DECEMBER 1977

Australia 75c
New Zealand 75c
South Africa 70c
Malaysia $2.25
50p

TELEVISION

SERVICING·VIDEO·CONSTRUCTION·DEVELOPMENTS

Ten Years of COLOUR

ALSO:
CRT FAULTS;
ACTIVE CO-CHANNEL INTERFERENCE FILTER;
VCR SERVO FAULTS

TELEVISION

December 1977

Vol. 28, No. 2
Issue 326

CORRESPONDENCE
All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", King's Reach Tower, Stamford Street, London SE1 9LS. All other 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 our Post Sales Department (address above) 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".

this month

OUR NEXT ISSUE DATED JANUARY WILL BE PUBLISHED ON DECEMBER 19

BRIARWOOD TELEVISION LTD.

Legrams Mills, Summerville Road, Bradford, West Yorkshire BD7 1NS. Tel: (0274) 22048.

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	0.18
AC128	0.18
AC131	0.13
AC141	0.23
AC141K	0.33
AC142K	0.33
AC151	0.17
AC165	0.16
AC166	0.16
AC168	0.17
AC176	0.18
AC186	0.26
AC187	0.21
AC187K	0.35
AC188K	0.37
AD130	0.50
AD140	0.65
AD142	0.70
AD143	0.70
AD145	0.70
AD149	0.75
AD161	0.45
AD162	0.45
AD161 / AD162	1.30
AF106	0.42
AF114	0.22
AF115	0.22
AF116	0.22
AF117	0.22
AF118	0.58
AF121	0.55
AF124	0.33
AF125	0.33
AF126	0.33
AF127	0.33
AF139	0.39
AF151	0.24
AF170	0.29
AF172	0.20
AF178	0.58
AF180	0.68
AF181	0.60
AF239	0.43
BC107	0.12
BC108	0.12

TYPE	PRICE £
BC109	0.12
BC113	0.12
BC114	0.12
BC115	0.12
BC116	0.12
BC117	0.12
BC119	0.24
BC125	0.15
BC126	0.11
BC136	0.14
BC137	0.14
BC138	0.30
BC139	0.20
BC140	0.25
BC141	0.22
BC142	0.24
BC143	0.23
BC147	0.09
BC148	0.09
BC149	0.09
BC153	0.12
BC154	0.12
BC157	0.09
BC158	0.11
BC159	0.11
BC160	0.28
BC161	0.27
BC167	0.13
BC168	0.13
BC169C	1.00
BC171	0.11
BC172	0.11
BC173	0.15
BC177	0.16
BC178	0.12
BC179	0.12
BC182L	0.09
BC183L	0.09
BC184L	0.09
BC186	0.20
BC187	0.20
BC209	0.14
BC212	0.13
BC213L	0.09
BC214L	0.09
BC240	0.31
BC281	0.24
BC262	0.20
BC263B	0.20
BC267	0.19
BC301	0.26
BC302	0.30

TYPE	PRICE £
BC307A	0.12
BC308A	0.12
BC309	0.14
BC547	0.09
BC548	0.11
BC549	0.11
BC557	0.11
BD112	0.50
BD113	0.65
BD124	1.00
BD131	0.39
BD132	0.39
BD133	0.39
BD135	0.30
BD136	0.30
BD137	0.30
BD138	0.30
BD139	0.40
BD140	0.34
BD222	0.50
BDX22	0.73
BDX32	2.30
BDY18	0.75
BDY60	0.80
BF115	0.23
BF121	0.30
BF154	0.16
BF158	0.20
BF159	0.20
BF160	0.27
BF163	0.27
BF164	0.20
BF167	0.21
BF173	0.23
BF177	0.28
BF178	0.33
BF179	0.29
BF180	0.31
BF181	0.33
BF182	0.35
BF183	0.33
BF184	0.27
BF185	0.27
BF186	0.30
BF194	0.10
BF195	0.10
BF196	0.12
BF197	0.12
BF199	0.14
BF200	0.28
BF216	0.12
BF217	0.12

TYPE	PRICE £
BF218	0.12
BF219	0.12
BF220	0.12
BF222	0.80
BF221	0.21
BF256	0.37
BF258	0.34
BF259	0.34
BF260	0.24
BF262	0.32
BF263	0.25
BF271	0.28
BF273	0.17
BFX84	0.27
BFX85	0.27
BFX88	0.24
BFY37	0.22
BFY51	0.20
BFY52	0.21
BFY53	0.27
BFY55	0.27
BHA0002	1.90
BR100	0.32
BSX20	0.23
BSX76	0.23
BSY84	0.36
BT106	1.10
BU105/04	2.25
BU126	1.40
BU208	2.45
OC22	1.10
OC13	1.30
OC24	1.30
OC25	0.45
OC26	0.40
OC28	0.60
OC35	0.45
OC36	0.58
OC38	0.43
OC42	0.45
OC44	0.18
OC45	0.18
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

TYPE	PRICE £
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	0.06
BRC4443	0.85
R2008B	1.80
R2010B	1.80
R2305	0.38
BY126	0.09
BY127	0.11

VALVES

TYPE	PRICE £
DY87	0.40
DY802	0.48
ECC82	0.42
EF80	0.40
EF183	0.50
EF184	0.50
EH90	0.60
PC86	0.70
PC88	0.70
PCC89	0.55
PCC189	0.60
PCF80	0.50
PCF86	0.58
PCF801	0.60
PCF802	0.70
PCL82	0.60
PCL84	0.55
PCL86	0.60
PCL805	0.60
PLF200	0.70
PL36	0.85
PL84	0.52
PL504	0.90
PL509	1.75
PY88	0.52
PY500A	1.00
PY801	0.50

E.H.T. TRAYS MONO

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 1BV	0.75

TYPE IC's	PRICE £
SN76013N	1.48
SN76013ND	1.20
SN76023N	1.50
SN76023ND	1.20
SN76226DN	1.50
SN76227N	1.00
TBA341	0.97
TBA520Q	1.75
TBA530Q	1.55
TBA540Q	1.75
TBA560CQ	1.90
TBA570Q	1.75
TBA800	1.12
TBA810	1.50
TBA920Q	2.00
TBA990Q	1.85
TCA270SQ	1.75
TCA270SA	1.50
TDA13278	1.10

E.H.T. TRAYS COLOUR

Pye 691 693	4.81
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	5.97
GEC Hybrid CTV	5.57
Thorn 3000/3500	5.50
Thorn 8000	2.42
Thorn 8500	5.23
Thorn 9000	6.10
GEC TVM 25	2.50
ITT/KB CVC 5/7/8/9	5.96
RRI (R8M) AB23	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

P&P on all trays 70p

HB ELECTRONICS

22 Newland Street, Kettering, Northants.
Mail order, phone Kettering 83922.
All other enquiries Kettering 520910.

Shop open, Monday to Saturday 9.00 to 6.00.
Early closing Thursday 1.00 p.m.
Closed daily for lunch 1.00 to 2.00.

PROBABLY THE LARGEST ALL ELECTRONICS STORE IN THE UK WITH 1000's OF SQUARE FEET DEVOTED TO THE BEST IN CONSTRUCTIONAL ELECTRONICS.

TELETEXT DECODER

TEXAS INSTRUMENTS XM-11 TELETEXT DECODER MODULE NOW AVAILABLE ON THE AMATEUR MARKET

Special arrangements with Texas now make this purpose designed decoder available to the non-professional user.

DAILY TELETEXT DEMONSTRATIONS NOW RUNNING IN OUR SHOWROOM.

DECODER FEATURES:

- Character rounding
- Alphanumerics
- Graphics
- Flashing display
- Update facility
- Date and Time on screen
- Boxed display
- Sound muting
- Seven colour display
- Upper and lower case characters

Full colour teletext decoding for less than the cost of discrete – Black and White only – designs.

£132.00 + 12½% VAT

Send SAE for further details. Installation advice and assistance freely available.

FULL COLOUR T.V. GAMES

NATIONAL'S FULL COLOUR TV GAME CHIP SET SK 1122

Why settle for Black and White games or 'quasi colour' when the real thing is here now?

Six exciting colour video games on ordinary colour TV receivers as featured in this magazine.

Balls, paddles, scores, borders and background are each presented in their own vivid colour, with different combinations for each game; hit, border and scoring sounds are also generated during operation for greater realism.

Chip Set Complete............£21.00 + 12½% VAT includes the three game chips, plus selected voltage regulator, plus all other semiconductors.

Send 30p for further details of the chips and colour TV game kit.

LOW COST CMOS

THE AWAITED BREAKTHROUGH IN CMOS PRICES IS HERE!

Brand new full spec devices fully guaranteed at prices you'll not believe.

And an SAE brings details of even lower quantity mix prices and functional details of all the super MSI and LSI devices that are available.

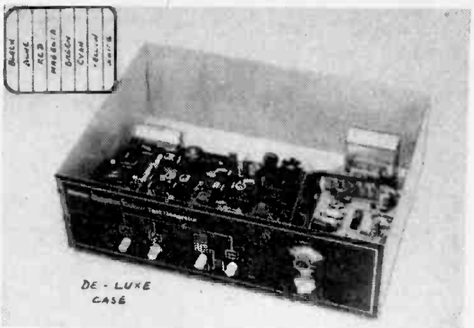
CMOS data book available with pin outs, diagrams and circuits etc. Hundreds of pages for only £4.25

4000	.16	4044	.93	4440	13.93
4001	.16	4046	1.23	4450	3.22
4002	.16	4049	.39	4451	3.22
4006	1.00	4050	.39	4490	7.83
4007	.16	4051	.85	4501	.16
4008	.91	4052	.86	4502	.81
4011	.16	4053	.85	4503	.67
4012	.16	4066	.57	4507	.34
4013	.39	4068	.16	4508	2.27
4014	.94	4069	.16	4510	1.14
4015	.94	4070	.16	4511	1.42
4016	.43	4071	.16	4512	1.05
4017	.94	4072	.16	4516	1.14
4018	.94	4073	.16	4517	3.37
4020	1.04	4075	.16	4521	1.78
4021	.94	4076	1.21	4522	1.31
4022	.85	4077	.16	4526	1.11
4023	.16	4078	.16	4527	1.49
4024	.69	4081	.16	4528	.98
4025	.16	4082	.16	4529	1.08
4027	.46	4093	.57	4530	.64
4028	.84	4160	1.08	4536	3.30
4032	.94	4161	1.08	4541	1.27
4035	1.02	4162	1.08	4543	1.47
4038	.99	4163	1.08	4553	3.96
4040	1.03	4174	.98	4557	3.81
4042	.69	4175	.90	4566	1.32
4043	.93	4194	1.07	4583	.70
				4584	.56

MANOR SUPPLIES

COLOUR BAR GENERATOR

plus CROSS HATCH KIT (Mk. 4)



- ★ Output at UHF, applied to receiver aerial socket.
- ★ In addition to colour bars, all R–Y, B–Y and Lum. Combinations.
- ★ Plus cross hatch grey scale, peak white and black levels.
- ★ Push button controls, small, compact battery operated.
- ★ Simple design, only five i.c.s. on colour bar P.C.B.

PRICE OF MK4 COLOUR BAR & CROSS HATCH KIT £35.00 + 8% VAT + £1.00 P/Packing.

CASES, ALUMINIUM £2.40, DE-LUXE £4.80, BATT. HOLDERS £1.40. ADD 8% VAT TO ALL PRICES!

ALSO THE MK3 COLOUR BAR GENERATOR KIT FOR ADDITION TO MANOR SUPPLIES CROSS HATCH UNITS. £25.00 + £1.00 p.p. CASE EXTRA £1.40. BATT. HOLDERS £1.40. ADD 8% VAT TO ALL PRICES.

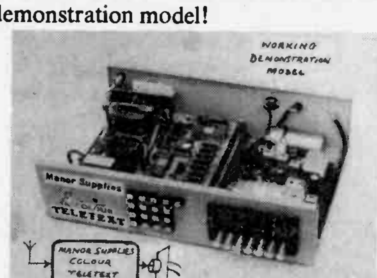
- ★★ Kits include drilled P.C. board, with full circuit data, assembly and setting up instructions.
- ★★ All special parts such as coils and modulator supplied complete and tested, ready for use.
- ★★ Designed to professional standards.
- ★★ Demonstration models at 172 West End Lane, NW6.
- ★★ Every kit fully guaranteed.

ALSO NOW AVAILABLE

MK4 DE LUXE (BATTERY) BUILT & TESTED £58.00 + 8% VAT + £1.20 P/Packing.

ALTERNATIVE MAINS SUPPLY KIT £5.78 + 8% VAT + 65p P/P.
VHF MODULATOR (CH1 to 4) FOR OVERSEAS £3.50.
INFORMATION ON VIDEO TAKE-OFF FOR C.C.T.V.

MANOR SUPPLIES TELETEXT 77 KIT (incl TEXAS DECODER). Full facilities in colour. External unit. AE input to set. Write or call for further information. See working demonstration model!



COLOUR, UHF & TELEVISION SPARES

T.V. PORTABLE PROJECT LOPT, SCAN COILS, DRIVER £12.50. EHT RECTIFIER £1.20; VIS GAIN, VIS SELECT (TESTED) £3.80 p.p. 85p. MANY OTHER PARTS AVAILABLE.

TELETEXT 77, MANOR SUPPLIES NEW "EASY TO ASSEMBLE" KIT, INCL. TEXAS DECODER. AERIAL INPUT, COLOUR, MIXED T.V. PROGRAMME & TELETEXT, NEWSFLASH, UPDATE, AND MANY SPECIAL FEATURES NOT FOUND IN OTHER UNITS. DEMONSTRATION MODEL IN OPERATION AT 172 WEST END LANE, N.W.6. CALL OR WRITE FOR FURTHER INFORMATION.

CROSS HATCH UNIT KIT, AERIAL INPUT TYPE, INCL. T.V. SYNC AND UHF MODULATOR. BATTERY OPERATED. ALSO GIVES PEAK WHITE & BLACK LEVELS. CAN BE USED FOR ANY SET £11.00 + 45p. p.p.* (ALUM. CASE £2.00 p.p. 75p.*) COMPLETE TESTED UNITS, READY FOR USE (DE-LUXE CASE) £19.00 p.p. 90p.* ADDITIONAL GREY SCALE KIT £2.90 p.p. 30p*

"NEW TYPE" UHF SIGNAL STRENGTH METER KIT £18.00 p.p. 90p. (VHF VERSION £18.80 p.p. 90p.*)

CRT TESTER & REACTIVATOR PROJECT FULL KIT £18.80 p.p. £1.30.*

"TELEVISION" COLOUR SET PROJECT. MARK II DEMONSTRATION MODEL WITH LATEST IMPROVEMENTS. WORKING AND ON VIEW, SPARE PARTS STILL AVAILABLE.

"TELEVISION" PROJECT CROSS HATCH KIT £3.60 p.p. 20p.*

VIDEO PRE-AMP MOD. KIT (Oct. '75 Article) **£1.20** p.p. 20p.

SPECIAL OFFER I.F. Panel, leading British maker, similar design to "Television" panel. Now in use as alternative inc. circuit and connection data, checked and tested on colour **£14.80** p.p. 95p. Also **DECODER** panel checked and tested on colour, full details, **£19.80** p.p. 95p.

"FIVE in ONE" PANEL replaces Tuner IF, Decoder, RGB, and sound boards of original project. Tested on colour, with all data. **£35.00** p.p.£1.20.

MAINS TRANSFORMER 280W for "T.V." Colour Set **£11.50** p.p. £1.50.

TRIPLER £6.00 p.p. 75p, **ERIE FOCUS £2.20**, p.p. 30p, **NEW AUDIO UNIT £2.60** p.p. 35p.

STABILISER UNITS, "add on" kit for either 40V or 20V, **£2.80** p.p. 35p.

GEC 2040 Surpl Panels, ex-rental, Decoder **£5.00**. T.B. **£5.00** p.p. 90p.

BRC 3000 Surplus/Salv Panels, Decoder **£7.50**, Video **£7.50** p.p. 90p.

DECCA Colour T.V. Thyristor Power Supply. HT, LT etc. **£3.80** p.p. 95p.

BUSH CTV25 Power Supply Unit **£3.20** p.p. £1.50.

PYE 697 Line T.B. P.C.B. for spares, **£1.50** p.p. £1.00.

MULLARD AT1023/5 convergence yoke. New **£2.50** p.p. 75p.

DLIE delay line. New **90p** p.p. 40p. AT1025/06 blue lat. **75p** p.p. 30p.

PHILIPS G6 single standard convergence panel, incl. 16 controls, switches etc., and circuits **£3.75** p.p. 85p, or incl. yoke, **£5.00. PHILIPS** G8 panels for spares, decoder **£2.50** p.p. 85p.

VARICAP, Mullard ELC1043 UHF tuner **£4.50,** ELC1043/05 **£5.50,** G.I. type (equiv. 1043/05) **£3.50** p.p. 35p. Control units, 3PSN **£1.25,** 4PSN **£1.80,** 5PSN **£2.20. Special offer** 6PSN **£1.00,** 7PSN **£1.80** p.p.35p. TAA 550 **50p** p.p. 15p.

VARICAP VHF PHILIPS £3.80, ELC1042 **£4.80,** p.p. 35p, ELC1042 on PYE P.C.B. **£5.40,** p.p. 65p.

VARICAP UHF/VHF ELC 2000S **£12.50** p.p. 65p.

UHF/625 Tuners, many different types in stock. Lists available. **UHF** tuners transistd. incl. s/m drive, indicator **£3.85**; 6 posn. or 4 posn. push-button **£4.20** p.p. 85p. Integrated tuners **BUSH, PYE 40** 6 posn. **£4.50** p.p. £1.20. AE ISOL **30p** p.p. 20p.

TRANSISTORISED 625 IF for T.V., sound tested (as featured in Practical Wireless, Nov. '75). **£6.80** p.p. 65p.

PHILIPS 625 I.F. Panel incl. cct **50p** p.p. 50p.

TURRET TUNERS, KB "Featherlight" VC11, Philips 170 series, GEC 2010 **£2.50.** GEC 2018, 2019, 2038, 2039 5 position **£4.20** p.p. 85p.

TBA "Q" I.C.s. 480, 530, 540, **£2.20,** 550, 560C, 920 **£3.20** p.p. 15p.

HELICAL POTS, 100K. 4 for **£1.20** p.p. 20p.

BRC 1500 Mains Droppers, two for **90p** p.p. 50p.

LINE OUTPUT TRANSFORMERS. New guar. p.p. 85p.

BUSH 105 to 186SS, etc	**£6.80**
DECCA DR1, 2, 3, 121/123, 20/24, MS1700, 2001, 2401	**£6.40**
DECCA MS2000, 2400	**£5.80**
FERG., HMV, MARCONI,	
ULTRA 850, 900, 950 Mk. 1	**£7.30**
950II, 1400, 1500, 1590	**£5.90**
GEC 2000, 2047 series, etc.	**£6.40**
INDESIT 20/24EGB	**£6.40**
ITT/KB VC2 to 53, 100, 200, 300	**£6.20**
MURPHY 849 to 2417, etc.	**£6.80**
PHILIPS 19TG121 to 19TG156	**£4.80**
PHILIPS 19TG170, 210, 300	**£6.40**
PYE 11U, 368, 169, 769 series	**£6.40**
PYE 40, 67 series (36 to 55)	**£3.80**
PAM, INVICTA, EKCO, FERRANTI equivalents as above.	
SOBELL 1000 series	**£6.40**
STELLA 1043/2149	**£6.40**

SPECIAL OFFERS

BUSH TV53/86, 95/99	**£1.00**
EKCO 380 to 390	**£1.00**
EKCO 407/417	**£1.00**
FERR. 1084/1092	**£1.00**
FERG. 506 to 546	**£1.00**
GEC 448/452	**£2.50**
KB VCI, VCII (003)	**£2.80**
P/SCOTT 733 to 738	**£1.00**
REG 10-6, 10-17 etc.	**£1.00**
SOBELL 195/282/8	**£2.50**

MANY OTHERS STILL AVAILABLE

COLOUR LOPTS p.p. £1.00.

BUSH 182 to 1122 etc	**£9.80**
MURPHY Equivalents	**£7.60**
DECCA "Bradford" (state Model No. etc)	**£7.80**
GEC 2028, 2040	**£9.20**
PYE 691, 693, 697	**£16.80**
THORN 8500	**£8.80**

THORN 850 Time Base Panel, Dual Standard **50p** p.p. 80p.

MULLARD Scan Coils Type **AT1030** for all standard mono 110° models, Philips, Stella, Pye, Ekco, Ferranti, Invicta **£2.00** p.p. 85p.

PHILIPS G8 Tripler (1174) **£6.00** p.p. 75p. Others available.

6·3V CRT Boost Transformers **£2.90** p.p. 75p.; Auto type **£1.80** p.p. 45p.

CALLERS WELCOME AT SHOP PREMISES

THOUSANDS OF ADDITIONAL ITEMS AVAILABLE NOT NORMALLY ADVERTISED

MANOR SUPPLIES

172 WEST END LANE, LONDON, N.W.6.

(Near W. Hampstead tube stn: 28, 59 159 Bus Routes) 01-794 8751

Mail Order: 64 GOLDERS MANOR DRIVE, LONDON N.W.11.

PLEASE ADD 12½% VAT TO PRICES (EXCEPT * 8%)

TELEVISION

EDITOR
John A. Reddihough

ASSISTANT EDITOR
Luke Theodossiou

ART EDITOR
Roy Palmer

ADVERTS MANAGER
Roy Smith

CLASSIFIED ADVERTS
Colin R. Brown 01-261 5762

Ten Years of Colour

During mid and late 1967 we had been running a series of articles entitled "Colour is Coming". With the December issue we proclaimed "Colour is Here!": December 2nd marked the official start of the BBC's colour service on BBC-2. That date is possibly arguable – as are so many historical "starts" and "firsts" when you try to pin them down – since there had been regular colour transmissions since Wimbledon in the summer of 1967, while the service after December 2nd was not a full colour one. Nevertheless, the BBC had been preparing the public for colour, and getting the trade used to what this would involve, and on December 2nd released its plans for extensive colour programming.

It was a proud moment, and those of us who had been watching the early colour transmissions were impressed by their quality. But most of us probably held our breath. Would the public be interested? Would it pay up? And more to the point for us, how on earth were we going to sort out the problems and faults that were going to come our way? A whole new dimension had been added to television and, it seemed, was going to double at least the problems of servicing.

The reputation that colour had established for itself in N. America didn't help. We laughed at the joke about the serviceman moving into the spare room when the colour set was installed in the lounge, but at the same time were deeply uneasy. We thumbed through the US magazines – particularly Jack Darr's famous Service Clinic in *Radio-Electronics* – and wondered how we were going to be able to make head or tail of the strange things that could apparently happen to the colour display. We then noted that PAL was more complex, with things like a PAL switch which could stop, Hanover blinds, and so on – and pushed the whole matter as far as possible to the backs of our minds while attending to the present crop of open-circuit dropper resistors.

Then we thought of all the heat generated by those early NTSC colour sets – there had been a few around in the UK for experimental purposes – bristling as they did with mighty valves, and of the e.h.t. voltage in the region where X-ray radiation starts to increase rapidly. There'd been reports of US colour sets having to be recalled by the manufacturers for safety modifications....

But even if there have been many headaches, in the event things turned out to be a lot easier than anyone to start with dared hope. For one thing the PAL decoder is a very logical arrangement, and therefore ideally suited for making a few quick key checks. Then again most wrong colour faults turned out to be a simple enough matter – once you'd got used to the three primaries and how they add or should add up. Then, as with monochrome, the majority of faults turned out to be of the burnt dropper, no e.h.t., horizontal white line variety with which we were familiar enough. And the industry was rapidly moving over to transistors, with their cool operation. We had to get used to transistors at the same time that we got used to colour of course, and this didn't exactly help. Nor did dual-standard operation.

Two years later however saw the duplication of BBC-1 and ITV at u.h.f., in colour. Dual-standard colour sets were suddenly a thing of the past, and a new, simpler breed of sets started to appear. At the same time public interest began to perk up, and when the next consumer boom was unleashed in late 1972 colour suddenly became a feature of most people's living rooms.

This month we've departed slightly from our usual formula, in order to commemorate what in the event has turned out to be quite a success story. Looking back over those ten years – did they go that quickly because colour has in one way or another kept us so busy? – I think we are all entitled to a pat on the back. Early apprehensions proved unfounded. The public has been well served – to a considerable extent by service engineers who picked it all up as they went along! The broadcasting authorities have maintained a very high standard. Right then, are you all ready for what's in store for you next – teletext, video discs and the domestic TV as a home computer VDU?!

CORRECTION

There was an error in Fig. 1 on page 21 last month. There should be no electrical connection between S1a and S1b/S2 which are in parallel. The arrangement is shown correctly in Fig. 3.

FRONT COVER

The two sets shown contrast a typical 1967 colour receiver, a bulky Bush CTV25 dual-standard hybrid set with 25in. tube, and one of the very latest releases, a Bang and Olufsen Model 4402 which features a 26in. 20AX tube and ultrasonic remote control. The Bush CTV25 is still going strong after ten years' use!

Teletopics

HOME TV COMPUTER

Digital computer techniques have been gradually finding their way into the domestic TV set. First came digital methods of controlling the varicap tuner. Next came TV games, which use digital techniques with the TV set acting as a VDU (visual display unit). More recently we've had the advent of teletext, and the prospect of Viewdata. Along with these, setmakers are already producing elaborate remote control systems using digital techniques. The latest hand-held remote control transmitters resemble the pocket calculator, with their rows of buttons to tell the TV set what to do – to change channels, display one of the several hundred teletext pages, turn the sound or brightness up/down and so on. A set with all this digital hardware in it is already half way to being a simple computer, so it's not surprising that someone's decided to go the whole way and convert it into being just that – in addition to its normal functions of course. Just to remind ourselves of what's involved, Fig. 1 shows the basic elements of a simple digital computing system. The control section enables us to tell the computer what we want it to do. What it can do for us is stored in the programme memory as a number of programmes. Once the control system has told the programme memory which programme is required, and the computing memory the numbers involved, the memories take over, using the counter to do the donkey work. Once the computation is complete, the computing memory feeds the result to the display unit.

The main element that's missing from our latest TV sets is the all important programme memory – the expensive part of a computer. The necessary step to fill this gap has now been announced by General Instrument Microelectronics Ltd. who, in conjunction with EMI Tape Ltd., have developed an inexpensive method of providing a computer data store. This consists of conventional audio tape cassettes and a standard audio cassette mechanism or deck. The technique, for which patents have been obtained, enables 1·6 million data bits to be stored on each side of a conventional thirty minute per side C60 audio cassette, and offers a one hundredfold increase in storage capacity in comparison with ROM microcircuit cartridges, at a quarter of the price. The technique also allows voice and digital data to be stored on the same cassette.

GIM and EMI see the widespread availability of inexpensive hardware for the storage and playback of computer programmes as the key requirement in developing the domestic TV set into a computer system which can be used for such purposes as programmed learning, an information terminal and as a centre for TV games of a far more elaborate kind than those currently available. The two companies are collaborating in the development of programme material, with EMI taking responsibility for producing and distributing the tapes. The first products likely to become available – through normal tape/record shops – are ranges of TV games and educational programmes.

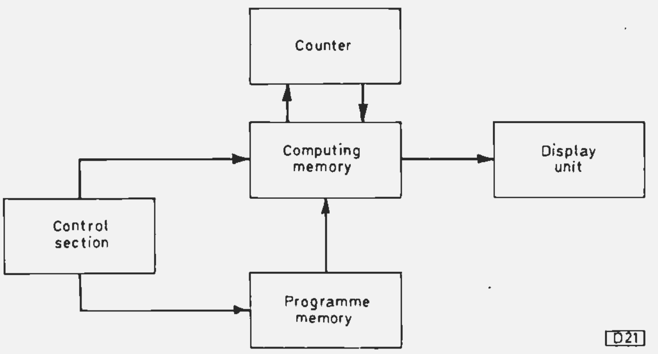


Fig. 1: Basic elements of a simple digital computing system. The counter and computing memory functions are commonly combined in a microprocessor i.c.

The possible range of programmes is virtually unlimited. By plugging a suitable cassette programme into a cassette deck contained in a TV games unit, the TV set can be transformed into a scientific or business calculator display in which every stage of calculation is displayed on the TV screen. Insert another cassette and the TV set can be transformed into a games terminal on which games of the complexity of chess can be played. Alternatively, language tapes could be made available combining on-screen text with the spoken word. Another big market is considered to be children's educational games, including arithmetic and spelling games in which the terminal's instant response to question and answer quizzes provides both entertainment and educatation.

The development of the programmable television terminal could lead to the growth of a major new software industry for educational and entertainment programmes. To avoid a proliferation of incompatible hardware, an industry standard for recording cassette data is required. The joint EMI/GIM technique for recording data on to cassettes, combined with the EMI patented watermark technique for protecting tape material copyrights, could become the standard.

An "electronic interface" which provides data retrieval and error checking, and which can be used with standard cassette recorder heads to play back the EMI/GIM record data, is to be marketed by GIM. It will form part of a complete programmable television terminal microcircuit chip set.

A key element in this system is the microprocessor, which incorporates in a single microcircuit package all the computing memory/counting functions of a complete computer. Costing one hundredth to one thousandth the price of a conventional computer, the microprocessor is already incorporated in GIM's decoder system for teletext and Viewdata.

GIM have in an advanced state of development a set of compatible MOS microcircuits for interfacing the television to its CP1600 microprocessor family. Modular in concept, these interface circuits can be used by the setmaker to offer a wide range of optional extras on the standard TV set, culminating in a complete home computer system. These interface circuits are also suitable for receiving the Viewdata and teletext services. Provision is made for remote armchair control, and for interfacing to the cassette mechanism for the playback of TV games and educational programmes.

It's important to emphasise that the system is still under development. We suspect that it will be some time before the chip set becomes available to anyone other than setmakers and systems manufacturers, but as soon as it does . . . watch this space!

PHILIPS LAUNCH THE N1700

Philips have now officially launched their N1700 130-minute VCR in the UK and expect deliveries to start reaching dealers towards the end of the year. The machine, which can record for over two hours on a single VC60 cassette, will be the only VCR which Philips promote on the domestic market. The N1502 will continue in production alongside the N1700, but will be available only through audio/visual specialist distributors. Philips say that the longer playing time of the N1700 is much more suitable for general consumer use, since many TV programmes run for longer than an hour. Schools, training establishments, industry, etc. on the other hand do not require such long recordings. These users can save about £250 by purchasing the N1502. The price of the N1700 is likely to be around £750 including VAT. Philips state that there are around 35,000 VCRs in use in the UK at the present time, and they expect to more than double this figure in N1700 sales. The company has a 600 strong dealer network, but it's not planned to expand this in the near future. Philips have retained the modular method of construction, and initial tests have shown the recorder to be reliable. Servicing is said to be no more complicated than with the N1502.

Philips have also announced a monochrome camera for use with the N1700. The price of this is likely to be around £450.

RIC SUMMIT

Leading figures in the radio and television industry spoke at the recent Radio Industries Club convention called to discuss the depressed state of the industry. Thorn's group chairman and MD Sir Richard Cave suggested that Thorn would have sunk on TV alone: he commented that Thorn's results had not been satisfactory since the year ending March 1974, with the return on capital at less than the Bank Rate, and with their TV plant operating at only 60 per cent capacity – a figure which applies to the industry as a whole – since April 1975. TV setmakers have managed to remain in business only by being parts of larger industrial groups. Sir Richard said "we are selling very good equipment very much too cheaply: the UK customer is certainly getting a very good buy".

It seems that due to the highly competitive marketing in the UK the prices of domestic electronic equipment are markedly cheaper than in other parts of the world. The result may be good for the consumer, but makes the profitability of setmakers, component manufacturers and distributors such that their future is uncertain. Mullard's MD Jack Ackerman pointed out that the UK is currently importing over 90 per cent of the i.c.s used, 75 per cent of other semiconductor devices and 60 per cent of passive components. He called for increased investment, comparable to that in other advanced countries, if the UK's electronics industry is to survive.

Sir Richard spoke about the greatly improved reliability of the latest UK produced sets – a theme we've mentioned before in these pages. Interestingly, he mentioned that they would have to reduce the time at present required on inspecting and repairing faults, since this takes three times as long as their competitors.

US VCR SCENE

Some fifteen companies are planning to introduce new two- and four-hour VCRs on the US domestic market towards the end of the year. The number of basic systems now seems to have been reduced to three. The Matsushita VHS system gets up to four hours' on to a ½in. tape by using the skip-field principle – since each stripe on the tape consists of a complete field, the bandwidth can be considerably reduced by recording only alternate fields and playing these back twice. This reduces the vertical resolution of course, but still provides acceptable quality. You get the best of both worlds with switchable machines that operate either normally or in the skip-field mode to give either two or four hours' playing time. The Matsushita (National Panasonic) VHS system has been adopted by RCA, Sylvania and Magnavox amongst others. The latter is intriguing, since Magnavox is owned by Philips.

Philips plan to launch their video disc in the US within a matter of weeks.

SINCLAIR INCREASE MICROVISION PRODUCTION

Sinclair have announced that as a result of the success of their multi-standard 2in. Microvision miniature portable TV receiver production is to be increased from 2,000 to 4,000 a month. The main market for the set is in the USA.

STATION OPENINGS

The following relay transmitters are now in operation:

Dolgellau (Gwynedd) BBC Wales channel 55, ITV (HTV Wales) channel 59, BBC-2 channel 62. Receiving aerial group C/D.

Ivybridge (Devon) BBC-1 channel 39, ITV (Westward Television) channel 42, BBC-2 channel 45. Receiving aerial group B.

Llwyn Onn (Gwynedd) BBC Wales channel 22, ITV (HTV Wales) channel 25, BBC-2 channel 28. Receiving aerial group A.

Machynlleth (Powys) BBC Wales channel 57, ITV (HTV Wales) channel 60, BBC-2 channel 63. Receiving aerial group C/D.

Sennybridge (Powys) BBC Wales channel 40, ITV (HTV Wales) channel 43, BBC-2 channel 46. Receiving aerial group B.

DECCA'S QUALITY CONTROL

Decca have invested more than half a million pounds in new test facilities and quality control at their Bridgnorth television factory. Every colour set now has a 24-hour soak test, which includes cycling on/off periods and mechanical bump tests, while passing along a 1,000ft. conveyor system. After repair, faulty sets receive a further 24-hour soak test. Decca comment that this test is equivalent to at least a week's use by the customer, and enables those irritating faults that occur early in a set's life to be avoided – especially as the components causing such troubles can be pinpointed and measures taken with suppliers.

TV GAMES: NO HAZARD

Videomaster have commented that there is no evidence to show that TV games can harm TV sets, pointing out that with modern vacuum techniques of tube manufacture there is no danger of static images being left on the screen. Their research suggests that a game would have to be played for 2,000 hours before any damage occurred. Videomaster now take extra precautions to ensure that their games cannot be displayed too brightly on the screen, and feel that as a result a Videomaster game could be played for 4,000 hours before having an adverse effect. It seems that such damage as has been experienced has been mainly due to the misuse of games: the advice given by Thorn (see *Teletopics*, October 1977) is worth noting.

TEN YEARS OF COLOUR
1: Choice of Colour System

Pat Hawker

ENGINEERING, industrial, administrative and political factors all became hopelessly intertwined in the long but eventually unsuccessful attempt to establish a single colour-encoding system for Europe. From 1962-67 the struggle oscillated wildly between the three main systems – the American NTSC, the French SECAM and the German PAL. There were also many variations within the SECAM and PAL systems, plus some outsiders such as NIIR, FAM, TSC, SEQUIN, LEP, and counter ideas such as the Post Office's pilot-tone reference system for NTSC, suggested by Dr N. W. J. Lewis in 1964.

