JULY 1978

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TELEVISION

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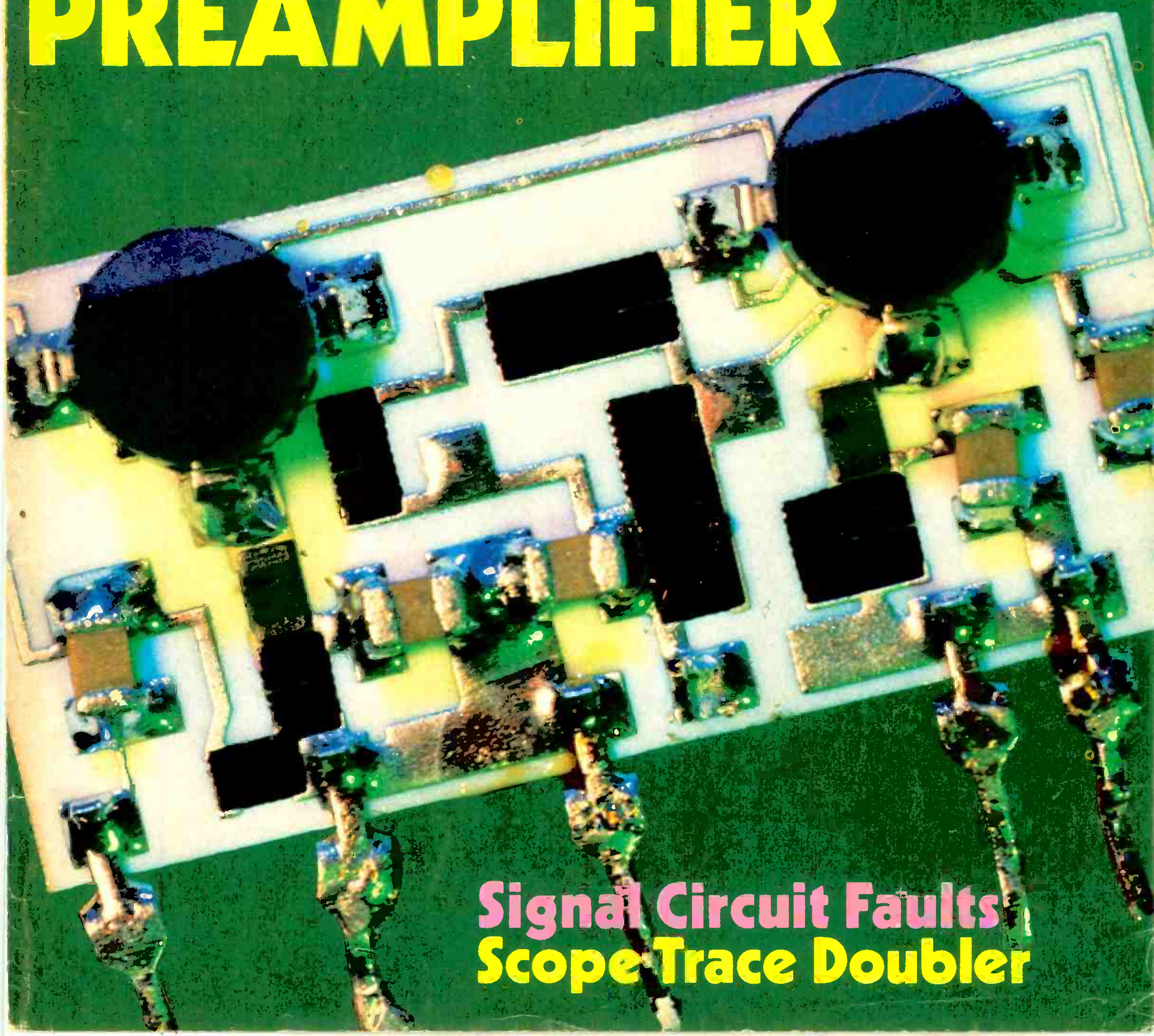

Signal Circuit Faults

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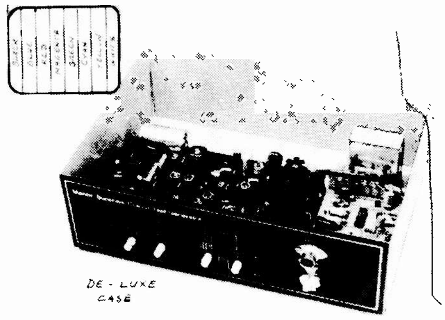
COLOUR BAR GENERATOR

plus CROSS HATCH KIT (Mk. 4)



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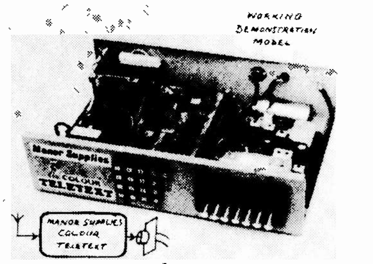
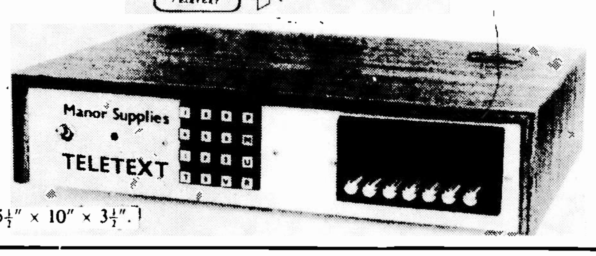


Changes from Teletext to picture without switching aerials

Armchair control of Teletext and T.V. stations.



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GEC 2000, 2047 series, etc.	**£6.80**
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MURPHY 1910 to 2417 series	**£6.95**
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TELEVISION

July 1978

Vol. 28, No. 9
Issue 333

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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". Send to the address given above (see "correspondence").

this month

OUR NEXT ISSUE DATED AUGUST WILL BE PUBLISHED ON JULY 17

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(tested)
19" Rimguard **£4.50**
23" Rimguard **£6.00**
20" Rimguard **£6.00**
24" Rimguard **£7.50**
+ £3.00 p.p.

MONO TUNERS
6 - button integrated all at **£6.50**
U.H.F. P/Button D/S **£4.50** U.H.F. P/Button S/S **£6.50** Rotary **£3.00**
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+ £1. p.p.
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MONO PANELS
i.e. Philips, Bush etc.
£3.50 + £1 p.p.
Quotations for complete S/Hand chassis if required. (Diff prices)

MISC. S/Output Trans.
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Scancoils £1.50 + VAT + £1. P&P. Other spares available, please write or phone for details.

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PCL86	0.10	PCF80	0.10	EF85	0.10	PL36	0.25	ECC82	0.10	PCH200	0.50
PFL200	0.10	PCC189	0.10	EF183	0.10	PL504	0.25	ECC81	0.10	PCF200	0.50
PCF801	0.10	PCC86	0.10	EF184	0.10	PL81	0.10	ECH81	0.10	CEY51	0.15
30C1	0.10	30C15	0.10	68W7	0.10	6/30L2	0.10	ECL80	0.10		
30C17	0.10	30C18	0.10	ECC85	0.10	U26	0.10	ECL82	0.10		
PL83	0.10	PL84	0.10	EH90	0.10						

Please note there is 25p p.p. per order

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	IF	LUM	CHROMA	EHT	REG	CON	S/OUTPUT	POWER	L/TB	F/TB
Bush/Murphy	6.50	6.50	6.50	–	–	6.50	1.50	6.50	–	–
GEC/Sobell	6.50	7.50	–	–	–	6.50	–	–	–	7.50
Philips	6.50	9.50	–	–	–	7.50	–	–	–	6.50
Decca	6.50	12.50	12.50	–	–	6.50	2.00 (19" only)	8.00	–	6.00
Thorn 2000	6.50	7.50	7.50	6.50	6.50	7.00	–	8.00	15.00	6.50
Pye	7.50	7.50	9.50	–	–	6.50	–	–	–	4.00
Baird	6.50	8.50	8.50	–	–	6.50	–	–	–	6.00

Postage & Packing £1.25

S/STANDARD COLOUR SPARE PANELS

	IF	LUM	CHROMA	VIDEO	CON	POWER	L/TB	F/TB
Bush 184	9.50	–	20.00	–	8.00	6.00	15.00	–
GEC Hybrid	9.50	9.50	15.00	–	6.00	–	—	12.00
Philips G6 S/S	9.50	–	10.00	–	9.00	–	–	10.00
Thorn 3000	10.00	9.00	18.00	10.00	6.00	20.00	20.00	10.00
Pye 691/693	15.00	7.50	18.00	–	15.00	–	15.00	7.50
Thorn 3500	10.00	9.00	18.00	10.00	10.00	20.00	20.50	10.00

Korting and other foreign panels available on request.

Postage & Packing £1.25

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19"	18.00
19" A49.192	£20
20"	20.00
22"	25.00
25"	18.00
26"	32.00

Plus P & P £4

COLOUR TUNERS

Bush	6.50
GEC	6.50
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MISC.
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CHROMA £12.00
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Bush	19" £60.00	22" ~~£70.00~~	26" £80.00	
Philips G6	–	22" £58.00	26" £70.00	

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Who repairs what?

The TV cowboys letter we published in our April issue produced a considerable response from readers – as we thought it would, the subject being one on which many readers hold strong views. It bears upon difficult problems however. At one extreme, there's the view that only those licensed to do so should be allowed to offer the public a TV repair service. This approach has been adopted in one or two countries, and there are precedents here. If you offer credit facilities, you now have to be licensed; if you offer driving instruction for payment you likewise have to have a licence. But the British public does not take too kindly to this sort of thing. If it did, we would all cheerfully carry identity cards and have our finger prints stored away somewhere, all of which would undoubtedly help in the battle against crime. The public won't have it however. And, returning to the business of getting TV sets repaired, it's unlikely that it would be happy about being told how to go about this – though it's ready enough to complain if it feels it's been done. There's also the practical problem of supervising any "authorised" system. Would the police be expected to check on shops and advertisers in local papers? Would you be committing an offence if you got a friend to "have a look at" your telly? No, this just doesn't look like being on. Nor is the analogy with credit or driving instruction particularly pertinent. The former brings us into the realms of banking and public funds, the latter could involve injury – though so could a faulty TV set, while you can give driving instruction to your friends provided they don't pay. It's a question of where to draw the line, never an easy thing to decide. Usually someone eventually sets up an official enquiry, in the fullness of time a lengthy report is produced, then the argument starts in earnest!

One can appreciate why some of those in the trade feel that steps should be taken to give the public greater protection. If you've gone to the trouble of taking the appropriate courses, gaining your certificates, and ensuring that you either have or have access to adequate equipment and spares, it's a bit galling to find some dabbler having a go on the side and undercutting the cost of providing a professional service. It's especially galling if you get only the awkward, time consuming faults or the set that's been well and truly got at, while the local handyman or part timer creams off the simple jobs on a cash only basis.

To go to the other extreme, there's the argument about freedom of choice. Just why shouldn't you go to whomsoever you please? Why should anyone lay down rules as to how you should go about as simple a matter as having your telly repaired?

These are the extremes, and there's a wide range of possible viewpoints in between. We hesitate advocating anything very specific ourselves, and would prefer to let readers, who after all often have greater experience of dealing with the public in such matters, air their views. At the end of the day however it's a matter of trying to ensure that the public gets a fair deal. It's in everyone's interest that servicing is carried out efficiently, safely and at a reasonable cost. So far as retailers are concerned, the RETRA sets guidelines and adjudicates where a dispute is taken to it. That's fair and is the sort of thing traditionally done in many other fields in the UK – it's called self-policing.

Could such an approach be extended? It seems unlikely. How do you involve those who operate on a part time basis? You can't stop them, and if you could do we really want to? As several letters have pointed out, many an enthusiast finds work building up because the service provided by local established shops has been found wanting.

In this age of consumer protection you might think that protecting the public and restricting the often dangerous efforts of the bodger would be part of our consumer legislation. In practice, in a field as diffuse and diverse as repairing broken down tellys it seems unlikely that anything much can be done to ensure higher standards to the public. The problem may well simply fade away with time however: the more complex TV sets become, the less likely they are to appeal to the dabbler when defective.

CORRECTION

The power supply pin connections for the 7490 i.c. were given incorrectly on page 415 of the June issue in the sync pulse generator article. Pin 10 should be connected to chassis, with the 5V supply to pin 5.

Teletopics

CALL FOR INDUSTRY CUTBACK

The recently published progress report of the National Economic Development Council's sector working party on the consumer electronics and components industry recommends that the size of the industry needs to be urgently cut by something of the order of 20-30 per cent, with the government considering support for the creation of alternative jobs. The report also recommends that the strongest possible diplomatic support should be given to the industry's demands for cuts in imports – particularly in TV and audio products, not only from Japan but also from other "far eastern bloc sources".

The report says that the industry's fixed assets are being used at only about 50 per cent of their potential. Our report on TV plant closures and other steps last month suggests that the industry is already in the process of reducing capacity, while the latest BREMA figures show that the per centage of the TV set market taken by imports has already been reduced slightly compared with last year. The situation nevertheless needs to be carefully watched. There's the possibility of a flood of Japanese video equipment in the offing, while promises by the Japanese to limit unofficially their exports in various fields and reduce their mammoth trade surpluses have on too many occasions come to nothing. There are good reasons for this: the whole growth of the Japanese economy has been based on large scale exports of consumer products, and to change the balance of the Japanese economy is not something that can be done overnight. The trouble is that one doubts whether the will to do so is there: the giant Japanese corporations are probably beyond any effective control.

Returning to the NEDC report, the following targets for the industry are suggested: reducing import penetration to 37 per cent by 1980 and to 35 per cent by 1984, with exports increased from their 1975 level of £78 millions to £150 millions by 1980 and £280 millions by 1984. It may appear ominous that the year 1984 was chosen as the target date, whilst the realism of pulling figures that far ahead out of the hat is open to question. It would be nice to be right, but other countries will be aiming for the same ends, seemingly against a background of stagnant world trade. The one hopeful thing is the signs that the industry has already set about achieving a better performance and is holding its share of the market. The main present weaknesses are on the audio and radio side, while for the future one's concern must be as to whether the industry will be in a position to take advantage of technical developments and breakthroughs.

In a particularly interesting passage the NEDC working party complains that its attempts to work out a possible industrial strategy were "considerably handicapped" by the efforts it had to put into opposing the Hitachi project for an additional TV plant in the UK. It seems to have been singularly unimpressed by assurances that this would use mainly UK produced components, and estimates that had the plan gone ahead the net loss of jobs could have reached 5,000, accompanied by a substantial worsening in the industry's trade balance.

The working party feels that significant progress was made last year, and suggests that the industry can increase its share of the Western European markets where it benefits from a significant cost advantage. On quality and reliability the report comments that further progress has been made in eliminating the gap between Japanese and British products, but points out that the fragmented nature of the industry (there are eleven companies making colour TV sets in the UK) means that the companies do not have the scope for a sustained, aggressive, volume-based export programme.

According to the report imports rose from 8 per cent in 1970 to 41 per cent in 1976, while exports improved from 8 per cent of output to 23 per cent. With the decline in the home market from the cataclysmic boom of 1973, and the improved exports, the industry's balance of trade deficit narrowed from £219 millions in 1973 to £131 millions in 1976.

Employment in the industry has fallen from a peak of 70,000 in 1973 to 49,000. Rationalisation and modernisation will cut jobs further in the short term, but it's hoped that a planned contraction will provide the basis for employment growth in the medium to long term.

COLOUR PORTABLES

One of the main features of this year's trade shows will be the introduction in many well known ranges of receivers of small-screen – 14 or 16in. – colour sets. Bush started the trend with their 14in. model BC6004, mentioned in the February *Teletopics:* more recently Philips followed up with their 14in. Model 825. The latter now makes its appearance in the Pye range as Model CT6225, while a 16in. model (MC6124) is to be added to the Murphy range. ITT are also poised to introduce a 16in. model.

One of the most interesting colour portables however is the new Ferguson 14in. Model 3787 "Movie Star", since this is designed for both mains and battery operation. A battery adaptor, type TA75, which fits inside the cabinet, converts the set for operation from a 12 or 24V battery. The set weighs 32¼lb, and the attractive black and silver cabinet is fitted with two recessed carrying grips.

Other interesting news from Thorn is the introduction of two new large-screen monochrome sets, the 20in. Model 3850 and 24in. Model 3852.

BRIGHTER COLOUR CRTs

Increasing the light output from colour tubes is one of the current development trends. Late last year ITT announced that a new version of their Model CC781 would be fitted with a new ITT tube – a version of the 20AX – giving 70 per cent greater light output. Mullard have now announced a new version of their 20AX tube called the Hi-Bri which again offers a 70 per cent increase in brightness, with no loss of contrast. Under normal viewing conditions where increased light output is not required the viewer gains from the improved resolution and the reduction in power consumption resulting from the lower beam current required. The extra brightness also makes it simpler to design an effective control circuit to optimise the brightness under different ambient lighting conditions.

The basic approach to obtaining increased light output from the 20AX tube has been to widen the slots in the shadowmask, thereby increasing its transmission factor. The Hi-Bri tube's shadowmask transmission factor is in fact 30 per cent greater than that of a standard 20AX shadowmask. The contrast range is maintained by increasing the transmission factor of the glass faceplate by the same amount. These changes give 70 per cent greater light output, with the contrast range increased by 7 per cent. Increasing the shadowmask's transmission calls for a high degree of precision in order to retain the same purity, since the increased area of the phosphor stripes activated by the beams reduces the effective guard band between stripes.

Meanwhile, Thorn have announced that improved c.r.t.s with higher light transmission glass and pigmented phosphors to improve the contrast range are being used on the latest versions of their 8000 and 9000 chassis. The tubes are types A44-272X and A51-163X respectively. This technique was described on page 530 of our August issue last year, when we reported on a visit to Thorn's Enfield TV plant. The improved type A67-128X tube is being used in 26in. models.

STATION OPENING

The **Chagford,** Devon relay station is now in operation on channels 21 (BBC-1), 24 (Westward Television) and 27 (BBC-2). A vertically polarised group A receiving aerial should be used.

MORE VCRs

Thorn are to introduce a VCR to the JVC VHS standard at the forthcoming 1978 trade shows. It will be known as the Videostar and will give up to three hours' continuous record or playback. Distribution will be via appointed dealers, and sales and product training sessions will be available at twenty six different venues throughout the country.

A new Grundig VCR-only factory is nearing completion at Nuremburg, the aim being to counter the increasing competition from Japanese VCRs in the European market. Their new Model SVR4404 will have a four-hour capability and is to be shown at the forthcoming trade shows. Grundig plan to produce 10,000 of these VCRs by the end of the year.

SOLID-STATE VALVE REPLACEMENTS

As the days when valves were used in current production TV sets recede into the past so the price of replacement valves escalates – if indeed you can get them. We had the latter experience ourselves recently when we approached our local supplier for a new PL83 – the video output pentode that was the standard device before the PFL200 came along. "Not in the list any more old chap" said he. We found a source shortly after, but it set us thinking. It seems that the rental organisations, which still have large numbers of hybrid sets (our set wasn't even that!) in use, are much concerned about the cost of replacement valves to keep their sets going. One rather notorious valve (though it does lead a hard life) is the PL802 luminance output

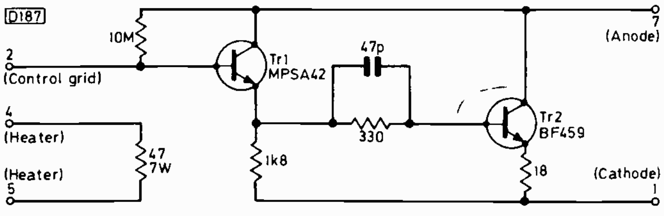


Fig. 1: A solid-state PL802: resistors 0·33W unless otherwise indicated; 47pF capacitor ceramic plate.

pentode, and one or two solid-state equivalents are appearing. Fig. 1 shows a typical example. An emitter-follower is required to provide a high-impedance input, and a BF459 provides the high-voltage swings to drive the c.r.t. cathodes. A 7W, 47Ω resistor is included to provide heater line continuity, and the whole thing is arranged as a plug-in replacement. Neat.

TV SOUND CHANNEL IC

There have been several combined intercarrier sound channel/audio amplifier/output i.c.s announced by the various i.c. manufacturers, but very few seem to have been adopted so far by setmakers. The only model we can think of in a UK range using such an i.c. is the German-produced Bush Model BC6004 small-screen colour transportable which features a TDA1035 6MHz sound/audio i.c. Maybe RCA will have more success with their newly introduced CA1190GQ, a version of their industrial type TDA1190Z, differing primarily in its provision for external feedback components and the use of a higher value volume control. The i.c. consists of a multistage i.f. amplifier/limiter section, f.m. demodulator, regulated power supply, d.c. volume control and an audio amplifier designed to drive an 8, 16 or 32Ω speaker. The nominal power output is 3W and the device will operate at supply voltages over the range 9-28V. Typical performance figures are: quiescent current 25mA, 5kHz deviation sensitivity 1W, 3dB limiting sensitivity 50μV and a.m. rejection 50dB. The electronic volume control incorporates improved taper and single-wire control. The CA1190GQ is supplied in a hermetic gold-chip 16-lead QUIL plastic package with integral heatsink for printed-board mounting.

VIEWDATA AND TV USER

A new quarterly journal entitled *Viewdata and TV User* is to be launched by IPC Electrical-Electronic Press, aimed at all those interested in the expanding use of the TV screen as a comprehensive information service. The first issue will follow on the start of the trial Viewdata service this summer. In addition to feature articles and latest news and product information, each issue will contain an updated Prestel (as the PO has now decided to call its Viewdata system) directory for users of the service.

TV AERIAL/GAMES COMBINERS

A TV set's aerial input connector is a fairly delicate arrangement not intended for constant plugging in and unplugging. Generations of service engineers know about no or poor results due to a fracture or break, and the problem has increased with the popularity of TV games. The aerial lead can also be damaged. The answer of course is an external combiner for the aerial and TV games inputs, with a switch for selection of either input. Quality components are required however if signal deterioration is to be avoided.

We mentioned one such unit, available from Adam Imports Ltd., Harrogate, in the March *Teletopics*. Two more units have since been introduced, one by Voltmace Ltd., Knap Close, Letchworth, Herts and the other, type CM7042, by Labgear. The insertion loss with the CM7042 is less than 2dB for the selected input and the isolation between the two inputs 50dB – good isolation is essential to avoid the TV games signal being radiated via the aerial. Labgear suggest three other uses: for combining VCR and aerial inputs; for combining two aerials where ghosting prevents the use of inductive combiners; and, in reverse, to switch a single input between two receivers.

Hot Pyes

Les Lawry-Johns

TIME after time we've noticed that if you get one awkward one in of one type you're bound to get half a dozen of them in a row. A little while ago we were plagued with Thorn 3500 chassis, one after the other, all awkward, nothing easy. Then came the Philips G8s, one after the other again until we cried out in anguish, enough, enough, let's have an end to it. The other day though it was the turn of the Pye group hybrid models – 691, 693 and 697 chassis, Pyes, Ekcos, Invictas, etc. Normally these sets are no trouble to us at all: one can usually put a couple of items in one coat pocket, a couple of tools in another and carry a soldering iron etc. to the scene of the crime in full knowledge that if the customer has described the symptoms correctly the job will be done in minutes. You know the sort of thing: picture went off, sound still o.k., a smell of burning (or saw smoke) and switched off (or the set went off completely as the fuse failed). The one or two items in this case would be a 100kΩ 1W resistor, an $0 \cdot 1\mu$F 1kV capacitor and the usual fuses normally in the trouser pockets anyway.

The Stock Troubles

Avid readers will have no trouble in identifying this common fault. The $0 \cdot 1\mu$F capacitor (C224) decouples the boost line feed to the c.r.t. first anode presets, coming via the 100kΩ resistor (R227). The capacitor shorts, the resistor cooks and the fault then becomes the same as if the $0 \cdot 47\mu$F boost capacitor has shorted, the difference being given in the description, i.e. smoke or a smell of burning which doesn't occur when the boost capacitor goes short-circuit because the PY500 immediately passes excess current and the fuse fails.

For the benefit of less avid readers, or if the symptoms have not first been properly described, the way to tackle the condition is as follows. Check the fuse. Connect an ohmmeter from the top cap of the PY500 (or PL509) to chassis. If there is a low reading (should be about 1MΩ, give or take a few hundred thousand – let's not be mean about this, say the needle moves on the ×1 scale or more likely swings over to give a definite reading) there is a short on the boost line. There are two likely conditions (lots of others, but two likely). One is that the $0 \cdot 47\mu$F boost capacitor C218 on the line output transformer assembly has shorted, the other that R227 has become a charred image of its former self due to C224 shorting, the 100kΩ now being more like something under 100Ω (hence the unspecified movement or deflection on the low ohms range). The clue is in the appearance of the 100kΩ resistor. If it's clean and brightly showing its brown-black-yellow bands, suspect it not. Neither suspect C224 of course. Snip one end of C218 (the fat capacitor) and read again.

