85
Dropper TCE 1600	0.89
Dropper TCE 3000/3500	0.54
Dropper TCE 8000	0.80
Dropper TCE 8500	0.85
Dropper Philips G8	0.49
Dropper Philips G8	0.25
Dropper Philips 210	0.63
Philips 210 (Link)	0.54
Dropper RRI 141	0.42
Dropper RRI 161	0.58
Dropper 27840	0.83
Dropper GEC 2000	0.71
Dropper PYE 11062	0.85
Dropper PYE	0.85

DIODES & RECTIFIERS

AA116 Diode	0.11
AA117 Diode	0.11
AA119 Diode	0.11
OA47 Diode	0.08
OA79 Diode	0.08
OA81 Diode	0.08
OA85 Diode	0.08
OA90 Diode	0.08
OA91 Diode	0.08
OA95 Diode	0.08
OA202 Diode	0.12
BA100 Diode	0.12
BA102 Diode	0.07
BA130 Diode	0.10
BA145 Diode	0.20
BA148 Diode	0.20
BA154 Diode	0.06
BA155 Diode	0.09
BA164 Diode	0.09
BAX13 Diode	0.11
BAX16 Diode	0.07
BAY38 Diode	0.11
BY206 Diode	0.20
SK3F/04 Diode	0.20
IN4148 Diode	0.05
IS44 Diode	0.05
BY126 Rectifier	0.10
BY127 Rectifier	0.12
BY133 Rectifier	0.15
BY164 Rectifier	0.50
BY179 Bridge Rectifier	0.96
BY182 Bridge Rectifier	1.27
BY238 Rectifier	0.14
BYX10 Rectifier	0.16
BY187 High Voltage Rectifier	0.30
IN4001 Rectifier	0.08
IN4002 Rectifier	0.08
IN4003 Rectifier	0.09
IN4004 Rectifier	0.09
IN4005 Rectifier	0.10
IN4006 Rectifier	0.10
IN4007 Rectifier	0.11
BY142 Rectifier	0.10
BR100	0.30
BR101	0.35
BRY39	0.35
BT116	1.70
BT119	2.00
BT120	2.00
TV106	1.40
2N4443	1.00
BT100A/02	1.50
OT112	3.50
BYX55/350	0.60
BYX55/600	0.60
BYX71/600	0.60
2N4444 Thyristor	1.27
BT109 Thyristor	1.27

TRANSISTORS

AC107 Transistor	0.20
AC126 Transistor	0.20
AC127 Transistor	0.20
AC127/01 Transistor	0.30
AC128 Transistor	0.20
AC128/01 Transistor	0.30
AC141 Transistor	0.20
AC141K Transistor	0.30
AC142 Transistor	0.27
AC142K Transistor	0.45
AC153 Transistor	0.45
AC176 Transistor	0.30
AC176/01 Transistor	0.45
AC186 Transistor	0.30
AC187 Transistor	0.30
AC187K Transistor	0.45
AC188 Transistor	0.30
AC188K Transistor	0.45
AC193K Transistor	0.45
AC194K Transistor	0.45
AD140 Transistor	1.50
AD142 Transistor	1.50
AD143 Transistor	1.50
AD145 Transistor	1.50
AD149 Transistor	1.00
AD161 Transistor	0.50
AD162 Transistor	0.50
AD262 Transistor	1.20
AF114 Transistor	0.45
AF115 Transistor	0.45
AF116 Transistor	0.45
AF117 Transistor	0.45
AF118 Transistor	0.45
AF121 Transistor	0.45
AF124 Transistor	0.45
AF125 Transistor	0.45
AF126 Transistor	0.45
AF127 Transistor	0.45
AF139 Transistor	0.45
AF239 Transistor	0.60
AL102 Transistor	2.70
AU107 Transistor	2.70
AU110 Transistor	2.70
AU113 Transistor	2.70
BC107 Transistor	0.15
BC108 Transistor	0.15
BC109 Transistor	0.15
BC113 Transistor	0.12
BC114 Transistor	0.12
BC115 Transistor	0.15
BC116 Transistor	0.15
BC117 Transistor	0.15
BC118 Transistor	0.12
BC119 Transistor	0.33
BC125 Transistor	0.15
BC126 Transistor	0.14
BC136 Transistor	0.14
BC137 Transistor	0.14
BC138 Transistor	0.28
BC139 Transistor	0.28
BC140 Transistor	0.28
BC142 Transistor	0.28
BC143 Transistor	0.28
BC147 Transistor	0.10
BC148 Transistor	0.10
BC149 Transistor	0.10
BC153 Transistor	0.10
BC154 Transistor	0.10
BC157 Transistor	0.10
BC158 Transistor	0.10
BC159 Transistor	0.28
BC161 Transistor	0.28
BC170 Transistor	0.10
BC171 Transistor	0.10
BC172 Transistor	0.10
BC177 Transistor	0.17
BC178 Transistor	0.17
BC179 Transistor	0.17
BC1821 Transistor	0.10
BC183 Transistor	0.10
BC183L Transistor	0.10
BC184L Transistor	0.10
BC184LC Transistor	0.12
BC186 Transistor	0.18
BC187 Transistor	0.18
BC203 Transistor	0.10
BC204 Transistor	0.10
BC205 Transistor	0.10
BC206 Transistor	0.10
BC207 Transistor	0.10
BC208 Transistor	0.10
BC209 Transistor	0.10
BC212L Transistor	0.10
BC213L Transistor	0.10
BC214L Transistor	0.10
BC225 Transistor	0.30
BC237 Transistor	0.10
BC238 Transistor	0.10
BC251A Transistor	0.10
BC301 Transistor	0.30
BC303 Transistor	0.30
BC307 Transistor	0.10
BC308 Transistor	0.10
BC327 Transistor	0.11
BC328 Transistor	0.11
BC337 Transistor	0.11
BC338 Transistor	0.11
BC547 Transistor	0.11
BD115 Transistor	0.35
BD116 Transistor	0.80
BD124P Transistor	1.80
BD131 Transistor	0.45
BD132 Transistor	0.45
BD133 Transistor	0.54
BD134 Transistor	0.54
BD135 Transistor	0.54
BD136 Transistor	0.54
BD137 Transistor	0.54
BD138 Transistor	0.54
BD139 Transistor	0.54
BD140 Transistor	0.54
BD144 Transistor	2.50
BD155 Transistor	0.60
BD157 Transistor	0.60
BD159 Transistor	0.60
BD163 Transistor	0.60
BD165 Transistor	0.60
BD175 Transistor	0.60
BD177 Transistor	0.60
BD183 Transistor	0.60
BD187 Transistor	0.60
BD210 Transistor	1.24
BD235 Transistor	0.54
BD236 Transistor	0.54
BD237 Transistor	0.54
BD238 Transistor	0.54
BD239 Transistor	0.54
BD380 Transistor	0.54
BD437 Transistor	0.54
BD439 Transistor	0.54
BD441 Transistor	0.54
BD535 Transistor	0.54
BD536 Transistor	0.54
BD537 Transistor	0.54
BD538 Transistor	0.54
BDX73 Transistor	0.60
BDY201 Transistor	2.10
BF115 Transistor	0.45
BF118 Transistor	0.45
BF121 Transistor	0.60
BF152 Transistor	0.30
BF154 Transistor	0.15
BF157 Transistor	0.50
BF158 Transistor	0.30
BF160 Transistor	2.16
BF163 Transistor	0.45
BF167 Transistor	0.45
BF173 Transistor	0.45
BF177 Transistor	0.45
BF178 Transistor	0.50
BF179 Transistor	0.50
BF180 Transistor	0.50
BF181 Transistor	0.50
BF182 Transistor	0.50
BF183 Transistor	0.50
BF184 Transistor	0.50
BF185 Transistor	0.50
BF194 Transistor	0.10
BF195 Transistor	0.10
BF196 Transistor	0.10
BF197 Transistor	0.10
BF198 Transistor	0.10
BF199 Transistor	0.10
BF200 Transistor	0.10
BF224 Transistor	0.10
BF240 Transistor	0.12
BF241 Transistor	0.12
BF256LC Transistor	0.36
BF257 Transistor	0.36
BF258 Transistor	0.37
BF271 Transistor	0.45
BF273 Transistor	0.15
BF274 Transistor	0.18
BF336 Transistor	0.37
BF337 Transistor	0.37
BF338 Transistor	0.39
BF355 Transistor	0.63
BF458 Transistor	0.75
BF459 Transistor	0.75
BFT43 Transistor	0.39
BFX29 Transistor	0.35
BFX84 Transistor	0.33
BFX85 Transistor	0.33
BFX88 Transistor	0.33
BFX89 Transistor	0.33
BFY50 Transistor	0.33
BFY51 Transistor	0.33
BFY52 Transistor	0.33
BFY90 Transistor	0.90
BDX32 Transistor	2.40
BU105 Transistor	1.50
BU105/01 Transistor	2.40
BU105/02 Transistor	2.40
BU105/04 Transistor	2.40
BU108 Transistor	2.40
BU204 Transistor	1.50
BU205 Transistor	1.50
BU206 Transistor	2.40
BU208 Transistor	2.40
BU208/02 Transistor	2.40
BU326S Transistor	1.98
BU406 Transistor	1.89
BU406D Transistor	2.66
BU407 Transistor	1.59
BU407D Transistor	2.10
2SC1172Y Transistor	2.40
R2008B Transistor	2.25
R2009 Transistor	2.25
R2010B Transistor	2.55
R2540 Transistor	3.00
ME0404 Transistor	0.15
ME0412 Transistor	0.15
ME4003 Transistor	0.10
ME6002 Transistor	0.15
ME8001 Transistor	0.12
MJE340 Transistor	0.75
MJE520 Transistor	0.60
MJE2955 Transistor	0.96
MJE3055 Transistor	0.87
MJ2955 Transistor	1.20
MJ3055 Transistor	1.20
MP8113 Transistor	0.75
MPSU05 Transistor	0.90
MPSU55 Transistor	0.90
TIP31A Transistor	0.48
TIP32A Transistor	0.48
TIP41A Transistor	0.75
TIP42A Transistor	0.75
TIP2995 Transistor	0.96
TIP3055 Transistor	0.96
TIS91M Transistor	0.21
2N2904 Transistor	0.33
2N2905A Transistor	0.36
2N2905 Transistor	0.36
2N3053 Transistor	0.36
2N3055 Transistor	0.88
2N3703 Transistor	0.12
2N3705 Transistor	0.12
2N3710 Transistor	0.12
2N5296 Transistor	0.57
2N5298 Transistor	0.57
2N5496 Transistor	0.63
2N6178 Transistor	0.90
2N6180 Transistor	0.90

INTEGRATED CIRCUITS

TAA550 Int Circuit	0.25
TAA570 Int Circuit	2.10
TAA611 B12 Int Circuit	2.00
TAA630S Int Circuit	2.50
TAA661B Int Circuit	1.60
TAA700 Int Circuit	3.50
TAD100 Int Circuit	1.75
TBA120AS Int Circuit	0.63
TBA231 Int Circuit	1.05
TBA325 Int Circuit	0.50
TBA480Q Int Circuit	1.94
TBA520Q Int Circuit	2.80
TBA530 Int Circuit	2.25
TBA530Q Int Circuit	2.40
TBA540 Int Circuit	2.60
TBA540Q Int Circuit	2.60
TBA550 Int Circuit	3.15
TBA550Q Int Circuit	3.15
TBA560C Int Circuit	3.15
TBA560CQ Int Circuit	3.48
TBA570 Int Circuit	1.62
TBA570Q Int Circuit	1.74
TBA641 BX1 Int Circuit	2.61
TBA641 B11 Int Circuit	3.18
TBA651 Int Circuit	1.75
TBA700Q Int Circuit	1.25
TBA720AQ Int Circuit	2.60
TBA730 Int Circuit	0.50
TBA750 Int Circuit	2.25
TBA750Q Int Circuit	2.40
TBA800 Int Circuit	1.30
TBA810S Int Circuit	1.50
TBA820 Int Circuit	1.05
TBA920 Int Circuit	3.66
TBA920Q Int Circuit	3.75
TBA990 Int Circuit	3.75
TBA990Q Int Circuit	3.66
TCA270Q Int Circuit	2.00
TCA900 Int Circuit	0.87
TCA940 Int Circuit	2.25
TDA1170 Int Circuit	2.60
TDA1200 Int Circuit	2.25
TDA1270 Int Circuit	2.60
TDA1412 Int Circuit	0.90
TDA2020 Int Circuit	3.80
MC1307P Int Circuit	1.60
MC1310P Int Circuit	1.80
MC1327P Int Circuit	2.10
MC1327PQ Int Circuit	2.10
MC1330P Int Circuit	1.35
MC1351P Int Circuit	1.74
MC1352P Int Circuit	1.30
MC1358PQ Int Circuit	1.40
SN76003N Int Circuit	3.10
SN76003ND Int Circuit	2.60
SN76013N Int Circuit	2.20
SN76013N07 Int Circuit	2.20
SN76013ND Int Circuit	2.00
SN76023N Int Circuit	2.20
SN76023ND Int Circuit	2.00
SN76033N Int Circuit	3.00
SN76110N Int Circuit	1.60
SN76131N Int Circuit	1.90
SN76226DN Int Circuit	1.30
SN76227N Int Circuit	1.00
SN76532N Int Circuit	1.50
SN76533N Int Circuit	1.50
SN76544N Int Circuit	1.70
SN76650N Int Circuit	1.50
SN76660N Int Circuit	0.80
SN76665N Int Circuit	1.25
SN76666N Int Circuit	0.60
SL901B Int Circuit	7.50
SL917B Int Circuit	9.90
TBA396Q Int Circuit	0.50
TDA440 Int Circuit	2.50
SN76001N Int Circuit	2.00

VALVES

DY86/87 Valve	1.00
DY802 Valve	1.20
EABC80 Valve	1.50
EB91 Valve	1.10
EBC81 Valve	0.60
EBF80 Valve	0.65
EC86 Valve	1.10
EC88 Valve	1.10
ECC40 Valve	1.20
ECC81 Valve	1.20
ECC82 Valve	1.02
ECC83 Valve	1.02
ECC84 Valve	1.35
ECC85 Valve	1.75
ECC88 Valve	0.75
ECC189 Valve	1.20
ECF80	1.50
ECF82 Valve	0.65
ECF86 Valve	1.10
ECH81 Valve	1.80
ECH83 Valve	0.75
ECH84 Valve	2.10
ECL80 Valve	1.50
ECL82 Valve	1.32
ECL83 Valve	1.10
ECL84 Valve	0.90
ECL86 Valve	1.60
EF80 Valve	1.20
EF83 Valve	1.70
EF83 Valve	1.70
EF85 Valve	1.20
EF86 Valve	2.20
EF89 Valve	2.45
EF91 Valve	0.60
EF95 Valve	0.65
EF183 Valve	1.10
EF184 Valve	1.10
EH90 Valve	1.90
EL34 Valve	3.25
EL36 Valve	0.90
EL41 Valve	1.20
EL81 Valve	0.90
EL84 Valve	1.35
EL86 Valve	0.75
EL95 Valve	1.50
EM84 Valve	1.20
EM87 Valve	1.50
EY51 Valve	0.65
EY86/87 Valve	1.20
EY88 Valve	0.75
EZ80 Valve	1.00
EZ81 Valve	1.00
GY501 Valve	2.40
GZ34 Valve	2.25
PC86 Valve	2.00
PC88 Valve	2.00
PC97 Valve	1.60
PCC84 Valve	1.25
PCC85 Valve	1.50
PCC89 Valve	2.00
PCC189 Valve	2.00
PCC806 Valve	2.50
PC900 Valve	1.70
PCC88 Valve	1.70
PCF80 Valve	1.50
PCF82 Valve	1.90
PCF86 Valve	2.00
PCF200 Valve	1.20
PCF201 Valve	1.25
PCF801 Valve	2.10
PCF802 Valve	1.30
PCF806 Valve	2.10
PCH200 Valve	2.10
PCL82 Valve	1.50
PCL83 Valve	1.80
PCL84 Valve	1.50
PCL85/805 Valve	1.50
PCL86 Valve	1.50
PD500/510 Valve	4.80
PFL200 Valve	2.50
PL36 Valve	1.70
PL81 Valve	1.70
PL81A Valve	1.70
PL82 Valve	0.75
PL83 Valve	1.50
PL84 Valve	1.50
PL95 Valve	1.05
PL504 Valve	1.80
PL508 Valve	2.40
PL509 Valve	4.10
PL519 Valve	5.40
PL802 Valve	4.95
PY33 Valve	1.00
PY82 Valve	0.60
PY83 Valve	0.75
PY88 Valve	1.75
PY500A Valve	2.40
R19 Valve	0.75
U25 Valve	0.75
U26/KY80 Valve	2.20
U49 Valve	0.75
U191 Valve	0.75
UBF89 Valve	0.75
UCC85 Valve	0.75
UCH81 Valve	0.75
UCL82 Valve	1.50
UCL83 Valve	0.75
UF41 Valve	0.75
UL84 Valve	1.80
UY85 Valve	1.50
6BW7 Valve	2.10
6F23 Valve	2.40
6/3012 Valve	2.40
30C15 Valve	2.40
30C17 Valve	2.40
30F5/6F23 Valve	2.40
30FL2/1 Valve	1.70
30FL12/PCE82 Valve	2.50
30L15/PCC805 Valve	2.50
30L17 Valve	2.50
30P12/PL801 Valve	2.50
30P19/PL36 Valve	1.70
30PL13 Valve	2.50
30PL15 Valve	2.50

EHT TRIPLERS

TCE950 Doubler	2.25
TCE950/1400 Tripler	3.50
TCE1400 (Pied system only)	4.00
TCE1500 Doubler	3.00
TCE500 Tripler	3.50
TCE1600 1/2 Wave	3.50
Decca CS1730/1830 Doubler	3.60
Decca CS1910/2213 Tripler	6.50
Decca 30 Series Tripler	6.50
Decca 80 Series Tripler	6.50
Decca 100 Series Tripler	6.50
GEC Hybrid 2028 Tripler	6.50
GEC2110 Tripler Pre Jan 77	7.00
GEC2110 Tripler Post Jan 77	6.50
ITT CVC5/8/9 Tripler	6.50
ITT VCV20/25/30 Tripler	6.50
Philips 520 Tripler	6.50
Philips 550 Tripler	6.50
Philips G9 Tripler	6.50
PYE 691/693/697 Tripler	6.00
PYE 731/725 Tripler	6.50
Philips 570 Doubler	6.50
PYE 713/CT2001 only/Doubler	6.50
RR1823 Tripler	7.00
RR1Z179/823 Tripler	6.00
TCE3000/3500 Tripler	6.50
TCE4000 Tripler	8.00
TCE8000 Tripler	3.00
TCE8500 Tripler	6.00
TCE9000 Tripler	6.50
TVK52 Continental Sets	6.00
Korting 90% Tripler	6.50
Autovox Tripler	6.50

MISCELLANEOUS PRODUCTS

Sets of Avo Leads	9.50
ELC1043/05 Tuners	6.50
4.443 MHz Crystals	1.30
Cut Out TCE3500	1.20
Cut Out Grundig	1.50
Cut Out GEC	1.50
Cut Out TCE 8500	2.50
TV18 Rectifier Stick	0.50
TV20 Rectifier Stick	1.30
VA1104 Thermistor	0.35
Aerial Isolator	0.65
Solder 18SWG 60/40 0.5KGM	5.00
Plug 13A	0.36
Super Servisol	0.75
Foam Cleanser	0.75
Silicone Grease	0.75
Plastic Seal	0.75
Aeroklene	0.75
Freezit	0.75
Antistatic	0.75

TELEVISION

November 1978

Vol. 29, No. 1
Issue 337

this month

OUR NEXT ISSUE DATED DECEMBER WILL BE PUBLISHED ON NOVEMBER 20

CORRESPONDENCE
All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", King's Reach Tower, Stamford Street, London SE1 9LS. Editorial correspondence should be addressed to "Television", IPC Magazines Ltd., King's Reach Tower, Stamford Street, London SE1 9LS.

BINDERS AND INDEXES
Binders (£2.85) and Indexes (45p) can be supplied by the Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. Prices include postage and VAT. In the case of overseas orders add 60p to cover despatch and postage.

BACK NUMBERS
Some back issues, mostly those published during the last two years, are available from the Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF at 70p inclusive of postage and packing to both home and overseas destinations.

QUERIES
We regret that we cannot answer technical queries over the telephone nor supply service sheets. We will endeavour to assist readers who have queries relating to articles published in *Television*, but we cannot offer advice on modifications to our published designs nor comment on alternative ways of using them. All correspondents expecting a reply should enclose a stamped addressed envelope.
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").

TELEVISION SALE

DISCOUNT FOR QUANTITY

MONO
Rotaries 19" & 23"

	£
GEC	3.00
Thorn 950 etc.	3.00
K.B.	3.00
Pye	3.00
Thorn 1400	4.50

D/S P/B 19" 23"

	£
Thorn 1400	7.00
Bush 161 etc.	7.00
Baird 660 etc.	7.00
Philips 210 etc.	7.00
Pye Olympic etc.	7.00

D/S P/B 20" 24"

	£
Bush	10.00
GEC	10.00
Philips	10.00
Pye	10.00
Thorn	10.00

S/S 20" 24"

	£
Bush 313 etc.	12.00
Pye 169 chassis	12.00
Thorn 1500	12.00
GEC series 1 & 2	12.00
Decca MS series	12.00

S/S COLOUR

	19"	20"	22"	25"	26"
	£	£	£	£	£
GEC	40	45	45	45	50
Philips	–	–	45	45	50
Thorn	65	–	65	65	85
Bush	60	–	65	65	75
Kort	–	–	65	–	75
Pye					
Varicap	–	–	60	–	70

MAINS DROPPERS

All Popular Makes now in stock e.g.

1500 @ 60p Philips 210 @ 40p
8000 @ 54p Bush 161 @ 40p
G8 @ 36p Pye 723 @ 47p
GEC 2110-41R @ 45p

PLEASE NOTE THERE IS 12½% V.A.T.

Please note all mono sets sold as 100% comp. No broken masks, no broken panels etc.
Colour sets sold with good c.r.t.s and 100% comp.
Working Mono £3.00 extra
Working Colour £15.00 extra
Supplied in 1's or 100's

WE DO NOT SELL RUBBISH AT BRIARWOOD TV LTD

EXPORT

COLOUR & MONO T.V.s AVAILABLE READY FOR USE ABROAD

BRIARWOOD TELEVISION LTD.

Briarwood House
Preston Street, Bradford, West Yorkshire BD7 1NS.
Tel: (0274) 306018.

All transistors, IC's, offered are new and branded. Manufactured by Mullard, I.T.T., Texas, Motorola etc.

Please add 12½% VAT to all items and overseas at cost.

P & P U.K. 25p per order, overseas allow for package and postage. Cash with all orders. All prices subject to alteration without notice.

TYPE	PRICE £
AC107	0.23
AC113	0.17
AC115	0.17
AC117	0.24
AC125	0.20
AC126	0.18
AC127	0.19
AC128	0.17
AC131	0.13
AC141	0.23
AC142	0.19
AC141K	0.29
AC142K	0.29
AC151	0.17
AC165	0.16
AC166	0.16
AC168	0.17
AC176	0.17
AC176K	0.28
AC178	0.16
AC186	0.26
AC187	0.21
AC188	0.20
AC187K	0.34
AC188K	0.34
AD130	0.50
AD140	0.65
AD142	0.73
AD143	0.70
AD145	0.70
AD149	0.64
AD161	0.41
AD162	0.48
AD161 / AD162	1.30
AF106	0.42
AF114	0.23
AF115	0.22
AF116	0.22
AF117	0.30
AF118	0.40
AF121	0.43
AF124	0.33
AF125	0.29
AF126	0.29
AF127	0.29
AF139	0.39
AF151	0.24
AF170	0.25
AF172	0.20
AF178	0.49
AF180	0.60
AF181	0.30
AF186	0.29
AF239	0.43
AU113	1.29
BA130	0.08
BA145	0.14
BA148	0.17
BA155	0.10
BAX13	0.05
BAX16	0.08
BC107	0.12
BC108	0.12
BC109	0.12
BC113	0.12
BC114	0.14
BC115	0.12
BC116	0.12
BC117	0.13
BC119	0.24
BC125	0.15
BC126	0.09
BC136	0.14
BC137	0.14
BC138	0.24
BC139	0.21
BC140	0.31
BC141	0.22
BC142	0.19
BC143	0.19
BC147	0.09
BC148	0.09
BC149	0.09
BC153	0.12
BC154	0.12
BC157	0.10
BC158	0.11
BC159	0.11
BC160	0.28
BC161	0.28
BC167	0.13
BC168	0.10
BC169C	0.12

TYPE	PRICE £
BC171	0.12
BC172	0.12
BC173	0.15
BC177	0.14
BC178	0.14
BC179	0.14
BC182L	0.08
BC183L	0.07
BC184L	0.11
BC186	0.18
BC187	0.18
BC209	0.14
BC212	0.13
BC213L	0.09
BC214L	0.14
BC237	0.07
BC240	0.31
BC281	0.24
BC262	0.20
BC263B	0.20
BC267	0.19
BC301	0.26
BC302	0.30
BC307	0.10
BC337	0.13
BC338	0.09
BC307A	0.12
BC308A	0.12
BC309	0.14
BC547	0.09
BC548	0.11
BC549	0.11
BC557	0.11
BD112	0.39
BD113	0.65
BD115	0.40
BD116	0.47
BD124	1.30
BD131	0.32
BD132	0.34
BD133	0.37
BD135	0.26
BD136	0.26
BD137	0.26
BD138	0.26
BD139	0.40
BD140	0.28
BD144	1.39
BD145	0.30
BD222/T1P31A	0.39
BD225/T1P31A	0.39
BD234	0.34
BD222	0.50
BDX22	0.73
BDX32	1.98
BDY18	0.75
BDY60	0.80
BF115	0.24
BF121	0.21
BF154	0.19
BF158	0.19
BF159	0.24
BF160	0.23
BF163	0.23
BF164	0.17
BF167	0.23
BF173	0.21
BF177	0.26
BF178	0.24
BF179	0.28
BF180	0.30
BF181	0.34
BF182	0.30
BF183	0.29
BF184	0.23
BF185	0.29
BF186	0.30
BF194	0.09
BF195	0.09
BF196	0.12
BF197	0.10
BF198	0.15
BF199	0.14
BF200	0.28
BF216	0.12
BF217	0.12
BF218	0.12
BF219	0.12
BF220	0.12
BF222	0.12
BF221	0.21
BF224	0.12
BF256	0.37
BF258	0.27
BF259	0.27

TYPE	PRICE £
BF260	0.24
BF262	0.28
BF263	0.25
BF271	0.20
BF273	0.12
BF336	0.35
BF337	0.24
BF338	0.29
BFT42	0.26
BFT43	0.24
BFX84	0.27
BFX85	0.27
BFX88	0.24
BFY37	0.22
BFY50	0.18
BFY51	0.17
BFY52	0.18
BFY53	0.27
BFY55	0.27
BHA0002	1.90
BR100	0.20
BSX20	0.23
BSX76	0.23
BSY84	0.36
BT106	1.18
BT108	1.23
BT109	1.09
BT116	1.23
BT120	2.08
BU105/02	1.87
BU105/04	2.25
BU126	1.40
BU205	1.97
BU208	2.49
BY126	0.09
BY127	0.10
OC22	1.10
OC23	1.30
OC24	1.30
OC25	1.00
OC26	1.00
OC28	1.00
OC35	1.00
OC36	0.90
OC38	0.90
OC42	0.45
OC44	0.20
OC45	0.20
OC46	0.35
OC70	0.22
OC71	0.28
OC72	0.35
OC74	0.35
OC75	0.35
OC76	0.35
OC77	0.50
OC78	0.13
OC81	0.20
OC810	0.14
OC82	0.20
OC820	0.13
OC83	0.22
OC84	0.28
OC85	0.13
OC123	0.20
OC169	0.20
OC170	0.22
OC171	0.27
OA91	0.05
BRC4443	0.65
R2008B	1.50
R2010B	1.50
R2305	0.38
R2305/BD222	0.37
SCR957	0.81
TIP31A	0.38
TIP32A	0.36
TIP3055	0.53
T1590	0.19
T1591	0.19
TV106	1.09

DIODES

TYPE	PRICE £
1N4001	0.04
1N4002	0.04
1N4003	0.06
1N4004	0.07
1N4005	0.07
1N4006	0.08
1N4007	0.08
1N4148	0.30
1N4751A	0.11
1N5401	0.10
1N5404	0.12
1N5406	0.13
1N5408	0.16

VALVES

TYPE	PRICE £
DY87	0.52
DY802	0.64
ECC82	0.52
EF80	0.40
EF183	0.60
EF184	0.60
EH90	0.60
PC86	0.76
PC88	0.76
PCC89	0.65
PC189	0.65
PCF80	0.70
PCF86	0.68
PCF801	0.70
PCF802	0.74
PCL82	0.67
PCL84	0.75
PCL86	0.78
PCL805	0.75
PCF200	1.00
PL36	0.90
PL84	0.74
PL504	1.10
PL509	2.45
PY88	0.63
PY500A	1.60
PY81/800	0.57

E.H.T. TRAYS MONO

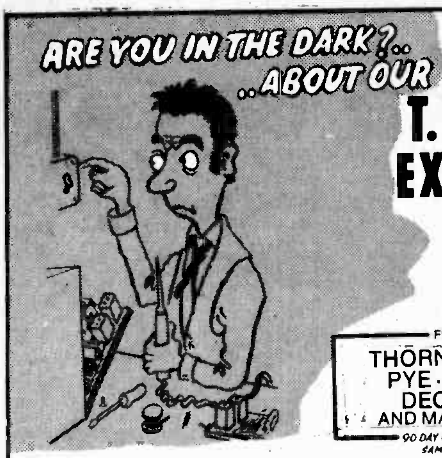
TYPE	PRICE £
950 MK2 1400	2.26
1500 18" 19" stick	2.37
1500 24" 5 stick	2.48
Single stick Thorn TV 11.16K 70V	0.75
TV 20 2 MT	0.75
TV20 16K 18V	0.75

IC's

TYPE	PRICE £
SN76013N	1.20
SN76013ND	1.00
SN76023N	1.20
SN76023ND	1.00
SN76226DN	1.50
SN76227N	1.20
TBA341	0.97
TBA520Q	1.45
TBA530Q	1.20
TBA540Q	1.45
TBA550Q	1.60
TBA560CQ	1.80
TBA570Q	1.00
TBA800	1.00
TBA810	1.50
TBA920Q	1.80
TBA990Q	1.60
TCA270SQ	1.45
TCA270SA	1.45
TCA1327B	1.00