In February 1965 the official UK delegation went to the CCIR Study Group XI meetings at Vienna firmly committed to support NTSC – yet before the end of that year it had swung over equally firmly to support PAL. Indeed for much of 1964 and 1965 the only *public* support in the UK for either PAL or SECAM came from a few technical journalists and the small engineering team at ABC, Teddington. At that period the British industry, through BREMA, was solidly behind NTSC. The BBC's then Director of Engineering, Sir Francis McLean, wrote in March 1965 that "the NTSC system is much to be preferred". The PMG made a statement in the House of Commons on February 3, 1965 in favour of NTSC. Yet today almost everyone in British broadcasting circles sincerely believes that the UK made the right choice in opting for PAL. Even in the United States, the birthplace of NTSC, one finds a belief that European television benefits from having chosen PAL or SECAM, though clearly many of the original problems in handling and, particularly, in tape recording NTSC have now been largely overcome.

Why did it take skilled engineers and administrators so long to come to what, with hindsight, may seem the obvious choice? And why are we still left with all three systems in general use?

History of Colour

Baird, in his disconcerting manner of rushing on to the next problem before solving the last one, demonstrated low-definition colour in the 1920s. Less well known was his later war-time demonstration of relatively good quality electronic colour, and his development of the two-gun and three-gun Telechrome picture tubes.

In the 1930s there had also been proposals by the Frenchman Georges Valensi that a compatible colour system, i.e. capable of being received also as black-and-white, might be based on the concept of luminance and chrominance.

But much of the early work on colour was based on sequential, non-compatible systems. CBS in America demonstrated a 343-line 120-field sequential colour system in 1940 and, after the war ended in 1945, developed a 525-line, 144-field sequential system which required a 12MHz channel – this system was even used operationally for a time, during the course of 1951.

But in 1949 the FCC decided that for colour to be used generally it must be capable of fitting within the standard American 6MHz channel, and began a series of hearings. The industry formed the National Television System Committee, whose purpose was to assist the FCC and bring together the ideas then being pursued separately by different firms.

This period also saw the development by RCA, under a crash programme, of the Tricolour shadowmask display tube. This was an immensely important development, since it made obsolete the spinning colour discs used in sequential systems and the then possible alternatives – the costly projection systems based on Schmidt optics, or the bulky three orthogonally mounted cathode-ray tubes viewed through diachroic mirrors. The shadowmask tube drew on the ideas of W. Flechsig, Dr A. N. Goldsmith, A. C. Schroeder and others. The key problem – how to line-up accurately several hundred thousand tiny holes with an equal number of phosphor-dot triplets – was solved by Harold Law with his "lighthouse" technique, using light to simulate the electron beams. In 1950 the first shadowmask tube was demonstrated.

During 1950-52 NTSC emerged as a "system", drawing freely on the work of several firms and including the colour-dot sequential and other ideas of RCA. One of the ideas that was considered but not adopted was "colour phase alternation" (CPA), which was proposed by B. D. Louglin of Hazeltine. It was later the genius of Dr Walter Bruch to join the potential advantages of CPA with the electrical memory introduced by Henri de France for SECAM in order to form the basis of PAL – but we are running ahead of our story.

Although it is often said that a camel is a horse designed by a committee, the NTSC standard that emerged from all this was undoubtedly a work of genius. It solved each of the problems it had been set: a fully-compatible system, in the standard channel bandwidth; good reverse-compatibility (display of black-and-white pictures on a colour set); excellent potential colour fidelity with an absence of crawling patterns (other than the degree of cross-colour inherent in any system using frequency interleaving), and virtual absence of colour dots on black-and-white displays.

The FCC authorised NTSC colour transmissions from January 1, 1954, and NBC (the broadcasting company affiliated with RCA) was particularly prominent in promoting the system.

But the growth of colour set sales was slow. Early sets were expensive and unreliable; colour cameras were bulky, required intense light, and were prone to drift. And the whole system was soon found to be susceptible to differential phase and differential amplitude problems, particularly when networked across the country. The user needed to compensate for phase variations by means of a hue control, and it was soon clear that many viewers found it difficult to adjust both the saturation and hue controls.

TTLs by TEXAS

7400	16p
74HDD	30p
74LSDO	32p
74SDD	48p
7401	18p
7402	18p
7403	18p
7404	24p
74H04	40p
7405	25p
7406	45p
7407	45p
7408	25p
7409	27p
7410	18p
74H10	30p
7411	28p
7412	28p
7413	36p
7414	96p
7416	35p
7417	40p
7420	18p
7421	43p
7422	27p
7423	36p
7425	33p
7427	40p
7430	18p
7432	34p
7437	37p
7438	37p
7440	18p
7441	85p
7442	75p
7443	130p
7444	130p
7445	108p
7446	108p
7447	90p
7448	90p
7450	18p
7451	18p
7453	18p
7454	18p
7460	20p
7470	32p
7472	32p
7473	36p
7474	37p
7475	48p
7476	37p
7480	54p
7481	108p
7482	85p
7483	95p
7484	103p
7485	130p
7486	36p
7489	340p
7490	43p
7491	90p
7492	55p
7493	43p
7494	96p
7495	75p
7496	90p
7497	340p
74100	116p
74104	60p
74105	60p
74107	36p
74109	70p
74110	55p
74111	80p
74116	220p
74118	90p
74120	95p
74121	32p
74122	53p
74123	73p
74125	70p
74126	76p
74128	90p
74132	76p
74136	81p
74141	85p
74142	300p
74145	90p
74147	275p
74148	173p
74150	135p
74151	77p
74153	92p
74154	164p
74155	97p
74156	97p
74157	96p
74158	160p
74159	220p
74160	120p
74161	120p
74162	120p
74163	120p
74164	130p
74165	150p
74166	136p
74167	340p
74170	250p
74173	160p
74174	130p
74175	92p
74176	130p
74177	130p
74180	118p
74181	324p
74182	88p
74185	144p
74186	995p
74190	155p
74191	160p
74192	130p
74193	130p
74194	130p
74195	104p
74196	130p
74197	130p
74198	214p
74199	214p
74221	175p
74251	151p
74265	97p
74278	314p
74279	151p
74283	205p
74290	162p
74293	162p
74298	216p
74365	162p
74366	162p
74390	216p
74393	243p

C-MOS ICs

4000	21p
4001	21p
4002	21p
4006	110p
4007	22p
4009	67p
4011	21p
4012	21p
4013	55p
4014	110p
4015	120p
4016	54p
4017	110p
4018	120p
4019	54p
4020	95p
4022	100p
4023	21p
4024	75p
4025	21p
4026	220p
4027	81p
4028	152p
4029	120p
4030	59p
4040	130p
4042	90p
4043	100p
4046	150p
4047	110p
4049	68p
4050	54p
4055	120p
4055	140p
4056	145p
4060	120p
4069	40p
4071	29p
4072	29p
4081	25p
4082	29p
4093	95p
4510	142p
4511	160p
4516	140p
4518	140p
4528	130p
4553	575p

MEMORY

RAM	
2102-2	270p
2112-2	470p
ROM	
RO3-2513	850p
74S262N	1650p

Branded devices from RCA. Texas,Motorola. Mullard, etc.

OP AMPS

1458	75p
301A	40p
3130	100p
3140	105p
3900	70p
LM324N	130p
LM339N	225p
709	40p
741	25p
747	70p
748	40p

Linear ICs

AY-1-0212	650p
CA3028A	112p
CA3046	85p
CA3048	275p
CA3053	75p
CA3080	97p
CA3089E	250p
CA3090AQ	500p
LM318N	175p
LM380	115p
LM381	190p
MC1310P	200p
MC1330P	102p
MC1351P	104p
MC1358P	195p
MC1495	370p
MC1496	115p
MC3340P	160p
MFC4000B	120p
NE504L	175p
NE555	40p
NE556	90p
NE561	425p
NE562	425p
NE565	200p
NE566	200p
NE567	200p
SG3402N	275p
SL432A	475p
SL437F	960p
SL901B	520p
SL917A	675p
SL918A	760p
SN72710N	45p
SN72733N	150p
SN76003N	275p
SN76008	275p
SN76013N	175p
SN76018	275p
SN76023N	175p
SN76033N	275p
SN7660N	90p
TAA350	205p
TAA570	240p
TAA621A	275p
TAA661B	150p
TBA120	75p
TBA480Q	200p
TBA570	145p
TBA6418	300p
TBA651	275p
TBA800	100p
TBA810	125p
TBA820	100p
TDA2020	400p
ZN414	140p

AC125	20p
AC126/7	20p
AC128	20p
AC141/2	20p
AC176	20p
AC187/8	20p
AC187K	25p
AC188K	25p
AD149	58p
AD161/2	39p
AF114/5	22p
AF116/7	22p
AF124	36p
AF127	36p
AF139	43p
AF239	48p
BC107/8	10p
BC108/8	10p
BC109/C	11p
BC147/8	9p
BC149/C	10p
BC157	11p
BC158/9	12p
BC169C	16p
BC172/B	12p
BC177/8	20p
BC179	20p
BC182/3	12p
BC184	14p
BC187	32p
BC212	14p
BC213	12p
BC214	16p
BC337	27p
BC338	27p
BC478	32p
BCY70	20p
BCY71	24p
BD115	90p
BD131	65p
BD132	65p
BD135	54p
BD136	55p
BD139	56p
BD140	60p
BDY56	225p
BF115	24p
BF167	25p
BF173	27p
BF178	40p
BF179	40p
BF180	40p
BF184	30p
BF194/5	12p
BF196/7	18p
BF200	40p
BF244	40p
BF257/8	36p
BF259	40p
BF336	32p
BF337	32p
BFR39/40	34p
BFR79/80	34p
BFR88	40p
BFX29/30	34p
BFX84/85	30p
BFX86/7/8	30p
BFY50	22p
BFY51	22p
BFY52	22p
BRY39	45p
BSX19/20	20p
BT106	140p
BU105	175p
BU108	315p
MJ2955	130p
MJE340	70p
MJE2955	130p
MJE3055	97p
MPF102/3	40p
MPF104/5	40p
MPSA06	37p
MPSA12	61p
MPSA56	37p
MPSU06	78p
MPSU56	98p
OC28	90p
OC35/36	90p
OC71	30p
R20088	225p
R20108	225p
TIP29A	50p
TIP29C	62p
TIP30A	60p
TIP30C	72p
TIP31A	56p
TIP31C	68p
TIP32A	63p
TIP32C	85p
TIP33A	97p
TIP34A	124p
TIP35A	243p
TIP35C	290p
TIP36A	297p
TIP36C	360p
TIP41A	70p
TIP41C	84p
TIP42A	76p
TIP42C	96p
TIP2955	76p
TIS43	40p
TIS93	30p
ZTX108	12p
ZTX300	16p
ZTX500	20p
2N697	25p
2N698	40p
2N706/8	22p
2N918	43p
2N930	19p
2N1131/2	25p
2N1304/5	75p
2N1306/7	75p
2N1613	22p
2N1711	22p
2N1893	32p
2N2160	120p
2N2219	22p
2N2222	22p
2N2369	15p
2N2484	32p
2N2646	52p
2N2904/A	22p
2N2905/A	22p
2N2906/A	24p
2N2926RB	9p
2N2926OYG	11p
2N3053	22p
2N3054	65p
2N3055	65p
2N3442	151p
2N3702/3	14p
2N3704/5	14p
2N3706/7	14p
2N3708/9	14p
2N3773	320p
2N3819	27p
2N3820	50p
2N3823	54p
2N3866	95p
2N3904/5	22p
2N3906	22p
2N4060	12p
2N4123/4	22p
2N4125/6	22p
2N4401/3	34p
2N4427	97p
2N4444	175p
2N4871	64p
2N5296	65p
2N5457/8	40p
2N5459	40p
2N6027	60p
2N6107	70p
2N6247	200p
2N6254	140p
2N6292	70p
3N128	97p
3N140	105p
3N141	97p
3N187	200p
40361/2	45p
40409/10	65p
40411	325p
40594	90p
40595	97p
40673	70p

Miscellaneous

BYZ13 1A DIL Bridge	55p / 40p
10000uF 16V Cap.	250p
Mains Transformer	£6
7805	130p
7812	130p
2102 RAM	220p
16 pin Skt	14p
OA90	9p
SN74S262N	1650p
Soldercon Pins	100/75p

VOLTAGE REGULATORS (Plastic) Fixed

1 Amp + ve			1 Amp — ve		
5V	7805	130p	5V	7905	200p
12V	7812	130p	12V	7912	200p
15V	7815	130p	15V	7915	200p
18V	7818	150p	18V	7918	200p
24V	7824	150p	24V	7924	200p

TELETEXT DECODER

(as being featured in current issue)

SPECIAL OFFER TO CONSTRUCTORS AT REDUCED PRICES:–

1) Power Supply Unit kit £19.00 inc.
2) Input Logic Card kit £14.25 inc.
3) Memory Board kit £20.20 inc.

Above kits contain all the components as listed in each article except P.C.Bs.

DISPLAY CARD KIT

All Resistors, Presets and Capacitors

3 – OA90	1 – 7402	1 – 7490
1 – 74165	1 – 7400	1 – 74121
1 – SN74S262N	1 – 7408	1 – 74123
1 – 74153	1 – 7404	2 – 74177
3 – 7474	1 – 7492	20 – Soldercon Pins
2 – 7412	1 – 7473	

Complete Kit as above £25.00 inc.

ALL ICs BY TEXAS INSTRUMENTS

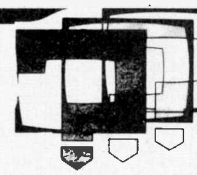
All First Grade Branded Products Only

VAT INCLUSIVE PRICES — Add 25p P. & P.

MAIL OROER ONLY — Govt., Colleges orders accepted

TECHNOMATIC LIMITED

54 Sandhurst Road, London NW9. Tel. 01-204 4333 Telex: 922800



Technical Reading for Television Servicemen and Engineers

COLOUR TELEVISION SERVICING – 2nd Edition
Gordon J. King

CONTENTS: Preface. Introduction. The Science of Colours. The Colour Camera. Signals and Displays. The Shadowmask Colour Tube. An Overall View of the Colour System. Purity and Convergence. Timebases. E.H.T. and Power Supplies. Luminance and Colour-difference Amplifiers and Grey-scale Tracking. Vision Chroma, Reference Generator and Sound Stages. Encoding and Decoding. Test Instruments and Signals. Locating the Fault Area. Servicing procedures. Servicing in the Field. Tuned Circuit Alignment. Faulty Picture Tube Symptoms. Receiver Design Trends. Television Standards. Index.

1976 *328 pages* *£6.50*

NEWNES COLOUR TELEVISION SERVICING MANUAL
Gordon J. King

Volume 1
CONTENTS: BRC 2000 Dual-standard Chassis and 3000 Single-standard All Transistor Chassis. Bang and Oulfsen 3000 Single-standard Hybrid Chassis. Decca CTV25 Dual-standard Hybrid Chassis. Decca Bradford Single-standard Hybrid Chassis. Rank/Bush/Murphy A823 Single-standard All Transistor Chassis. GEC/Sobell/Masteradio Dual-standard Hybrid Chassis. ITT CVC5 Single-standard Hybrid Chassis. Pye 691 Single-standard Hybrid Chassis. Sony Non-PAL KV 1320U8 Single-standard Decoder Principle. Appendix I: Notes on U.H.F. Reception. Appendix II: U.H.F. Channels and Stations. Appendix III: Notes on Aerials. General Index. Index to Models.

1973 *240 pages* *£6.40*

Volume 2
CONTENTS: Philips G8 Chassis: 8RC 8000 Chassis. Grundig 717G8 Chassis. ASA CT 5003 and CT5004 Receivers. Saba Chassis (including T2700F, S2700F, T2704F and T2705F Receivers). GEC and Sobell Single-standard Hybrid Chassis. Telefunken 710 110 Degree Tube Chassis. Pye 713 Chassis. General Corporation of Japan Decoder Principle. Appendices on Test Instruments and Colour Fault Symptoms and Their Causes. General Index. Index to Models.

1975 *244 pages* *£6.40*

Volume 3
CONTENTS: R8M Z179 Chassis. Hitachi CSP-680 Receiver. ITT CVC8 Chassis. B&O Beovision 4000 and 5000 Receiver. Decca Solid State 40 Series Receiver. Thorn 9000 Series Chassis. Philips G9 Chassis. Appendix I In-line Picture Tubes. Appendix II Picture Tube Faults. Appendix III Component Symbols and Fuse Ratings. Appendix IV Quick Vision Picture Tubes. Appendix V UHF aerial evaluation. General Index. Index to Models.

1976 *240 pages* *£7.80*

SOLID STATE COLOUR TELEVISION CIRCUITS
G. R. Wilding

CONTENTS: Devices and Principles. Power Supplies. Timebase Circuits. Sync Separators. Convergence and Degaussing. Tuners and I.F. Amplifiers. Luminance Circuits. Chrominance Circuits. Burst Gates and Reference Oscillators. Demodulator and PAL Switch.

1976 *200 pages* *£5.75*

TELEVISION ENGINEERS' POCKET BOOK – 6th Edition
Revised by P. J. McGoldrick

CONTENTS: Standards and Waveforms. Basic Receiver Unit Circuitry. Basic Timebase and Power Supply Circuits. Television Integrated Circuits. Colour Television. Valve Timebase Fault Finding. Installation and Servicing Techniques. Servicing Equipment. Fault Finding and Alignment. Aerials and Interference. Cathode-ray Tubes. Valve and Transistor Data. Colour Codes and Useful Addresses. Index.

1975 *380 pages* *£4.45*

TELEVISION SERVICING HANDBOOK – 3rd Edition
Gordon J. King

CONTENTS: Introduction. No Sound, Vision or Raster. No Raster – Normal Sound. No Sound or Vision – Raster Normal. No Vision – Sound and Raster Normal. Fault-tracing in the Sound Channel. Servicing the Timebases. Synchronising Faults. Vision a.g.c. Systems. Picture – Tube Faults. Receiver Alignment. Miscellaneous Faults. Colour Television. Television in the u.h.f. Bands. Dual Standard and 625-Line-only sets. Transistor Television Receivers.

Reprint 1975 *358 pages* *£5.20*

NEWNES–BUTTERWORTHS Technical Publishers
Borough Green, Sevenoaks, Kent TN15 8PH

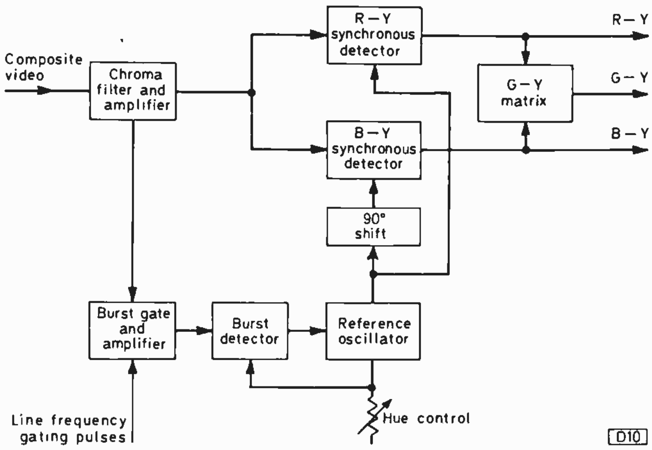


Fig. 1: Basic NTSC decoder. Detection takes place on the tips of the reference signal. Since the phase of the signal determines the colour, if the signal phase shifts spuriously incorrect colours are detected. The hue control enables the reference signal to be shifted to compensate.

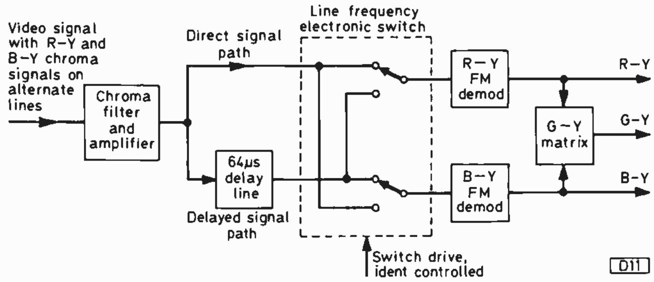


Fig. 2: Simplified SECAM decoder. The R−Y and B−Y colour-difference signals are transmitted on alternate lines. The combination of the delay line and the switch enables the lines to be repeated, the demodulators detecting alternate lines twice. The reduced vertical colour resolution is of little practical significance, the great advantage of the system being that detection is not phase sensitive. The switching has to be synchronised, so that the correct signals are fed to the two demodulators, and for this purpose positive- and negative-going sawtooth signals are transmitted during the field flyback blanking interval to provide the necessary identification – because of the odd number of lines per picture, the first line of each alternately carries R−Y and B−Y chrominance signals.

For the broadcaster a new and unexpected problem soon arose. In 1956 Ampex startled the television world with the first successful videotape recorders. But the early VTR machines introduced linear phase errors which made their performance on colour at best marginal (even when the recording heads were sent with the tapes for playback). If NTSC had been drawn up *after* the development of the VTR, it is highly likely that more attention would have been given to the idea of phase alternation.

A combination of factors – high receiver price, limited amount of colour programming, variable colour fidelity, VTR problems etc. – kept demand for colour sets in the United States low. At one period only NBC were regularly transmitting colour. It took almost ten years for colour sales to reach one million a year (1963, with 1.4 million, was the turning point). Europe was in no hurry to start colour under those conditions.

Some European engineers felt that the slow start to colour in the USA was influenced by the unnatural hues seen due to the susceptibility of NTSC to small phase errors. There were two ways out of this problem: to develop better studio equipment and tighten the specification of distribution links; or to develop a new system less susceptible to phase errors.

Start of SECAM

Henri de France proposed a system which he called SECAM ("sequential and memory"). This encoded the colour without using quadrature modulation for the two colour-difference signals: instead, he proposed that at any given moment only one chroma signal would be transmitted, and introduced the idea of storing the signal temporarily by means of a delay line. This would then provide him with both signals simultaneously, but with reduced vertical colour resolution, a matter of little practical importance. He originally proposed to carry the chroma information on an amplitude-modulated subcarrier, but the system was soon redesigned for frequency-modulation of the subcarrier. In both systems, unlike NTSC, the subcarrier is continuously present (NTSC uses suppressed-carrier quadrature amplitude modulation for the two colour-difference signals.) Henri de France's ideas were adopted by a French company, CFT, which was set up by two large French firms, the electronics company CSF and the large glass manufacturer Saint-Gobain.

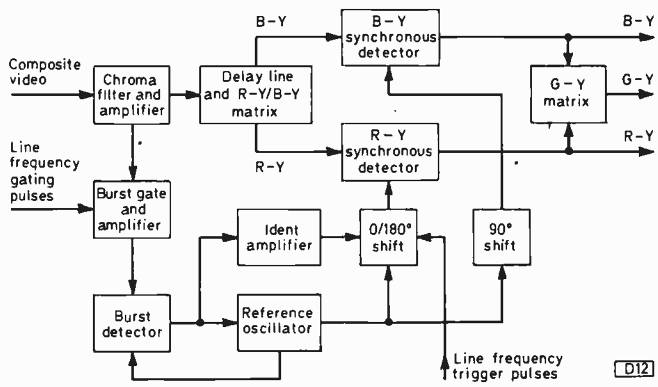


Fig. 3: Basic PAL-D decoder. The use of a delay line and a matrix circuit enables the two transmitted colour-difference signals to be separated prior to detection. To make this arrangement work, the polarity of one of the colour-difference signals (in practice R−Y) has to be reversed, i.e. its phase shifted by 180°, on alternate lines. This means that a 0/180° phase shift switch is required in the decoder, with ident to synchronise its operation with the switching at the transmitter. By processing the signals in the delay line/matrix circuit, the effect of spurious phase shifts is converted into a slight loss of saturation.

Henri Peyroles of CFT became extremely active in propagating the ideas of SECAM, and his engineering team included the redoubtable Pierre Cassagne. It was also clear that behind CFT stood the active support of President De Gaulle, and indeed a Government minister was for a time directly concerned with promoting SECAM.

Birth of PAL

In Germany Dr Walter Bruch of Telefunken, who had been concerned with television for many years, shared the view of Henri de France that colour was being held back by the phase problems of NTSC. For a time he worked on SECAM, with its electronic memory, but he was equally attracted by the quadrature modulation suppressed-carrier techniques of NTSC. In 1962 he married the two, and so was born PAL (phase alternation line), using the phase alternation ideas of CPA, the basic techniques of NTSC, and also the delay-line memory of SECAM.

But the other systems had both had some years in which to sort out their problems. PAL came just in time to be adopted as a serious contender by the EBU, but its parameters had virtually to be optimised during the investigation – giving rise to the tag "Pray and Learn". SECAM also continued to offset problems as they were uncovered, by changing its basic parameters (SECAM I, II III and IV). It became known as the "Supreme Effort Contré les Americans"! NTSC in turn was dubbed "Never Twice the Same Colour".

The Battle

Looking back through a pile of fading press clippings, I find that the battle between the systems began in earnest at the beginning of 1963. It reached London that summer during a series of demonstrations, and became a war of attrition throughout 1964 when CFT began production of a few SECAM receivers. The Post Office rescued NTSC from its dependence on high-grade microwave links by devising a pilot-tone reference system, and the controversy rose to fever pitch at Vienna in 1965. It finally collapsed in failure to agree at Oslo in April 1966.

Rome and Moscow were also battlefields, and the PAL system was demonstrated to the press for the first time only in February 1965, in Berlin. This led me to forecast then that "PAL could be the compromise system for Europe". The EBU ad hoc Committee published massive reports in October 1963 and February 1965, based on extremely intensive investigations by a whole series of groups. Both reports were crammed full of engineering facts.

But nobody was prepared collectively to pick a single system as "the best": each had advantages and disadvantages. SECAM was rugged and easiest to record and distribute over long distances and could use steel delay lines. NTSC was tried and tested and showed every promise that with better cameras and VTRs it would give good quality. PAL came in the middle, with more pros than cons but still posing the problem – could precision glass delay lines be made at low cost in mass production? At the time they were high cost, specialised radar components. Telefunken guaranteed to supply them to West German manufacturers for less than DM20, but what about the rest of Europe?

The BBC co-operated with Ampex in improving colour video recording, and this led to the development of high-band recorders that gave good performance on all three systems (indeed the 8-field sequence adopted for PAL has tended to make this the most difficult system to record). They also presented a rather questionable demonstration that highlighted SECAM's vulnerability to "silver fish" beyond the service area, due to the f.m. threshold.

The ABC team, on behalf of ITV, developed – under Howard Steele – methods of transcoding between systems, and also improved the "mixing" of SECAM signals in the studio. ITV in fact became the only group to transmit NTSC, PAL and SECAM in 405-lines.

BREMA produced a report to show that the extra "hue" control on a NTSC receiver would not often require adjustment by the user. By a tactical error they issued only part of the report to the press, and that part appeared to prove that NTSC *did* involve user problems!

Philips in Eindhoven – with their own colour systems out of the running – quietly went on developing the Plumbicon camera tube. This arguably played an even greater part than any encoding system in improving the standard of colour.

RCA, misjudging the European mood, issued a series of highly partisan booklets in support of NTSC. Several British engineers were dissuaded from speaking in Moscow about SECAM!

Some firms were by now convinced that colour was unlikely to appeal to a mass audience until the prices came down, and were quite content to stand by and watch the in-fighting. Several ceased development work on colour, though Bush was an exception.

Some continental firms were so uncertain which way the fight would go that, for example, I was shown excellent SECAM receivers by one international firm in France only on the explicit understanding that I would not disclose which firm I was writing about!

The Chairman of the EBU ad hoc Committee, the late Dr. Richard Theile, due to report on the work of the Committee at the 1965 Montreux Symposium, withdrew his paper at the last moment.

At Oslo in 1966 it was even thought that one way out of the impasse was, instead of changing the parameters, simply to change the name. PAL almost became SEQAM, or alternatively "The Oslo system". There was a move to insist that all countries should look at SECAM IV/NIIR while shelving further work on other systems.

The administrators and telecommunications people at Oslo fell out bitterly with the broadcasters, whom they dismissed as a troublesome clique, prone to "political rigging and manoeuvring".

In the end it was agreed that the parameters of the three colour systems should be registered by the CCIR, but that individual countries should make up their own minds. So failed the attempt to choose a colour system for Europe. But it left the UK free to adopt PAL, and there are few regrets. Somehow, almost by accident one feels, we chose the right system.

In the UK however that was not the end of the controversy. ITV wanted a chance to start colour as quickly as possible – and that meant 405-line colour on v.h.f. Why and how they lost that struggle is another story.

In the end the BBC was authorised to begin its colour service on BBC-2 by the end of 1967. On July 27, 1967 the PMG announced that ITV could begin 625-line u.h.f. colour "early in 1970". In fact colour on BBC-1 and ITV began on November 15, 1969.

Table 1: Some system comparisons

	NTSC	SECAM	PAL
Tolerance to differential phase errors	±12°	±40°	±40°
Tolerance to differential gain errors	30%	65%	30%

PAL improvements on NTSC

Horizontal resolution and vertical edge effects when transmitted on European "G" standard; tolerance to distortions of upper sideband of chroma signal; sensitivity to multi-path echoes.

PAL disadvantages to NTSC

Basic receiver cost; compatibility on black-on-white; adaptability to single-gun tube; experience.

Loosely based on the EBU ad hoc Committee reports of 1963-65.

Subcarrier frequencies

625-line PAL	4·43361875MHz
625-line NTSC	4·4296875MHz
625-line SECAM	4·4375MHz (f.m. ± 770 kHz)
525-line NTSC	3·579545MHz
405-line NTSC	2·6578125MHz

TEN YEARS OF COLOUR

2: Servicing and Receiver Developments

E. Trundle

IT seems incredible that regular colour transmissions in the UK have been going on for ten years now – that ten years has flown! It was on December 2nd 1967 that the regular BBC-2 colour service started – heralded by lots of little kangaroos. This was not the first time that colour had been seen by the UK public, as for several months test programmes had been transmitted while for some years previously most setmakers had mounted displays at the annual Radio Show (in those far off days when it was at Earl's Court, and the public was allowed in as well!). I remember a row of darkened booths, each one painted matt black and containing a 21in. circular RCA shadowmask tube displaying locally generated demonstration films with varying degrees of fidelity. Purity and convergence left a bit to be desired in some cases, but it was nevertheless very impressive. The BBC and ITA (as it then was) had already been active in the colour field for some time before 1967, with experimental 405-line colour using NTSC and other systems.

First Experiences

My first introduction to colour was when a huge 25in. dual-standard colour console receiver was delivered to the workshop for setting up. It was a Philips G6, bristling with valves and presets, and what on earth was that relay on the c.r.t. base for? We all had a go at purity adjustments, and each engineer spent about a day on the convergence, after which it was almost as good as when it was unpacked.

I left the employ of that firm shortly afterwards, but not before being taken to one side by Jim. Now Jim had had dealings with projection equipment years before, and solemnly told me of the evil effects of X-ray radiation upon the human frame. Certain extremities of a confidential nature, said Jim, were likely to drop off under the influence of X-rays. . . . To this day I have been hesitant to approach GY501s and especially PD500s closely, but all is well, Jim, as I write this.

I then secured a post seven doors down the road as one-man-band in the TV service department of the local branch of a well-known divi-giving national store. My arrival coincided with that of their first colour set, a dual-standard GEC model with a vast cabinet, a 19in. screen and a colour beacon to proclaim to the world that its purpose in life was being fulfilled. It was humped up three flights of stairs, through the furniture and accounts departments to my lair at the top of the building (why are TV workshops always upstairs?) where it was pored over and played with before being borne in triumph to the showroom, there to be degaussed and meticulously pointed due East in glorious demonstration.

Complete Colour Capability?

As we started to rent and sell colour receivers, so my worries increased. Like most of the trade at that time, I was grossly under equipped, boasting only a Bemix crosshatch generator in addition to monochrome TV servicing gear, and living in fear of the under-manager's regular refrain: "Mr. Wigg's set's gorn again!" Large areas of the colour set were still shrouded in mystery – how I wished that the Complete Colour Capability of my Mullard PL802s and PL509s extended to the man who fitted them! Many readers will remember, perhaps with some affection, the demonstration films shown on BBC-2 in the early days. Our favourite was the colour installation cartoon film. How confidently did the little technician degauss and converge that TV! How readily did the pert little housewife accept the shortcomings of her indoor aerial! I could swear that the technician winked as he pulled closed the curtains preparatory to setting up the c.r.t.

For two years or so, colour sets were quite thin on the ground. It seems that they were the province of the better-off, with the vast majority of people being interested, but waiting for the price to come down (!). It never did in terms of pounds, but in real terms colour TV is getting cheaper all the time: what other commodity can claim to have held its price virtually steady for almost ten years? As the trade was still feeling its way on the servicing side, in retrospect the gradual introduction of colour was a good thing for both setmaker and dealer.

The Early Sets

On the technical side there was much of interest. Mullard had published, quite early on, a sort of Bible for setmakers, with suggested circuits using their hardware and a very good basic design for a dual-standard colour receiver. Many setmakers adopted the Mullard approach, and this accounts for the similarity between early models from such makers as Decca, Rank, Pye, and GEC. The latter firm was amongst the first to employ an e.h.t. tripler instead of a thermionic rectifier, in an otherwise conventional receiver. Thorn were the great innovators in the early days: they never built a hybrid colour receiver at all, but plunged boldly into solid-state technology from the word go. An example of the 2000 series dual-standard chassis occupies a well deserved place in the National Science Museum as the world's first production all transistor colour receiver. Looking at a 2000 now, it seems very involved and complex in comparison with the 8500 chassis from the same stable.

Colour Adaptor

In the first year or two much thought was given to the possibility of getting colour out of monochrome sets. There was a sort of colour filter marketed very cheaply. It adhered to the front of the c.r.t. screen, was divided into three horizontal sections, with the lower band red-brown, the

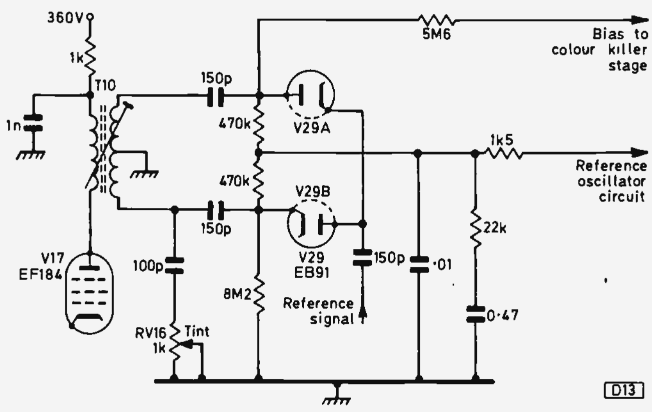


Fig. 1: The control you never had to use. RV16 is the tint (hue) control in this circuit from the Ekco Model CT100, an NTSC, v.h.f./u.h.f. 21in. set. V29 is the burst detector – very similar to the circuit commonly used in subsequent production chassis, except for the use of a valve. RV16 altered the tuning of the burst detector transformer T10, giving a phase shift of approximately 90°.

middle band green and the upper one blue – not very inspiring surperimposed on Crossroads or the newsreader! A more serious attempt was made by a firm which marketed an apparatus consisting of a decoder and TRITCH (TRIple sequential swiTCH). This operated a system of tinted translucent perspex shutters in front of the c.r.t. screen, with subliminal lighting from miniature bulbs hidden behind the frame of the front shutter. RGB signals were sequentially switched to the c.r.t. cathode in synchronism with the gyrations of the shutter gear. This equipment foundered on the twin rocks of mechanical problems and colour flicker – notwithstanding the subliminal lighting.