Ah, you may say. This is all very well, but where do we look for the 100kΩ resistor, to see if it is feeling poorly? Ah, we reply. It all depends. If the right side section is mainly a metal box, look underneath on a tag panel about half way between the PL509 and the PCF802 valve bases, with the $0 \cdot 1\mu$F capacitor laying along toward the shift controls (early models), or smack in the middle on later models (691). If the right side is occupied by a vertical printed panel (later 697 chassis), note the top centre red box with the fuse inside. Look down the centre about a third of the way down, just above the transformer, and there it is, with C224 leading off to the right. All right?

Unstable Sound

Well now, none of this applied to our row of Pyes, and more's the pity. The first one seemed simple enough to start with. No valves glowing. Early model, metal box on right side. Move it out to check the supply line. O.K. Check PY500 and PL509 heaters. O.K. Move the box unit back but fail to notice that the rubber sleeve has slipped down from the end of the focus unit (the e.h.t. end). Find break in heater circuit on left side colour-difference amplifier panel – crack in track to one of the PCL84 heater pins. Repair track. Valves light up. Lovely picture and sound. Sharp crack as e.h.t. discharges to convergence panel. Picture still o.k. Sound goes funny. Very slow motorboating, low sound clear, loud sound increases the rate of motorboating to make the effect garbled.

This could be due to an open-circuit electrolytic in the power unit or a fault in the audio module, possibly a faulty transistor. Check the easy thing first. Clip a high capacitance electrolytic across the supply to the module. No improvement. Fault must be in module.

Now the module in these earlier models is a Mullard LP1162. The most common complaint is failure of the output transistors. This cooks up the 2.2Ω resistors which are connected between the emitters for bias purposes. Replacement is no joke, as we've mentioned before. Rush down to van and say unkind things to sleeping guard dog who continues sleeping. Rummage in spares box. Two modules. One used, one new. Rush up with both. Fit new one. Similar symptoms as before. What now? Don't know. Check this, that and the other. Remove front control panel again. Remove module again. Fit used one. Lovely clear sound. I hate modules. Make sure e.h.t. cannot discharge again. Carefully mark modules u/s.

No Signals

Carry on to next set not too far away. Ekco with the 697 chassis. Varicap tuner. Raster and noise on screen, just as if aerial is disconnected. Aerial is disconnected. Plug in aerial. No change. Check tuning. Suspect loss of h.t. to the two $9 \cdot 1$kΩ resistors on top of the tuning panel (Fig. 1). H.T. present, and just over 30V at the TAA550 zener. Now what?

Remove tuner panel and check voltages. A.G.C. o.k. at A. +12V at B, nothing at C. This is where the tuning voltage should be. Check again and hold tuner steady. Tuning voltage o.k. at around 10V and lots more noise. Reach round and tune in sound and vision. I.F. unit on one knee, tuner on other, very uncomfortable. Let go of tuner. No tuning voltage, no sound only hiss. Move legs. Sharp point on i.f. panel penetrates trousers. Has to be 200V h.t. Move more quickly and wish I were dog in van. Examine tuner more carefully. Intermittent short to earth from tuner voltage point C when tuner is moved. Take off cover and find tiny piece of wire which had no right to be there.

This was a bit of a relief actually, because we've had our fair share of trouble with varicap tuners of various types. It's usually a faulty transistor or wires touching (just) the side wall, but we had one where the tuning voltage was lost due to a coil inside the screened compartment intermittently touching the wall of the compartment (lid soldered on).

Intermittent Blue

So having restored normal signals and replaced the tuner and i.f. panel we thought we'd finished. No such luck. "While you're here," said the gaunt Mr. Moneypenny, "perhaps you'll clear a minor thing. The blue keeps going." I like this "minor" business. It implies that it won't take a moment, any fool could do it if he wasn't so busy, and of course it won't be worth charging for.

Anyway, the blue did drop out as we watched the test card, and promptly dropped back in again. We diagnosed a poor contact under the blue PCL84 on the CDA panel. Inverting this, we were surprised to find hardly any sign of deterioration. All was bright and clean. No poor solder, no cracks, nothing. Tapping around above the panel produced blue drop out all around the area however. More gentle disturbance finally seemed to cast suspicion on RV27, the B–Y drive control which is part of the blue preamplifier transistor VT31's load, as the collector voltage of this transistor came and went as the preset was moved one way and then the other. Fitting another preset seemed to clear the condition, but on checking the control later nothing seemed to be wrong with it at all.

Dealing with Weak Line Hold

Back on the bench sat yet another specimen, this time a Dynatron set resplendent with a black front control panel with lots of little chrome knobs, but still a Pye at heart. Again the 697 chassis (glad of this really, because we're still not completely at home with the later solid-state 725 etc. with vertical swing panels). The note read "loses line hold after one hour, also poor brightness and colour." Coward to the last, we tackled the poor colour and brightness first. A new PL802 worked wonders for the brightness and definition. Soldering suspect joints under the panel and improving the earth contacts to the rear edge clips seemed to clear up the colour.

Now for the line hold. Always tricky on these sets, purely because of the vertical right side panel. The PCF802 line

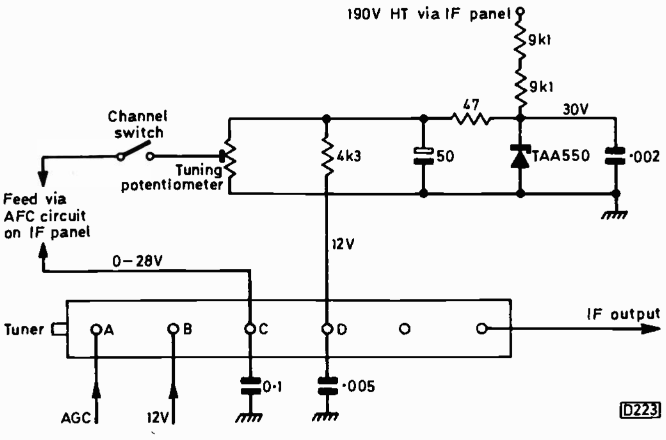


Fig. 1: Varicap tuner supplies, Pye 693/697 chassis. There are six channel selector switches/tuning potentiometers.

oscillator, line hold control etc. are at the bottom and are most inaccessible. So we don't use normal methods of fault tracing on these sets when such line troubles raise their ugly heads.

Remove the side and top edge connectors, partly withdrawing the unit. Remove the cover of the line output transformer and the clip earth connectors. Remove the front PK headed 4BA screw which secures the e.h.t. tripler. Lower the panel. Components can now be seen. First check the 47kΩ flywheel sync circuit flyback pulse integrating resistor R203. If it looks discoloured or reads less than 47kΩ on the meter, change it. If it's much less than 47kΩ, check the discriminator diodes D40 and D41 which can suffer if R203 goes low. Remove one end of R210 (in series with the line hold control) and check its value (100kΩ). If much less than 100kΩ, replace it. Even if it's not at fault now it soon will be and can cause other troubles. Then check the large 16μF electrolytic and the smaller 1μF and 4μF ones. These are C215, C213 and C210 respectively, in the line oscillator circuit. If these checks are inconclusive, change the PCF802 and the feedback capacitor C211 (320pF). This completes the normal checks.

Swing up the panel, refit the tripler screw, line output transformer cover, not forgetting the grommets at either end, and the earthing clips, especially that of the focus unit. Replace the edge connectors and refit the unit. If the convergence is wrong or there's something else not working, recheck the edge connectors. This method of attack has proved its worth over and over again. Indeed, after this the Dynatron dyned very well.

Explosions

We have always had difficulty in identifying which Dawe brother is which. Jack Dawe had bought a 26in. Invicta set from us some four years ago (697 chassis), whilst his twin, Oven, had more recently (about two years) bought a 20in. Thorn set (9000 chassis). We had not heard a word from either by way of trouble, which is not bad when you think of it, although we have had a drink with them from time to time.

Anyway, in walked Mr. Dawe. "Hallo Oven," we greeted him.

"I'm Jack" he corrected me. "Where's the complaints department? That rotten set you sold me's gone wrong. I bought it only four years ago. Frightened the life out of our dog when it went bang. He hasn't been the same since. And there was a flash on the wall at the back, or so the wife says. I wasn't looking at it at the time myself."

"How's the wife Jack?" I enquired. "Shelagh isn't it? Lovely girl! Went bang eh? I wonder why?"

"I'm on my way home now," said Jack. "You coming?"

"Rightho Jack, I'll follow you up just as soon as I've put a new mains dropper in this brand new set that I've just unpacked."

So off we went up the hill. Pity his wife's name wasn't Jill, but we mustn't invent names just for effect, must we?

When we got there the poodle was running round in circles, apparently chasing his tail.

"Been doing that ever since the set went bang" said Jack.

"Probably checking up to see that he's still all there" I suggested helpfully, being an expert on dogs.

Taking the back off the Invicta we were not surprised to find a nasty mess on the top centre of the right side vertical panel. The mains input is taken directly to the 2·5A fuse, with tracks leading to the edge connectors which lead back to the on/off switch. The supply then comes back again to the panel to the rectifiers etc. This means that the supply fuse and its connections are alive when the set is off, a point well worth bearing in mind.

When there's been a minor explosion, it's difficult to say exactly what the chain of events were. There's some molten copper and a blackened area. The idea is to clean up the panel, accepting the fact that there's been conduction across the panel between the tracks, the cause of the trouble in the first place rather than the failure of a component. First establish which tracks did which job (when they were there) and carefully wire up as neatly as possibly, cutting away any remaining sections of conductive panel. Some confusion is possible, so the original circuitry must be kept clearly in mind.

There's another and very important factor. Some long thin tracks run down from the top edge connectors, near the area likely to have been damaged. Although they may have been intact at the time of the original trouble, subsequent handling of the panel may have extended any fine cracks farther across the paxolin, fracturing these tracks. This can lead for example to field collapse due to the 20V supply to the height control suddenly being lost. Careful examination can save an awful lot of trouble later.

Having patched the patient up nicely, the set was tried out. Picture rather dark at maximum brilliance. Fit new PL802. Plenty of brilliance. Convergence had wandered over the years, but responded to a few minor adjustments. All in all, not bad for four years' service.

Incidentally, the audio module is replaced by an i.c. on some of these 697 chassis, and there's a separate 1N4002 diode to supply the i.c. instead of the supply being derived from the bridge rectifier.

A further note may be necessary. We've outlined what happens when there's a breakdown of the panel insulation itself. This condition should not be confused with the type of blow out that occurs when the mains filter capacitor, wired across the on/off switch, goes short-circuit. This shatters the fuse of course, but can also damage the print beneath, discolouring a small area of the panel. If the panel itself isn't damaged but the tracks are, check the capacitor which will almost certainly be found shorted.

The next job was to seat the poodle in front of the set so that it could see that it wasn't going to go bang again. Being satisfied on this point, it no longer chased its tail or whatever it was. With the poodle straightened out we thought that a quiet five minutes would be in order. It wasn't.

No Raster

A Pye 691 was apparently no longer entertaining its elderly owner. Off we went armed to the teeth, to wrestle with the final electronic cock up of the day. We won't bore you with the old girl: suffice it to say that she didn't stop nattering from the time we entered to the time we exited. The set however was a different matter.

The fuse had failed and there was a short from the top cap of the PY500 to chassis. Oh well we thought (as best we could against the old girl's incessant chatter), back to the old routine.

Turn up the unit to have a look at the resistors. We expected R227 (100kΩ) to be charred – as mentioned earlier. It wasn't. Or rather they weren't. In fact the 100kΩ resistor had been replaced by two 56kΩ resistors in series, and these were obviously in the best of health. Looking around however we found the 100kΩ resistor (R210) to the line hold control burnt out instead. This made the look under the unit worthwhile after all.

Now whilst this could affect the h.t. supply to the line oscillator, it wouldn't explain the boost line short which we foolishly attributed to the 0·47μF boost capacitor on the line output transformer. Having fitted a new 100kΩ resistor to the hold control, we were then stupid enough to remove the side panel of the transformer housing to expose the said capacitor, instead of checking something else first. Needless to say the 0·47μF capacitor proved innocent when disconnected at one end. Then the penny dropped.

Take out the PY500. No short then present. Heater-cathode short in the PY500 you stupid clot. Why didn't you check that first?

Well, if we had we wouldn't have found the duff 100kΩ resistor to the hold control. All right then, make excuses for yourself, after all it is getting late and the old girl is still on about her sister who died three years back.

Right then. New PY500, new fuse, no shorts. Switch on, lovely sound, real nice that sound. Wonder why the valves aren't lighting up? The sound which sounded so nice by the way wasn't really sound, just a nice loud hiss since the aerial was not in. Put the aerial in. No difference.

Wait a minute. Even if the valves were not lighting, that's nothing to do with the sound. It's not a 691! It's got a varicap tuner that needs h.t. dropped to supply the 30V for tuning. Quick check. No h.t. Now the old girl is on about her school days. Wish she'd stop for a moment so that I can think. Turn the power unit round. A.C. supply o.k. at one end of the surge limiter resistor, not at the other end. 5·6Ω wirewound. Fit another. Try again. Sound o.k., news reader now competing with old girl.

Right. Why don't the valves light up? PY500 is getting heater supply and is new. What about the PL509? Open-circuit heater.

Oh dear, where's it all going to end? Fit new PL509. Heaters light. Allow time for set to warm up. Rustle of e.h.t. Can now see news reader. Not bad. Square up all round and wonder what the sequence of events must have been. Switch set off and wait for lady to stop going on about present day school standards. At last we manage to get our bit in and escape. Name on the cheque, Nightingale. Not very clever and logical was it? We do try to be but confusion usually sets in toward the end of the afternoon. Getting old.

Wideband Signal Preamplifier

using a thick-film integrated circuit

Roger Bunney

THE present signal preamplifier is based on the SGS/ATES SH221 thick-film integrated circuit, which was selected as a method of providing a simple yet effective amplifier covering the v.h.f./u.h.f. television spectrum. The SH221 is referred to as a "hybrid v.h.f./u.h.f. wideband amplifier" in the SGS/ATES data sheet, and contains all the active and passive components required, the only external arrangements necessary being the provision of a suitable supply voltage plus mounting and interconnections.

The need for such an amplifier became evident when the author reviewed a wideband v.h.f./u.h.f. aerial signal preamplifier of Danish origin in the October 1977 issue. Unfortunately distribution of this amplifier in the UK ceased just prior to publication of the review, which resulted in a couple of hundred orders which could not be fulfilled.

The first sample SH221 i.c. we received was not encapsulated (see cover photograph) and all the components, including the two transistors, could be clearly seen. They are mounted on one side of the basic substrate. Subsequent versions obtained were coated with a caramel coloured substance. Mullard have recently introduced a similar range of hybrid wideband amplifiers, but these have not been tried out to date.

Pin Connections

The SH221 is conveniently compact and has seven connection pins. Four of these go to earth, two are for signal input and output and the final one is for the supply voltage. The electrical performance is excellent, the specification sheet quoting a gain/bandwidth product of 17dB ± 1dB over the range 30-900MHz with a typical noise figure of 5dB. The supply voltage required is 24V at 35mA, with a maximum applied voltage of 28V. Fig. 3 shows the gain/bandwidth response at 24V.

★ Components list

IC1	SH221
D1	BY127
C1	0·001μF ceramic
C2, 3	220μF 40V electrolytic
C4	0·001μF feedthrough
C5	470pF ceramic
R1	250Ω 5W, WW (220Ω for 26V supply)
RFC	1A VHF choke
SW1	Miniature d.p.d.t. mains switch
F1	500mA miniature
N1	Mains neon
T1	Eagle MT150

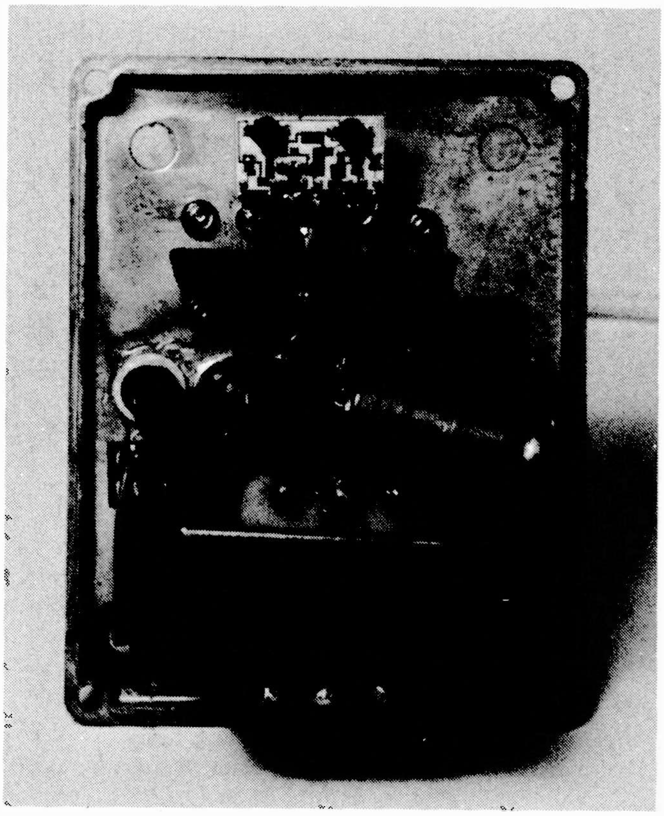
Tagstrip, diecast box, two coaxial sockets, solder tags, grommet (tailed).

Performance

On test, the prototype worked immediately with no trace of instability within the bandwidth – even when running with the input unterminated. With a 24V supply the current taken was found to be 32mA, slightly lower than specified. In view of the 4V maximum supply voltage margin however it was decided to accept slightly reduced gain, erring on the side of safety. An increase of perhaps 2V could be entertained, increasing the current to around the 35mA level.

Gain/frequency Measurements

The voltage gain was measured at certain spot frequencies (see Table 1), and on the prototype was found to be generally lower than quoted in the specification,



Internal view of the prototype.

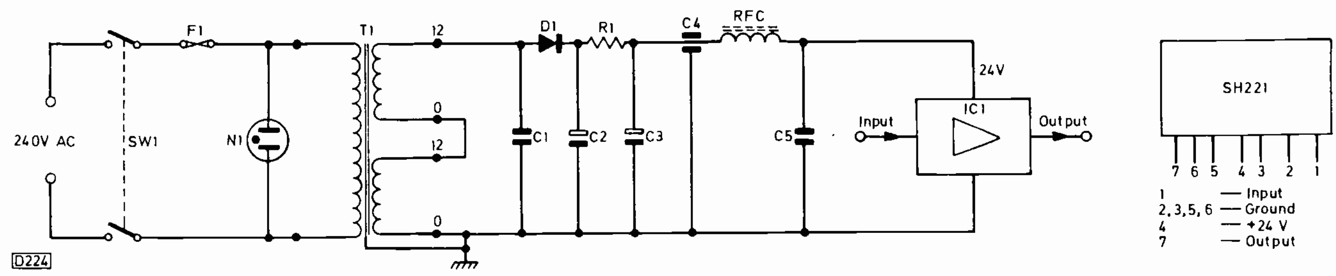


Fig. 1: Complete circuit left, SH221 pin connections right.

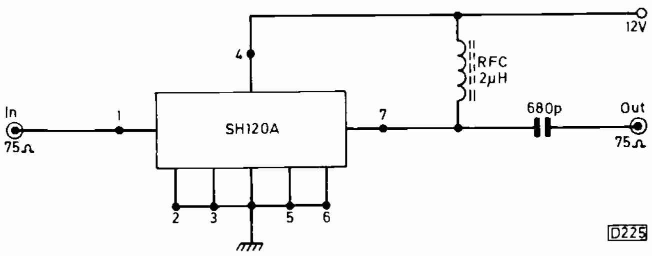


Fig. 2: Test circuit for the SH120A thick-film wideband signal preamplifier i.c. This version operates at 12V with a current consumption of 20mA. The input pin is d.c. isolated internally by means of a 680pF, 50V capacitor.

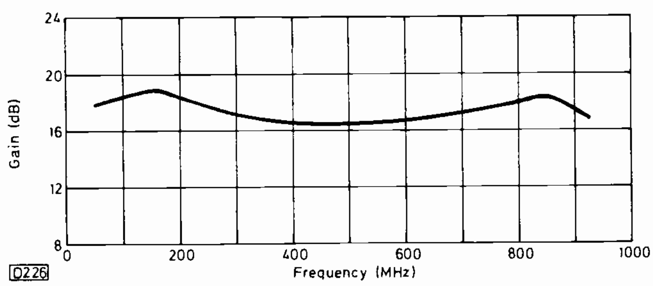


Fig. 3: Gain/frequency characteristic curve.

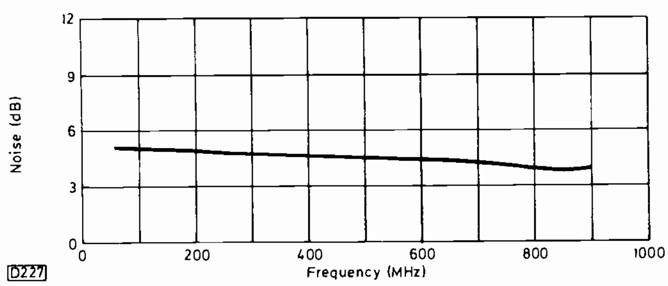


Fig. 4: Noise/frequency performance.

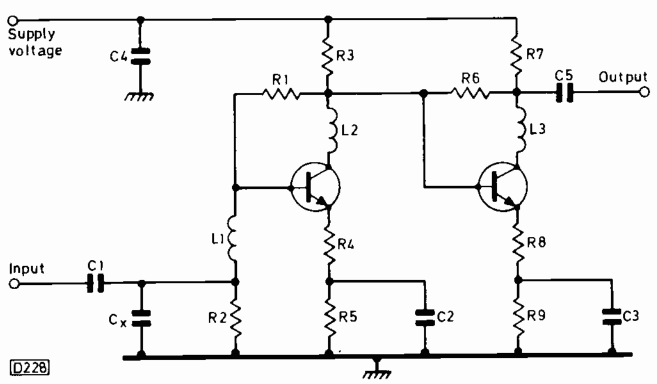


Fig. 5: Internal circuit of the SH221 thick-film wideband signal preamplifier i.c.

doubtless due to the current factor mentioned above. This apart, the gain tended to follow the curve shown in the SGS data sheet (Fig. 3) except for a surprising lift over the 100-150MHz section. No reason could be found for this within the simple signal coupling, and it was assumed to be a peculiarity of the particular sample. The voltage gain figures

Table 1: Spot gain measurements on the prototype SH221 wideband amplifier.

45MHz	15·1dB	500MHz	15·5dB
50MHz	15·8dB	600MHz	15·5dB
100MHz	19dB	700MHz	15·5dB
150MHz	20dB	800MHz	15·5dB
200MHz	15·5dB	900MHz	16·2dB
250MHz	14·8dB		

shown in Table 1 were measured with the input and output terminated at 75Ω.

Construction

Construction of the complete unit is simplicity itself, and provided the absolute minimum lead length is used for the input and output feeders the amplifier will work straight off! An RS/Doram diecast box was used, with signal connection via the shortened central pins of standard coaxial sockets.

The Eagle MT150 mains transformer has two 0-12V secondary windings which are connected in series to give an effective 0-24V output. Having completed construction and testing of the prototype, I reflected that despite the advances in modern technology, enabling amplifier capsules to be produced in miniature form, the power supply still looks enormous when the two are seen side by side!

In passing, note that the two transistors in the unit run very slightly warm to the touch. This is normal for the circuit and no special precautions are necessary.

12V Version

SGS/ATES have also released preliminary details of a second, similar hybrid amplifier, type SH120A. Its physical and electrical characteristics are similar to those of the SH221 except that it requires 12V at 20mA.

Availability

SGS/ATES inform us that the SH221 is stocked by Hawnt Electronics Ltd., Firswood Road, Birmingham B33 0TQ (telephone 021-784 2485), and that the small quanitity (0-24) price is £8.35 plus VAT at 12½%. The author wishes to express his thanks to SGS/ATES for their prompt help and attention. ■

Test Report:
B & K Model 530 Semiconductor Tester

E. Trundle

B & K PRECISION, the American makers of test equipment, are not as yet well known in the UK. They produce a vast range of test gear intended mainly for use in radio and TV service work and for the radio amateur. The equipment in the range is reasonably priced in view of its capabilities and we are reporting here on one example, a comprehensive semiconductor tester.

The 530 has facilities for checking all the important parameters of all types of semiconductor devices likely to be encountered in the entertainment, light industrial and amateur spheres, with the exception of diacs and triacs. A full list of its capabilities appears in the accompanying table, from which it will be seen that it can do anything short of tracing characteristic curves!

In-circuit tests can be made with in most cases no necessity for disconnection of the device. At the commencement of the in-circuit test it's not necessary to know the polarity, lead-out identity or whether the device is bipolar or f.e.t.

A six-position switch in conjunction with a lead identification window and two LEDs indicate the polarity, type and pinning of the device as well as confirming that it functions. A loudspeaker is fitted, and will perk up when a device tests good for "eyes-off" testing. The test signal for the "good/bad" check is a pulsed waveform, with low duty-cycle for best results when testing in the presence of shunting circuitry.