E.H.T. TRAYS COLOUR

TYPE	PRICE £
Pye 691 693	4.50
Decca (large screen) CS2030/2232/2630/2632/2230/2233/2631	5.67
Philips G8 520/40/50	5.66
Philips G9	5.79
GEC C2110	5.50
GEC Hybrid CTV	5.40
Thorn 3000/3500	5.50
Thorn 800	2.42
Thorn 8500	5.23
Thorn 9000	6.10
GEC TVM 25	2.50
ITT/KB CVC 5/7/8/9	5.50
RRI (RBM) A823	5.89
Bang & Olufsen 4/5000 Grundig 5010/5011/5012/6011/6012/7200/2052/2210/2252R Tandberg (radionette) Autovox	6.60
Grundig 3000/3010 Saba 2705/3715 Telefunken 709/710/717/2000	6.80
Korting	6.80



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OB2	0.40	6E5	1.00	30F5	0.70	ECC88	0.72	EZ80	0.42	PY33/2	0.50
1B3GT	0.55	6EW6	0.85	30FL2	2.25	ECC189	1.00	EZ81	0.45	PY81	0.60
5CG8	0.75	6F1	0.80	30L15	0.75	ECC807	2.80	GY501	1.40	PY82	0.40
5R4GY	1.00	6F6G	0.70	30L17	0.70	ECF80	0.65	GZ32	1.00	PY88	1.12
5U4G	1.00	6F18	0.60	30P12	0.74	ECF82	0.50	GZ33	4.00	PY500A	2.05
5V4G	1.00	6F23	1.00	30P19	0.90	ECF86	0.80	GZ34	2.25	PY800	0.60
5Y3GT	0.65	6F28	0.85	30PL1	2.20	ECH35	2.00	HN309	1.70	PY801	0.60
5Z3	1.40	6GH8A	0.80	30PL13	1.30	ECH42	1.00	KT66	3.50	PZ30	0.50
5Z4G	0.75	6GK5	0.75	30PL14	1.50	ECH81	0.55	KT88	6.75	QQV03/10	2.00
6/30L2	0.90	6GK6	2.00	50CD6G	4.00	ECH84	0.75	P61	0.60	QV06/20	4.70
6AC7	0.70	6GU7	0.90	85A2	1.40	ECL80	0.55	PC86	0.80	R10	5.00
6AG7	0.70	6H6GT	0.50	807	1.10	ECL82	0.60	PC88	0.80	R19	0.75
6AH6	0.70	6J5GT	0.65	5763	3.65	ECL83	1.50	PC92	0.65	UABC80	0.45
6AK5	0.45	6J6	0.35	AZ31	1.00	ECL86	0.64	PC97	0.75	UAF42	0.70
6AM8A	0.70	6JU8A	0.90	AZ41	0.50	EF22	1.00	PC900	0.65	UBC41	0.70
6AN8	0.78	6K7G	0.50	DY51	2.00	EF40	2.00	PCC84	0.39	UBC81	0.55
6AQ5	0.75	6K8G	0.50	DY86/7	0.52	EF41	1.00	PCC85	0.47	UBF80	0.50
6AR5	1.05	6L7(M)	1.50	DY802	0.50	EF80	0.40	PCC89	0.49	UBF89	0.39
6AT6	0.60	6Q7G	0.75	E80CF	6.00	EF83	1.70	PCC189	0.60	UC92	0.50
6AU6	0.62	6SA7	0.70	E88CC	1.20	EF85	0.45	PCF80	0.80	UCC85	0.50
6AV6	0.65	6SG7	0.70	E80F	5.50	EF86	0.52	PCF82	0.45	UCF80	0.80
6AW8A	1.15	6SJ7	0.70	E188CC	5.00	EF89	0.55	PCF86	0.57	UCH42	1.00
6AX4	0.75	6U4GT	1.00	E280F	12.50	EF91	0.70	PCF200	1.55	UCH81	0.60
6BA6	0.65	6V6G	0.50	EA50	0.40	EF92	0.70	PCF201	1.45	UCL82	0.75
6BC8	0.90	6X4	0.95	EABC80	0.48	EF183	0.50	PCF801	0.49	UCL83	1.00
6BE6	0.70	6X5GT	0.50	EAF42	1.00	EF184	0.50	PCF802	0.80	UF41	1.00
6BH6	1.10	9D7	0.70	EAF801	1.50	EH90	0.75	PCF805	2.25	UF42	1.00
6BJ6	0.75	10C2	0.70	EB91	0.25	EL34	2.50	PCF806	0.70	UF80	0.40
6BK7A	0.85	10DE7	0.80	EBC41	1.00	EL41	1.00	PCH200	1.20	UF85	0.50
6BN8	1.50	10F1	1.00	EBC81	1.00	EL81	1.00	PCL82	0.62	UF89	0.52
6BQ7A	1.40	10F18	0.65	EBF80	1.00	EL84	0.48	PCL83	1.20	UL41	0.90
6BR7	1.00	10P13	0.80	EBF89	0.40	EL95	0.95	PCL84	0.65	UL84	0.90
6BR8	1.25	10P14	2.50	EC86	0.84	EL360	2.50	PCL86	0.85	UM80	1.00
6BW6	3.75	12AT6	0.45	EC88	0.84	EL506	2.00	PCL805	0.85	UY41	0.70
6BW7	0.65	12AU6	0.50	EC92	1.00	EL509	2.50	PFL200	1.35	UY85	0.70
6BZ6	1.50	12AV6	0.60	EC97	0.75	EM80	1.00	PL33	1.00	U19	4.00
6C4	0.50	12BA6	0.50	ECC33	2.00	EM81	1.00	PL36	0.80	U25	1.00
6C9	2.00	12BE6	0.85	ECC35	2.00	EM84	1.00	PL81	0.49	U26	0.90
6CB6A	0.65	12BH7	0.68	ECC40	1.00	EM87	1.45	PL81A	0.75	U191	0.50
6CD6G	4.00	13D8	2.00	ECC81	0.52	EY51	0.80	PL82	0.50	U301	1.00
6CG8A	0.90	19AQ5	0.65	ECC82	0.62	EY81	1.50	PL83	0.50	U404	0.75
6CL6	0.75	19G6	6.50	ECC83	0.62	EY83	1.50	PL84	0.50	U801	1.00
6CL8A	0.95	19H1	4.00	ECC84	0.50	EY87/6	0.45	PL95	1.00	X41	1.00
6CM7	1.00	20P1	1.00	ECC85	0.50	EY88	1.00	PL504	1.05		
6CU5	0.90	20P4	0.84			EY500	1.45	PL508	1.85		
6DE7	0.90	30C15	1.00			EZ40	1.00	PL509	3.10		

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AC107	0.48	AU103	2.40	BC192	0.56	BC377	0.29	BD234	0.68	BF222	†0.51	BPX29	1.62	MPSU05	0.66	ZTX500	†0.18	2N3819	†0.47
AC117	0.38	AU107	2.75	BC204*	†0.39	BC394	0.39	BD235	0.63	BF224 & J	†0.22	BR101	0.53	MPSU06	0.76	ZTX502	†0.22	2N3820	0.72
AC126	0.36	AU110	2.40	BC205*	†0.39	BC440	0.52	BD236	0.63	BF240	†0.32	BR103	0.64	MPSU55	1.26	ZTX504	†0.28	2N3866	1.08
AC127	0.54	AU113	2.60	BC206*	†0.37	BC441	0.59	BD237	0.88	BF241	†0.31	BR303	1.06	MPSU56	1.32	2N404	1.30	2N3904	†0.20
AC128	0.46	BC107*	0.16	BC207*	†0.39	BC461	0.78	BD238	0.88	BF244*	†0.51	BRC4443	1.76	MPSU60	0.82	2N696	0.46	2N3905	†0.20
AC128K	0.55	BC108*	0.15	BC208*	†0.37	BC477	0.30	BD253	1.58	BF245*	†0.43	BRY39	0.60	MPU131	†0.59	2N697	0.46	2N3906	†0.20
AC141	0.65	BC109*	0.16	BC209*	†0.39	BC478	0.25	BD410	1.65	BF254	†0.48	BRY56	†0.44	OC26	1.90	2N706A	0.33	2N4036	0.94
AC141K	0.70	BC113	†0.22	BC211*	†0.36	BC479	0.33	BD433	0.65	BF255	†0.58	BSS27	0.92	OC28	1.49	2N708	0.29	2N4123	†0.17
AC142	0.60	BC114	†0.22	BC212*	†0.17	BC547*	†0.13	BD435	0.70	BF256L*	†0.49	BT106	1.50	OC29	1.60	2N914	0.32	2N4124	†0.17
AC142K	0.65	BC115	†0.24	BC212L*	†0.17	BC548*	†0.13	BD436	0.71	BF257	†0.44	BT109	1.99	OC35	1.25	2N916	0.46	2N4126	†0.17
AC151	0.31	BC116*	†0.25	BC213*	†0.17	BC549*	†0.15	BD437	0.74	BF258	0.52	BT116	1.45	OC36	1.25	2N918	0.54	2N4236	2.20
AC152	0.36	BC117	†0.30	BC213L*	†0.16	BC550	†0.24	BD438	0.75	BF259	†0.54	BT119	5.18	OC42	0.90	2N930	0.29	2N4289	†0.32
AC153	0.42	BC118	†0.24	BC214*	†0.18	BC556	†0.23	BD519	0.68	BF262	0.73	BU102	2.85	OC44	0.88	2N1164	8.29	2N4292	†0.32
AC153K	0.52	BC119	†0.34	BC214L*	†0.18	BC557*	†0.16	BD520	0.68	BF263	0.88	BU105	†1.80	OC45	0.63	2N1304	1.40	2N4416	0.85
AC154	0.41	BC125*	†0.30	BC225	†0.42	BC558*	†0.16	BD599	0.87	BF270	0.47	BU105/02	†1.95	OC70	0.65	2N1305	1.29	2N4444	1.90
AC176	0.45	BC126	†0.30	BC237*	†0.16	BC559*	0.17	BD600	1.23	BF271	0.42	BU108	†2.98	OC71	0.73	2N1306	1.49	2N4921	0.80
AC178	0.51	BC132	†0.20	BC238*	†0.15	BCY10	0.30	BD663BR	0.86	BF272A	0.80	BU126	†2.91	OC72	0.73	2N1307	1.32	2N5042	1.65
AC179	0.55	BC134	†0.22	BC239*	†0.22	BCY30A	1.06	BDX18	1.55	BF273	†0.33	BU204	†2.50	OC81	0.83	2N1308	1.53	2N5060	†0.28
AC187	0.56	BC135	†0.21	BC251*	†0.25	BCY32A	1.19	BDX32	2.95	BF274	†0.34	BU205	†2.78	OC81D	0.95	2N1711	0.47	2N5061	†0.30
AC187K	0.65	BC136	†0.22	BC252*	†0.26	BCY34A	1.02	BDY16A	0.63	BF336	0.63	BU206	†3.09	OC139	1.30	2N1893	0.52	2N5064	0.63
AC188	0.52	BC137	†0.30	BC253*	†0.38	BCY72	0.27	BDY18	1.55	BF337	0.65	BU208	†4.88	OC140	1.35	2N2102	0.71	2N5086	†0.49
AC188K	0.61	BC138	†0.35	BC261A*	†0.28	BD115	1.35	BDY20	2.29	BF338	0.68	BU407	†1.38	OC170	0.80	2N2217	0.55	2N5087	†0.50
AC193K	0.70	BC140	0.36	BC262A*	†0.28	BD123	1.50	BDY38	1.38	BF355	†0.72	BUY77	2.50	OC171	0.82	2N2218	0.38	2N5208	†0.59
AC194K	0.74	BC141	0.44	BC263*	†0.26	BD124	1.85	BF115	0.48	BF362	†0.49	C106D	0.60	OC200	3.90	2N2219	0.42	2N5294	0.66
ACY17	1.20	BC142	0.35	BC267*	0.20	BD130Y	1.56	BF117	0.45	BF363	†0.49	C106F	0.43	OC201	3.95	2N2221A	0.26	2N5296	0.68
ACY19	0.95	BC143	0.38	BC268*	0.20	BD131	0.58	BF120	0.55	BF367	†0.29	C111E	†0.46	OC202	2.40	2N2222A	0.41	2N5298	0.71
ACY28	0.98	BC147*	†0.12	BC286	0.40	BD132	0.68	BF121	0.65	BF451	0.43	D40N1	0.64	OC205	3.95	2N2369A	0.40	2N5322	1.16
ACY39	2.02	BC148*	†0.12	BC287	0.49	BD133	0.70	BF123	0.48	BF457	0.46	E1222	0.47	OCP71	1.98	2N2401	0.80	2N5449	†0.18
AD140	1.79	BC149*	†0.13	BC291	0.27	BD135	†0.37	BF125	0.68	BF458	0.49	E5024	†0.19	ON236A	0.94	2N2484	0.35	2N5457	†0.46
AD142	1.90	BC152	†0.42	BC294	†0.37	BD136	†0.38	BF127	0.51	BF459	0.52	GET872	0.46	R2008B	†2.92	2N2570	0.74	2N5458	†0.40
AD143	1.78	BC153	†0.38	BC297	0.36	BD137	†0.40	BF137F	0.78	BF594	†0.16	MC140	†0.36	R2010B	†2.79	2N2646	0.82	2N5459	†0.58
AD149	1.92	BC154	†0.41	BC300	0.62	BD138	0.42	BF152	†0.19	BF596	†0.17	ME0402	†0.18	R2322	†0.75	2N2784	1.15	2N5494	0.95
AD161	0.66	BC157*	†0.13	BC301	0.38	BD139	0.46	BF158	†0.25	BF597	†0.27	MF0404/02	†0.18	R2323	†0.85	2N2869	2.08	2N5496	1.05
AD161/162	1.22	BC158*	†0.12	BC302	0.86	BD140	0.50	BF159	†0.27	BFR39	†0.30	ME6001	†0.18	ST2110	0.49	2N2894	0.45	2N6027	0.55
AD162	0.71	BC159*	†0.14	BC303	0.64	BD144	2.24	BF160	†0.20	BFR40	†0.29	ME6002	†0.18	ST6120	0.48	2N2904*	0.40	2N6107	0.71
AF114	0.35	BC160	0.52	BC304	0.44	BD145	0.75	BF161	0.84	BFR41	†0.30	MJ2955	1.30	TIC44	†0.25	2N2905*	0.39	2N6122	0.60
AF115	0.35	BC161	†0.58	BC307*	†0.17	BD150A*	†0.51	BF163	†0.65	BFR50	†0.29	MJ3000	1.58	TIC46	†0.35	2N2906*	0.36	2N6178	1.07
AF116	0.41	BC167B	†0.15	BC308*	†0.14	BD155	†0.90	BF164	†0.95	BFR52	†0.33	MJE340	0.68	TIC47	†0.45	2N2926G	†0.15	2N6180	1.39
AF117	0.42	BC168B	†0.14	BC309*	†0.18	BD157	0.51	BF166	0.50	BFR61	†0.29	MJE341	0.72	TIP29A	0.47	2N2926O	†0.14	2N6211	2.74
AF118	0.98	BC169C	†0.15	BC317*	†0.15	BD158	0.75	BF167	0.38	BFR62	†0.28	MJE370	0.74	TIP30A	0.50	2N2926Y	†0.14	2SB3378P	4.28
AF121	0.68	BC170*	†0.15	BC318*	†0.15	BD159	0.68	BF173	0.35	BFR79	†0.30	MJE371	0.79	TIP31A	0.51	2N2955	1.12	2SC458C	0.78
AF124	0.38	BC171*	†0.15	BC319*	†0.19	BD160	2.69	BF177	0.36	BFR80	†0.29	MJE520	0.85	TIP31C	0.67	2N3053	0.48	2SC643A	2.25
AF125	0.38	BC172*	†0.14	BC320	†0.17	BD163	0.67	BF178	0.46	BFR81	†0.30	MJE521	0.95	TIP32A	0.56	2N3054	0.86	2SC930D	1.50
AF126	0.36	BC173*	†0.22	BC321A&B	†0.18	BD165	0.66	BF179	0.58	BFR88	†0.42	MJE2955	1.20	TIP32C	0.72	2N3055	0.72	2SC1061	1.45
AF127	0.86	BC174A & B		BC322	†0.28	BD166	0.88	BF180	0.53	BFT41	0.48	MJE3000	1.95	TIP33A	0.77	2N3250	0.52	2SC1172Y	3.55
AF139	0.58		†0.26	BC323	1.15	BD175	0.90	BF181	0.53	BFT43	0.55	MJE3055	1.22	TIP34A	0.84	2N3254	0.58	2SD234	1.48
AF147	0.52	BC176	0.22	BC327	†0.16	BD177	0.58	BF182	0.44	BFW11	1.02	MPF102	†0.40	TIP41A	0.72	2N3391A	0.38	3N128	1.60
AF149	0.45	BC177*	0.20	BC328	†0.18	BD178	0.92	BF183	0.52	BFW30	2.58	MPS3702	†0.33	TIP42A	0.80	2N3633	12.70	40250	0.58
AF178	1.35	BC178*	0.22	BC337	†0.17	BD181	1.94	BF184	0.44	BFW59	†0.19	MPS3705	†0.30	TIP2955	0.77	2N3703	†0.17	40251	1.14
AF179	1.36	BC179*	0.28	BC338	†0.17	BD182	2.10	BF185	0.42	BFW60	†0.20	MPS6521	†0.36	TIP3055	0.58	2N3704	†0.19	40327	0.67
AF180	1.35	BC182*	†0.15	BC340	0.19	BD183	1.34	BF186	0.42	BFW90	†0.65	MPS6523	†0.36	TIS43	†0.44	2N3705	†0.17	40361	0.48
AF181	1.33	BC182L*	†0.15	BC347*	†0.17	BD184	2.30	BF194*	†0.14	BFX29	0.38	MPS6566	†0.44	TIS73	†1.36	2N3706	†0.16	40362	0.50
AF186	1.48	BC183*	†0.14	BC348A & B		BD187	1.20	BF195*	†0.13	BFX84	0.42	MPSA05	†0.30	TIS90	†0.23	2N3707	†0.18	40410	0.94
AF202	0.27	BC183L*	†0.14		†0.17	BD188	1.25	BF196	†0.14	BFY50	0.38	MPSA06	†0.32	TIS91	†0.28	2N3708	†0.17	40429	0.88
AF239	0.73	BC184*	†0.15	BC349B	†0.17	BD189	0.71	BF197	†0.15	BFY51	0.37	MPSA55	†0.43	ZTX108	†0.14	2N3715	1.70	40530	0.79
AF240	1.40	BC184L*	†0.15	BC350*	†0.24	BD222	0.91	BF198	†0.29	BFY52	0.36	MPSA56	†0.45	ZTX109	†0.16	2N3771	2.39	40595	1.39
AF279S	0.91	BC185	0.36	BC351*	†0.22	BD225	0.91	BF199	†0.29	BFY53	0.36	MPSA93	†0.56	ZTX213	†0.23	2N3772	2.58	40603	1.13
AL100	1.30	BC186	0.25	BC352A*	†0.24	BD232	0.91	BF200	†0.25	BFY90	1.98	MPSL01	†0.33	ZTX300	†0.16	2N3773	3.90	40636	1.25
AL103	1.58	BC187	0.27	BC360	0.59	BD233	0.62	BF218	†0.42	BPX25	1.62	MPSU01	0.61	ZTX304	†0.26	2N3794	†0.40	40654	0.83

Alternative gain versions available on items marked*.

For matched pairs add 20p per pair.

LINEAR IC's

Type	Price (£)
BRC1330	†0.93
CA810QM	2.44
CA3005	1.85
CA3012	1.45
CA3014	2.23
CA3018	0.71
CA3020	1.89
CA3028A	0.80
CA3028B	1.09
CA3045	3.75
CA3046	0.70
CA3065	1.74
CA3068	1.90
CA3130S	1.57
FCH161	†2.40
FCJ101	†3.32
LM309K	1.98
LM380N-14	1.65
LM1303N	3.08
MC1307P	†1.82
MC1310P*	†1.94
MC1312P	2.34
MC1327P*	†1.86
MC1330P	†0.93
MC1350P	†1.22
MC1351P	†1.42
MC1352P	†1.42
MC1357P	†2.92
MC1358P*	†2.30
MC1458G	1.43
MC1496L	1.15
MC3051P	0.58
MFC4008	0.85
MFC4060A	0.98
MFC6040	1.11
MIC1P	2.58
ML231	†3.57
ML232	†3.57
NE555	0.72
NE556	1.34
NE566	1.95
SAA1024	†5.70
SAA1025	†10.35
SAS560A	†2.01
SAS570	†2.01
SC9503P	†1.40
SC9504P	†1.38
SL414A	1.91
SL432A	2.52
SL450	5.10
SL901B	†4.20
SL917B	†5.60
SL918A	†5.95
SN72440N	†2.21
SN76001N	†1.67
SN76003N	2.22

Type	Price (£)
SN76008KE	1.56
SN76013N	1.56
SN76013ND	1.40
SN7601BKE	1.56
SN76023N	1.56
SN76023ND	1.40
SN76033N	2.22
SN76110N	1.20
SN76115N	†1.62
SN76116N	1.78
SN76131N	†2.10
SN76226N	†2.60
SN70227N	†1.61
SN76228N	†1.80
SN76502N	†1.92
SN76530P	†0.97
SN76533N	†1.38
SN76544N	†1.85
SN76546N	†1.85
SN76570N	†1.81
SN76620AN	†0.99
SN76650N	†1.48
SN76660N	†0.64
SN76666N	†0.96
TA7073P	†3.51
TAA263	†2.20
TAA300	†3.85
TAA320	1.10
TAA350A	†2.48
TAA370A	3.18
TAA435	†1.70
TAA450	†3.39
TAA521	1.10
TAA522	2.09
TAA550	0.45
TAA560	1.93
TAA570	†2.30
TAA611A	1.67
TAA611B	1.89
TAA621AXI	2.33
TAA630Q	3.91
TAA630S	4.18
TAA661A	2.39
TAA661B	1.75
TAA700*	†2.80
TAA840	†3.38
TAA861A	0.95
TAA930A	1.43
TAA930B	1.43
TAA960	†2.25
TAA970	†2.48
TAD100	†2.66
(Filter)	0.98
TBA120A	†0.90
TBA120S*	†0.99
TBA120SA	†1.02
TBA231	1.12

Type	Price (£)
TBA240A	†3.98
TBA281	†2.07
TBA395*	†2.58
TBA396	†2.40
TBA400	†2.20
TBA480Q	†1.84
TBA500*	†2.21
TBA510*	†2.21
TBA520P*	†3.40
TBA530P	†2.24
TBA540*	†2.88
TBA550*	†3.13
TBA560C*	†3.18
TBA570*	†1.29
TBA611B	2.68
TBA641	2.55
TBA641A12	2.35
TBA641B11	2.61
TBA651	†2.12
TBA673	†2.19
TBA700*	†2.50
TBA720AQ	†2.38
TBA720Q	†2.38
TBA750*	†2.18
TBA800	1.65
TBA810AS	1.69
TBA920*	†3.80
TBA940	†3.52
TBA950	†2.78
TBA990*	†2.90
TCA270A*	†3.55
TCA280A	1.43
TCA290A	3.46
TCA420A	1.98
TCA440	1.67
TCA640	2.76
TCA650	2.76
TCA660	2.76
TCA730	3.54
TCA740	3.04
TCA750	2.53
TCA760	1.52
TCA820	3.29
TDA440	†4.16
TDA1003	1.52
TDA1004	2.73
TDA1005	3.04
TDA1022	6.89
TDA1024	0.97
TDA1034	1.98
TDA2610	2.86
TDA2640	2.86
ZN414	1.45

* Indicates Q version is also available.

DIODES

Type	Price (£)	Type	Price (£)
AA113	0.17	BY114	0.60
AA119	0.21	BY118	1.10
AA129	0.28	BY126	0.20
AA143	0.18	BY127	0.21
AAY30	0.28	BY133	0.35
AAZ13	0.42	BY140	1.40
AAZ15	0.35	BY164	0.75
AAZ17	0.28	BY176	2.80
AY102	3.85	BY179	0.83
BA100	0.24	BY182	1.14
BA102	0.36	BY184	0.44
BA104	0.19	BY189	5.30
BA110	0.80	BY190	4.90
BA111	0.70	BY206	0.26
BA115	0.17	BY238	0.25
BA116	0.56	BYX10	0.30
BA121	0.85	BYX38/600	0.70
BA129	0.45	BYX70/500	0.53
BA145	0.19	ITT44	0.08
BA148	0.19	ITT210	0.63
BA154	0.06	ITT827	0.80
BA155	0.17	MCR101	0.43
BA156	0.12	MR854	1.10
BA157	0.25	OA5	0.88
BA158	0.28	OA10	0.58
BA159	0.40	OA47	0.20
BA164	0.14	OA81	0.19
BA170	0.18	OA90	0.13
BA182	0.27	OA91	0.15
BA201	0.13	OA95	0.20
BA202	0.14	OA200	0.13
BA203	0.14	OA202	0.13
BA216	0.08	OA210	0.89
BA219	0.11	TIL209	0.14
BA243	0.45	TIL211	0.18
BA317	0.06	TV20	2.25
BA318	0.07	IN914	0.06
BAV10	0.10	IN916	0.06
BAV21	0.18	IN4001	0.06
BAW62	0.06	IN4002	0.07
BAX13	0.07	IN4003	0.08
BAX16	0.10	IN4004	0.08
BAX17	0.19	IN4005	0.09
BAY72	0.16	IN4006	0.10
BB104B	0.52	IN4007	0.12
BB105B	0.33	IN5400	0.15
BB105G	0.30	IN5401	0.17
BR100	0.40	IN5402	0.20
BY100	0.35	IS920	0.09
BY103	0.35	IS921	0.11

ZENER DIODES

400mW plastic	3.0-33V	14p each
1/1.3W plastic	3.3-180V	18p each
1.5W flange	4.7-75V	£1.26 each
2.5W plastic	7.5-75V	67p each
20W stud	7.5-75V	£1.31 each
75W stud	7.5-75V	£7.95 each

VDR's, etc. (†)

Type	Price (£)
E295ZZ	
/01	0.28
/02	0.28
E298CD	
/A258	0.25
E298ED	
/A258	0.22
/A260	0.22
/A262	0.22
/A265	0.22
/P268	0.22
E298ZZ	
/05	0.25
/06	0.22
E299DD/P116-P354	all 0.23
E299DH	
/P230	0.72
R53	1.75
VA1015	0.92
VA1026	0.79
VA1033/34/38/39/40/53	all 0.20
VA1055s/56s/66s/67s	all 0.23
VA1074	0.20
VA1077	0.31
VA1091	0.29
VA1096/97/98	all 0.20
VA1103	0.32
VA1104	0.46
VA1108/09/10/11/12	all 0.24
VA8650	1.20
2322 554 02221	0.59
2322 662 98003	0.88

VALVES (†)

Type	Price (£)
DY86/87	0.75
DY802	0.75
ECC81	0.78
ECC82	0.95
ECC83	0.78
ECH81	0.83
ECL80	0.82
EF80	0.60
EF183	0.75
EF184	0.75
EH90	0.94
EL34	3.08
EY51	1.20
EY86/87	0.67
PCC84	0.61
PCC85	0.79
PCC89	0.74
PCC189	0.94
PCF80	1.20
PCF86	0.87
PCF200	2.32
PCF801	0.74
PCF802	1.20
PCF805	3.37
PCF808	2.00
PCL82	0.93
PCL83	1.12
PCL84	0.65
PCL86	1.27
PCL805/85	1.00
PD500	3.75
PFL200	1.40
PL36	1.20
PL81	0.94
PL84	0.79
PL504	1.50
PL508	1.85
PL509	3.10
PL519	3.10
PL802	3.25
PY81/P810	0.60

BRIDGES

Rating		Price (£)	Rating		Price (£)
1½A	50V	0.27	2A	100V	0.36
	100V	0.28		200V	0.40
	200V	0.32		400V	0.47
	400V	0.40		600V	0.53
	600V	0.50		800V	0.60
	800V	0.58		1000V	0.87
3A	100V	0.52	6A	100V	0.66
	200V	0.55		200V	0.68
	400V	0.61		400V	0.74
	600V	0.67		600V	0.80
	800V	0.80		800V	0.86
	1000V	1.20		1000V	0.95

10A and 25A ranges also stocked.

RESISTORS

Carbon Film (5%) (†)

	10 of one		Mixes of a minimum of 10pcs of any value:		
	Ea	value	50pc	100pc	500pc
¼W 5.6Ω-330kΩ (E12)	3p	25p	95p	£1.48	£8.40
½W 10Ω-10MΩ (E24)	3p	25p	95p	£1.48	£8.40
1W 10Ω-10MΩ (E12)	5p	45p	£1.95	£3.40	£15.25
2W 10Ω-10MΩ (E6)	9p	80p	£3.80	£6.40	£28.90

Wirewound (5%)

2½W 0.22Ω-270Ω	18p
4W 1.0Ω-10kΩ	22p
7W 0.68Ω-22kΩ	24p
11W 1.0Ω-22kΩ	28p
17W 1.0Ω-22kΩ	33p
Vertical mounting pillars	3p

Presets (†)

0·1W (Vertical and Horizontal)
100, 220, 470Ω, 1, 2·2, 4·7, 10, 22, 47, 100, 220, 470kΩ, 1, 2·5, 5MΩ **all 14p each**

0·2W (Vertical and Horizontal)
Values as 0·1W **all 14p each**

FUSES (all packs of 10)

20mm Time Delay (BEAB)

40mA	£3.68
50, 63mA	£2.55
100mA	£1.86
160, 200, 250mA	£1.44
315, 500, 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 5A	all £1.19

20mm quick-blow (BEAB)

100mA	68p
200, 250, 315, 500, 630, 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 5A	all 56p

2A circuit breakers metal **£1.52** plastic **£1.48**

LABGEAR (Details of full range on request)
COLOURTEXT ADAPTOR 7026
Full facility Colourtext decoder to place between aerial and receiver. All you would expect of a quality ready-made unit. Leaflet on request. **†£340.20**

COLOUR BAR GENERATOR
CM6052/DB. VHF/UHF gives standard 8 band colour bars + variable tuning + front panel on/off switch + sync trigger output + blank raster + red raster + crosshatch + greyscale stepwedge + colour bar + centre cross + dot pattern + centre dot. **£182.25**

TELEVISION COLOUR RECEIVER MK II

SEMI CONDUCTOR PACK No. 1 (Power Supply)

All Parts as Published £6.45 (inclusive of 51p VAT and p & p)

CAPACITORS

Metallised Paper (†)

2n2F	1500V DC	60p	10nF	500V AC	80p
2n2F	600V AC	24p	15nF	300V AC	30p
3n6F	1700V DC	60p	22nF	300V AC	32p
4n7F	1500V DC	60p	100nF	1000V DC	20p
10nF	1000V DC	22p	470nF	1000V DC	60p

H.V. Disc Ceramic (†)

1kV	1.5nF	18p	8kV	250, 270, 300pF	39p
3kV	1.5nF	20p	10kV	1nF	67p
8kV	10, 22, 47, 82, 100, 120, 150, 180, 200, 220pF	30p	18kV	1nF	73p

CONVERGENCE POTENTIOMETERS
5, 7, 10, 15, 20, 50, 100, 200, 500Ω **†38p each**
Spindles for above **5p each**

VHF to UHF CONVERTER CM6022/RA. "Televerta" for DX-ing or uhf receiver use on relay systems, Eire etc. †£24.40

P. & P. UK: £0.12 per order. **Overseas:** At cost.
Please add VAT at 8% and 12½% on items marked†.
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TELEVISION

Know-How

The future structure of the UK's TV industry is becoming clearer. Decca and Thorn have reduced their production capacity, with Thorn now undertaking fresh investment at its two remaining plants. The multinationals ITT and Philips seem to have survived the traumas of recent years reasonably well: Philips has absorbed Pye, and ITT is setting up new plant at Basildon to produce its new small-screen colour chassis. The most intriguing factor however is that the Japanese have ended up with a significant chunk of the industry. Sony and National Panasonic both have plants in South Wales, while Toshiba is forming a joint company with Rank to handle the audio/TV side of Rank's operations. Talks between Hitachi and GEC are continuing.