An Experiment

Inspired by contemporary articles in *Practical Television* I took to my garden shed, wherein lived a vidicon camera. This was fitted with a three-section rotating colour wheel in front of the lens, the wheel having three magnets to excite an adjacent tape head to produce trigger pulses. Said pulses were processed in the inevitable tritch, which culminated in three triodes arranged to switch in sequentially the first anodes of a recently acquired Pye dual-standard colour set.

The camera output was fed via a modulator to the Pye set's aerial input socket, and this very hairy equipment fired up. It worked, although there was only one chance in three of getting the right colours at switch-on, and results were much marred by colour flicker and the lag of the vidicon camera tube. These experiments were abruptly terminated one day when the colour wheel came adrift while rotating at full pelt, and stuck quivering in the wooden wall of the shed. The inventor/operator staggered white-faced from the shed – the colour wheel had almost succeeded where the X-rays had failed!

Colour on all Channels

With experience came growing confidence, and this was just as well, because November 1969 saw the simultaneous introduction of colour on BBC-1 and most of the ITV network. As anticipated, this led to greatly increased sales of colour receivers, and the welcome introduction of single-standard sets. Far and away the best of these sets was the Danish Bang and Olufsen, as pointed out by Keith Cummins in a recent issue.

Initially, most British setmakers brought out a single-standard version of their current dual-standard design, perhaps fitting a tripler in place of the hot and bulky, but very effective, e.h.t. rectifier valve/shunt stabiliser arrangement. These seemed to perform better than their predecessors. In 1969 a new type of c.r.t. was introduced, marking the beginning of the end for the ungainly 19in. and 25in. types. This was the square 22in. size, and its push-through presentation gave a very pleasing and modern appearance to the first UK single-standard colour set – the Philips 511, with the single-standard G6 chassis.

Two important solid-state chassis made their first appearance in 1969. The Rank A823 chassis had some very original thinking, with a purpose-designed i.c. at the back-end of the decoder (see last month), and an unusual passive subcarrier regenerator. The A823 chassis and its later derivatives proved to be a long-lived and successful design.

Thorn released what is probably the most numerous TV chassis around, the 3000. It was similar to the 2000 series in many ways, but introduced the chopper concept in the power supply, the first application of this principle in television receivers and an approach which many other manufacturers followed in the fullness of time. In spite of the introduction of the 8000, 4000 and 9000 series, the larger-screen version of the 3000 chassis (series 3500) has continued in honourable service for many years and is only now being phased out.

The Sony Trinitron

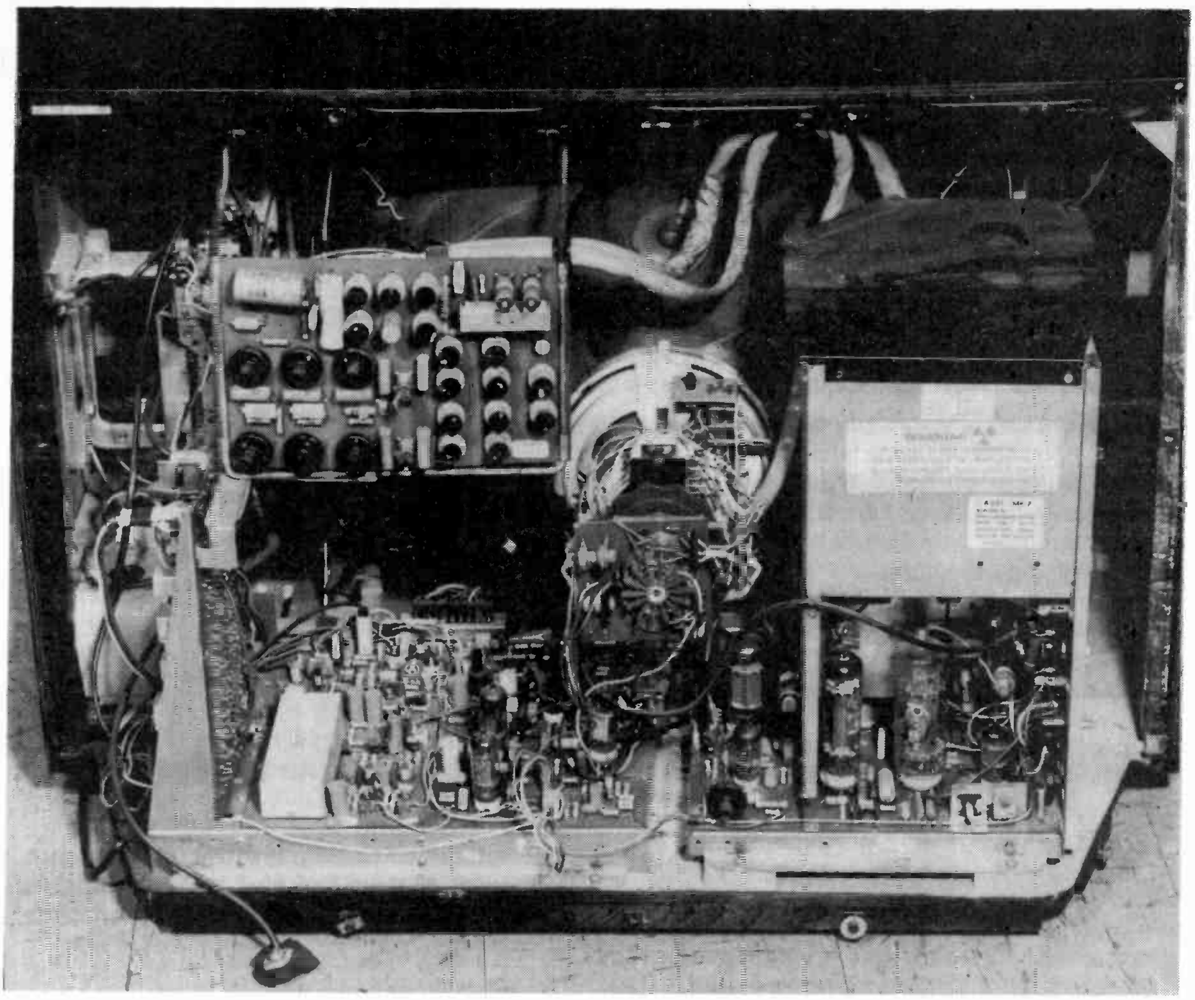
In the early days we had to look to Japan for the really unconventional, and the 13in. Sony Trinitron receiver had everything! It seems Sony decided that if a decoder could be devised that did not decode in the normal PAL manner, it would not be necessary to obtain a licence from the Telefunken Company of Germany, the holders of the PAL patents. The result was a decoder which deleted alternate lines of the chroma signal, substituting the chroma from the previous line by means of a delay line. Two local oscillators in the decoder drove two synchronous detectors, leading up to the crowning glory, the Trinitron c.r.t. How many of us were fooled into thinking that that big knob on the e.h.t. tripler was a focus control?

With hindsight, the Trinitron c.r.t. was a harbinger: in-line guns and simple convergence adjustments – familiar now, but the Trinitron was around in 1971! With the exception of the Trinitron, the 90° delta-gun shadowmask c.r.t. reigned supreme for many years.

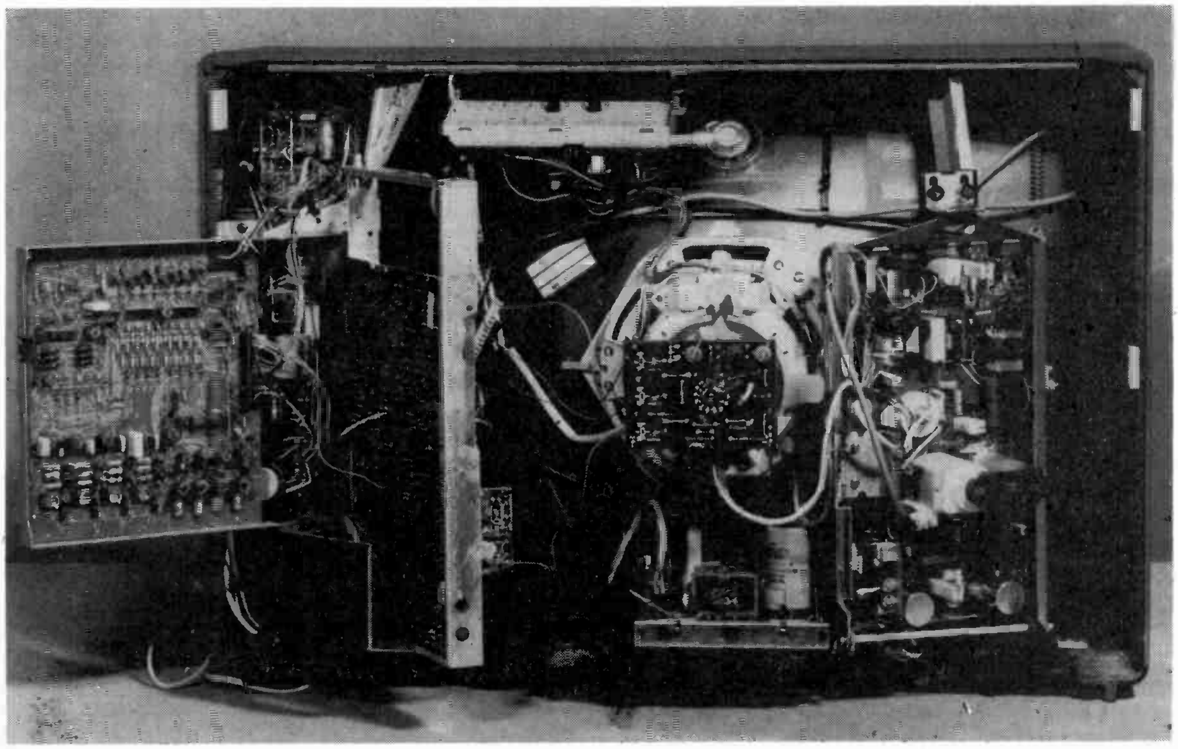
Varicap Tuning

Varicap tuning is used exclusively these days. It's a mixed blessing, and while it has eliminated the problems inherent in mechanical tuners, it has brought with it a whole crop of problems of its own – chop the pliers in for a digital voltmeter, substitute the circuit diagram for the vice, and we're in business again! The changeover happened just when the fiendish Heath-Robinson style mechanical tuner had given way to the simple and almost foolproof slide-bar mechanism, of which the Thorn four-button tuner is a good example. Philips were first in the field with varicap tuning, in the G8 single-standard chassis in late 1970.

We often feel that we would as lief be without varicap tuning as with. Tuning drift always seems to be intermittent and elusive when electronic tuners are involved, and there are so many possibilities when it does happen! The situation was not helped by a certain European component manufacturer who turned out thousands of tuner control



The contrast inside those sets shown on the front cover. Above, the dual-standard Bush Model CTV25, a hybrid chassis with valves in all the high voltage and power sections. The e.h.t. valves are in the screened section on the right. Note the clutter around the c.r.t. neck – and almost everywhere else! The convergence panel is at the top left. By contrast, below the Bang and Olufsen Model 4402 with its 20AX tube: the few convergence tolerance controls are on the small panel at the top left. All the timebase circuitry is on the right-side vertical panel, with a diode-split line output transformer. The signals section on the left includes the remote control system.



units whose resistive elements changed value on a regular basis! Touch-tuning came next, ranging from a delightfully simple transistor-plus-neon arrangement by Rank to an incredibly involved 24 transistor set-up in the ITT Feathertouch 100. Like many other functions of a TV receiver, touch-tuning (and remote control switching) is becoming the exclusive province of integrated circuits.

Came the Boom

From the low set sales up to 1969, sales of colour sets then gradually went into top gear, and in 1972-3 a peak was reached. All manufacturers were going flat out to meet the demand. Apart from the economic boom, demand was fuelled by the rapid spread of colour throughout the UK as new transmitters were opened, sometimes at the rate of several a week by each authority. One or two small setmakers sprang up in the UK, and imports of large-screen (20in. and upwards) models from Europe blossomed. As far as this engineer was concerned, this was a definite pain in the neck. The situation often arose that a handful of each of several obscure makes were purchased by his firm, and from then on these had to be serviced, spares stocked, manuals and training made available to each field engineer and so on. The ludicrous thing was that for some models we had to obtain more service manuals than we had sets if each engineer was to be able to service them in the field!

The 110° Tube

In 1972 came the 110° tube. As yet it was still in the form of a delta-gun thick-neck device, needing prodigious deflection power and elaborate high-power convergence and raster-correction arrangements. Some European setmakers introduced 110° models immediately, others sat on the fence, as did the public and the dealers – not surprising, in view of the considerable complexity of the sets, which often produced a picture no better and in some respects (like purity, focus and convergence) sometimes markedly poorer than their contemporary 90° counterparts. All this for 3 in. or so off the cabinet depth! Some customers did not even realise at the time of purchase that they had bought or rented a 110° set; certainly the sales staff did not make it a big selling point – perhaps they were unaware too!

The arrival of 110° deflection did not make a big impact in my part of the world. Probably the most elaborate wide-angle set was the 3400 model from Bang and Olufsen. This receiver boasted ten valves, 104 transistors and 89 diodes, with two PL509s providing line deflection/e.h.t. Other features were dynamic (line-rate) focusing and a separate class B push-pull output stage for each set of horizontal dynamic convergence coils. Thirty convergence controls and six raster-correction adjustments were provided in a set which vies with Thorn's 2000 model for the distinction of being the most involved colour receiver ever to be released on the domestic market.

Receiver Developments

As colour receiver technology advanced, the field timebase shrank even faster than the pound. In the beginning, the norm was a PL508 valve working with at least one triode, feeding a big output transformer. After a few years that old standby, the PCL85/805, was to be found manfully scanning a 90° shadowmask tube in some makes, the alternative being a pair of BD124s or something similar in solid-state and some hybrid models. With the new in-line gun c.r.t. types came the tiny 12-pin class B i.c. type TDA1170, and now here we are on the brink of class D i.c.s for field deflection.

All sections of the colour receiver have undergone this shrinking process, not least the low-level signal stages, which are most amenable to integrated circuit techniques. In 1977 transistors are starting to become rare in the i.f. stages, and now that the SAW filter is with us (see the October 1976 issue) i.f. strips will change beyond all recognition.

Early decoders using discrete components certainly took up more room, but given an oscilloscope, a colour signal and a crocodile clip with which to override the colour killer, diagnosis of faults was a pleasure unsullied by inter-i.c. loops with their attendant chicken-and-egg problems. Modern three- and four-i.c. decoders, while undeniably capable of consummate performance, are in my experience more confusing to service than the conglomeration of BC108s, OA90s and little transformers of yore. The latter, I might add, generally stayed wrong when they went wrong (with one or two notable exceptions!) whereas today's chipped decoders seem to show frustrating intermittent effects when troubles develop.

Due to multiple-reflection techniques, chrominance delay lines are getting smaller too – I've got a big old DL1E gathering dust in my stores, and likely to stay there now.

Have you noticed how the number of adjustments necessary (and hence maladjustments possible) in a colour set has shrunk? The i.c. decoder removed many of the setting-up trimmers associated with the colour circuitry, while modern c.r.t.s have few or no convergence controls. The arrival of the SAW filter deletes virtually all the i.f. response adjustments, and that doesn't leave much!

The Line Timebase

Turning to the line timebase, the growing pains have been greater here than anywhere. The earliest transistors capable of the onerous duties of line deflection and e.h.t. generation were low-voltage types working from an h.t. line in the region of 60V. Most manufacturers at this time were using the Volks-valve, the PL509, in an arrangement that differed little, except in power output, from monochrome practice.

On the semiconductor front, the next generation was the BU105 type, fine for monochrome but with a p.i.v. rating that meant two were needed in series for colour TV applications when working from an h.t. line of 180V or so. All very well as long as the two drive waveforms were correctly adjusted and the tuning capacitors held out! Development work was going on apace however, and soon the BDX32 and BU206 appeared, capable of servicing a 90° c.r.t. by themselves. We come up to date with the current favourite, BU208A, which can control a vast amount of energy. For an A66-140X for instance, the line scan current is in excess of 6A peak-to-peak with a maximum e.h.t. power consumption in the region of 30W. Add to this the fact that several other stages of the receiver are powered from the same department, and this represents quite an achievement! The other contender in the line deflection stakes, the thyristor system, has not become as widespread as it might – possibly because of the cost of the special wound components and capacitors needed.

Mains Consumption

Mains consumption has gone down steadily. Some early receivers sucked 350-400W from the mains. The norm for modern receivers is nearer 120W, and even this is markedly affected by beam current. The switch-mode power units now generally used are capable of operating at as low as 160V. This low mains consumption and wide voltage tolerance is good not only from an energy conservation point of view. Out here in the sticks we have seasonal influxes of caravanning types with invertors – as well as hillbilly-style homesteads powered by generators. Even with a mains supply laid on, we have known a cold winter's evening to reduce the mains voltage to less than 200V in cases where a farm or group of cottages are at the end of the line. If Jarge invests in the latest model, he'll no longer have to switch the electric fire off to watch TV!

A Profusion of CRTs

For those who have to maintain a component store, an increasing headache is the profusion of colour c.r.t.s now in use. Time was when one of each of the popular sizes of 90° delta-gun tube would cover virtually any set one encountered, with only the Mazda-type mutations (A55- and A67-series) to cloud the horizon. With six or more types of tube, and at least seven sizes, today's customers will have to wait while the glassware is ordered, probably at great expense – should not our re-gun man be looking to the future instead of nonchalantly rebuilding yet another A56-120X?

The Present Day

Recession followed the boom, setting in during late 1974. But while customers may have been lacking, technical innovation certainly has not. I have just encountered my first diode-split line output transformer (described in the February 1977 issue), in a Bang and Olufsen receiver. D.C. coming straight out of an overwind will take some getting used to! Here's hoping it will be as reliable as promised – that transformer looks very expensive!

Bang and Olufsen are well known for their comprehensive remote-control systems, and other manufacturers have followed this trend, ranging from simple mute-and-sequential-channel-change (ITT, Rank and Thorn) to sophisticated systems offering infinite control over all functions, like the Tandberg Model TV133. This can be awkward in the showroom – when selecting ITV on a B and O switches off the Bush and mutes the ITT! Other refinements currently available are sets which incorporate TV games, and the Grundig which offers digital readout of TV channel and time – we've come a long way since 1967!

Finally, I must congratulate the UK broadcasting authorities. The other day, I heard a television critic being interviewed on the radio. He was apparently a widely travelled man and gave it as his considered opinion that British audiences did not know what bad TV was. He was referring, of course, to programme standards and presentation quality, but this is no less true of the engineering standards maintained by the two UK television authorities. Mrs. Perkins telephones for help if Ena Sharples' face is a bit on the orange side. "I'm very disappointed with it," says she. She should be so lucky! – her American counterpart can rotate her vectors through the best part of 360° (what are vectors, Dad?). There seems to be no doubt that the decision to adopt the PAL system was the right one, although it is probably fortunate that most of us have never met a PAL-S receiver.

What will the next ten years bring? Possibly stereo sound with TV, almost certainly a fourth channel. It seems that the design of TV receivers will not fundamentally change until the flat screen arrives, and by all accounts this is still a long way off.

TEN YEARS OF COLOUR
3: Producing the Sets

Harold Peters

THE previous article, by the middle man of the "we make them, they break them, he mends them" trinity, just about sums up the first decade of PAL colour TV. Although my viewpoint was a little different, my feelings are about the same but if, as I suspect, you are either an enthusiast or in retailing, it may interest you. It may even explain why setmakers do some of the things they do, and if you end up understanding us a little better then it will have done more than just entertain.

The Beginning

To get a set into its carton, with serial no. 00001 on it, takes about ninety weeks' preparation. So it doesn't take much imagination to realise that we began about mid 1966 to prepare sets for "opening night". At that time there was very little detail, material, or know-how to draw upon. The only sets were those left over from the NTSC 405-line "Ally Pally" experiments, and they were huge things, bristling with valves, and with a round 16in. tube with a metal cone anode, the protection for which has given us the name coneshield for today's tin degaussing coil holder.

To our surprise, the components we were offered for our PAL prototypes were 90° rectangular tubes and fully transistorised small signal stages. The Mullard Bible mentioned in the previous article was ours as well, only we read it in draft form, badly copied – for there were no zeroxes (zeroxii?) then. Slide rules whizzed like trombones – we had no calculators either – and the skill of our monochrome production line was creamed off to form a small, rather elite colour crew. Each final test operator had her individual cubicle, and a lot of personal attention was lavished on every set we made. We still marvel today at the early basic Mullard design, which proved itself so dependable right through the boom years that came with the duplication of BBC-1 and ITV. What we didn't like about those early sets was all the dual-standard switching and the rather lethal shunt stabiliser e.h.t. arrangement, which for some obscure reason was known as the smokestack. Sighs of relief all round therefore when we switched to our single-standard version – but even that was not all smooth sailing. The demand for sets brought about by service duplication caused colour production to displace much of our monochrome line. This was a pity, for we had just turned out a quite handsome and dependable single-standard monochrome chassis. We eventually moved this into a separate building hitherto used as a store, but it all took time and for some years we were a little cramped to say the least.

Economies

Parallel with the activity on the factory floor, our technical staff were trying to keep the price of the set down – a crazy situation really when you consider that every setmaker was able to sell all the sets he could turn out. If you had bought a set for "opening night" it would have set you back about £350: the minivan which delivered it would have cost the same price. Today the set would still be in the £350 price range, but the delivery minivan is close to £2,000. Ironically our industry is currently struggling to survive, the minivan is state-assisted.

As far as knocking a fiver off the price of the set, we were not given a very large area to explore. If you completely remove *our* bit – the chassis – from the set, what remains, apart from falling face down, comprises four large items which we buy in: the c.r.t., cabinet, speaker, and deflection yoke. These add up to over half the price of the set, so we knew that even if we performed a minor miracle the total price would never reflect a proportional reduction. Somehow we managed however.

ICs

The single-standard set, needing only intercarrier sound, was a sitting duck for device makers to "throw in their hat" with an i.c., and we handled our first TAA350 as if it was the Cullinan Diamond, observing to the letter all the ritual requirements of heatsinks, non-static clothing and quick soldering. Familiarity soon bred contempt, and by 1976 we were plugging them in and out like EF80s. In 1976 came the touch tune circuits with MOSFETS in them, and it was back to square one with static-free areas, cotton clothing, conductive pads and all the rest. Then last week a teletext demonstrator calmly changed programme by swapping over two 24-pin MOSFETS in the coder without even turning off the supply – and he got away with it!

By comparison with the old ratio detectors, the alignment of i.c. sound strips was too simple to be true, but because all the gear and expertise were at hand we methodically checked out all the device parameters, such as limiting point, a.m. rejection and output, even though we realised that the thing either worked or it didn't. To the dismay of some device makers the habit persists today. Should they think we are too fussy, some of our best customers live down by the river where the signal is low.

A twinge of nostalgia overcame me as we said goodbye to valves. Troublesome they might be, but when since have you been able to get instant fault diagnosis at the expense of a scorched handkerchief?

Where i.c.s were concerned a lot of heartsearching went into the problem "to be pluggable or not". An i.c. is so reliable once reposing in its correct circuit that a holder, if fitted, became the most unreliable part. It's like digital watches, where the trouble is nearly always with the battery rather than the watch itself. In the main our i.c.s are soldered straight into the board, but as an exception we fit holders on circuitry which requires an elaborate pre-test, because the wide i.c. tolerance spreads do not permit us to work with as narrow a window of acceptance as we would like.

Test Features

It surprised me, in preparing these notes, when I saw how much some of our testing had changed, and how little the rest had changed. To begin with items like decoders and i.f. strips were laboriously plugged up and progressively aligned by hand, using test probes applied to the board by solder blobs. Tuners were married to i.f. strips and were serialised in case they got split up. Coils left the winding factory "rough aligned" with such precision that one of them had to be deliberately mistuned to ensure that alignment of the strip was fully carried out. We still do it this way, but with sufficient experience to be able to issue units or pretuned modules to the service trade so that fitting in the field will not involve realignment.

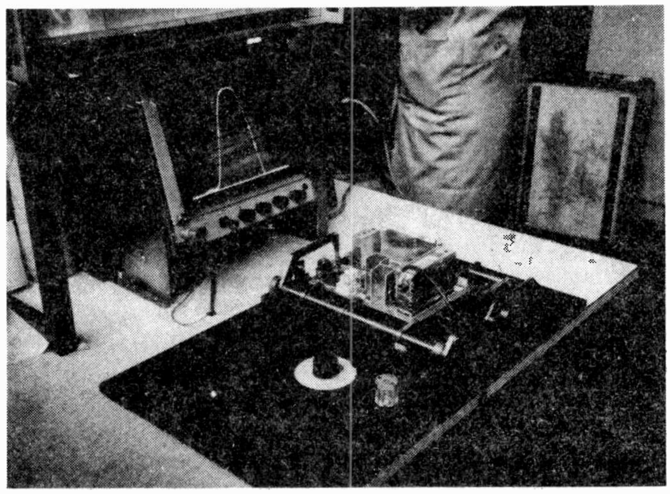
The synchronous vision detector (TCA270 in our case) was the i.c. which caused us most headaches. It isn't a true synchronous demodulator since it has no separate phase-locked oscillator, using the residual i.f. signal carrier, suitably limited and phase shifted, instead. This is variously called a quasi-synchronous demodulator, or an exalted carrier demodulator, depending on whether you are for or against it. Whatever you call it, its mode of operation caused it to defy sweep generator alignment of the conventional type, and forced us to abandon overnight the habits of a lifetime.

By the time the sales boom of 1972-3 hit us, i.f. and decoder alignment had become a press-button affair. The panel was clamped into a frame and its copper side impaled by sharp, spring-loaded pins through which the appropriate test signals were applied via relays enabled by a diode matrix. If the presence of a pin affected alignment or produced any form of undesired loading, it was pulled down by a solenoid when not required. From then on, modifications involving work on the copper side were out. One frustrating effect of this streamlined testing was, and is, to be able to go down the production line and see a girl align a set better in twenty seconds than you could in an hour.

1975 saw us extend this pin-jig feature further. By the addition of more pins to the jig, and more test pads to the copper side of the board, it became possible to test panels for correct component values prior to alignment. This was done by comparison with a standard set of components within the test gear. If you think this is unimportant, just mix up six 1·2kΩ resistors with six like type 12kΩ ones, and see how accurately you can sort them out in ten seconds starting now.

As technology moved us forward, so the Health and Safety at Work Act backpedalled us a bit. Our latest test benches guard the work (more strictly the operator) with heavy perspex covers, through which protrude spring-loaded adjustment tools which sometimes line up with their intended preset. Rather like you would expect to handle a radioactive railway ham sandwich. We now have a full-time safety officer, and to our credit have had only two small fires since the act has been in force. We didn't have any previously.

At the point where the chassis meets its tube, the final test area, the amount of test equipment per operator position has been greatly reduced. The majority of our involved setting-up procedure is carried out by subjective assessment of a variety of test patterns radiated over the factory signals system. Our mainstay is the ubiquitous PM5544 coloured circle pattern, with which we check just about everything, even the 4·43MHz reference oscillator by swinging the pattern's subcarrier. Signals at the ends of the bands ensure complete tuner coverage, and the centre cross pinched from the PM5544 is overlaid on the convergence crosshatch. We distribute at u.h.f. through high-quality feeders and terminate in variable attenuators, providing an accurate signal from 10μV to 30mV to up to 500 simultaneous positions. A far cry from the beginning when, in default of a satisfactory cable distribution system, we radiated the signal down each production line and collected it at the test points on small aerials. The factory fabric absorbed most of the



The modern method of factory alignment, with the i.f. board mounted on a pin jig through which signals are injected and extracted and power supply connections made. The large knob on the left is the signal attenuator. Each step is selected by a push button. As the monitor screen shows, a text book i.f. trace is obtained every time! (Courtesy Pye, Lowestoft.)

stray radiation, to the annoyance of neighbours hoping to set up their newly acquired sets.

Soak Testing

The size of the early sets made us glad to get them into their cartons and out of the factory as quickly as we could. Today we give every set two long soak periods before the dealer gets it. The first happens as soon as it has been assembled, but before any setting up is done. At his stage the pictures are unbelivably grotesque, but we accrue the advantage of spotting trouble before too much work has been done on the adjustments. Imagine what it feels like to set everything up carefully, only to find that the c.r.t is dud. . . .

Power supplies

Soaking sets for long periods means that several hundred will be fired up at the same time. As well as making demands on our transmitters, the mains supply comes in for a caning too. We knew that our 110° delta-gun c.r.t. set would have a single thyristor power supply as well as the new tube, so each set would take a huge gulp of mains, all at the same time, and all at the back end of the positive mains half cycle. This lowers the r.m.s. level of the positive half cycle, or put it another way pushes negative d.c. back up the mains (Fig. 1). This d.c. will saturate any isolators interposed for safety, which means that their rating must be twice what you would expect from the wattage printed on the back of the set.

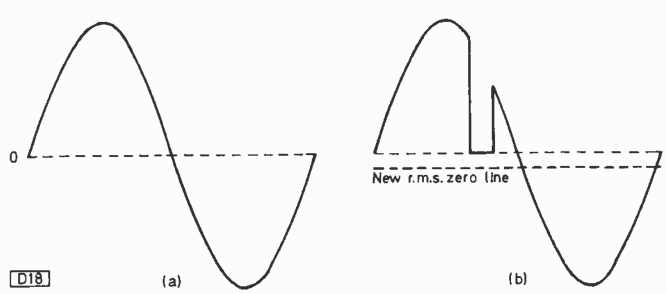


Fig. 1: (a) The normal mains waveform. (b) The mains waveform showing the chunk extracted by a thyristor controlled power supply: since the waveform is now assymmetrical, the r.m.s. zero line shifts, producing a negative d.c. component.

We accordingly asked the Electricity Board to provide for this, which they did, and at the same time they carried out a number of tests here and elsewhere to study the effects that large numbers of these sets would have upon the supply waveform. The results were rather frightening, with a set of oscillograms looking like the Fourier analysis of the last chord of "Rite of Spring". Their report suggested that too many of this type of power supply used too close to a computer installation (for example) could affect its performance due to waveform distortion. Please don't try it or you will get me into trouble. Our latest sets have a full-wave rectifier system, which pleases the Board but leaves servicemen with a half mains potential chassis.

Covergence and Purity

Initially purity, covergence, degaussing, and grey-scale tracking were taken to be part of the dealer's installation procedure. Where perfection is required, they still are. Discount warehouse marketing of latter years however has demanded a set which, when unboxed by the user, will give a reasonably good picture without any adjustment at all.

We first stumbled on this requirement when we sent our export models into W. Europe and Scandinavia. In remote areas, buying a TV set is usually a mail order affair, with the chosen model being delivered halfway up a mountain side by the Postbus. The need for extra precision would have to coincide with the advent of 110° deflection, which bothered us anyway.

To see the problem, imagine a line drawn two inches in from the edge of the screen on the tube face. If all that is within the line represents the area of a 90° set, the part outside is the additional area needing purifying etc. on a 110° set. No doubt you are familiar with the way purity on 90° sometimes makes it only just. If so you can appreciate the problem posed by the extra angle of the 110° tube.

Imagine our dismay when we realised that in order to cover the Postbus requirement we had not only to tackle the extra screen area but also to ensure that the beam landings were in the middle of their respective phosphor dots, not just hitting them somewhere.

Todays in-line guns give better results with considerably less trouble, so with that hurdle behind us for keeps you would expect to find us reasonably happy. But no, TV setmakers are like farmers: nothing seems to please them. "Self-convergence" makes the set easier to assemble, with fewer components, but requires a rather special convergence/scanning yoke. The total difference to the shop price is small, the difference being where the work is done. Europe's gain is one of our lines lost, and at the same time the control of the manufacture of that bit of the set passes out of our hands.

The same applies with the surface acoustic wave filter, which removes any control we have of the i.f. response but does not save us a mint. Despite the assertions of SAW suppliers, the group delay response of the average hand-crafted i.f. strip is not too bad, and when it comes to teletext it's the transmission system which worsens the eyeheight more than anything, as you would expect when you squeeze a 6·9 megabit quart into a 5·5 megahertz pint pot.

Safety

More progress has been made in the safety field than anywhere. I doubt if there is a non-BEAB approved set on sale today. We were lucky enough to get some experience of the requirements with our export range, which had to satisfy the similar requirements of the various European inspectorates, or "Test Houses" as we call them. These vary slightly from country to country, and if anything the BEAB tests are the most demanding of them all. Without realising it, this fact has contributed to stability of design, since a setmaker thinks twice about putting in a modification which will involve him trailing the length and breadth of Europe to get it approved. A domestic grey area which thankfully has never been put to the test is when a BEAB approved set is repaired using a non-approved part and as a consequence later causes damage or injury. It could easily happen.

Service and Serviceability

Right from the start we knew that a colour set was going to be the most complex item any industry had let loose inside the homes of the general public. So we made sure that our service manuals were as comprehensive as possible. At the same time our Technical Manager toured the country imparting know-how.

In the years that followed we have forged links with a number of dealers upon whom we can count for an unbiased report, and have set up a group comprising factory, spares, and service personnel so that information coming back can be quickly acted upon. By comparison with monochrome the serviceability of early sets was poor, but it's got better. We still have to convince the production staff of the need for change, but happily the majority of service improvements benefit them as well. The only outstanding, and possibly insoluable, difference is that production like their panels big, but service prefer them to be small isolated boards, each one an entity itself.

The Japanese

Strenuous efforts were made prior to the boom to keep out Oriental imports. The PAL patents were invoked, the European test houses were very stringent, and all manner of discouragement was put in their way. The boom changed all that, because setmakers needed a certain amount of oriental components and tubes in order to maintain their share of the market. The dependability of the complete receivers supplied by Japan is now history, and arose from their strenuous efforts to satisfy all the test houses with a common chassis. It caused our Quality Assurance Department to switch its sights from the German attainment to the Japanese – possibly a false promise, since their quality is rooted in conception as well as design and execution. I have heard that the only place not troubled much by oriental competition is France, who insist on all imports being capable of resolving the 819-line system as well as 625. Why didn't we think about deploying 405 lines that way?!

Where now?

Traditionally we should end up with a peep around the corner into the future. Not this time! Successive Governments have used our trade so readily as a convenient economic regulator that we are no longer masters of our own destiny. So instead I am going back in time, past this decade, past the two previous years when "Late Night Line Up" went into colour and only a handful knew, past the 405-line midnight tests from Ally Pally, right back to an evening in 1935, just after the last jubilee, when my mother scorched my rugby shorts.

The occasion was the burning down of the original Crystal Palace – and from our house we had a grandstand view. I recall my mother's words at this final Brocks Benefit. "I suppose it's that Mr. Baird and his Colour Television Experiments." To set the record straight, it wasn't: his equipment and the nearby South Tower were just about all that remained, but you can see that I was biased from an early age.

LETTERS

SPLICING VIDEOTAPES

In your October issue reference is made to splicing videotapes (VCR Notes). Some two years ago I tried the butting method suggested, but found that the splice lasted for only a short time. I also believe, but can't prove, that the splice accelerated head wear since the head failed approximately 30 hours after starting to use the spliced tape (with the spliced tape itself in use for about ten hours), giving a total head life of approximately 300 hours.