Out-of-circuit Tests

The other tests are made with the unkown device out of circuit, and with the lead-outs having been identified by the

The B & K 530 semiconductor tester.

first go/no go test. Beta or Hfe is indicated by a clear meter directly calibrated, and can be measured under high and low drive conditions. In the former case, no less than 2A can be passed through the device, but the same pulse technique as in the first test is used with a 1% duty-cycle to avoid over dissipation in power transistors and obviate the risk of damage to signal types. For f.e.t.s the same meter provides a directly calibrated readout of the equivalent parameter gm.

The leakage current test is carried out by applying an adjustable d.c. potential between the electrodes in question, any resulting leakage current being indicated on the meter. Leakage in any mode may be checked, and because of the wide variations possible the meter is driven by an ingenious four-stage circuit each section of which drives a segment of the meter. This results in an approximately logarithmic current scale capable of resolving with ease any current from a microamp to five milliamps. For applied voltages up to 10V, leakage current is limited to 5mA by the internal circuitry. For test voltages above 10V the current is limited to 100μA.

This brings us to the breakdown voltage test. All semiconductor junctions will break down at some point of reverse-bias voltage, the most common example being the zener diode in which the reverse breakdown voltage is the primary parameter. Except for MOSFET devices, this breakdown is not destructive provided the current is limited to a suitably low value. These requirements are met in the 530, and a calibrated potentiometer is provided with which the applied voltage can be wound up to 100V. A sudden increase in the leakage current reading signifies the onset of breakdown, and the voltage at which this occurs can be determined.

HF Testing

The ft testing facility is unusual in any transistor tester. It gives a fair idea of the high-frequency limitations of the device under test. This check is available only for bipolar transistors, which for the purpose of this test are driven from an internal oscillator running at 1, 10 or 30MHz depending on the setting of the ft switch. The selected input frequency is amplitude-regulated to a fixed level, while the transistor under test is automatically biased to a collector current of 10mA at which most signal transistors provide the highest ft. The transistor in question will provide an output proportional to its gain at the selected frequency.

This is processed in a buffer and amplifier, then peak-rectified and applied to a separate meter calibrated in MHz from which the ft can be read direct, in three ranges covering ft from 5 to 1,500MHz.

In-circuit Test Results

We commenced with in-circuit tests, bearing in mind the performances of in-circuit testers previously reviewed in this magazine – the Avo TT169 and the Datest 1. As is usual with this type of test, i.f., small-signal stages and class A amplifiers were easily amenable to in-circuit testing. We moved on to class B field and audio output circuits to find that as with the instruments previously tested some direct-coupled devices would check in-circuit while others would not give a reliable indication, depending on the configuration of parallel junctions. In the ITT CVC20 TV chassis for instance, the tester checked one half of the field output stage (T9) satisfactorily but we had to isolate the base of the complementary device T10 before it gave a "good" indication.

We gained the impression that the in-circuit tests were more tolerant of shunt resistance and inductance than shunt capacitance, probably due to the nature of the low duty-cycle of the pulsed test waveform. As an example, the machine happily tested good, in-circuit, the BU126 switch-mode output transistor in the CVC20 chassis. The shunt path between the base and emitter of this transistor consists of a 5·6Ω resistor in series with some inductance! This is remarkably good. Where the shunt path is shorter – line output transistors for instance – the test is misleading unless the base of the device is isolated. This was confirmed by the instrument's ability to test the chopper transistor in a Thorn 3000 TV chassis in-circuit but not the line output transistor.

Given roughly the same circumstances, germanium power transistors fared less well during in-circuit tests. Thus the h.t. regulator transistor of a portable TV, a type AD149 with 10Ω shunt resistor across the c-e junction and some capacitance about, would not give a "good" indication without disconnection.

We found the instrument very tolerant of shunt resistance across the junctions of the device being tested. For silicon transistors, both signal and power, 6-8Ω, depending on the gain of the device, was tolerated across the c-e junctions during successful tests. Across the c-b junction 30Ω was found to be the lower limit with the majority of transistors tested. In most circuits the lowest shunt resistance is usually found across the b-e terminals, and here the 530 really shines, tolerating 4Ω for most silicon transistors and as little as 1 or 2Ω for germanium devices!

Where large values of capacitance appeared across the device under test the 530 fared rather worse than other in-circuit testers. Test results were indeterminate if much more than 50μF was present, or rather less if in combination with other shunt components. It has to be pointed out that this is better than the machine's specification, and that such large values of capacitance are seldom directly across a junction in circuit.

F.E.T.s and thyristors were easily checked in-circuit without disconnection, with the usual proviso that in the rare case of a thyristor being fed direct from a pulse transformer the gate must first be isolated.

In-circuit diode tests are of little practical use, though the tester is in most cases capable of identifying the polarity of a diode in-situ.

If the lead-out identification is known, the loudspeaker can be used to test awkwardly-placed semiconductor devices in-circuit, so there's no need to look at the tester each time. We can vouch for the usefulness of this facility with certain types of printed panel and layout!

Out-of-circuit Test Results

The beta and *gm* tests were found to be useful, particularly where matched pairs of semiconductors are required, whether identical or complementary. We would

SPECIFICATION

IN-CIRCUIT TESTS:

★ Good/bad test for transistors, f.e.t.s and thyristors.
★ Identifies bipolar transistors as npn or pnp types and f.e.t.s as n- or p-channel types.
★ Identifies gate lead of a f.e.t. or base lead of a transistor ("hi" drive).
★ Identifies all leads of a transistor when using "lo" drive.
★ Identifies all leads of a thyristor.
★ Identifies polarity of diodes.

OUT-OF CIRCUIT:

★ Good/bad test for transistors, f.e.t.s or thyristors.
★ Identifies transistor as npn or pnp type and f.e.t.s as n- or p-channel types.
★ Identifies gate lead of a f.e.t. by test lead colour.
★ Measures breakdown voltage up to 100V for transistors, thyristors and diodes.
★ Measures reverse leakage from 0·5μA to 5mA for transistors, thyristors and diodes.
★ Measures source-drain current and gate leakage of f.e.t.s.
★ Measures ß for low- and high-power transistors.
★ Measures *gm* for low- and high-power f.e.t.s.
★ Measures *ft* (gain-bandwidth-product) of bipolar transistors up to 1·5GHz.

APPLIED TEST CURRENTS:

★ Base drive: 200mA ("hi" drive) or 1mA ("lo" drive) at 4% duty-cycle.
★ Collector drive: 100mA at 4% duty-cycle.
★ Test repetition rate: 7 per second.
★ Reverse voltage for leakage test: 0 to 10V (5mA) and 10V to 100V (100μA).
★ Beta base drive current: low power at 50μA continuous; high power at 10mA pulsed at approximately 1% duty-cycle.

LIMITING IN-CIRCUIT SHUNT VALUES FOR VALID GOOD/BAD TEST:

★ Resistance: down to 10Ω with "hi" drive;
down to 1·5kΩ with "lo" drive.
★ Capacitance: up to 15μF with "hi" drive;
up to 0·3μF with "lo" drive.

ft MEASUREMENTS:

★ Test voltage: 8V.
★ Test current (fixed) 10mA.
★ Test ranges:
(1) *ft* 0 to 100MHz, test frequency 1MHz.
(2) *ft* 0 to 500MHz, test frequency 10MHz.
(3) *ft* 0 to 1500MHz, test frequency 30MHz.

ACCURACY OF TEST MEASUREMENTS:

Measurement	Typical at 25°C	Guaranteed at 25°C	Guaranteed at 0-50°C
Beta (high- and low-power)	7%	10%	15%
gm (high- and low-power)	7%	10%	15%
Leakage current	10%	20%	25%
ft	10%	20%	30%

ACCESSORIES:

★ Three test leads with mini-lock clips supplied.
★ Short test leads for *ft* measurements supplied.
★ FP-5 dynaflex probe (optional).

SIZE:

13⅜" x 10⅛" x 4" (34cm x 25·7cm x 10·2cm).

WEIGHT:

5·9lb (2·67kg).

have liked a bit more scale length on the beta test, as some modern transistors can exceed the f.s.d. of 600 on this test. The gain test results agreed in the main with the published specifications of the devices tested, and we were amazed at the very wide gain spread of different batches of the same type of device and the variation in gain with drive level and current. As an incidental bonus, we found a couple of faulty transistors amongst our new stock, and indignantly returned them to the suppliers!

Leakage current and breakdown tests were carried out on a wide range of devices, with less happy results. Certainly the instrument does what the specification says it should, but in practice we found that most silicon transistors had breakdown voltages beyond the 100V capability of this test and so could not be checked. Germanium transistors on the other hand usually have an intrinsic leakage current higher than the limiting level of the test circuitry: thus leakage current readings were indeterminate and for the same reason the breakdown voltage test, which relies on the detection of a sudden increase in leakage current, could be carried out only by connecting an external voltmeter to indicate roughly the "zenering voltage" of the germanium device being tested. Other leakage and breakdown checks were satisfactory where they fell within the instrument's limiting values of voltage and current, and zener diodes could be tested easily and speedily.

A separate meter and sockets are provided for the *ft* test facility. The *ft* (transition frequency) is the frequency at which the gain of the device (in the common emitter mode) has fallen to unity, and is the most common way of defining the h.f. capabilities of a transistor. In the Model 530, bipolar transistors can be checked up to 1,500MHz.

We found that the only transistor types which gave reliable results on this test were low-power silicon devices. Let us say at once however that this probably covers 90% of the transistors for which *ft* characteristics might be required. The 10mA collector current applied during this test means that the *ft* of medium- and high-power transistors cannot be accurately established. We were similarly unsuccessful with germanium transistors where *ft* was concerned, even with civilised types like the AF115-8 and recent u.h.f. devices like the AF139, AF239 and AF180. The reason for this is shrouded in mystery: certainly the review instrument was operating correctly, for we went through the recalibration procedure and found that all was spot-on.

Conclusion

The 530 is a smart looking instrument, and comes with a very detailed manual. It is one of the easiest to use in-circuit testers we've come across, and within the limitations given above gave a good account of itself. In view of its price however and the almost universal practice of testing semiconductors by substitution we cannot see that it will find very wide acceptance in the servicing trade and do not feel that it's really a laboratory instrument either. The experimenter would find many uses for the instrument, and it would be a godsend to the "unmarked, untested" brigade in spite of its apparent aversion to germanium devices. On the other hand, for the price of the Model 530 one could buy a mighty lot of marked, tested and guaranteed transistors! ■

Editorial note: The B-K 530D (230V mains version) is available from Tony Chapman Electronics Ltd., 80A, High Street, Epping, Essex CM16 4AE. The price is £180 plus VAT at 8%.

Faults Analysed

Robin D. Smith

Overload Trip Problem

What we thought would be a simple fault to cure turned out to be rather interesting. The set concerned was a single-standard hybrid GEC colour receiver, and the problem was that the overload trip in the cathode circuit of the PL509 line output valve would operate 20-30 seconds after the set was switched on. Removing the line output valve's top cap stopped the trip operating, so we naturally suspected a fault in the line timebase. Before checking on the normal short-circuits in the line output stage we checked to make sure that the line oscillator was working and generating the usual −60V drive at the control grid of the PL509. With the top cap still disconnected, the control grid voltage was measured and, although slow to reach −60V, the oscillator eventually warmed up and produced the correct drive. Investigation of the line output stage revealed nothing amiss – even after changing the line output transformer (which has always been very reliable on these sets) and the e.h.t. tripler.

So we decided to take a short cut and see what happened. We replaced the top cap, reset the cutout and switched on, allowing the trip to operate. The set was left for another 20 seconds, and the reset button then held in. Up came the picture, which was quite normal, and on releasing the button the trip remained inoperative. What the hell was happening we thought! The set was run for five minutes and everything remained correct. Switch off, switch on again three minutes later and the set still worked normally. We decided to leave the set to cool down thoroughly, for about an hour, then once again switched on. Twenty seconds later the trip cuts out.

This time however we noticed something else which we'd seen before but not taken into account. What we had seen was that when the set was first switched on the valve heaters would glow bright and then settle down, but just before the trip operated the heaters of the valves on the output panel (the three PCL84s, the PL802, PCL86, also the PCF802) would go very dull (about half power) and the line output and boost diode valves would glow a little brighter. We now had a good idea of what was happening.

If you look at the order of the valves in the heater chain (see Fig. 1) you will see that the valves which glowed brighter are at the high-voltage end and the ones that went dull are at the low-voltage end. Clearly one of the PCL84s was developing a heater-cathode short as a result of which the heater chain was being starved of voltage. This in turn would stop the line oscillator delivering sufficient output (remember we noticed that the −60V took a long time to develop). In consequence the line output valve, with inadequate drive and increased heater voltage, would pass excessive current and operate the trip.

A replacement PCL84 cleared the fault, but without a valve tester I could not determine exactly what was wrong

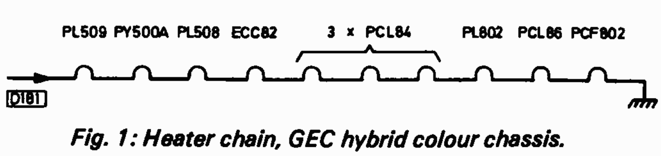


Fig. 1: Heater chain, GEC hybrid colour chassis.

with the old one – as I said before the oscillator did come on eventually, which meant that the short in the PCL84 was clearing after about a minute. If someone asks why we overlooked the heaters in the first place, all I can say is that on a day when sunlight is pouring through the workshop window it's easy to get the wrong impression.

Intermittent Picture

The fault we had on a hybrid Thorn monochrome portable (1580 chassis) was a very intermittent picture, with the raster going to white without modulation but the sound O.K. The fault lasted about five seconds each time. A friend happened to call in, so I asked his opinion. Check the connections to the BF178 video output transistor (VT6) he said, as there's probably a dry-joint. And he was dead right, all three legs were dry (funny this didn't show up when we were tapping around). Resoldering VT6 completely cured the fault.

There's no heatsink on this transistor (remember that its collector voltage is quite high), the heat dissipated by the transistor being taken away via its leads to the solder on the printed board.

Resistor Problems

Back to the GEC solid-state chassis (C2110 series) we mentioned in the May issue. If you find that the 1MΩ resistors R607 and R608 on panel PC481 (line output top panel) have burnt out or fallen in value, just change them and see what happens. They provide the d.c. return path for the e.h.t. current, being connected across the c.r.t. first anode supply reservoir capacitor C608, and have a habit of going faulty just by themselves. 1W hystab resistors are suitable – don't use a single 2MΩ one. When they fall in value, the c.r.t. first anode voltages are reduced. Usually however the fall is rapid and drastic (to approximately 100Ω), with smoke and fuse blowing.

Rank Two-chip Decoder

One of the chassis we deal with most is the Rank A823A and A823B 90° solid-state series. I enjoy working on these, my only complaint being that some of the panels cannot be worked on in situ: they have to be pulled out and operated via short extension leads between them and the main chassis.

Very little has been published on how to go about fault-finding on the decoder. This is a pity, but as the faults are usually of an obscure nature I can understand why the manufacturers don't say too much.

One of the most common faults I'm called out to is intermittent colour or a phase change when changing channels or when the camera changes from one scene to another. It's very important that the subcarrier is correctly adjusted if intermittent colour is to be avoided, and that the ident control 3RV4 is correctly adjusted to prevent phase changes. Rank produced a very handy and inexpensive little meter that I carry with me in order to set up the burst gating, subcarrier and ident. The procedure I use is as follows (for the Z584 and Z971 decoder panels).

(1) Connect test meter to appropriate test points.

(2) Adjust the preset colour control 2RV6 on the i.f. panel to read 600mV of U reference signal at 3TP7 on the decoder.

(3) Adjust the burst output coil 3L1 for maximum meter deflection (this coil drives the crystal circuit to provide the subcarrier). If this coil is out of alignment (reds appear to be desaturated) I find there is a marked effect in the meter reading. It may then be necessary to readjust 2RV6 for 600mV.

(4) Adjust the burst gate pulse generator coil 3T1 for maximum meter deflection. Then reset 2RV6 again.

This will overcome intermittent colour. All that's left to do is to set 3RV4 as follows.

(1) Rotate 3RV4 fully clockwise.

(2) Connect a 10kΩ resistor between the slider of 3RV4 and 3TP8. Interrupt the signal until a reverse ident display is obtained (desaturated wrong colours).

(3) Rotate 3RV4 slowly until a correctly idented display is obtained. Interrupt the signal a few times to ensure that the ident remains correct after each interruption, then remove the 10kΩ resistor.

The customer's saturation requirements can finally be set by means of the preset saturation control 3RV1.

No colour can be due to several things, but the culprit is usually the SL917A i.c.

A set I serviced last week had an odd display. Checking around the SL917A i.c. on the decoder revealed that the bistable was not working, due to absence of the 1·5V trigger pulse at pin 5. This pulse is also fed to the base of the brightness pulse inverter transistor 3VT10, but a healthy waveform was present there. The connection is direct, so I assumed that there was a print break – 3VT10 is some distance away from the SL917A and there are five wire links along the route. Working back with the scope, I found the waveform not present at one of the links so I checked for a dry-joint. Everything O.K. Turning the decoder over however, I saw that there was a resistor (3R91) in place of one of the links and a capacitor (3C66) in place of another one. I then realised that the Z584 and Z791 decoders are not quite the same in this respect, and that I'd been looking at the wrong circuit. Anyway, 3C66 turned out to be intermittently open-circuit, the decoder working correctly when it was replaced. The lesson is to check that you're using the right circuit.

Multiple Defects

I had to repair a Rank A823A which had been got at by the customer. The symptom was no h.t.: the power supply panel (A801) was not secured to the chassis. Refitted it and checked the voltage on the h.t. fuse 8F3: no 200V. The h.t. filter resistor 8R15 was found to be open-circuit, while the smoothing capacitor 8C10 was leaky. So I decided to carry out the repair on the workbench. After changing 8R15/17, the main smoothing block 8C9/10 and the parallel discharge resistors 8R18/19 (both charred) I switched on and, with reduced h.t., saw that the set was working again. Increase the h.t. to 200V, but the tube then presented a negative picture with flyback lines and no colour. The decoder panel was substituted, restoring a normal picture, but the tube was knackered.

From experience I decided that the SL901B i.c. on the decoder panel was faulty and replaced it. It's my opinion that due to the original power supply fault there must have been a c.r.t. flashover which destroyed this i.c.

Anyway, when this repair was completed I switched on and waited for the picture. When it finally appeared I wondered whether a £30 repair bill was worth it with the tube in its present condition. It turned out however that the customer was aware of the condition of the tube and paid the bill happily. Personally, I wouldn't have watched the set like that.

Reduced Width

Now a tip on a fault that can be misleading on these sets. If you find there's reduced width, a good picture but an e.h.t.

of about 30kV, change both flyback tuning capacitors 6C5 and 6C6. They either change value or go open-circuit. This means an increased amplitude flyback pulse – hence the high e.h.t. and consequent lack of width, and the likelihood that the line output transistors will be destroyed. That's why I always replace these capacitors when it's necessary to change the line output transistors.

Suspect Line Output Transistors

What looked like a simple fault was the start of a whole chain of faults on one of these sets. Initially, the mains fuse had blown due to the h.t. rectifier thyristor going short-circuit. Replacements restored normal results but a couple of hours later the customer rang to say that the set was dead again. This time there was no h.t., due to the smoothing resistor going open-circuit. A replacement brought the set to life again, but the set failed after a couple of hours due to the h.t. fuse blowing. This is usually due to either of two capacitors in the line output stage going short-circuit – the s-correction capacitor 6C3, or the c.r.t. first anode supply reservoir 6C13. Both were O.K. however, so attention was turned to the line output transistors and the associated flyback tuning capacitors. No signs of a short-circuit and the transistors read normally, but I've been caught out by that before. So a couple of BU205s went in, together with new tuning capacitors (6C5/6, see Fig. 2).

A further check was then made to see whether there was a short-circuit present – by measuring the resistance to chassis at the collectors of the two transistors. The readings were approximately 1kΩ and 3kΩ, which was normal. The line output transistors were then balanced – by measuring the a.c. voltage across 6R6 in the flyback pulse balancing network and adjusting coils 6L4 and 6L5 in the base circuits of the transistors for minimum voltage. This is best done by reducing the h.t. to 140V by means of the set e.h.t. control 8RV1 – it's important before switching on that the cores of the two coils are both flush with the tops of the formers. On switching on the reading was 9V a.c., and there was a small picture present. First 6L5, then 6L4 was adjusted, the final voltage reading being 1·5V a.c. After restoring the h.t. the balance was again checked and the set reassembled for test.

The results, for a tube nearly four years old, were excellent. After making some final adjustments however I noticed that the set overvoltage control 5RV5 was wound round to maximum and thus inoperative. I came to the conclusion therefore that the original line output transistors had probably succumbed to a rising h.t. voltage – or was it just coincidence (Sod's Law)? Anyway, the set was now operating satisfactorily, after a final check on the h.t. line and resetting the overvoltage control so that the circuit tripped at 220V.

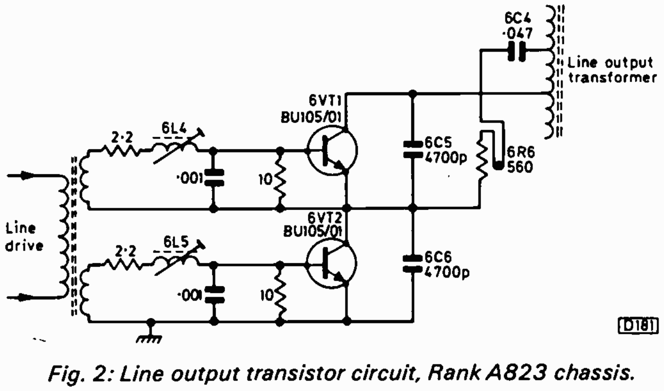


Fig. 2: Line output transistor circuit, Rank A823 chassis.

That's not the end of the story however. Two days later the new thyristor went out of control, triggering the overvoltage protection circuit. If I hadn't noticed the misadjusted 5RV5 I'd have been replacing line output transistors again.

Poor Results and Jitter

We'd been called out to this particular Rank A823A chassis before, to replace a short-circuit l.t. bridge rectifier, and had warned the customer that at six years the tube looked as if it was starting to age. This time the surge limiting thermistor was open-circuit, and on replacing this we noticed that the tube still looked poor and that the field was jittering badly. So we decided to take the set back to the workshop.

The h.t. was steady, so we tried a replacement scan drive panel. That cured the jitter, so our first thought was to try replacing the field output transistors on the set's own panel. No more jitter.

By now the test card was showing, and it was noticed that the picture was overscanned both vertically and horizontally while the tube still looked to be in poor condition. The h.t. was low at 170V, but increasing it would merely produce an even larger picture. Check the e.h.t., which was only 18kV: so something had to be wrong with the line output stage.

Try balancing the line output transistors – but the voltage across 6R6 was zero and no amount of adjustment to the balancing coils would make the needle flicker. The transistors were suspect, but substituting a second-hand pair I'd got in stock, not perfect but good enough to prove the point, still produced no meter reading. So I rang Rank's technical department and asked why no voltage across 6R6? On being told the age of the set, the technical liaison officer commented that he thought he knew what had happened though it had come up only once before. "The purple lead is in the wrong place, so the flyback pulse balancing capacitor 6C4 is out of circuit."

And he was right! Now when these sets were first introduced 6R6, which is in series with 6C4, was an ordinary wirewound resistor and only one of the balancing coils could be adjusted. A modification was introduced, necessitating repositioning most of the components and wires on the line output stage tagstrip. I've done many of these modifications, but the set in question hadn't been supplied by us. There was the purple lead, soldered to tag 2 still on its own. Move to tag 1, switch on, and we have about 35V across 6R6. Too high, but then I'd put in second-hand transistors.

A check on the original transistors revealed the true cause of the trouble: one of them was defective, so what was happening was that the low e.h.t. and poor picture with excess scan were due to just one transistor operating in the line output stage. A new pair of BU205s plus new flyback tuning capacitors followed by transistor balancing and resetting the h.t. produced an excellent picture with correct scanning – and the customer was certainly pleased to hear that his tube was o.k. after all.

The 6C4 business was a bit of a red herring of course. In the latest versions of these sets the flyback pulse balancing network 6R6/6C4 has been deleted.

Other Fault Experiences

We've had many other fault experiences on these sets, but most were covered in the excellent series of articles on the chassis by R. W. Thomson in the November 1977-January 1978 issues of the magazine.

Service Notebook

G. R. Wilding

Loss of Colour Sync

An ITT colour set fitted with the CVC8 chassis would give a perfect picture for an hour or more but would then lose colour sync, though the owner found that retuning would sometimes, if only temporarily, restore colour lock. Naturally the first move was to check that the preset control (R311) in the reference oscillator circuit was set up for optimum results. Making this adjustment seemed to cure the trouble, but about an hour and a half after our return the owner phoned to report that colour sync had again been lost.

This time we brought the set back to the workshop, where we found that with the back removed the fault took over two hours to develop, clearly indicating that it was temperature sensitive. Readjusting R311 would restore colour lock, but on switching off and then switching on after the set had cooled down lock would again be lost.