It's the Rank-Toshiba link that hit the headlines however, with questions in parliament and a brief hullabaloo. The general tenor of press comment seemed to be concerned with the UK acquiring Japanese know-how – as if no one in the UK knew how a transistor worked, or how to make a c.r.t.! In practice of course basic electronics know-how is nowadays pretty widely spread. Get together a handful of engineers almost anywhere and provide them with the necessary components and they'd have a TV set working without too much difficulty. But would it be reliable, and a sound commercial proposition? This in fact is where the required know-how lies.

In a modern mass TV assembly plant production engineering know-how is probably more important than electronics know-how. In other words, the vital ingredient today is the ability to test and assemble sets rather than to knock up circuits that work. But production know-how is expensive, and can be generated only through intensive, large-scale operations. A great deal of money is required, because whereas electronic components are comparatively cheap, the computer to check them with isn't. Nor is automatic insertion equipment, the equipment that produces reliable soldered joints, and the equipment to check panels and sets. What it boils down to is that the lack of profitability of the UK's TV industry in recent years means that instead of generating our own production know-how we're now having to buy it in. A frustrating situation for a long established industry to find itself in.

It's likely however that this sort of thing is pretty general in UK industry. In the semiconductor field for example designing the circuits is no problem: the chemistry, testing, getting the encapsulation right and so on is. Dare one mention the car industry?

It's interesting to note that the multinationals Philips and ITT have fared comparatively well in recent times, presumably because they've had international know-how to call upon. Figures of investment per employee are often quoted when making international comparisons of economic performance, the UK coming out rather badly. The figures may seem rather pointless by themselves, but take on greater significance when considered in the light of the technology required for today's mass production. The obvious reason why the necessary investment hasn't been made in the UK is shortage of funds, but other factors are involved as well. For example, the role of the engineer in industrial management. Decisions on investment are made in company boardrooms: is the engineering voice adequately represented there? International comparisons suggest not. That's one factor that requires urgent review. Another factor is education, training and the ability to get the right mix of skills. If it's production and materials engineering skills that are required, is enough training being devoted to them? Is the training of technicians and engineers unduly specialised, so that shortages keep arising because no one's adaptable enough to be able to tackle different subjects?

Another problem is industrial organisation. We don't just mean the old blue/white collar business, though that should have been sorted out long ago. Problems do seem to arise in industries such as TV and car manufacture, where products are assembled from bought in components. Who specifies what, and who's responsible for the necessary research? To put it crudely, should the capacitor manufacturer or the setmaker find out why mains filter capacitors fail so frequently? Things can easily go wrong where an industry is not integrated, a point again brought out by the comparative success of the multinationals. This is a factor that's probably by now largely been resolved however – but at what a cost in terms of a reputation for unreliable products.

Just now industry looks set for a brighter future. There's still a lot for the UK to do in getting its industrial strategy right however.

COVER PHOTO

Test Card F shows ghosting up very well! Note that the card is the joint copyright of the BBC, BREMA, EEA and the IBA.

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Teletopics

RANK-TOSHIBA

After many months' negotiations, Rank Radio International and Toshiba (UK) have announced the setting up of a jointly owned subsidiary, Rank Toshiba Limited, which will take over and develop Rank's television and audio manufacturing plants in the west country. Rank has been making losses on its TV making operations for several years now, and the join up with Toshiba will give it much needed cash plus access to Toshiba's technology. The project is being backed with £1·95 millions of government funds. Rank say that their colour TV output this year will amount to some 175,000 sets, and the aim is to increase this to around 350,000 by 1981, of which 40 per cent will carry the Toshiba brand name while the remainder will be sold as Bush, Murphy or Rank-Arena sets. Two-thirds of the Toshiba sets will be earmarked for export.

For Toshiba, the venture means access to large-screen TV sets, manufacturing capability within the EEC, and an interest in Rank's expertise in the fields of teletext and viewdata – Rank have been active in this area from the start, and introduced the first teletext receiver for sale to the general public. Rank will start to manufacture small-screen colour sets, and by 1981 production will be centred on the Toshiba X53 chassis. It's not clear how Mullard will be affected, and doubtless the yen-pound exchange rate will be the deciding factor here. Rank started to use Toshiba's RIS colour tubes in early 1975, with the introduction of their Z718 chassis. More recently with the introduction of the T20 chassis they have been switching over to use of the Mullard 20AX tube, and currently 85 per cent of Rank's colour sets are being fitted with the Mullard 20AX tube.

A group of Japanese technicians is to work at Plymouth for the next couple of years on getting the new production lines into operation. This gives an indication of the type of technology that Toshiba will be contributing.

RCA'S S4 PIL TUBE

RCA have announced the introduction of a new version of their PIL tube, called the S4. It will be available in both 110° and, for the smaller sizes, 90° versions. The main changes are the use of a new deflection yoke, with higher sensitivity and consequently reduced receiver power consumption, and a new high-resolution gun which gives improved focus performance. Previously announced developments such as the contoured-line screen, super-arch mask, pigmented phosphors etc. are all incorporated in the new tube.

The new saddle-toroidal yoke – saddle-wound line deflection coils and toroidally-wound field scan coils – has a significantly improved efficiency and offers optimum impedance matching to present day high-performance circuitry. The peak energy requirement is 4·3mJ for the horizontal deflection and 3·9W for vertical deflection. The series-connected horizontal deflection coils have a resistance of 1·05Ω and require a peak-to-peak current of 5·4A at 25kV. The vertical scan coils may be series- or parallel-connected. In the former case the resistance is 10Ω and the p-p deflection current required is 1·25A at 25kV; in the latter case the figures are 2·5Ω and 2·5A respectively. This enables the tube to be used with each of the popular vertical deflection systems at present used in Europe.

The new gun incorporates a larger diameter lens to give a smaller spot size and thus improved focus. The focus electrode operates at 7kV compared to the 4·6kV of current PIL tubes. In the interests of reliability, a new base and socket have been designed to accommodate this increased focus voltage.

RCA point out that the tubes have been specifically designed to meet European TV receiver requirements. Note that our colour receiver project is based on the current generation of PIL tubes and cannot be adapted to use with the new version, which is not yet in full scale production.

PRESTEL'S EXPORT SUCCESSES

The Post Office seems to be enjoying considerable export success with its Prestel (viewdata) system. An agreement in principle has been reached with Insac Data Systems Ltd., the firm set up by the National Enterprise Board to market British computing systems and software overseas, to make a Prestel service available to users in the USA late next year. This follows the signing of a letter of intent by the Hong Kong Telephone Company to purchase Prestel technology. West Germany and the Netherlands have already bought Prestel equipment from the PO. The Hong Kong Telephone Company is negotiating separately with GEC Computers Ltd for the supply of a GEC Series 4000 computer on which the service will be based. The start of the public Prestel service in the UK is now planned for the first quarter of 1979.

NEW CATALOGUES

Best Electronics have just published their largest ever TV spares catalogue, covering semiconductor devices, capacitors, resistors, e.h.t. rectifiers, picture tubes, valves, fuses, instruments, soldering equipment, tools and chemicals. Each section is thumb indexed for easy reference, and is written specifically for service engineers. Setmakers' part numbers are included, together with a semiconductor index detailing over twelve hundred device alternatives, all manufacturers' recommended ones. Copies of the new seventy-two page catalogue are available free, from Best Electronics (Slough) Ltd, Unit 4, Farnburn Avenue, Slough, Berks SL1 4XU, or telephone Slough (0753) 39322.

A new 36-page catalogue has been published covering the entire range of Telequipment oscilloscopes and accessories. Copies are available from Tektronix UK Ltd., Beaverton House, PO Box 69, Harpenden, Herts.

We have received from Anglia Components of Burdett Road, Wisbech, Cambridgeshire PE13 2PS a copy of the latest edition of their very comprehensive components catalogue which includes resistors, capacitors, semiconductor devices, e.h.t. triplers and many other TV components. Anglia Components supply trade customers only. Telephone 0945 63286.

RELAY STATION OPENINGS

The following relay stations are now in operation:

Bellair (Antrim) BBC-1 channel 48, Ulster Television

channel 52, BBC-2 channel 56. Receiving aerial group C/D.
Box (Wiltshire) BBC-1 channel 40, HTV West channel 43, BBC-2 channel 46. Receiving aerial group B.
Fort Augustus (Scotland) Grampian Television channel 23, BBC-2 channel 26, BBC-1 channel 33. Receiving aerial group A.
Kington (Herefordshire) BBC-1 channel 39, BBC-2 channel 45, ATV channel 49. Receiving aerial group B.
Lochwinnoch (Strathclyde) BBC-1 channel 57, Scottish Television channel 60, BBC-2 channel 63. Receiving aerial group C/D. Note that horizontal polarisation is used.
Primrose Hill (Huddersfield, Yorkshire) BBC-1 channel 57, Yorkshire Television channel 60, BBC-2 channel 63. Receiving aerial group C/D.

Except for Lochwinnoch, all the above transmissions are vertically polarised.

NEW CIRCUITRY FROM RANK

Rank have introduced a new colour TV chassis, type T22A, which is initially used in the Bush Models BC6268, BC6368 and BC6468. The chassis uses the 20AX c.r.t., and has the same timebase and switch-mode power supply circuitry as the T20A chassis. There's an interesting new signal panel however. To start with, a surface-wave filter (type SW102M) is used to form the i.f. bandpass response at the input to the i.f. strip, preceded by a wideband two-transistor amplifier. The rest of the i.f. strip consists of a Mullard TDA2540 i.c., with an SGS TDA2190 i.c. combining the intercarrier sound and audio functions. The decoder consists of a TDA2560/TDA2522 combination followed by a TDA2532 matrixing i.c. This is an up-dated version of the TBA530, and drives class AB RGB output stages. These are unusual, and a simplified circuit of the R output stage is shown in Fig. 1. The R output is applied to the base of VT9, which has a very high value load resistor (R136). Positive-going signal excursions drive VT9 to saturation, the output being conveyed to the c.r.t. cathode via D39. On negative-going signal excursions VT9 is driven to cut-off, its positive-going collector voltage driving VT12 on to provide a low-impedance, emitter-follower output. R142 is included to reduce the dissipation in VT12, and the gain is set by the ratio of R139 to R116/R117 in parallel. A similar circuit is used in the B and O 3500/4000/5000 chassis and the Rediffusion Mk.III chassis. The panel incorporates circuitry for interfacing with a teletext decoder module.

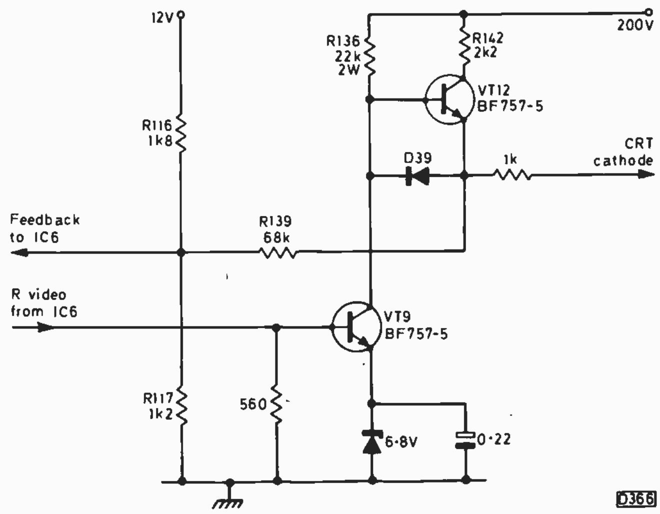

Fig. 1: Class AB video output circuit used in the new Rank T22A colour chassis.

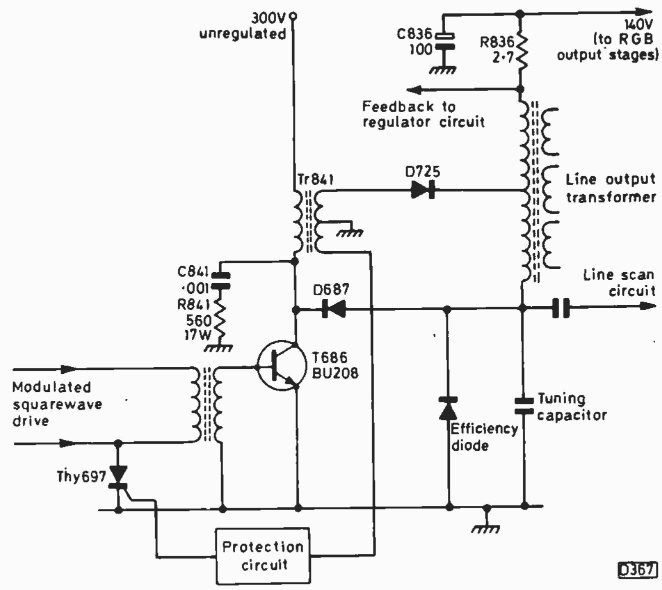

Fig. 2: Basic Wessel combined switch-mode power supply/line output stage circuit used in Rank's W. German produced small-screen colour sets. From the regulated power supply viewpoint, the stage acts as a parallel switch-mode power supply. The arrangement is such that the rectifier (D725) switches on when the transistor is switched off and vice versa however.

THE WESSEL CIRCUIT

In our original note on the Rank small-screen colour set (*Teletopics*, May 1978) we slipped up over the system of e.h.t. regulation used. In fact the chassis uses a combined switch-mode power supply/line output stage known as the Wessel circuit. It's been talked about for some time, but this is the first time it's put in an appearance in a set sold in the UK. A simplified circuit is shown in Fig. 2. The line output/switch mode transistor T686 is fed with an unregulated 300V supply from a bridge rectifier via transformer Tr841. The rest of the supplies are obtained from the line output transformer. As with any switch-mode circuit, regulation is achieved by varying the on/off time of the control transistor. Thus a modulated squarewave drive is applied to the base of T686, the mark/space ratio varying as required to stabilise the supplies obtained from the line output transformer. When T686 is driven on, D687 also switches on and the right-hand side of the screen is scanned in the normal manner, the efficiency diode providing the initial, left-hand part of the scan. When T686 is switched off at the end of the forward scan, D725 conducts and charges C836. D725 remains conducting until T686 is switched on again. Thus the more T686 conducts, the less D725 conducts and vice versa, achieving regulation of the supplies. The voltage across R836 is fed back as the reference to a squarewave modulator circuit which is interposed between the TDA2590 sync/line oscillator i.c. and the line driver stage. A start-up circuit is required for the line oscillator i.c. A short-circuit across any of the outputs would result in excess current in T686. Under these conditions the protection circuit fires the thyristor Thy697, removing the drive to T686. Needless to say, the transformer Tr841 is a rather special one. C841/R841 are included to provide protection for T686.

SATELLITES FOR BROADCASTING

The latest IBA technical review is entitled *Satellites for Broadcasting* and must surely be the first book to be published on this subject. Full of interesting information and lavishly illustrated, the book is available from the IBA, Engineering Information Service, Crawley Court, Winchester, Hants SO21 2QA at £1.50 a copy.

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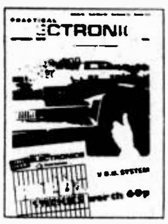

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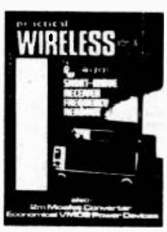

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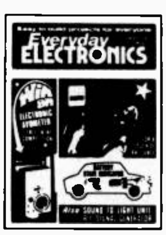

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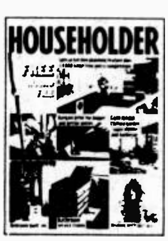

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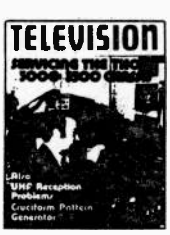

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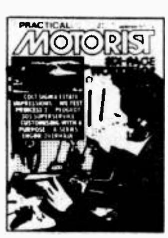

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Eliminating Ghosts

Bill Wright

FORTUNATE indeed is the aerial contractor who operates where good, strong signals abound. But pity the poor soul who has to live with good, strong ghosting as well. Ghosting, as all customers know, is something that can be cured by any half-competent aerial man in next to no time and at minimal cost. "The man who mended the telly said the aerial just needed moving round a bit to get rid of the ghosting." The service engineers who cover our patch seem fond of such unguarded statements! The truth, unfortunately, is often sadly different. Faced with a really good aerial installation which is nevertheless producing very ghosty pictures, the aerial contractor is very much aware that things aren't as simple as the customer (and the TV engineer!) sometimes seems to believe.

As aerial contractors in an area of generally high field strengths but often very bad ghosting, we've been much involved with the "ghost problem" over the years. In the early days of u.h.f. transmissions most of the major aerial manufacturers produced stacked arrays. These were supposedly the ultimate answer to ghosting. In practice however results were variable. No improvement at one call; a pleasant surprise at the next; and so on. The whole thing had an alarming air of unpredictability, while the time and trouble involved in each installation meant that a high failure rate was quite unacceptable.

Log-periodic Aerials

The manufacturers' next bright idea was in the shape of the log-periodic aerial. And a very peculiar shape we thought it to be (see Fig. 1). Log-periodic aerials are enigmatic, inscrutable devices. They are quite unlike more familiar aerials in that every element is driven. In other words there are no reflectors or directors, but simply a series of dipoles which are connected to the downlead via the boom. In fact there are two parallel booms. Each dipole is connected at its centre point across the two booms, and the polarity of this arrangement alternates along the boom. The ends of the booms farthest from the transmitter are shorted together, whilst the downlead is connected across the front end. Don't be misled by the appearance of the Antiference TS21: the coaxial feeder emerges from the back end of the aerial but runs along inside the boom to the connection point at the front. Log-periodic aerials generally have a characteristic impedance about 100Ω, but matching devices are not considered necessary. The coaxial inner is connected to the uppermost boom, and the outer to the lower one.

The "spread" of dipole lengths from smallest to largest determines the aerial's bandwidth and, since the gain suffers little if this spread is relatively great, log-periodic aerials designed for domestic TV reception usually cover the whole of the relevant band, be it channels 6 to 13 or 21 to 68. If the gain is plotted against frequency (within the designed bandwidth) the result is a surprisingly straight line.

This flat response is one outstanding characteristic of the log-periodic aerial. The other is its extremely clean and sharp polar response pattern (see Fig. 2): undesirable rear and side lobes are smaller than those of a conventional aerial of comparable size. This is because the phase relationship between the voltages developed across each dipole (as they appear at the downlead having travelled varying distances along the booms) tends to favour signals arriving from the front of the aerial rather than those arriving from any other direction. The lack of parasitic elements also helps to keep the response clean.

A highly directional aerial immediately suggests itself for anti-ghosting work of course, and the log-periodic aerial begins to sound ideal. The drawback is its poor forward gain, which seems to be an unavoidable feature of aerials based on this principle. The forward gain figure usually quoted is 8·5dB, which is significantly lower than a conventional 10-element Yagi aerial's gain of about 11dB. In many locations the poor gain of the log-periodic aerial effectively disqualifies it from anti-ghosting work, which is a great pity.

Some time ago Antiference produced a version of their 21-element log-periodic aerial with an amplifier attached. This alleviated the problem to a limited extent, but the cost of the product compared very unfavourably with that of a straight 18-element Yagi aerial without amplification and the results often didn't in the customer's eyes justify the extra expense. Antiference no longer produce a log-periodic aerial for ordinary domestic use: possibly they feel that their XG8, XG14, and XG21 aerials provide a more useful combination of gain and directivity.

Log-periodic aerials are nevertheless nice, light, compact arrays with low wind resistance, and in some locations the extra height that this allows, combined with the aerial's directional properties, will do the trick.

We've used a great many log-periodic aerials over the years to combat ghosting, but we very soon became aware that they don't produce the complete answer in every case.

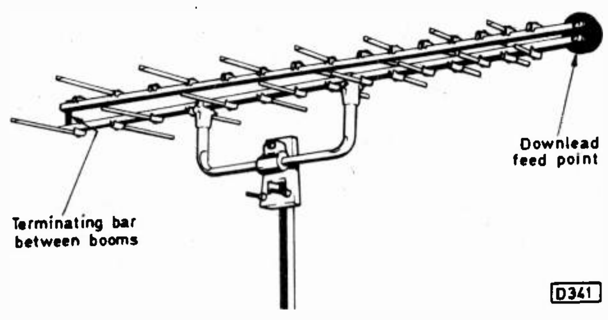


Fig. 1: The Jaybeam LBM2 log-periodic aerial.

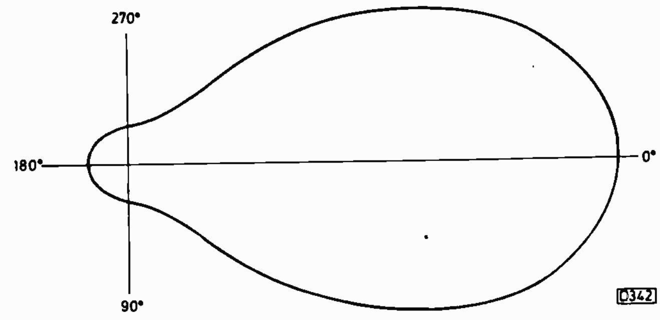


Fig. 2: Polar response of the LBM2 at 500MHz.

They were found to be at their best in areas of high field strength where, with say a combination of half a dozen factory chimneys to the rear and some local obstruction to the fore, strong multiple images are present on the screen. In this sort of place a ten or eighteen element Yagi would produce unrecognisable and unlockable images but a log-periodic aerial might, if it was your lucky day, give watchable but still very ghosty results. The fact that the customer would then appear to be unable to detect any improvement is neither here nor there.

The majority of our ghosting problems are not of this sort however. Often the problem is one solitary ghost image which can be strong enough to make the picture unwatchable. Forty-four footballers controlled by two referees.... Video in stereo.... In these conditions log-periodic aerials seem as unpredictable as the earlier stacked arrays. Unpredictable except that they tend to be at their least effective on the roofs of the most critical customers, just like all other aerials. Log-periodic aerials are cheaper than stacked arrays – if you can manage without an amplifier. They are quicker to assemble. Perhaps they work on average a little bit better. But they don't really solve the problem.

Back to the Drawing Board

So we started to experiment extensively, and spent a lot of time working with stacked arrays. We needed to tailor the response pattern of the array at each location to reject signals from one specific direction, that of the ghosting. At the same time, maximum forward gain must be maintained. This is important because the strength of the ghost image as it appears on the screen is dictated not by the strength of the ghost signal in absolute terms but by the ratio between it and the signal received direct from the transmitter.

In the early days we had simply fixed two aerials together and rotated the whole assembly for the best results. This was a bit hit and miss. A typical polar response diagram for a horizontally stacked array of two aerials is shown in Fig. 3. Ghosting from directions A1 and A2 will be largely rejected by the array, but ghosting from directions B1 and B2 will be rejected to a much lesser extent. We can't move the factory chimney, gasometer, or other reflecting object, so we must alter the angles of minimum and maximum signal acceptance. We must do this while still keeping the largest forward lobe pointing at the transmitter.

How? Consideration of the way stacked arrays achieve their directional characteristics lead us to realise that we have to satisfy the following conditions: (1) Both aerials must receive as much signal as possible direct from the transmitter, and these signals must be combined exactly in phase. (2) The ghost signals received by the two aerials must be of equal amplitude and must be combined exactly out of phase.

Alignment Procedure

If there's only one really troublesome ghost signal to deal with, the above conditions can be satisfied quickly and easily as follows.

Fix a horizonal boom on a vertical mast (see Fig. 4) with an 18-element aerial at one end of the boom. The aerial's supporting cradle should be roughly central on the boom. Rotate this assembly for maximum signal strength, using a field strength meter or a portable TV set with an attenuator. Ignore ghosting at this stage. The boom should now be at right-angles to the direction of the transmitter. Secure the assembly in this position.

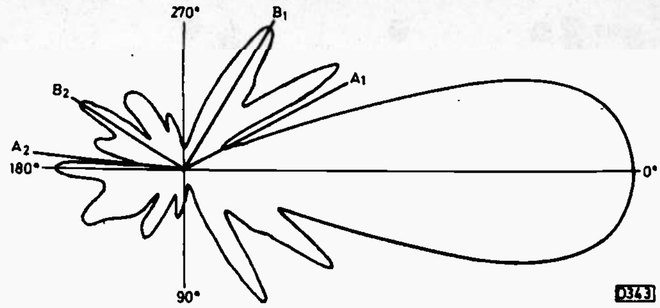


Fig. 3: Polar diagram of a stacked Yagi aerial array.

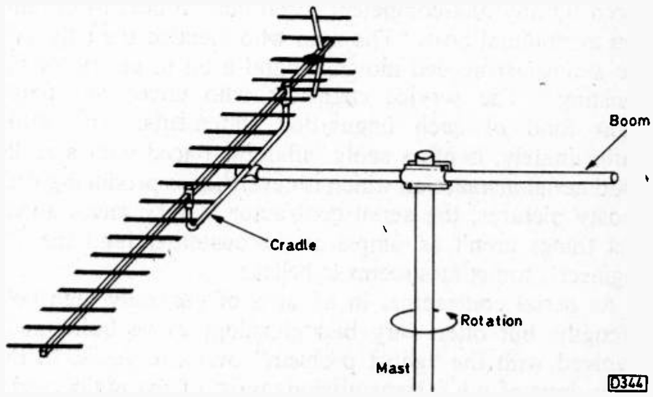


Fig. 4: Aligning the first aerial.

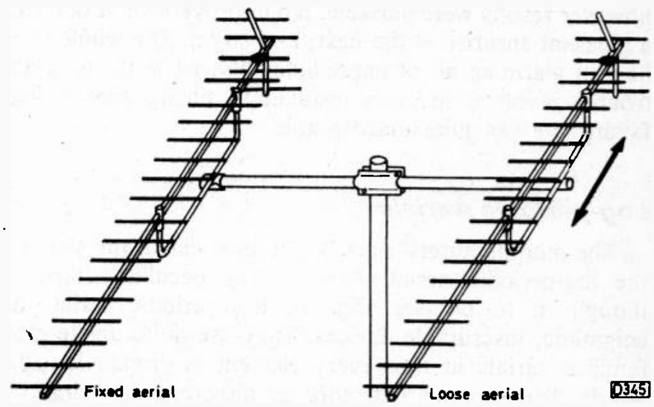


Fig. 5: Movement of the second aerial towards and away from the transmitter for correct phasing of the signals received by the two aerials direct from the transmitter. Adjust for maximum signal pickup. The phasing harness used when adjusting the aerials consists of a quarter wavelength of 50Ω coaxial lead connected between the 75Ω downlead and the equal-length 75Ω leads from the two aerials.

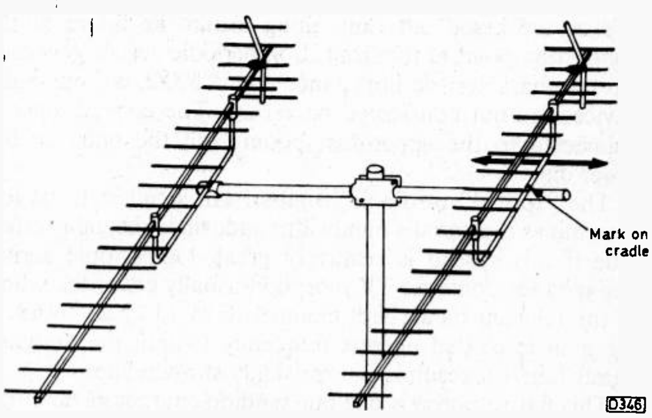


Fig. 6: Sideways movement of the second aerial. This adjustment is made so that the ghost signal pickup by the two aerials cancels out.

Connect this aerial and an identical one to the meter or TV set, using a phasing harness. Holding the second aerial in position along the boom, move it towards and away from the transmitter (see Fig. 5), carefully keeping it pointed *at* the transmitter. Since this movement alters the phase relationship of the two aerials, a maximum and minimum meter indication will occur. If a meter is not available and a TV set has to be used, the effect is visible but less obvious. Obtain a maximum reading, then mark on the cradle with felt pen the point where it crosses the boom. Again, ignore ghosting. Repeat this procedure several times, with the loose aerial at different distances from the fixed one. The same mark on the cradle should coincide with a maximum meter reading at all points along the boom. If not, the boom is not at right-angles to the transmitter direction. Realign it if this is the case.

You can now alter the distance between the two aerials while they remain exactly in phase. In this way the foward gain of the combined array is always at maximum. The mark on the cradle must always be kept exactly on the boom of course. Don't be tempted to skimp on the adjustments leading up to this point: if there's a phase error between the two aerials at any point along the boom there will be a reduction of forward gain if the loose aerial is mounted at that point. This will make nonsense of any subsequent attempts at alignment for minimum ghosting.

With the two aerials still connected together via the phasing harness, next move the loose aerial sideways (see Fig. 6), observing the results on the TV set. It should be possible to identify a series of points along the boom where the loose aerial should be fixed for the two aerials together to produce minimum ghosting. At these points the ghost signals from the two aerials are exactly out of phase with each other. This happy condition will recur every time the loose aerial is moved through one wavelength towards or away from the source of the ghosting. If the ghosting is only slight it may be easier to find the points along the boom where the ghost is most visible: mark these, then mount the aerial mid-way between them.

If the source of the ghosting is at right-angles to the transmitter direction the points of minimum ghosting will be at one wavelength intervals along the boom. In fact the distance between the two aerials will be λ (n + $\frac{1}{2}$). In cases where the ghost signal comes from an angle other than 90° or 270° the optimum positions will be more widely spaced. If the ghosting originates from almost exactly the same direction as the transmitter, or from almost exactly the opposite direction, the two aerials will need to be very far apart for phase cancellation to occur. In fact if the ghosting originates 5° from the transmitter axis (that is, from 5°, 175°, 185°, or 355°), the two aerials will need to be about 140cm apart for channel group A.