It seems to be very difficult to make a satisfactory butt joint. I did not initially use the spliced tape with the new head, but when this head reached 500 hours' use I decided to try again – particularly as by then I had another broken tape. This time I overlapped the broken end portions and stuck them together. The splices have not parted so far, and with three tapes (two spliced) in use more or less in succession the second head is still in use after 800 hours. I cut the ends perpendicularly, smear adhesive (Dunlop Thixofix) thinly on to the outer side of the leading tape end portion for some two inches, and before the adhesive dries press the two portions together and leave for a few minutes. Any exposed adhesive must be carefully removed with methylated spirit, though if the splice is carefully done this will be on the outer (non-head) side of the tape only. To avoid head wear, the head side edge must be the trailing edge of the splice. A line or lines will pass down the picture as the splice passes round the head, but this is tolerable. I also use Thixofix for sticking on stop foils cut from aluminium foil.

Regarding distortion of the tape edge portions at the beginning of the tape, repositioning the stop foil, as suggested, won't cure it for long. The distortion is caused by the flange at the lower end of the upper of the two white guide rollers of the cassette. This flange is presumably intended to position the tape correctly, but in practice what happens after a few uses of the tape is that it folds over a part of the lower edge portion of the tape, thus doubling the thickness for about $\frac{1}{16}$in. at the lower edge portion. When this thicker portion is wound on to the reel it slightly distorts the corresponding edge portion of at least the next layer of tape, making it easier for the flange to fold it next time the tape is used. Thus a bit more is folded every time the tape is used.

It's possible to remove the folds by hand, although the tape will remain creased lengthwise and hence be likely to fold again. It's better to cut out the bad portion and splice the tape as described above, adding a new stop foil. In an attempt to avoid this trouble, I've tried changing over the two rollers in the cassette. This seems to work better. The tape edge portion can still become folded over on the cassette case, but not so readily. – **W. H. Hammond,** *Gravesend, Kent.*

DON'T SPLICE VIDEOTAPES!

As an engineer with considerable experience in the video field I was surprised to read some of the statements made on the subject of VCRs in your October issue. First, I can say with great confidence that anyone who tries to splice cassette tape together and anyone who attempts to wind on other tapes is doomed to failure. It is *not* folk lore that splicing tape will "strip the heads in one go": it takes approximately one and a half seconds for a vertical splice to go around a head drum revolving at 1,500 r.p.m., so this gives each head some 40 goes at shattering, not such good odds. The splicing tape eventually stretches anyway, thus widening the gap with time: worse odds now!

Scotch Guardsman tape is part of a family, and I assume the reference is to type 8173 — ½ — 3550: this is thin low-energy (density) tape designed for time-lapse machines or extended playing time on the Sony CV2100. Although it's nearly as thin as VC60 tape it's certainly not chrome oxide (Philips, BASF, Memorex), nor is it cobalt (Scotch), so it's use on a VCR will cause it to saturate, resulting in a low f.m. signal on replay. This will show up most frequently as replay colour drop out. All of this does not take into account chewed tapes which stick as a result of many greasy finger marks.

While agreeing in principle that saving money is a good idea, remember that new VCR heads, fitted, will cost about £55-£60. What price then do you pay for cheapness? This also applies to the use of computer tape (this was not recommended in the original article – *Editor*) or high-energy tape on normally low-energy machines, when bills of £250-£350 can result for new drums and guides – poor performance and incompatibility are suffered long before the wear is noticed.

The new Philips N1700 is a special machine. Professional engineers are fed up with being asked to modify N1500s and /01s and are not going to be plagued by requests to convert N1502s into N1700s, because they are not the same thing. On an N1700 the head gaps are oppositely inclined, with no guard band between the tracks: the principle is that if one head scans the other's track there will be little or no output. As for skip field principles, due to the PAL four-field sequence anyone who goes about chopping this up ad lib will end up with intermittent colour drop out and gross phase errors at the top of the picture as the PAL squarewave loses continuity. The Sony VO2850 and Philips N1520 ignore this when editing, but quad machines do not.

As to the bit about disconnecting the N1520 edit clearing button relay, if an N1520 releases edit buttons during an edit it does so for a reason, even if it is a fault condition: the cause should be cured rather than the symptom removed. The release relay is there to stop any normal recordings being done in any edit mode. Someone at Mr. Matthewson's establishment is going to complain that a tape replay won't track, probably because there's no control track as someone did a recording in the insert edit mode due to someone removing a wire from the pushbutton release relay. – **S. R. Beeching, T. Eng (CEI), A.M.I.E.R.E.,** ***B & B*** *Electronics, Newark, Notts.*

JOSTYKIT HF385 VHF/UHF AMPLIFIER

We regret that Jostykit electronic kits are no longer being distributed by Jostykit (UK) Ltd., Middlesbrough. The above amplifier, featured in our August issue, is not currently available in the UK therefore.

We will be featuring a wideband aerial amplifier for the constructor in a future issue.

TV Teletext Decoder Update

Steve A. Money, T. Eng. (CEI)

DURING the series on constructing the *Television* Teletext decoder there were a few omissions and errors. Whilst the more important of these have already been dealt with it was felt that for the sake of completeness all these errors should be collected together and presented, along with one or two hints on construction and some recommended modifications to improve the operation of the decoder.

INPUT LOGIC CARD

Since there were no errors in the power supply module we shall start by dealing with the input logic card which was described in the April and May issues. The circuit diagram in the April issue should be modified as follows:

(1) On IC1c the pin numbers are incorrect. The input should be pin 13 and the output should read pin 12.

(2) The inverter between IC6 pin 5 and IC13 pin 12 is section f of the 7404 IC10.

(3) Resistor R5 was omitted from the circuit diagram and should be inserted between pin 9 of IC8 and pin 1 of IC5a, as shown in Fig. 1.

(4) For more reliable operation, pins 2 and 4 of the 7485 IC24 should be connected to 0V.

In the table of top soldered connections to the ICs, printed in the May issue, the number of connections to IC2 should be 6 and not 7 as printed. This makes the total number of top soldered connections on the board 114.

On the component layout diagram, capacitors C6 and C7 are incorrectly numbered. The capacitor near IC1 should be labelled C7 and that near IC5 should be C6.

The component layout for this card does not show the positions of the decoupling capacitors C1 and C2. Capacitor C1 is connected across the +5V and 0V supply input tracks running from pads 14 and 17 of the edge connector. It is convenient to use the leads of this capacitor to form the through board links on these two supply tracks. The second capacitor C2 is connected between pins 5 and 10 of the 7493 IC7 and is mounted on the track side of the board.

Pins 2 and 4 of the 7485 IC24 should be connected to 0V. This is simply done by linking them with short wires to the track running alongside them from pin 8 of the i.c.

It has been found that the latest version of the i.f. card gives slightly different clock timing from the original prototype design, and that for optimum decoder operation capacitor C7 on the input logic card should be removed from the circuit.

DISPLAY LOGIC CARD

Since there are no errors on the memory board the next card to be dealt with is the display board described in the July and August issues.

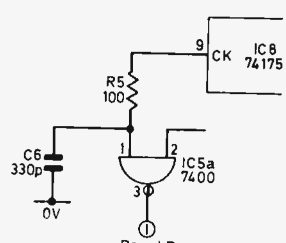
Some readers have been puzzled by the fact that on the mother board there are tracks carrying −5V and −12V supplies to the display board edge connector whereas there is no mention of either of these supplies on the display board circuit or printed board layout. These supplies were required for the 2513 character generator ROM originally used on the display board, but when the circuit was updated to use the Texas SN74S262 ROM these supplies were no longer required since the newer device runs from +5V only.

In the process of changing the ROM however an error slipped into the graphics/alpha switching logic. In the circuit diagram the connection from pin 11 of IC6d should go to the DB4 input and not to DB5 as shown. Unfortunately this error also occurs in the printed board layout, and will be present on some of the early PCBs supplied to readers. It is quite easy to modify the board to correct this error. Cut the track from IC6d pin 11 at a point just short of its junction with pin 4 on IC3, then link the open end of the track across to pin 11 on IC3 with a short piece of wire. This modification is shown in Fig. 2.

There were one or two errors on the layout diagram, Fig. 5. Pin 7 of IC5 and IC7 require top soldering, pin 1 of IC13 doesn't.

Some problems have been experienced with the loading operation of the 74165 shift register IC1. The circuit uses the input impedance of the 74165 to produce a differentiating action and thus generate a short load pulse for the shift register.

Because of variations in the input characteristics of different makes of 74165, and even between different batches of the same make, this circuit does not always work correctly. The recommended modification to the display board to ensure reliable operation is shown in Fig. 3. Capacitor C1 is removed from the board. Gate IC8b was



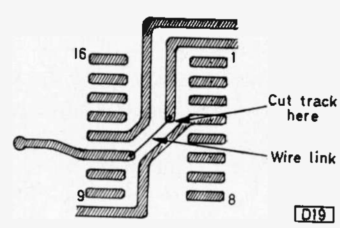
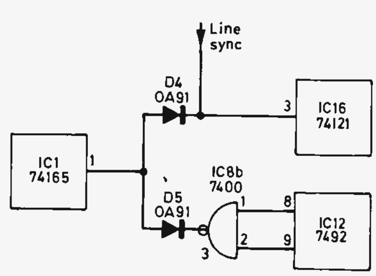


Fig. 1 (left): Position of resistor R5 in the circuit of the input logic card.

Fig. 2 (right): Modification to the display board.



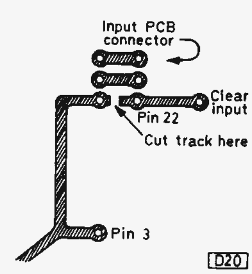


Fig. 3 (left): Modified 74165 (IC1) load circuit on the display board.

Fig. 4 (right): Modification to the mother board.

originally used with the 2513 ROM and produces a pulse at the end of each symbol period. Diodes D4 and D5 act as an OR gate which ensures that the shift register is loaded by either an end of symbol pulse or the line sync pulse. If the line sync pulse was not included, the first symbol of each row of text would not get loaded into the shift register and would not be displayed on the screen. The two diodes are mounted on the component side of the board directly from pin 3 of IC8 and pin 3 of IC16 to the track leading to pin 1 of IC1.

MOTHER BOARD

On the mother board described in the September issue the sound feed for the text mode was omitted. There should be a link from pin 3 of the i.f. board to pin 3 of the display board. This should be made by joining these two points with a length of insulated wire.

There is an incorrect link on the board and this must be cut. It occurs at pin 22 of the input board connector, where the input from the Clear Page switch is connected. The short link to this pin should be cut so that only the Clear input connects to pin 22. This is shown in Fig. 4.

IF BOARD

Since the design was published, the package used for the surface wave filter has been modified. PCBs will be supplied to suit the new version of the SW150 filter.

In addition to the amendments listed on page 39 last month, we have omitted to show pin 13 of the CA3046 on the circuit diagram. This pin must be earthed. The p.c.b. is also shown incorrectly in this respect, although boards purchased from the Readers' PCB Service will be correct.

Modifications giving more reliable i.f. board performance under different signal conditions are being tested and details will be given next month.

THROUGH BOARD LINKS

A. S. Denby of Alcester has an interesting tip for inserting the through board links on the logic cards. He uses a length of 10A fuse wire and threads it back and forth through all the link holes before putting any other components on the board. Then each link is soldered on both sides and finally the surplus wire is cut away. This approach could certainly be much quicker than inserting the linking wires individually. ■

Co-Channel Interference Filter

Allan J. Latham

THE author lives approximately the same distance from Crystal Palace (70 miles) and Stockland Hill (80 miles). Because the location is on the western side of a hill, we are shielded from Crystal Palace and Stockland Hill is usually the stronger signal. Since the ITV transmissions from both stations are on channel 23, co-channel interference is a serious problem: at times it can make both stations unwatchable, although Stockland Hill is usually reasonable. The filter described was devised to reduce the interference.

The vision carriers of U.K. u.h.f. TV transmitters are offset from their nominal frequency in order to reduce the visible effects of co-channel interference. The offsets used are 0, + 5/3 and −5/3 of the line frequency. This results in differences of 0, 5/3, or 10/3 of the line frequency. The visual effect is of diagonal lines which are very nearly horizontal (zero difference is rarely used since in practice a beat frequency of tens or hundreds of cycles would result, and the visual effect would be very disturbing).

The notch filter (see Fig. 1) was built into the luminance channel of the author's set, immediately before the black-level restorer circuit. The circuit consists of an *RC* notch filter followed by an amplifier to increase the *Q* of the circuit. The overall gain of the circuit is a little less than

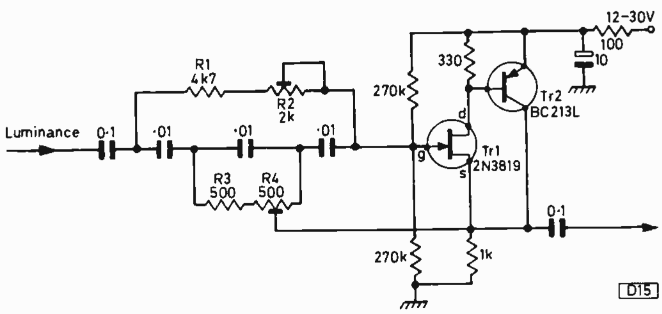


Fig. 1: Circuit of the active notch filter.

unity (at other than the notch frequency) because all the output voltage is subtracted from the input to the f.e.t. gate. At the notch frequency the gain is the notch depth plus the open-loop gain of the f.e.t./transistor combination – it should be about −30dB, but was not measured.

The unit was constructed on Veroboard, and no stability problems were encountered. The frequency control potentiometer R4 must be a multiturn trimpot type because tuning at the h.f. end is very critical. The other potentiometer is not so critical. The prototype used a BC213L transistor (Tr2) but any pnp plastic general purpose type with a gain of about 100 could be used. The power supply was taken from the set: two rails were available, 30V and 12V, and either worked satisfactorily.

Setting up and Use

The setting up procedure is very easy. Adjust R4 for minimum interference (the 50kHz notch is with the slider near the capacitors). Then adjust R2 for minimum interference, and finally readjust R4.

It should be possible to completely remove the offending interference. One thing that will become apparent however is slight smearing of some parts of the picture due to phase shifts of video components near the notch frequency. This is worse at 50kHz (10/3 line frequency), and when a grey raster is being transmitted three faint vertical bars are apparent due to the phase error at 45kHz. This is a small price to pay for the removal of co-channel interference however and is much less objectionable.

The unit was arranged so that it could be switched in or out as required. The phase errors are not visible on channels not suffering co-channel interference therefore.

The author would be interested to hear from others who have experimented with methods of co-channel interference rejection. ■

It won't take you a minute . . .

Les Lawry-Johns

THERE are days when everything goes with a swing: there are others when you are on a roundabout which keeps bringing you back to where you started from. Not only do you get nowhere, but the damned thing starts going backwards and you end up hate filled, bitter and frustrated. Much like that ladybird I was watching the other day walking round and round the top of an empty bowl, not realising that it kept coming back to where it started. But then ladybirds can fly off and escape from that type of torture. For me there was no escape when that Hitachi monochrome portable arrived for its three day stay which I thought was going to be a couple of hours at the outside. You could call it a mother-in-law, and it behaved in much the same way.

A Good Start

It (the day) had started off quite well really: three colour sets polished off in minutes each. The first, an Ultra with a 3500 chassis, simply needed a red button cut-out because it had cut out and wouldn't come back. Twist, twist (the tabs), unsolder two leads, plonk the new one in and that was that.

The second was a Decca with the Bradford chassis. Poor focus, width o.k., check the resistors associated with the focus unit (two 4·7MΩ resistors, one from the tripler to the focus unit, the other from the unit to chassis) and find one high. Snip snip and Bob's your auntie.

The third was an ITT CVC5 with no sound (PCL86) and an initially rolling picture (PCL805). It doesn't happen very often like that but there they were, three in a row and I was smiling. Then in walked Stan.

The Hitachi Portable Arrives

"Just have a look at this portable will you, you did it a couple of years ago and it took only a few minutes, probably the same thing again. I'm going to have a haircut – collect it on the way back". Before I could think of a cutting remark he had gone, leaving his Hitachi P32 monochrome portable for me to wave my magic wand over.

Although there were several other things to be attended to I thought I'd try to oblige. Screw either side and two underneath, pull off the side contrast and brightness knobs and lift off the cabinet shell. Plug in aerial and switch on. Still tuned in as sound came on full strength, but no picture. E.H.T. o.k. Tube base voltages: first anode pin 7 o.k., grid pin 5 near enough right, cathode pin 2 high at 100V (should be about 54V).

Well that looks easy enough: video output transistor not drawing any current. Where is it? There, with a heatsink on it: check collector, 100V; base 2·5V; emitter 2V. Switch off and cold check the transistor. Reads right and as the base should be at 4·2V check back through the contrast control to the emitter of the video emitter-follower. Voltage low here too, and the base low at about 2V (should be 4·95V). Where does it get its bias from? Check bias network, having removed the screening covers (soldered on in several places) to get at the print. These and other components seemed to be blameless.

Some time had gone by and back came Stan. "Done it?" he enquired cheerfully. "No", I growled. "If you think it's that easy, do the bloody thing yourself".

Only the Sound's Slipped Out

"Don't be like that", said Stan. "It's only that the sound slipped out".

"Slipped out, slipped out", I croaked. "I suppose the picture slips in when the sound slips out?".

"Yes, that's right. The knob's probably loose", said Stan helpfully. This was too much for me. Putting the set back upright, I asked him to give me a demonstration. He turned the tuner knob slightly and the sound slipped out and some sort of picture slipped in. I clutched at a straw.

"You haven't just come back from a wine tasting trip to Germany have you, and had this thing seen to out there?"

Stan looked at me as if I'd gone loony.

"I don't drink wine if that's anything to go by, and I haven't been to Germany or Timbuktu, and if I had I wouldn't have taken this with me, so what are you on about".

"Never mind, I only thought... Oh well", I floundered.

I returned to the tuner. Tuned in correctly, there was no illumination on the screen at all. Detuned, the screen lit up and the sound naturally slid off. The possibilities were endless and my mind went numb. "Better leave it with me Stan, there's nothing easy about this one".

Stan departed, mystified that such a small thing could take so long to put right. He said he'd call in when he finished work on Monday evening, leaving us the weekend. When he had gone there were several other sets to see to before we could get back to the mystery. When we did get back to it however we didn't get very far.

The AGC Circuit

It was now obvious that when a full-strength signal was tuned in there was insufficient output from the detector to drive the video emitter-follower. Without an aerial at all, the set behaved itself and a grainy picture could be tuned in with almost normal sound. This naturally directed attention to the a.g.c. line, which was checked through bit by bit as the circuit (see Fig. 1) is not all that easy to follow from the manual. The two transistors appeared to be in order on a cold test, the capacitors had capacity, and the resistors were right. With the set on again, everything was in order! Therefore all the testing had been in vain, since the fault was not present. After some time however the picture started fluttering and back we were to square one. After some more fruitless checking we put it down until the next day.

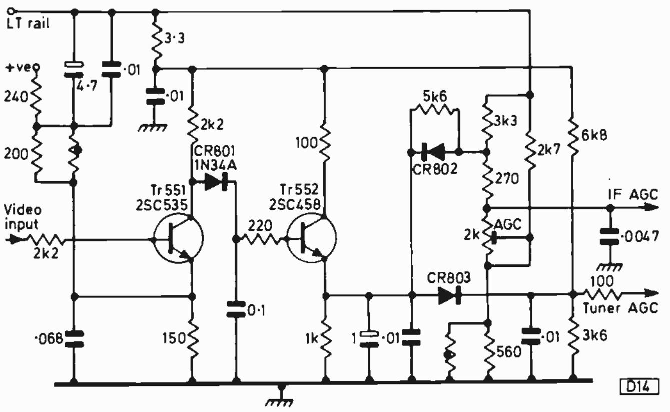


Fig. 1: A.G.C. circuit, Hitachi monochrome portable Model P32.

The next morning we started again. So did the set. Fine for a few minutes, and then the overloading started. Without turning off, we returned to the testing. Still the low detector output, so we worked back along the i.f. strip.

The a.g.c. applied to the first two i.f. stages seemed very small and varied little as the aerial was withdrawn. There was a good swing at the base of TR551, but not at the base of TR552. This directed attention to both transistors and CR801. The latter checked out o.k., and bearing in mind the fact that we had already had some hanky panky with the fault coming and going we replaced both transistors with BC107 types (for convenience) and were rewarded with a steady, unblinking picture with normal sound.

Many hours had been spent tracing this simple fault but there had been several interruptions to distract us. When Stan returned his comment was "I knew it wouldn't be very much. Fancy it taking you all that time to do it". Our reply was unprintable.

A Very Grainy Picture

Hardly had we sorted this one out when a Pye 180 arrived. Picture very grainy indeed, suggesting a poor aerial socket, or perhaps a defective tuner. This solid-state Pye monochrome set uses the same i.f. selectivity/gain module as the CT200 and the Philips 570 series. It's been a constant source of trouble, due to defective soldering to the capacitors and coils in the unit. We disregarded the tuner etc. therefore and without further ado set about removing the i.f. module. Using a solder sucker or desoldering braid, this can be done in a matter of minutes, so we soon had the suspect stripped out of its can.

There are several possible trouble spots with this unit, as we have mentioned before in previous issues. We always go straight to the components on the print, which are soldered on both sides. Lifting the small capacitors a fraction with the solder melted ensures that the legs get the solder and not the cement. This is normally all that is required, and once again this seemed so as a normal picture appeared when the unit was replaced. After twenty minutes however the same symptoms returned and the whole process had to be repeated, this time with lasting success.

A Rigonda Starlet

Then followed a long, involved tussle with a Rigonda Starlet 603. We do not normally handle these, but this set belonged to a close relative so with bad grace we got down to it. The complaint was that it would function for a time and then intermittently go off as though switched off.

As the owner was a first class poacher (not really, he does get permission from the farmer), I suggested that a nice fresh rabbit would come in handy, skinned and dressed of course. He readily agreed but complained that the rabbiting was not so good of late because his wife had been petting one of his ferrets. The result was that as soon as it was released at the rabbit hole instead of going down it would roll over on its back to have its belly tickled. This is not at all the idea, so until he could break the habit the catch would be reduced. I found this hard to believe because every ferret I've ever met seemed to have had but one desire, to bite my fingers off. Since these were very young ferrets however I presumed that they would develop their more ferocious habits later. Ah yes, the Rigonda.

Now these are made up in slabs which can be separately detached – top, bottom and sides. Since the power pack is at the bottom we removed the four screws and then the bottom slab. This gave us partial access, at least enough to confirm that although the supply voltages were reaching the base and emitter of the regulator transistor its collector was shutting down with monotonous regularity. At first sight the regulator looked very much like an AD149 or similar, except that it had three legs in the same configuration as the more common smaller drivers etc. Never to be accused of wasting an opportunity, we stuck a 10Ω dropper section between the emitter and the collector to bring it more into line with what we are used to. The thing then worked and regulated correctly. Remove the resistor and it reverted to its hysterical behaviour. Check the transistor and it read o.k. Replace the resistor and the thing worked for an hour with the resistor taking only a small amount of current.

I suppose the resistor kept the emitter voltage just that little bit over the base voltage so that the transistor continued to conduct, but the appearance of the control panel persuaded us not to argue with the other three control transistors over the matter. In our tattered nervous condition we did not feel inclined to delve deeper, so we replaced the power slab and called it a day, rabbit or no rabbit.

If it comes back I'll fit an AD149 and see if that cures the condition, but so far everyone appears to be happy.

The Television

MONOCHROME PORTABLE RECEIVER

Part 3 **Keith Cummins**

LAST month we covered the signal circuits in the receiver. It's time now to turn to the timebases, starting with the SN76544N i.c. which contains a sync separator, noise gate, and the line and field generators. First of all a couple of corrections. C36 (0·1μF) was unfortunately omitted from the circuit diagram: it decouples the feed from R79 to the tuning voltage pin of the varicap tuner. Tr8 and Tr10 should have been shown on the circuit as type BC212L: the pin connections to the BC212 are different. The volume control RV1 was shown as 25kΩ on the circuit diagram and 5kΩ in the components list: either will do but the latter value gives a better control range. The correct value for C62 is 22nF (0·022μF) – shown incorrectly on the circuit and in the components list. A chassis connection should have been shown to the tuning head (Fig. 2), and pin 8 of IC103 should have been shown connected to chassis. C16 is 0·47μF as on the circuit diagram, not 4·7μF as listed in the components list.

Sync/Timebase Generator IC

The SN76544N i.c. (IC105) is a 16-pin device and all its pins are used. The makers state that the individual connections are short-circuit proof to their adjacent neighbours, and also short-circuit proof to earth. It's better of course if the constructor does not put this to the test. It's certainly *not* true of the SN76001N audio i.c. I write from rueful experience: the AVO prod slipped!

A block diagram of the SN76544N i.c. is shown in Fig. 6. It requires a d.c. supply of course, at 11V, and this is filtered by R30, C19 and C33. Its inputs consist of the output from the first sync separator Tr10, an input from the video distribution point to the noise gate, and finally a sample pulse from the line output stage for phase comparison in the flywheel sync circuit. The outputs consist of drive pulses for both the line and field timebases. Complementary pulses are available at field rate: the positive-going one is used for field flyback blanking, by injection at the tube cathode as described earlier.

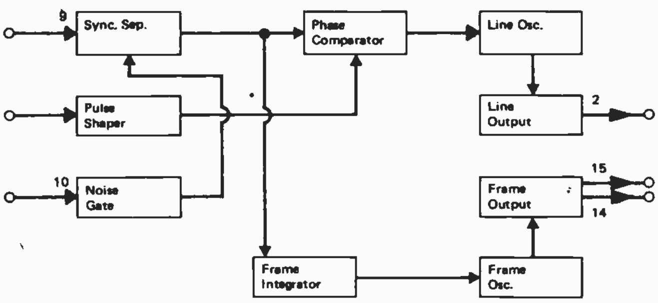


Fig. 6: Block diagram of the SN76544N i.c.

It's probably best to take the i.c. connections pin by pin, and describe the circuits connected to each one. Pin 1 has the frequency-determining resistive network for the line oscillator connected to it, with RV4 the line hold control. The line stability is very good, and once set the control should not need readjustment.

The output to the line driver stage appears at pin 2. Pin 3 is a supply input. Pins 4 and 5 have the line oscillator timing capacitor C18 connected across them. The flywheel sync reference pulse is fed in at pin 6. Pin 7 is connected to the horizontal a.f.c. line, and has the usual "flywheel" type network – C16, C17 and R19 – connected to it.

The flywheel sync comparison ramp is generated across C15, which is connected to pin 8. The sync separator input is pin 9, and in our case is fed with sync pulses from the first sync separator.

The noise gate circuit is connected to pin 10. D15 acts as a threshold diode. Normal amplitude video, negative-going, is applied to it via R21 and C13. The positive-going sync tips cause D15 to conduct only slightly once C13 has charged to a stable value. Large noise pulses drive D15 into heavy conduction however, and the input which results to pin 10 turns off the sync separator. By this means, spurious sync pulses are eliminated. The circuit works well under conditions of simulated interference. The whole circuit appears to be able to cope with interference signals in an efficient and rugged manner. Pin 11 is a general earth connection.

The field timing components are connected to pin 12. These consist of the capacitor C20 and R24, RV5 and R25. Different samples of the SN76544N require slightly different values of timing resistor, and to avoid having too high a value field hold control R24 is included. It can be shorted out if the total resistance is too high.

Pin 13 is another supply point, and in our circuit is

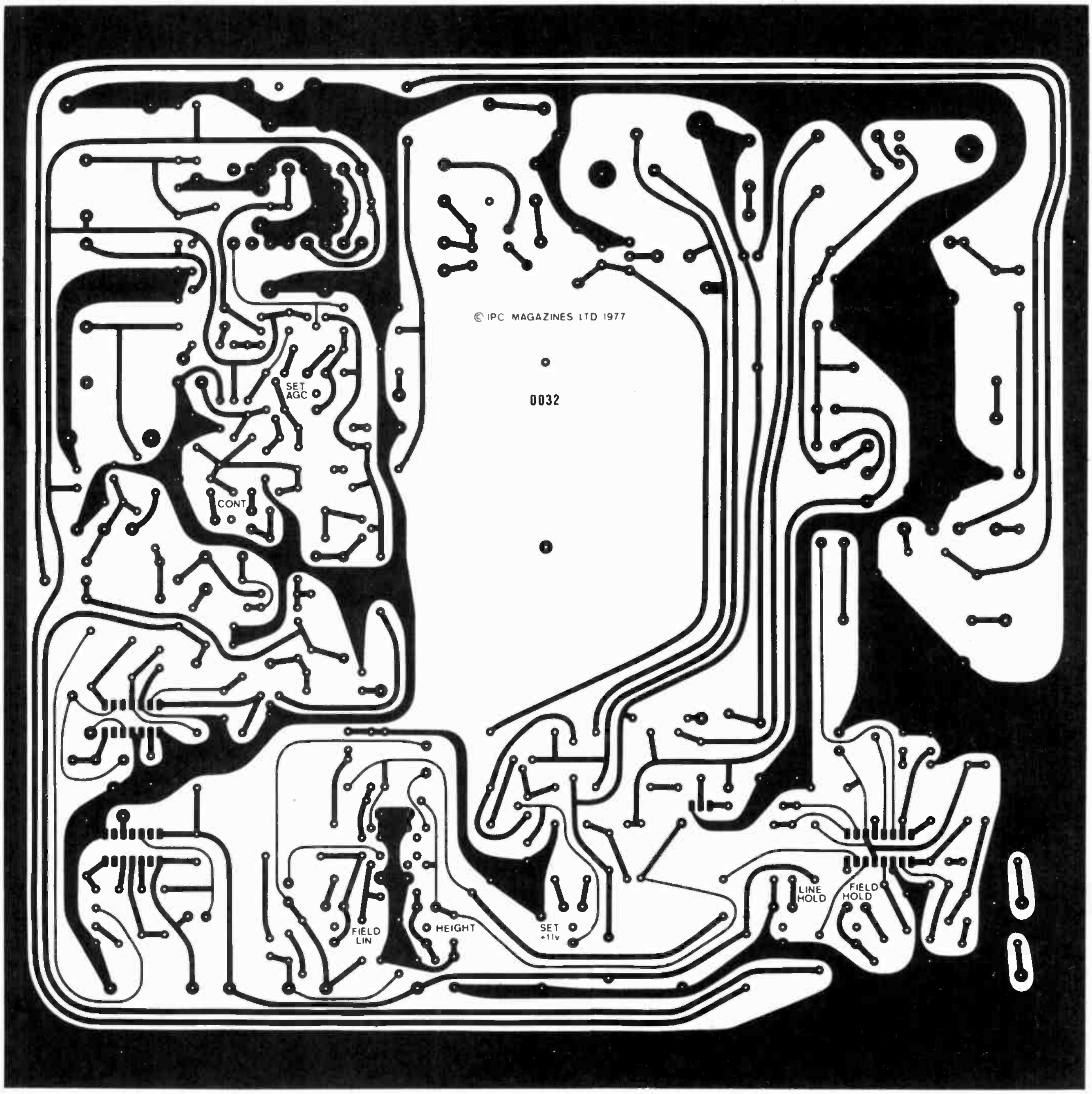


Fig. 7: Printed board print pattern (not to scale). The actual size is $11\frac{3}{4}$ x $11\frac{3}{4}$in.

connected directly to pin 3. The field blanking output, mentioned earlier, is taken from pin 14.

A negative-going pulse from pin 15 is used to discharge the field charging network.

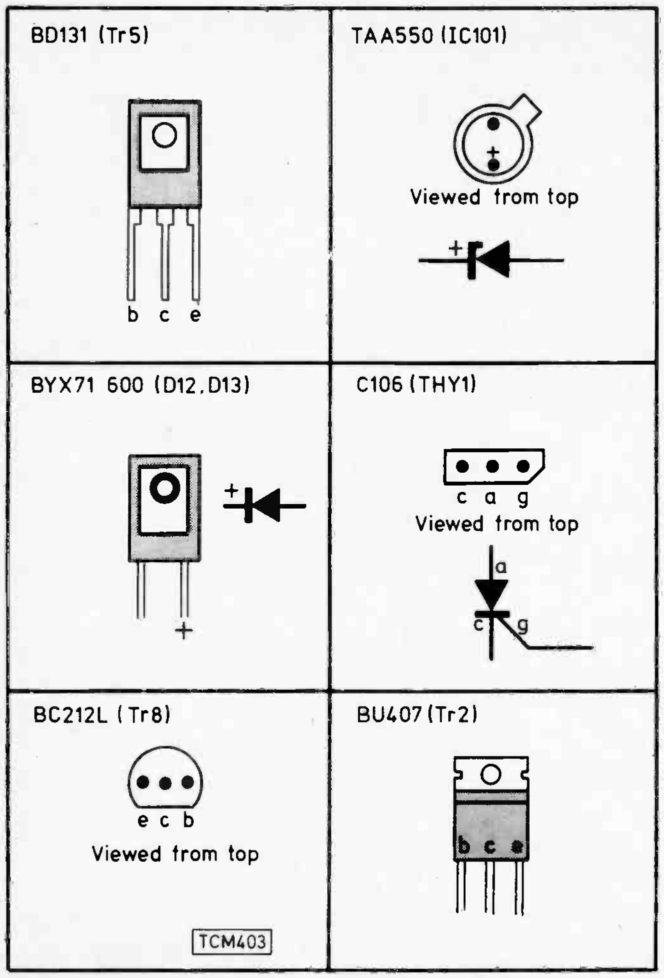
Pin 16 is another earth connection.

Line Driver Stage

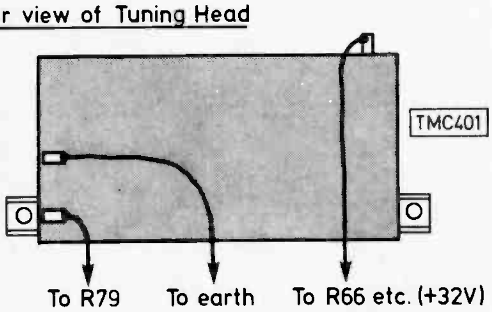
We shall now deal with the line driver stage Tr5. The output from pin 2 of IC105 is fed via the current limiter R28 to the base of Tr5, with C31 providing integration to clean up the waveform. Note that since we are using a driver transformer to match the low impedance of the output transistor's base-emitter junction, the flux in the driver transformer core will reverse as the driver stage turns on and off, thereby producing both turn-on and *turn-off* current for the output transistor. This latter is very important for the correct operation of the line output stage. Note that turning *on* the driver stage produces the change of flux necessary to produce the turning *off* current for the output transistor.

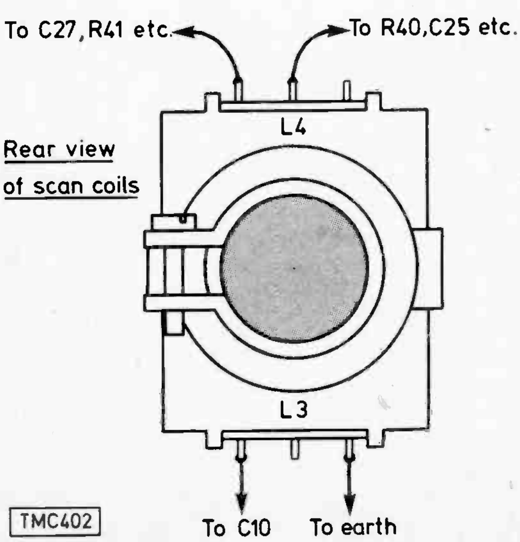
The turn-on waveform from IC105 to the driver Tr5 has a steep edge. Also, Tr5, working into a mainly inductive load, produces steep transients at the instant of turning on.