The drift was occurring in either the reference oscillator, the following reference signal amplifier circuit or the burst detector, and many components could conceivably be responsible, with the reference oscillator transistor T38, the burst detector diodes and the electrolytic C208 in the detector filter circuit high on the list of probables. It was a simple matter to replace the electrolytic so this was done. Once again however colour lock was lost after the usual warm-up period. We then took a good look at the circuit and discovered that there's a 1·5V zener diode (D36) associated with the burst detector circuit. This is d.c. coupled through to the base of the reference oscillator transistor and is present to stabilise the circuit against the effect of temperature change. It could obviously be the cause of the long term thermal drift therefore, and on fitting a replacement and resetting R311 no further loss of colour sync was experienced.

No EHT

No e.h.t. was the trouble with a monochrome set fitted with the Thorn 1500 chassis, and it was found that the fusible resistor in the h.t. supply to the line output stage was open. There was no short-circuit from the anode of the PL504 line output valve to chassis, so the only thing to do was to resolder the resistor, switch on and note results. After a very short time the PL504 began overheating, indicating lack of drive. A new 30FL2 line oscillator valve was tried but failed to effect a cure, so before making further checks the screen grid feed resistor to the PL504 was disconnected in order to prevent damage in the line output stage.

On checking at the anode of the triode section of the 30FL2 (the triode acts as a blocking oscillator) the voltage was found to be much lower than usual. This showed that the stage was not oscillating, since when operating normally the negative voltage developed at the grid restricts the anode current. In this chassis the grid of the oscillator is d.c. coupled to the collector of the d.c. amplifier transistor in the flywheel sync circuit. Thus if the transistor was not conductive its high collector voltage would result in incorrect grid bias. The collector voltage turned out to be pretty well normal however so we next checked the two capacitors in the oscillator circuit – a short in either would stop oscillation. Both proved to be in order so the transformer came under suspicion as the only thing left. D.C. Checks showed that the windings were intact, so the probability was shorting turns. This turned out to be the case, since a replacement restored normal operation.

Intermittent Troubles

The owner of a Grundig Model 6011 colour set reported that it would work quite normally for about half an hour after which the sound and picture would often disappear, returning within a second or so. On test the set worked perfectly for twenty minutes then, far from momentarily going off and on, the width varied spasmodically, returning to normal after a second or two. It seemed to start with therefore that there was a line output stage fault, though rapid h.t. supply interruptions could also be responsible.

The hinged chassis was lowered and a careful visual inspection made. Everything appeared to be normal around the line output stage, but there was considerable panel discolouration around the h.t. bridge rectifier's soldering tags. On switching on again, slight pressure at one side of the unit produced symptoms similar to those described. We hadn't an exact replacement bridge to hand, so instead wired in four separate rectifiers. This completely cured the intermittency and width variations.

Misleading Symptoms

It's very easy for a simple component failure to give completely misleading symptoms! The owner of a Philips set fitted with the 210 chassis – the six push-button dual-standard job – complained of sound but no picture, inspection showing that the latter was in fact field collapse, though the horizontal white line displayed was of such low brightness that the tube seemed to be low-emission. The owner said that the picture had been quite good before the field collapse however.

On removing the back we noticed that the tube and valve heaters were not their usual cherry red, while the glass envelope of the PL504 line output valve was far from its normal high temperature. It was then noticed that the 125Ω heater section of the mains dropper resistor had previously gone open-circuit, and had been replaced by two wirewound resistors in parallel. One was quite hot, but the other was being warmed only by the adjacent resistors and was clearly open-circuit. The original markings had burnt off both resistors, but the intact one was found to be about 250Ω. On then fitting a single, correct value replacement a good picture was obtained. The field collapse had been due to inadequate heater current, as a result of which the field timebase was not oscillating.

Weak Field Hold

The field on a set fitted with the ITT VC200 hybrid monochrome chassis could be locked only when the hold control was at one end of its travel. The control is in series with a 180kΩ resistor in the grid circuit of the triode section of the PCL805 field timebase valve, so our first suspicion was that this resistor had changed value. It was found to be within tolerance however, as was the other resistor in the circuit, so it seemed that there was a defective capacitor somewhere. The fault turned out to be due to the field sync pulse coupling capacitor C70 (0·0047μF).

Scope Trace Doubler for TV Use

Ian Pawson

THE circuit to be described enables two separate traces to be displayed on a single-beam scope, with triggering at either line or field rate from either input. For use in the alternate (alt) mode, the scope timebase ramp output is required. If your scope does not have this facility, the unit will work in the chop mode only.

Principle of Operation

The basic principle of operation is shown in Fig. 1. The two inputs A and B are connected to two analogue switches in IC3 whose outputs are connected together and fed to the Y input of the scope. The control for these switches is provided by the Q and $\overline{Q}$ outputs of a D type flip-flop IC2 connected as a divide-by-two counter. Thus at any one time only one of the inputs is connected to the output. Depending on the state of the flip-flop, either input A or B will be connected to the scope.

In the chop mode IC2 is fed from an oscillator built round the two NAND gates IC1a/b, with a third gate IC1c acting as a buffer. The oscillator runs at approximately 250kHz.

In the alt mode the timebase ramp from the scope is fed to a negative-going edge detector (IC1d). This produces a pulse at the end of every trace on the scope. The pulse is fed to IC2, changing the switch states with every trace and thus giving an alternating display.

To enable the two traces to be separated on the scope, a d.c. bias is added to the signal before it's fed to the scope. This is applied via the two remaining switches in IC3, and is also under the control of the Q and $\overline{Q}$ outputs of IC2. By using a cross-connected ganged potentiometer (VR2a-b), a single control varies the bias applied to both channels, increasing one while decreasing the other.

Sync Separator

To enable the scope to be correctly triggered, a sync separator, switchable between the inputs, is used. This provides separate line and field rate pulses which are fed via SW3 to the Darlington buffer amplifier Tr4/5. This provides an adjustable level, positive-going pulse to the external trigger input of the scope.

Practical Circuit

The complete circuit is shown in Fig. 3. Gates IC1a-d and IC4a-d comprise two CD4011s, the flip-flop IC2 is half a CD4013, and the four analogue switches consist of the CD4066 IC3. If the i.c. pin numbers are used as shown a PCB can be easily made without the use of straps (see Fig. 2).

The timebase ramp input attenuator can be altered to suit individual needs. My own all-valve scope produces a 50V ramp. The preset control VR1 is adjusted to give a pulse output on the lowest (slowest) timebase range for which alt operation is required. This makes the pulses on the higher ranges quite wide but doesn't affect the operation of the circuit as IC2 is positive-edge clocked.

Supply Voltage

The supply voltage depends on individual requirements: to avoid damage to IC3, the peak-to-peak voltage to be measured must not exceed the d.c. supply voltage. Also the higher the supply voltage, the higher the timebase voltage required to trigger the circuit. The supply can be anywhere between 3 and 15V. The prototype used 6V and consumed 8mA. It can easily be battery powered therefore.

Trace Separation

The separation of the traces on the screen will vary as the gain of the scope is altered. It can be varied over a wide

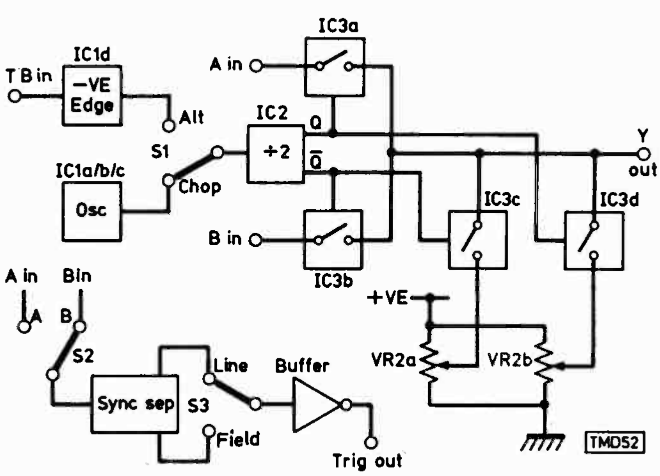


Fig. 1: Block diagram of the unit, showing the principles of operation.

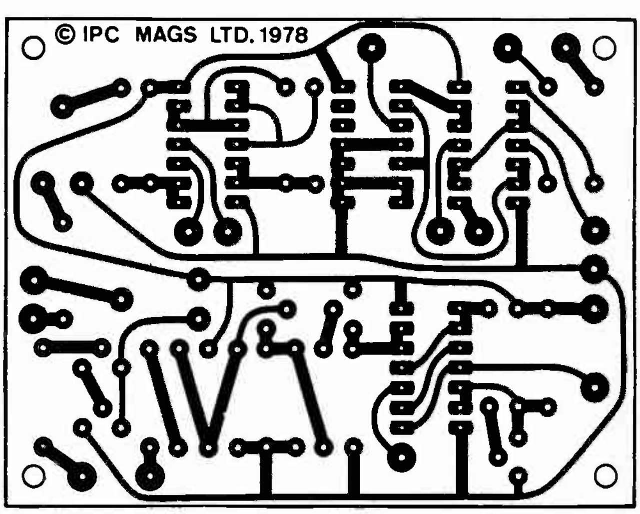


Fig. 2: Suggested printed board pattern for the unit.

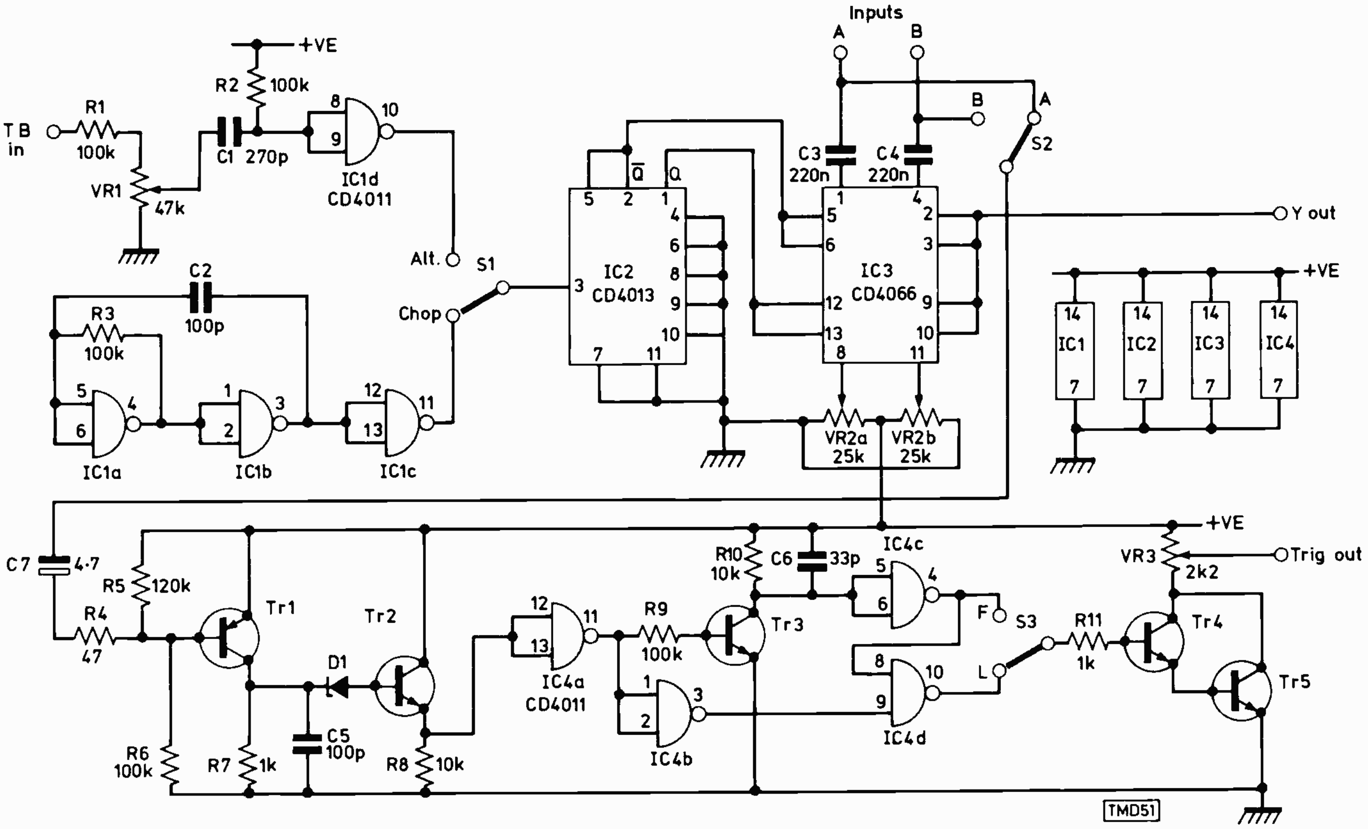


Fig. 3: Circuit diagram of the unit. The prototype operates with a 6V rail. A battery can be used to supply the power therefore.

Parts list

Resistors:

R1	100kΩ
R2	100kΩ
R3	100kΩ
R4	47Ω
R5	120kΩ
R6	100kΩ
R7	1kΩ
R8	10kΩ
R9	100kΩ
R10	10kΩ
R11	1kΩ
VR1	47kΩ preset (Ramp level)
VR2	25kΩ ganged pot. (Separation)
VR3	2·2kΩ preset (Trig op. level)

Switches:

SW1 Mode – Chop/Alt
SW2 Trig Select – A/B input
SW3 Trig Select – Line/field
All single-pole changeover.

Capacitors:

C1	270pF ceramic
C2	100pF ceramic
C3	0·22μF polyester
C4	0·22μF polyester
C5	100pF ceramic
C6	33pF ceramic
C7	4·7μF 35V tantalum

Semiconductors:

ZD1	BZX83/C3V3
Tr1	BCY70
Tr2-5	BC109
IC1	4011
IC2	4013
IC3	4066
IC4	4011

range by the separation control VR2 however. In fact the traces can be made to cross over each other. Because both inputs are fed through the same Y amplifier in the scope, they must be of reasonably similar amplitude. An amplifier and/or attenuator can be included in the inputs if required.

Prototype Protection

A 10MΩ resistor was connected from the input to IC2 (pin 3) to chasssis in the prototype to protect IC2 from damage when SW1 or its connections were left open-circuit. This resistor is not required during normal operation of the unit of course. ■

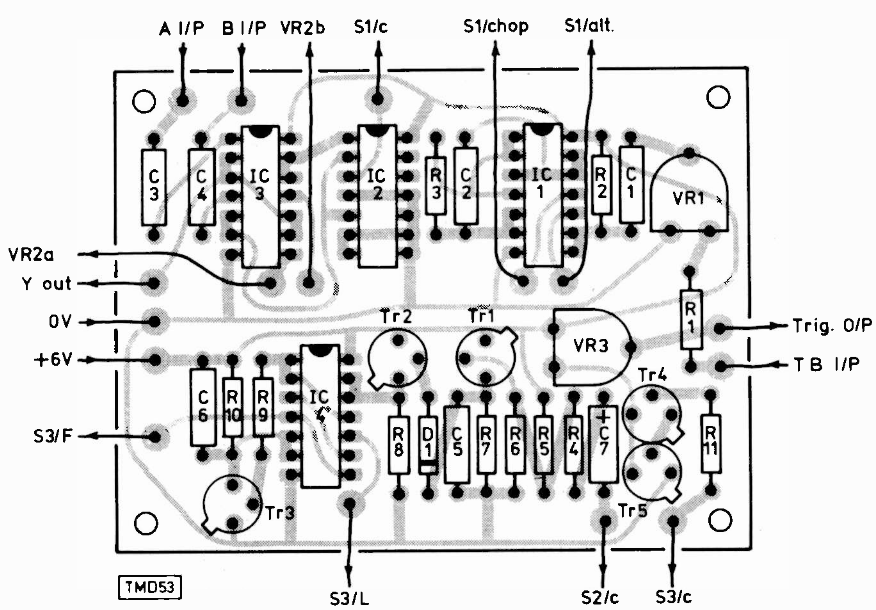


Fig. 4: Component layout.

Transistors in TV Circuits

Part 3

S.W. Amos, C.Eng., B.Sc., M.I.E.E.

In Part 2 we ended by considering audio amplifiers, i.e. amplifiers with a frequency range extending to say 15kHz. This is approximately equal to the line frequency of the 625-line television system, and we shall next consider the applications of transistors in line-frequency circuits. These are numerous of course, because the line timebase is the heart of a television receiver.

Sync Separator

The sync separator is possibly the simplest stage in a television receiver and usually consists of a common-emitter stage with a video input from the video output or driver stage via an *RC* circuit with a long time-constant. For the typical circuit shown in Fig. 1, the video input has positive-going line sync pulses and these drive the transistor into conduction, the base current charging C1 so that the right-hand plate is negative. In the intervals between successive line sync pulses C1 begins to discharge through R1, but the time-constant R1C1 is made long compared with the line period so that very little of the charge is lost during these intervals. The voltage generated across C1 effectively adds a negative bias to the video input, so that only the tips of the sync pulses approach zero base voltage and so drive the transistor into conduction. The remainder of the line sync signal and the whole of the picture signal correspond to a negative base voltage beyond cut off, to which the transistor does not respond therefore. Thus the collector current consists of line-frequency pulses, and negative-going line sync pulses are generated at the collector.

The circuit is interesting because it is the first practical application we have encountered that makes use of the base-emitter junction of the transistor as a diode. The bursts of base current which charge C1 and so generate base bias are amplified by the transistor which thus functions as a normal current amplifier.

Sync Phase Splitter

Rivalling the sync separator for simplicity is the sync phase splitter used in some receivers after the sync separator to produce opposite polarity sync pulses to drive a balanced flywheel sync discriminator circuit. Here (see Fig. 2), as in the sync separator circuit, R1C1 develop a negative bias and the transistor is punched into conduction only by the positive extremes of the input signal. If the input pulses are positive-going, then the bursts of collector current generate negative-going pulses at the collector and positive-going pulses at the emitter. These opposite polarity voltage pulses are of equal amplitude provided R2 and R3 are equal.

The circuit also operates if the input consists of negative-going line sync pulses (such as the output from the circuit in Fig. 1) but the transistor is then conductive for most of the time and is cut off for only the brief periods of the sync pulses. R1C1 can then have a much smaller time-constant, because C1 has such a long period in which to charge and such a short period in which to discharge. A time-constant of 1ms is satisfactory whereas for Fig. 1 a time-constant of nearly one second is common.

Provided the input pulse amplitude is large enough, the output pulses have a voltage amplitude approximately equal to one half the supply voltage, the collector and emitter potentials almost meeting when the transistor is driven hard into conduction. This is an example of a digital application of the transistor, because it is at all times either cut off or fully conductive, the switch from one state to the other being very rapid.

Line Oscillator

The line oscillator is commonly a Hartley circuit, a typical example being shown in Fig. 3, where Tr1 is the oscillator. Such a circuit can be regarded as an amplifier capable of supplying its own input. Thus the centre-tapped inductor, characteristic of the Hartley oscillator, provides a means of feeding the output signal from the collector back to the base.

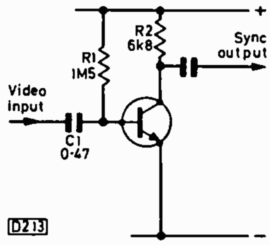
If the signal generated is of small amplitude, the transistor may operate in class A. In this case some means of stabilising the mean collector current is desirable. More usually however, as here, a larger output is generated and the transistor operates in class C, automatic base bias being provided by R1C1 as described for the sync separator circuit. Thus the charge on C1 provides negative bias for the transistor, which takes one pulse of base current and collector current per cycle of oscillation. Across R2 therefore approximately rectangular line-frequency pulses are generated, and these can be used as the input for the line driver stage.

In addition to providing base bias, C1 also acts as a tuning capacitor for the inductor L1. Similarly R1 in addition to providing a discharge path for C1 also provides damping for the resonant circuit L1C1. Manual tuning of L1 is also possible by mechanical movement of the permeable core: this is used to bring the resonance frequency within the range of the a.f.c. circuit. It serves therefore as the line hold control.

Reactance Stage

Tr2 functions as a reactance stage, that is to say it's a stage designed so that the signal-frequency component of the collector current is in quadrature with the signal-frequency voltage impressed on it by the inductor L1. In fact in Fig. 3 the current leads the voltage by 90°, so that Tr2 behaves as a capacitance which contributes to the tuning of L1 and can thus control the oscillator frequency.

The phase relationship required between the collector voltage and current is brought about by C2 and R3. The reactance of C2 at the line frequency is made large compared with the value of R3, so the current in R3 leads the collector voltage by 90°. The voltage generated across R3 is in phase with this current and is applied via C3 to the emitter of Tr2 which is a common-base amplifier, the base being effectively decoupled at line frequency by C4. There is



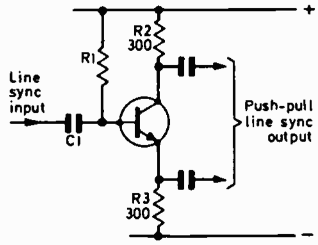


Fig. 1 (left): Typical sync separator stage.

Fig. 2 (right): Sync pulse phase-splitter stage.

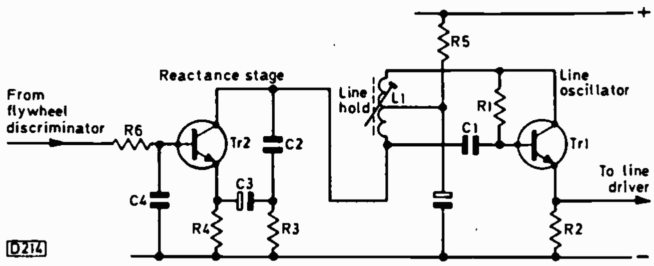


Fig. 3: Simplified line oscillator/reactance stage circuit.

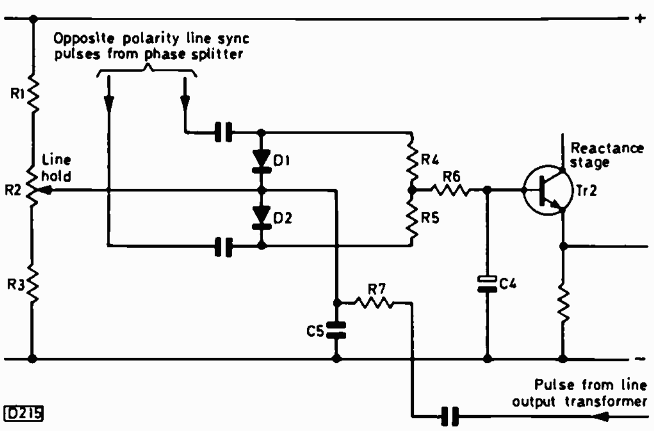
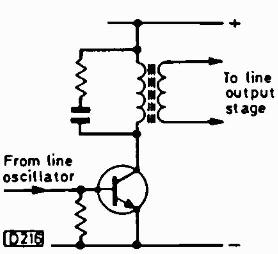


Fig. 4: Simple flywheel line sync discriminator circuit.



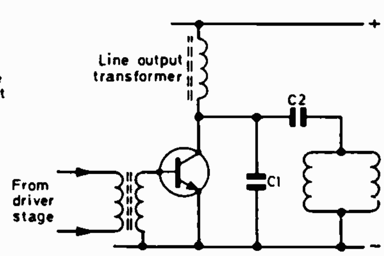


Fig. 5 (left): Basic features of a line driver stage. .

Fig. 6 (right): Basic transistor line output stage circuit.

no phase inversion in a common-base amplifier, so the collector current is in phase with the voltage across R3 and is thus in quadrature with the collector voltage, which is the required condition.

The magnitude of the effective reactance thus achieved is inversely proportional to the mutual conductance of the transistor and this, as pointed out in Part 1, is linearly related to the collector current and can thus be controlled by adjusting the base bias. Hence by varying the base bias we can control the reactance and the oscillator frequency. By feeding the output of the flywheel sync discriminator circuit to the base of the reactance stage we obtain an automatic frequency control system. The reactance transistor must operate in class A, because every change in base bias must produce a change in mutual conductance: thus this circuit makes use of the curvature of the *IcVb* characteristic of the transistor.

Flywheel Sync Discriminator

Although the a.f.c. circuit is effective in controlling the line oscillator frequency within a certain frequency range, it's important that the oscillator frequency should be stable in its own right, i.e. with no input to the reactance stage from the discriminator. Thus a measure of d.c. stability is required for Tr2's mean collector current. This can be achieved by the normal technique of using a potential divider to feed the base, and by including an emitter resistor. R4 is the emitter resistor and the potential divider can be embodied in the discriminator circuit as shown in Fig. 4. In this particular example, R2 is made variable to provide a line hold control. Line flyback pulses are integrated by R7,C5 to produce a reference sawtooth waveform. The output from the discriminator consists of the clamped sawtooth which is smoothed by R6C4 for application to the reactance stage Tr2. As the sawtooth moves positively or negatively with respect to the potential tapped from R2, so the output at the base of Tr2 varies.