Those of a mathematical bent will realise that the distance along the boom between the two arrays can be derived from the wavelength (λ) and the angle between the transmitter and ghost directions (θ). The formula is λ (n + $\frac{1}{2}$) sin θ.

Being more nimble on a roof than with a calculator we usually proceed by trial and error. The mathematical approach can help when there are two strong ghost signals from different directions however. The series of possible inter-aerial distances for each can be worked out, and a position for the second aerial chosen which approximates to one value for both. This should be regarded as a starting point for practical experiment however, not as a definitive answer. The easiest way to find the necessary angle for the calculation is to use a large-scale Ordnance Survey map and a protractor. The direction of the source of ghosting can be found by rotating the aerial whilst observing the TV screen. There is seldom any problem here, since the highly reflective culprit can usually be seen clearly on the skyline. In the highly unlikely event of the ghosting coming from *exactly* 180°, no phase cancellation would be possible and the ghosting would triumph. Fortunately this remains for us a hypothetical case.

Final Adjustments

Because the final adjustments are extremely critical, and involve moving a fairly large aerial accurately through small distances, great care should be taken. It's impossible to eliminate ghosting if it can't be seen properly in the first place, so the right sort of programme must be on the air. If you find yourself trying to do this job with a rapidly changing selection of cluttered shots on the screen, well, go down the ladder and have a cuppa, and admire the customer's new microwave oven for a bit. This problem brings the writer dangerously close to his number one hobby horse, which concerns the lack of BBC-2 test transmissions for most of the working day. 'Nuff said!

If the ghosting cannot be eliminated completely the reason may be that the ghost signals received by the two aerials are not of equal amplitude. If one aerial appears to be screening the other in this respect they can be mounted at different heights by simply inverting one cradle. The aerial itself should remain the same way up of course. Remember that it isn't essential for the two aerials to receive exactly the same amount of signal direct from the transmitter (although this is usually the case): it's the ghost signals that need to be exactly equal.

When a satisfactory picture has been obtained it will probably be found that the two aerials are at different distances from the mast. You can't move the mast sideways because it's attached to the chimney, but fortunately the two aerials and the boom can be moved sideways without the previous critical adjustments being invalidated. The distance between the two aerials must be kept exactly the same of course, so it's usually easiest to keep them clamped to the boom and move the whole thing in one piece. Check orientation by visual sighting along one aerial before and after moving.

Bandwidth Requirements

In theory the correct inter-aerial spacing for one channel will not be correct for the other two. In practice this doesn't seem to be a problem. We usually carry out the alignment procedure on the most ghosty channel of the three or on the middle one. Minor adjustments can then be made if necessary after the pictures have been scrutinised. Reducing the distance between the aerials will favour the higher channels and vice versa. These adjustments are small: the theoretically correct positions for each channel may be only 2-3cm apart if the two aerials are reasonably close together. This makes it easier to find a position which works on all channels however, and for this reason the two aerials should not be mounted unnecessarily far apart. We usually start with the aerials about one wavelength apart, and use the first optimum position greater than this distance.

Connecting the Aerials Together

An ordinary splitter can be used to connect the aerials together. Both inductive and resistive types are suitable. The split must be exactly equal, otherwise complete cancellation of the ghost signals will be impossible. Commercially available splitters are generally satisfactory in this respect, but a check can be performed quickly with the field strength meter. Connect the common terminal of the splitter to a signal source, and measure each output. The other output should have a dummy load connected.

We use splitters for this purpose because they give us an accurate impedance match in a simple and straightforward way. We haven't worried much about phasing arrangements, which might give better gain, because we are rarely troubled in our area by weak signal problems. With an ordinary resistive splitter the gain, as you might expect, is about the same as the equivalent single aerial. Those who wish to experiment with phasing harnesses of greater efficiency are referred to Nick Lyon's article on *Removing Ghosts* (March 1978) and to *Long-Distance Television* (March 1977).

Don't be tempted to connect the two feeders to the downlead without any impedance correcting device. The resulting mismatch will cause all sorts of unpredictable effects.

The two feeders which take the signal from the aerials to the splitter should be of exactly the same length. If not it will still be possible to carry out the alignment procedure but one aerial will end up slightly forward of the other, which looks odd. There is also the possibility of unbalanced standing waves or some other inequality affecting the overall performance.

Choice of Aerial

The two aerials must of course be identical. After some experimentation we now always use Antiference 18-element aerials for the job. When used singly these aerials seem to us to be as directional as any on the market within the price range. We have not used large, high-gain aerials in the stacked mode – as already mentioned, we have few field strength problems to contend with. The cost of two XG21s might also have something to do with it! We can see no reason why these very large aerials should not be efficient when used in this way, though they would need a well thought out mounting and stacking arrangement. We've removed many a nasty ghost simply by replacing the existing cheap 18-element aerial with an Antiference TC18 incidentally.

Co-channel Interference

From the aerial rigger's point of view co-channel interference presents exactly the same problem as ghosting: how to achieve maximum gain in one direction with minimum gain in another. Stacked arrays can do a really good job here, because the signal rejection is usually required on only one channel of the three. Alignment can thus be carried out on this channel, with no need to worry about the others. Co-channel interference disappears in a much more definite and obvious way than ghosting when the final adjustments are made, so finding the exact position along the boom for the second array is that much easier.

Mounting the Array

Rigid mounting is essential if the results are to be reliable. The mast should be of 1½ or 2in diameter, with a 12in chimney bracket or the equivalent wall bracket. A 6ft × 1in heavy gauge mast is ideal for the boom, which should be cut to length when all adjustments have been made. All cables, splitters, etc. should be well secured. The feeders should be brought away from the aerials as neatly and cleanly as possible, and in an identical manner on both sides of the array.

As already stated, the technique depends for its success on each array receiving an identically strong ghost signal. For this reason the field strength of the ghost signal must be uniform over the area of the array. When considering where to mount the array therefore, keep it away from other aerials or anything else that might obscure or reflect the signal.

With a single aerial, it's often possible to find a place for the installation where the ghost signal is attenuated by intervening brickwork, stone or trees. Unfortunately this normally useful wheeze doesn't combine well with the use of stacked arrays, presumably because the ghost signal is of an uneven and irregular nature in such a location. Stacked arrays seem to be happiest nice and high and as far away from other objects as possible. ■

Letters

STANDARDS OF SERVICE

The question of what constitutes good service doesn't seem to have come up for discussion recently, though in the fast changing world of TV I think it's very important. If the customer phones to say his TV set has gone wrong and a technician calls within a few hours it's assumed by all concerned, including the customer, that the service was excellent, regardless of whether the technician left the set in a satisfactory condition. Suppose the set concerned suffered from intermittent sound or loss of one colour. Unless the cause was readily identifiable on the spot, the chances are that the technician left with one or other of the following comments: "It should be all right now I've adjusted it; let us know if not." "It should be all right now I've put in a new valve." "I can't find any fault, let's see how it goes . . ." "It needs a new panel: I'll bring one in a day or so." "We'll arrange to take it to the workshop for a soak test."

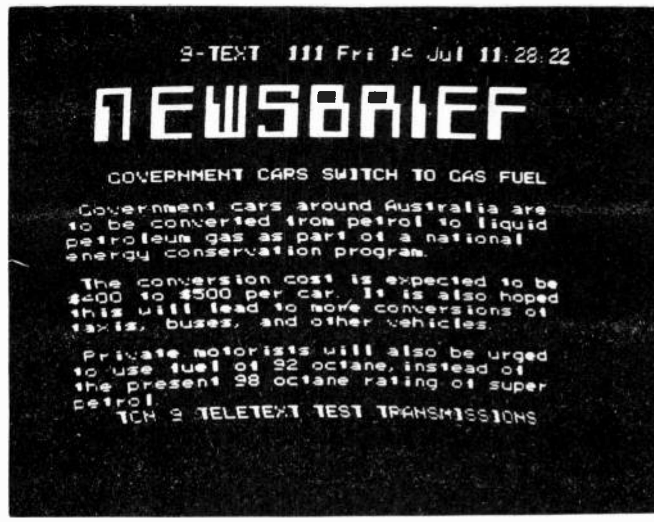
This sort of vagueness does not amount to good service, because the repair may or may not have been completed and more calls may be required until either the staff or customer become so tired of the situation that more drastic action is taken. The problem mainly concerns large service organisations and rental companies, where technicians may have a dozen or more calls to make in a day, inadequate records of calls and the action taken are kept, and perhaps a different technician calls on each occasion. This situation means that each service call is a potential problem to the technician, impeding his progress through the day, with the result that he hasn't the time to get involved or to deal with an interesting problem from beginning to end – if he fails to find the cause of the trouble in the limited time available, it's back to the bench engineer.

Provided the number of complaints reaching head office are few and the usual credit-debit figures show a healthy profit, no concern is shown and the illusion of good service is maintained. One solution would be to enable the field technician to do his own bench work as well. He then won't get tired of and waste time making repeated calls to faults he can't find, but will be able to get to know a number of sets thoroughly and ensure that their performance standards are maintained. He'll be able to carry out preventive maintenance and safety checks, thus reducing his future workload.

This brings us to the quality of work carried out in the workshop. The preoccupation of large concerns with time sheets and figures leads to the dangerous situation where the main consideration is the number of "completed" outgoing sets. The pressure from sales staff in rental companies can be such that incoming decontrolled sets from other subscribers are sold before they are checked, or re-rented without any form of inspection other than a cursory glance by the non-technical installer – who's often underpaid and dependent on commission.

It amazes me that companies so run have any customers at all. It's interesting to look at the sets working in the showrooms. In some the standards are high, but in others one sees sets with dim pictures due to failing tubes, weak or no colour, incorrectly centred pictures, intermittent rolling, and a truly amazing variation in colour fidelity. One can't expect the performance of an early design to come up to the standards of more recent times of course, but it's not unreasonable to expect old sets to perform as they were designed to do. There seems in particular to be very little appreciation of colour pictures. Setting up each receiver on a vectorscope would be expecting too much, but decent reproduction of test card F by all sets should be possible.

In conclusion, it seems to me that reappraisal of the basic approach to service is needed. There should be standard checks on sets in the workshop for safety, then assessment of the picture under various conditions to show up faulty colour reproduction, poor synchronisation, picture geometry faults and, in addition, a check on anything that to an experienced hand doesn't "feel" right, such as a badly operating on-off switch or worn tuner buttons. This should be coupled with extensive soak testing and checking to ensure that as far as possible the sets are working in peak condition. By adopting such standards, engineers will achieve greater job satisfaction, and there'll be more time too for the numerous obscure faults which increasingly complex technology is building into sets. – **Malcolm Burrell,** *Halstead, Essex.*



Australian teletext reception. Sydney channel 9 relayed by coaxial cable to Melbourne and transmitted by Melbourne channel 9. Received by P. Izzard in Niddrie, Victoria.

Teletext transmitted on Melbourne channel 7.

THE COMMON-EMITTER CIRCUIT

I've read with interest the correspondence in the September issue on the common-emitter circuit variant, and feel that any confusion is mainly due to the statement that a common-emitter stage imparts a 180° phase shift. In fact a common-emitter stage at normal signal frequencies provides a signal at its collector in phase with, but the inverse of, that at its base. Although the effect with a symmetrical waveform can be considered to be the equivalent of a 180° phase shift, consider what happens with an asymmetrical waveform as shown in Fig. 1(a). This shows that the phase relationship between the input and the output is maintained.

The "unconventional" common-emitter circuit shown in Mr. Amos's Fig. 1(c) appears rather more conventional when the a.c. conditions only are considered and, as shown in Fig. 1(b), the supply impedance is regarded as being zero. It can be seen that all the terminals are now connected to either the input or the output in the usual manner. It can also be seen that with respect to the common line A the output will be in phase with but the inverse of the input, as in the conventional way of showing the circuit. – **H. Evans,** *Crewe, Cheshire.*

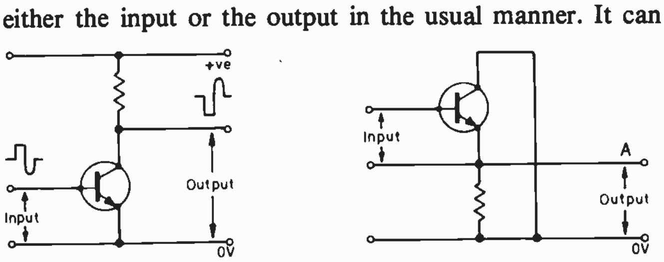


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Fig. 1: Common-emitter arrangements.

AUSTRALIAN TELETEXT RECEPTION

I have recently completed construction of the *Television* teletext decoder and thought you might be interested in the results obtained here. The decoder was built to gain experience with teletext. The input logic, memory and display boards are as published, but for various reasons the front end differs. I chose to pick off the detected video from a standard Japanese (National) monochrome portable, passing the signal through a simple two-transistor video amplifier to the input of the CA3046 i.c. The output from the display board is then returned via a transistor back into the set's video circuitry.

The results, after some fault finding, are very encouraging. Melbourne channels 7 and 9 transmit a teletext test service, and I was able to produce stable, clear teletext from both sources. No doubt the results would have been even better following the front end as published. The accompanying photos show the reception, and I'd like to thank all those involved in the project. – **P. Izzard, M.T.E.T.I.A.,** *Niddrie, Victoria, Australia.*

Thorn 9000 Chassis Faults

John Coombes

THE 9000 colour chassis was introduced in early 1975 and was another Thorn innovation, for two reasons. First, it's fitted with the 20in., 90° version of the RCA PIL self-converging c.r.t. And secondly the single R2540 "Syclops" transistor acts as both a parallel chopper transistor for h.t. regulation and as the line output transistor, driving two transformers. Because of the latter feature a fairly comprehensive over-voltage/excess current trip circuit is incorporated. There's NS and EW raster distortion correction, and a rather complex eight-transistor field timebase which owes something to the RCA influence, being designed to drive the low-impedance toroidal scan coils. The signal side is fairly conventional, with a varicap tuner, three-chip decoder, and cascode RGB output stages driving the c.r.t. cathodes.

No Results

As with all sets, no results is the most common fault. It's necessary first however to decide whether the set is actually dead or tripping, since the observable symptoms will be the same. A voltage check at pin 7 or 8 of socket 16 on the bottom PC752 switch-mode power supply/line output panel will show a fast flicker if the set is tripping – with the meter on the 10V or 30V range.

If the set is completely dead, the first thing to check is the mains fuse F1 (2·5AT) which, being BEAB approved, must be replaced with the same type. If it's found to be open-circuit, first check the mains filter capacitor (1μF, no circuit reference number, on the PC752 panel), then the mains rectifier W701 (MR510). Another possibility is the Syclops transistor VT701.

W714 Defective

If you find that VT701 is being ruined at an alarming rate, though there doesn't seem to be any apparent reason, check diode W714 (1S44) which may be open-circuit – the set will continue to operate, but the Syclops transistor will be without protection since W714 senses its emitter current, operating the overload trip if this is excessive. W714 can also be responsible for intermittent tripping. To provide increased protection for the Syclops transistor, W729 (ITT44) is added in parallel with W714 in later sets.

Set Tripping

Before dealing with the causes of tripping, it's important to emphasise that the set should not be operated with any of the trips disconnected – five factors are monitored, the Syclops transistor's collector voltage (via W703), its emitter current (W714), the mains input (W716 in the thick-film unit on panel PC752), the field timebase h.t. supply (W723) and the 240V video supply (W724).

One cause of tripping is excessive e.h.t. If R606 (set e.h.t.) is not incorrectly adjusted (see later), check the efficiency diode W705 (MR510) which can cause this trouble. Other diodes which can cause tripping when faulty are W723 (BZX83C30, one of the trip sensors) and the 90V supply rectifier W706 (F247). The line oscillator transistor VT411 (BC212C) can be responsible for tripping, while another cause is a defective thick-film unit (R704-7/W716) which must be replaced as a complete unit – very often it will seem to check o.k. but a replacement unit will cure the fault. Other transistors which can cause tripping are the line driver VT412 (TCE527) and the 12V regulator transistor VT413 (BC182L) which is in series with the line driver. The correct type must be used when replacing the line driver transistor, otherwise you can get a white line, like a striation, down the side of the screen.

If the set keeps tripping the best course of action is to remove fuse F4 (1·6A), thus disconnecting the supply to the field timebase. If the tripping persists, remove F2 (1A), disconnecting the 30V supply. If the tripping then stops, the 30V supply rectifier W708 (BY210/400) is suspect.

If the raster appears and the set just trips out, check C602 (0·068μF) and the voltage comparator transistor VT601 (BC212L) on the Syclops control panel PC756.

Intermittent tripping can be the result of incorrect e.h.t. adjustment which should first be checked. R606 should be adjusted for 720V at TP708, using a 10kΩ/V or higher sensitivity meter. To make the reading, connect the meter to TP708 via a BY127 or 1N4007 rectifier diode (anode to the test point) and shunt the meter with a 1kV d.c. 0·01μF capacitor. If the trouble persists, change C741 (1μF) which decouples the emitter of the Syclops transistor.

Tripping with hum from the speaker is caused by a defective mains rectifier reservoir capacitor C702 (400μF).

Sound, No Raster

The most likely cause of sound but no raster is a faulty e.h.t. tripler. The line output transformer can also be responsible, often due to dry-joints – on the transformer itself, between the coil leads and connecting pins, not where the pins are connected to the board. If the e.h.t. tripler is faulty, check whether the efficiency diode W705 (MR510) is open-circuit.

No Sound or Raster

No results due to failure of the Syclops circuit to operate (set not tripping, F1 o.k.) can be due to a defective ramp reset transistor VT602 (BC182L) on the Syclops control panel. Alternatively the ramp charging capacitor C604 (0·0039μF) may be faulty. Other semiconductor devices on the panel may have to be checked.

The EW modulator diodes are W711 (MR814) and W712 (MR854, later MR914). The supplies for the field timebase, the decoder and the i.f. strip are derived from this circuit (though in early production sets the decoder/i.f.

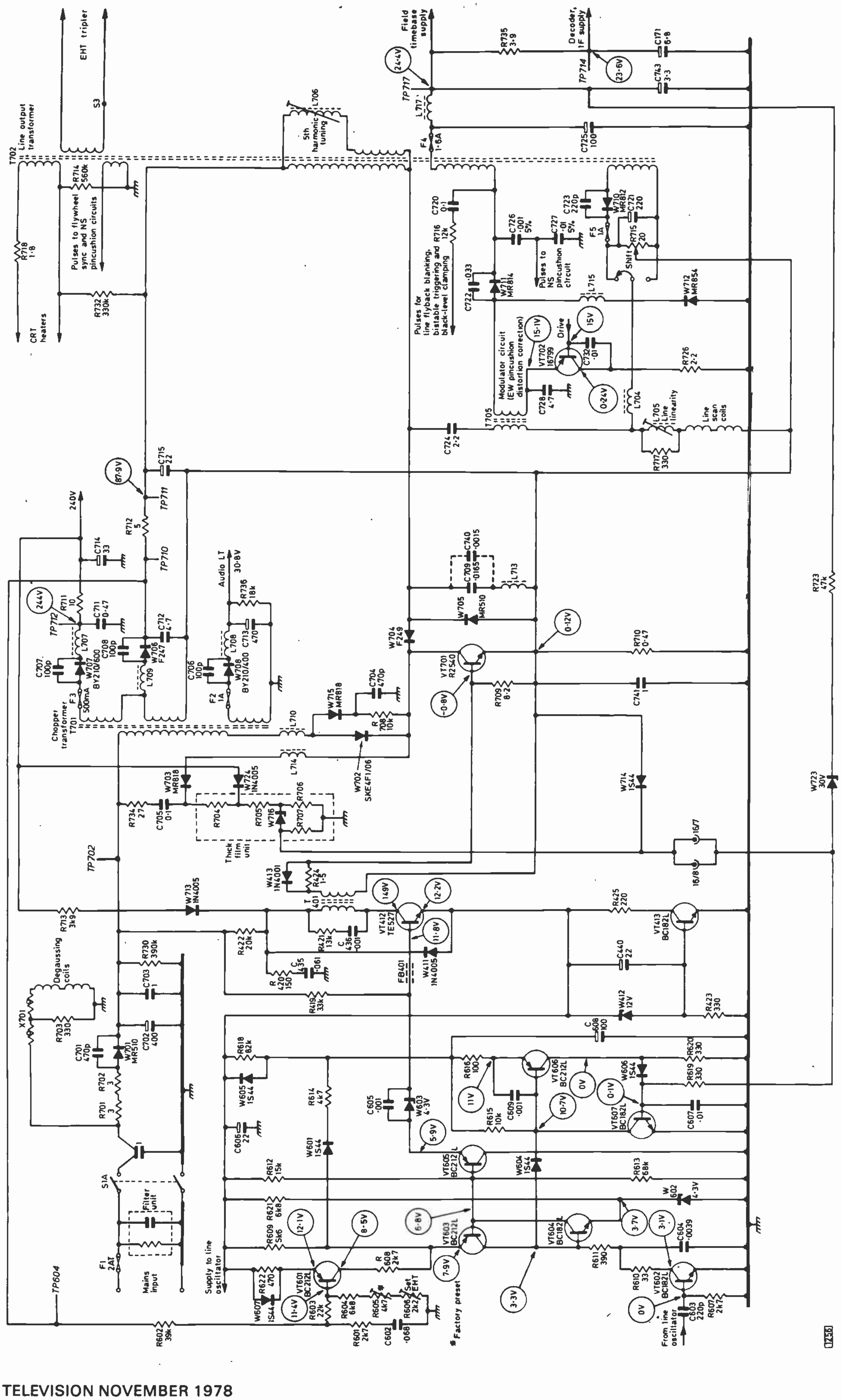

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Fig. 1: The Syclops switch-mode power supply/line output stage circuit used in the Thorn 9000 chassis, including the line driver and Syclops control circuits. Components prefixed 4 are on the timebase panel (PC751), those prefixed 6 are on the Syclops control panel (PC756) while those prefixed 7 are on the Syclops panel (PC752). There have been several modifications. In early sets the decoder/i.f. supply was obtained from a 24V regulator fed from the 30V audio supply. Early sets use an OVB AB thick-film unit with W724 omitted, later sets an OVB B AB or OVP-B unit. Don't use the early type if W724 is present. F1 changed to 2·5A anti-surge.

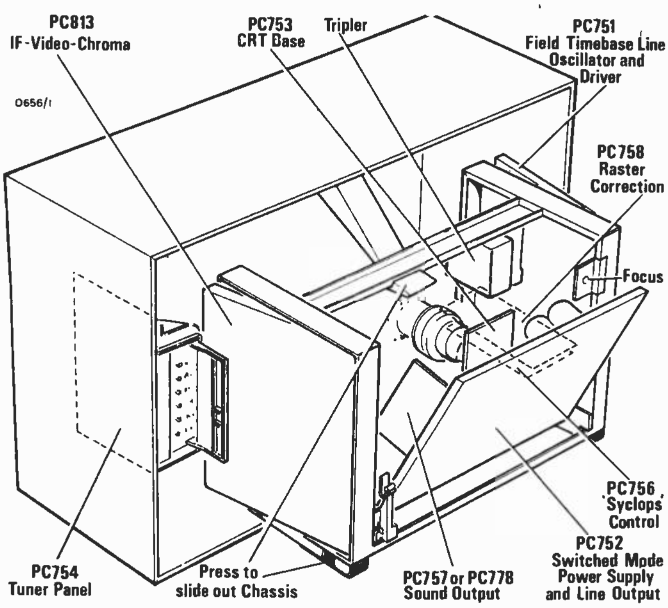


Fig. 2: Locations of the printed panels, with the bottom panel shown in the raised position for access to the print side. If the 24V field timebase supply rises excessively, the over-voltage trip operates. Check by removing F4. If this clears the trouble, connect a 120Ω 5W resistor across the field timebase supply, replace the fuse and check the field timebase circuitry.

supply is obtained from a regulator fed from the audio supply line). When W711 or W712 is open-circuit the tube heaters will be alight and e.h.t. will be present but the 24V supply will be lost and there'll be no sound or raster (c.r.t. cathode voltages high). First check fuse F4 (1·6A) however. If it's open-circuit, C196 on the i.f./video/chroma panel PC813 may be faulty. Change it to an electrolytic if it's a tantalum type. Check the field timebase supply line.

No sound or raster with no e.h.t. and the c.r.t. heaters out will be the symptom when the 90V supply to the line output transformer is absent. Check whether R712 (5Ω) or alternatively W704 (F249 between the Syclops transistor and the line output transformer) is open-circuit.

Excessive Width or Line Jitter

The symptom when W712 in the EW modulator circuit goes short-circuit is excessive width. W712 can also be responsible for line jitter: to prevent this, it was changed from type MR854 to type MR914.

R736 (18kΩ) has been added across the 30V supply reservoir capacitor C713 to prevent this voltage rising if the sound output panel PC757 or PC778 is removed. It's worth adding this resistor on all sets.

Excessive Brightness

Loss of the 240V supply to the RGB output stages will result in excessive brightness. Check whether fuse F3 (500mA) has blown. If it has, the filter capacitor C711 (0·47μF) could well be short-circuit. If the fuse is in order, the 240V rectifier W707 (BY210/600) is probably open-circuit. Excessive brightness with the 240V supply present is usually due to a defective i.c. – the SN76227N-07 demodulator/matrixing i.c. which drives the RGB output stages (IC4).

Unstable Grey Scale

Since the first anodes are internally connected in the PIL tube, the grey scale is entirely dependent on the RGB output stages. Unstable grey scale can be caused by one or other of the three emitter circuit decoupling capacitors C174/5/7 (560pF) being defective.

Crinkley Verticals

Returning to the line timebase before going on to the field timebase, the only other trouble we've had is C431 (10μF) drying up. This decouples the emitter of the line oscillator transistor, and the result is crinkley verticals.

Field Timebase Faults

Common causes of field collapse are VT407 (16801) which is one of the field output transistors, VT408 (BC327) which drives it, the field output stage driver transistor VT404 (BC182LB) and the source-follower f.e.t. VT403 (BF256L). We've also had one of the transistors in the field oscillator circuit, VT402 (BC182L), cause field collapse.

VT407 and VT408 can also be responsible for lack of height, or bottom cramping.

The other output transistor VT406 (16802) generally causes excessive height when it goes faulty. This fault can also be due to diode W406 (1N4001) being leaky.

The components which cause field collapse can also do so intermittently. This is harder to track down of course, but a freezer spray and hairdryer help. Don't apply excessive heat however as this can cause more trouble.

Signal Board Faults

In addition to causing excessive brightness, IC4 (SN76227N-07) can be responsible for loss or intermittent loss of colour. The luminance and chrominance signal processing i.c. IC3 (SN76226DN-07) can also cause loss or intermittent loss of colour. It can also be responsible for loss of colour on various parts of the screen. Other causes of no colour are a defective chroma coupling capacitor C181 (22pF) or C186 (6·8μF) which decouples the supply to IC5 (pin 2) going short-circuit or leaky.

A ghost or a weak signal can be responsible for intermittent colour drop-out. There's a modification that can help here – adding a 12kΩ, $\frac{1}{4}$W resistor (R270) in series between C194 (1μF) and pin 13 of IC5. The fault affects only a small number of sets however.

The PAL switch is in IC4, which can be responsible for PAL switching faults.

Slow colour drop-in may be due to incorrect adjustment of the reference oscillator frequency control R210 (10kΩ) associated with IC5 (TBA395). In later production sets a zener diode W107 (BZX83C8V2) is added from pin 2 of this i.c. to chassis to eliminate hum effects on some areas of the picture.

Striations can be caused by capacitor troubles in the a.g.c. circuit. In later production C125 is changed to 100μF and C116 to 0·001μF to counter this problem.

Loss of colour can be due to incorrect tuning or a defective tuner. The tuning capacitors associated with the TCA270 vision demodulator i.c. can also be responsible. These are C136 (47pF) which tunes the a.f.c. circuit coil and C138 (75pF) which tunes the detector tank coil.

The tuning voltage stabiliser i.c. (TAA550) can cause this trouble or drifting completely off signal.

On one or two rare occasions we've found the TCA270 i.c. to be the cause of drifting, where it's been very difficult to tune the receiver to the station correctly. ■

Long-Distance Television

Roger Bunney

Two firsts to report this month. On Wednesday, August 9th the first European television signals at 12GHz were received at the IBA's Crawley Court, Winchester engineering centre, from Italy via the OTS-2 satellite. The IBA reported that the vision quality was good, confirmed by subsequent tests which occur on various days during the periods 1200-1400 and 1700-1900 BST (normally, that is). Steve Birkill, of ATS-6 fame, is working on an installation which he hopes will enable him to receive the signals successfully.

The second and rather startling item, a first in the DX-TV field, occurred on July 30th, yours truly participating. RUV Iceland ch. E4 was being received at good strength at 1830, with the aerial pointing north west. There was no ch. E3 RUV signal however, so I tuned in to this channel and hopefully awaited the RUV "ISLAND" test card. Signals appeared at 1845, but did not lock. Adjustment of the line and field hold controls enabled the picture to be locked, displaying a picture of a variety show but lacking in height. Tuning back to ch. E3, I passed through American speech: it then became clear that the ch. E3 signal was actually a ch. A2, System M, 525-line one. Tuning back up to the sound, another System M vision signal became apparent, just above the sound frequency but slightly below the ch. E4 vision – obviously ch. A3! A hurried call was made to David Martin at Shaftesbury, and some ten minutes later he logged both signals.

Efforts were made to record the ch. A2 sound, which at 1925 went on to commercials, then to what at first seemed to be a station identification but subsequently seems could have been a promotion for a radio station. We've been unable so far to trace the source of the signals, but are awaiting information from the US. After several commercials, the following was resolved at about 1925: ".?. News Service, coming your way with stereo .?. coverage promptly at 7·30 here on ??? TFL. More coverage, better than ever. This is coast to coast action, ??? TFL MV. You'll enjoy better coverage in Telfor (Telford?) 10·30 ????? A is for astronaut." A characteristic background musical accompaniment was noted. So far, a small town called Telford has been located near Philadelphia, but no matching call letters WTFL. The investigation continues.

Hugh Cocks, some 70 miles to the west of Romsey, was contacted but RUV ch. E3 was so strong there that nothing could be resolved through it. As far as I know, this is the first time that North American ch. A2 and A3 signals have been received in Europe. They came via double/triple hop Sp.E.

As regards more conventional reception, August remained a very active month, with a high level of Sp.E activity. There was an aurora on the 4th, and improved tropospheric reception during the last week. There was continued F2/TE reception, with Gwelo, Rhodesia ch. E2 putting in an appearance on several dates – in fact its reception is becoming rather a common event in the south of England, though it hasn't reached very far north.

Sp.E signals have arrived from most of Europe, with prolonged reception of RTVE (Spain) and NRK (Norway). Excellent Sp.E conditions were noted here on the 1st, 2nd (including Finland), 3rd, 8th (RTVE were using a variety of patterns), 10th (Rhodesia), 11th, 12th (Rhodesia), 14th, 15th, 16th, 17th (Rhodesia), 22nd, 23rd, 24th (Rhodesia again), 26th and 27th. Altogether an eventful and interesting month.