The line output transistor acts as a switch, earthing pin 2 of the line output transformer when it switches on some way into the forward scan. It's switched off at the end of the line to give the flyback. The line output transistor does not turn off instantaneously however, taking about 10μsec to do so. This means that the line driver transistor has to be turned on about an inch before the end of the scan, at the right-hand side of the screen. The size of the transients developed across the line driver transformer is limited by the inclusion of the damping network R29/C22. The driver transistor is supplied from the 25V boost rail via R31, with C21



Rear view of Tuning Head





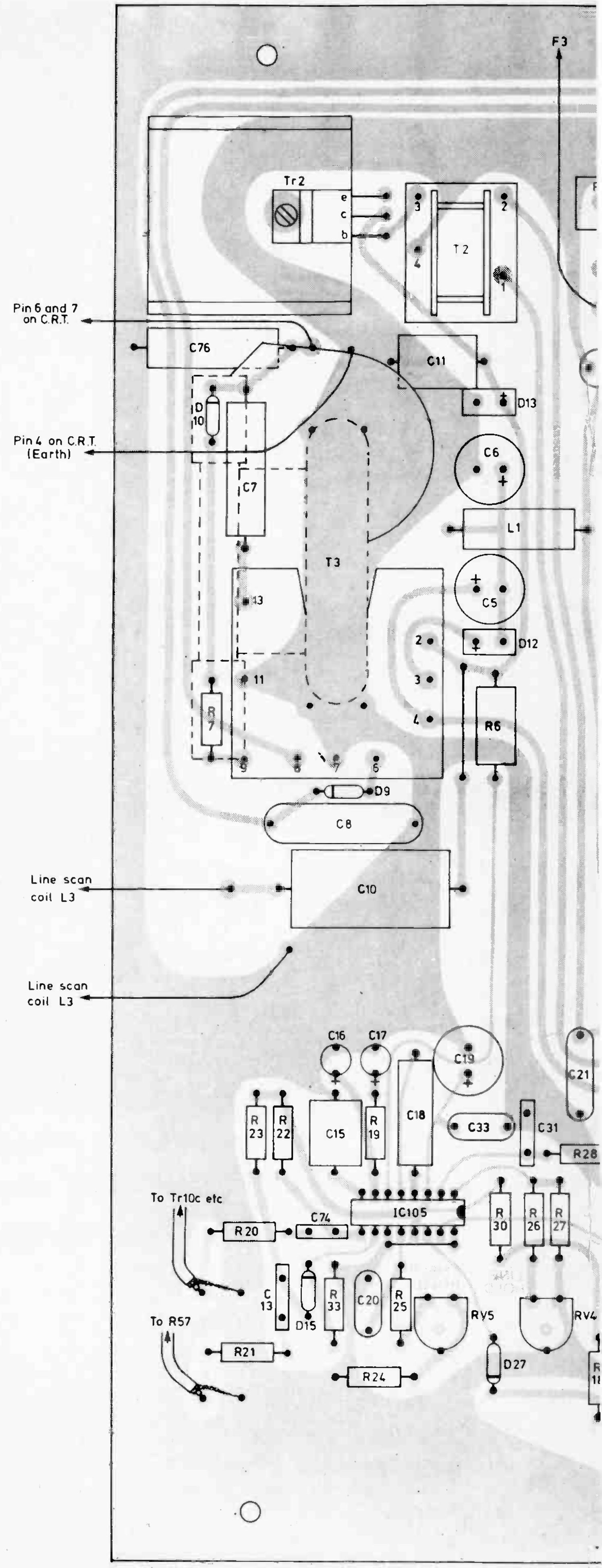
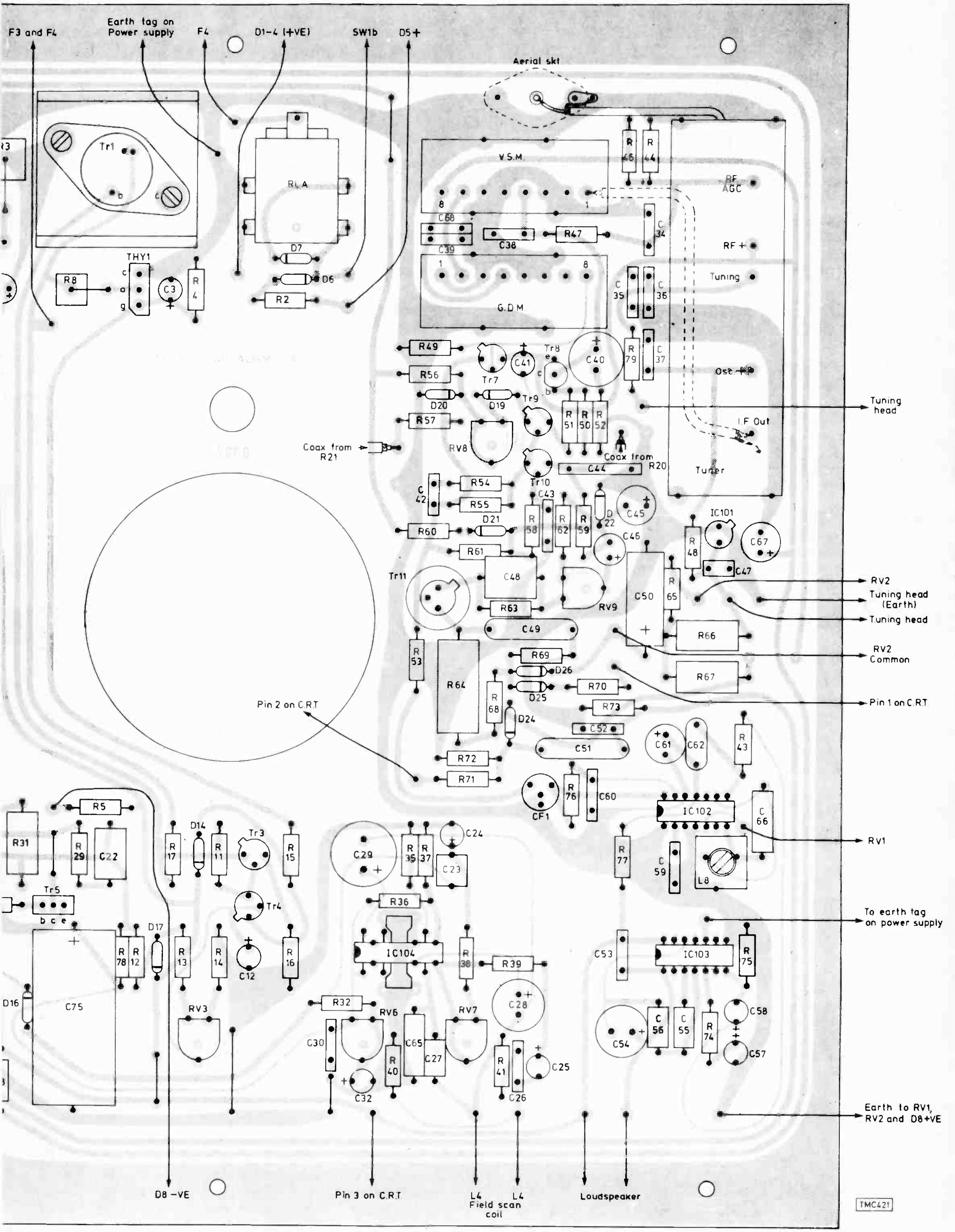


Fig. 8: Component layout and connections.


F3 and F4
Earth tag on Power supply
F4
D1-4 (+VE)
SW1b
D5+
Aerial skt
V.S.M.
RF AGC
RF +
Tuning
Osc
I.F Out
Tuner
G.D.M
RLA
Tr1
THY1
Coax from R21
Coax from R20
Tuning head
RV2
Tuning head (Earth)
Tuning head
RV2 Common
Pin 1 on C.R.T
Pin 2 on C.R.T
RV1
To earth tag on power supply
Earth to RV1, RV2 and D8+VE
IC101
IC102
IC103
IC104
CF1
L8
D8 -VE
Pin 3 on C.R.T
L4 L4 Field scan coil
Loudspeaker
TMC421

providing decoupling. We will deal with the line output stage itself later.

Field Timebase

The field output stage is built around the well-known TBA800 audio i.c. A field-frequency sawtooth voltage waveform is generated by charging C23 from the boost rail via RV6 and R32, and then discharging it through diode D16 and IC105. The cathode of D16 is normally at 8V: when the field drive pulse arrives from pin 15 of the SN76544N i.c. this voltage drops to near zero. Consequently C23 is discharged. The ratio of RV6 and R32 to R35 defines the charge which is developed across C23, and therefore the amplitude of the sawtooth voltage. R35 also provides scan correction by reducing the "aiming" voltage so that the curvature of the charging waveform is increased at the end of the scan. For the moment we are ignoring the linearity correction feedback which is applied to the junction of C23/C24.

The i.c. is fed from the 25V boost rail, with R78 and C75 providing filtering. Rhythmical expansion and contraction of the field scan was experienced before R78 was added. C30 provides h.f. decoupling to ensure stable i.c. operation.

During the forward field scan the scan coils appear predominantly resistive. The i.c. takes the sawtooth voltage generated across C23, amplifies it and delivers it to the scan coils from a low source impedance, thereby producing the scanning current.

During the field flyback the inductive component of the scan coils becomes dominant, due to the higher frequency compared to the forward scan. This inductance would introduce a large negative spike on the sawtooth voltage appearing across the scan coils. Since the coils are always connected to the i.c. however, the spike is clamped to earth, the remaining energy being dissipated in the i.c. This type of circuit is for obvious reasons called a "clamped" circuit. Its main disadvantage is that the i.c. has to dissipate this extra energy. Therefore with this type of circuit the power capability of the i.c. needs to be greater than if we could isolate the scan coils from the i.c. during the flyback.

One way of doing this is to place a transistor in series with the output from the i.c. and to arrange its bias so that it switches off when the flyback pulse arrives. This leaves the coils open-circuited, so we need to put a capacitor across them (usually 2·2μF, depending on the inductance of the coils) so that during the flyback the coils and the capacitor form a resonant circuit which defines the frequency (i.e. duration) of the flyback and consequently its amplitude. This is called an "unclamped" circuit. Its main disadvantage lies in the fact that it requires a medium power transistor, a rather bulky capacitor, plus several biasing components.

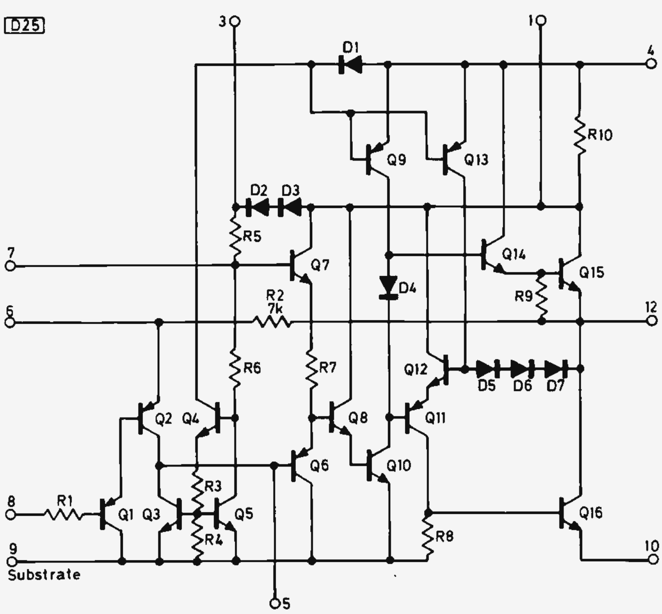


Fig 9; Internal circuit of the TBA800 i.c.

In this particular circuit the cost advantage of a clamped system using the TBA800 and the space saving compared to an unclamped system made the choice easy.

Most transistor field charging circuits differ slightly from the one used here in that C32 is normally absent, so that the combined resistance of R32 and RV6 (at any given setting) determine the charging rate. In this design, at high-resistance settings of RV6 C32 acts as a reservoir capacitor whose voltage is determined by RV6 in conjunction with the current drawn by the remainder of the circuit. The charging rate is therefore determined by R32. At low-resistance settings of RV6 C32 has little or no effect. Its purpose is to ensure that the charging voltage source is cleaned of any unwanted signals which may interfere with the charging circuit.

The output from the i.c., at pin 12, is coupled to the field scan coils by C29. C28 is a bootstrap capacitor which ensures that a symmetrical waveform is obtained from both "halves" of the quasi-complementary output stage within the i.c. The capacitors connected to pin 5 (C27 and C 65) prevent the circuit from oscillating, by feeding back a phase-shifted signal at higher freqencies. R41 and C26 are also used to ensure stability, by compensating for the inductive nature of the coils.

A small sawtooth voltage is developed across R40 and is fed back to the inverting input of the i.c. via C25 and R39. These components define the closed-loop gain of the amplifier. Field linearity is corrected by feeding back part of this signal (adjusted by RV7) via R38 to the junction of C23/C24. As a result, a parabolic waveform is developed across C24. The combination of this parabola and the sawtooth voltage across C23 provides a scan-corrected drive waveform (necessary because of the wide deflection angle of the c.r.t.). The value of C23 is much less than that of C24: as a result, the charging current in C23 has little effect on the charging of C24. Further correction is provided by R35 as mentioned earlier.

Resistors R36 and R37 provide a bias voltage for pin 7 of the i.c. This puts a d.c. shift on the quiescent output voltage, which is normally sitting at half the supply voltage. This ensures that most of the scanning current is provided by the upper of the two output transistors in the i.c., thus allowing sufficient margin for the flyback pulse to be developed at the required amplitude.

Line Output Stage

The final section of the receiver to investigate is the line output stage. The stabilised 11V supply is fed to the line output stage via choke L1, which is decoupled by C6. The purpose of this arrangement is to prevent line-frequency pulses reaching the other parts of the receiver via the 11V rail. The supply reaches the transformer via the boost diode D12, which operates in exactly the same way as in a valved receiver, charging the boost reservoir capacitor C5 to produce a 25V supply for the line output stage and other sections of the receiver. There is also a shunt efficiency diode (D13) which we'll come to shortly.

The BU407 silicon npn line output transistor acts as a switch, again in the conventional manner, connected across the flyback tuning capacitor C11. It's switched on some way into the forward line scan, at the end of the energy recovery period at the start of the scan.

We have to produce a sawtooth current (scan-corrected as in the case of the field scanning current) in the line scan coils, which at line frequency are predominantly inductive. It may not seem immediately obvious, but the scan coils are in effect connected in parallel with the primary winding (tags 2-4) of the line output transformer – the a.c. path is via T3 4-2, C10, L3, C6 and C5. The d.c. resistance of the transformer's primary winding is very low, and is less than that of the coils. When Tr2 is turned on, there is a d.c. path from the boost rail to chassis, via the transformer's primary winding and the transistor. Applying a voltage across an inductance (which, as we've pointed out, also includes the scan coils) results in a linear rise in current flow. This completes the scan and, when the spot is at the right-hand side of the screen, the line output transistor is switched off by the drive waveform provided by T2.

When Tr2 turns off, the flux in the scan coils and the transformer collapses, producing the familiar positive pulse voltage – the flyback pulse. The inductive components form a resonant circuit during this time in conjunction with the tuning capacitor C11. At the end of the pulse, the spot has returned to the left-hand side of the screen in order to commence the next line. The energy in the circuit during this half-cycle of oscillation is first stored in the tuning capacitor C11 and is then returned to the inductive components. The circuit tries to continue to oscillate, but as the voltage reverses so the boost diode D12 switches on, transferring energy to the boost capacitor C5. The clamping action of D12 and C5 result in a linear current decay through the coils and the transformer, so moving the scan from the left-hand side of the screen towards the centre. When about a third of the screen has been scanned in this way, Tr2 is switched on again. The current flow first falls to zero (middle of screen), then increases linearly in the opposite direction to complete the scan.

The efficiency diode D13 also conducts during the first part of the scan. It's included mainly to remove spurious line output transformer resonances however, contributing little in practice to the operation of the circuit. It could possibly be omitted, or the cheaper BYX55-350 used: the latter is not suitable for D12 however – the function of the boost diode is very rigorous and only the type specified should be used.

In order that the charge stored in the base of the line output transistor at the point when it's switched off can be efficiently removed, its base circuit requires a series inductance. This is built into the driver transformer in the form of the correct leakage inductance, providing a means of shifting the charge from the capacitance of the transistor to the inductance. By this means we avoid turning the transistor off slowly while its collector voltage is rising – a condition which would result in excessive dissipation and breakdown of the transistor.

C10 in series with the scanning coils provides scan correction as well as acting as a d.c. block. Scan correction is required in order to slow down the start and the finish of the scan, where for a given deflection angle there is a greater movement across the nearly flat face of the tube. C10 resonates with the inductance of the coils to superimpose a sinusoidal waveform upon the sawtooth.

A line linearity coil was included in an early prototype but, despite being correctly damped, seemed to produce ringing at the end of the scan. The linearity was found to be perfectly satisfactory after removing it however so it was left out of the final circuit.

As we have seen, C11 tunes the circuit, determining the flyback time and hence the rate of change of flux in the transformer. This in turn determines the flyback pulse amplitude and hence the e.h.t. C64 contributes towards the tuning, but is also there to protect the line output transistor against pulses which may be developed across the coils in the event of a flashover in the tube.

Scan-derived Supplies

The line output transformer also provides various supplies for other sections of the receiver. The usual e.h.t. overwinding provides a positive pulse which is rectified by D11, charging the tube capacitance to the required e.h.t. potential. D9 charges C8 to approximately 95V to provide a supply for the video output transistor, the 32V stabiliser, etc. D10 charges C76 to approximately 550V for the c.r.t. first anode and focus electrodes. The negative-going pulse at tag 13 is coupled to this feed via C7 to provide line flyback blanking. C7 initially fulfilled both functions – blanking pulse coupling and reservoir for D10, but it was found that without C76 transformer resonances produced vertical striations across the screen.

Finally, winding 7-8 produces the –8V pulse required for a.g.c. gating and to produce a –5·6V supply in the video circuits.

In the concluding article next month we'll be giving constructional notes, the setting up procedure, and some fault finding advice.

CONTINUED NEXT MONTH

Servicing the Rank A823 Colour Chassis

Part 2

R. W. Thomson

THE timebase panel, type A803, is situated at the extreme right of the chassis and contains the sync separator, the field oscillator and output stages, the flywheel line sync and line oscillator stages and the line driver transistor. The latter drives the two series-connected BU105 line output transistors, which are housed within the can screening the line output transformer, the e.h.t. tripler and the focus unit. Fig. 4 shows the sync separator and line generator circuits.

Sync Circuit

5VT1 is the sync separator, which is biased during the scan period to a point just beyond cut-off. The arrival of a sync pulse drives 5VT1 into conduction, pulling the collector voltage down far enough to cut-off 5VT2 whose base is d.c. connected to the collector of 5VT1. The fast interruption of current through the primary of 5T1 causes this inductance to "ring", similar waveforms being generated in the secondary winding 5L2. 5C7 tunes the primary 5L1, and a sinewave of approximately 50V p-p is developed across the secondary 5L2 as a reference waveform for the discriminator diodes 5D2 and 5D3. The "hot" end of 5L2 is connected to the junction of these two diodes. When 5VT1 returns to the cut-off state, 5VT2 turns on again, taking diode 5D1 into conduction and damping any further oscillation in 5T1 until the next sync pulse arrives.

Positive and negative pulses from the line output transformer are fed to the outer ends of diodes 5D2/3. The resultant phase comparison of the two pulses with the sinewave from 5L2 creates a voltage across the balance control 5RV2 which, when correctly adjusted, supplies the correct voltage conditions for varicap diode 5D4.

Line Oscillator and Driver

Any change in the capacitance of 5D4 is multiplied by the reactance multiplier 5VT4, varying the reactance across 5T2, thus keeping the frequency and phase of the line oscillator in strict relationship with the sync pulses. The line oscillator transistor 5VT5 is driven hard on and off by the feedback pulses from 5C21, and in consequence a rectangular waveform appears across 5C23 to drive 5VT6/7. 5D5 protects the base-emitter junction of 5VT5, while 5D6 d.c. restores the waveform at the base of 5VT6. The emitter-follower 5VT6 drives the base of 5VT7 at low-impedance, ensuring that the latter is effectively bottomed by the drive pulse. This keeps the dissipation in 5VT7 low, hence the absence of a heatsink on this BD131, a transistor which usually runs very hot in other types of circuit.

Line Generator Faults

It will be noted that the primary of the driver transformer 6T1 is shunted by the damping network 5C25 and 5R35. This is essential to avoid the back-e.m.f. from the primary destroying 5VT7. These two components, particularly the capacitor 5C25, should be checked in all cases of BD131 failure since this is a prime cause for the failure of this transistor, an event which is regularly encountered in these sets. The result is no e.h.t. of course, but since 5VT7 usually goes short-circuit the l.t. fuse 8F1 blows and there is no sound either – in fact nothing except the tube heater glowing. Also check the connections to 2R35/2C25 should 5VT7 have failed since a dry-joint here can be responsible. The BD131 can also go open-circuit of course, but this time the fuse doesn't fail.

The capacitors in this area can be troublesome. 5C14, 5C20, 5C21 and 5C23 have all been found responsible for no e.h.t. Intermittent loss of e.h.t. has been traced to 5C7, 5C17 and 5C18 – also 5D6, which can be checked with freezer. Loss of line sync can be caused by 5C14, 5C20 (also check whether it's dry-jointed), 5C21 and 5C23; also the flywheel sync discriminator diodes, usually 5D2. Intermittent loss of sync can be 5C17/18 or the line oscillator coil (5T2) former warping. Intermittent line jitter can be 5C17/18 again. Finally 5C22 can be responsible for bent verticals, maybe intermittent.

If false line lock is experienced with early sets, look at 5T1 and see whether it bears a green spot. If it doesn't, replacing it with a modified transformer will cure this fault. Later transformers had a green spot to indicate that the phase of the primary/secondary had been changed.

Line Output Stage

As with other early solid-state designs there are two line output transistors, connected in series in order to share the line flyback pulse between them. Loss of e.h.t. (with 8F3 blown) due to failure of the line output transistors is not common. When it does happen the cause is lack of balance between the two: if the base drive waveforms are not adjusted so that the two transistors switch off at the same time, the first one to switch off will have the full flyback pulse voltage across it. To prevent this, chokes 6L4 and 6L5 are included in the base drive circuits: one has a movable core which is adjusted to equalise the decay of the base currents and ensure that the two transistors switch off at the same instant. The way of doing this is described below – the method for later versions differs because with these both coils are adjustable.

The e.h.t. tripler and focus arrangements follow the normal lines in this type of chassis, but a point worth mentioning is the extremely high reliability of the line output transformer. The only one I've had to replace didn't fail of its own accord but due to a non-soldered joint that somehow missed the factory's inspection department. So in cases of no e.h.t., the line output transformer is the last thing to suspect.

In cases of no e.h.t. where 6R6 is of the fusible type check whether this has gone open-circuit. If so, check the line output transistors and the flyback tuning capacitors 6C5 and 6C6. The main cause of line output stage failure in early sets was these two polystyrene capacitors, so much so

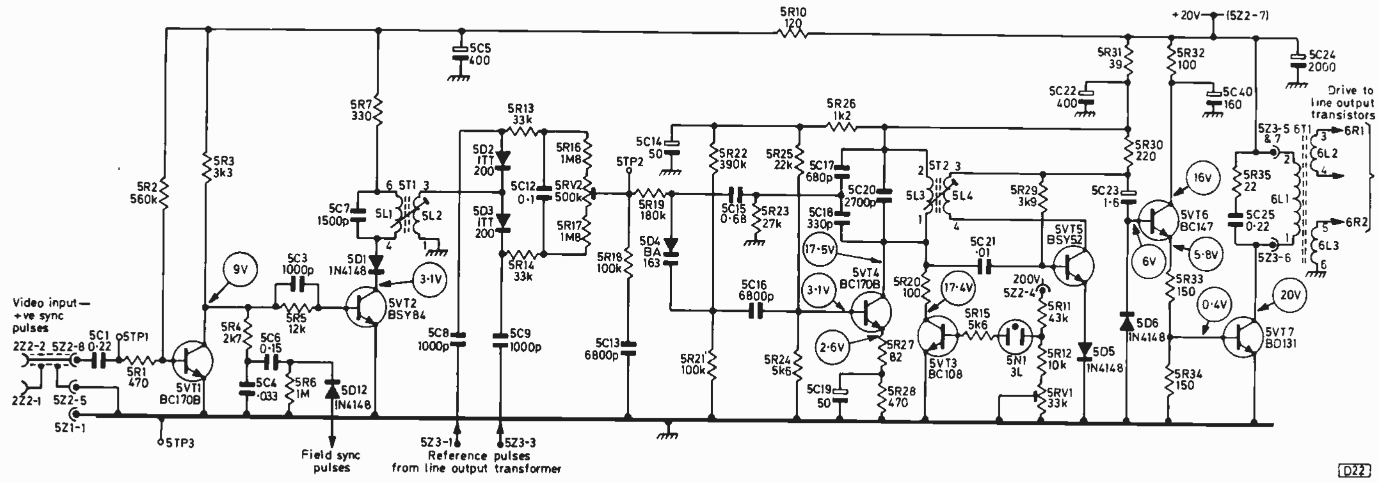


Fig. 4: Sync separator and line generator circuits. See Fig. 7 for modifications. 5TP4 (not shown) is a chassis connection.

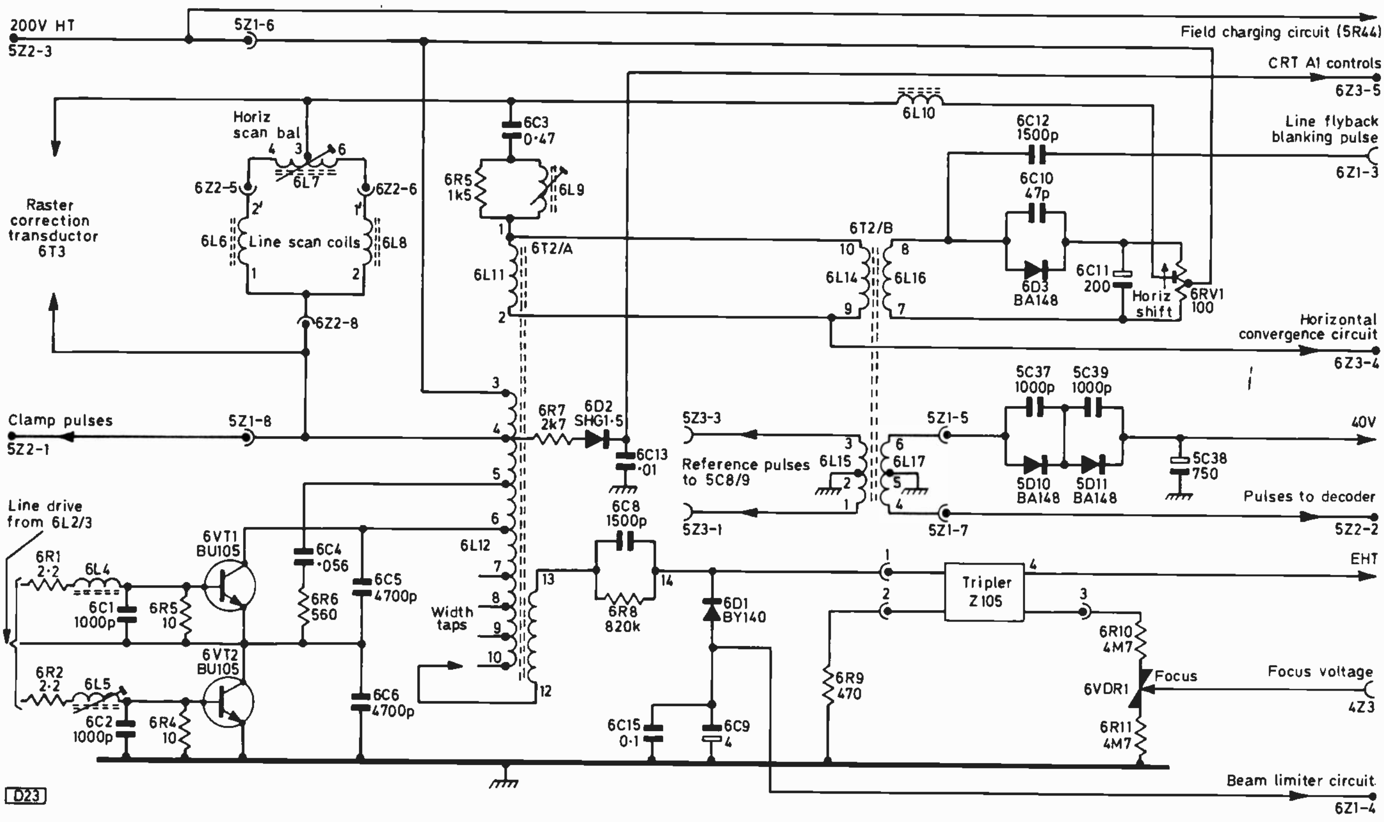


Fig. 5: Line output stage circuit. See Fig. 7 for modifications.

that many engineers automatically replaced them with alternative types before putting sets into service. The capacitors chosen were the tubular types supplied at the time by RS Components – listed as 800V a.c. buffer types. Subsequently Rank themselves started to use these capacitors. Although they are not close tolerance types, they worked and still do.

Adjustments

Balancing the line output transistors is, as you've now gathered, highly important. The writer checks this every time a receiver comes into the workshop, no matter for what reason. Perhaps this is the reason why the failure rate of line output transistors has been so low in the receivers I've handled. It doesn't take long to rebalance the stage, which *does* go out of balance over the years. The procedure for early versions is as follows:

(1) Note the voltage at 8F3 on the power panel, then switch off the set.

(2) Solder a 390kΩ resistor in parallel with 8R9. Switch on and set 8RV1 to give 100V at 8F3.

(3) Tune the set to a test card or pattern generator or other stationary picture source, relock the line hold if necessary, and switch off again.

(4) Swing the scan output panel out on its hinges, and connect the meter's negative lead to the pin carrying two red wires on the scan control panel. Connect the positive meter lead to the fuse 8F3. Switch on again and adjust 6L5 for minimum reading on the meter, starting with the 250/300V range and progressively changing downwards until on the 10V range. A reading of less than 3·5V should be obtained. This will be the point at which the circuit is working most efficiently, with both transistors driven equally.

(5) Switch off and remove the meter leads and bridging

resistor. Check that 8R9 is a good, sound 390kΩ resistor. Replace the panel and the job's done.

If adequate width is obtainable with 200-210V at 8F3 all is well, but if the width is excessive or insufficient the tapping at tags 7, 8, 9 or 10 on the line output transformer should be selected for correct picture size in the horizontal direction, adjustment of field balancing being necessary if any change is made.

The line oscillator is easily adjusted by shorting pins 5TP2 and 4, then adjusting the core of 5L3/4 until a near stationary picture is obtained. 5RV2 should be adjusted to the centre-point between break-up in either direction, and if the displayed picture is not right in relation to the raster the core of 5T1 should be used to correct this.

Overvoltage Protection

Overvoltage protection of the line output transistors is provided to avoid over-running and possible destruction of these components, plus the avoidance of excessive e.h.t. This is done by having a normally non-conducting transistor 5VT3 shunted across the line oscillator coil 5L3. If the h.t. rises above a voltage preset by 5RV1, neon 5N1 strikes and 5VT3 switches on, effectively shorting 5L3. This stops the oscillator and switches off the output transistors. The circuit remains in this condition until the set is switched off and the neon is extinguished.

To set this stage accurately, two spare resistors, of 220kΩ and 270kΩ, should be connected in series across 5R11. A temporary short is then made across the 270kΩ resistor, the receiver switched on, and 5RV1 adjusted until the neon strikes. After switching the set off and removing the temporary short across the 270kΩ resistor, switch the set on again and the neon should, if properly set, remain unlit. If it does strike, either the procedure has been carried out too roughly or there is a fault in the circuit. The overvoltage circuit should be reset whenever the set h.t./e.h.t. control 8RV1 has been adjusted.

Note that a diode was added in place of 5R20 fairly early on in the life of the A823 chassis. This was to allow the use of low-gain transistors for 5VT3.

If the overvoltage neon keeps striking despite correct setting up, check the transistor 5VT3 and the value of 5R11. The neon itself can be faulty, striking to produce loss of raster a short while after switching on.

Modifications

Various modifications were made in the line output stage before the introduction of the later A823A version of the chassis. Fig. 7 shows the changes, which include adjustable coils in the drive to each line output transistor. The procedure for balancing the output transistors is in this case as follows:

(1) Switch off, remove fuse 8F1 and fit an additional 390kΩ resistor in parallel with 8R9.

(2) Switch on and reduce the h.t. to approximately 100V by means of 8RV1.

(3) Switch off, replace 8F1 and set the cores of 6L4 and 6L5 to be flush with the top ends of their formers. Connect a meter on the 250V a.c. range across 6R6.

(4) Switch on and rotate the core of 6L5 clockwise, by no more than three turns, for minimum reading on the meter (after three turns the reading will not change due to the coil inductance being at maximum). If the adjustment results in an increased reading on the meter, return the core to the flush position and then rotate the core of 6L4 inwards. When the minimum reading has been obtained with either

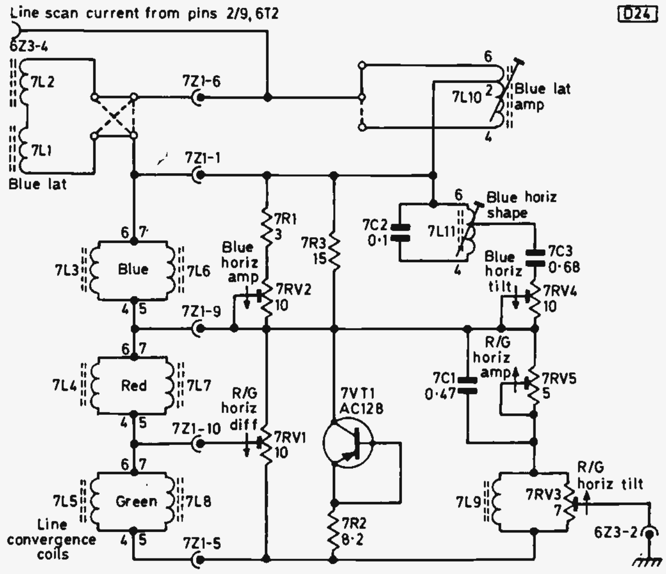


Fig. 6: Horizontal convergence circuit.

coil the other must then be adjusted to finally achieve balance. Rotate the cores slowly, because the minimum reading may be missed due to the damping in the meter. Reduce the meter range as adjustment proceeds, making the final adjustment on the 10V range.

(5) Return the h.t. voltage to normal by removing the added 390kΩ resistor and resetting 8RV1.

Fault Summary

It's possible for the line output stage to work after a fashion with only one of the line output transistors operational. This will result in an unusually large raster due to the low e.h.t. In addition to balancing the line output transistors, their base circuit series resistors 6R1/2 should be checked since they tend to change value. It's best to change line output transistors in pairs.