Line Driver Stage

The line driver stage is a pulse amplifier, the transistor being switched between conduction and non-conduction by the line oscillator output. There is no need for stabilisation of the mean collector current therefore, making the circuit particularly simple as shown by the typical example in Fig. 5. A current pulse output of the order of 1A amplitude is necessary to drive the line output stage, and to achieve this an output transformer with a large step-down ratio is used to couple the driver to the output stage. This in turn necessitates a high collector voltage supply for the driver stage. The *RC* network across the primary winding is to damp the inductive overshoots generated by the rapid changes in collector current.

Line Output Stage

Circuit diagrams of line output stages tend to be complicated because this stage performs so many functions in addition to providing the line scan current. In Fig. 6 however the circuit has been simplified to essentials. This is another application in which a bipolar transistor is used as a switch. When the line output transistor is turned on by the 1A pulse from the driver stage it effectively connects the primary winding of the line output transformer across the supply, and current therefore grows linearly with time in the transformer and in the line scan coils: this period of current growth is the latter part of the forward scanning stroke, and during it the collector voltage is zero as would be expected in a transistor driven hard into conduction.

When the input current pulse from the driver stage falls to zero the line output transistor turns off and the abrupt fall in collector current in the inductive load generates a large positive voltage at the collector. This is used as a source of e.h.t. and other supplies for the receiver and also charges capacitor C1 in parallel with the transistor. This in fact is the beginning of a half-cycle of free oscillation of the resonant circuit comprising the net inductance and capacitance in the collector circuit. After the positive peak the collector voltage falls to zero and the current in the transformer reverses direction. This period of oscillation, barely amounting to half a cycle, constitutes the line flyback period. The collector voltage attempts to swing below zero but immediately it does so the collector-base junction of the line output transistor becomes forward biased and of low resistance. The base-emitter circuit is also of low resistance, because of the secondary winding of the driver transformer. Again therefore the line output transformer primary winding is effectively connected across the supply, but this time current flows from the inductance to chassis, falling linearly to zero to form the first part of the forward line-scanning stroke.

The line output transistor has to be a special type which can safely tolerate high collector currents and high collector voltages. An interesting feature of the circuit is the reverse conduction of the transistor's collector-base junction during the first part of the forward scan.

AGC Circuit

The a.g.c. circuit of a television receiver generally uses at least one transistor. In the 625-line system, with negative modulation, the amplitude of the sync pulse is used as a measure of signal strength. The transistor is employed as a peak detector therefore.

A typical circuit is shown in Fig. 7. R8,R9 is the potential divider which applies base bias to the controlled stage(s). Tr1 is the a.g.c. detector, with R9 its collector resistor. Tr1 is direct coupled to the collector of Tr2, the video driver stage, and the biases on Tr1 and Tr2 are so adjusted that in the absence of a video signal Tr1 base is a volt or so positive with respect to its emitter potential, which is determined by the potential divider R6,R7. As Tr1 is a pnp transistor, it's cut off therefore and no a.g.c. signal is applied to R9.

The video signal at Tr2 collector has negative-going sync pulses and these drive Tr1 into conduction to an extent proportional to the amplitude of the sync pulses. Thus the collector current of Tr1 is also proportional to sync signal amplitude and this current, in flowing through R9, increases the forward bias to the controlled stage(s) – assumed to be npn types and designed for forward a.g.c.

The standing bias at the base of the video driver can be altered by adjustment of R1. This can be used to provide manual control of the gain of the controlled stage(s), and can act as a contrast control therefore.

Bistable Multivibrator

Some colour receivers use a bistable multivibrator circuit to drive the PAL switch. This consists of two common-emitter stages, as in Fig. 8, with each collector direct coupled to the other base so that when one transistor is on the other must be off. The significant feature of a bistable circuit is that when it's in one state (say Tr1 on and Tr2 off) it will remain in that state indefinitely unless compelled to leave it by an external triggering signal. When triggered it will enter the other possible state (Tr1 off and Tr2 on), and this state too will persist indefinitely unless an external trigger is used to change it.

In a colour receiver such a bistable circuit is triggered by line flyback pulses and because there are two states two pulses are required to produce one complete cycle of multivibrator action, i.e. the triggered bistable circuit runs at half the line frequency (7·8kHz). The voltage output from say Tr2 collector consists of a high voltage (when Tr2 is off) for one line period and a low voltage (when Tr2 is on) for the following line period. This is the type of signal required

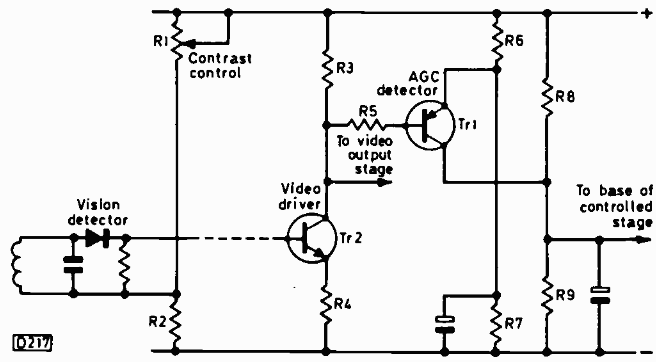


Fig. 7: A pnp transistor (Tr1) used as a peak detector to develop an a.g.c. bias proportional to sync pulse amplitude.

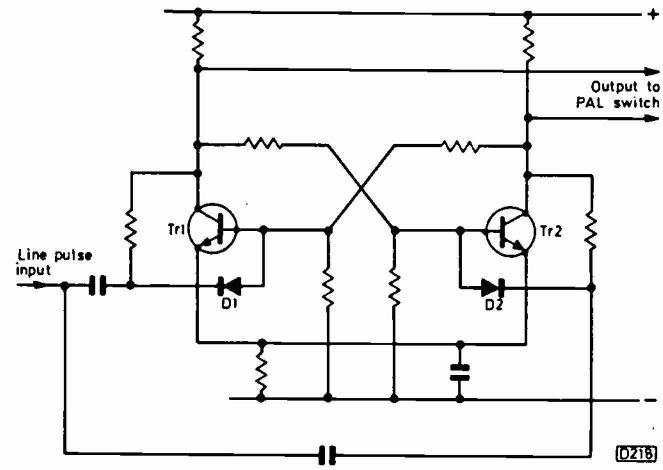


Fig. 8: A bistable multivibrator triggered at line frequency to provide 7·8kHz outputs to drive a PAL switch. Simplified by omission of the ident circuit which synchronises the PAL switching in the receiver with that at the transmitter.

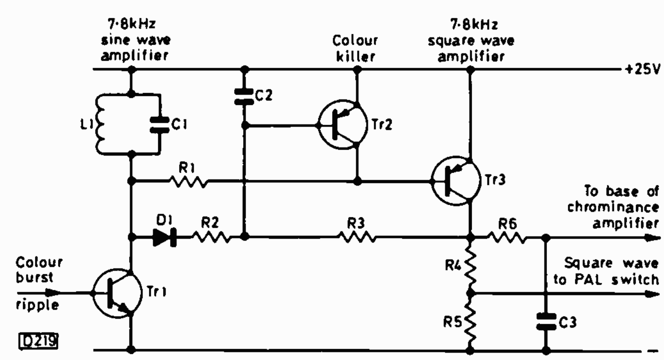


Fig. 9: The colour-killer arrangement used in the Thorn 8000 series chassis. The colour burst ripple input is taken from the burst detector: the ripple arises due to the phase changes ($\pm 45°$) of the burst signal on alternate lines.

to drive the switching diodes in the V-axis switching circuit.

For correct operation a negative-going pulse is required to cut off Tr1 and thus switch on Tr2. The next negative pulse must be directed to Tr2's base to cut this transistor off. The steering diodes D1 and D2 are included to route the line pulses alternately to the two bases. When Tr1 is on its collector potential is near its base potential and thus D1 can conduct the negative-going pulse to its base. At the same time Tr2 is off and the large difference between its collector and base potentials biases D2 off so that it cannot conduct the line pulse to Tr2 base. After a change of state the conditions are reversed, D1 being cut off while D2 can conduct the next pulse to Tr2's base. This bistable circuit is an example of a digital application of transistors.

Colour Killer

Colour television receivers incorporate a colour killer circuit to cut off the chrominance amplifier during reception of a monochrome signal to avoid spurious colour effects from video components within the chrominance passband (4·3 ± 1MHz). Fig. 9 shows an example of a bipolar transistor used as a switch to achieve this. Tr1 is a 7·8kHz sinewave amplifier: it operates in class A, but for simplicity the stabilising components, i.e. the potential divider connected to the base and the decoupled emitter resistor, are omitted. Tr2 is the colour killer and Tr3 a 7·8kHz squarewave generator which takes the place of the multivibrator featured in the previous circuit.

During monochrome reception there is no 7·8kHz output from Tr1, and Tr2 is turned on since its emitter is connected to the 25V rail whilst its base is biased by the network D1, R2, R3, R4 and R5. The collector-emitter path in Tr2 is therefore of very low resistance, causing Tr3 to be turned off. Tr3's collector potential is near the supply negative value, therefore, and this potential is fed via R6 to the base of one of the chrominance amplifiers, cutting it off.

During colour reception the 7·8kHz signal from Tr1 collector is rectified by D1, and C2 is charged to a steady voltage approximately equal to the amplitude of the 7·8kHz signal across L1,C1. The voltage across C2 biases Tr2 base positively and cuts this transistor off, allowing the base of Tr3 to receive the 7·8kHz output developed across L1,C1 via R1. Tr3 is thus punched into conduction by the negative half-cycles from Tr1 collector, and the smoothed voltage across C3 rises to approximately 14V – sufficient to allow the chrominance amplifier to operate normally.

MULLARD HYBRID AMPLIFIERS

A series of hybrid i.c. wideband amplifiers, announced by Mullard, cover the frequency range from 40MHz to 860MHz and provide a choice of gain and output voltages. They can be used as masthead booster amplifiers in aerial systems, as preamplifiers in MATV systems, and as instrumentation amplifiers.

Output	Type	Stages	Gain (dB)	V_O* (dBμV)
Low	OM320	2	15.5	92
	OM321	2	15.5	98
	OM335	3	27	98
Medium	OM322	2	15	103
	OM336	3	22	105
High	OM323	2	15	113
	OM337	3	26	112

* minimum values
measured at –60dB IMD (DIN 45004, 3-tone)

With the exception of the OM322 which was designed for stripline techniques, all the amplifiers are encapsulated in a resin-coated body with in-line pins on 2·54mm centres for ease of mounting. Input and output impedances are 75Ω, and the supply voltage is nominally 24V. The devices, which can be cascaded if desired, have good linearity without trimming, a wide operating temperature range, small dimensions, and are easily handled and mounted.

Servicing Saba Colour Receivers

Solid-state Chassis H: Decoder

Part 5

P. C. Murchison

THERE are four i.c.s concerned with the colour signal, a TBA510 which provides chrominance and burst signal amplification and separation, a TBA540 which contains the reference oscillator and its a.p.c. loop, a TBA520 which provides chrominance signal demodulation and PAL switching, and a TBA530 which matrixes the luminance and the demodulated colour-difference signals to provide three primary-colour output signals. These are amplified by conventional single-transistor class A output stages which drive the c.r.t. cathodes.

Chroma Amplifier IC

Fig. 14 shows the TBA510 and its peripheral circuitry. The chroma signal from the i.f. strip arrives at pin 4. After amplification it appears at pins 8 and 9 for feeding to the chroma delay line circuit. During its journey through the i.c. it is subjected to various processes.

In Part 4 we saw how a delayed, negative-going pulse is generated for the a.g.c. circuit in the TBA500 luminance i.c. This same pulse is used for burst gating in the TBA510, being applied to pin 13. The resultant burst output appears at pin 12 and is fed via C447 to the TBA540 i.c. which incorporates the burst detector circuit.

The TBA540 incorporates a second detector which produces outputs used for automatic chrominance control, ident and operation of the colour-killer circuit. The a.c.c. output from the TBA540 is proportional to the amplitude of the burst signal, and is fed back to pin 2 of the TBA510 where it's used to control the chrominance signal amplitude. The signal path is via R452, with R456, R457 and C453 forming a damping network to suppress the effect of sudden changes in chrominance signal level.

Noise Suppression

With a monochrome signal being received, the a.c.c. circuit will increase the gain of the chrominance amplifier to maximum. Under these conditions several volts of noise appear at the burst output pin 12. Diodes D441/D442 and the associated capacitors C443/C444 are used to suppress this noise signal. On colour reception the two diodes are cut off by the voltage produced by the potential divider network R446/R445 (approximately 1·5V). The burst signal at pin 12 is around 1·5 peak-to-peak in amplitude so the diodes remain cut off, the burst peaks not being large enough to turn them on.

On monochrome however the several volts noise signal forward biases the two diodes and as a result C443 is charged negatively. This voltage is applied to pin 3 via R442 and R456, shutting down the chroma amplifier.

Colour Killer and Saturation Control

There's also a conventional colour-killer circuit, the control voltage (1·4V on monochrome, 2·6V on colour) from the TBA540 i.c. being applied to pin 5 of the TBA510. To override the colour killer when fault finding, link terminals G2 and G3.

Saturation control is effected by varying the voltage at pin 15. It's worth noting that the contrast control is interconnected with the colour control circuit. The slider of the contrast control is connected to the base of T351, thus controlling the conduction of this transistor. The colour control is connected in series with T351's emitter, its emitter voltage adjusting the colour so that the contrast and colour track together. This arrangement isolates the contrast and colour controls so that the beam limiter has minimal effect on colour.

No Colour

This part of the set has proved to be reliable, the i.c. very seldom failing. To check the circuit, override the colour killer and see if there's any colour present on the screen. If the picture remains in monochrome, check the i.c. and the 12V supply to pin 1. Lack of colour is sometimes due to leakage in C457, as a result of which the 12V supply is reduced. The i.c. is unpluggable. Substitution is quick and easy therefore, enabling this part of the circuit to be eliminated from suspicion with minimum effort.

Another cause of loss of colour is when the burst signal coupling capacitor C447 goes open-circuit. In this case however overriding the colour killer results in unlocked colour (horizontal colour bars) on the screen.

Reference Oscillator IC

The TBA540 reference oscillator i.c. is mounted on a separate, unpluggable board on the left of the signal board. The circuitry associated with the TBA540 and the rest of the decoder is shown in Fig. 15.

As previously mentioned, the TBA540 and TBA510 are interconnected. The TBA540 also provides at pin 4 the reference signal for the synchronous demodulators in the TBA520 chrominance demodulator i.c. The TBA540 has its own synchronous demodulators however, one for burst detection and a second which is fed (internally) with the detected bursts and with a half line frequency squarewave (from the TBA520 i.c.) which is fed in at pin 8. This second demodulator compares the squarewave and the burst component of the video signal in order to develop a.c.c., colour killer and ident signals. Only when the amplitude of the burst signal is large enough and the bistable in the TBA520 is operating in the correct phase will the control voltage at pin 9 be of the correct sense, decreasing with increase in the amplitude of the burst signal. If the phase of the bistable is incorrect, the voltage at pin 9 will rapidly rise. This voltage will be passed to pin 1 of the TBA520, where it will stop the bistable momentarily so that it's restored to the correct phase.

The voltage at pin 9 of the TBA540 is phase shifted and fed to pin 7 which provides the colour-killer voltage for the TBA510. The voltage here should be about 0·2V on monochrome and 8·5V on colour with correct ident phase.

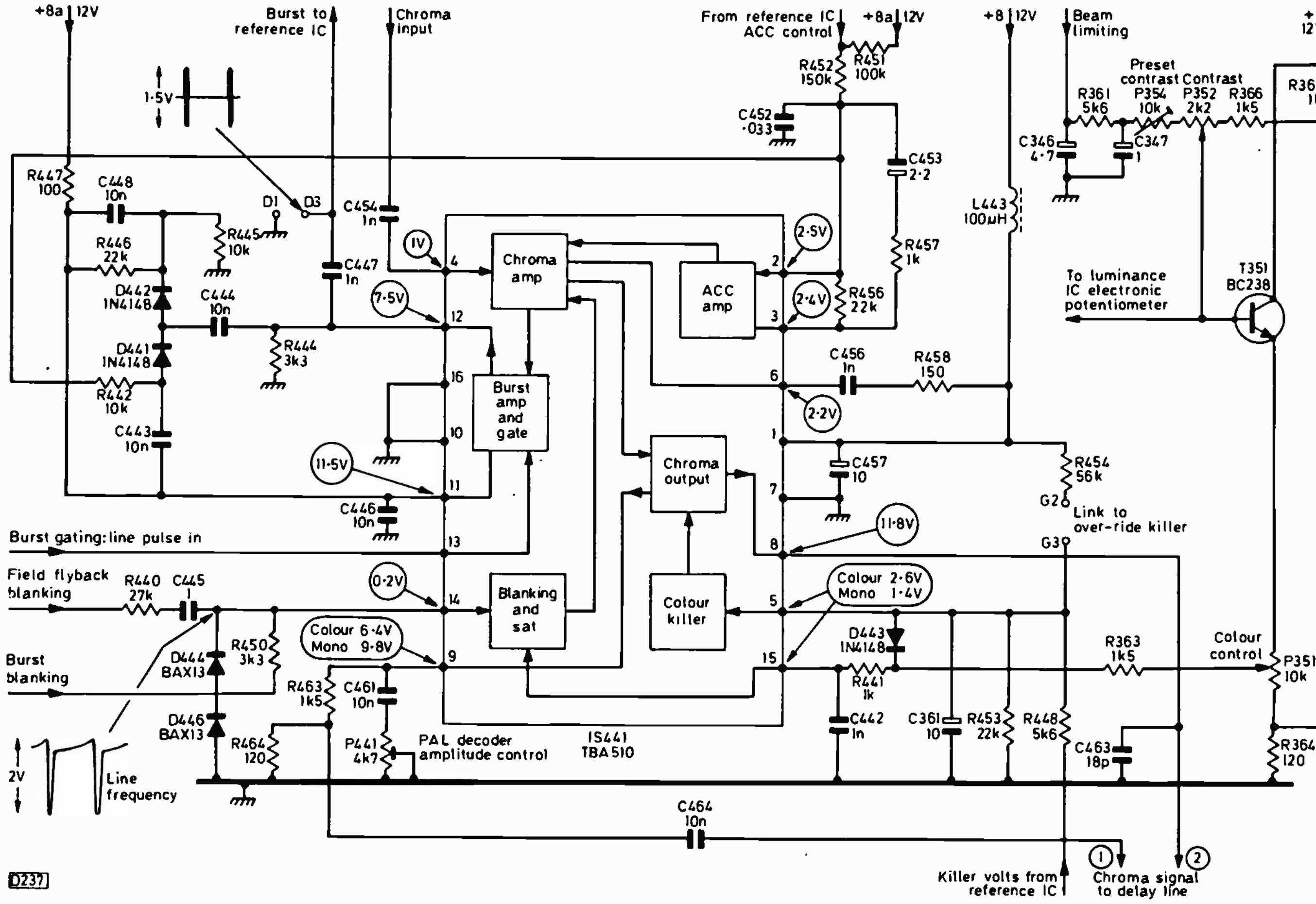


Fig. 14: The TBA510 chroma amplifier i.c. and its peripheral circuitry.

The reference signal at pin 4 is fed via R428/C363 and R439 to pin 2 of the TBA520. It's also phase shifted by R416 and C367 (90° shift, with C367 being adjustable) and then fed via R427 etc. to pin 8 of the TBA520.

The internal oscillator is controlled by the external 4·43MHz crystal Q371 which is connected between pins 1 and 15. The burst phase detector which compares the phase of the bursts and the reference oscillator's output drives an internal reactance stage whose output appears at pin 2. The a.p.c. loop's filtering components are connected between pins 13 and 14. The burst signal is coupled to pin 5 via C447, a minimum burst amplitude of 1·15V being required to operate the circuit.

The output at pin 2 is of very low impedance. The signals at pins 1 and 2 are in opposite phase, and the 60pF trimmer C370 is connected between these pins. The fact that the signals at each side of C370 are in opposite phase has a curious effect (in fact a Miller effect) on the effective value of C370 – its capacitance appears to increase by a factor dependent on the gain of the reactance stage driving pin 2. The gain of the reactance stage is controlled by the output from the burst detector, so the effective value of C370, which tunes the crystal, is determined by the phase relationship between the bursts and the reference oscillator. Such an arrangement is fairly critical in operation, and faults often seem to occur around this part of the receiver.

Loss of Colour

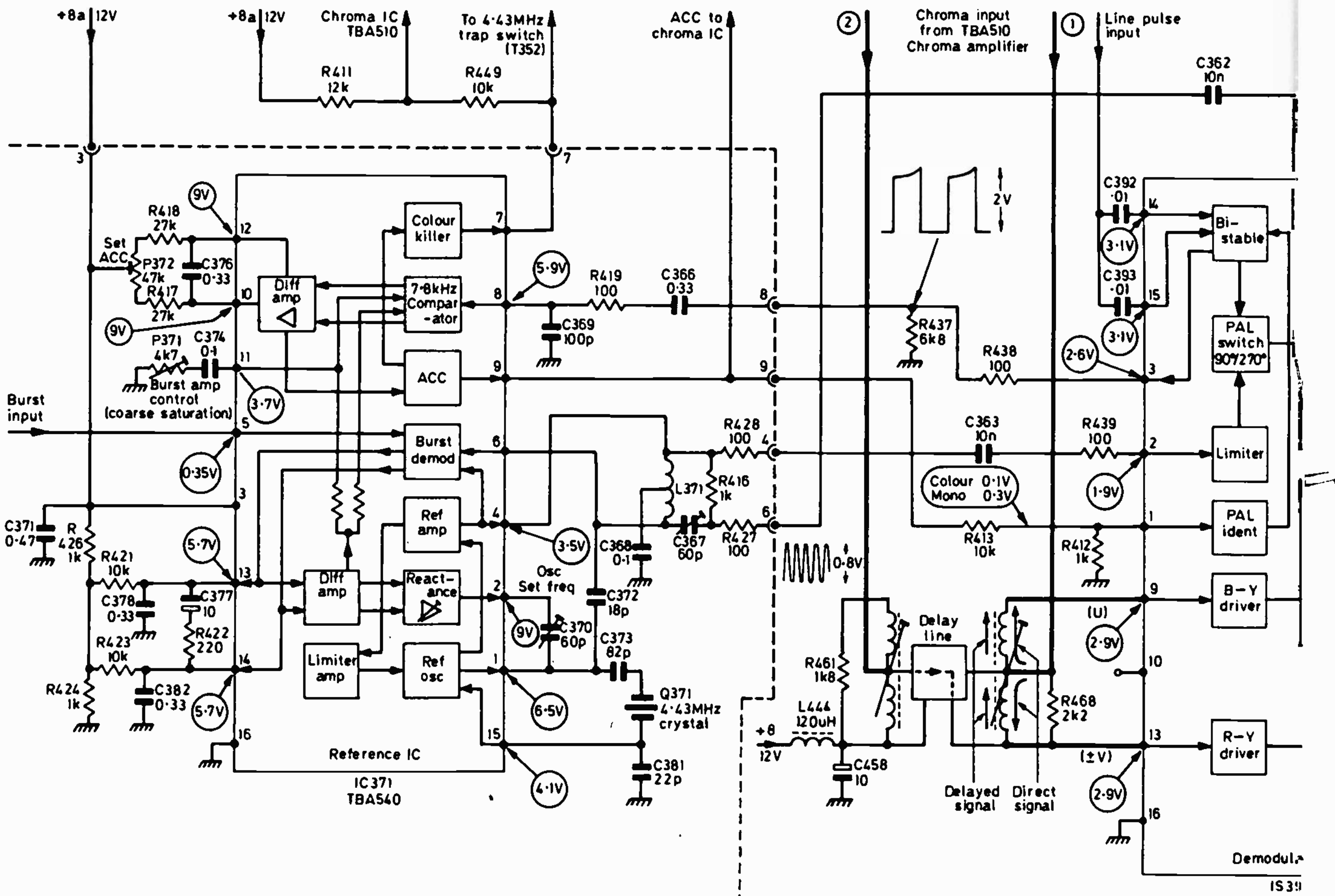
The usual fault symptom is complete loss of colour since the colour-killer voltage is absent at pin 7 of the i.c. The first thing to do is make sure that the set's tuned to a colour transmission or connected to a colour-bar generator. Then override the colour-killer (link pins G2 and G3). If there's no colour of any sort on the screen, it's quite possible that the oscillator has stopped. The best check is to try to look at the reference signal with a scope. At pin 4 or pin 6 of the subpanel there should be 1·2V p-p and 0·8V p-p respectively of reference signal. If there's complete lack of signal, suspect the i.c. itself or the 0·33μF capacitor C378 in the a.p.c. filter circuit – in extreme cases it will shut the oscillator down. Since the i.c. is soldered in, it's best to try the capacitor first.

A more likely effect on overriding the colour-killer is unlocked colour – coloured bands seem to move continually over the screen. Once again C378 is number one suspect, followed by C376 (0·33μF), C371 (0·47μF) and the trimmer C370. The 0·33μF capacitors have proved to be rather unreliable, being commonly responsible for intermittent loss of colour or colour fluctuation – because the reference oscillator intermittently goes out of lock and the a.c.c. voltage tends to vary (C376 is the a.c.c. filter capacitor).