News Items

Jordan: Reports suggest that JTV is to transmit a daily one hour programme in French – so take care on ch. E3.

Canada: An unlicensed TV transmitter has been established in the North West Territory, radiating programme material recorded in the Buffalo NY area (USA), including commercials. The output comes from two stations in Buffalo. Transmissions last for some 20 hours daily. The radiated power is low, and it's expected that other transmitters in isolated areas will follow.

Sunspots: Sunspot activity may peak towards the end of 1979, not in early 1980 as earlier suggested. The Swiss Solar Observatory expects the smoothed numbers to reach 103 in November, 107 in December and 111 in January 1979.

United Kingdom: The IBA is transmitting a new experimental test pattern from its Rowridge, Isle of Wight transmitter (and its relays). The pattern generator was constructed and designed by the IBA.

New EBU Listings

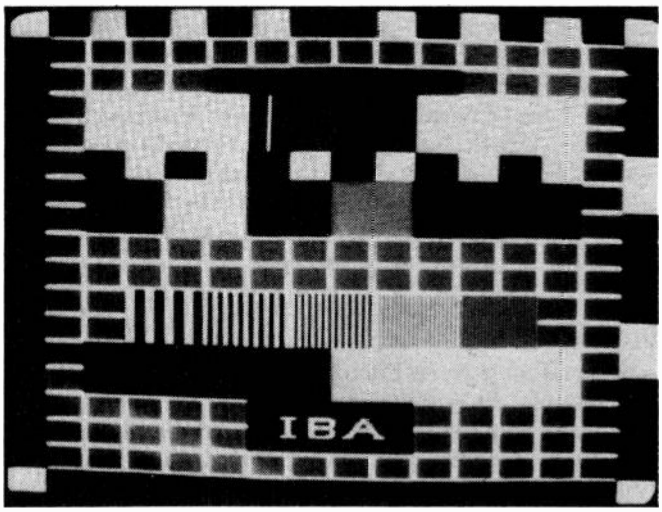
France: Saint Etienne TF1 ch. E35 10kW horizontal; Limoges TF1 ch. E56 1000kW horizontal; Niort FR3 ch. E58 310kW horizontal.

Eire: Cairn Hill RTE-2 ch. E43 800kW horizontal.

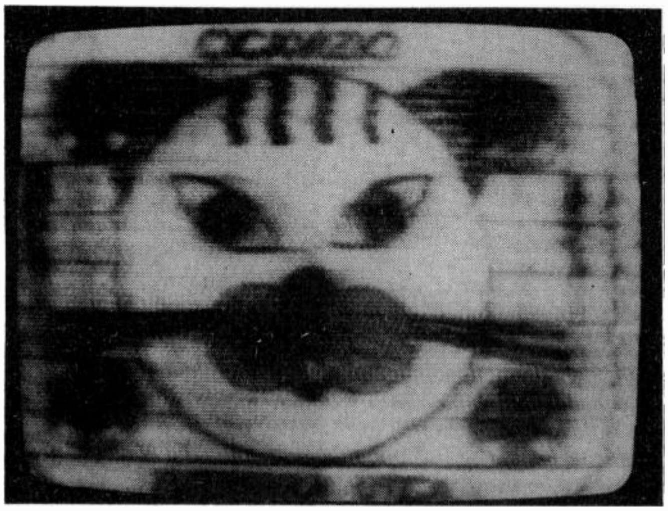
Morocco: Boukhoual RTM ch. M5 520kW horizontal. Ch. M5 vision is at 171·25MHz – a good one for MS reception.

Astra Aerials

Having noticed the Astra (D.I.Y.) Aerials advertisement alongside this column for several months, I decided to contact the Dwyer family – who are Astra Aerials! The business was started in 1954 and currently stocks a vast range of aerials and associated equipment, both of UK and continental manufacture. It's very obvious that they've gained a great deal of practical experience over the years,



The IBA's new electronic test pattern, which is undergoing evaluation. A sixth set of frequency gratings has since been added – sinewaves, same frequencies as Test Card F.



Italian "free" TV test card received by D. F. Browne.

and are consequently well qualified to advise upon and undertake even the most difficult reception projects and installations. Aerials stocked include the wideband v.h.f. Antiference MH308 and MH311. An aerial rigging crew specialises in large masts and rotor systems. Enquiries should be accompanied by an SAE.

From Our Correspondents . . .

We've had a vast pile of mail this month! Cyril Willis (Cambridge) sent in a long list of tropospheric successes at u.h.f., using a group A aerial with a Labgear 6040/WB amplifier, feeding a 22in. Pye colour receiver and an Ekco monochrome dual-standard set. Though Cambridge is low, he managed to resolve Dutch and French signals.

Des Walsh (Co. Tipperary) reports that he's received ch. 40/43 signals from Cairn Hill, a distance of some 140 miles, at up to 50μV, despite intervening hills. Des is using a Wolsey Colour King and suggests that much of the signal is due to diffraction. Apparently reception in the Cork area is more difficult, due it's suspected to the more rounded hills there than the rugged Tipperary terrain. Des goes on to say that in December 1977 Harlech TV signals at about 860MHz were received along the Waterford coast, from the NE. This is above any allocated frequency at present, and could possibly have been the result of activity by a commercial relay company. The signals were "very clear".

Garry Smith (Derby) has received the normal electronic RTVE (Spain) test pattern, but including a black bar. Since the reception was on ch. E3, it's thought that the signal could have come from the Canary Islands, the pattern relayed via Intelsat 4a with the Madrid time removed (the Canary Islands' time is an hour later than mainland Spain).

Finally Derick Browne (Portslade) reports a most remarkable reception, on July 8th on ch. E3 for about two minutes, at 1925. He thinks the signal was from an Italian "free" transmitter (see accompanying photo) as the test card is not one of the recognised ones.

Interference

In a recent column I went into the subject of electrical interference in some detail, including arcing from thermostat contacts. It's been pointed out that Radiospares have a reasonable selection of mains suppression and contact filters, one of particular interest being called a "contact suppressor". This is a small, encapsulated component containing an 0·1μF capacitor and a 100Ω resistor in series, with a maximum voltage rating of 250V a.c. The filter is connected across the switch, relay contacts etc. to suppress interference caused when switching reactive loads.

Varicap Tuners

Quite a number of v.h.f., u.h.f, and v.h.f./u.h.f. varicap tuners are now available, and selection of a suitable one for DXing can be a confusing business. Regular advertisers Sendz Components seem to have a vast number of tuners, many of Telefunken manufacture. Those I've obtained from them have generally proved to be extremely useful, a good example being the "new v.h.f. varicap tuners covering 49-219MHz". These were apparently made for use in Australian receivers, and normally cover chs. E2-4 and up to 110MHz in Band I (ideal for sweeping through the European Bands I/II), and approximately 135-225MHz in Band III. Excellent value at £1.50. Sendz can usually supply a circuit on request with order, and exchange faulty units.

The first Mullard varicap tuner with full Band I/III coverage was the ELC1042, which requires a 12V l.t. supply and Band switching voltage and an 0·3-28V tuning supply. A noise figure of 7dB in both Bands is quoted, with power gains of 20dB and 22dB in Bands I and III respectively. Signal handling capability without overloading is 20mV in Band I and 13mV in Band III. The later ELC1042/05 has a slightly improved performance, with a 2dB higher Band III power gain.

The Mullard V311 is a late production v.h.f. tuner featuring improved overload performance, lower noise and a higher gain at 25dB in Band I and 26dB in Band III.

The Mullard u.h.f. range is larger. The partner to the ELC1042 is the ELC1043, which requires the same supplies. The later ELC1043/05 has a 2dB higher gain at 22dB and an average 1·5dB lower noise figure at 6·5dB. The /06 version has a lower gain than the /05 due to the i.f. output coil being damped by a 680Ω resistor. The overload figure is given as 15-20mV compared to the 8mV of the original ELC1043.

The new U321 u.h.f. tuner features pin diodes for gain control. It's designed for good overload performance, and can handle in excess of 20mV throughout the range. The average power gain is 22dB with a noise figure of 7dB. The U321-LO is similar but modified for use with digital tuning systems. The U322 is also similar but has a higher gain at the h.f. end of the u.h.f. band – a 26dB power gain is quoted at ch. E69. For further details of these new tuners see Part 2 of the colour receiver project elsewhere in this issue.

Undoubtedly the most sought after Mullard varicap tuner for DX purposes is the ELC2000S, though it's usually difficult and expensive to obtain. The ATS-6 satellite was received here at Romsey using one of these tuners, the other tuners available here not quite reaching 860MHz. The coverage is 47-88MHz in Band I (ideal for Sp.E, covering all channels from E2 to IC inclusive), 170-230MHz in Band III, and 470 to over 860MHz at u.h.f. The supply voltages required are the same as for the other Mullard tuners. The power gain in Band I is 29dB, Band III 28dB, u.h.f. low 32dB, high 33dB, and the noise figures are 6·5dB in Bands I/III and 9·5dB at u.h.f. Altogether a reliable, high-gain tuner which I thoroughly recommend.

FET Circuits

Our Abu Dhabi correspondent Allan Latham recently sent in a couple of interesting circuits using f.e.t.s. They've proved to be most successful apparently. The masthead amplifier (see Fig. 1) uses a dual-gate, n-channel MEM680 to give wideband Band I coverage. My own previous

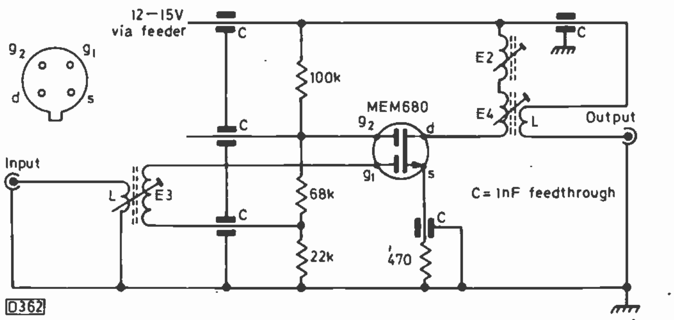


Fig. 1: Wideband f.e.t. amplifier covering chs. E2-4 inclusive. Coil data: E2 12 turns, E3 10 turns, E4 eight turns 24 s.w.g. close spaced ¼in. diameter. L 3 turns wound at dead end. For non-masthead use connect earthy end of output coupling coil to chassis. Observe normal v.h.f. constructional practice.

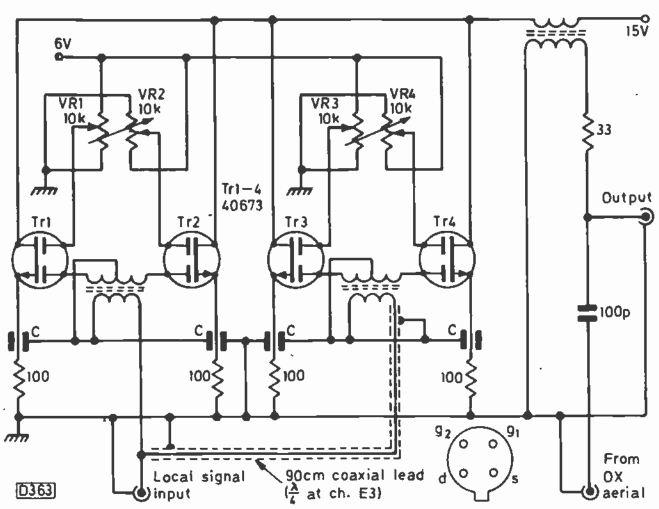


Fig. 2: Electronic phasing unit for Band I use. Coils wound on ferrite beads, primary 3 turns, secondary 5 turns with centre taps where indicated.

experiments using E300 f.e.t.s revealed that they worked well in the narrow-band mode but didn't like wideband operation. Allan's circuit with the double-tuned load seems to work well however – the power is fed to the amplifier via the downlead.

The second circuit (Fig. 2) should help all those Band I enthusiasts plagued with "interference" from a strong local signal. Previous experiments feeding a phasing circuit with the signal from the DX aerial (containing both the DX and local signals) and a signal from an aerial orientated for maximum local signal pick-up, adjusting the phase and amplitude of the latter so as to cancel out the local signal picked up by the DX array, met with fair success but needed careful adjustment for good results – while any rotation of the DX aerial meant that the phasing unit's two controls required retuning. The circuit Allan has devised is by all accounts a successful electronic equivalent using f.e.t.s and providing easy tuning with carbon potentiometers.

Basically, the local signal is fed to two balanced pairs of 40673 dual-gate n-channel f.e.t.s, with a 90° phase shift in one feed, the ganged potentiometers (of the type used for stereo amplifiers) being used to adjust the gain and phasing relative to the signal from the DX array. The result is virtual elimination of the unwanted signal, with very easy adjustment. Allan comments that he's used the circuit with great success over many months, but wishes to stress that it's purely experimental. We'd like to hear from anyone who tries it. Adjustment to phase out the local signal takes only a few seconds.

Colour Receiver Project

Part 2

Luke Theodossiou

Introducing the signal board

FOLLOWING last month's very simple power supply board, we now get our teeth into some real circuitry. For a while the author was tempted to design a modular signal board – there's such a big song and dance about modules these days. The idea was finally rejected on the grounds of expense and unnecessary complexity. It's true of course that modular construction makes for more instant servicing – but only if you have replacements ready to hand: how many constructors would be prepared to go to the trouble and expense of building spares? You should have no difficulty in servicing the design adopted however. By the end of the project you should also be so familiar with the circuitry and layout that diagnosis and cure will be fairly simple should faults develop.

The board we start to deal with this month contains the signals side of the receiver. It takes the aerial signal and delivers R, G and B outputs to drive the c.r.t. cathodes – also an audio signal to drive the speaker. It could be called a "five-in-one" panel, i.e. tuner, i.f., chroma decoder, video output stages and sound channel. We'll try to describe the circuit in a logical manner (allowing for the author's shortcomings), starting with the tuner.

The tuner

The tuner was first mentioned over a year ago as a new product from Mullard, destined eventually to replace the ELC1043 and its derivatives. The new unit, the U321, is smaller than its predecessor, boasts improved performance, and has already put in an appearance in the Philips G11 chassis and the ITT CVC40 16in. portable chassis. We'll probably see more of it elsewhere in the future. Since we haven't to date described the unit, a fairly close look at it is in order.

R.f. stage and a.g.c.

The circuit is shown in Fig. 1. The r.f. stage consists of a BF480 high-current, low-noise transistor which is preceded by a pin diode attenuator using two BA379 diodes (D7004 and D7005). The receiver a.g.c. system controls the current through these diodes, which behave as a virtually linear u.h.f. attenuator. Current flows out of the tuner and is "sinked" by the TCA270S i.c. in the detector module. At maximum a.g.c. current (this is externally limited to 9mA), D7004 is hard on, while D7005 is switched off (high impedance). This results in minimum attenuation and therefore maximum gain. As the current decreases, the d.c. bias on the diodes is such that at minimum a.g.c. current (1mA) D7004 is switched off and D7005 is hard on. This shunts the signal to earth via C2007, and leads to minimum gain.

Signal handling

Since signal attenuation occurs at the input of the tuner, the signal handling capability is increased compared to previous designs in which the gain of the r.f. amplifier was controlled by the a.g.c. potential. There's a dip in the in-band cross-modulation characteristic however, due to the influence of the BF480's emitter current variations – the emitter is d.c. coupled to the pin diode attenuator to optimise the a.g.c. characteristic. Overall, the cross-modulation performance of the U321 tuner is something like ten times better compared to other tuner units in current use. This is a direct result of using a pin diode attenuator and a high-current r.f. stage.

Mixer stage

The oscillator is conventional, using a BF480 (Tr7002) transistor and its associated components. The mixer stage is somewhat unusual though. It uses a Schottky diode, type BA280 (D7006). The conventional transistor mixer can suffer from signal handling problems due to its non-linear characteristic. The result is poor cross-modulation performance. Using a diode improves the performance but results in a conversion loss (unlike the transistor mixer, which is why the latter is normally used). In this design, the loss is made up by the additional common-base i.f. amplifier stage built around the BF324 transistor (Tr7003). Note that there is no d.c. return path for this transistor – it's provided by R410/R412/L411 in the vision gain/selectivity module. This arrangement makes the output circuit more flexible so that it can be readily interfaced with a variety of i.f. strip designs. Needless to say, tuning is performed by varicap diodes.

Incidentally, the Schottky barrier diode (to give it its full title) may be a newcomer to some readers. It consists of a semiconductor (silicon) to metal rectifying junction which eliminates charge storage effects since the offending semiconductor junction capacitance is not present. Other properties include a lower forward voltage drop, which results in lower power dissipation, low reverse leakage current and fewer reflection problems.

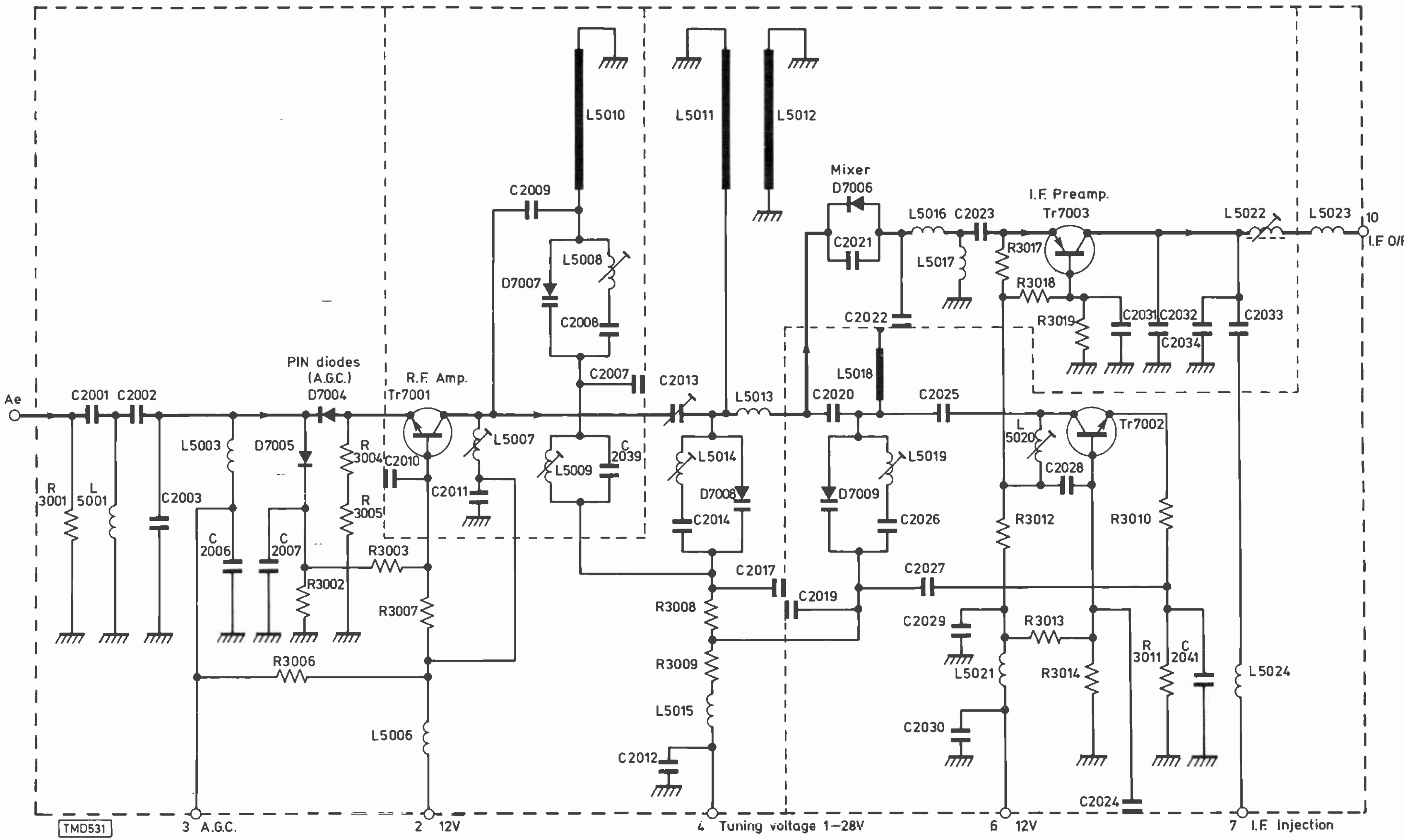


Fig. 1: Circuit diagram of the Mullard U321 tuner. The bold line shows the main signal path, whilst the dotted lines indicate metal screening.

Last month in the components list for the power supply we neglected to mention the regulator i.c.s: IC1 is a 7824 and IC2 a 7805. They are each mounted on a 10·5° C/W heatsink (RS Components stock no. 401-964). Most of the connectors we have used in the project are the Molex 0·2in. p.c.b. mounting types. They come in strips which can be very easily cut to the required number of ways. The reference no. is 3003-x, where x is the number of pins. We have found that the 15-way is probably best, since it results in little waste. We shall deal with the mating connectors when we come to the interconnections.

The i.f. output from pin 10 of the tuner is directly coupled to the Philips vision selectivity and gain module (from the G11 chassis). This and the following vision detector module are prealigned, ready-made units and were chosen for a number of reasons. First, using these units cuts out all i.f. strip alignment, making the construction of the signal board wholly uncritical. This would not have been so had we decided to design our own i.f. strip, even if a surface acoustic wave filter (SAWF) had been used. The detector, a.f.c., 6MHz attenuator and 4·43MHz subcarrier trap would still have needed setting up – and the first two of these adjustments are very critical. A glance at the signal board circuit (Fig. 3) shows the simplicity of the i.f. strip as a whole.

Secondly, since all alignment has been dispensed with, consistent receiver performance is assured. If the board is correctly built, the least that can be guaranteed is that a video signal will be present at the output of the i.f. strip – in many cases both sound and a picture should appear on switching on, without any adjustments whatsoever. This would not have been the case if the constructor had to build his own i.f. strip!

Thirdly, the author loathes winding all those damn coils! If coils had been bought in they would have been rather expensive – also the signal board would have had to be larger to accommodate a "flat-on-your-back" i.f. strip p.c.b. design.

The modules win!

Overall then, and not forgetting their reasonable price, these modules offer the constructor distinct benefits, while the quality of the signals is very good. We understand that Philips are in the process of updating the two modules, with the incorporation of a SAWF and an up-to-date i.f. i.c. Should this happen, the new modules are likely to be plug-in replacements for the current ones. As soon as we have more definite information on the introduction of the new modules we will let you know. There's no need to wait for the new modules on performance grounds however, as we don't think they will offer any improvement. We believe that the aim of the exercise is to simplify production, since the performance of the current circuits is very high indeed.

Selectivity and gain

The circuit of the vision selectivity and gain module is shown in Fig. 2. It's quite conventional, consisting of a medium-gain, three-stage amplifier with little selectivity. The first two stages are choke-capacitor coupled, the final stage being *RC* coupled to the synchronous vision demodulator i.c. in the following module. The bandpass response is determined mainly by the selectivity filter between the tuner and the i.f. amplifiers. The i.f. coil in the tuner is part of the selectivity filter.

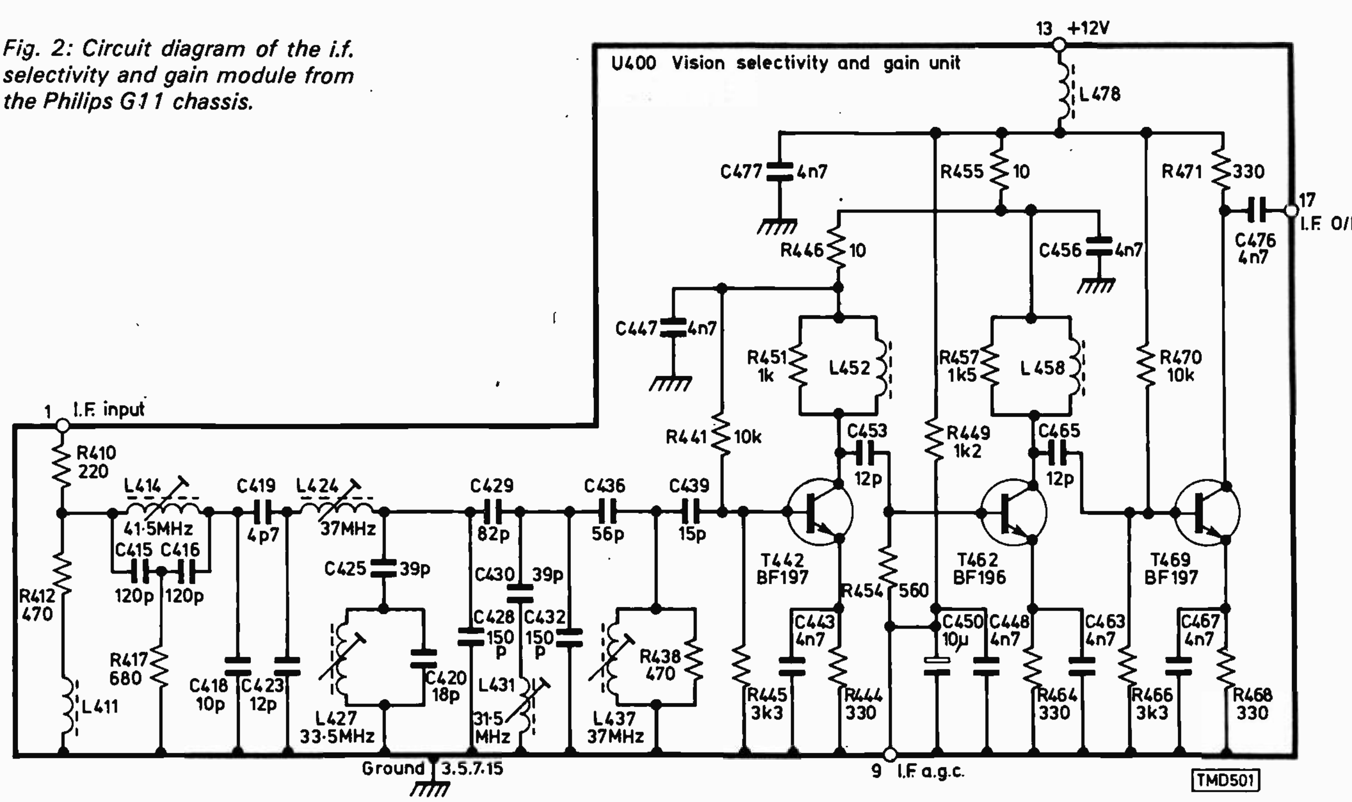
Forward gain control is applied to the second i.f. amplifier stage. The a.g.c. crossover characteristic is modified by the action of the external zener diode D1, which is used to "catch" the i.f. gain control voltage.

Vision detector

The amplified i.f. signal appears at pin 17 of this module and is directly linked to pin 1 of the vision detector module. The circuit for this module is shown in Fig. 4. The signal first passes through a double bridge-T filter which rejects the channel 1 vision and sound carriers which can be picked up by the vision selectivity and gain module (due to the use of untuned gain stages) in areas of high signal strength such as Crystal Palace.

The TCA270S i.c. is too well known to warrant much comment. Suffice to say that is produces both negative- and positive-going video signals; an a.f.c. signal; and i.f. and tuner a.g.c. signals. There are two quadrature coils, L626 for the vision synchronous demodulator and L630 for the a.f.c. synchronous demodulator. The a.g.c. detector is gated by negative-going line pulses which are fed in at pin 16 of the module.

Fig. 2: Circuit diagram of the i.f. selectivity and gain module from the Philips G11 chassis.



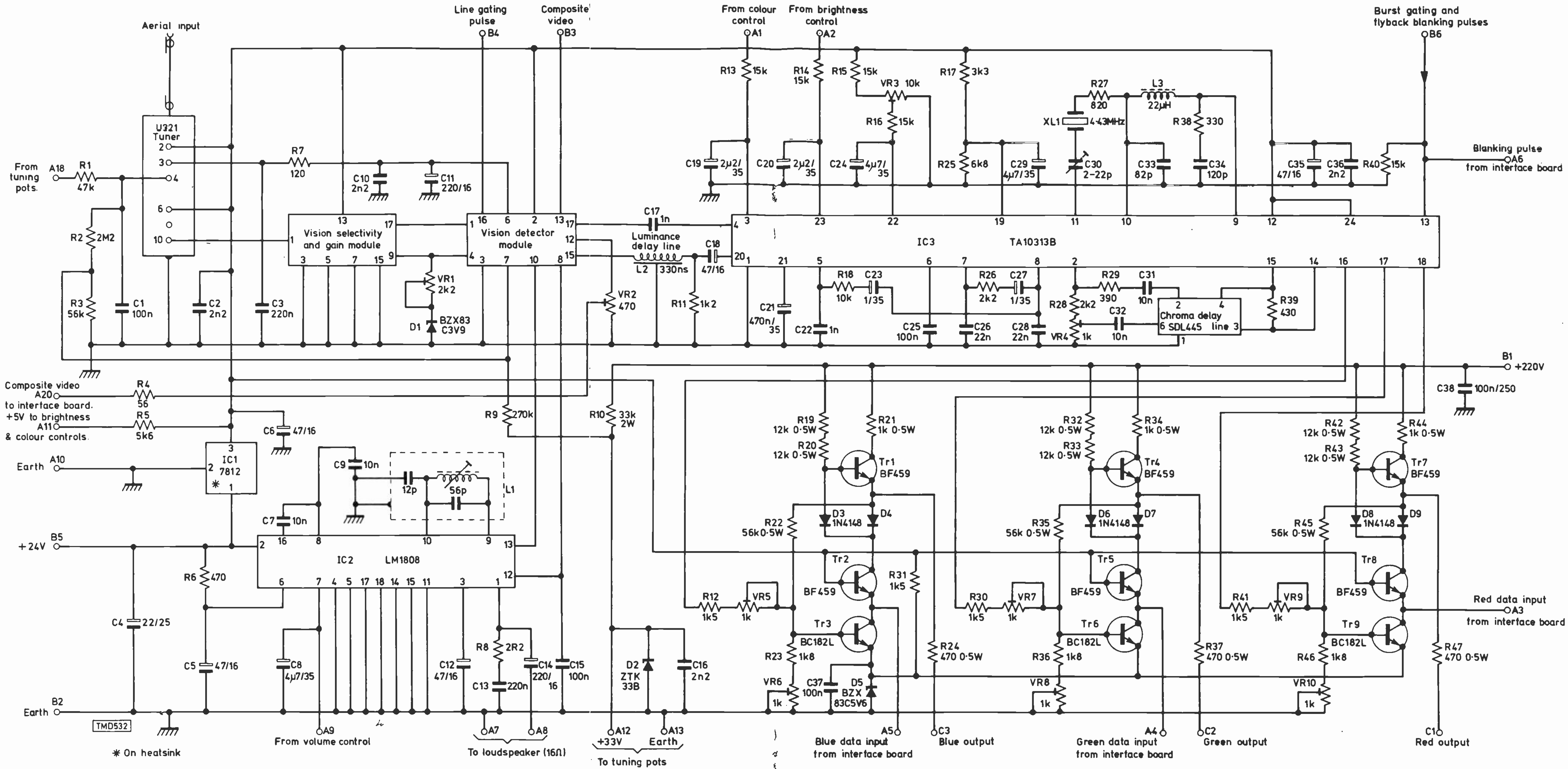


Fig. 3: Complete circuit diagram of the signal board.