In addition to the line output transistors going short-circuit, several other components in the line output stage can cause the h.t. fuse 8F3 to blow. One is the tuning capacitors (6C5/6) previously mentioned, another is the c.r.t. first anode supply rectifier 6D2 and/or its reservoir capacitor 6C13 (in either case 6R7 will probably be burnt). Other causes are the horizontal shift circuit rectifier diode 6D3 and its reservoir capacitor 6C11, the scan-correction capacitor 6C3, shorting turns in the pincushion distortion correction transductor 6T3 (which may smoke!), and, not so common, short-circuit scan coils.

The tripler gives its share of trouble, from ballooning when the brightness control is advanced to no e.h.t. Depending on what's wrong within it, 6R9 may be found in a charred condition.

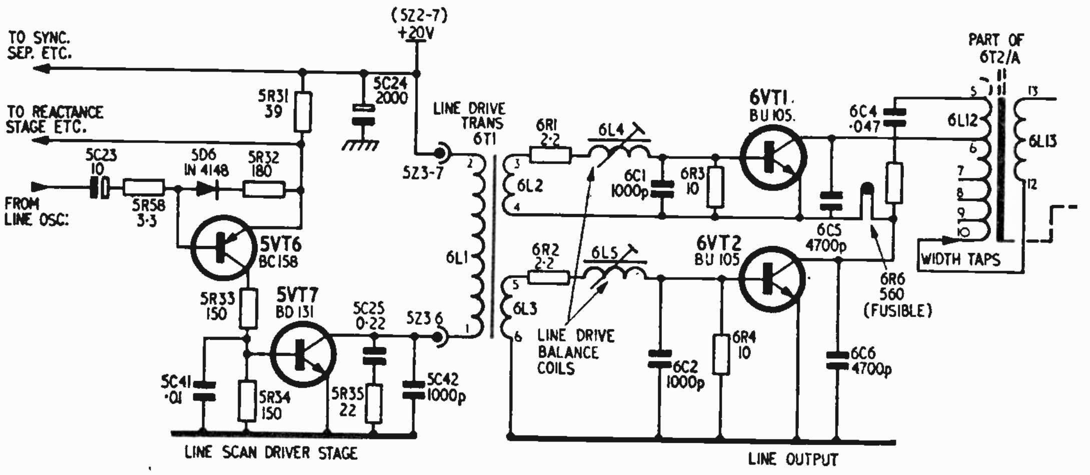
A not uncommon fault is a narrow picture (may be about 2in. wide), with smoke from the convergence board. The cause is the R/G horizontal tilt control 7RV3 on this board burning up – the line scan current returns to chassis via this control.

The old fault of striations across the screen is due to the usual cause – the linearity coil damping resistor, in this case 6R5. The striations are usually down the left-hand side of the screen only.

Focusing

Focus is effected in the now well-established manner, using a tapping on the tripler to supply a resistor chain

Fig. 7: Line driver and output stage modifications. In addition, 5R20 replaced by a 1N4148 diode, 5C43 (390pF) added from 5VT1 base to chassis, 6C9 changed to 5µF and 6D1 to type BY182, and 6L25 added between 6L17 pin 6 and 5Z1-5.



consisting of two 4·7MΩ resistors, 6R10 and 6R11, at either side of a variable focus unit comprising a VDR and a sliding contact tapping from it. The faults in this system are well-established too! If the top resistor in the chain (6R10) goes high, focus is lost and is outside the range of the control; whereas if the other one (6R11) gives up, the full output from the tripler is allowed to reach the c.r.t. unattenuated, usually causing the spark gap 4SG3 to burst into flame and melt. Occasionally the series resistor 4R8 goes high, and this should always be checked when investigating focus faults.

TO BE CONTINUED

Service Notebook

G. R. Wilding

Fuse Failure

After working normally until switch off the previous evening, a Philips colour set fitted with the G8 chassis was found to be completely dead the next day. This is common enough of course, and is usually due to the switch-on surge blowing an elderly fuse or causing an ageing component in the power supply to break down and blow the fuse. Inspection showed that the 3·15A mains fuse was open-circuit and blackened internally, but the usual cause of this in these models, the BT106 thyristor rectifier, was o.k. No other fuses were blown, and there were no signs of any damaged components nor of any short-circuits, so we replaced the fuse and switched on. The result was a good picture and sound. The static and dynamic convergence were somewhat away from optimum however, and as a test card transmission had conveniently commenced we spent quite some time adjusting the magnets and presets.

As usual with a fault of this nature, we then switched the set off and on several times to see whether the new fuse might blow. We then switched off and replaced the back. On switching on again – no results! The mains fuse had blown, but as before there were no signs of a short in the BT106 or anywhere else. Since these thyristors do commonly break down after some years' service however we fitted a replacement. Some weeks later there has been no further call for service so it seems that the original must have been shorting intermittently.

Loss of Sound

One of the few stock faults on Decca hybrid colour receivers (series 10 and 30) is complete loss of sound from the PCL82 audio circuit. In most cases it will be found that the valve is running quite cool, due to the wirewound resistor R82 on the power supply panel being open-circuit. The resistor is not of the same value, nor used for the same purpose, in the various versions of these chassis however. In the 17in. Model CS1730 and the 10 series chassis it's 12kΩ and supplies the pentode section's screen grid and the triode anode's 220kΩ anode load resistor. In the later 30 series chassis, with the vertically mounted tuner, R82 is 1·8kΩ and feeds the screen grid and both anodes. The best way to change the resistor is first to unclip the vertically mounted timebase panel, after which it will be found readily accessible on the horizontally mounted power supply panel.

Failure of this resistor is generally due to ageing, but in several cases I've found that after replacing it and retesting the sound quality soon deteriorated. The cause was a leak in the 0·1µF coupling capacitor (C82) between the two sections of the valve. As a result it was also necessary to change the valve and the pentode section's bias resistor.

Philips 210 Chassis

A dual-standard Philips monochrome set fitted with the 210 hybrid chassis produced a very elongated picture, especially in the top half of the screen. The main and top field linearity controls had only marginal effect, so clearly there was something wrong with the negative feedback loop used to provide field linearity. There are several components involved here, the source of the feedback being a tertiary winding on the field output transformer. Unfortunately the winding turned out to be open-circuit, necessitating a replacement transformer.

There are many tens of thousands of these sets still in service and, apart from the two droppers which develop open-circuit sections more than most, they've proved very reliable. The right-hand section of the left-hand dropper, R1544, is particularly vulnerable since it consists of many turns of fine wire to give a resistance of 2·85kΩ. It's used to drop the h.t. supply to a voltage suitable to feed the transistor circuits. In cases of an unmodulated raster with no sound therefore, first check R1544. I find it's worthwhile carrying exact replacements for both droppers: there's no temporary substitute possible for R1544, while there's insufficient room under the heat dissipating plate to satisfactorily mount those resistors which are usually so useful for bridging open-circuit dropper sections.

TV Servicing: Beginners Start Here...

Part 3

S. Simon

HAVING looked at how valves use a controlled flow of electrons to provide amplification, we will now take a look at the heart of a TV set, which is of course the cathode ray tube. This again makes use of a flow of electrons, but this time to provide a visual display. The idea is to find a material which will glow when struck by a beam of electrons, and to coat this on to the inside of the front of an evacuated glass envelope. This can be of any size, but as we are all familiar with domestic TV we need not describe the appearance of the front end since this is what we look at for a good deal of our lives (for better or worse). We can call this the display end.

Several things are necessary to obtain a readily identifiable picture on such a screen. First we need and have got a thing called persistence of vision. This simply means that we see light for a fraction of a second after it has actually gone. Thus we can "see" a complete image or picture which is actually made up of a quickly moving series of "pieces", be they dots, lines or one of those seaside pier peep shows of what the butler saw. In our case a concentrated beam of electrons is required to produce a glowing spot on the screen, and this spot must be moved rapidly across the screen to produce a line, then flying back to repeat the process a fraction lower down the screen and so on until the whole screen has been scanned.

This produces a nice bright plain raster of lines quickly enough to enable the process to be repeated with another set of lines interlaced between the first set, so that you have to look carefully in order to see the line structure. You may say why not make the spot bigger so that you cannot see the scanning lines. The snag with this is that detail would be lost. In other words, the definition would be impaired. So you must have a small spot and it must work overtime in order to produce a well defined picture.

Now bear in mind that to start with we are talking about a monochrome or black and white picture. The actual white depends upon the chemicals on the screen face and the number of electrons which hit them at any given moment. Thus by reducing the number of electrons we can obtain varying shades of grey down to black, where no electrons hit the screen at all. Just as in the valve, we heat a cathode which emits electrons which speed toward any electrode which is positive (lacking electrons). In this case however we require a concentrated spot, so we want an electrical "lens" which will converge the electron beam on a particular point at a particular time, while at the same time being varied in intensity to give the light output required from each part of the screen.

Instead of a control grid in the form of a wire mesh, we need a disc with a hole in it or a tube with a hole so that, as we vary the potential on this disc or tube with respect to the cathode, the number of electrons passing through the hole is controlled (see Fig. 1).

Then we need an accelerator to speed things up a bit (this is normally called the first anode), a focusing electrode to get the beam down to the right size by the time it reaches the screen, and a final anode with a very high potential to really fling the electrons at the tube face. There is room for variation in the design of this gun assembly, but this is a very crude idea of the general pattern of events from the cathode to the tube face.

Deflection

At the same time that all this is going on, we must move the electron beam horizontally to produce the lines and more slowly from the top to the bottom. When the spot has been deflected to one side it has to flyback at a high speed as we said before. Also, when it reaches the bottom it must flyback quickly to the top. Thus we have a line flyback and and field or frame flyback. Obviously the spot would cause a visible line which is not required while flying back, and this is suppressed either by reducing the grid voltage at this time, raising the cathode voltage (which amounts to the same thing), or by turning off the first anode. You could call it flyback suppression or blanking if you will.

You could now say that we have left out the electrodes which deflect the spot horizontally and vertically. This is true, and indeed there are such electrodes in some types of tube used mainly in oscilloscopes (this is electrostatic deflection). We have enough to think about with our domestic TV however, so we will not go into specialist tubes. Our type of deflection is obtained electromagnetically, from a slab of coils on the tube neck secured well up to the bowl of the tube. The rising and falling currents through these scan coils produce electromagnetic fields which deflect the beam horizontally and vertically.

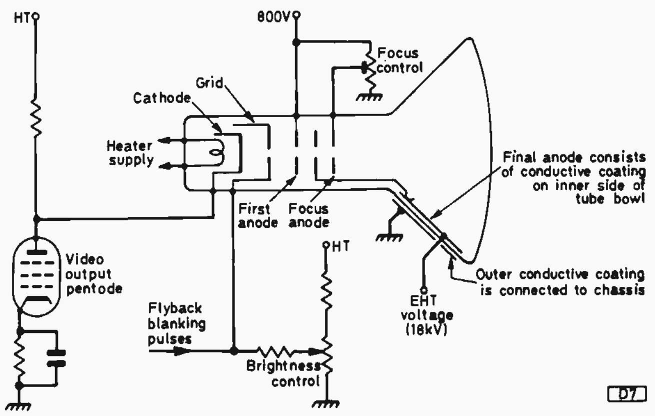


Fig. 1: The electrodes in a monochrome tube, and a simple drive circuit. The output pentode is direct coupled to the c.r.t.'s cathode, with the grid returned to the brightness control which sets the bias applied to the tube. It should be adjusted to give the correct black level: the brightness range will then be correct. The flyback blanking pulses are negative-going to cut off the beam at the grid.

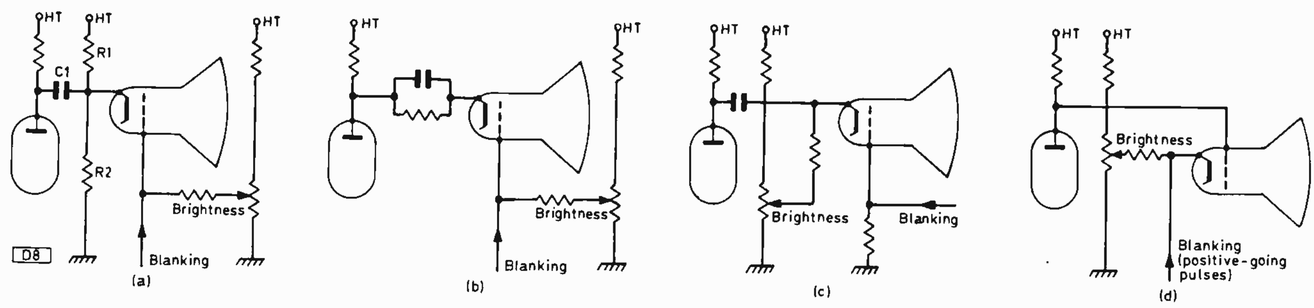


Fig. 2: Alternative tube drive arrangements to that shown in Fig. 1. (a) A.C. coupling (C1) to the cathode, with a fixed potential divider (R1/R2) to set the d.c. voltage level: the a.c. drive signal is superimposed on this d.c. level. The tube's bias is determined by R1/R2 in conjunction with the brightness control. (b) Partial a.c. coupling to the cathode. (c) A.C. cathode coupling, with the brightness control this time setting the d.c. voltage at the cathode and the grid used for blanking. When not being blanked, the grid is at chassis potential. (d) Applying the video drive signal to the grid, with the brightness control in the cathode circuit.

The current flowing must build up in a linear manner and collapse very rapidly, hence the use of a sawtooth waveform as mentioned last month.

Operating Voltages

We've mentioned the electrodes which make up the gun assembly, now what about voltages? The final anode must have a very high potential in order to get the electron beam moving at the high speed necessary. If this voltage falls, the beam will slow down and the picture will appear larger and lifeless. The final anode potential is called the e.h.t. or extra high tension voltage. A typical figure for a monochrome tube with a tube face diagonal of some 50 centimetres or 20in. is about 18kV or 18,000V. We shall see how this high voltage is obtained later.

Now voltages like this can jump about a bit, and this is why the e.h.t. connection is in an isolated position on the tube bulb with nothing but plain glass around it. This connection can retain a high voltage when the source is no longer working: it must be discharged therefore before any attempt is made to touch it. A lead or other conductor should be connected from the outer graphite coating to the cavity connector on the tube, preferably more than once. The reason for the retention of voltage at this point is the capacitance formed by the inner and outer graphite coatings of the tube bulb. This capacitance is necessary in order to smooth the e.h.t. which would otherwise have a fairly high-frequency ripple on it.

The first anode does not require such a high potential but is potent nevertheless. A figure of some 600V-1kV is fairly typical and this can be connected to the tube base, say to pin 3, without much risk of it jumping across to an adjacent pin.

There is often a spark gap between this (and other connections) and a chassis point however, in order to discharge any sudden increase of voltage (caused by say a spark from the final anode inside the tube). This spark gap is much narrower than the distance between the tube pins, so as to provide a more inviting path. The other side of the gap not only goes to a chassis point but also as a rule directly back to the outer coating of the tube, in order to provide the shortest route back to the source. This avoids the possibility of damage to some sensitive components which might not like the less direct chassis route. Readers may think that this is unnecessarily fussy, but bitter experience has shown that funny and nasty things can happen when the e.h.t. or a small part of it suddenly appears where it shouldn't.

The voltages at these anodes must be kept steady for good picture presentation, and obviously so should the focus voltage. In order to vary the beam current (to provide our picture information) however there must be a corresponding variation of potential between the grid and the cathode. If the grid is held steady at say zero voltage – except for flyback blanking pulses – the cathode must be made to vary say above and below some 100V which is its bias voltage. Below this it will be approaching the grid voltage and therefore the screen will be brighter at that point (the grid will be less negative with respect to the cathode, and more electrons will pass). As the cathode is swung higher so the beam current is reduced as the grid is then more negative compared to the cathode. The picture at that moment becomes darker therefore. It's all a matter of timing you see.

The alternative is to keep the cathode at a steady voltage and apply the picture information voltage swings to the grid, and if you don't get the direction of the voltage swings right you have a lovely negative, i.e. black shirts and faces, with white suits and hair (except for blondes that is).

One method of driving the tube is shown in Fig. 1: some alternatives are shown in Fig. 2.

Tube Defects

Having had a brief look at the inside of the everyday monochrome tube we can discuss some of the things which stop it working properly. One sure way of stopping it working completely is to crack the glass. It is pretty difficult to crack the front. When this goes it really goes and you shouldn't be around when it does because thick, razor edged glass flying at high speed is pretty lethal.

There is a tendency for modern sets to be front heavy, and they don't need a lot of push therefore to make them fall forward. Normally this doesn't crack the face (don't bet on it though): instead, the tube is pushed violently back into the cabinet and it is the fragile base end which is broken. When this happens there is a violent rush of air into the tube, and this often destroys the coating on the inside of the tube face. You are then privileged to look through the front into the innards. This is all pretty obvious however so we won't dwell upon it.

Another less common defect is when an electrode (usually the grid or cathode) becomes internally disconnected. This usually results in a very dim raster which cannot be controlled. Some makes of tube seem, or seemed, to suffer from this defect more than others, and although attempts may be made to weld the connection by applying a high pulse voltage this approach is usually doomed to failure and the only answer is to have the tube rebuilt with a new gun assembly.

Far more common is loss of emission as the cathode surface becomes coated with impurities which harden over the emitting surface. As a general rule this happens in tubes which do not possess the high degree of vacuum that others do. Anyone concerned with servicing over a period of years can specify the life expectancy of various makes of tube. He may well be wrong sometimes, but nine times out of ten he will be right. This all revolves around care in manufacture.

Whatever the merits of this however, it doesn't help when one is faced with a tube that is not very old but displays the classic symptoms of blurred and pearly whites which can be helped only by turning down the brightness to reduce the demand on the emitting ability of the cathode. The blurring occurs due to the lower vacuum leaving traces of gas which impede the electron beam and defocus it.

Several designs of tube reactivator have been described in these pages at various times, but basically there are two methods. One is simply to overrun the tube heater by say 20%, either by using a separate transformer or in some cases by connecting a resistor from the supply mains to one pin of the tube heater. The other involves applying a fairly high voltage to the grid for a very short period so that this attracts a fairly heavy current from the cathode. The idea is to "pulse" the cathode surface and uncover a fresh emitting surface. Although this does not help the lack of hardness of vacuum, i.e. the tube is still basically soft, the electron emission is improved however – perhaps for only a short period – and the picture quality is therefore improved.

A fault which can give rise to the same (or very similar) symptons is a defective heater element, where part of it shorts across to another part thereby lowering its effective resistance and thus developing a correspondingly lower voltage. The visible sign, looking at the heater, is that it does not glow at its normal intensity. The net result is that it is no longer able to heat the cathode sufficiently and therefore the electron emission is drastically cut. A sharp tap on the tube neck will often clear the short, albeit for a short period (or a long one if you are lucky), and the picture then comes up just as bright and crisp as ever as the electron flow is restored. Again however the only sure remedy is tube replacement.

Once in a while we still encounter yet another fault which at one time was very common. This is a cathode to heater short-circuit. Since the heater is at a low voltage (quite often one of the heater pins is connected direct to chassis), the cathode is not only robbed of its picture information (assuming that the cathode and not the grid is fed with the video signal) but it also loses its positive bias and there is therefore no control of the electron beam, leaving a bright white raster if the e.h.t. supply can cope with this current demand. If it can't, the result could be a large defocused and dim raster with a dark patch in the centre, or simply no raster at all. Once again, a voltage check on the tube base will reveal the absence of cathode voltage.

There are several ways of coping with this, one being to change the method of tube bias and signal feed. We will not go into this however as it's of limited interest and there is a simpler alternative. This is to supply the heater from a separate transformer with a very low capacitance between its two windings. The primary winding must be suitable for 240V a.c. input, with the secondary wound to give the required tube heater voltage (say 6·3V, but with perhaps an extra tapping for a 20% boost should this be required). The existing heater leads are removed from the base and joined together to preserve the heater chain continuity. The transformer secondary is connected to the tube's heater pins and the cathode can then be directly connected or left as it is with a resistor (say 100kΩ) wired to the heater to keep the heater winding at the same voltage as the cathode. With the voltage difference removed the short may no longer occur, but this is of little consequence since the low capacitance between the windings will not rob the cathode of its picture signals. An ordinary close-wound transformer has a large capacitance between its windings and this would have the same effect as wiring a capacitor from the cathode to chassis, i.e. it would short-circuit the varying picture signal voltages above a certain frequency and result in a very smeared and unacceptable picture. All this may be of limited interest as you may never encounter this type of fault, but it's as well to cross the tees and dot the eyes (oh dear) as it may help in the basic understanding of how tubes work and why they sometimes don't.

Colour Tubes

We don't wish to jump the gun as it were and get too complicated at this stage, but it's logical to have a brief look at colour tubes next. A short while ago only one type need have been described, but the scene has changed and there are now so many that we don't propose to attempt to describe the basics of them all.

Instead of the one gun required to scan the monochrome tube face, we need three separate cathodes, each to activate one basic primary-colour phosphor on the tube face (see Fig. 3). The phosphors (red, green and blue light emitting) can be deposited on the inside of the tube face either as groups of dots or in vertical stripes.

It's obvious that one particular cathode must have its beam directed to one particular colour only, and must not overlap on to another. This is no easy task. To put it another way, if we switch off two of the beams, say blue and green, the colour produced by the remaining beam must be red only, with no patches of impurities anywhere on the screen. To achieve this, steering (purity) magnets are provided to accurately direct the beams through certain holes or slots in a mask (the shadowmask) which is mounted just behind the screen. This ensures that only the correct phosphors are activated. Similar magnets are found on monochrome tubes, just behind the deflection coils, in order to move the picture vertically or horizontally. They are in the form of discs which can be rotated with respect to each other. Picture shifting has to be done by other means in colour receivers.

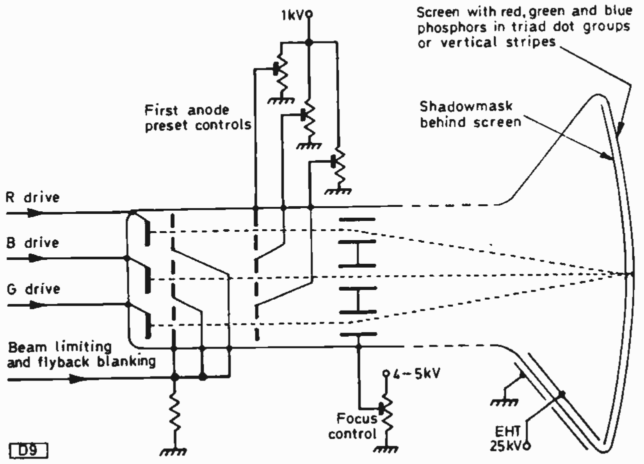


Fig. 3: Basic colour-tube drive arrangements, excluding the deflection and convergence systems. In some tubes the grids and the first anodes are connected together internally. Some smaller tubes operate with a lower focus voltage. In some earlier receiver designs video signals were applied to the cathodes and to the grids as well.

It will be clear that the electron beams in a colour tube have a much harder life since not all the electrons find their way through the holes in the shadowmask. In fact most of them hit the mask, their energy being expended in the form of heat. This is not only a waste but as the heat distorts the mask the problems are compounded. More can get through slots to activate vertical stripes than through holes to activate dots: that's why this newer type of tube has a higher light output although the detail is not quite so good.

Now this is only the start of the troubles. You cannot have three guns in exactly the same position. With the dot formation the guns are mounted in a triangular formation and for the stripe formation they are side by side horizontally. Since the guns are not in the same position, the beams will have to travel along different paths to reach different parts of the screen. Unless correction is applied, the resultant red, green and blue pictures will not be correctly superimposed. This means that there must be quite a bit of beam bending, slowing up and speeding up and other correction, in order to get reasonable convergence. In the case of the triad tube, which has been the norm until recently, this is a formidable task needing many convergence controls and circuits. A good deal of interaction takes place, and complete convergence setting up is an operation that requires a lot of patience and a fair amount of experience if acceptable results are to be obtained. A glow of self satisfaction is well deserved when a good black and white picture can be displayed on the screen of a colour tube. We will delve a little deeper into this, and into grey-scale tracking etc., later in the series.

The more recent receivers with in-line gun tubes do not require such a high degree of correction and therefore life is a little easier although, as we shall see, it gets far more complicated in some other respects.

Colour tubes are heavier than monochrome ones and require more care in handling. They also have more external hardware, such as degaussing coils to demagnetise the shadowmask (otherwise the mask itself will deflect the electrons, which are supposed to pass through it), very carefully designed scan coils, and other devices varying according to the type of tube.

TO BE CONTINUED

Aerial Review: Plemi 103-element Array

Hugh Cocks

I recently had the opportunity to test a 103-element u.h.f. array made by the Dutch firm Plemi. The 103-element aerial consists of 25 multiple director units, a dipole, reflector and launch director.

Our test aerial covered channels 21 to 51, but the gain did not fall off until channel 57. It was a massive aerial indeed, being some 12ft. 3in. long. Various groups are available, matching the British groups A, B and C, plus a wideband version. Peak gain is claimed to be 18.9dB, which on our aerial occurred between channels 40 and 50. Due to the size of the array two support booms are used. The aerial is surprisingly light for its size however, due no doubt to the light gauge metal elements employed. The large grid-type reflector used results in an extremely good back-to-front ratio, and the aerial also has a very narrow beam width.

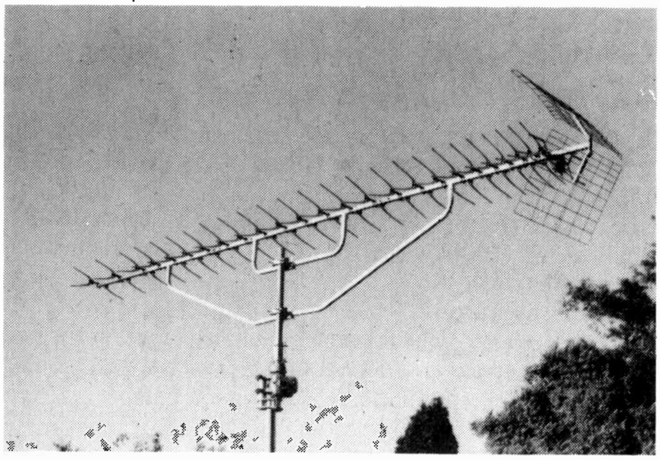
The results obtained with the aerial were very encouraging. With most of the aerials tried here the French television transmissions from Le Havre on channel 40 are almost swamped by the vertically polarised signal from Weymouth. The Plemi aerial gave the best results seen to date on this channel. Even on a test pole about 10ft. above ground the Channel Islands transmitters were pulled in at a similar strength to the main aerial at 35ft.

The aerial elements are pale green in colour and the reflector matt black. Once installed on the roof with the sun shining on it the aerial is a sight to behold!

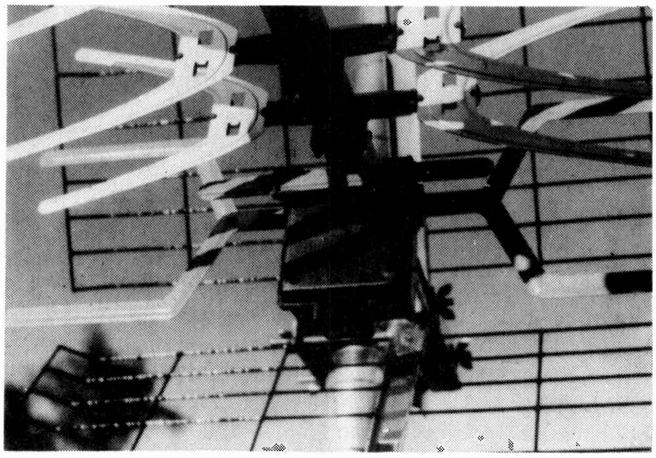
Our only criticism is of the dipole insulation box which would tend to let water in over a long period. We would recommend thoroughly greasing the inside of the box and taping it over thoroughly outside in order to avoid the demon moisture. But I would certainly advise anyone in the market for a good high-gain aerial to consider this new product.

Pricewise the aerial competes well with UK produced aerials. Plemi also produce smaller versions of the aerial. Those interested can obtain further details from: Eastern Antennae, 87 Norwich Road, Ipswich, Suffolk IP1 2PR.

The Plemi aerial range has a five-year guarantee against faulty materials/workmanship and normal weather hazards.



The Plemi 103-element u.h.f. aerial has 25 multiple directors, a launch director, X-dipole and reflector.



Close up view of the dipole and the feeder connection box. The launch director is just in front of the dipole.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

SEPTEMBER is traditionally good for trophospheric reception. This year there was a good opening into central Europe from the 10th to the 14th. A relatively static high pressure system provided the right conditions, and from reports coming in it seems that signals were mainly from southerly and south-eastern directions.

Several East Anglian DXers have reported reception from Switzerland and Austria. Clive Athowe logged the Pfander ORF (Austria) transmitter on Band III and at u.h.f. on the 13th, along with many Swiss stations. The signals continued on the 14th, with yet more Swiss ones and DFF (East Germany). David Martin (Dorset) and High Cocks (Devon) had similar successes, but with reception from RTVE (Spain) at both v.h.f. and u.h.f. Hugh logged an RTVE transmitter on ch. E6 – the only high-powered one below 40°! Hugh seems ideally placed for Spanish reception, since he received the ch. E3 and E4 transmitters on an omnidirectional Band I array. David logged RTVE on the 11th, during the morning, on chs. E3, 4, 5, 7 and 11, followed by strong Swiss u.h.f. signals.

It's interesting that W. Germany, usually a good source of strong signals during a tropospheric opening, was generally absent, all reception of consequence coming from the south/south east following the prevailing isobar pattern. David is now using a u.h.f. double-backfire array which was previously on my own mast. It was erected at Shaftesbury to reduce the effects of a new source of interference – a nearby relay operating in the group A section of the u.h.f. spectrum. The side-stacked backfire is working very well, giving deep lobes so that weak signals can be received and also providing a wide capture area. This is often a greater asset than using a single long, high-gain Yagi, with its high gain concentrated in a reduced capture area.

RTVE ch. E4 was logged here at Romsey on the 10th, a difficult signal for me since any tropospheric signals from this direction are effectively screened by the Abbey, its recently releaded roof providing an efficient signal screen! Although I carefully tuned over Band III and the u.h.f. channels on the 11th there was no sign of RTVE, but several W. German Band III and u.h.f. signals were noted. On the 14th there were strong TDF (France) Band III and u.h.f. signals, giving the usual identification problems.

There was little Sporadic E reception during the month. TSS (Russia) and MTV (Hungary) chs. R1 and R2 were present on the 3rd, while TSS was also present on the 7th and SR (Sweden) ch. E2 on the 8th.

Reception here is at present being disrupted due to re-arrangement and construction of a DX-TV room. This should ease domestic problems, and I hope to be operational again within three weeks. Monitoring during the early morning period has ceased until the new lines are ready.

News Items

Satellites: The first OTS 12GHz experimental satellite was unfortunately destroyed on take-off. The replacement isn't due to be launched until early Spring.
Poland: The Krakow TV centre is now producing SECAM programmes – previously only Warsaw provided network colour. It is anticipated that most of the country will have TVP-2 coverage by 1980.
Spain: RTVE is extending its u.h.f. coverage with four new transmitters. A high-powered transmitter at Mijas will come into service in 1978 to relay programmes to Southern Spain and North Africa.
Bahamas: Radio Bahamas will be opeing a new station (on ch. A13, system M) at Nassau in Autumn 1977 to establish the first colour service in this area. Its coverage will include the neighbouring islands of New Providence and part of the Family Islands. RCA have been awarded the main contract for studio equipment through to the transmitters.

In Brief . . .

Caen, TF1 France on ch. F2 has been noted using 625-line tests with PAL colour information . . . Sendz Components (2, Wood Grange Close, Thorpe Bay, Essex) is selling a brand new varicap v.h.f. tuner of Telefunken origin with coverage from below ch. E2 to approximately 105MHz in Band I and with a Band III coverage from 140-230MHz. These were apparently made for the Australian market. This is obviously the answer for DXing and for coverage of the elusive Band II TV spectrum and chs. R3, 4, 5 and IC. Previously coverage of Band II has been either via an upconverter or a Mullard ELC2000S tuner. The price is around £1.50 + VAT. Apart from a 12V supply, the gain control feed needs 8V for maximum gain down to 3V. I expect these will soon sell out!

New Dutch Programme Network

The NOS-3 network is to commence in 1980. The channel allocations (thanks Gosta V.D. Linden) are as follows:

Goes ch. E7 (formally NOS-1)
Lopik ch. 30 (1000kw erp)
Roermond ch. 34
Wieringermeer ch. 42.
Smilde ch. E44 (1000kw)
Arnhem ch. 58
Markelo ch. 51

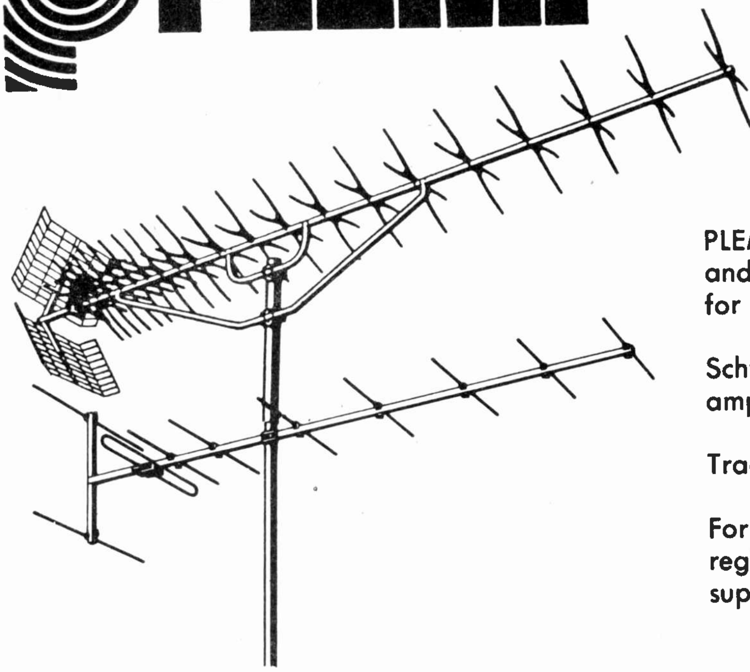
There are also plans for a large number of relays for both the NOS-3 service and the existing NOS-2 network, mainly low powered except for Den Helder on ch. E10.

Algeria

Pierre Godou (Rennes) has kindly sent us information on

PLEMI

WHEN PERFORMANCE MATTERS!



PLEMI 'color cross' UHF Tv, Bands I & III, and FM stereo aerials – all guaranteed for FIVE YEARS!

Schwaiger mast-head & distribution amplifiers and accessories.

Trade & Wholesale enquiries welcome.

For full literature, prices, and details of regional stockists and Mail Order suppliers contact the UK distributor:

EASTERN ANTENNAE 87 Norwich Road, Ipswich, Suffolk IP1 2PR
Tel: 0473 217217

CATRONICS FOR ALL THE LATEST COMPONENTS

for the Television

TELETEXT DECODER

SPECIAL PRICE COMPLETE KIT

£215

+ £2 P & P.

★ All the kits for this project are now available from CATRONICS all backed by Catronics Ltd. exclusive FOUR STAR SERVICE

★ ALL THESE SPECIAL PRICES INCLUDE VAT!

Catronics Guaranteed kits contain all components required for the specific unit, INCLUDING A REPRINT OF THE ORIGINAL ARTICLE, plus the PCB as indicated.