Should the oscillator still be unlocked after changing the 0·33μF capacitors (C378/C376/C382), C370 may require resetting. To do this, override the colour killer and remove the burst by shorting together test points D1 and D3 (see Fig. 14). Then adjust C370 for stationary colour bars on the screen. Remove the short-circuit and if all is well the colour should lock in normally.

Hanover Blinds

The operation of the bistable in the TBA520 can be



Reference oscillator— this unit is mounted on a separate plug-in board

Fig. 15: The reference oscillator, demodulator and lumi

disrupted should C366, another 0·33μF capacitor, go open-circuit so that no half line frequency squarewave reaches pin 8 of the TBA540. As a result, no ident signal goes back to the TBA520 and the bistable no longer operates, producing the Hanover blind effect on the picture. This is a fairly common fault: any 0·33μF capacitor coloured green is suspect and should be replaced with something more reliable.

Matrixing and Demodulation

The two antiphase chroma signals from the TBA510 arrive at points 1 and 2 in Fig. 15 and then pass to the delay line/matrix circuit. One signal passes through the delay line while the other goes to the centre tap of the output coil where the delayed and direct signals are added and subtracted to give separate U and ±V outputs for pins 9 and 13 respectively of the demodulator/PAL switch i.c. TBA520. The demodulated B − Y and R − Y outputs appear at pins 7 and 4, while an internal matrix produces the G − Y signal at pin 5. The quadrature reference signals for the synchronous demodulators are fed in at pins 2 and 8, the V reference signal passing to the demodulator via the integrated PAL switch which inverts it on alternate lines.

PAL Switch

The internal bistable which drives the actual PAL switch is triggered by line pulses fed in at pins 14 and 15. As we've seen, this stage is interconnected with the TBA540 for ident purposes: the idea is that should the bistable phase be incorrect it's momentarily stopped by the signal applied to pin 1. Any voltage greater than 0·1V will stop the bistable operating.

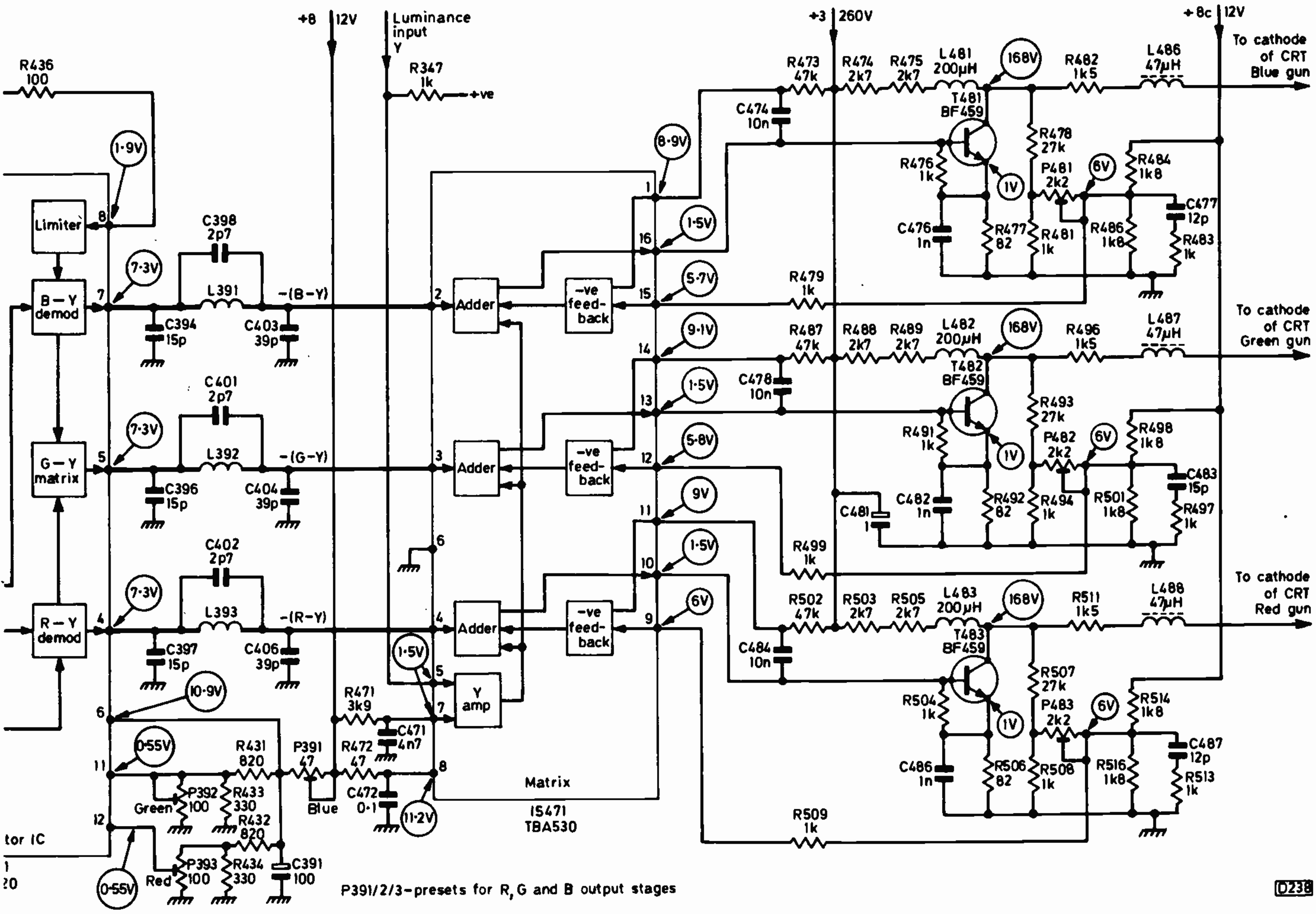
Luminance/chrominance Matrixing

The demodulated colour-difference signals appearing at pins 4, 5 and 7 are fed to pins 4, 3 and 2 of the TBA530 luminance/colour-difference signal matrixing i.c. via filters which remove any remaining r.f. components. The luminance signal is fed into the TBA530 at pin 5, and the R, G and B outputs appear at pins 10, 13 and 16 respectively. The RGB signals are d.c. coupled to the output transistors and then d.c. coupled to the c.r.t. cathodes.

Operation of the Drive Controls

The three drive controls P481, P482 and P483 are used to set the signal levels/white tones at the c.r.t. cathodes. These controls apply negative feedback to the TBA530, and it's interesting to see how they operate so as not to alter the picture black level. We'll take the blue drive control P481 as an example.

The track of P481 is connected between the junctions of two potential dividers, R478/R481 on one side and R484/R486 on the other. This bridge arrangement means that from the d.c. point of view there is 6V at either side of P481 and thus no voltage across it. There will be signal variations on the left-hand side however, as this potential



...ance/chrominance matrixing i.c.s and RGB output stages.

divider is connected between the collector of the output transistor and chassis. So signal variations will be developed across P481, and a proportion is tapped off from the control and fed back to pin 15 of the TBA530 i.c., controlling the gain of the B channel. The other channels are controlled in the same way.

Hanover Blind Effects

The TBA520 section of the decoder is reliable, the only fault we've had on occasions being failure of C392 or C393 which couple the line pulses to the bistable. Sometimes the result is complete failure of the bistable to operate, with the symptom Hanover blinds on a colour picture. More often however the capacitors fail intermittently, the effect being normal colour over most of the screen with sections of the picture occasionally flashing over to Hanover blinds. A check with an oscilloscope will reveal whether the 6V pulses are present and correct at pins 14 and 15 or whether they are intermittent or missing.

All Red, Green or Blue Raster

One of the main problems with the decoder is that the TBA520, the TBA530, the output transistors and the c.r.t. are all d.c. coupled. Thus a fault way back in the TBA520 for example can upset the operation of all the following circuitry, often resulting in a brilliant red, green or blue raster. This is because the output stage affected is driven hard on, with the appropriate c.r.t. cathode voltage dropping to almost the grid voltage. The net result is that the automatic overload protection circuit shuts the set off completely.

Should this state of affairs be encountered – a brilliant raster of one colour, the set then switching itself off – the first suspect is the TBA530, the second suspect the TBA520 and the third suspect – the c.r.t. itself! We've had a lot of c.r.t.s with intermittent grid-cathode shorts on one of the guns. The usual complaint is that the screen suddenly goes brilliant red, green or blue, followed by the cutout switching the set off: if the set is then switched on again all may be well for half an hour or so after which there's a repeat performance. It's only a certain make of c.r.t. that does this. Unfortunately the only cure is an expensive tube change which doesn't go down too well with the customer.

RGB Output Stages

Before condemning the tube however it's as well to make sure that the output transistor in the offending channel is not short-circuit, and that the load resistors R474/5, R488/9 and R503/5 are in order. These have been known to go open-circuit with similar results.

Conclusion

This completes our survey of fault experiences with these sets. They were distributed throughout the UK, so you may well come across them. We hope these articles have provided useful clues. ■

Letters

TTL CIRCUITRY

I read with interest the article in the May issue on the simple test card generator, and would like to comment on some design points. These are as follows:

(1) R30 (1·8kΩ) in series with input pin 1 of IC30 will not allow this pin to reach logical zero. This is because the maximum input current is 1·6mA – the current flows via the external circuit – and to maintain a logical zero the input voltage must not exceed 0·8V. By Ohm's Law a resistor of 500Ω will satisfy this condition, but it's considered good design practice to choose a value nearer to 200Ω or less (to improve the logic zero noise immunity).

(2) R24 is suspect for the same reason. In addition, the differentiating network C22, R24 means that IC30 will receive an out-of-specification voltage at pin 2. During the high output at pin 8 of IC25 C22 charges via R24 (C22 is shown the wrong way round in the circuit and layout – its left-hand plate charges positively). When the output at pin 8 of IC25 falls to logic zero, pin 2 of IC30 will reach about −4V – until C22 discharges via R24. The SN7400N i.c. (IC30) can withstand a maximum of only −1·5V on any input pin. The solution is to connect a diode across R24 to clamp the input to pin 2 of IC30 at −0·6V.

(3) The output pins 3 and 6 of IC24 are connected together directly. Output pins should not be so connected however – this rule is true for all totem pole outputs from TTL logic devices. When a logic function of this type is required, the wired-or mode should be used. For this purpose an open-collector output stage is required – devices such as the SN7403N, SN7406N etc. are suitable.

IC26 (pins 8, 10, 12) and IC24 (pins 3, 8 and 11) are similarly affected.

(4) Multiple input gates are in several positions used as logic inverters. This is a standard procedure, and is very often used. The problem however is what to do with the unused inputs? They can be connected in parallel with other used inputs of the same gate, but this increases the loading on the driver. As an alternative, the unused inputs can assume a logic one state, known colloquially as "left floating". With this approach there's a severe risk of faulty operation due to the noise spikes which are present in any high-speed logic system and are easily coupled via stray capacitance.

The best solution is to establish a known logic level on these inputs by means of the "tie-high" system. This makes use of a series resistor, which can serve many inputs, to safeguard the logic against supply-borne interference. To hold a logic one, a voltage of 2V or greater at a maximum current of 40μA is required. To give a safety margin of 200mV, a resistor of about 4·7kΩ per TTL input (or 1kΩ per 5-10 inputs) should be used.

(5) As with point (1) above, the values of R2 and R13 are far too high. The combined load at pins 3 and 4 of IC20 is a maximum of 3·2mA (at logic zero). The highest resistor value for R13 therefore is 250Ω. With pin 5 of IC9 connected directly to pin 1 of IC8 and via C5 to pin 3 of IC10 we again have outputs driving outputs. As noted above, this should not be attempted. The d.c. block provided by C5 questions the use of R2 which provides an additional load at pin 1 of IC8.

(6) The ZNA134 sync pulse generator i.c. (not 2NA134 as in the components list) is fully TTL compatible, which means that it can operate from TTL 5V ± 0·25V supplies and interface directly with standard TTL logic devices. According to the operating characteristics given on page 2 of the data sheet the low-level output voltage is specified as 0·5V for a load current of up to 3·2mA. As a standard 74 series input consists of a 1·6mA load this means that only two loads can be driven by each ZNA134 output. In the case of the line drive output (pin 5) no less than seven TTL loads are being driven, which is out-of-specification.

From my own (limited) experience of the ZNA134 I've found it a good idea to drive only one TTL load from each output, i.e. 1·6mA maximum loading. A further problem arises from the output structure of the ZNA134, which consists of common-emitter output stages with 10kΩ load resistors integrated on the chip. To provide fast-rise pulse edges (TTL does not like slow edges, and has been seen to oscillate during a transition) the load capacitance must be very low therefore – a good value to aim for is less than 10pF. I've solved these problems by using a Schmitt type inverter gate such as the SN7414N to buffer each output.

A practical solution to the excessive loading on pin 5 in your design would be to use it to drive pins 4 and 5 of IC10 only, taking the other drives from pin 3 of IC10.

(7) The output pin 6 of IC2 drives pin 10 of IC2 (one TTL load) and also the reset pins on the counters IC3 and IC4. The total load here is four times 1·6mA (6·4mA), through R3 (220Ω). If pin 6 of IC2 is at logic zero, in the worst case it could be at 0·4V. This current demand through R3, plus the load imposed by R5, will cause a potential difference across R3 of 1·4V. Added to this is the output from pin 6 of IC2 (0·4V), leaving the reset pins of IC3 and IC4 at 1·8V. This is an indeterminate logic voltage and is therefore out-of-specification.

(8) Finally a word about supply decoupling, which is used to prevent interaction between various sections. In logic circuitry this is done with small (low-inductance) capacitors of 0·0047μF or 0·01μF and larger electrolytics of 4·7μF or 10μF. It's largely a matter of choice how many capacitors are used, but as a general guide every one or two i.c.s should have one 0·0047μF or 0·01μF capacitor, and for every five to ten i.c.s there should be one 4·7μF or 10μF tantalum bead electrolytic capacitor. The maximum noise on the 5V line should not exceed 100mV peak. Circuits may work without any decoupling capacitors at all, but bitter experience indicates otherwise. This is particularly true where monostable i.c.s are used. – **P. J. Stonard,** *Edgware, Middlesex.*

THE INDEPENDENT SERVICE ENGINEER

I was interested to read the letter in your April issue on the risk involved in using the services of a "TV cowboy". I'm tempted to write, having just completed my first year as a self-employed TV engineer.

After completing a one year, full time course in radio and

TV servicing I faced the choice of one last attempt to return to my previous career in research and development in industry, for which I was qualified with a B.Sc. in physics but had been out of work for a considerable time, or embarking on a new career with my new qualification. I found that the job market was just as bad as before. At interviews for industrial jobs I'd not the right experience, while I was considered to be too highly qualified for the TV trade. It was suggested at one interview that I considered going into management.

Some people felt that servicing work was a waste of a degree, but it occurred to me that with the enormous amount of theory that had been covered, especially on the PAL colour system, my servicing course had been more like a post-graduate course than a job retraining one. Anyway, I advertised in local papers and jumped into the deep end.

There was little money to be made to start with. Because of the large number of types and makes of set around it seemed an enormous undertaking to advertise the repair of any make of set, both monochrome and colour. Nearly every job entailed getting a manual and studying a chassis I'd not come across before. It seems that rental companies' service engineers have an easier life, since they deal with only a handful of different chassis and carry a comprehensive set of spares.

The first six months were like a practical training period. I was burning the midnight oil and making very little profit. As I got more proficient at servicing however I began to find that the attitude of some customers caused more problems than the repairs themselves.

An example. A monochrome set (Philips 300 chassis) was brought to me with the complaint no line lock. The customer asked for an estimate, as well as saying that he didn't think there was much wrong with the set. After fault finding for about an hour, because the part of the circuit concerned is not easily accessible for test purposes, I found the cause of the trouble – R2144 in the line sync pulse amplifier stage open-circuit. This enabled me to give a verbal estimate that I hoped the customer would find acceptable. After asking whether I could do the job cheaper than the amount I quoted the customer asked exactly what the faulty component was. If I'd told him it was an open-circuit resistor he'd certainly refuse the estimate – resistors cost twopence each and most do-it-yourself enthusiasts can use a soldering iron. When I would not be more specific than to say there was "a fault in the sync circuit" he took the set back unrepaired.

It's very true, as the letter in the April issue pointed out, that the customer is taking a chance on the competence of an engineer when he looks one up in a local paper. There are many cases however where he is taking a chance with a "reputable" high street TV shop. A number of people dissatisfied with the service they received from their local dealer started to approach me, hoping to get better service from a self-employed engineer.

A couple of examples. A Decca colour set (Bradford chassis) was brought to me with the complaint that the sound was badly distorted. The customer showed me the bill he'd received from the dealer, listing the work done to justify the total cost. One of the items mentioned was "replaced screen grid resistor". Well now, care should be taken since there are two versions of the Bradford chassis, the earlier 10 series and the later 30 series. They are very similar in appearance, but contain small, important differences in some parts of the set, one of them being a slight difference in the arrangement of the sound output stage. In the earlier 10 chassis R82 is 12kΩ and supplies the PCL82's triode anode and pentode screen grid, while in the later 30 chassis it's 1·8kΩ and feeds both anodes as well as the screen grid. Anyway, the wrong value had been fitted, causing the valve and the output transformer to overheat while all that was left of the pentode's cathode decoupling capacitor C81 was an empty can. Another colour set was brought to me with an intermittent fault. The customer showed me two bills, each for over £20, from a reputable firm to which he'd taken it. The fault was still present.

The cost of the journey also turned out to be a problem. On one visit to a high rise block of flats the set turned out to be a transistor radio, while on another visit the set was a 30 year old radiogram. There were other headaches with home visits, such as unfriendly dogs and time wasted removing vases and flower pots which the customer could easily have done beforehand. So with a few exceptions I stopped all home visits, offering a repair service only to those customers who brought their sets to me.

This led me to envisage what an efficient repair service might entail. The engineers would be carrying out repairs in the workshop: it's work that requires concentration. The engineer should not have to waste time dealing with awkward customers, nor tire himself out driving in a lot of heavy traffic. Transporting sets should be left to others employed for this purpose.

The customers who approached me after being dissatisfied with the service received from local dealers had not taken any legal action. But it seems that the self-employed engineer is in just as much danger of being cheated by the dishonest customer. A case in point. A customer came and inspected a stereo unit I'd repaired before taking it away. "Well I couldn't give you more than £5" was his reply after having previously accepted a verbal estimate. A dealer would be in a stronger position than a self-employed individual who can do very little. After giving me a cheque for £5 he proceeded to add insult to injury by insisting on showing me his cheque card.

Since that incident I've stopped all work for the public direct, and now carry out work only for dealers who don't have their own workshop. The work consists mainly of portable items where the customers are prepared to wait approximately a week before collection. – **R. Morris,** *London, NW10.*

NO GREEN

Other readers might find the following tip useful. The set was a colour one fitted with the Thorn 3500 chassis and the fault no green. The first check of course was at the green c.r.t. cathode, but the voltage here was much the same as on the red and blue cathodes, so the video panel was cleared of suspicion. Attention was turned to the convergence panel, on which the c.r.t. first anode preset controls reside. Operating the green switch produced a slight change in the purple picture, while with the red and blue switches off and the brilliance turned fully up there was some green present on the screen. Operating the green switch several times produced no change so I assumed it was o.k. and tried adjusting the green first anode control next to the switch. After several adjustments the green drive suddenly came on fully, then went off. So the control was taken out and dismantled, the track cleaned, and the contact arms bent out slightly to give firmer contact. On replacing the control the green was back to normal. – **M. J. Shepherd,** *Canvey Island, Essex.*

Editorial note: Leakage across the first anode switches is however a common cause of the fault on this chassis as, less common, is a defective decoupling capacitor at this point. The control feed resistors can also go high in value.

TV Servicing: Beginners Start Here...

Part 10

S. Simon

Signal Circuit Faults

A TV transmission consists of a composite signal, the parts of which determine the brightness of the picture, the colour, the synchronisation of the picture and of course the sound. Without sync pulses, which occur at the end of each line and field scan, there would be no recognisable picture. The sync pulses form part of the basic video waveform however, so what we are concerned with are three sets of signals – brightness, colour and sound. The transmitted brightness – or luminance as it is more correctly known – and colour signals are actually interleaved with one another. The sound signal is placed to one side. The important points are that these signals must be tuned in by the receiver, must not interfere with one another, and must at some point be correctly separated so that they go their separate ways. The luminance and colour signals eventually end up at the same place – at the display tube – while the sound signal ends up driving the loudspeaker.

The Television Channel

This group of transmitted signals occupies a band of radio frequencies – the bandwidth of a UK 625-line transmission is 8MHz, the vast majority of this bandwidth being occupied by the interleaved luminance and colour signals. For transmission purposes the programme is modulated on to the carrier frequency of a particular TV channel. The receiver's tuner selects the required channel, and at some later point in the receiver the carrier frequency is removed, leaving the original signals corresponding to the luminance, colour and sound. In practice things are a little more complicated: as there are three basic signals, there are also three carriers, one for sound, one for the luminance signal and a subcarrier for the colour signal (see Fig. 1). The carrier frequencies are fixed, but within the channel the signals corresponding to the luminance, colour and sound vary as the picture brightness and colour and the sound vary.

Aerials

The transmitting aerial is usually sited in a high position so that the signals stand the best chance of reaching the intended service area of the transmitter. The actual signal transmitted by the aerial consists of a complex electromagnetic wave, which will induce a corresponding signal voltage in any conductor that gets in the way. The dimensions of the conductor determine the results we get. If the length of the conductor corresponds to the carrier wavelength, or alternatively to half the carrier wavelength, we will get maximum response from the aerial (provided it's correctly positioned) to the transmitted signal. With other lengths we can get signal cancellation. Things are not too precise however since we are concerned with receiving a *band* of frequencies (the channel we tune to), and as is well known in practice a u.h.f. aerial is designed so that it will receive the three current programmes (BBC-1, BBC-2 and ITV) plus a few more adjacent channels so that aerial manufacturers don't have to go to the expense of having to make too many different aerials.

Tuner Unit

The signal voltages obtained from the receiving aerial are very small and require considerable amplification before they can be of use. The signal from the aerial passes to the set's tuner unit, which is designed to select and pass on only the group of frequencies required (the channel bandwidth). These it converts to a lower, intermediate frequency, which remains the same whichever of the available channels is selected, before passing the signal on to the set's i.f. strip where most of the signal amplification takes place. The tuner also provides a certain amount of initial amplification prior to the frequency changing process.

At u.h.f. it's impractical to use coils for tuning as we can do in other parts of the receiver. Instead, short lengths of metal are used, terminated by variable capacitors or a type of diode whose capacitance varies with the voltage applied across it. This latter approach means that a preset variable resistor instead of a mechanical variable capacitor can be used for channel selection.

Practical Aspects

Now let's pause for a moment and consider some of the practical aspects of what we have said so far.

We said that a group of frequencies, containing the varying signal voltages we eventually need for the c.r.t. and the loudspeaker, is bundled up on to a carrier at u.h.f. and transmitted from a high aerial. Your aerial is erected to intercept this, thereby inducing a wave along its length. This results in a maximum signal at the optimum point, which should be the centre of a halfwave dipole, where the

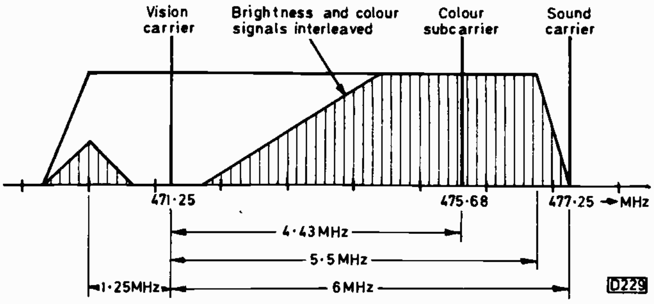


Fig. 1: Relative positions of the signals in a television channel. The carrier frequencies shown are for channel 21.

impedance is about 75Ω. A feeder cable of this impedance (usually coaxial cable, but it could be twin feeder if the receiver input is designed for this "balanced about a centre point" method) conducts the signal with as small a loss as possible to the receiver's tuner unit.

From this we must realise that a weak link in this sensitive chain can result in very poor reception. It's no use having a very complicated aerial if it's not made so as to "resonate" at the particular group of frequencies to be received. Again, it's no use having the correct aerial if the feeder cable is not suitable or is clumsily joined along its length. In addition, the receiver must be designed for this 75Ω input. Most are, and much of what we have said is taken for granted and the conditions met simply because the equipment available is designed to this standard. Some imported equipment is not however.

Many have experienced the disappointing results when a coaxial (unbalanced) system is connected to the 300Ω balanced input of an imported portable TV set or the similar input of a v.h.f. radio tuner. The simple answer to this problem is to employ a small transformer which is wound to receive a 75Ω (unbalanced) input and provide a 300Ω (balanced) output. The common name for this device is balun, would you believe it!

Another way of spoiling an installation is to split the cable so as to feed two sets. The result is that the 75Ω input is presented with two terminations instead of one, quite apart from the losses at the joint. If this must be done, it should be done properly with a resistor in each leg so as to preserve the original impedance. This makes a total of three resistors (one in series with the down lead and one to each lead off) to total 75Ω, i.e. 25-27Ω in each leg as shown in Fig. 2. The outer screening of the coaxial cables is joined together of course and the legs we refer to are the inners. The resistors are in a star formation as shown.