The positive-going video signal appearing at pin 9 of the TCA270S passes through a 6MHz trap (L641) to remove the intercarrier sound from the video signal which is then applied to the emitter-follower T653. The load resistor for this stage is R654, which must be removed from the module before this is soldered to the p.c.b. The reason for this is that the Tifax module we shall be using to decode the teletext signal needs a positive-going video signal whose amplitude must be adjusted between 1V and 3V peak-to-peak to obtain optimum performance from the data slicer circuit on the Tifax module. We therefore remove this resistor and replace it externally with a 470Ω preset (VR2). The operation is quite straightforward, but be careful with the soldering iron as the module's component density is very high. The connection from the emitter of T653 is brought out to an unused pin (pin 12), using an insulated wire.

From this point the signal goes two ways. First through a high-pass filter consisting of C651 and L650, which removes the sync pulses and luminance signal. The resultant chroma signal is then applied to the emitter-follower T668, appearing at pin 17 of the module. It's then coupled to the luma/chroma processor i.c. (IC3) via C17.

Luminance

Secondly, from the emitter of T653 the video signal passes through R661, after which the 4·43MHz trap C656/C657/L658 removes the chroma signal, then through R665, the resulting luminance signal appearing at pin 15 of the module. It's then applied to the luminance delay line. Note that the series combination of R661 and R665 matches the delay line impedance, so no external matching resistor is necessary.

The tuner a.g.c. voltage appears at pin 4 of the TCA270S, then at pin 6 of the module. After decoupling at both low and high frequencies by C11 and C10 respectively, it's limited to 9mA by R7, further decoupled by C3 and applied to the tuner. The a.g.c. crossover point is determined by VR1.

A.f.c.

The a.f.c. voltage appears at pin 7 of the module. The centre point voltage is determined by the potential divider consisting of R3 and R9 from the +33V stabilised tuning supply. With the values used, this is 6V; i.e. when there is no a.f.c. correction voltage from the TCA270S, this is the reference a.f.c. voltage. When the i.c. provides a correction voltage, the reference voltage either increases or decreases (depending on the output from the i.c.) and this information is added to the tuning voltage via R2. The "fierceness" of the a.f.c. action is determined by this resistor.

The negative-going video signal from the TCA270S appears at pin 13 of the module. This is connected to the sync separator i.c. on the timebase board.

6MHz extraction

The 6MHz intercarrier sound signal is extracted from the video signal by a top-coupled bandpass filter, using

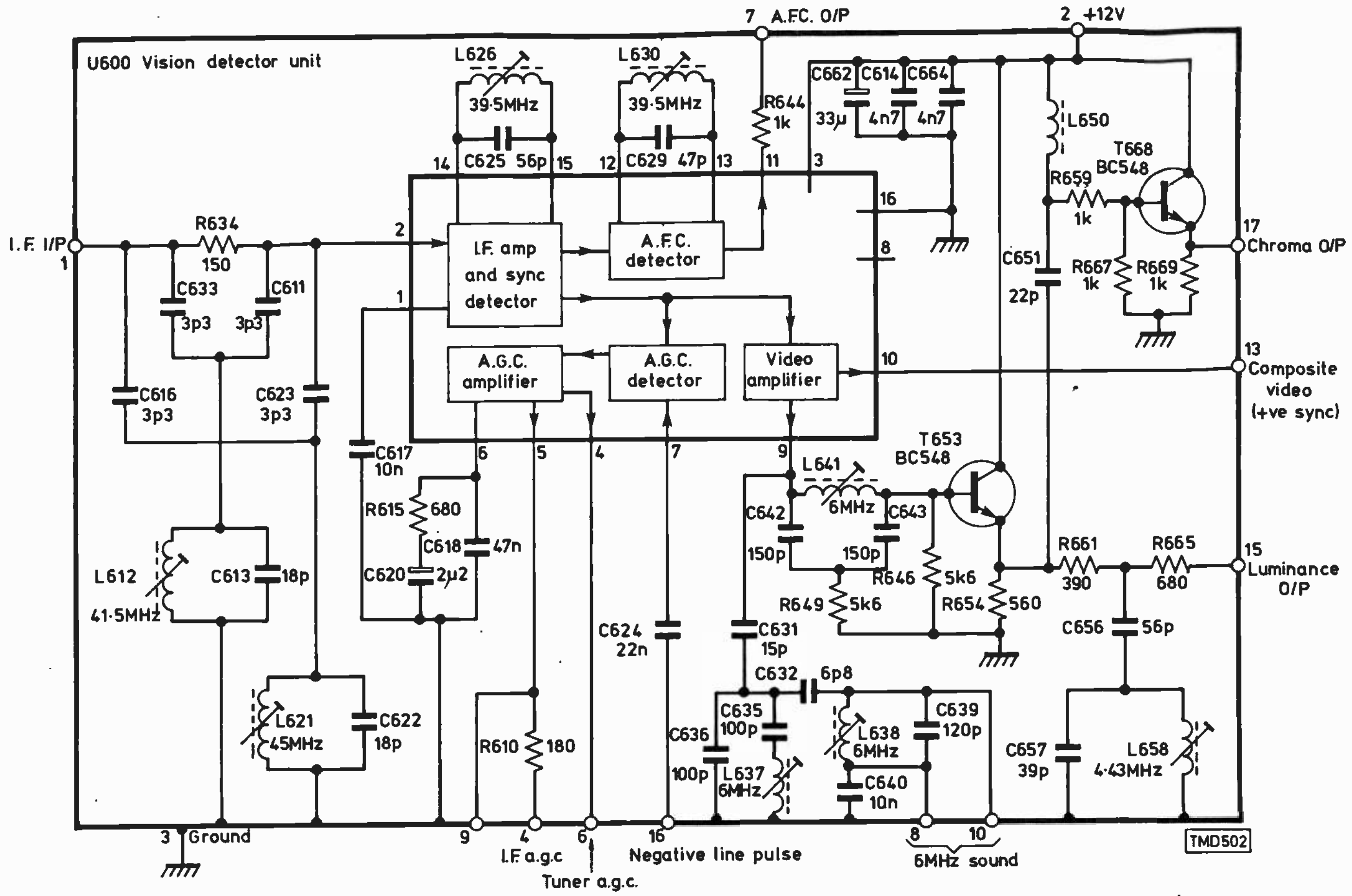


Fig. 4: Circuit diagram of the i.f. vision detector module from the Philips G11 chassis. See text for details of minor operation required to enable teletext reception.

inductors L637 and L638. The primary of this filter also incorporates a broad 4·43MHz notch filter. The 6MHz signal appears at pin 10 of the module. Pin 8 of the module is decoupled, both inside the module by C640 and outside by C15, and is at the same d.c. potential as pin 10 (via L638). This potential is used to provide bias for pin 13 of the LM1808 sound channel i.c. (IC2), coming from pin 12 of the i.c.

The LM1808

The sound channel i.c. has been described in a previous issue of *Television* (see December 1976) but a brief mention is included for completeness. There are a number of such i.c.s now on the market, but we chose this particular one for two main reasons. First it uses the least number of external components; secondly it doesn't need a heatsink.

A block diagram of the device is shown in Fig. 7, while Figs. 5 and 6 show the circuits of the i.f./detector and the power amplifier sections respectively. The i.c. provides a minimum of 2W output (although the typical figure is 3·5W) which we considered ample for all domestic listening conditions. The i.f./detector section is very similar to the LM3065. The main difference is in the volume control circuit, which is now a linear function of the volume control potentiometer (a logarithmic potentiometer is therefore required).

The audio power amplifier is similar to that of the popular LM380. Both short-circuit and thermal protection are featured, so it's pretty difficult to destroy (the author managed it once though!). The device is housed in a standard 18-pin d.i.l. package. The main reason for the very low external component count is that the power amplifier has fixed gain, which is certainly an advantage when one of the prime objectives is to produce a simple design.

Audio quality

Some purists may disagree with the author's view that 2W is adequate. More to the point, the limitations of a speaker housed in a TV cabinet certainly degrades the audio quality. Two options are possible to obtain improved results. One is to include a socket so that an external speaker can be connected. If a standard DIN socket is used, the internal speaker will be disconnected when the plug for the external speaker is inserted. The other possibility is to extract the audio signal after the detector and feed it into the auxiliary socket of your hi-fi system.

Extracting an audio signal

Around 500mV of audio is available at pin 8 of the i.c. It should be connected to an amplifier input whose impedance is 47kΩ or greater. Two points here. Unfortunately the signal level at pin 8 is determined by the volume control (it cannot be extracted prior to the volume control circuit). Secondly, the use of a screened cable is essential, but the results may still be poor. The reason for this is that the timebases of the receiver cause high peak currents to flow through the receiver's earthing system. This can give rise to all sorts of additions to the audio signal. These are not normally audible through the receiver's speaker, but when the signal goes through a hi-fi system all the warts start showing. This approach has not been tried

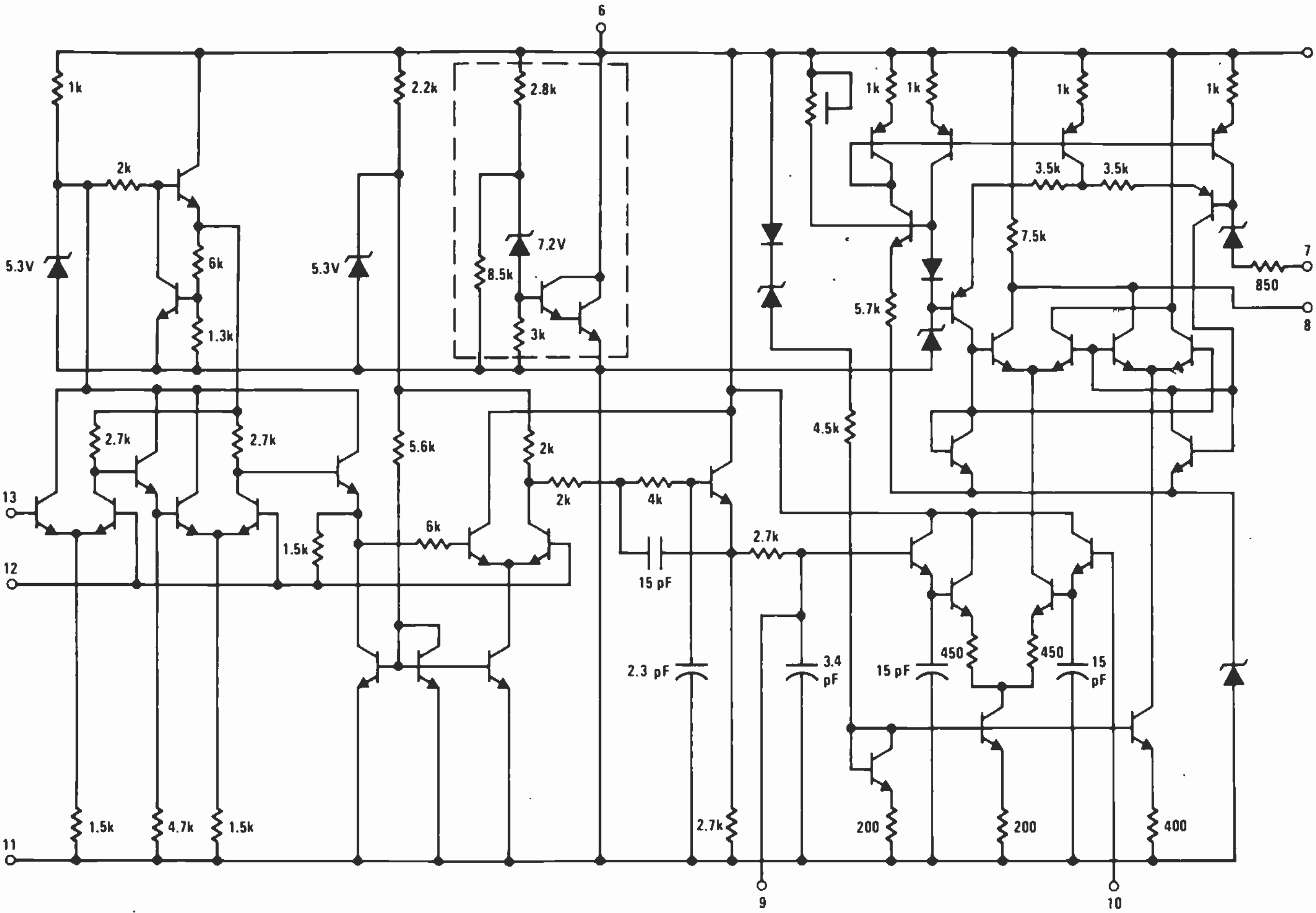


Fig. 5: Circuit diagram of the i.f. amplifier, detector and volume control sections of the LM1808 sound channel i.c.

by the author, but he would be interested to hear from any reader who may finally manage it. Incidentally, the positioning of the cable will prove critical, as will the position of the socket. This second method cannot be used unless the set is isolated from the mains.

Capacitor C9 provides de-emphasis; the audio signal is coupled to the power amplifier via C7. Resistor R6 feeds the i.f. section of the i.c., whose supply is stabilised around 11·5V (pin 6). The network comprising R8 and C13 ensures h.f. stability.

Supply Rails

All the small signal circuitry runs on +12V, which is provided by IC1 from the +24V rail used for the audio power amplifier of the sound channel i.c. The +33V tuning voltage is stabilised by regulator diode D2 from the +220V video supply rail via dropper R10.

Note that the RCA TA10313B decoder chip is still a development device. The decision to start quantity production has unfortunately been delayed, and it may therefore be necessary to use an alternative solution. The situation is being reviewed at the time of going to press.

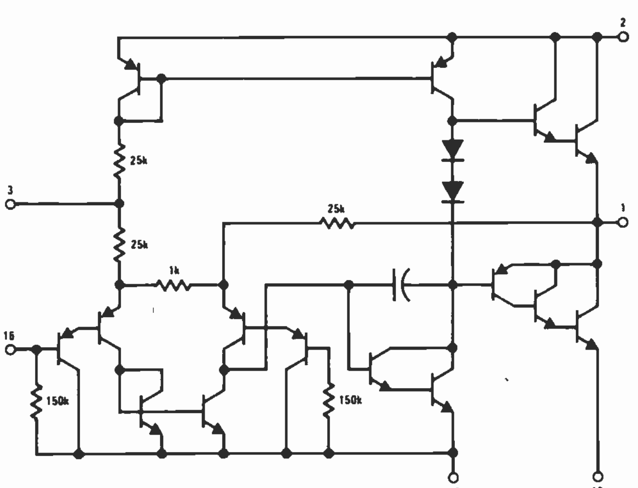


Fig. 6: Circuit diagram of the audio power amplifier section of the LM1808. This is very similar to the LM380.

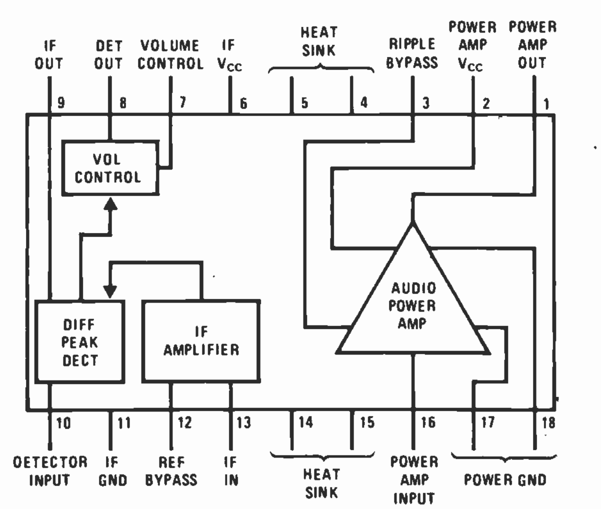


Fig. 7: Functional block diagram and pin-out of the LM1808.

Twisted Tails

Les Lawry-Johns

WE'VE had hot Pyes and burning Bushes, but the one we came across the other day takes the cake (Alfred's). You could call it a cooked up cake.

A nice young lady came in to pick up a few bits and pieces and casually mentioned that the next time she passed she would pop in a portable TV set which had been involved in a fire and could possibly be of some use for spares.

Sure enough, a couple of days later she popped in and left a twisted mass of plastic with us. Unfortunately, we didn't know her name or address and just accepted the mangled mass as a kind of burnt offering. When time permitted, we did a cut away job to see what was left inside. Much to our surprise the inside was practically untouched and was obviously almost new. If the on/off knob had not been welded to the front panel it could have been used.

Carefully arranging the component pieces on the bench we switched it on and everything functioned as it should, so we thought it worthwhile ordering a new cabinet from the makers.

On the phone this proved to be somewhat more difficult than we had anticipated. We explained that the set had been in a fire not of its own making, and that the complete outside shell was required.

A verbal tussle then ensued. We would have to specify exactly which parts were to be ordered. I never, in my ignorance, realised how many bits and pieces go to making up the cabinet of a portable TV set. Each piece was the subject of earnest discussion and apparently would be dispatched separately. So far four pieces have arrived, and by the time the rest have been accounted for the postage and packing will have cost more than the new one of the same type we have for sale. It would also appear that somehow we have ordered two of each piece!

Anyone want a £70 portable for £140?

We are never without a hybrid Pye colour receiver for very long. The report on this one said that for some time there had been a sparking noise from the back, the picture had been blurred and that finally there was lots of smoke and off it went.

Inspection showed that the long gondola type focus unit (697 chassis) was just a mass of twisted plastic which could not be separated from the VDR rod inside. This had broken anyway (hence the sparking from the rear, as the excessive voltage hopped across the focus spark gap with the slider wire contacting the rod above the break ... I think). The final demise came when the first anode supply $0{\cdot}1\mu F$ decoupling capacitor shorted and the associated $100k\Omega$ resistor cooked, as usual.

Replacing these items necessitates access to the component side of the panel, and a glance down inboard of the line output transformer showed R203 (the $47k\Omega$ reference pulse integrating resistor) to be in no fit state to be left in. In fact it just crumbled to dust when touched, so how the line hold had been locked we'll never know.

With these itmes in we were ready to check through the rest of the supply lines. These seemed to be in order. We could not check the thing however because we were out of the long VDR focus units. Phoning around proved that Don, Ray, Fred and Harry didn't have one either, which meant a delay.

Ever the impulsive type, we decided to hook up one of the square, thick-film types to a point of lower potential.

Now I don't know if you've ever looked at the tripler units used in these Pye group hybrids, but one of the three outlets is marked "focus" and connects to C226 on the transformer. Connecting the high end of the thick-film focus unit to this point, the centre to the focus lead and then earthing the low end produced just the right potential. The set was back in action and fit to fight another day.

Nothing to do with TV (as usual), but what is the answer to this one?

We ordered and received from a wholesaler some clock radios (UK made). One when unpacked was obviously not new, and on close inspection the guarantee card had been filled in and dated December 1977. We contacted the wholesalers (and their rep) who said they would collect it. Some time later they did. Some further time later a replacement was received. When unpacked, it proved to be the same set with the same filled in guarantee card.

We again contacted the wholesalers. "Good Lord" they said. "Fancy that!"

Will you collect it and supply us with a new one or give us a credit note for it?" we asked.

"Well, it's not really our pigeon. It's really between you and the makers you know. We have a directive from our head office that our responsibility ends when we have supplied goods to the dealer."

"Second-hand goods?" we queried.

"As far as were were concerned, all goods supplied by us are new."

So we thought about this and taxed the rep on his next visit. He said he knew how it had happened. When his branch were out of stock on some items they obtained them from another. It was obviously not intentional on their part, but they had sent one which had previously been returned to the makers for service by them instead of by the dealer who had given the customer a new set instead of loaning them one until their own was returned.

This left one used set which was now with us, and still is. The makers say they have discharged their obligations and have serviced the set, and that it is up to the wholesalers to put things right.

Back on the phone to the wholesalers who have now closed the branch where we obtained the set and are no longer trading in this part of the country.... Anyone want a new-used clock radio?

We called upon some friends to put their set right – an ageing ITT/KB VC4 used as a second set but still in mint condition except that the picture was dark and lacking width. Whilst we worked on the set, the lady of the house (a

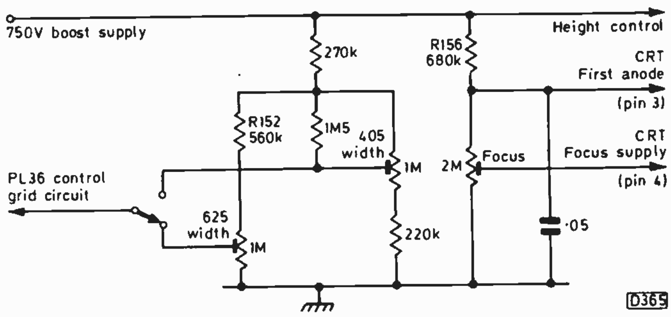


Fig. 1: Boost supply feeds in the ITT/KB VC4 and similar dual-standard monochrome chassis.

formidable character henceforward referred to as "our Glad") worked on the dog, an inoffensive black spaniel named Soot. In fact the set responded to our labours quite well, which was a good deal more than Soot did a short time later.

The lack of width turned out to be due to no more than a high-value resistor (R152, 560kΩ, see Fig. 1) in series with the 625-line width control, while the dark aspect was due to low voltage on the tube's first anode (pin 3 – there was also low voltage on the focus pin 4 with the control fully up). Following the supply lead back, we came to R156 which is a 680kΩ resistor going to the boost line. This had also gone high, and being in series with the focus control (to chassis) the result was that the voltage available at the top of the focus control had got lower and lower as R156 went higher and the focus control's value remained the same. So in went another 680kΩ resistor and the set then gave a full-width picture with plenty of brightness to spare.

While all this was going on, our Glad laboured with Soot. The idea was to comb out the tangled fur and clip off the surplus. Soot was becoming more and more anxious as Glad approached his rear end, and when Glad picked up the scissors his nerve snapped. It's one thing to have your sensitive areas combed, but when they are in danger of being clipped it is time to take action.

Giving a yelp of protest, Soot made for the door but found it closed. With his back to the door he prepared to do battle. He was not going to give up his vital organs without a fight. Glad was not used to dissention in the ranks however.

"Come here you stupid hound" she bawled in a voice which nearly shattered the windows. At the sound of that familiar trumpet Soot's courage deserted him. He slunk back to the spread newspapers and Glad's clutches. Just then Glad realised that I was ready to go.

"Sorry Les" she hollered. "This dozy dog made me forget you. How much do I owe you?"

I told her, but apparently her purse was in the kitchen.

"Hold on to him for a minute love she said more quietly. "Comb his ears or do something to keep him happy. They need clipping too."

So off went Glad and I soothed Soot.

"Has he got beautiful ears then?" I murmured, combing the long silky ears. "Does he want the naughty fur cut off? Yes, 'course he does." Being an expert on dogs, I grabbed the scissors and snipped at the long fur.

Soot gave an almighty scream and belted off dripping blood all over the carpet. At the same time I was surprised to find that as well as the fur I was also holding about half an inch of Soot's left ear in my hand.

Glad grabbed Soot as he shot through the kitchen and her scream rent the afternoon air.

"Ahhhh, Ahhhh, look at his bleeding ear. You've cut the end off."

I stood struck dumb for a moment, desperately searching for words.

"Er, well, you have to clip their ears Glad. Otherwise they dangle in the dirt and pick up all sorts of things: a vet told me."

Glad glared at me in disbelief. "You're supposed to clip the fur, not the ear, you bloody fool. Poor old Soot's going to look lop sided now until his fur grows."

"Sorry Glad, sorry Soot." And with the score at one TV set repaired and one dog with a clipped ear (neither chargeable) we beat a hasty retreat. Anybody want their dog groomed?

LED Channel Display System

Alan Damper

ONE of the problems of using varicap tuners for DX-TV is channel identification. Previous articles in *Television* have mentioned ways of solving the problem, the simplest being to use a meter fed from the tuning rail. Unless extra circuitry is included however the scale is non-linear and is therefore cramped at one end – usually the end with most of the required channels! An alternative solution is to use touch-tuning i.c.s, the problem in this case being that with the number of channels to be displayed for DX-TV the cost can be considerable. The unit described here indicates the channel tuned by lighting the appropriate LED. The number of channels catered for – twelve in the prototype – can easily be reduced or expanded as required.

Power Supply Circuit

The circuit can be split into two parts. First, the power supply which generates the 0-28V tuning voltage. Secondly, the display circuits which turn on a LED to indicate that the required channel is tuned in.

The power supply is shown in Fig. 1. The transformer, bridge rectifier and reservoir capacitor C1 present around 50V to the series regulator Tr1, R1, D1 which provides a regulated 35V supply – Tr1 acts as an emitter-follower, with its base voltage held constant by the 36V zener diode D1. The tuning voltage is set by VR1 and VR2 (coarse and fine tuning respectively). The potential at VR2's slider determines the voltage at the emitter of Tr3 and, due to the action of zener diode D2, the emitter of Tr4 is always at 5V less than this value. There is therefore a floating low-impedance supply available across R5 to power the display circuits. The tuning voltage itself is taken from the base of Tr4.

Display Circuit

The display arrangement is shown in Fig. 2. One of these circuits is required for each channel to be displayed. That may seem to be a lot of transistors, but they cost around £3.30 compared to around £10 for i.c.s providing twelve touch channels.

The LED D4 will light only when there is a certain potential between VR3's slider and the emitter rail for Tr6 and

★ Components List

Power Supply

Resistors:

R1	680Ω	1W
R2	10kΩ	½W
R3	47kΩ	½W
R4	560Ω	1W
R5	120Ω	1W
VR1	47kΩ	linear pot
VR2	2kΩ	linear pot

Capacitor:

C1	2200μF	63V

Semiconductors:

REC1	100V	1A bridge rectifier
Tr1, 3	BD131	
Tr2	BC107	
Tr4	BD132	
D1	36V	1·3W zener diode
D2	5·6V	1·3W zener diode

Transformer:

0-36V 500mA

Display circuit

(components for each display required)

Resistors:

R6	15kΩ	¼W
R7	6·8kΩ	¼W
R8	100kΩ	¼W
R9	22kΩ	¼W
VR3	100kΩ	horizontal preset

Semiconductors:

Tr 5,6,7	BC107	
LED	TIL209	or similar
D3	1N914	

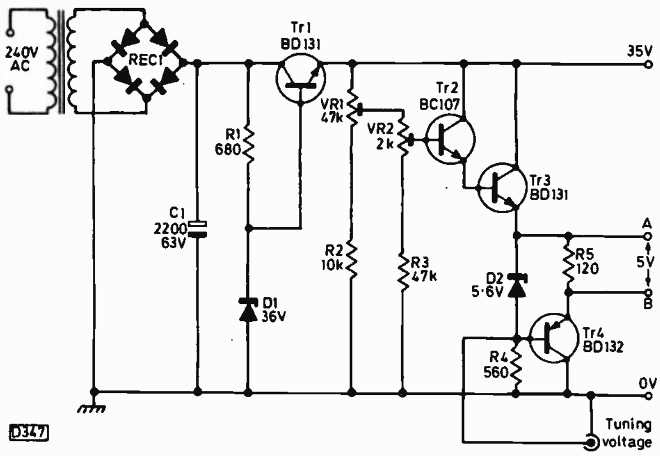


Fig. 1: Power supply circuit.

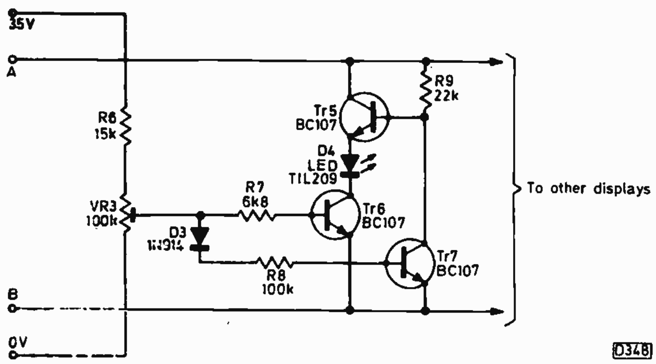


Fig. 2: Display section circuit.

Tr7. If the slider voltage is below this value both these transistors will be switched off, and although Tr5 is biased "on" no current will flow via the LED. As the potential rises above 0·6V, Tr6 will conduct and the LED will start to glow, increasing in brightness as the potential increases further. At around 1·2V (the sum of the forward voltage drops across Tr7 and D3) however Tr7 will start to switch on. Tr5 thus starts to switch off, depriving the LED of current. A point of maximum brightness occurs, and this can be used to indicate the exact tuning point.

In practice the emitter potential of Tr6/7 varies with the setting of VR1 and VR2, as does the rail (A) supplying the display circuit with a constant 5V. The setting of VR3 determines the point at which the LED lights.

Modifications

The prototype was built solely to provide a tuning voltage and a display, the other supplies needed for the tuner being available within the receiver. It would be a simple matter to derive a 12V supply from the 50V rail, together with a 0-8V "manual a.g.c." voltage, if these are not already available. Similarly, the 50V supply obtained from a transformer in the prototype could possibly be obtained from the receiver's own supplies, reducing the cost considerably.

When provided with adequate heatsinks, Tr3 and Tr4 can dissipate up to 11W. With the circuit values shown it's possible to drive many more than the twelve display circuits used in the prototype. A quick calculation suggested a limit of around 400 (well you never know – you might need them!!!) providing only one LED is lit at any time.

Construction

The method of construction is not critical. In the prototype the power supply section and the display circuits were built on two separate printed boards, but there's no reason why Veroboard should not be used throughout. The unit was built into an aluminium box, with the tuning voltage output available from a socket at the rear. Tr1, Tr3 and Tr4 should have heatsinks fitted.

Whether a separate transformer is used or the 50V rail is obtained from the receiver, all circuits *must* be isolated from the metal case which should be earthed.

Setting Up

Once the power supply has been built it should be tested by monitoring the tuning voltage output whilst varying VR1 and VR2 to check that the full tuning range is available. The displays are set up by tuning in the appropriate channel and adjusting the relevant preset (VR3 etc.) for maximum brightness of the associated LED. ■

The Language of Logic

Part 2

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

IN Part 1 we introduced the basic ideas of electronic logic, and explained how the basic circuitry used operates. We also saw how basic electronic logic systems operate. Since the groundwork has now been covered, the most compact way of taking the subject further is by way of a dictionary of terms used in electronic logic.

To keep within limits we've kept to common terms, omitting the more obscure and rare ones. Inevitably there's a lot of cross-referencing to other terms in the dictionary and Part 1. Cross-referenced terms are set in italics.