Kit	Incl. PCB	Less PCB	P & P
POWER SUPPLY UNIT	£26.75	£23.80	£1.00
INPUT LOGIC CARD	£25.85	£16.05	20p
MEMORY CARD	£30.80	£22.90	20p
7 sockets for 2102 i.c.s. – extra £1.60			
DISPLAY CARD	£34.65	£26.65	20p
MOTHERBOARD etc. ex. mod.	£29.75	£24.50	20p
MODULATOR Pre-aligned and tested		£17.00	20p
I.F. CARD	£34.00	£28.00	20p
CABINET – Ready Punched		£21.30	£1.25

Components are also available separately:

Thumbwheel Switch – £7.00; Push Button Switch Assy – £4.20; 32 way Edge Connector – £1.95; 47K 20T Cermet Pot – £1.10; ELC1043/05 Tuner – £9.15; SAW Filter – £2.85; SFE6 OMA Filter – 93p; BYZ13 – 70p; 1A Bridge Rectifier – 40p; 10,000mfd 16V capacitor – £2.75; Illuminated Mains Switch–£1.40; Mains Transformer – £6.25 (+ £1.00 p & p). 7805 – £1.50; 7812 – £1.50; 2102–£2.65; 74S262N–£17.00. Please add minimum 20p P & P.

See Price List for details of other components, incl. 7400 series i.c.s.

Catronics

CATRONICS LTD. (Dept. 762), COMMUNICATIONS HOUSE, 20, WALLINGTON SQUARE, WALLINGTON, SURREY SM6 8RG. Telephone: 01-669 6700.

SYSTEMS PLANNED FOR TV & FM SHOP DISPLAYS, HOUSE SYSTEMS, SMALL BLOCKS OF FLATS. ALL PARTS SUPPLIED (PARTS EXCHANGEABLE) 10% OFF ALL AERIALS, ACCESSORIES & ROTATORS. AFTER SALES ADVICE – ORDER OVER £25 CARRIAGE FREE.

A really personalised mail order service but S.A.E. PLEASE!

Stockists of:
FUBA TV & FM aerials also AM/FM aerials (W. Germany)
PLEMI TV aerials (Holland)
JAYBEAM TV & FM aerials
ANTIFERENCE TV & FM aerials
UKW FM aerials (E. Germany)

PLEMI

The amazing PLEMI TV aerials now stocked. High gain, anodised, yet no dearer than home produce.

ASTRA (D.I.Y.) AERIALS

GENUINE D.I.Y. AERIAL SPECIALISTS FOR ALL BAND TV RECEPTION ALSO FM/stereo RECEPTION: AM TOO

Backed by 23 years' practical aerial rigging experience

We can advise you of aerials needed for the entire U.K. Give us five minutes and we can advise you on which Band, which Channel, which aerial for any country in the world. We stock all ancillary parts to match. Also amplifiers to suit all Bands.

AERIALS & PARTS EXCHANGEABLE UNTIL SATISFIED. WHOLESALE SUPPLIERS TO THE TV & FM TRADE.

Over 2,500 aerials stocked: All Bands: also Set-Tops: Masts: Lashings: Wall Brackets: Rotators: Televertas: Diplexers & Triplexers (specially imported) for mixing variously. Bands 1, 2, 3, 4 and 5: Distribution and mast-head amplifiers: 2/3/4 way splitters: Padded outlets: Directional splitters: all types coax cable: quality 300 ohm cable.

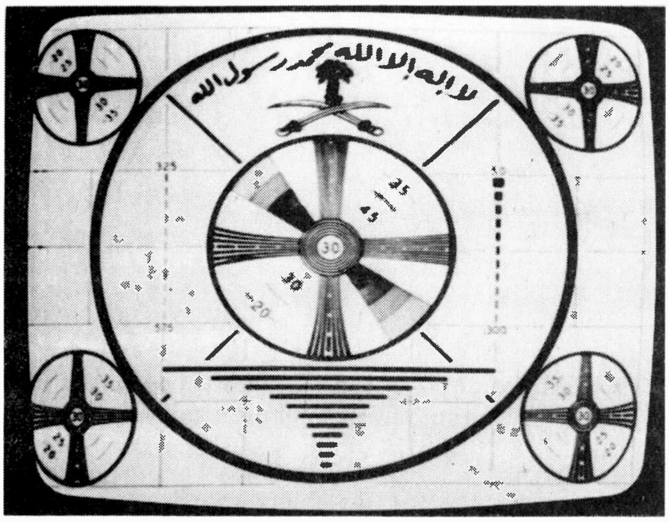
Many of our customers come from recommendation.

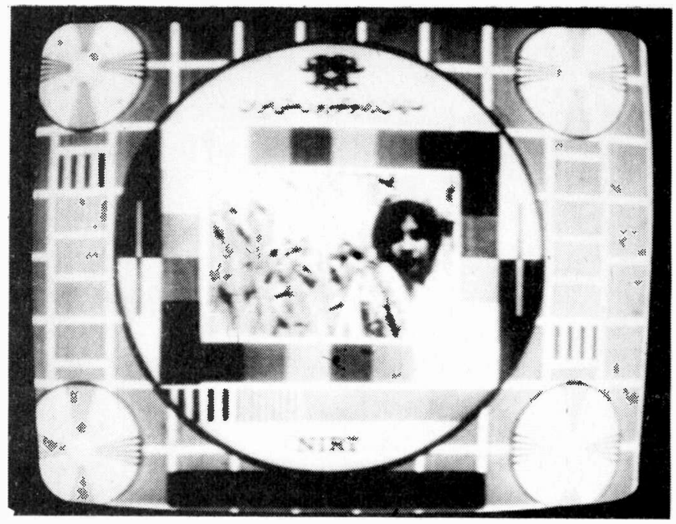
53 WHITEHORSE ROAD, CROYDON

Nr. Gloster Pub & Garage
Open 9.30-5.30 MON-SAT
Open lunchtime

Tel: 01-684 4300
01-684 5262
24 hr. answering service

FM & TV AERIALS AND ROTATORS ON DISPLAY





Further test cards received by Allan Latham during his recent visit to Abu Dhabi. Left, the Dahran ch. A2 station HZ22 Indian Head test card – with arabic identification replacing the Indian Head. Right, the NIRT, Iran test card used on chs. E8, E3 and E4.

the Algerian TV Service (RTA). System B is used, in Band III, and colour tests are being made with both SECAM and PAL. Almost all the country is served, helped in part by a satellite telecommunications network based on an Atlantic Intelsat leased channel. More relays have brought TV to the south of the country. RTA transmits 65 hours of programmes a week, in both Arabic and French. At the end of 1975 410,000 TV receivers were in use.

FM Video Demodulator

Several enthusiasts had great success with the video signals from the ATS-6 Indian satellite in late 1975/76. In the June 1976 column we published a circuit using the Signetics NE561B phase-locked loop i.c. as built by Steven Birkill. Ian Smith has now sent us information derived from a Signetics application note. This enables the operating frequency of the device to be extended to 60MHz. The modification – see Fig. 1 (a) – is relatively simple, consisting of two 10kΩ resistors from pins 2 and 3 to chassis. Adding a further 5kΩ potentiometer as shown in Fig. 1 (b) provides a degree of fine tuning. Although there are at present no suitable satellite transmissions available, the PLL may form the basis of a 12GHz f.m. video demodulator when experimental transmissions start in 1980.

From our Correspondents . . .

Robin Williams (Stratford-upon-Avon) has been extremely active this Summer, using a Sony colour Model KV1800UB and the upconverter featured in the September 1976 issue. He has received signals from most of Europe via Sporadic E, his aerial being a simple ch. B4 two-element one. He also uses the surplus Plessey "radar" i.c. amplifier. He's also received various W. German tropospheric Band IV signals. This is encouraging since Robin lives relatively deep inland and uses no masthead amplification at u.h.f. A useful tip from Robin is that tourist areas often sell foreign newspapers which contain details of overseas television programmes and timings.

Desmond Hellier has been receiving DX-TV signals at his Hampstead flat using a modified Bush Model TV125 and a Pye Model 40F. We have sent modification notes to Desmond since the latter receiver tended to have poor field lock on weak signals. Desmond suggests (and we agree) that it would be a good idea for enthusiasts to send in details of any receivers they have modified as alternatives to the popular Bush TV125 series.

A. Jaques (Urmston, Manchester), a licensed radio amateur (G3PTD, formally G6ACW/T), has suggested that it may be possible for DX-TV enthusiasts to receive the various amateur transmissions (TV) in the 433-450MHz band either by tuning to the l.f. end of a conventional u.h.f. tuner or by slight adjustment of the tuned circuits. He says that TV Hams will be pleased to receive reception reports from DX-TV enthusiasts. If you decide to cover this band do not adjust the normal DX tuner but obtain another for realignment.

Brian Fitch (Scarborough) tells us that Swaziland is to commence TV transmissions next year from its capital town Mbabane. Either system B or I will be used, with mainly European equipment. Programmes will consist of local productions and British film/tape.

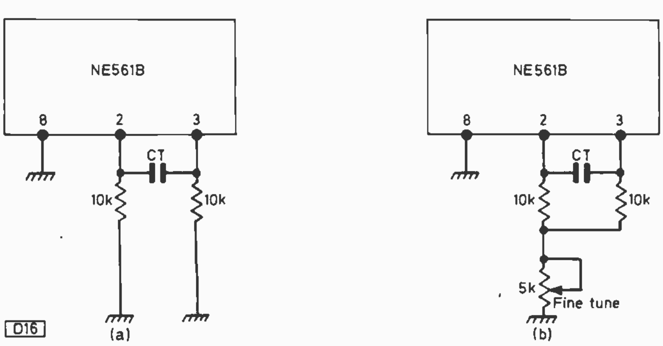


Fig. 1: Modifications to extend the operating frequency of the NE561B f.m. video demodulator circuit to 60MHz.

Auroral Reception

In a previous column I gave details of F2 propagation/reception since, with increasing sunspot activity as we continue along the upward part of the new sunspot cycle, there is an increasing chance of this. Such propagation depends on solar radiation, and can give reception over greatly enhanced distances. An associated phenomenon consists of an aurora, which produces variations in signal propagation and shows up visually as a coloured display in the night sky towards the north – appropriately known as the "Northern Lights" – or the south in the southern hemisphere. The display consists of a continually changing pattern of rays in colours from red to green, white and yellow, and from isolated rays to "great bundles of different colours".

The visual effect is as often as not obscured by cloud, but the secondary effect of v.h.f. back scatter can make reception possible up to Band III. The phenomenon is caused by solar storms, as a result of which a steady flow of ionised particles spiral outwards from the sun. They take about 24 hours to reach the Earth, and when they arrive they concentrate at the magnetic poles, causing severe disturbance to the Earth's outer radiation belts.

An aurora can occur at any time during a sunspot cycle, but there's a greater possibility of one during the more active periods, particularly at the equinoxes when the Sun's poles tilt towards the Earth. The equinoxes occur every six months, in early April and early October.

A characteristic of auroral openings is the two-phase effect, with an afternoon period and a late evening one. Either period may be the stronger, or both may be similar. Within each period there may be a tendency for the reception distance to gradually decrease and then increase again.

Unfortunately auroral reception gives poor quality signals. Due to the continually fluctuating state of the auroral currents, the signal may be diffused and reflected from several points, resulting in a poor quality video signal with multiple images and hum. There has been successful auroral reception in the UK from Finland and Sweden and stations in W. Europe however. The aerial must be pointed towards the north, $\pm 45°$.

Reception in Band I is easiest, and we've had one report in the past of transatlantic reception of a ch. A2 signal with the aerial pointing toward the north west. An intense aurora may allow propagation in Band III. Carefully monitoring the sound channel (a.m. if possible) should then reveal numerous rumbling and "zipping"noises. If an aurora is suspected at midnight when most European stations are off air, check carefully to the north west for possible reception of a Canadian signal.

The signals during an aurora sometimes tend to be concentrated in a particular direction rather than being a general, diffused back scatter from NW through to NE. With the aerial pointing north, a station to the east of the receiving site may be present. The main factor in successful auroral reception is vigilence: during peak periods, keep a careful check for such propagation by monitoring an empty local channel for evidence of the Scottish BBC-1 v.h.f. stations or rumbling noises as just mentioned. A check on the sun itself will reveal whether there are active areas, but we must again emphasize that instant eye damage will be caused by direct viewing with the naked eye or through a telescope or binoculars. If you can mount a telescope on a tripod, you can project the sun on to a white card in order to observe its surface clearly and safely.

VCR Servo Fault Finding

S. R. Beeching, T.Eng. (CEI), AMIERE

A PHILIPS N1500/15 videocassette recorder was brought into the workshop recently by a local TV shop which normally does its own repairs. It was said that the machine had been dropped, and whilst the physical damage had been tidied up there was a capstan servo fault which they'd been unable to resolve. To make matters worse, the owner's brother, who was a TV repairman, had also had a look at it....

I asked whether the servo lock fault was evident in the playback or record mode or both, and was told that the audio/sync head had been changed, the servo output transistors changed, etc., all to no avail. Some of this was evident at a quick glance at the butchered printed circuit board. I got no answer however to my question as to which mode the fault occurred in, but it was probably playback I thought as otherwise why would the sync head have been changed – the pulses from the sync track lock the machine during playback. The chances, now at least, were that the sync head was out of alignment.

Basic Principles

For those who don't know much about VCR servos, a brief description of the principles of operation of the system seems appropriate. The idea is shown in Fig. 1, and it will be seen from this that the servo has two inputs and one output – as with flywheel line sync. The reference pulses dictate the basic motor speed, the feedback pulses being used to hold the speed within fine limits. The output, which is proportional to the relationship between the reference and the feedback pulses, controls the actual motor speed. In the Philips VCR the two (head and capstan) motors are of the synchronous type and free run slightly faster than the required "locked in" speed (say 1,510 r.p.m. for a locked speed of 1,500 r.p.m). The servo systems drive current into the two braking coils, on the basis of more current, more braking.

In the record mode, the reference pulses are the field sync pulses from the off-air signal, the feedback pulses coming from the appropriate motor flywheel. Hence the speed is synchronised with the incoming video signal, any motor speed fluctuations being compensated for by the action of the servos in comparing the reference and feedback pulses from the flywheels. At the same time, 25Hz pulses (40msec apart) are recorded on the upper edge of the tape for replay purposes.

In the playback mode, the reference pulses are derived from the mains in order to synchronise the machine to a stable frequency source. The feedback pulses are those recorded on the sync track, picked up by the same sync head that recorded them. As the feedback pulses are derived from the moving tape, any speed changes will affect the timing of these pulses. As a result the servo systems will initiate the required compensating action. With the recorded sync pulses synchronised to the video signal and the tape speed locked to a 50Hz source (the mains), the video is replayed at the 50Hz field rate. Note that if a 60Hz reference say is used, the replayed video would be 625 lines at a field frequency of 60Hz. Hence the reason for not using something like a multivibrator, which may drift, as the playback reference source.

The Faulty Machine

Now back to the machine with the faulty capstan servo. On switching on I found that the reason for not getting an answer to my question as to whether the servo was unlocked in play or record was that there was no off-air signal due to a cracked tuner board! The previous repairs had had to be done in the playback mode therefore, resulting in the incorrect diagnosis of a faulty audio/sync head.

Initial Tests

When faced with a VCR servo problem, first do two important checks. Identify test point TP221 in the capstan servo circuit and test point TP220 in the head servo circuit. During operation, each should show a sawtooth or ramp waveform with a sample pulse on it (see Fig. 2) when checked with an oscilloscope. Put the machine in the record mode and tune in, with a cassette inserted. Do a short recording. If the pulses sit steadily on the slopes of the ramps the servos are o.k. Replay the recording and again check whether the pulses sit still on the ramps at the two test points. Any deviation discovered during these checks will indicate where the problem area is – capstan or head servo, on play or record.

In this particular case, having repaired the tuner board we found that all was well at the head servo test point. At the capstan servo test point TP221, well... First, there were two pulses instead of one (see Fig. 3); secondly they were running up the ramp and falling over the edge. This confirmed that the machine had indeed been got at. Experience counts here, and we knew the reason for the double pulses – someone had reversed the wiring on the

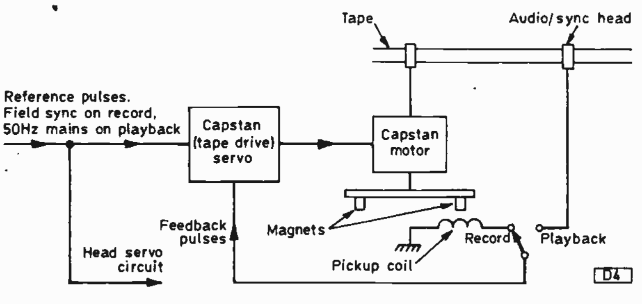


Fig. 1: Block diagram showing in simplified form the basic elements of the Philips N1500 VCR's capstan servo system. On playback the feedback pulses come from the tape via the audio/sync head. On record, the feedback pulses are obtained from magnets attached to the capstan flywheel: these induce a pulse voltage in the pickup coil.

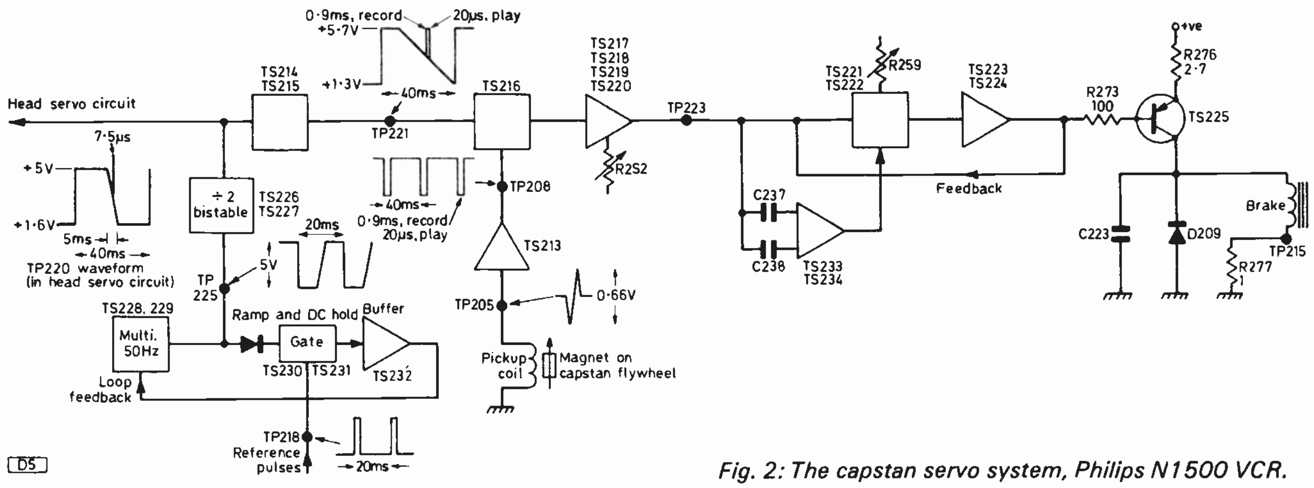


Fig. 2: The capstan servo system, Philips N1500 VCR.

capstan motor flywheel pickup coil/head. A quick rewire restored the single pulse, but it still ran up the ramp. Now the ramp is derived from the sync pulse and is steady, while the pulse comes from the capstan motor flywheel: the fact that it was running up the ramp showed that the motor was running fast, i.e. no servo braking.

Tracing the Fault

A more precise measurement is required next. First, check whether the ramp and the sync pulses coming in at TP218 (see Fig. 2) are synchronised by comparing the waveforms at TP221 and TP218 on a dual-beam scope. If they are not synchronised, the trouble is in the 50Hz multivibrator and its phase locked loop, or the divide-by-two bistable circuit. In our particular case the waveforms were synchronised, thus eliminating these areas.

The next point to check is TP223. The feedback pulse samples the reference ramp derived from the sync pulse and provides a d.c. voltage, buffered by the sample and hold circuit TS217-TS220, at TP223. With our fault conditions you would expect to find here a d.c. voltage that slowly rises and suddenly falls, representing the pulse running up the ramp and falling off the top. No reading would indicate a fault in the sample-and-hold circuit. Don't twiddle R252, as it can be set only when the servo is properly operational. The same goes for R259. There was a rising and falling voltage at TP223, so everything was all right up to there.

Due to the voltage conditions in the following section it's more difficult to see anything much, even when the servo is working. The main part consists of two d.c.-coupled differential amplifiers TS221-TS224 which are used for the small phase changes required. There is partial bypassing by TS233-TS234, which are a.c. coupled and are sensitive to the large changes in level when the servo is well out of lock, such as at switch on. They drive hard into the locked condition. The pulse falling off (or leaping up) the edge of the ramp is a large enough change, so this part of the circuit can be temporarily eliminated by disconnecting C237/C238.

Having done this however the fault was still present and the d.c. level change noted at TP223 continued through from TS221 to the output transistor TS225. This was removed and checked, but turned out to be all right. Continuity through the brake coil was checked, then D209

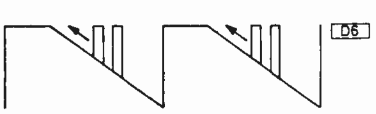


Fig. 3: The fault condition: waveform monitored at TP221.

and C223, but all were cleared. To summarise the situation: all transistors were o.k., the voltage and current variations seen at TP223 appeared at the collector of TS225 and, although small, across R227 via which the brake coil is returned to chassis. So the servo was working: why no lock? I decided to measure the brake current, which turned out to be 89-98mA, not enough. In the VCR setting up procedure provided by Philips, voltages of around 150mV are mentioned across R277 (measured at TP215). It was a fair guess therefore ($V = IR$) that the current should be in the 120-170mA region. This lack of brake current was obviously the cause of the motor running too fast.

So what was the very last thing I checked? Yes, R276 (2·7Ω). The one I removed read 13Ω. Replacing R276 with a 2·7Ω resistor restored lock at last. Reconnect C237 and C238, then adjust R252 for minimum ripple at TP223 and R259 to sit the feedback pulse half way up the ramp. Further work was required to reset the audio/sync head.

Other Servo Faults

A couple of other servo faults have caused headaches. The first I encountered some time ago: the capstan servo would not lock and on following the procedure just outlined lock was obtained on removing C237 and C238. The problem turned out to be a larger than normal ripple pulse at TP223. This kept kicking the servo out of lock via the lock-in circuit. The trouble was eventually traced to the pulse from the flywheel pickup coil. It should be 0·66V peak-to-peak at TP205 but was about 1·5V peak-to-peak, thus overdriving the servo. The cause was wear in the lower capstan flywheel bearing, as a result of which the magnets on the flywheel were lower than they should be and closer to the pickup coil, thus increasing its output.

The second fault, a more frequent one, is no capstan servo lock, with the feedback pulse running down the ramp, indicating that the motor is running too slowly. With slow running, if there is no electronic fault such as TS225 going short-circuit, see whether disconnecting the eddy current brake increases the motor speed. If the pulse is still running down the ramp, the motor is still running slow. The trouble has been overcome by replacing the motor, which seems to lose power though I've not established why.

If the feedback sample pulse is not present during playback the cause is often the sync part of the audio/sync head being defective. Other faults, such as open-circuit or short-circuit brake drive transistors with or without open-circuit emitter resistors, are fairly obvious to trace due to the lack of voltage variations at specific points and incorrect d.c. voltages. ■

Your PROBLEMS solved

Requests for advice in dealing with servicing problems must be accompanied by a 50p postal order (made out to IPC Magazines Ltd.), the query coupon from page 104 and a stamped addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets nor answer queries over the telephone.

Thorn 1500 Chassis

An otherwise excellent picture is marred by faint vertical striations on the left-hand side of the screen, covering the first two inches or so. The effect resembles that caused by a line linearity coil ringing – but this circuit doesn't use a line linearity coil.

First check C98 which decouples the screen grid of the PL504 line output valve. Then if necessary check the pulse winding ED on the line output transformer, and the components between it and the c.r.t. control grid.

Philips G8 Chassis

The raster is green when the set is switched on, and remains like this for approximately half an hour before correcting itself. Colour is then normal for the rest of the evening.

There have been various versions of the G8 chassis, so we don't know which one you have. There should be no difficulty however in finding the green output transistor, which is the centre one of the three heatsinked transistors where the coloured leads are taken to the c.r.t. base. The fault is probably nothing more than a dry-joint around the BD115 or BF337 transistor, its 5·1kΩ collector load resistor or the associated 47kΩ resistor. If necessary check the transistor by substitution and examine the print around it. The preceding i.c. (TBA530) could be at fault if the green output transistor's base voltage is in excess of 1·3V: also check if necessary the connections to the filter coil in the G – Y signal path between the TBA520 and the TBA530.

GEC 2010 Series

On u.h.f. reception the sound seems to be modulating the contrast: loud sound passages result in the picture going grey, while very loud sound detunes the picture altogether. The PFL200 video/sync valve has been replaced, also the EF183 first i.f. stage, but the fault persists. I am not in a position to be able to check the conditions on v.h.f.

There is a 32μF electrolytic behind the PFL200: this decouples a sub-h.t. line which feeds the video pentode's screen grid and the anode of the EH90 quadrature detector valve, and can be responsible for this sort of trouble when defective. If the effect is noticeable only when the volume control is advanced however the 32μF capacitor is not at fault and the 150μF electrolytic (dual 150 plus 50μF can) which smooths the HT3 line should be checked, also ensuring that the associated filter resistor R143 is intact (i.e. that it hasn't been shorted out).

Philips 170 Series

There is foldover at the top of the raster on this Philips dual-standard monochrome set. Altering the setting of the top linearity control makes very little difference – about 1cm. from one extreme to the other. When the height control is varied, the picture expands at the bottom only, the picture remaining where it is at the top – about two inches from the top of the screen. A new PCL805 has been tried without success, and the surrounding components checked.

Top foldover on these sets is unfortunately usually due to shorted turns in the field output transformer. Before condemning this however take a closer look at the preset linearity controls. They often have a poor rivetted connection (tag to track).

Decca CTV25

The focus deteriorated over a period and then the picture suddenly disappeared, leaving only a dimly lit raster on which the brightness control had no effect. It was found that the focus potentiometer was burnt out at one end, and that the focus rectifier had broken down, reading only about 1kΩ on an Avo Model 8. The control and rectifier were replaced and various checks made, but within a short time after switching on the rectifier blew and the control again started to burn out. Since then I've again replaced these components, also the focus reservoir capacitor C416, and in addition tried a new line output transformer primary winding, but to no avail.

The most common cause of the TV6·5 rectifier failing is C416: make sure that your replacement is a disc type rated at 8kV or more. Then check the insulation of the rectifier's cathode tag, and the insulation of the lead to pin 9 of the c.r.t. and the focus spark gap.

Philips T-Vette 11TG190AT

On v.h.f. it's impossible to tune in good sound and vision together: each can be obtained separately, but the other is then lost. There is also virtually no field sync, while the picture tends to pull to the right. The OC44 sync separator has been replaced and all resistors and capacitors in this circuit have been checked. The video output transistor has also been replaced as it had a broken lead.

Provided the aerial can provide an adequate signal on 405 lines the most likely cause of the sound and vision separation is a broken fine tuning slug. This can be removed by unscrewing it through C3022 on the tuner, using a fine screwdriver. Lightly oil the replacement before screwing it into position. If the core is not broken, try replacing the tuner transistors, which can be prised gently from their sockets on the top of the tuner. For the poor field sync replace the field sync clipper diode X4019 and check the associated components. For the line pulling suspect the smoothing electrolytics, check the line sync diodes X4018 (gating) and X4011/2 (flywheel sync discriminator) and ensure that the voltages on the reactance and line oscillator transistors T2022/3 are correct.

Philips G8 Chassis

The problem is that R4483 on the timebase panel is overheating and going up in smoke. What's causing this?

R4483 is in parallel with the pincushion distortion correction transductor. Disconnect plug H (red) from the panel – the set will function pretty well without this fitted – thus removing the line drive to the transductor. If this stops the overheating, replace the transductor.

SONY KV1810UB Mk II

After about ten minutes the picture starts to twitch and appears to be on the verge of collapsing, i.e. the height and width momentarily reduce. The raster does not collapse completely however. It seems that the h.t. voltage is lost for a split second. The sound is not affected, though there is the click you would expect to hear when the fault occurs. The fault does not clear, and switching the set off and on again has no effect.

We agree that the fault appears to be in the power supply, which is a fairly complex gate-controlled switch chopper circuit (see July 1977 issue). We particularly suspect the 4·7μF electrolytic C620 which decouples the feed to the monostable transistors Q606/Q607. Other possibles are C616 (0·47μF electrolytic) which decouples the emitter of the error detector/amplifier transistor Q608, and its reference zener D610 which is returned to chassis via Q601.

THORN 1580 CHASSIS

Here's one that may be of help to others. On switching on from cold there was about two inches of line scan at the centre of the screen. Then after about two minutes the thermal resistor in the h.t. line would open. If the resistor was reconnected and the set then switched on again a perfect picture would appear. We spent hours on this one, and changed everything relevant including the line output transformer – but still no good. The trouble turned out to be leakage between the pins under the PL81A line output valve base. This was loading the line output stage – Thorn tell us they've had quite a few like this!

Many thanks for passing this one on to us.

PYE 368 CHASSIS

I have the same fault on two of these sets. When the picture content is mainly peak white the line sync is weak, though the field sync, resolution and contrast are good. The fault may not appear for a whole evening, but on the odd scene with about 90% white background the picture has a wavy edge – with no signs of break up however. I've changed the sync separator and flywheel sync phase-splitter valves, and replaced the coupling capacitor to the control grid of the sync separator. The main reservoir/smoothing electrolytics have also been replaced.

It seems to us that the video output pentode's bias is not quite right. This could well be due to the input video coupling capacitor C68 (2·5μF) being slightly leaky.

THORN 1590 CHASSIS

The problem is horizontal splitting of the picture – not like loss of sync, but consisting of a bright line division at two or three points horizontally, the picture pulling along the light lines. This occurs only after several hours' use, and is sometimes accompanied by rolling. Switching off and allowing the set to cool restores normal operation.

Your first concern should be that the voltage from the regulator is not rising unduly. The regulator transistor is usually an AD149, mounted on the left side aluminium panel. Its body (the collector) should be at 11·5V. If this voltage is found to rise, check the regulator transistor, the error sensing transistor VT22 and the control R104, which should be set for 5V at the base of VT22. If the supply voltage is constant, check the reservoir electrolytic C85 as the tags of this do not always make proper contact with the capacitor's rivets.

Decca Series 10 Chassis

The problem is no raster. There is sound until the PL509 line output valve glows cherry red. The valves have all been replaced and a new line output transformer and e.h.t. tripler fitted. The resistors on the timebase panel appear to be all right, with no signs of burning or shorting.

The cherry red line output valve suggests that line drive is absent. Check for −70V on pins 1 and 8 of the PL509. If absent, check the voltages and components in the line oscillator (PCF802) stage. If you disconnect R465 (the PL509's screen grid feed resistor) you can investigate the line oscillator circuit without risk of overheating. If drive is present, disconnect the tripler from the line output transformer and if the line output stage comes back to life check whether C451 in the corner of the convergence board is leaky. This is the field flyback blanking pulse coupling capacitor and, if leaky, it places a high positive voltage on the c.r.t. grids. The result is very low e.h.t. and a very unhappy tripler. The reason for the sound going off is due to the action of the beam limiter, which works on the a.g.c. system.

GEC 2114 Junior Fineline

About a minute after switching on, a horizontal band about an inch wide which distorts the picture to the right starts to move up the screen. When it gets to the top the whole picture jumps for about five seconds. After it stops jumping the band reappears at the bottom.

This sort of thing is quite common with portables using an encapsulated bridge rectifier. It's almost certainly due to the rectifier being faulty. Remove the case and the four screws which hold the bottom centre power pack. The four-legged bridge rectifier is at the rear of this. Replace it and all should be well. If not, check the reservoir capacitor C410.

TEST CASE

180

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 ITT colour receiver fitted with the CVC8 chassis arrived in the workshop with the complaints of weak colour and "rippling" colour intensity following any sharp change in colour. These symptoms were confirmed on the test bench, and even with the saturation control at maximum the colour intensity was only about one third of normal. Using the signal from a colour-bar generator, it was noted that distinct "rings" were present at points of colour change.

This chassis uses a Motorola MC1327 i.c. for colour demodulation and matrixing, driven by the delay line and its driver. In front of this there is a two-stage chroma amplifier (BC172X and BF241 transistors). The chroma signal coupling to the delay-line driver transistor (BC171B) is via a pair of varicap diodes which are arranged in a bridge circuit and are biased by a potential-divider and a potentiometer which serves as the saturation control. The strength of the chroma signal let through to the delay-line driver depends on the degree of diode bridge imbalance. This is adjustable by the saturation control.

When the bridge is in perfect balance there is very little chroma coupling, so it was decided to check this part of the circuit first. The saturation control circuit is complemented by a second potentiometer which is ganged to the contrast control so that good colour balance is maintained regardless of the contrast control setting. These potentiometers and the associated resistors and diodes (which were changed) all appeared to be okay however.

An oscilloscope test of the chroma signal amplitude at the base and then at the collector of the second chroma amplifier transistor (BF241) revealed barely any gain in the stage. It was also noticed that the chroma at the collector was of distorted and asymmetrical envelope shape, though there was no distortion on the signal at the base. The BF241 was changed and the d.c. voltages measured, but no static fault could be detected.

What was the most likely cause of the symptoms? See next month's Television *for the solution and for a further item in the* Test Case *series.*

SOLUTION TO TEST CASE 179
– Page 49 last month –

The line oscillator in the Thorn 1500 chassis consists of the triode section of a 30FL2 valve in a blocking oscillator circuit. The oscillator transformer provides coupling between the anode and grid. It was found that by applying light pressure to the outer windings with the flat of a screwdriver a significant change in the line oscillator frequency was produced.

The transformer is mounted towards the top of the printed panel, not far from the mains dropper. Consequently it rises in temperature, due to the heat from the dropper. The result is that the wire expands slightly, altering the transformer's parameters sufficiently to move the line oscillator frequency outside the range of the line hold control.

Sometimes it's possible to minimise the effect by binding the transformer. For a permanent cure however the transformer should be replaced.

QUERY COUPON

Available until 19 December 1977. One coupon, plus a 50p (inc. VAT) postal order, must accompany EACH PROBLEM sent in accordance with the notice on page 102.

TELEVISION DEC 1977

Published on approximately the 22nd of each month by IPC Magazines Limited, King's Reach Tower, Stamford Street, London SE1 9LS. Filmsetting by Pacesetters, London SE1. Printed in England by Carlisle Web Offset, Newtown Trading Estate, Carlisle. Distributed by IPC Business Press (Sales and Distribution) Ltd., 40 Bowling Green Lane, London EC1R 0NE. Sole Agents for Australia and New Zealand – Gordon and Gotch (A/sia) Ltd.; South Africa – Central News Agency Ltd. "Television" is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, excluding Eire where the selling price is subject to VAT, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

TV LINE OUTPUT TRANSFORMERS

ALL MAKES SUPPLIED PROMPTLY by our

RETURN OF POST MAIL ORDER SERVICE

All Mono Lopts at the one price

£6.20 TRADE

£6.75 RETAIL
(V.A.T. INCLUDED AT 12½%)
Postage and Packing 70p

All Lopts NEW and GUARANTEED for SIX MONTHS

PAPWORTH TRANSFORMERS
80 MERTON HIGH STREET,
LONDON,
S.W.19

01-540 3955

T.V's! T.V's! T.V's!