Inside the Tuner

The average type of tuner uses two transistors. The job of the first one is to amplify the signal from the aerial and this is loosely known as the r.f. amplifier. The aerial input is usually coupled to the emitter, the base being held at a steady bias or connected to the a.g.c. (automatic gain control) line to even out the gain under varying reception conditions. A.G.C. is also applied to the early i.f. stages.

The tiny signal voltages at the emitter of the r.f. amplifier transistor cause a tiny variation of the base-emitter current. This causes a correspondingly larger variation of current in the collector circuit. The tuned circuit here turns this into a varying voltage replica of the original aerial signal, but considerably amplified and cleaned up (the tuning action rejects adjacent and unrequired signals).

Front-end Faults

This initial stage of amplification is the first common cause of likely trouble in the signal stages of the receiver. Being coupled to the aerial (albeit via a filter) the transistor attempts to respond to whatever signal is presented to it. Now under some conditions the aerial can become heavily charged with static electricity, and although discharge paths

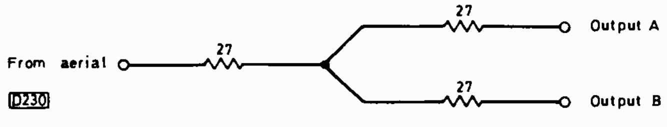


Fig. 2: Arrangement for feeding two sets from a single aerial.

are provided at the aerial socket and at the tuner it's common to find that the first transistor in the tuner is defective owing to a heavy static charge having found its way to the base-emitter junction and destroyed it. This means that the first stage of the tuner is out of action and the resulting reception is very poor indeed, some signal managing to get through purely due to the capacitance present.

If the reception is suddenly reduced to a mere shadow of its former self therefore, with heavy noise on the screen and on the sound, one should bear this possibility in mind whilst checking out others.

The others must start where we started: at the aerial, the cable, the plug, socket etc. The aerial itself is not often at fault – provided it's still there of course. The cable is also not often at fault unless it has been joined or contains junction boxes, plugs or what have you along its length. The socket at the rear of the set is most often the cause of poor connection, particularly if it is well used. Examine for poor connections and cracks etc.

Follow on up to the tuner, and if all seems well it is reasonable to examine the tuner more closely. If it's of the four push button type, incorporating a push bar actuated by the button shafts, check the bar to ensure it is still snug in its slots and hasn't been pulled out by the return spring. If necessary, remove the tuner and its cover and check the correct tracking of the tuning gang (if any) to ensure that the movable vanes fully close and fully open in response to the buttons, and that they do not foul the stationary vanes at any point. Fully closed, the tuner will respond to approximately channel 21. As the gang opens, the tuner response rises through the channels to about channel 65 when it's fully open. If the tuning is voltage controlled, the control voltage will rise to about 30V at the highest channel.

Having checked all this, remove the aerial plug from the cable. Connect a small capacitor to the free centre conductor of the cable and apply this to the aerial socket. Note the quality of the reception. Remove from the aerial socket and apply to the tuner input or input to the first stage. Note the reception.

Now apply to the other side of the first transistor (collector connection in the second compartment usually). If the reception is much improved, the first transistor or the supplies to it are suspect. If the reception is worse the first stage is unlikely to be at fault.

A note of caution is necessary here. The sudden appearance of noise on the picture and a dramatic loss of signal is not necessarily due to a tuner or aerial fault. It can be caused by a fault in the input filter at the beginning of the i.f. amplifier section of the receiver.

This is particularly so in some recent sets (mainly colour) where a faulty or improperly connected capacitor or coil can give these precise symptoms. In one or two cases we have found this to be so in the Thorn 8000 (and on) series where C107 has proved to be responsible for very noisy reception (or no reliable reception at all). In far more cases, we have found a slightly different condition responsible for noisy reception in the Pye solid-state colour receivers (713, 725, 731 etc. series, including the Philips 570 chassis). Here the fault is inside the "i.f. filter and gain" module.

Whilst it's possible to remove the cover and carry out the repair merely with the relevant panel withdrawn to expose it, we find it better to remove the solder from the several panel joints and remove the unit completely. The repair consists of noting which capacitors have soldered connections to the "top" of the panel as well as to the bottom, as is more normal, applying the iron to the bottom solder, and easing the relevant capacitor up slightly so as to allow the top solder to make more positive connection to the wire of the component instead of the paint. A tender touch is required to avoid damaging the fragile components. Several capacitors are so connected and need to be treated, all at the filter end where the coils are formed on the print, not at the other end where the coils are on formers and where three transistors reside. Careful refitting to the panel and resoldering completes the job and restores normal reception.

To clarify this brief description, first identify the panel (left side) containing the tuner on the rear edge (rectangular metal box) and then look for the filter-gain module, which is similar in general appearance, farther in and at right angles to the tuner.

We have mentioned this common fault in order to illustrate that not all cases of noisy reception are due to aerial or tuner defects.

Frequency Conversion

Having picked up the required signal by means of the aerial, and then having amplified it in the first stage of the tuner, it is next necessary to process the signal in order to make it easier to handle – the frequency changing process we mentioned earlier. It will be appreciated that signals at u.h.f. are difficult to process through a number of amplifiers and filters, and in fact they are at u.h.f. only in order to travel from the transmitter to the receiver. If we mix the received signal with a locally generated one (produced by an oscillator in the tuner) the *difference* between the two will still contain all the individual signals (luminance, colour and sound) but will be of much lower frequency (intermediate frequency or i.f.). This is much easier to handle (amplify and slice up, tune in or tune out). So in the tuner we require an oscillator and a mixer, which are normally combined in one stage.

Tuning Faults

Much care is needed in the design of such a stage to ensure frequency stability and even oscillation over the whole tuning band. Some early u.h.f. tuners tended to stop oscillating below a certain frequency, so that although channels in the upper bracket (say 30 to 60) could be tuned in without trouble the tuner would cut out as the lower channels were approached.

Another common trouble was intermittent tuning, where the required channel would rarely appear at the same setting twice, this being more awkward with push button tuners.

The type of tuner used in the Thorn 1500 series and some colour models was prone (is prone) to this trouble although the a.f.c. (automatic frequency control) tends to mask this on the colour sets. The trouble is usually due to poor contact on the leaf springs which contact the body of the tuner to the rotating shaft of the tuning gang. The best way of tackling this is to employ a fairly large soldering iron to melt the upper solder so that the leaves can be removed from the oscillator and the mixer compartment. The leaves can then be cleaned off and slightly bent to improve their contact when replaced – after the grease has been removed from the contact surfaces. Merely applying switch cleaner to clear away the grease and improve the contact without removing the leaves is rarely effective for long.

Such cleaner must be kept away from the tuning vanes. If the vanes do receive an accidental dose of switch cleaner, it must be allowed to dry out or be dried out before the tuner can be expected to work.

The vanes must not be opened out (or for that matter closed in) as this will change the capacitance of that particular circuit and the overall efficiency will be severely impaired. The fact that the vanes are opened out at various points and to varying degrees merely means that they were set like this initially to ensure correct tracking over the whole tuning range.

A fairly frequent fault occurs in this department in some makes of tuner. Obviously the moving vanes which rotate to vary the capacitance must not touch the fixed plates or stators. Examination may show that they are touching in one compartment, thus causing the signals to be lost. Closer examination may show that instead of being rigidly fixed, the stator has moved slightly and that this is due to a crack in the thin metal as it surrounds the ceramic post which supports and insulates it. Careful repositioning of the stator, with say a wood wedge or similar jig, to clear the rotor and close the crack, will allow the metal to be soldered quite easily and the tuner returned to active service.

IF Selectivity

So far then we have managed to capture a certain band of frequencies, due to the selectivity of the aerial and the tuning circuits in the tuner. We've selectively amplified them and next mixed them with a locally generated signal which is not too far removed in frequency from the signal itself. Clearly the mixer's output circuit must contain some means of selecting the required result of this mixing process, as a little thought will show that more than one band of frequencies is produced by this process (there will be sum as well as difference frequencies). The tuner's output coil is tuned to pass a band of say 30-40MHz, with simple filters to reject or short out much higher or much lower frequencies.

The really critical signal acceptance and rejection is carried out in the following section, which ensures that only the signals really required are passed on for major amplification, any others present which could cause trouble being rejected. The alignment of these filters is critical, and should be carried out only with close reference to the maker's instructions. The processes so far are shown in Fig. 3.

IF Amplification

Having "tailored" the intermediate frequency signal, which is still very weak, it is necessary to amplify it to a point where it can be demodulated, i.e. the carrier component (now an i.f. carrier) removed so as to leave the original voltages created by the studio microphone, camera and colour coder.

Several stages of i.f. amplification may be required, and may be provided by separate transistors or valves or by integrated circuits (i.c.s). The latter are commonly known as "chips" and may combine several functions.

Automatic Gain Control

Part of the resulting signal power is processed to obtain a smoothed voltage which is proportional to the received signal strength. This is fed back to the early stages in order to adjust the overall gain to compensate for variations in the strength of the received signal. The benefit of this automatic gain control (a.g.c.) is rarely appreciated until a fault which renders it inefficient or inoperative occurs.

The result of this controlled amplification is that a

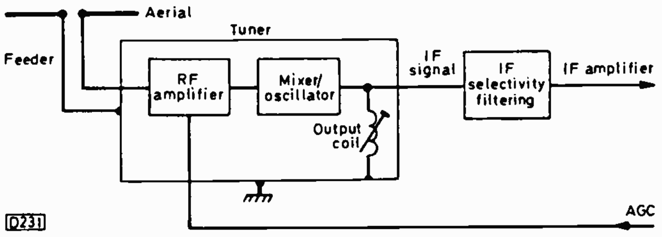


Fig. 3: Signal path up to the first i.f. amplifier transistor.

sizeable band of frequencies, containing the signals required, appears at the output of the i.f. amplifier. It is now necessary to "detect" or demodulate the signals.

Demodulation

There's more than one way of demodulating the signal, but by far the most commonly used circuit is the simple diode detector. See Fig. 4. The signal appearing at the output of the final i.f. amplifier stage consists of the i.f. carrier modulated by the wanted signals. These are present, as a result of the earlier mixing process, in both positive- and negative-going form, i.e. the composite signal is a mirror image of itself above and below zero volts. We want only half of this, so the first step is to pass the signal through a diode connected as a half-wave rectifier. The diode simply slices the signal so that only one half, depending on which way round the diode is connected, appears across its load resistor. The second step required is to remove the carrier frequency. This is done by means of a simple filter consisting of a coil plus tuning capacitance.

What we've just described is an amplitude modulated signal, i.e. the signal is used to vary the amplitude of the carrier wave. This is the type of modulation used for the vision signal. There are other forms of modulation, one of which is relevant here since it's used for the sound signal (on the 625-line system). In this case the amplitude of the carrier remains constant, the modulating signal being used to vary the frequency of the carrier, i.e. frequency modulation.

Intercarrier Sound

In the 625-line system the f.m. sound signal passes through the i.f. strip alongside the vision signal, and can be tapped off via a filter at virtually the last moment. Provided the amplitude of the f.m. sound signal is kept below a certain percentage of the peak vision signal amplitude the two signals do not interfere with one another. For this reason a trap is included in the filter network we mentioned earlier at the input to the i.f. strip to reduce the sound i.f. signal to a suitable level.

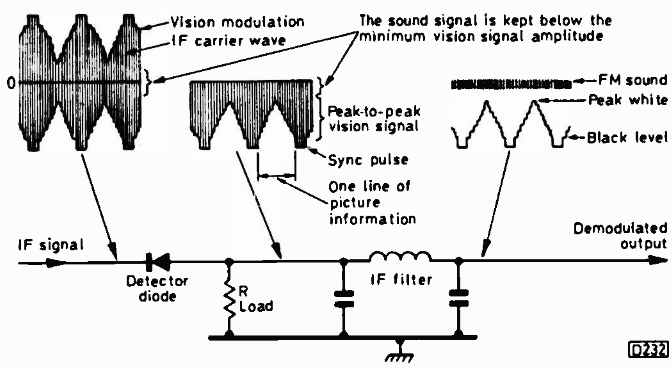


Fig. 4: Demodulation using a diode and LC filter.

The standard sound i.f. carrier frequency used for the UK is 33·5MHz, the vision carrier frequency being 39·5MHz. The difference is 6MHz, and at the output of the detector the f.m. sound signal appears at this "intercarrier" frequency. A 6MHz filter can be used to tap off this signal for feeding to the sound circuits while at the same time removing the signal from the vision channel. Note that slightly different frequencies are used on the continent, the intercarrier sound frequency being 5·5MHz. That's why continental sets can't be used in the UK without realignment. The extracted sound signal is, for the reasons previously given (to prevent interaction in the i.f. strip), tiny in comparison to the detected vision signal. It requires further amplification on its own therefore followed by f.m. demodulation. In modern sets these operations are usually carried out by an i.c. such as the TBA120.

Vision Buzz

We've mentioned the importance of keeping the proportions of the sound and vision signals correct in the i.f. channel. If the i.f. alignment should shift, this condition will not be maintained. The usual result is an annoying buzz on sound as the vision signal modulates the sound signal (vision-on-sound, or vision buzz, or whatever you like to call it). This was a fairly common complaint on older sets. The problem is not usually due to the main i.f. circuits however but to the 6MHz circuits going off-tune. As a result, the receiver has to be mistuned in order to get sufficient sound signal and in consequence the conditions in the i.f. strip are incorrect.

Separating the Signals

The other signals – colour and sync – are also present at the vision detector output. The colour (chrominance) signal can be tapped off via a filter and sent on its way to the colour decoder. The sync signals at the end of each line and field consist of pulses in the "blacker than black" region of the signal, i.e. they are below the signal amplitude set as the picture black level, and can be removed by a simple amplitude discriminating stage (the sync separator) and sent on their way to synchronise the line and field timebases.

Use of Filters

Signals up to about 5MHz are sufficient to provide all the information we require for a detailed picture. The 6MHz sound signal is outside this bandwidth and can be filtered out without affecting the vision signal in any way. The colour information is rather different, lying within the luminance bandwidth on its 4·43MHz subcarrier. The chrominance signal bandwidth is narrow however, since colour detail is not necessary (the human eye is not sensitive to colour detail). It can be largely removed by including in the luminance channel a filter with a sharp "notch" response at 4·43MHz. This will also remove some h.f. luminance signal components, but in practice this compromise arrangement works perfectly satisfactorily.

Picture Detail and Colour

The fine picture detail is contained in the wideband luminance signal, and is used to drive the tube whether it's a colour or monochrome one. The additional colour information, with little detail, is used in a manner similar to the once widespread process of photograph tinting. The

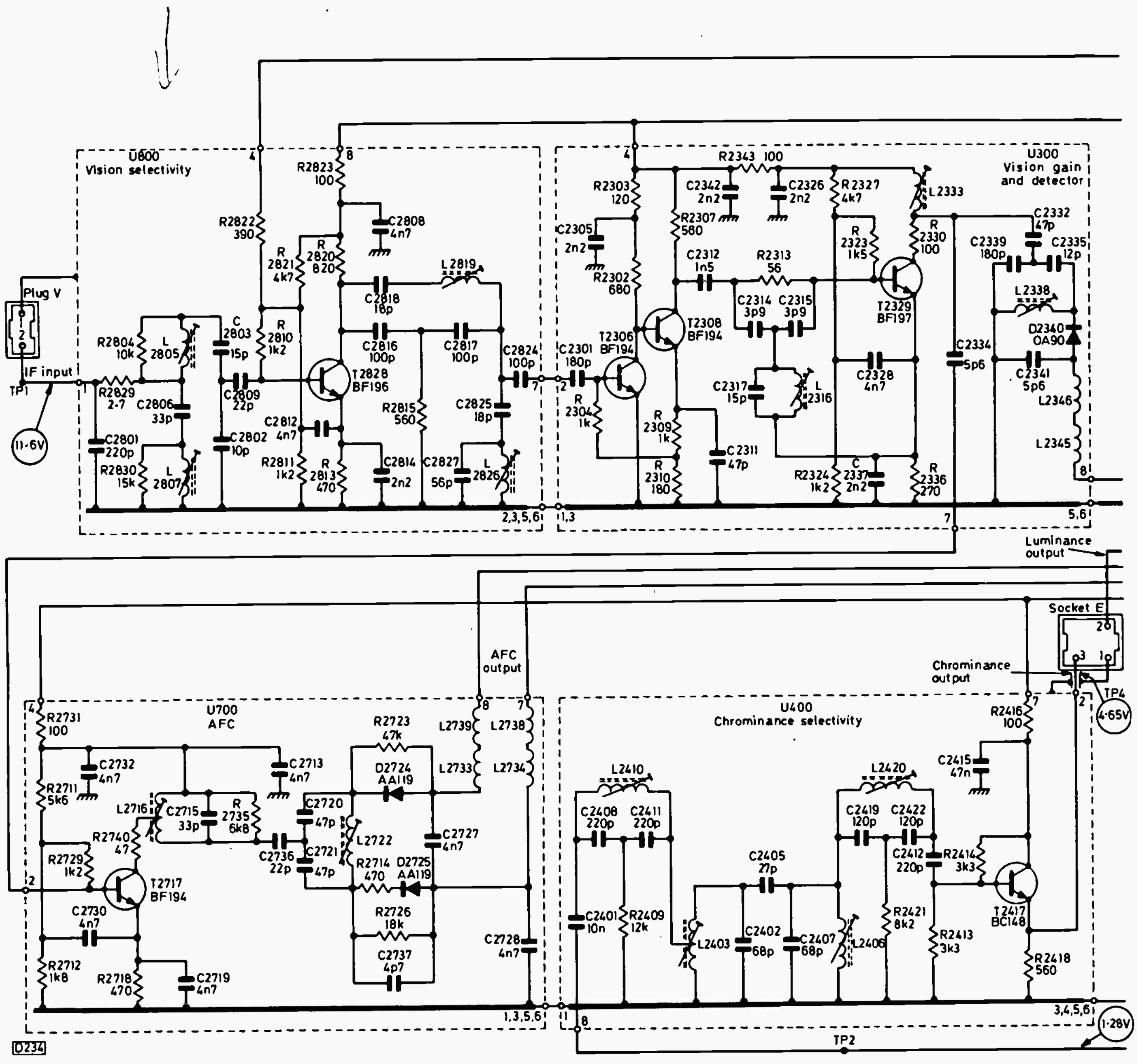


Fig. 8: Circuit dia

10kΩ resistor between pins 3 and 5 of IC2001 (see also timebase panel).

Tuning Faults

The tuner is a fairly reliable unit. Tuner drift is usually due to a faulty TAA550 or R2143 having altered in value – this component tends to become dry-jointed. Check also the pins of plug C on the tuner sub-panel. If pin 1 is open-circuit, the set will change channels normally due to the a.f.c. switch providing a temporary tuning supply, but will drift off when C6150 has discharged. C6150 has been known to cause erratic tuning, with the programme suddenly disappearing after staying tuned in for a while.

On depressing one of the push-buttons slightly so that all the buttons come out, the set should remain on channel for at least 10 seconds. Failure to do so normally means that one of the varicap diodes in the tuner is leaky. This usually also gives rise to slight noise, due to the tuner being in effect misaligned.

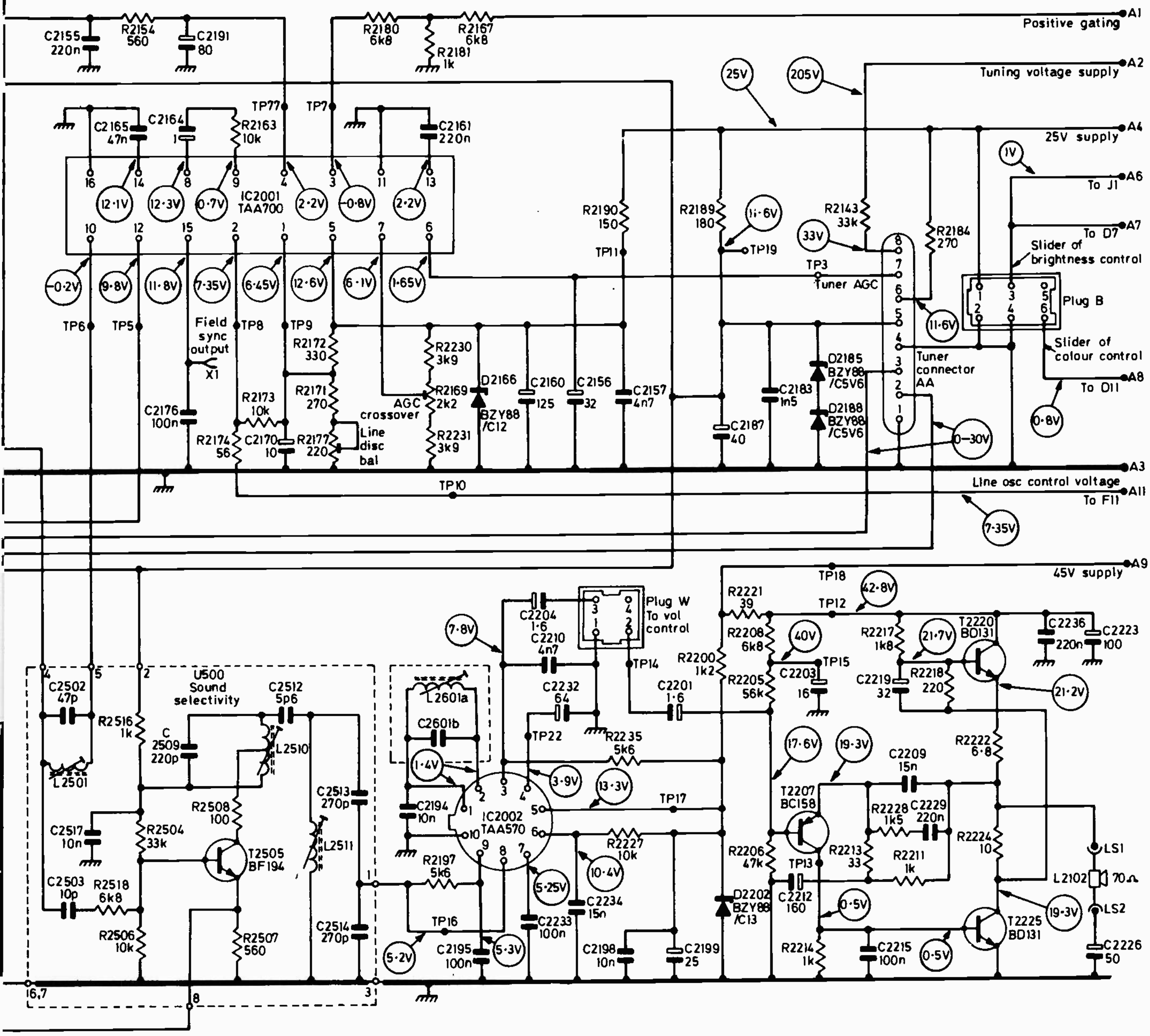
No a.f.c., or a hum bar which varies with tuning, is due to one of the small chokes in the a.f.c. can being open-circuit. A quick check of this is to remove the tuner panel and measure the resistance between pins 7 and 8 of the a.f.c. can. You should find about 20kΩ one way and 50kΩ the other.

IF Strip Faults

A very noisy picture can be due to failure of T2828 or the r.f. amplifier transistor in the tuner. Faults in either the vision gain or selectivity cans can give rise to flashing on the picture, and are rather difficult to find. C2337 in the gain can goes open-circuit and causes weak field sync! – rather misleading, until you also notice the lack of contrast and slight smearing.

The filter chokes in the vision detector circuit can go open-circuit to give no sound or vision. Check the output of the vision detector at pin 8: if this is present (negative voltage), check at TP6. If video is absent here, L2501 in the sound can is probably dry-jointed.

Another fairly common fault here is a dry-joint in the sound can at pin 8. This causes intermittent chroma, as do dry-joints in the chroma can. T2417 open-circuit causes no



ıram of the i.f. strip.

chroma: this can be restored by connecting an 0·1μF capacitor between pins 8 and 2 of the chroma can as a check.

A crackling buzz on sound (usually on one channel only) is due to L2807 in the vision selectivity can being fractionally off tune (left-hand core, looking from the rear of the set). Weak sound with sibilance will occur if L2601 is off tune, while if C2601b (100pF) is short-circuit there will be no sound and a very faint buzz. The TAA570 is fairly reliable, but can give distortion and crackling or no sound at all, although the latter fault is more likely to be an open-circuit speaker or the volume control plug – both of these can be intermittent. Quite often the speaker is off-centre. Before replacement, try slackening off the fixing screws or clips, as this may effect a cure. Later versions with a combined i.f./decoder signal panel use a TBA750Q intercarrier sound i.c. This is prone to causing excessive hiss at low volume control settings.