Access time: A measure of the performance of a *store* such as a *ROM* or *RAM*. It's the time between applying the *address* to the address lines until the data is available at the output lines.

Accumulator: A collection of *flip-flops* used to store one binary *word*.

Adder: A device or circuit for adding two binary numbers (see main text).

Address: In a *memory* such as a *RAM* or *ROM*, data is stored in the form of *words* (usually multiples of four bits). Each word is held in a specific location, which has a unique address. See Fig. 1.

The memory uses binary addresses, but it is usual to use *octal* or *hexadecimal* for convenience.

The address of a location is very similar to a postal address.

Analogue-to-digital converter (ADC): A device for converting an analogue signal to a digital form suitable for processing by a digital circuit. There are three main types of ADC, ramp, successive approximation, and parallel conversion.

A ramp converter is shown in Fig. 2. A free-running oscillator feeds a counter which in turn feeds a *DAC*. The counter cycles from 0 to full house, generating a ramp

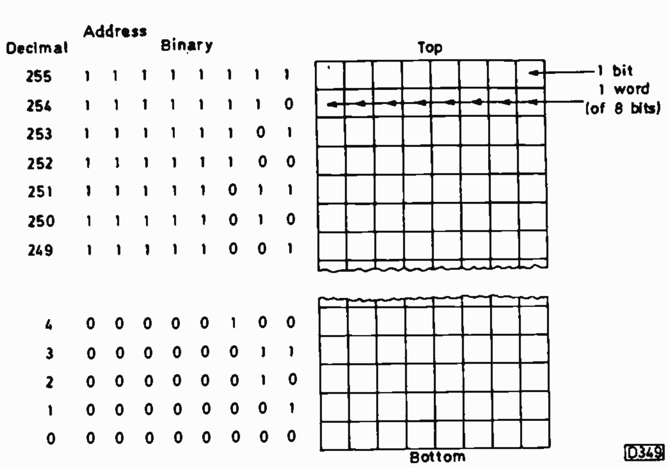


Fig. 1: A 256-location store, each location holding an eight-bit word.

output from the DAC. The ramp voltage is compared with the input voltage, and when the two are equal the counter state is gated into the output *latches*.

A successive approximation converter asks a series of questions, each of which reduces the range in which the voltage can lie. Suppose we have an input voltage range of 0 – 10V, and our voltage is 6V.

First question: "greater than 5V?"
Yes. Most significant bit is 1.
Next question: "greater than 7·5V?"
No. Next bit is 0.
Next question: "greater than 6·25V?"
No. Next bit is 0.
Next question: "greater than 5·625V?"
Yes, Next bit is 1.
Next question: "greater than 5·9375V?"
Yes. Next bit is 1.
Next question: "greater than 6·09375V?"
No. Next bit is 0.

And so on, each time halving the range in which the voltage can lie. This somewhat complex process is summarised in Fig. 3. The logic of a successive approximation ADC is obviously more complex than a ramp type.

Finally we have the parallel converter. This is a sledgehammer technique with the input voltage being fed to a bank of comparators. The logic sees which comparators are turned on and sets the corresponding output bits. See Fig. 4. Note that eight comparators are needed for a three-bit output. For a four-bit output 16 comparators would be needed, for five bits we would need 32. Parallel converters get complex and expensive for high resolution.

Important parameters of an ADC are resolution (the smallest voltage step we can recognise), conversion time (the time to get a result) and cost. Obviously there is the usual engineering trade-off.

Type	*Resolution*	*Speed*	*Cost*
Ramp	Medium (8 bits 0·5%)	Slow (10mS)	Low
Successive Approximation	Excellent (14 bits 0·01%)	Medium (1μS)	Medium
Parallel	Poor (5 bits 3%)	Very Fast (0·1μS)	Expensive

ADCs are widely used to convert TV signals to digital form for digital transmission between studios and transmitters.

And gate: A logical gate. See Part 1

ASCII: American Standard Code for Information Interchange. An eight-bit code for transmission of alphabetic, numeric and control characters. It uses seven data bits and one *parity* bit for *error checking*.

Asserted: A quick way of defining a particular digital signal. If we have a digital signal that represents oil level,

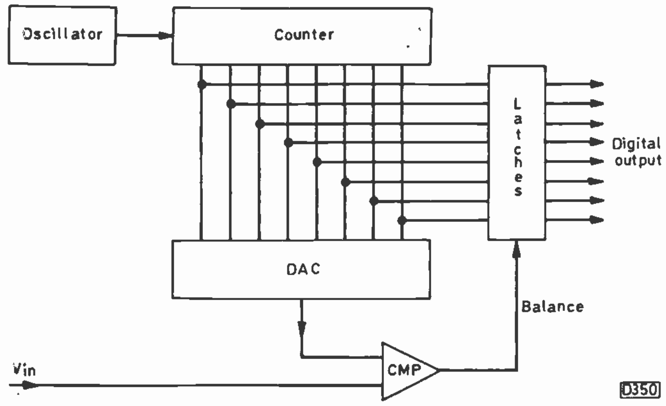


Fig. 2: Block diagram of an eight-bit ramp ADC.

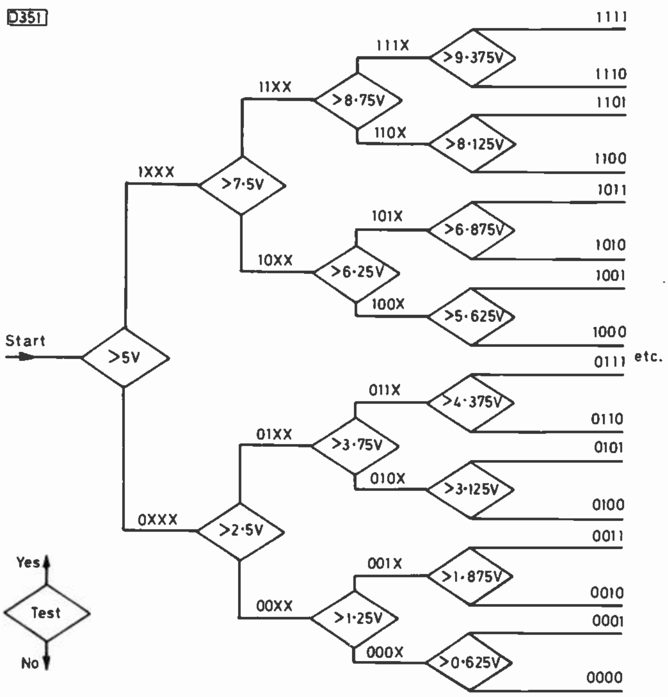


Fig. 3: Operation of a successive approximation ADC.

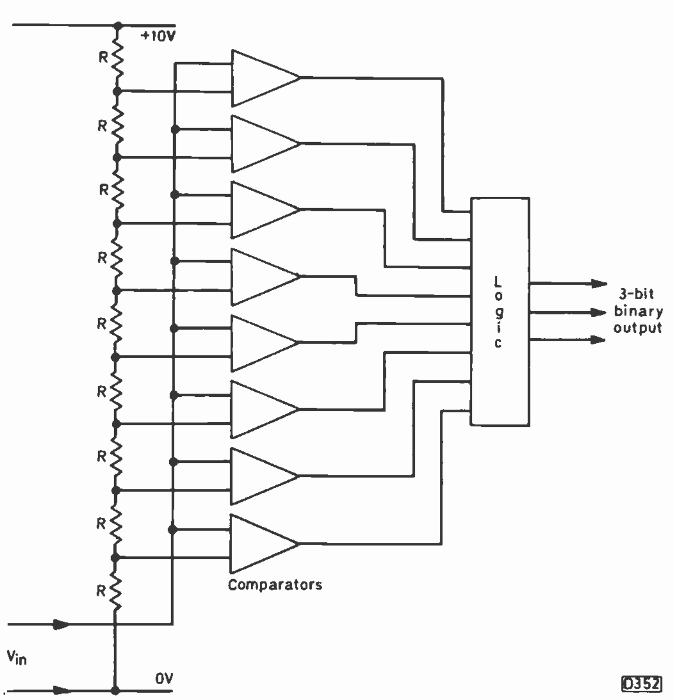


Fig. 4: The parallel ADC.

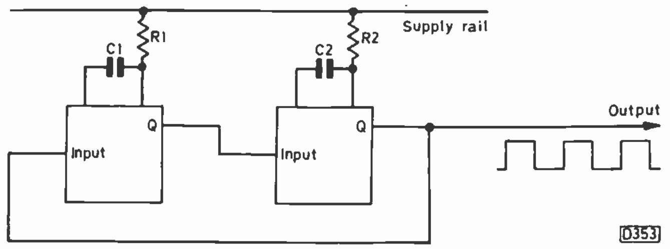


Fig. 5: Two monostable i.c.s connected to form an astable oscillator.

say, and is a 1 for oil level low, we describe the signal as "oil level low, 1 in the asserted state."

Astable: A digital oscillator giving a continuous stream of 1 and 0 signals. See Fig. 5. The astable can be made from a conventional multivibrator, or two *monostables* connected as shown.

Asynchronous: Large digital systems can be asynchronous or *synchronous*. In a synchronous system all operations are performed at a regular rate controlled by a central *clock* which acts like an orchestra conductor. In an asynchronous system each part of the system does its own thing in its own time, and there is no synchronisation of operations.

Baud: A measure of the speed of a digital transmission network. A baud is a rate of one-bit/second. A 300 Baud line can thus pass 300 bits per second.

Binary-coded decimal (BCD): BCD is a halfway house between our decimal system and pure binary. Each decimal number is encoded into a four-bit binary number, e.g.:

4	0	5	9
0100	0000	0101	1001

the resulting BCD number being 0100000001011001.

BCD is a slightly inefficient use of digital techniques. A true binary representation of 4059 is 111111011011 which uses 12 binary digits as opposed to the 16 of BCD. BCD is useful though where the digital logic is required to do only simple arithmetic operations (e.g. channel displays).

Note that each four binary bit group in BCD can only assume states 0000 to 1001. States 1010 to 1111 representing 10 to 15 are not allowed.

Binary: A number system based on base two. States 1 and 0 are the only states allowed, hence counting goes:

0	1	2	3	4	5	etc.
000	001	010	011	100	101	etc.

See Part 1 for further details.

Bistable: A circuit having two stable binary states. See *flip-flop*.

Bit: A shorthand way of writing binary digit, i.e. a signal with only two possible states, 1 and 0.

Buffer: A store for a binary *word* (which is usually 1, 4, 8, 12, 16, etc. bits long). A buffer is an isolating device, and stores a word between devices such as an *ADC* and the rest of the system.

Bus: A shorthand version of busbar. In digital systems a binary signal goes to several places, e.g. an *adder*, a *RAM*, an *ADC* and an output device. These are all connected by a common ribbon cable called a bus, which carries all the data. See Fig. 6. Signal flow along the bus is bidirectional, e.g. RAM to ADC and ADC to output. The actual transfer is controlled by the control logic. See *tri-state gate* and *open collector*.

Byte: A binary word of eight bits. Experience has shown that this is a convenient size for a binary number. A few years ago there was a suggestion that a four-bit word should be called a "nybble", but this was not adopted!

Clear. A term used with *flip-flops*. To clear a flip-flop is the same as to reset it, i.e. set Q=0 and $\bar{Q}$=1.

Clock: In a *synchronous* system, events are sequenced by a clock waveform which is connected to all units. The clock waveform is usually generated by an *astable* oscillator. See also *D-type flip-flop* and *J-K flip-flop*.

CMOS: A form of digital integrated circuit using integrated field-effect transistors (f.e.t.s). These are in theory the perfect digital circuits: they operate on a wide supply range (3-15V), have excellent noise immunity, and take a very small

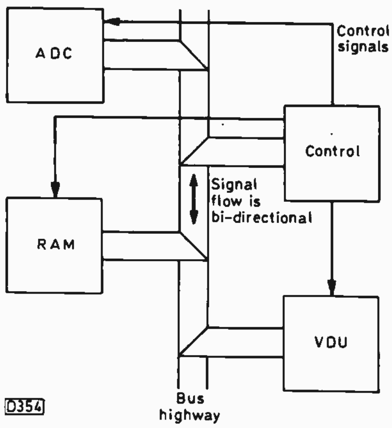
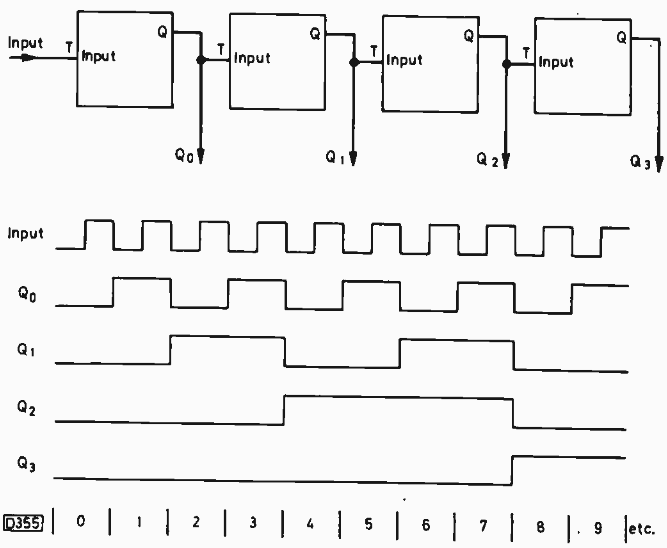


Fig. 6 (left): Digital system using a data bus.

Fig. 7 (below): A four-bit counter using toggle flip-flops.



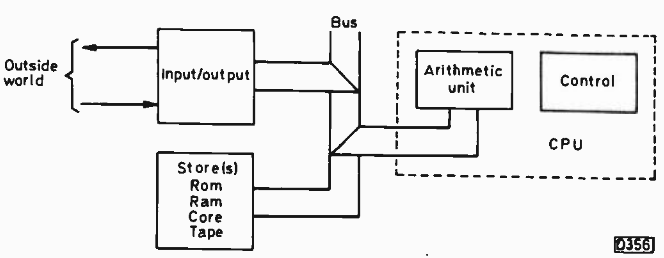


Fig. 8: Basic computer block diagram.

supply current (typically a few μA). In practice early CMOS acquired a bit of a bad reputation, as it was prone to die for no apparent reason. The cause of this was found to be static electricity. CMOS has an input impedance measured in megohms. As a result static electricity from nylon clothes or a soldering iron bit easily blasts a CMOS gate. This has now been cured, later CMOS having input protection. CMOS gates are designated by a 4 digit number in the 4000 range (e.g. 4016).

MOS stands metal-oxide-semiconductor, i.e. the f.e.t.s are of the insulated-gate type. C stands for complementary, i.e. both n- and p-channel devices are used.

Complement: (1) The $\bar{Q}$ output from a *flip-flop* or *monostable* is sometimes called the complement output.

(2) The act of inversion is sometimes called complementing (see Part 1).

Counter: A binary counter in its simplest form is constructed from *toggle* flip-flops as shown in Fig. 7.

If the toggle flip-flops change state on the 1 to 0 edge, this simple circuit will count input pulses with the Q outputs showing the correct state. Note that Q_0 is the least significant end of the counter.

It's unusual to find a constructed counter in a digital system, as counter chips are available (usually a 4-bit counter, but chips can drive each other to give 8-, 12-bit counters).

The above counter is called a ripple through counter. Suppose we have a 4-bit counter and it holds a count of 7, i.e. 0111. We give it one pulse and the counter goes to 8, 1000, but along the way we get other numbers:

Q_0 changes to 0,	counter state 0110
this changes Q_1 to 0	0100
this changes Q_2 to 0	0000
this changes Q_3 to 1	1000 (final state).

For a very brief time, the counter gave an output of 7, 6, 4, 0, 8. In many applictions this would not matter (the whole *glitch* probably lasts 10 nanoseconds) but if it's likely to cause trouble *synchronous* counters are available. These are glitch free.

Counters are available that can count up or down as desired, be preset, or count to bases of 10 (BCD) or 12.

CPU (central processor unit): A computer system has three parts (see Fig. 8). These are the store, the input/output interface, and the central control unit which does all the number crunching and control.

The central unit is called the CPU. In a *microprocessor* system, the actual microprocessor chip is the CPU. Other chips need to be added to provide the store and input/output interface.

D-type flip-flop: A form of *flip-flop* with two inputs, labelled D and Clock, and the usual two outputs Q and $\bar{Q}$, see Fig. 9. The operation is *synchronous*. The Q output assumes the same state as D when a pulse is applied to the clock input (see Fig. 10). Data sheets specify the polarity of the clock pulse.

Note that the D input cannot be allowed to change during the clock pulse. D-type flip-flops usually have S and R inputs as well (often labelled preset and clear, or load and clear).

Decimal: A number to base ten (see Part 1).

Decoder: A device for going from one number system to

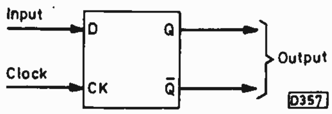


Fig. 9: D-type flip-flop.

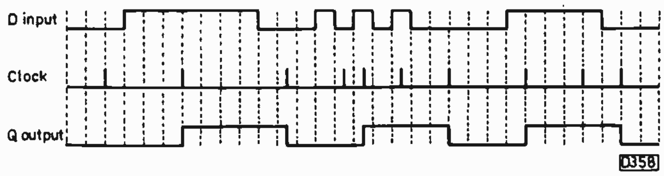
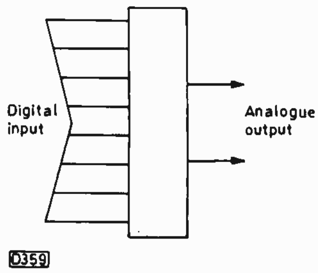


Fig. 10: How a D-type flip-flop operates.



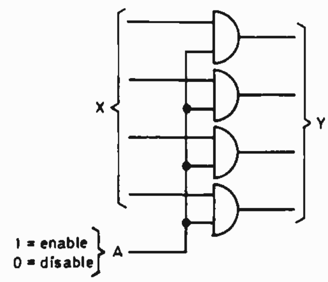
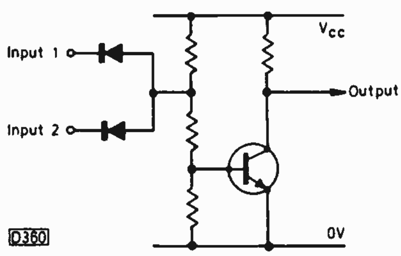


Fig. 11 (left): Digital-to-analogue converter.
Fig. 12 (right): Disabling or enabling a group of gates.



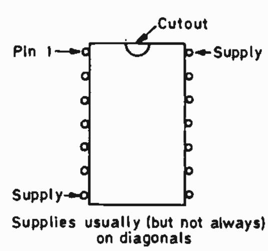


Fig. 13 (left): A two-input DTL nand gate.
Fig. 14 (right): The dual-in-line i.c. pack.

another. Usually the change is from binary to decimal. See Part 1 for details and encoders.

Decoupling: Digital integrated circuits operate at very high speeds (in excess of 20MHz). Combined with this we have 0 to 1 transitions measured in nanoseconds. The effect is to produce sharp spikes on the supply rails, causing subsequent problems with *counters* or *flip-flops*.

The conventional 10,000μF capacitor is of no use here, as it's the inductance of the supply leads that causes the trouble. The problem is overcome by liberally sprinkling 0·01μF capacitors between the supply and 0V. These are added at a density of one capacitor to two integrated circuits. *TTL* is particularly prone to supply problems, but liberal decoupling always works.

Decrement: To reduce by one. Thus 9 decremented is 8, and 1010 decremented is 1001.

Delay: Another term for *monostable*.

Digital-to-analogue converter (DAC): A device for converting a digital number (usually binary) into an analogue voltage (see Fig. 11). A DAC is thus the converse of an *ADC*, and the two together are used in digital transmissions of analogue signals (e.g. TV, telephone). A typical DAC is the Ferranti ZN425E i.c.p., which is widely available. Its data sheet is particularly informative.

Disable: To inhibit a gate or output. Usually applied where a common line goes to several gates (Fig. 12). A 0 on line A disables the transfer of data from X to Y.

DTL: Diode-transistor logic. An early form of digital integrated circuit, not widely used today. Its internal circuit is along the lines shown in Fig. 13. Because the 0 to 1 transition at the output relies on a simple resistor, DTL is poor at driving capacitive loads.

Dual-in-Line (DIL): The official name for the familiar beetle encapulation used for digital integrated circuits – refers to the dual rows of in-line pins. DIL packs are available with a vast array of pins from four upwards. Pin 1 is always to the left of the package cutout (viewed from above). See Fig. 14.

Edge: Many devices are specified as responding to an edge signal, i.e. a transition from 1 to 0 or 0 to 1. *Counters* in general are typical devices behaving like this. A positive edge is a transition from the 0 to the 1 state, a negative edge is a transition from 1 to 0 (for positive logic).

Enable: To allow a gate or output. The opposite of *disable*.

Encoder: A device for converting a number (usually in decimal form) into binary form.

EPROM: An erasable *PROM*. This type of PROM can be changed, with some effort, by the user. The most common type of EPROM is cleared by flooding it with ultra-violet light through a transparent window in the chip. Once cleared, the chip can be reprogrammed.

Error checking codes: In digital data transmissions systems, noise can easily turn valid data into gibberish. To overcome this, check bits are often inserted with the data to indicate if an error has occured.

The simplest error checking system is parity. We transmit the data in blocks of seven bits, with an eighth (parity) bit added. The parity bit makes the total number of bits in the eight bit word even (if even parity is chosen) or odd (if odd parity is chosen).

To see how this works, let us send the data stream 1011011101011011111011101101000001101110010 using odd parity. We split this into blocks of seven, adding a parity bit each time.

Transmitter	*Parity*	*Receiver*	*Parity*	*Check*
1011011	0	1011011	0	OK
1010110	1	1010110	1	OK
1111101	1	Error 1101101	1	Wrong
1101101	0	1101101	0	OK
0000011	1	0000011	1	OK
0110010	0	0110010	0	OK

Error checking codes can be made far more sophisticated, allowing identification and correction of errors. Such codes are used in teletext.

Exclusive-or: A logical gate. See Part 1 for details.

Fan out: The number of gate inputs a gate (or other device) can drive is limited. The drive capability of a device is defined in terms of the unit loads it can drive: this is known as the fan out. Gate and other inputs are also defined in unit loads and this is known as the fan in.

For example, three D-type flip-flop clock inputs (each fan in 2) and two gate inputs (each fan in 1) can easily be driven from a gate output with a fan out of 10 since the total load is only 8.

TV Servicing: Beginners Start Here . . .

Part 14

S. Simon

WE should by now know what jobs the timebases do. The line timebase deflects the spot across the screen at a fairly high speed, then makes it fly back to the left-hand side at an even higher rate. Left to itself it would merely produce a white line across the centre of the screen. This would appear at very high intensity and would very quickly burn away the coating on the inside of the glass so that there would thereafter be a nasty dark line to forever record the event. This in fact is what can happen when the field timebase ceases to function. This timebase's job is to deflect the spot vertically twice for every complete frame (the two being interlaced, remember?). Dear oh dear you may say. If failure of the vertical scan concentrates the electron beam in the centre so as to burn the screen, what happens when both timebases fail? Surely the resultant laser like spot will push a hole clean through the glass, never mind the coating.

Not quite. The beam has lots of energy, but not enough to come through the glass. It could however completely burn away the coating in a split second, leaving a nasty spot at the centre of the screen. We say could. In fact this is not likely to happen as the line timebase is a maid of all work and supplies, along with other things, the final anode voltage (e.h.t.) for the tube. Thus line timebase failure means no e.h.t. and no beam. The only way in which an undeflected spot could appear is when the field and line deflection both fail although the line timebase continues to function. This would be the result if both sets of scan coils failed together (unlikely), or if some donkey of an engineer left the deflection coils' plug out of its socket. But even here the makers often provide a safety link in the plug to disconnect the line timebase power (say the screen grid feed in the case of a valved circuit). Not all do however, so watch this point.

More often only one deflection is affected. So we can have a line across the screen to denote failure of the field scan, or far less common a line down the centre to denote that there is a failure of continuity from the line output transformer to the line scan coils. We say far less common though you will in fact come across this. It's usually the result of a poor contact between the line output transformer leadouts where they connect to the printed panel (perhaps marked by initial arcing), or associated with the series-connected scan-correction capacitor. So the rule in this event is to check the connections from the line output transformer to the scan coils and the capacitor and line scan coils for being open-circuit. These are the only causes of a vertical white line, as a failure earlier in the line timebase will result in a blank screen. O.K.?

Horizontal White Line

In the vast majority of cases if only a line can be seen it will be across the screen (east to west you might say). When this is encountered, take a closer look. If the line is straight, the fault is most likely to be in the oscillator/output section

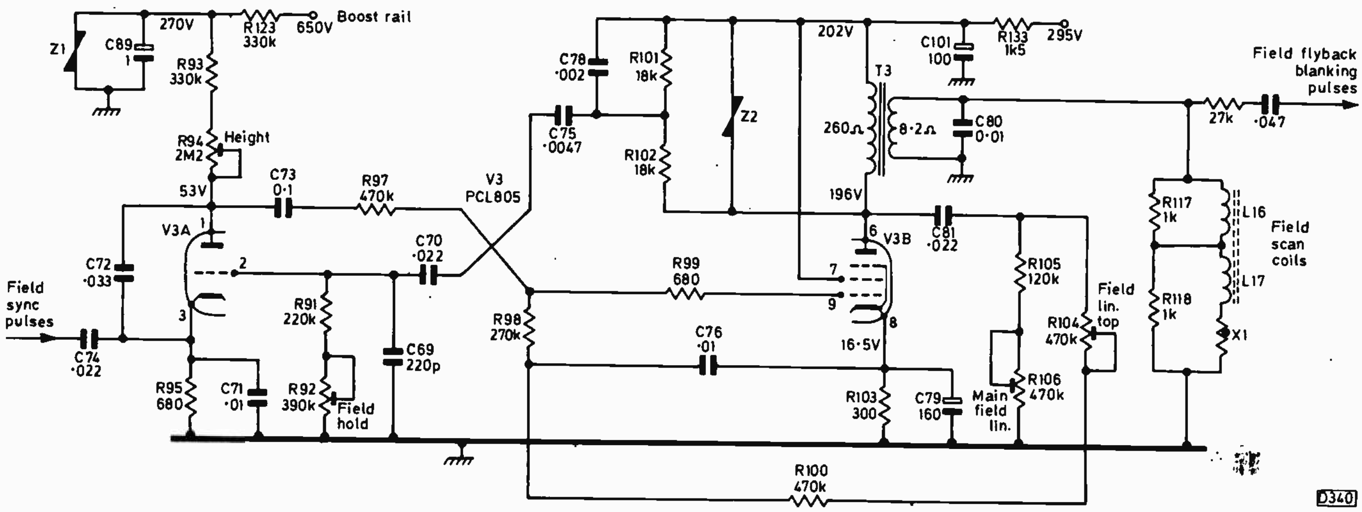


Fig. 1: The valve field timebase circuit used in the Thorn 1500 chassis. The negative-going field sync pulses are fed to the cathode of the oscillator triode section of the valve to ensure that it switches on at the right time to discharge C72. In many circuits you'll find the triode cathode connected direct to chassis, with the sync pulses applied to the control grid circuit of the pentode section of the valve, switching it off at the correct time to initiate the flyback. It's also common to find the earthy side of the field waveform generator charging capacitor connected to the cathode of the output pentode in order to provide a certain amount of linearity correction. In this circuit the same effect is achieved by returning C76 to the cathode of the output pentode. Feedback between the output pentode's anode and control grid is used to provide the main linearity correction, via C81, R104 etc. The feedback waveform is differentiated by C81/R105/R106, then integrated by R104/R100/C76, to achieve the correction required.

of the timebase. If the line has a distinct curve (a sort of depressed sinewave) however the first suspect must be the deflection coils themselves. These consist of two slabs connected in series with a little round disc thermistor (which corrects for the effect of temperature rise). Thus the fault could be an open-circuit in either winding or in the thermistor. Identify the windings, disconnect one end (to remove the shunting effect of the field output transformer secondary) and measure with an ohmmeter.

Scan Coil Identification

Identification of the windings is not difficult. The line slabs are at the top and bottom and are connected in parallel: two wires in (probably thick) and two scan coil connections to each with a pair to the top and a pair to the bottom. The field scan coils have two leads in (probably thinner), with one to the disc thermistor (tucked under a clamp?) and the other to a single lead contact. There is a double connection, but the supply leads do not connect to this as this is the series connection. The assembly may be complicated by resistors across these tags, but you should get the general idea.

Field Timebase Failure

If the horizontal white line is straight however we come to the ifs and buts. If the field timebase is valved (easier to deal with) there will be an output transformer, as in the case of the sound output stage, to match the high impedance of the output valve to the low impedance of the coils. We will deal with this arrangement first.

In a lot of sets the transformer is fixed to the printed panel, and this in itself is where the field collapse can originate. Careful examination may well show that the fixing is not all that it should be, and as the primary and secondary windings connect to the fixing pegs the search may be ended before it even got started. It's in the nature of a transformer to vibrate at the frequency at which it operates (a blinding glimpse of the obvious). This can result in fine cracks appearing around the soldered connections, and eventually all contact will be lost at this point. The process can be hastened by dropping the set. . . . It can be seen then that defects on the printed panel loom large in our quest for the cause of a horizontal white line.

The next step if necessary is to check the valve base voltages to ensure that the anode, screen grid and cathode voltages are right. We've already covered this part of the operation (valve amplifiers), so we shouldn't need to go into it in too much depth here. We will however repeat the salient points in relation to the common PCL805 field timebase valve found in most monochrome sets and some colour ones, e.g. the ITT CVC5, CVC8 etc.

We can again refer to the Thorn 1500 chassis where the output transformer T3 will be found at the top right side (check soldered contacts) and the PCL805 a little to the left and lower.

Two of the transformer contacts should have h.t. on them (the primary winding), one of these leading to pin 6 of the PCL805 valve base (anode), the other being the h.t. point from R133 which also feeds pin 7 (screen grid), see Fig. 1. If either or both voltages are absent the valve cannot start to operate. If there is no voltage at pins 6 or 7, check back to R133 which could be open-circuit. If pin 7 is about right at a little over 200V but the voltage at pin 6 is absent or very low, check up to the transformer contacts and, if these are intact, check the continuity of the primary winding as this could be open-circuit. On a cold test the resistance should read about 260Ω.

The significant reading is at pin 8 (cathode). This records the voltage across the cathode bias resistor R103, which should have a value of 300Ω. Note that we said should. At the correct resistance value the voltage across this resistor (i.e. between pin 8 and chassis) should be 16·5V. If this figure is wrong, the valve could be faulty (assuming that the voltages at pins 6 and 7 are correct) or the resistor R103 could have changed value (which it does).

When faced with the fault of mainly top compression, most impulsive young men rush to the linearity control or circuitry when they should instead first check the value of R103. When it goes high you get top compression, when it goes low (less often) you get bottom compression. A 330Ω 2W resistor is O.K. as a replacement. More often bottom compression is due to the capacitor C79 drying up.