Special clearance of 25" dual std. Philips G6. Thorn 2000 and RBM C.T.V's from only **£16.00**

19" GEC S/STD from only **£24.00**. Working from **£40.00**
(limited number without tubes at only **£16.00**)
22" Philips 511 S/STD from only **£28.00**. Working from **£44.00**
22" Pye Hybrids from only **£32.00**. Working from **£48.00**
22"/26" Pye Varicaps from only **£48.00**. Working from **£64.00**
19"/22"/26" Bush Integrated. Beautiful sets all prices.
20"/22"/26" Thorn 3500 – working or not. Lots of choice.
26" EMO Eurosonic 110° tube. Slimlines from **£60.00**

Hundreds of Mono T.V's – all makes – all sizes.

Colour Tubes – Ex equipment tested 25" **£16.00**
19" **£20.00.** 20"/22" **£24.00.** 26" **£28.00.** Plus **£4** P & P

New tubes from **£40.00**

Mono tubes any size all at **£5.00** + **£3** P & P

ALL PRICES PLUS VAT

Please write for quotations on any set or spares.
Quality discounts. Callers welcome. Deliveries arranged.

TRITEL

WEST	SOUTHERN	NORTHERN	SCOTLAND
Unit 4A, Bulwark Industrial Estate, Chepstow, Nr. Bristol. Tel. Chepstow (02912) 6652	Watling Street, Hockcliffe (3 miles north of Dunstable on A5). Tel. Hockliffe (052521) 768	Thornbury Roundabout, Leeds Road, Bradford 3. Tel. (0274) 665670	Peacock Cross Industrial Estate, Burnbank Road, Hamilton. Tel. (06982) 29511

A. P. ELECTRONICS

Manufacturers & Distributors of Electronic Components
3 MILDMAY ROAD, ROMFORD, ESSEX RM7 7DA.
Telephone: ROMFORD 28882

BONANZA

4 MILLION RESISTOR'S Brand new. A fabulous range of ¼ Watt, ½ Watt, 1 Watt and 2 Watt. Carbon Film Resistor's. 1,000 mixed values. For the lowest price ever, VAT included **£3.50** only.
This is a bargain you cannot miss, only from A. P. ELECTRONICS. Count by weight. Post & Pack only **45p**.

½ A MILLION MINIATURE CERAMIC PLATE CAPS. 200 for only **£1.25**. Mixed values all brand new VAT included. Post & Pack **25p**. Count by weight.

¼ OF A MILLION MULLARD C296 POLYESTER'S. Many values, 75 for only **£1** VAT included. Post & Pack **30p**. Brand new. Count by weight.

MULLARD C280 75 mixed values for only **£1** VAT included. Post & Pack **20p**. Count by weight.

A FABULOUS PACK OF HARDWARE. Self tappers, nuts, bolts, washers, spacers, grommet's, etc. etc. **£1** VAT included. Post & Pack **40p**.

200 METRES CONNECTING WIRE. Mixed colours, stranded and single only **£1.25**. Post & Pack **25p**.

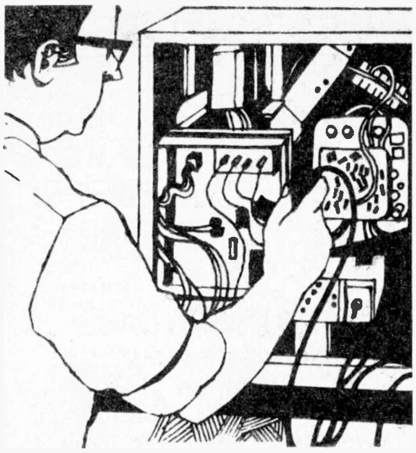
50 ELECTROLYTICS CAPACITORS. Mixed values for only **£1** VAT included. Post & Pack **25p**.

50 WIREWOUND RESISTORS. From 2·5 Watt. Mixed values for only **£1** VAT included. Post & Pack **30p**. Count by weight.

OVERSEAS POST AT COST.

EX-STOCK. Transistors, Diodes, I.Cs, C.MOSs, Thyristors, Knobs, Pre-sets, Resistors, Capacitors, Tant's, Bridge-Rectifiers, Transformers.

Open all day from 9am till 5.30pm.
Open all day Saturday.



NOTA BENE

When replying to Classified Advertisements please ensure:

(A) That you have clearly stated your requirements.
(B) That you have enclosed the right remittance.
(C) That your name and address is written in block capitals, and
(D) That your letter is correctly addressed to the advertiser.

This will assist advertisers in processing and despatching orders with the minimum of delay.

SMALL ADS

The prepaid rate for classified advertisements is 16p per word (minimum 12 words), box number 60p extra. Semi-display setting £3.20 per single column centimetre. All cheques, postal orders, etc., to be made payable to Television, and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Television, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.
2. The publishers reserve the right to refuse or withdraw any advertisement.
3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

FOR SALE

TOP U.K. SOURCE FOR QUALITY USED T.V.

10,000 mono & 5,000 CTV always available

Stable competitive prices – delivery arranged – generous quantity discounts – used spares always in stock.

TRADE ONLY Colour from £15.00 Mono from £2.00

Colour Televisions From £25.00 VAT inc.
D/S Mono From £4.00 VAT inc.
S/S Square Screens From £12.00 VAT inc.

VISIT OUR WAREHOUSE AND SEE FOR YOURSELF.
WE HAVE 4 DELIVERIES OF FRESH STOCK WEEKLY.

TELECARE

BRITAIN'S LARGEST USED T.V. DISTRIBUTOR.
Unit B.1, Eley Road, Eley Estate,
Edmonton, London N18.
Tel: 01-807 5908/9 807 5900.

"TELEVISION" COLOUR RECEIVER. Panels assembled/aligned. 25" shadow mask tube. Good cabinet. Nearly completed. £65. Folkestone 76598.

Owing to bereavement coloured television parts, tools, tubes, leaflets, television books from 1963. Liphook 724380.

WANTED

GRUNDIG Remote control colour Television wanted. Model 6010 or 6011. Working or not. Telephone 0782 535898.

SURPLUS??? Turn it into cash. Phone 0491-35529 (Oxon).

WANTED FOR CASH
COLOUR & B/W T.V.'s ANY QUANTITY – WILL COLLECT
SHEFFIELD PANEL REPAIRS
RING 0742 745168.

NEW VALVES and CRT's required. PCL805, PL504, PL509, PY500A etc. Cash waiting. Bearman, 6/8 Potters Road, New Barnet, Herts. Tel: 01-449 1934/5.

WANTED – New Valves, Transistors. Top prices, popular types. Kensington Supplies (A), 367 Kensington Street, Bradford 8, Yorkshire.

NOTICE TO READERS

Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from non-current issues of the magazine.

EDUCATIONAL

BETTER JOB! BETTER PAY!

GET QUALIFIED WITH ICS IN:
COLOUR & MONO TV SERVICING
COLOUR & MONO TV ENGINEERING
COLOUR & MONO TV MAINTENANCE
PLUS: Telecommunications, radio, electronics, electrical engineering, technical communications, radio communications, etc., etc.,
NEW: Self-build radio courses with free kits
Train in your own home, in your own time with ICS, the world's most experienced home study college.
RETURN THIS COUPON TODAY FOR FREE BROCHURE!

ICS Int Correspondence Schools
800P Intertext House Stewarts Rd
London SW8 4UJ. Tel: 01-622 9911

Name ....
Address ....
....

TELEVISION TRAINING

12 MONTHS' full-time course in Radio & TV for beginners. (GCE – or equivalent – in Maths. and English.)

26 WEEKS' full-time course in Mono & Colour TV. (Basic electronics knowledge essential.)

13 WEEKS' full-time course in Colour TV. (Mono TV knowledge essential.)

These courses incorporate a high percentage of practical training.

NEXT SESSION starts on January 3rd.

PROSPECTUS FROM:
London Electronics College, Dept. TT12
20 Penywern Road, London SW5 9SU.
Tel. 01-373 8721.

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next available issue of Television for .... insertions. I enclose Cheque/P.O. for £ ....
(Cheques and Postal Orders should be crossed Lloyds Bank Ltd and made payable to Television)

NAME ....
ADDRESS ....
....

Send to: Classified Advertisement Manager,
TELEVISION,
GMG, Classified Advertisement Dept., Rm. 2337,
King's Reach Tower, Stamford Street,
London SE1 9LS. Telephone 01-261 5846.
Rate
16p per word, minimum 12 words. Box No. **60p** extra.

Company registered in England. Registered No. 53626. Registered Office: King's Reach Tower, Stamford Street, London SE1 9LS.

PHILIP H. BEARMAN (VALVE SPECIALISTS)

SUPPLIERS TO H.M. GOVT. Etc.

NEW valves by Mullard, Mazda, Telefunken, Tungsram, etc.

"QUALITY" BRANDED VALVES ONLY CARRY THE 90 DAY GUARANTEE, SEE OUR LISTS.

IMMEDIATE POSTAL DESPATCH **LISTS S.A.E.** **DISCOUNT PRICES INCLUDING 6% ALLOWANCE IN LIEU OF GUARANTEE**

PRICES FROM SEPT 1977 INCL. 12½% VAT (Correct at time of going to press)

DY86/7	55p	GY501	£1.35	PCF802	78p	PL36	95p	U25	60p	30P12	70p
DY802	60p	PC86	85p	PCF805	£1.45	PL84	70p	U26	60p	30PL1	£1.40
ECC81	45p	PC88	85p	PCF808	£1.45	PL504	£1.30	6F23	60p	30PL13	£1.00
ECC82	50p	PC97	75p	PCH200	£1.25	PL508	£1.40	6F28	92p	30PL14	£1.20
ECL80	70p	PCC84	35p	PCL82	65p	PL509	£2.25	20P4	70p	30PL15	£1.10
EF80	55p	PCC89	62p	PCL83	75p	PL802	£2.45	30C1	60p	Etc., Etc.	
EF183	70p	PCC189	62p	PCL84	70p	PY81/83	50p	30C17	80p		
EF184	70p	PCF80	65p	PCL85 }	85p	PY800	65p	30FL1	£1.05	BY 100/127 etc.	
EH90	75p	PCF86	65p	PCL805 }		PY801	65p	30FL2	£1.05	all 21p each	
EY51	80p	PCF200	£1.30	PD500	£3.25	PY500	£1.40	30L15	75p	with 10W	
EY86/7	45p	PCF801	65p	PFL200	88p	PY500A	£1.40	30L17	75p	resistor.	

MINIMUM ORDER 75p!

ENQUIRIES WELCOMED ON OUR VAST RANGE

SEND SAE FOR COLOUR & MONO TRIPLER LIST. ALSO LATEST COMPONENT LIST.

HUNDREDS OF OTHER TYPES AVAILABLE, VAST STOCKS.

See separate Component, CRT and Transistor List. Many obsolete types available.

SAE with enquiries please. Please verify current prices due to inflation etc.

Overseas Post @ Cost. U.K. Post 13p per valve under £15.00 (max. 75p) but 2p extra larger valves (ADDITIONAL VALVES 7p)

TELEPHONE ENQUIRIES WELCOMED.

(Adjacent to Post Office) **6 & 8 POTTERS RD., NEW BARNET HERTS. Tel:449/1934-5** (Robophone on 449/1934 also 441/2541)

(CLOSED 12.30–2 p.m. DAILY. OPEN SAT. A.M. ONLY)

STOP PRESS PC92/96, PCL200, PL95, PL519 available! Also EY500A, EL509 etc.

NOTE. Any excess paid will be refunded.

EMO – EUROSONIC – GRUNDIG – TELETON + ALL BRITISH MAKES
ETC, ETC. ● ALL SPARES READILY AVAILABLE ● PANEL REPAIR SERVICE

EXAMPLES

Thorn 1500 Smoother			£2.18
Philips E8 Smoother			1.95
Thorn 8500 Dropper			0.72
R.R.I. 141 Dropper			0.70
Philips 210 Dropper			0.60
BF258	0.38	8U126	1.95
BYX10	0.12	OA90	0.07
IN414S	0.03	B2Y88	0.12
Pye 691 Tripler			5.25
Korting Tripler			7.02
PCL85	0.69	PY500	1.21
DY802	0.44	PL504	0.87

+ VAT 12½% + 25p P & P
Orders Over £15 Free

ALMOST ANY T.V. COMPONENT SUPPLIED By return "off the shelf" e.g. LOPTX – EHT trays – droppers – OSC coils – switches – cans – smoothers – transistors – diodes – I.C.'s, etc, etc.

IF YOU REQUIRE ANY TV COMPONENT YOU CAN BE 95% SURE WE CAN SUPPLY BY RETURN.
IF YOU'RE WAITING FOR SPARES – RING NOW!

FREE SERVICE CATALOGUE EMO CIRCUIT

Send 25p to cover post & packing

TELE-PART (W'TON) THE TELECENTRE, WORCESTER ST., WOLVERHAMPTON (0902) 772293

SOUTHERN VALVE COMPANY

Upper Floor, 8 Potters Road, New Barnet, Herts.

Telephone: 01-440/8641. MAIL ORDER ONLY. MINIMUM ORDER 75p

ALL NEW & BOXED, "QUALITY" BRANDED VALVES GUARANTEED 3 MONTHS. BVA ETC. (TUNGSRAM ETC.).
6% ALLOWED IN LIEU OF GUARANTEE! ALREADY DEDUCTED FROM OUR PRICES!

NOTE: PLEASE VERIFY CURRENT PRICES. *Correct only at time of going to press.*

Some leading makes available. *VAT invoices issued on request.*

DY86/7	49p	EF86	52p	GY501	£1.10	PCF802	65p	PL36	70p	PY500A	£1.33
DY802	50p	EF89	40p	PC86	63p	PCF805	£1.45	PL81A	53p	UBF89	40p
ECC81	45p	EF183	42p	PC88	63p	PCF806	75p	PL83	50p	UCC85	46p
ECC82	45p	EF184	42p	PC97	72p	PCF808	£1.45	PL84	48p	UCH81	50p
ECC83	45p	EH90	56p	PC900	50p	PCL82	54p	PL500 }	90p	UCL82	55p
ECC85	40p	EL41	70p	PCC84	35p	PCL83	70p	PL504 }		UCL83	58p
ECH81	53p	EL84	40p	PCC85	44p	PCL84	48p	PL508	£1.30	UF89	45p
ECH84	58p	EL509	£2.60	PCC89	50p	PCL85 }	62p	PL509	£2.20	UL41	75p
ECL80	52p	EM84	50p	PCC189	53p	PCL805 }		PL519	£2.80	UL84	52p
ECL82	48p	EY86/7	38p	PCF80	50p	PCL86	65p	PL802	£2.45	UY41	48p
ECL86	63p	EY500A	£1.50	PCF86	58p	PCL200	£1.40	PY88	58p	UY85	40p
EF80	33p	EZ80	40p	PCF200/1	£1.30	PD500	£3.25	PY800	50p	U25	60p
EF85	38p	EZ81	40p	PCF801	50p	PFL200	73p	PY801	50p	U26	60p

We offer return of post service.

CWO ONLY, No C.O.D. Post free over £18.

£6 to £15 – 75p (max.)

Items in stock at time of going to press but subject to possible market fluctuations if unavoidable.

One valve post 13p, each extra valve 6p. MAX 75p. LISTS & ENQUIRIES, S.A.E. PLEASE!
Large valves 2p. each extra. ALL PRICES INCLUDE VAT @ 12½%.

ENQUIRIES WELCOMED FROM TRADE & RETAIL (same prices)

PHILIP H. BEARMAN
6 & 8 POTTERS ROAD, NEW BARNET, HERTS. Tel: 01-449 1934/5

EXPORT ENQUIRIES WELCOMED

PRICES CORRECT AT TIME OF GOING TO PRESS

SHORT SEA JOURNEY £1 EXTRA.

NEW COLOUR TUBES

Carriage £3.00

A44/271X	£55.00
A49/191X }	£60.00
A49/192X }	Also A51/220X
A51/110X }	£65.00
510DNB22 }	
A56/120X	£65.00
A63/11X	£75.00
A63/200X	£75.00
A66/120X	POA
A67/120X	£89.50
A67/150X	POA

One year guarantee.
(Add £9.00 for 4 years where available)

New tubes, fully tested

SPECIAL NOTE
NEW MONO TUBES AVAILABLE

A31/410W Mullard }	£18.00
CME1220/A31.120 }	
CME1420/A34.120/160	£19.50†
CME1520/A38.160	£21.00*
CME1713/A44.120	£21.00*

Limited stocks
2 year guarantee

MAZDA, TOSHIBA, USA, ETC. OTHERS AVAILABLE SHORTLY.

*£1 less } 1 year
†£2 less } g'tee

NEW MONO TUBES

Carriage £1.50

MW31/74	£3.00
14" 70°	£5.00

12"/14" 110°. Prices as per centre column.

A47/14W	£11.50
A59/15W	£14.00
A50/120WR	£18.00*
A61/120WR	£21.00*

Others often available.
£1 less for one year guarantee.

Mostly two year guarantee.
SAE with enquiries please.

NOTE: *All prices subject to alteration due to market fluctuation and inflation.* 110° prices usually as above. £5 allowed on old colour tube. Occasionally seconds available cheaper, enquiries welcomed. VAT included in all quoted prices at 12½%.

PLEASE MENTION TELEVISION WHEN REPLYING TO ADVERTISEMENTS

TELEVISION TUBE SHOP

NEW TUBES AT CUT PRICES

A28-14W Equivalent	£17.95
A31-410W	£16.95
AW59-91/CME2303	£15.50
CME1201/A31-18W	£13.50
CME1220/A31-120W	£15.95
CME1420/A34-100W	£16.50
CME1520/A38-160W	£17.50
CME1602/A40-12W	£13.50
CME1713/A44-120	£17.50
CME1906/A47-13W	£12.50
CME2013/A50-120	£17.95
CME2306/A59-13W	£14.50
CME2313/A59-23W	£18.95
CME2413/A61-120W	£18.95

JAPANESE etc. TUBES

9AGP4	£17.50
190AB4	£15.00
190CB4	£15.00
230ADB4	£15.95
230DB4/CT468	£15.95
CT507	£17.50
240AB4A	£15.95
310DMB4/DGB4	£19.00
310DWB4/DJB4	£19.00
310EUB4	£19.50
310EYB4	£16.50
310FDB4	£19.95
310FXB4 Equivalent	£15.95
310GNB4A	£25.19
310HCB4	£19.95
340AB4	£19.50
340AYB4	£22.00
340CB4	£19.95
340RB4	£19.95
340AHB4	£24.50

COLOUR TUBES

12VARP22	£62.50
330AB22	£57.50
470FUB22B	£75.50
A47-342X	£75.00
A49-191X/120X	£52.00
A51-220X/510DJB22	£59.00
A56-120X	£62.00
A56-140X/410X	£55.00
A66-120X	£75.00
A63-11X/120X	£69.50
A67-120X	£77.00
A66-140X/410X	£55.00

ALL TUBES GUARANTEED 12 MONTHS

CARRIAGE:
Mono £1.50. Colour £2.50
N. Ireland £4.00

ADD VAT TO ALL PRICES

TELEVISION TUBE SHOP
52 BATTERSEA BRIDGE RD., LONDON, SW11. Tel. 228 6859

WE GIVE GREEN SHIELD STAMPS

SIDS Components

FAST, RELIABLE AND COMPETITIVE

SIDS full stock + price list available — Just telephone 061-480 8244 or write to — SIDS (Electronic Components) Ltd. 251, Wellington Road South, Stockport, Cheshire.

TV Replacement Mains Droppers

MANUFACTURER	CHASSIS	MAKERS CODE	VALUES	SIDS ORDER CODE	SIDS PRICE EACH (p)
T.C.E.	1400	06E5.016	128R+16R+1K7+116R+462R+126R	C121	85
	1500	06E5 018	350R+20R+148R+1K5+317R	C113	63
	3000/3500	00E5 071	6R+1R+100R	C105	53
	8000	90E5.006	56R+1K+47R+12R	D123	59
	8500	90E5.007	50R+40R+1K5	D127	70
PHILIPS	210	50501	30R+125R+2K85	D112	49
	210	50511	118R+148R+LOOP	D108	41
	G8	50811	47R	C103	24
	G8	50832	2R2+68R	C102	39
PYE	725	PL11062 PL10064	27R+56R	0106	44
G.E.C.	2018	27840	8R+15R+17R+70R+63R+188R	OS114	55
R.R.I.	TV161	AP48928	250R+14R+156R	D109	39
RR1	A823		56R+68R	D150	63

POWER WIREWOUND RESISTORS – DROPPER SECTIONS
OVAL SECTIONS: 25mm x 25mm x 7mm
WATTAGE: 12W
ORDER CODE: F104/VALUE REQUIRED
VALUES: 4R7 7RS 10R 12R 15R 18R 22R 24R 27R 33R 39R 47R 51R 56R 68R 75R 82R 100R 120R 150R 180R 200R 220R
PRICE 0.25p EACH

Diodes

TYPE		PRICE (p)
BA	115	16
BA	145	18
BA	148	16
BA	154/201	12
BA	155	14
BAX	13	5
BAX	16	9
BY	126	12
BY	127	13
BY	133	20
BY	199	25
BY	206	18
BYX	10	14
OA	47	10
OA	90	6
OA	91	7
OA	95	7
OA	202	9
IN	914	5
IN	4001	6
IN	4002	6
IN	4003	7
IN	4004	8
IN	4005	6
IN	4006	10
IN	4007	10
IN	4148	4

ORDER NOW!

Valves

		PRICE EACH (p)
DY	87	56
DY	802	56
ECC	82	47
EF	80	40
EF	183	46
EF	184	46
EH	90	46
PC	86	69
PC	88	69
PC	900	56
PCC	89	57
PCC	189	57
PCF	80	49
PCF	86	55
PCF	801	60
PCF	802	62
PCL	82	57
PCL	84	63
PCL	85	63
PCL	86	60
PFL	200	75
PL	36	69
PL	84	51
PL	504	99
PL	508	105
PL	509	195
PL	519	270
PY	88	52
PY	500A	137
PY	800	52

Integrated Circuits

At New Low Prices following Bulk purchase of New Plessey and Toshiba Stocks.

TYPE		PRICE (p)
MC	1349	160
ML	231B	230
ML	232B	230
SL	414A	240
SL	415A	280
SL	1310	160
SL	1327	115
SL	3046	82
SL	76544	140
SN	76003N	180
SN	76013N	140
SN	76013ND	124
SN	76023N	140
SN	76023ND	124
SN	76033N	180
SN	76110N	142
SN	76226N	180
SN	76227N	140
SN	76532N	160
SN	76533N	140
SN	76544N	150
SN	76650N	120
SN	76660N	70
SN	76666N	100
TA	7050P	125
TA	7051P	165
TA	7072P	170
TA	7047P	150
TA	7141AP	120
TA	7171P/SAS 560S	186
TA	7172P/SAS 570S	186
TA	7173P	160
TA	7176P	120
TAA	550	45
TAA	570	185
TAA	661B	100
TAA	700	165
TBA	120AS	80
TBA	120SQ	100
TBA	440	300
TBA	480Q	140
TBA	520Q	170
TBA	530Q	130
TBA	540Q	180
TBA	550Q	200
TBA	560CQ	210
TBA	750Q	150
TBA	800	120
TBA	920Q	210
TBA	990Q	180
TCA	270Q	225
TCA	800	225
TDA	440	310

NO MINIMUM ORDERS!
CASH WITH ALL ORDERS
ADD 12½% VAT PLUS 25p POSTAGE.

EHT Trays

TYPE	DESCRIPTION	PRICE EACH (p)
101/TH	Thorn 950 Mk 11 1400	2.35
102/TH	Thorn 1500 3 Stick	2.30
103/TH	Thorn 1500 5 Stick	2.50
104/TH	Thorn 1590 Stick	40
105/IT	ITT Philips Mono Large Screen	72
106/RA	Rank Z 718	1.82
107/TH	Thorn 3000/3500	6.00
108/TH	Thorn 8000	2.30
109/TH	Thorn 8500	4.40
110/TH	Thorn 9000	6 60
111/OE	Decca Doubler	3 20
112/OE	Decca 30 Series	5 30
113/OE	Decca 80 Series	5 80
114/GE	G.E.C. Hybrid	5.30
115/GE	G.E.C. Solid State	5.80
116/IT	ITT CVC 1-5	5.30
117/IT	ITT CVC 20	5.80
118/PH	Philips G8	5.30
119/PH	Philips 550	5.30
120/PY	Pye 691/693	4.40
121/PY	Pye 731	5.80
122/RA	Rank A823	5.30
125/KO	Korting	5.30
126/MU	Telpro/Carnival/Hamilton Steepletone	5.30
128/PH	Philips G9 T25 DB	5.80
129/DE	Decca 100 T30 AV	5.80

Subject to 10% Discount – 5 of any one type or 10 mixed types.

Resistors

Power Wirewound	Price (p)	Trade Pack Qty.
10 Watt. Style: Axial Leads – cement coated. Range 10R 12R 25R 30R 33R 39R 47R 50R 68R 75R 82R 100R 120R 150R 180R 220R 250R 270R 330R 400R 470R 500R 550R 1K0 2K2 3K3 6K0 8K0 10K	60	(5)
5 Watt. Style: Radial Leads – cement coated. Range 10R 15R 25R 33R 47R 68R 82R 100R 120R 150R 180R 220R 270R 330R 390R 470R 560R 680R 820R 1K0 1K2 1K5 1K8 2K2 2K7 3K3 3K9 4K7 5K6 6K8 8K2 10K 12K	60	(5)
2.5 Watt. Style: Radial Leads – cement coated. Range R22 R33 R50 1R0 1R5 2R2 2R7 3R3 3R9 4R7 5R6 6R8 8R2 10R	60	(5)

RESISTORS: High Stability Carbon Film E.12 Range

Power Ratings: 0.5W 1.0W & 2.0W watts. 0.5W rated at 70°C. 1.0W & 2.0W rated at 40°C.

Tolerance 5%.

Style – Axial Leads.

Values: 10R 12R 15R 18R 22R 27R 33R 39R 47R 56R 68R 82R 100R 120R 150R 180R 220R 270R 330R 390R 470R 560R 680R 820R 1K 1K2 1K5 1K8 2K2 2K7 3K3 3K9 4K7 5K6 6K8 8K2 10K 12K 15K 18K 22K 27K 33K 39K 47K 56K 68K 82K 100K 120K 150K 180K 220K 270K 330K 390K 470K 560K 680K 820K 1M 1M2 1M5 1M8 2M2 2M7 3M3 3M9 4M7 5M6 6M8 8M2 10M

	Price	Trade Pack Qty
0.5W	.19	(10)
1.0W	.32	(10)
2.0W	.52	(10)

Capacitors

Electrolytic: Axial Leads

25V WKG Range

Value	Vwkg.	Dimensions	Price	Trade Pack Qty
22/uF	25	10 x 6mm	0.35	(5)
47/uF	35	18 x 8mm	0.60	(5)
100/uF	25	19 x 8mm	0.40	(5)
220/uF	25	21 x 11mm	1.20	(5)
470/uF	35	32 x 13mm	1.25	(5)
1000/uF	35	40 x 16mm	1.26	(3)
2200/uF	25	39 x 21mm	0.90	(3)

63V WKG Range

Value	Vwkg.	Dimensions	Price	Trade Pack Qty
4.7/uF	63	13.6 x 6.6mm	0.48	(5)
22/uF	70	18 x 7mm	0.50	(5)
47/uF	70	17 x 12mm	0.68	(5)
100/uF	70	32 x 10mm	0.90	(5)
220/uF	63	38 x 13mm	1.20	(3)
470/uF	70	38 x 16mm	1.20	(3)
1000/uF	70	38 x 24mm	1.35	(3)

450V WKG Range

Value	Vwkg.	Dimensions	Price	Trade Pack Qty
1/uF	450	28 x 12mm	0.80	(5)
2.2/uF	450	27 x 13mm	0.95	(5)
4.7/uF	450	32 x 13mm	1.05	(5)
10/uF	400	32 x 16mm	1.20	(5)
15/uF	450	40 x 19mm	1.40	(5)
32/uF	450	52 x 26mm	1.75	(5)

CAPACITORS Mixed Dielectric 1000V WKG

New 660 Capacitors (moulded in flame retardent material)

Value	Voltage	Price (p)	Trade Pack Qty.
0.01/uF	1000	45	(3)
0.022/uF	1000	54	(3)
0.033/uF	1000	40	(2)
0.047/uF	1000	40	(2)
0.1/uF	1000	45	(2)
0.22/uF	1000	38	(1)
0.47/uF	1000	55	(1)
0.1/uF	1250	35	(1)

CAPACITORS Polyester 600V

Sprauge Pum Range 416P Filmite

Value	Dimensions	Price (p)	Trade Pack Qty.
.001/uF	18.2 x 4.8mm)		
.0022/uF	18.2 x 4.8mm)		
.0033/uF	18.2 x 5.2mm)	50	(5)
.0047/uF	18.2 x 6.0mm)		
.01/uF	21.4 x 6.9mm)		
.022/uF	22.2 x 9.5mm)		
.033/uF	25.4 x 10mm)	60	(5)
047/uF	31.8 x 10.2mm)		

Multi Section Capacitors

ALL NEW AND BRANDED ITEMS

MANUFACTURER	CHASSIS Nos.	CAPACITANCE mfd	VOLTAGE v	SIDS ORDER CODE	SIDS PRICE EACH (p)
T.C.E.	1500	150.150.100	350	CMS/2	115
	3000/3500	175.100.100	400/350	CMS/3	185
	3000/3500	1000	63	CMS/4	68
	8000	2500.2500	63	CMS/5	165
R.R.I.	A823	2500.2500	30	CMS/7	115
	A823	600	300	CMS/8	155
PYE	691 697 & 723	200.300	350	CMS/10	180
PHILIPS	G8	600	300	CMS/8	155
DECCA	CS1910	400.400	350	CMS/14	245
G.E.C.	02110	600	300	CMS/8	155

YOU'LL GO A LONG WAY FOR A BETTER DEAL

Fuses

PRICE (p)

Anti-Surge 20mm x 5mm — Range 100MA, 160MA, 250MA, 315MA, 500MA, 630MA, 800MA, 1A, 1.25A, 1.6A, 2A, 2.5A, 3.15A — 12p Each

Anti-Surge 1¼" x ¼" — Range 160MA, 250MA, 500MA, 630MA, 800MA, 1A, 1.25A, 1.6A, 2A, 2.5A, 3.15A, 5A — 13p Each

Quick Blow 20mm x 5mm — Range 100MA — 6p Each; 200MA, 250MA, 315MA, 500MA, 630MA, 800MA, 1A, 1.25, 1.5A, 2A, 2.5A, 3.15A, 5A — 4p Each; 35 All values – 200MA/5A

Quick Blow 1¼" x ¼" — Range 100MA, 150MA — 5p Each; 250MA, 500MA, 600MA, 750MA, 1A, 1.5A, 2A, 2.5A, 3A, 5A — 4p Each

Semi Conductors

TYPE	PRICE (p)	TYPE	PRICE (p)	TYPE	PRICE (p)	TYPE	PRICE (p)	TYPE	PRICE (p)
AC 107	28	BC 113	12	BC 213	15	BF 160	30	BRY 52	33
AC 126	27	BC 114	15	BC 213L	13	BF 167	26	BT 106	120
AC 127	22	BC 115	16	BC 214	13	BF 173	24	BT 108	132
AC 128	17	BC 116	16	BC 214L	13	BF 178	30	BT 116	120
AC 128K	33	BC 116A	30	BC 237	15	BF 179	32	BU 105/02	190
AC 141	27	BC 117	17	BC 238	12	BF 180	33	BU 108	200
AC 141K	37	BC 118	17	BC 301	30	BF 181	32	BU 126	165
AC 142	20	BC 119	28	BC 303	31	BF 182	35	BU 204	160
AC 142K	33	BC 125	16	BC 327	20	BF 183	34	BU 205	160
AC 151	31	BC 125B	18	BC 328	12	BF 184	30	BU 206	210
AC 154	20	BC 126	15	BC 337	15	BF 185	28	BU 208	245
AC 155	20	BC 132	15	BC 338	18	BF 186	36	BU 208/02	264
AC 156	31	BC 135	18	BC 546	15	BF 194	12	BUY 69B	275
AC 176	24	BC 136	18	BC 547	12	BF 195	12	BUY 69A	300
AC 176K	38	BC 137	15	BC 548	10	BF 196	12	E 1222	42
AC 187	22	BC 138	20	BC 549	12	BF 197	13	MJE 340	44
AC 187K	40	BC 139	24	BC 550	15	BF 197A	18	MJE 520	50
AC 188	27	BC 140	38	BC 557	14	BF 198	19	2N 696	25
AC 188K	42	BC 141	26	BC 558	13	BF 199	20	2N 706	16
AC 193K	40	BC 142	24	BCY 72	20	BF 200	30	2N 3053	22
AC 194K	39	BC 143	24	BD 115	60	BF 218	56	2N 3054	72
AD 140	78	BC 147	12	BD 116	60	BF 224	30	2N 3055	60
AD 142	74	BC 147A	12	BD 124	70	BF 240	20	2N 3702	16
AD 143	72	BC 147B	12	BD 131	44	BF 241	20	2N 3703	12
AD 149	79	BC 148	10	BD 132	46	BF 257	30	2N 3704	12
AD 161	50	BC 149	12	BD 133	48	BF 258	32	2N 3705	11
AD 161/162PR	125	BC 153	15	BD 135	34	BF 259	28	2N 3706	11
AD 162	55	BC 154	15	BD 136	35	BF 336	37	2N 3819	25
AF 114	35	BC 157	13	BD 137	37	BF 337	34	2N 5293	60
AF 115	26	BC 158	12	BD 138	38	BF 338	34	2N 5294	52
AF 116	26	BC 159	12	BD 139	42	BF 355	45	2N 5295	60
AF 117	26	BC 160	40	BD 140	46	BF 457	60	2N 5296	50
AF 118	65	BC 161	40	BD 144	190	BF 458	40	2N 5297	60
AF 124	36	BC 171	14	BD 160	140	BF 459	42	2N 5298	36
AF 125	36	BC 172	13	BD 181	80	BFT 42	41	2N 5496	60
AF 126	36	BC 173	15	BD 182	85	BFT 43	30	OC 71	29
AF 127	36	BC 178	17	BD 183	68	BFX 29	29	OC 72	38
AF 139	44	BC 178B	21	BD 184	100	BFX 84	24	R 2008B	200
AF 178	66	BC 179	18	BD 222	60	BFX 85	30	R 2010B	190
AF 180	70	BC 182	14	BD 225	60	BFX 86	28	RCA 16334	100
AF 181	70	BC 182L	11	BD 232	70	BFX 88	25	RCA 16335	100
AF 239	50	BC 183L	10	BD 233	50	BFY 50	20	S 2802	200
AF 240	22	BC 184	13	BD 234	55	BFY 51	22	S 6080	320
AL 102	120	BC 186	24	BD 235	55	BFY 52	20	A KIT	
AL 103	144	BC 187	24	BD 236	58	BFY 90	78	TIP 31A/	
AU 107	165	BC 204	15	BD 237	58	BR 100	26	2N 5298	36
AU 110	190	BC 212	13	BD 238	55	BR 101	36	TIP 32A	38
AU 113	130	BC 212L	11	BOX 32	270	BRC 4443	90	TIP 41A	44
BC 107	12			BDY 20	100	BRY 39	38	TIP 42A	48
BC 107B	15			BF 115	30			TIS 91	19
BC 108	14			BF 123	35			2SC 1172A	300
BC 109	14			BF 152	20			2SC 643A	140
BC 109C	15			BF 158	20			4.43MHZ Crystal	120

YOUR GOODS ARE POSTED THE SAME DAY WE RECEIVE YOUR ORDER!