Once in a while one may well find that there is no or very little voltage reading across R103 (we are still looking for the reason for the horizontal white line), and although the h.t. may be present at pins 6 and 7 and the PCL805 itself has been checked the reason for the fault may begin to look illusive. A cold resistance check across R103 may show 300Ω, which means that capacitor C79 is not short-circuit (you thought it would be, didn't you?) and that the resistor is keeping its correct value.

At this point you should remember what we have said about capacitors. If one side of a capacitor is subjected to a positive potential (a positive dearth of electrons you might say) the other side or plate will become crowded with the little horrors: it's as heavily negative therefore as the other plate is positive. The electrons will stay where they are if they have nowhere to go (no d.c. path to discharge through). Now if the capacitor is C73, the control grid of the PCL805 pentode section (pin 9) will be heavily negative, thus cutting off the normal current flow through the valve. The discharge path is R97, R98, R100, R104, R105 and R106. If any of these items are open-circuit, the capacitor holds its charge and the control grid stays negative and there you have it. The fixed resistors are rarely at fault, but the preset linearity controls R104 and R106 are highly suspect and should be treated accordingly.

Oscillator Section

Now it's often the case that the output section is beyond reproach and is passing current (as denoted by the 16·5V across the bias resistor) but there's nevertheless a horizontal white line on the screen. In this event we must remember that an amplifier will amplify only if there's something for it to amplify (loud cheers). At this point we may pause for thought.

If the amplifier is willing to amplify, why not use this fact to prove that the output section and the scanning coils are in order? The output section control grid is pin 9 in the case of a PCL805. So, if we apply a signal to pin 9 there should be a variation of current through the output section of the valve and thus through the field scan coils. Ideally, this should be a 50Hz signal, and it's an amazing coincidence that this is exactly the frequency of the mains supply.

In earlier sets the heater line was derived directly from the mains, via dropping resistors. Therefore a capacitor of say 0·1μF could be touched from a heater pin (4 or 5) to pin 9, thus opening up the field scan and proving that the amplifier section is working. Where there's a diode in series with the heater circuit nearly half the a.c. waveform is snipped off, leaving a pulsed d.c. which in the 1500 series is later smoothed by C58 and C56 to provide a supply line for the transistor stages. Even so, there's still a small ripple at the PCL805's heater pins and a capacitor from pin 5 to pin 9 will give an indication that from this point on the circuit is willing to work, given something to work on. Even a hand-held screwdriver blade will induce sufficient hum on the control grid to open up the scan slightly.

If this is so, we know that the driving force is absent. This force, applied to pin 9, should be in the form of a saw-toothed voltage waveform.

Now there are many ways of producing a sawtoothed waveform. Imagine a steep approach to a cliff edge. You slowly plod up the slope, then fall straight off the top. You could say that the descent was much quicker than the ascent. Even so, it still takes time to meet your mangled end on the rocks below. Have you got the picture?

This is the shape of the current waveform required to push the tube beam (or beams in a colour receiver) from the top of the screen to the bottom. An even build up, then a sudden collapse to speedily induce the flyback to the top. Ah, you may say, what about all these magnetic fields which will want to build themselves up and collapse in the field output transformer when we don't want them to (a collapsing field induces another flow of current which induces another field and so on – ringing, you might call it). Well, this is what the VDR (voltage dependent resistor) Z2 is for, wired across the transformer's primary winding. The resistance of this device falls as the voltage across it tries to rise. So it damps the circuit's attempts to ring. Oil on troubled waters you could say.

Where were we? Oh yes. How to provide a waveform with a nice linear slope up and a rapid drop down. Well now, what about that capacitor we talked about just now. We could charge it up slowly, then discharge it quickly.

How to do this and at the right rate? Obviously the timing is of paramount importance. We need a resistor in series with the capacitor to slow down the charging rate, and the time the capacitor takes to charge will depend upon the resistance value of the resistor and the capacitance value of the capacitor (now look up $T = R \times C$ or something like that in any basic reference book).

Say we want to charge C72 through R93 and R94 (which is variable so that the charging rate can be adjusted). With V3A cut off, due to a negative charge on C70, C72 will charge up, the voltage at its "top end" rising evenly. This rise is passed on via C73 to the amplifier section (provided everything is working properly of course).

Once the voltage across C72 reaches the required figure, how do we rapidly discharge it? Well, we could have wired a neon across it so that at a certain level the neon would have "struck", conducting heavily and thus discharging the capacitor to produce the rapid fall in voltage. As a neon is none too precise in its action however we use a transistor or a valve instead, turning it on and off at the right time like an oscillator. In the 1500 chassis a valve, the triode V3A, is used.

How to turn it on and off? Well, you could use a transformer to couple the output back to the input to form a blocking oscillator, or two cross-connected transistors or valves to flip each other on and off (sorry, flipping one on and flopping the other off), or you could do much the same thing by taking part of the amplifier's output and feeding it back as is done in the 1500 chassis and many others.

You will observe two 18kΩ resistors (R101 and R102) with a connection from their junction feeding back through C75 to a timing circuit which consists of the capacitor C70 with R91 and R92, the latter being adjustable to enable the timing of the circuit to be varied. This variable resistor is termed the vertical hold, frame hold, field frequency or something like that on various chassis, to denote that it varies the repetition frequency of the sawtooth. The size of the sawtooth thus generated is determined by the voltage applied to the charging capacitor by R94, which is termed the height, amplitude or vertical size control.

Now let's look briefly at the oscillator action. When V3A conducts (we'll come to how in a minute) C72 is discharged, the voltage at V3A anode falling sharply. This fall is communicated to V3B's control grid (pin 9) by C73, V3B thus being cut off. A positive-going voltage spike occurs at its anode, and does two things. It moves the spot rapidly to the top of the screen and, being communicated to V3A's control grid via C75 and C70, ensures that V3A turns on hard to discharge C72 fully. Now as we've seen before, when a valve is driven into heavy conduction, there's current flow in the control grid circuit. Hence the left-hand plate of C70 charges negatively, cutting V3A off again and holding it cut off until C70 can discharge via R91 and R92. This then is the timing action, that determines the "natural" repetition rate of the circuit's oscillatory action. Once C70 has discharged, V3A will switch on again. The potential divider R101/R102 determines the amplitude of the pulse fed back to the control grid of V3A to drive it into full conduction.

So there you are. Provided the components have the right value and keep the right value, the screen will be scanned at the right amplitude and at approximately the right frequency. The exact frequency is determined in the studio by the sync pulses inserted on to the transmitted signal. We talked about these last month. The field sync pulses are applied to pin 3 (triode cathode) of the valve to trigger it precisely – provided the coarse frequency setting (R92) is not too far out. If the circuit values are disturbed, the repetition rate will be outside the influence of the sync pulses and the picture will appear to roll rapidly. If on the other hand the sawtooth is not produced by this oscillatory action there will be no field scan at all and we are back to our horizontal white line. So what goes wrong and how do we tackle it when it does?

Checking the Oscillator Circuit

We have already proved the amplifier section, so this cannot be at fault. Or can it? Remember that it's also part of the oscillatory circuit, and that there are in the output stage components which determine what's fed back. Remember those 18kΩ resistors. These often change value, changing the field scanning rate and eventually causing complete field collapse. To check them, disconnect one end of one resistor and measure them both. The feedback capacitors C75 and C70 are not often at fault, and there are other things to check before these. The valve itself is most often at fault, and must come early in the checking list. This can also cause loss of field hold, particularly when the set is first switched on, i.e. the valve gets lazy and requires more time to reach its operating efficiency. If a new valve doesn't help matters, do the valve base voltage checks on pins 6, 7 and 8. If 8 is low, apply the meter to pin 9 and if this action opens up the scan suspect the linearity controls of being open-circuit as already described – the point here being that the meter itself has provided a d.c. return to chassis to "unblock" V3B's control grid.

Having ensured that the amplifier section voltages are right, check at pin 1. This is the triode anode, and the reading here should be about 50V. That is, it should be about 50V if the oscillator section is working. As we have said, the capacitors in the timebase proper don't often give trouble and it's better to concentrate on resistors if the valve is not at fault. The resistors must include the 18kΩ ones mentioned above (R101/R102), also the height control if this has a healthy 270V at one end and precious little at the other.

If the oscillator has stopped due to some other reason (say a mangled vertical hold control, damaged by an irate user merely because the 47kΩ sync circuit resistor R44 has gone high and left the timebase floating), the triode will pass excessive current and as a result the voltage across R93, which is in series with the height control, will increase considerably, leaving a reduced voltage at both ends of the height control, thus removing suspicion from this component. Let's give this a little more thought.

A non-working oscillator draws more current than a working one. Hence its anode voltage will be low. Why?

Because a non-working oscillator doesn't develop the self-bias (in this circuit, a negative charge on C70) that cuts a working oscillator off for most of the time. It simply sits there passing a steady, increased current, hence the low anode voltage, because an increased voltage will be developed across the anode circuit resistors. It fails to develop self-bias because there's no feedback pulse to drive it hard enough for grid current to flow. O.K.?

In many chassis the feedback pulse coupling network is rather more complex than here, with extra components to shape the pulse. Obviously an open-circuit coupling capacitor or resistor or a short-circuit capacitor to chassis will result in non-oscillation.

Insufficient Height

Insufficient height is another common complaint which can originate in the oscillator stage. The cause is usually in the supply, normally derived from the boost line (line output stage), to the triode anode. The boost voltage depends upon the particular design, and will normally be found to be from around 600V to about 900V. There is usually a series resistor which reduces this voltage to the figure required at the "top end" of the charging circuit resistors. Associated with the series resistor is some sort of decoupling capacitor, usually about 0·1μF in value, to stabilise this point. Some designs use a higher value capacitor (say 1μF), so that in the event of line timebase failure the consequent collapse of the height circuit voltage is delayed – the larger capacitor takes longer to discharge thus avoiding the appearance of a concentrated spot at the centre of the screen.

Taking a look at the 1500 circuit, we find the boost line supply is via R123 which drops the 650V line down to 270V where it's decoupled by the 1μF electrolytic C89 (the original design used a 0·1μF capacitor in this position) and stabilised by the VDR Z1. When the voltage at this point tries to rise, the VDR conducts more heavily, and vice versa less heavily when the voltage tries to fall, providing the stabilisation effect. Thus Voltage Dependant Resistor.

So when the complaint is loss of height, we look for reduced voltage – provided the PCL805 is in good order and the loss of height is even at the top and bottom of the screen. C89 can (and does) leak, thus dropping the voltage, and R123 can rise in value (less often). R94 can develop a dud spot on its track, where the wiper arm contact to the track is not good (fit a new preset control), or R93 can rise in value (less often). The VDR is often suspected but in fact these little fellows are almost trouble free and can put up with a lot of mistreatment (even more so those used in width stabilising circuits). So the VDR is the last item likely to require replacement. In short, if lack of height is the problem, leap at the preset height control and then at C89 – if the valve is in order.

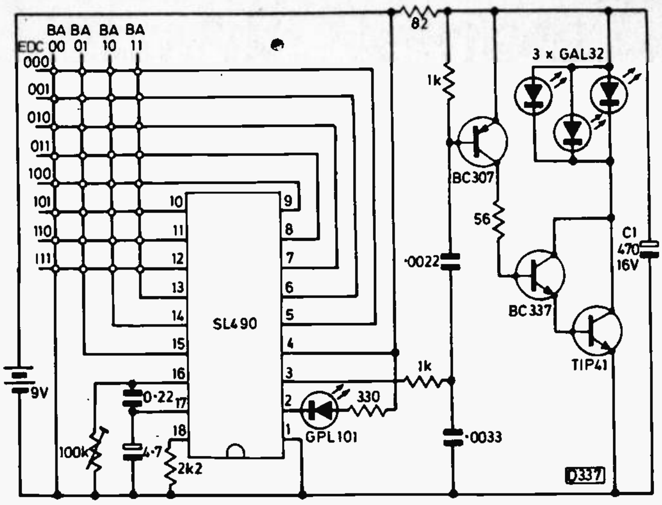


Fig. 7: Infra-red transmitter circuit.

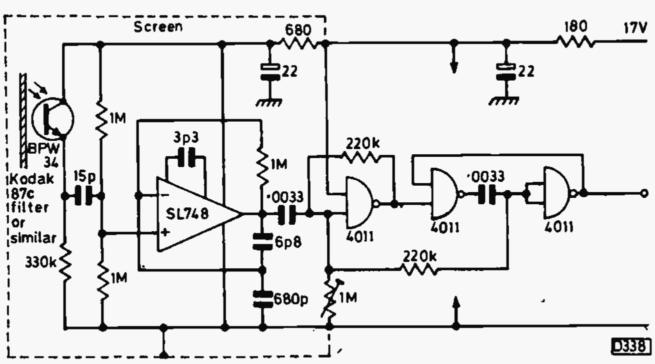


Fig. 8: Infra-red receiver circuit.

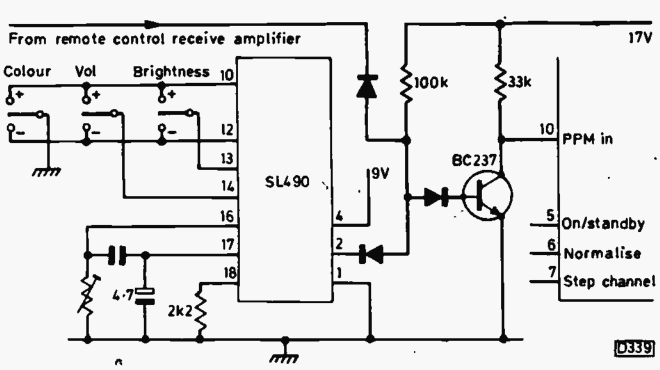


Fig. 9: Using an extra SL490 for manual receiver control.

directly control the volume, brightness and colour, as shown in Fig. 6. The circuit also has a second mute facility which instantly removes the sound without the need to reduce it over a period of a few seconds through the 32 possible sound levels. The sound returns to its original level when the mute button is pressed a second time.

The on/standby command switches the television receiver on from a standby condition. The receiver can't be switched on from the remote control unit when completely off. This prevents the possibility of a spurious signal switching the receiver on and causing a fire risk.

Infra-red linked remote control systems are slightly more complex but offer the advantages of higher data rate capability, less chance of the radiation being noticed by animals or even by humans, and less multipath interference.

The transmitter for an infra-red system must generate short d.c. pulses. These are applied to one or more infra-red emitting diodes. A typical infra-red transmitter circuit is shown in Fig. 7. The internal oscillator of the SL490 is not required in this circuit, so it's disabled by connecting pin 18 to earth through a 2.2kΩ resistor.

Short current pulses from pin 3 drive the BC307 pnp transistor which feeds an npn Darlington pair (BC337/TIP41). The latter provides current pulses of up to 10A for the three parallel connected GAL32 infra-red emitting diodes.

The maximum range of a circuit of this type is about 27 metres – far more than that of an ultrasonic system. A simpler infra-red system with a single npn transistor instead of the Darlington pair and a single emitter diode was found to have a range of about eight metres.

Although a current of 10A from the small battery in the hand-held infra-red transmitter unit may appear excessive, the pulse width is only of the order of 15μsec. This pulse is drawn from the 470μF capacitor C1 which must not have excessive inductance and must have short connections to the circuit if sharply rising pulses are to be obtained.

Attempts to use a pulse width of less than 15μsec may result in a diminished response due to the response time of the phototransistor employed in the receiver.

A suitable infra-red receiver circuit is shown in Fig. 8. A light filter is employed in front of the receiving phototransistor since this is also sensitive to visible light. The filter removes the visible light but has very little effect on the 940nm infra-red radiation from a gallium arsenide emitting diode. The SL748 amplifier/filter stage in Fig. 8 must be well screened to prevent electrical interference: it's possible to include screening (in the form of wire mesh) over the phototransistor window.

The output from the SL748 is fed to one of the two-input nand gates of a 4011 CMOS i.c. (which contains four such gates). The first gate is biased for Class A operation, whilst the succeeding two gates are connected as a monostable circuit. The 1MΩ potentiometer varies the monostable threshold voltage, acting as a sensitivity control. This circuit produces very clean output pulses which are fed to pin 10 of the ML920 (see Fig. 6).

The circuits described enable up to 20 channels to be selected individually by remote control or to be stepped sequentially until the required programme is reached. If less than 20 channels are required, 6, 8, 10, 12 or 16 channels can easily be used. If the least significant bit of the transmitted word is ignored, one has a 10-channel system without any other modification.

An additional SL490 device can be used at the receiver to provide local push-switch controls. See Fig. 9.

A single transmitter can be used to control more than one receiver. In this case a switch in the pin 16 circuit of the SL490 is used to alter the *RC* time-constant and hence change the pulse modulation rate. If the command signal rates differ by more than 30 per cent no mutual interference or cross coupling should be found between the system. A second receiver can be incorporated in a high fidelity system so that both the television receiver and one's Hi-Fi system can be controlled from a single portable unit. A second receiver can even be used to switch on the oven.

Remote control facilities are especially important in receivers incorporating teletext decoders. The ML920 decoder can be interfaced with a teletext receiver using CMOS logic elements.

The new integrated circuits used in the remote control system described here are in production and readily available for large or small orders. It's interesting to note that they can be used not only for television remote control but also for industrial and commercial applications (such as automatic telephone answering equipment). It's understood that one TV setmaker has already adopted this remote control system. Others are due to follow. ■

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DECCA 30 SERIES CHASSIS

With the colour control at maximum, the colour spreads over the edges of faces (particularly) and objects. Turning the brightness up fully has much the same effect. With a lower colour control setting, the faces in particular have a blue tinge. On monochrome, there are very slight red borders on all objects and people.

The first effect is usually due to the video stages operating under the wrong d.c. conditions. The luminance signal is a.c. coupled to the emitter-follower TR204 which drives pin 3 of the MC1327P demodulator/martrixing i.c. Associated with the a.c. coupling is a d.c. restorer and a preset control VR239. Reduce the brightness level by turning VR239 until the effect disappears (with the brightness control advanced), then restore normal brightness control range by means of the preset brightness control VR601 on the bottom power supply panel. If this action results in a dark picture at full brightness, advance all three c.r.t. first anode preset controls, ensuring that the grey-scale remains correct. The fringeing should be cured by adjusting the static convergence.

PYE 691 CHASSIS

The picture is good but on a normal colour transmission the red information disappears intermittently, details which should be red turning to orange over wide sections of the raster. The purity and convergence have been checked and are correct, and when the guns are separately switched, red, green and blue rasters are obtained.

The symptom is unfortunately that of a c.r.t. with a failing red gun. It would be worth checking the red output pentode's cathode decoupling capacitor C364 (0·0015μF) however. You could try reactivating the red gun.

GEC C2110 SERIES

When the set is switched on from cold there's inadequate field scan and foldover at the bottom of the raster. The picture corrects itself gradually, and after about six minutes is normal.

The thermistor TH451 (VA1034) in the field output stage is suspect, also the field charging capacitors C458 (22μF) and C457 (47μF). Also check the field linearity control P453. If this doesn't solve the problem, you'll have to check the semiconductor devices in the field output stage – TR454/5 and D451/2.

GRUNDIG 5010GB

The problem with this set is a line foldover of approximately half an inch down the centre of the screen. In a past issue, L515 was suggested as a possible cause. The fault remains however after replacing this coil with one from another set.

L515 is in the circuit which drives the scan thyristor. Make sure that you've used the correct coil, as it's critical in value. Also make sure that it's a good one. It's not an expensive item, and easy to replace. C515 and R515 in the same circuit tend to suffer in this chassis and should be replaced at the same time as the coil. Failing this, ensure that all joints on and around the commutator coil are sound, and if necessary check the scan thyristor and efficiency diode (Ty518 and Di518). Note that in this condition the e.h.t. will usually rise to around 30kV and at this voltage the resistors (R545/6) in series with and one or more of the c.r.t. first anode presets may fail. Other possibilities are the tuning capacitors C516/8/9 and C517. Replacements must be of the correct type, since they have to handle a ripple current of some 40A peak.

THORN 980 CHASSIS

There's an odd fault on this v.h.f. only portable. On ITV only, about a quarter of an inch of video information is being repeated down the centre of the screen, correct in every way (perhaps a line or two lower) and about 1¼in. to the right of its correct position. The contrast of both sets of information is the same. BBC-1 is excellent in every way.

If the fault is still present as say a lighter patch with no signal or a short length of wire connected to the aerial socket, there's a tendency to instability in the tuner, probably due to a faulty biscuit. If there's no sign of a fault under this condition, try reducing the signal level and see whether the fault appears at some particular signal level. If so, look around the a.g.c. line for a faulty decoupling capacitor. It would be interesting to see whether the fault is present with say a crosshatch signal applied. If not, the signal itself must be subject to some form of distortion.

PYE 697 CHASSIS

The two 100Ω wirewound resistors R462/R463 on the convergence board were getting very hot, though the picture and sound were both o.k. before I switched the set off.

The two resistors are connected across the R/G line symmetry coil L64/5. It's unusual for this coil – which carries the line scan current – to become open-circuit, so the probability is of a break in the copper circuit around its base. The d.c. resistance of each half of the coil should be 0·5Ω.

THORN 2000 CHASSIS

The picture is good but there's reduced height and width, varying with picture content and the brilliance control setting. Examination of the boards has failed to reveal any defective components.

It's essential to check first that the stabilised voltages from the power regulator board are correct: there should be 53V at TP3 and 55V at TP1. If these are wrong, suspect the regulator transistors VT2/3/7. If all is well here, the probable cause of the trouble will be excessive e.h.t., in which case the feedback amplifier output transistor VT6 (D1693, use type 2N3055) in the e.h.t. generator circuit may be leaky or short-circuit. Adjust R14 on the e.h.t. board for 24kV at the c.r.t.'s final anode.

DECCA 30 SERIES CHASSIS

With the slider of the set width/e.h.t. control VR451 hard over to the right (viewed from the rear) there's still lack of width. Moving the slider to the left narrows the picture. I've checked all the resistors in the width circuit, also the line drive coupling capacitor C430, and replaced the PCF802 line oscillator valve and PL509 line output valve. Before finally suspecting the line output transformer, has anything been missed?

There are several things to check before suspecting the line output transformer. First ensure that the h.t. at F1 is above 265V. If not, replace the reservoir/smoothing electrolytic block C601/2. Next try a new PY500 boost diode. Measure the resistance of the width/e.h.t. control VR451 (2MΩ) – it sometimes changes value to give low width. Check the damping/tuning capacitors C433/C435 associated with the line output transformer – one or other could be open-circuit. Finally disconnect the shift choke L402 at the shift-sense tag to see whether this component has short-circuit turns.

ITT/STC VC51 CHASSIS

There is constant field slip on this set – the picture will stop for a few seconds only. The picture looks as if it would be good if only it would stop. Adjusting the height control affects the rolling, but a new PCL805 field timebase valve has made no difference.

This is a common fault with the VC51 chassis. The pentode section of a PCF80 is used as the sync separator, and its anode load and screen grid feed resistors tend to change value. They are R66 (220kΩ) and R63 (330kΩ) respectively. Check these, also the 390kΩ and 470kΩ resistors in the cathode circuit of the PCL84's triode section (field sync pulse amplifier).

KORTING 51763 SERIES

The set was left idle for several months. On switching on, it comes to life and produces a dullish raster and after 15 seconds a crackle on sound. The PY500A boost diode then starts arcing inside, followed by fuse blowing. The line output stage valves have been replaced, the set isn't damp, and no definite short-circuit can be found with a meter.

The e.h.t. tripler could be breaking down. Disconnect it and see whether the PY500A continues to arc. If it does, disconnect the 82/150pF high-voltage ceramic capacitors, which provide the line output stage fifth harmonic tuning, one at a time. There are usually three (C427/8/9), in the PY500A's cathode circuit.

GEC 2040 SERIES

There is no raster on this set. At the time of the failure, R705 on the raster correction panel glowed brightly – its value is not now discernable, i.e. it's thoroughly cooked. Are the two faults associated?

R705 is part of a network across the pincushion distortion correction transductor T701: the network is also in parallel with the line scan coil circuit. It's possible for R705 to become very hot should the line oscillator change frequency as a result of a component failure, then ceasing to operate. So first check whether the line oscillator is working – there should be −60V at the control grid (pin 1) of the line output valve. If the line oscillator is working correctly, check the continuity of the transductor, the scan coils and the R/G symmetry coil L701.

WALTHAM W125

We're having difficulty obtaining certain components for this set and would appreciate any suggestions for suitable replacements. The components are the TS18 e.h.t. rectifier, the OA1161 diode in the line oscillator circuit, the two diodes (same type) used in the flywheel sync discriminator circuit, and the OA1160 detector diodes.

The following types are suitable:
D304 TS18 e.h.t. rectifier, use a TV18.
D101 OA1160 vision detector, use an OA90.
D102 OA1160 6MHz sound detector, use an AA119 or OA91.
D301/2/5 OA1161 line timebase diodes, use a BA129 or BA154.

MITSUBISHI CT200B

What appear to be hum bars travel either up or down the picture from time to time. They are not intrusive on bright scenes, but noticeable on dark scenes, sometimes causing a local sideways movement over a few lines.

It seems likely that one of the series regulator transistors is leaky. There are two of them, Q941 and Q943. They are on the left-hand side, with access after lowering the vertical chassis. Alternatively the mains bridge rectifier could be responsible.

BUSH TV350 PORTABLE

The sound is very distorted and the picture only faint. The screen is bright, but the brilliance control does not have much effect when turned down. There's line pairing, with a faint grey picture in the background.

The regulated l.t. line could be incorrect. Check for 11V across C609. If the supply is in order, suspect the video emitter-follower Tr9 (2SC829, 2SC838 or 2SC839 may be fitted) – the sound and sync signals are extracted from its collector circuit, so a defect here would account for the various symptoms present. There should be 7·1V at its collector, 2·7V at its base and 2V at its emitter.

THORN 3500 CHASSIS

If the brightness control setting is increased there's excessive h.t. current with the result that the excess-current trip operates, causing field foldover due to the reduced h.t. The voltages in the beam limiter and field output circuits seem to be correct. The fault occurs only when a very bright scene is displayed or the brightness control setting is increased. One other point is that when a dark scene is displayed there is progressive width cramping (pincushion shape) on the right-hand side only, the cramping increasing in proportion to the darkness of the picture, reaching a maximum of about 1in. The h.t. is stable and correct with this cramping. Neither the cramping nor the foldover occur until the set has been on for about half an hour.

We have an uncomfortable feeling that either the line output transformer or the e.h.t. transformer has one or two shorted turns. This is enough to reduce the width at low brightness and increase the line output current (though apparently the voltage across the beam limiter sampling resistor R907 is correct). The line output transistor could also be at fault, but with a fault of this nature one can never be sure. The a.c. blocking choke L504 is also not above suspicion. It might also be worthwhile checking the condition of the pincushion distortion correction transductor and its associated resistors on the convergence panel.

ELIZABETHAN T12

The trouble with this set is field slip. The picture and sound are all right and the line timebase works perfectly, but the picture rolls.

If the picture can be made to hover by adjusting the field hold control, check the 3·3μF a.g.c. reservoir capacitor C145, the two coupling electrolytics in the sync circuit (C302 and C303, both 0·47μF), and the sync separator transistors Tr302 and Tr301. Otherwise a general check of components around the field oscillator transistor Tr303 will be necessary.

ITT VC100

The picture and sound come on normally, but after three-four minutes a loud bang comes from the loudspeaker, followed by a chain of lesser noises. The picture appears to jolt when the bang occurs, but otherwise remains normal.

This often occurs with the VC100 and similar ITT chassis, and can usually be cured by replacing the PCL86 audio valve. If necessary, its holder may have to be changed. Very occasionally the coupling capacitor C108 (0·01μF, between pins 8 and 9) will be found to be responsible due to leakage.

TEST CASE

191

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.

An ASA hybrid colour receiver (of Finnish origin), Model CT5004, was working perfectly on sound but the display was marred by a small, seemingly defocused, displacement of blue with respect to the vertical picture content. The owner confirmed that the fault had developed gradually, and that before the blue started to "drift" horizontally the picture was of high colour quality.

The overall convergence adjustment is not unduly difficult on this model, and as the symptom gave a distinct impression of misconvergence steps were taken to check the adjustments while at the same time getting a feeling of how the convergence controls influenced the fault.

The convergence unit is somewhat complex (by today's standard), with diode-rectified d.c. fed through the coils for static convergence, the magnetic field in some versions (as that under investigation) being supplemented by small permanent magnets for coarse adjustment.

All the controls appeared to work and although the convergence was marginally in error the display could not be significantly improved. For a subjective test of the blue display the set was arranged so as to produce a modulated blue raster. This was well defined in terms of scanning lines, but the modulation content was of a "diffuse" nature – rather like a tube with astigmatism. Red and green modulated rasters were then similarly arranged, and both were found to be well defined in terms of picture content.

Attention was then directed to the colour drive circuits, which consist of transistor driver/output pairs for each colour, primary-colour drive being applied to the tube's cathodes. All the voltages around the blue transistor stages appeared to be correct, but when the meter probe was touched on the collector of the blue output transistor the fault condition worsened quite substantially. When the probe was touched on the emitter the fault almost completely cleared!

After a short while the service technician had located the trouble, aided by the clues just described, and changing one small component restored the picture to its original high quality. What was the most likely cause of the fault, and how did the effects of the probe connections assist the technician? See next month for the solution and for a further item in the series.

SOLUTION TO TEST CASE 190
– Page 665 last month –

As in many mains/battery portables, the c.r.t. heater in the Thorn 1690 chassis is connected between chassis and the regulated l.t. rail. The small tubes used in portables tend to be more susceptible to intermittent heater-cathode shorts than the larger types used in table models, particularly if they've been subjected to excessive vibration while being carried around in a car or caravan.

The trouble was eventually traced to such a short or, rather, more of a high-resistance leak. When the tube was cold the insulation resistance was very high, but when the resistance was checked after the set had warmed up it was found to have fallen in value. This not only reduced the cathode voltage, thereby reducing the bias and causing the screen to brighten, but also attenuated the video drive signal.

The technician was presented with a good clue when his test prod inadvertently knocked the tube neck – indeed tapping the neck of the tube with a screwdriver is a good way of verifying a tube fault of this type, provided undue force is not used! (But don't do it when people like Sid and Grace are around – see page 626 last month.)

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TELEVISION NOV 1978

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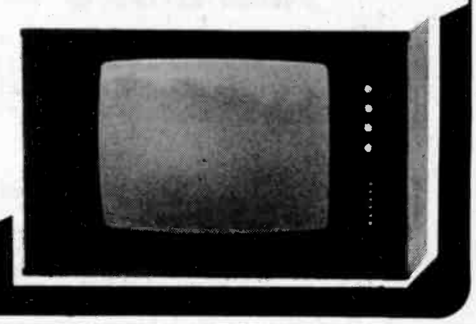

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