The sound output pair do not often fail, but when they do R2221 will burn up. C2223 short-circuit will also burn it up. Replace R2221 with the same rating as the original, mounted ¼in. away from the panel. This applies to R2200 and R2190 as well – they go up in smoke if D2202 or D2166 respectively goes short-circuit. D2166 usually goes open-circuit intermittently however, giving line drift for a short while until the set warms up.

C2160 has been known to go open-circuit, giving weak field sync and corrugated verticals – rather like an ailing Thorn 3000!

D2185 and D2188 do not seem to give rise to any trouble. They are fed by R2184 and R2189 in parallel, the latter remaining in circuit when the tuner sub-panel is withdrawn, so that the i.f. stages still receive a 12V supply.

Video IC Faults

The two types of video i.c. TAA700 and TBA550Q differ only in the way the pins are bent – also the TAA700 has wider pins. So it's possible to interchange them. A faulty TAA700 can give no video at all, no sync, or what appears to be a black hum bar, with a buzz on sound, variable by the a.g.c. crossover control. The TBA 550Q can give any of these faults plus no field sync and a noisy picture due to faulty a.g.c. action.

Long-Distance Television

Roger Bunney

APRIL has traditionally been a quiet month for DX-TV, with perhaps a mid-month Sporadic E opening prior to the main season starting in the second week or so of May. This year however April has been somewhat different, with the increasing solar activity we've mentioned in recent columns. True, an April Sp.E opening was noted on the morning of the 26th, with sustained ch. R1/2 signals from TSS (USSR) and TVP (Poland). But the main interest once again has been in F2 layer propagation.

Reports of F2 Reception

Several reports have come in from various parts of the world, and despite the sunspot maximum being some time away I already feel confident that we shall experience some quite exceptional reception over the next two years. Ian Roberts has sent from Pretoria State, S. Africa a most detailed report covering the early April period. Using a v.h.f. sound receiver and a conventional v.h.f./u.h.f. TV receiver, he reports as follows:

6/4/78 French language programme at 1435 local time on 41·25MHz (ch. F2), flutter free and at good strength. MUF 43MHz.
7/4/78 French TV sound again heard, and at 1315 BBC-1 sound (ch. B1) until 1500. MUF reaching barely 42MHz.
9/4/78 Things start to happen! French TV sound on ch. F2 at 1400, followed by video buzz at 48·25MHz, the ch. F2 video carrier at 52·4MHz and later still Italian ch. A video buzz at 53·75MHz. The ch. F4 sound channel then became audible at much higher levels than the ch. F2 sound. By 1500 a wideband Band I array had been hurriedly erected, feeding the TV receiver via an up-converter, and at 1710 signals were being locked. The BBC-1 news was heard at 1834, and the m.u.f. peaked at 56MHz. By 1930 conditions had declined, leaving only the French TV sound which remained audible until 2330.
10/4/78 The m.u.f. lifted to give the French ch. F2 sound only.

Ian comments that using a 120ft. long wire always gave superior results to the v.h.f. Band I array. Another interesting point is that the French TV sound was always stronger that the BBC-1 ch. B1 sound. This is either because of the vertical BBC polarisation against the horizontal French polarisation, or because BBC ch. B1 is located that much farther North.

Meanwhile Alan Latham in Abu Dhabi comments that from the 5th April Gwelo, Rhodesia was being received on ch. E2 on a daily basis, with slow fading reaching to strong signals from 1250-1345 (at this time his local blotted out Gwelo). The signals were subject to severe distortion.

Alan has also scoped certain Spread F signals. He comments that these are narrow-band signals – it's possible to pick out the field syncs, but anything above line frequency is lost in noise. The scope shows vertical patterns (as indeed appear on a TV screen). He suggests that there's a multipath type of reception which will give noise only above about 10kHz, while any picture element can arrive over many paths differing by more than 64μS. This type of signal is usually strong.

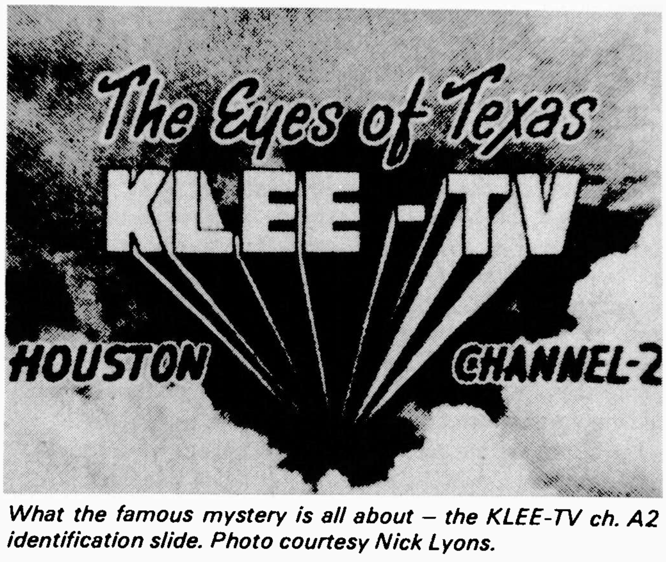
On April 10th Alan noted further signal activity, to the south east on chs. E3 and 4. He eventually resolved the ch. E3 signal at 1616GMT – a Chinese news announcer, possibly originating in Thailand or Malaysia!

Farther east Anthony Mann and Robert Copeman in Australia have also experienced enhanced signal reception. Robert (Sydney) received transpacific paging stations at 35·58MHz, both Hawaii and Oklahoma City, with at times Russian communications. Other signals throughout the 30-40MHz spectrum were heard. Anthony (near Perth) again heard stations in West/East Malaysia (ch. E2), Vladivostok and China (ch. R1) during the latter part of March, with radio amateurs at 52MHz. Apparently East Malaysia is still using the PM5544 pattern, with the West on test card G.

Reception in the UK

So much for what's been happening in warmer climates, now back to the UK. With increased latitude North one seems to be less favoured with such exotic signals. Maybe this is why Ian Roberts noted that BBC-1 was much weaker than the French signals. Certainly signals are reaching (just?) the UK South coast and it follows that maximum height for a receiving array is essential, particularly farther north in the UK.

Consequently the F2 reception that's been seen here was observed by the rather well known names Hugh Cocks and David Martin, at South Devon and North Dorset respectively – and for once myself near Southampton!



What the famous mystery is all about – the KLEE-TV ch. A2 identification slide. Photo courtesy Nick Lyons.

On April 15th at 1535 local time Hugh noted a ch. E2 signal with a ghostly appearance. This turned out to be a football match with coloured participants. The line syncs were slightly l.f. of the UK normal lock however, and the signal faded at 1603. David was contacted but saw nothing. On the 19th yours truly was viewing ch. E2 (as usual) with a south facing array when at 1845 local time weak line syncs were noticed above the noise. The signal was locked (just) but no detail could be resolved. A hurried telephone call to David alerted him but nothing was noted at Shaftesbury on ch. E2. Returning from the box further effort was applied with alternative arrays etc. to improve the fading signal – but in vain! Meanwhile at Shaftesbury and in Devon (and free from a ch. B3 local!) NTV Nigeria ch. E3 was pouring in at good strengths, reaching a measured 2mV!! It faded at 1928. At 1920 the m.u.f. was such that the main carrier had gone, leaving an l.f. video sideband that gave a most unusual video effect – tending to lock with inverted video. I now view the evenings on ch. E2 with a ch. B3 sound notch filter, albeit a matter of bolting horses and stable doors!

On April 11th a massive flare on the Sun caused widespread radio blackouts, but to date no reports of Auroral activity have arrived.

The April Lyrids Meteor Shower gave excellent signal pings, and stronger bursts on the morning of the 22nd. This day and the 23rd produced increased tropospheric reception, particularly at u.h.f. from France. Mike Allmark at Leeds also reported improved trop reception from the south/south east on April 5/7th.

All in all a busy and exciting (if not for me frustrating) month!

News Items

Belgium: There have been changes to the PM5544 test pattern, additional information now being given. For example, ch. E8 Wavre carries "WAVRE CANAL 8" at the top and 'RTBF' at the bottom.

West Germany: Ryn Muntjewerff reports that the aerial company Wisi is to introduce a wideband Band III array with 24 elements! Gain is quoted (l.f.) as 12·5dB – I assume at the E5 end. This could indicate an h.f. gain of perhaps 16dB.

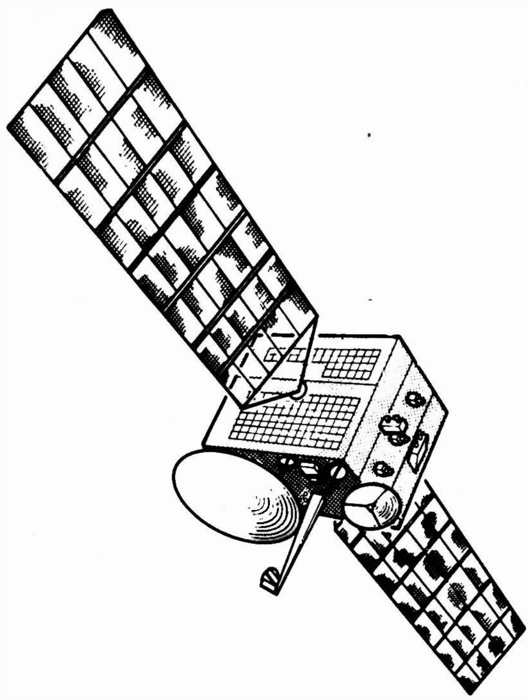
Spain: RTVE has been discussing with the EBU the establishment of a Spanish programme satellite. Known as 'H-SAT' it would be owned by ESA. It's hoped to commence experimental transmissions in 1981. RTVE is to expand its regional centres in order to establish good relationships with groups such as the Basques.

Swaziland: Swaziland has commenced transmissions. The system used is B/G, and at present confined to low transmitter power. Chs. 25, 27 and 35 are already in use, and in due course ch. 4 and 7 transmissions will start.

Italy: Brian Fitch reports that Italy is to go ahead with RAI-3, to be on-air at the end of 1980.

From our Correspondents...

A report from Khajag Latchinian (BDXC), who lives in Beirut, Lebanon, has come via Peter Vaarkamp. His local Band I transmitter, some 50km to the north at Masser el Chouf, at a height of 2,000 metres, radiates a test grid (with no identification) for one hour prior to programmes. Other identifications include a station slide with a view of a cedar tree. The clock carries an advertisment for Kent cigarettes – the clock is often on the screen for five minutes. A ch. E3 signal from Port Said can also be received.



An impression of the OTS-2 satellite in orbit.

Vladimir Petuzilka (Prague, Czechoslovakia) has written to tell us about TV there. He says that Slovakian TV uses the PM5544 pattern with the identification "SR 1TV" or "SR 2TV". About 60 per cent of the programmes are in SECAM colour. Most TV sets are produced in Czechoslovakia, including the Tesla Colour and Tesla Spectrum with 59cm 90° deflection tubes. Other colour receivers come from the USSR – Rubin, Elektron and others. Sony are well represented, with models switching between PAL/SECAM. Vladimir comments that for a time TVP used the USSR UT electronic pattern but they've now gone back to the PM5544 pattern.

Following the discussion of KLEE-TV ch. A2 being received some years after it ceased to operate, Nick Lyons has sent us a photostat of a report which repeats what is already known but also comments that several viewers took photographs. An accompanying photograph shows the KLEE identification slide. It must have been taken from the original in the USA, but at least shows what a signal from KLEE looked like – in Texas!

Wideband Amplifier

In the January column a wideband (25-1,000MHz) amplifier circuit using two Siemens BFT66 transistors was shown. These transistors are available from Electrovalue Ltd., 28 St. Jude's Road, Englefield Green, Surrey TW20 0HB at £2.54 each plus 8% VAT and 25p post and packing. Do *not* contact Siemens directly – they cannot undertake to deal with enquiries/orders from the public.

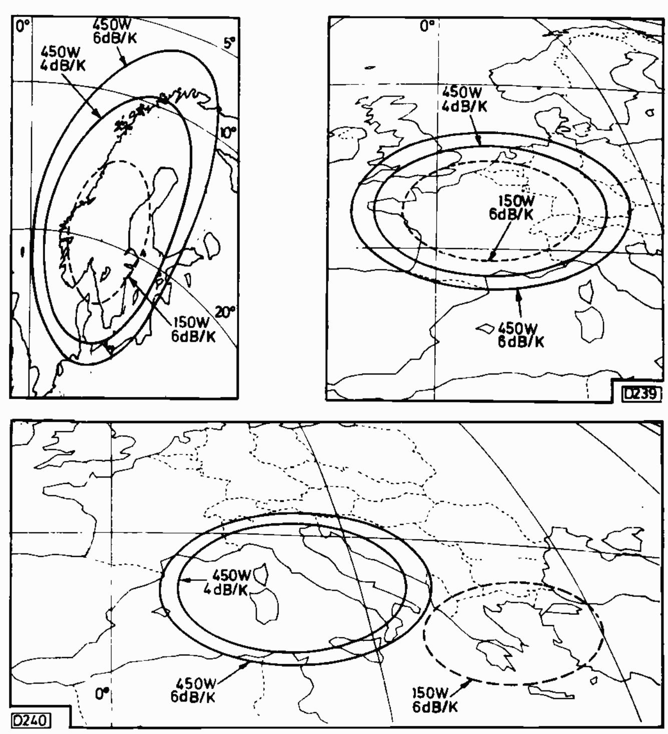
Satellite TV

Satellite transmissions now form an important part of the international TV network, and experimental satellite TV transmissions to the European land mass are to start shortly. The replacement OTS-2 satellite has now been launched from Cape Canaveral, and will provide signal propagation experiments at 12GHz.

The World Administrative Conference (convened by the ITU) which decided on the future for satellite transmissions in the 12GHz band took place in Geneva between January 10th and February 13th 1977. Some of the more important results are reported below: for more detailed information, consult the April 1977 *Technical Review* of the European Broadcasting Union.

Frequency modulation is to be used for the video signal, with an overall channel bandwidth of some 27MHz and 20MHz between channels. This gives 40 channels in the 11·7-12·5GHz spectrum (for Region 1 – Europe, Africa). Interference ratios between the f.m. transmissions to be not less than 35dB for one interfering signal and a total of 30dB for all interference in a given channel, the preferred protection ratio decided on being 31dB for co-channel and 15dB for adjacent channel interference. Signal polarisation to be circular, with the "down" signal having clockwise rotation of the E field looking from the satellite, and the "up" signal anticlockwise rotation. The power flux at a preferred site on the Earth's surface is based on the use of a 90cm. diameter receiving dish (3dB beamwidth at 2°), giving a receiving system noise figure of 8dB. A smaller, say 75cm., dish would give a correspondingly lower receiving system noise figure of about 6dB. Most European countries, including the smaller ones such as Monaco, wanted channel allocations for future services. The final decision was to allocate five channels per country, the bandspace to be used either entirely for TV purposes or mixed with other uses such as multiple-channel f.m. radio etc.

The longitude position 1°W was given to Eastern Europe, 19°W to the continental West European countries, 31°W to Ireland and the UK, and 37°W to the S.W. European countries. The UK channels are 4, 8, 12, 16 and 20, at the lower end of the band. A larger beam coverage is



Examples of the OTS-2 satellite's European "footprints". Top left, coverage of Scandinavia by both beams (450 and 150W). Top right, coverage of Western Europe with both beams directed at the same area. Bottom, Southern European coverage, with the 450W beam directed at Italy and the 150W beam at Greece.

required for Scandinavia, from a satellite at 5°E. Solar cells will be used for power generation, and for this reason the satellite will be to the west of its planned service area. This minimises the problems that could arise with the satellite in shadow (running on batteries), since transmissions will normally be during the latter part of the day when the solar panels are illuminated.

It may be wondered why wideband f.m. video transmission is to be used when the established terrestrial service uses a.m. To obtain an acceptable picture signal/noise ratio of 36dB using a.m. and a 1° beam would require an r.f. power of 10-20kW. Wideband f.m. (16MHz peak-to-peak with a channel width of 32MHz) would give a 36dB signal/noise ratio with perhaps 500W. F.M. seems essential therefore in view of the power considerations. It also gives better interference protection.

One problem is in trying to ensure that transmissions to a small country do not spill over into adjacent countries – there could be political problems and so on. It's unlikely to be possible to obtain a beamwidth of less than 0·6°, which would give coverage over an area of say 200km. – assuming a transmitting array of perhaps 3m.

European Experimental Transmissions

The initial experimental European transmissions from the Ariane satellite are due to start next Summer (1979), which isn't all that far away! The satellite will carry two transmitters, one of 450 or 400W and the other of 150W, both intended to provide direct reception, the former naturally over a larger area. The two beams will be independently steerable over the European land mass, parts of North Africa and the Middle East. The accompanying maps show typical coverages (footprints) for both beams. The service contours indicate where a signal of quality as previously defined will be obtained, provided the receiver's figure of merit corresponds to the figure shown against the contour, e.g. 6dB/K.

Uplink transmissions will be in the 14-14·5GHz band. Additional experiments will be carried out, including beacon signals at 20 and 30GHz to check propagation at these frequencies. With the two steerable beams, it's possible to use the higher power transmitter for vision and the lower power one for sound, with possibly the sound transmitter carrying several languages for a programme being broadcast to several countries.

The massive solar panel assembly is capable of supplying 2·5kW at 50V for a load of 2·3kW which includes electrical propulsion for stabilisation, an accuracy of 0·05° being required for beam pointing.

Acknowledgement

Grateful thanks to the EBU, Brussels, for information and diagrams, and to K. Freeman of the Mullard Research Laboratories for further information.

Your PROBLEMS solved

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DECCA 80 CHASSIS

Sometimes there's snow on the screen, disappearing when there's a camera change etc. This is not troublesome once the set has warmed up. There is also a flash across the screen on blue backgrounds, with white flyback lines showing. This clears when the set is switched off for a minute or so.

Transpose the red and blue leads from the c.r.t. base to the video panel. If the fault now appears on red backgrounds, check the transistors (TR202 and TR203) in the blue output stage, the blue drive control VR261, the blue black-level control VR276 and if necessary the MC1327 demodulator i.c. IC202. If the fault remains, the c.r.t. could be faulty. The intermittent snow effect could be due to a faulty tuner but is more likely to be a poor joint or hairline crack on the aerial, tuner or i.f. panel. It would also be worth checking the tuner supply decouplers C1 and C3 (both 0·1μF).

THORN 1591 CHASSIS

The trouble is lack of height, about three-quarters of an inch at the top and bottom unless the height control is set at one end of its track, when the bottom of the raster is badly bowed. If the set is run in this condition, the height progressively decreases by about a further quarter of an inch at the top and bottom, more pronounced at the bottom.

First ensure that the h.t. line is correct at 11·6V. If the fault persists, check the electrolytics in the field output stage (C78 and C80) by substitution, then if necessary check all five transistors VT16-VT20 following the field oscillator for leakage, starting with the output pair VT19/20 which are the most vulnerable.

PYE 169 CHASSIS

The picture takes a long time to appear, and when it does it's poor, not good enough for daylight viewing. On switching off, the picture goes to a thick line which then goes to a bright spot before fading away. The sound is o.k.

If the picture is lacking in width, check the PL504 line output pentode and the two 4·7MΩ resistors R85 and R86 in the width circuit. If the picture highlights are blurred and negative, the c.r.t. is low-emission and reactivation or replacement will be necessary. If the picture is of normal size and just dark, check the c.r.t. grid and cathode voltages to find out whether the grid is low or the cathode high, and proceed from there.

RANK Z718 CHASSIS

The sound and picture are normal for the first quarter to half an hour after the set has been switched on, but the picture then fades away. Occasional blue highlights can be seen and adjustment of the brightness control has no effect at all. Before the picture disappears, occasional horizontal black lines appear. When the fault first developed the picture would reappear after a time which varied from ten minutes upwards. Now however the picture does not reappear unless the set is switched off for ten minutes or so. The procedure then recurs.

Sometimes the fault is due to the rivetting at one end of the brightness control being loose. Alternatively the TBA560C i.c. in the decoder may be responsible. These comments assume that the RGB output transistor collector voltages rise during the fault. If this is not so the c.r.t. first anode voltages are probably dropping, and in this case voltage checks around the associated stabiliser transistor 4VT14 should reveal the cause of the problem.

GRUNDIG 1500GB

The problem with this set is that the tuning keeps drifting.

The trouble could be due to a faulty voltage stabiliser i.c. Di121 (TAA550) or the tuning potentiometer bank. It's much more likely however that the varicap diode voltage feed ceramic C24 (0·001μF, feedthrough type) is leaky. This calls for a replacement capacitor or an exchange tuner unit.

RANK A823A CHASSIS

Over the last year the width has gradually decreased. I measured the e.h.t. and found that it was over 30kV. The flylead on the line output transformer was set to the maximum width position and the set e.h.t. control adjusted for correct width. The e.h.t. was still around 28kV however while the h.t. voltage was high at 220V. With 8RV1 set for the correct h.t. voltage the e.h.t. was down to 25kV but the picture is too narrow, in by about an inch on either side. Also the picture is difficult to watch, as if out of focus.

The width will be insufficient if the e.h.t. is too high. The usual cause of this trouble is incorrect flyback tuning in the line output stage. Check the tuning capacitors 6C5 and 6C6 by substitution. After doing this, rebalance the output stage with 6L5/6.

THORN 3000 CHASSIS

The picture is steady but too bright, with flyback lines showing and very pale colour. The brightness control only seems to pull a shadow over the whole picture. The contrast control reduces the picture content and produces defocusing, but the flyback lines are still visible at all settings. The colour control must be full on to get even weak colour: if it's adjusted very slightly below maximum the picture turns to monochrome – and still too bright.

First check C520 (7,500pF) on the line timebase board, then if necessary the associated capacitor C519 (0·015μF). Pulses from the junction of these capacitors go to the video and decoder panels. If the fault persists, check and replace as necessary VT901 on the beam limiter panel and VT204 and VT205 on the video panel. Set up R450, R221, R230 and R903 according to the instructions in the manual. You should then have the correct grey scale and brightness range. If the saturation is still low check C330 (4·7μF) and C349 (50μF) and adjust R308 on the decoder panel.

PYE 697 CHASSIS

When the set's switched on there's just a horizontal white line, i.e. field collapse. After about two minutes the picture suddenly flicks on and there's an excellent picture for the rest of the evening. This happens every time the set is switched on.

Just to the left of the right side power supply/line timebase panel there's a subpanel which carries the field timebase (vertical hold control protruding). There are two transistors on a separate heatsink and two on the panel itself, one the oscillator and the other the driver for the output pair. First ensure that the supply lines to this panel are intact, then by heating, cooling, disturbance etc. plus voltage readings ascertain whether the trouble is in the oscillator, driver or output stage. We are inclined to suspect the AC128 driver, which is probably mounted under the panel, or a poor connection on a leadout wire.

THORN 3500 CHASSIS

The fault first appeared on the screen as r.f. signal lines, similar to finger prints, the sound at the same time turning to a loud buzz. It was thought that this was due to excessive signal strength, but this theory has been disproved. The fault could be cleared for different lengths of times by turning the set off and then straight back on again. A can on the i.f. strip was changed, curing the trouble for about a week. The symptoms have now changed slightly. The lines appear when the set's been on for approximately ten minutes, the colour going at the same instant with the sound turning to a buzz. The picture is basically monochrome, but there are patches of green and mauve, sometimes turning to lines of these colours. If left on, the set will occasionally return to a perfect picture, then back to the fault condition.

The i.f. strip in this chassis has proved to be very reliable, but when trouble does occur it's usually the a.g.c. decoupling capacitors, especially the electrolytic C179 (10μF). Check this, and the 0·1μF one (C178). If the trouble persists, probe the i.f. panel looking for dry-joints, especially the earthing of components and the screening cans in the first three i.f. stages. Finally, check the h.t. decouplers C177, C108, C176 and C117 if necessary.

PHILIPS K70 CHASSIS

The colour suddenly disappeared leaving a monochrome picture. The set had been working perfectly before. The voltages at the anodes of the PCF200 pentode section colour-difference output valves are reasonably correct, but there's no voltage at the anodes of the three associated clamp triodes. Applying the meter prod to the anodes of the blue and green clamps produces a green or blue picture, but this effect cannot be achieved with the meter prod at the anode of the red clamp. R1120 which provides the common cathode feed to the triodes was found to be open-circuit. Replacing this restored the cathode voltages but there are still no anode voltages despite the 250V line being correct. Also the picture now lacks contrast, with flyback lines showing even at low brightness control settings. Disconnecting R1120 restores a normal monochrome picture.

The key to this problem lies in the fact that the grids of the three clamp triodes are connected together. Thus if the red colour-difference clamp triode is defective, with an internal short-circuit say, the other two clamps will be affected, causing them to draw excess current. Check the PCF200 valves therefore, then check that line pulses are being fed to the grid circuit – check back to the coupling capacitor C747 which receives pulses from tag 3 of the line output transformer.

GEC 2038

This set is used as a stand-by. Recently I had occasion to use it, after having stored it away for some six months, and discovered that the contrast control is ineffective on both systems. The PFL200 video output valve has been replaced, and the value of R52 (2·7MΩ) in series with the slider of the contrast control has been checked and found to be correct. The fault persists however and all voltages seem to be normal.

The contrast control can be effective only if there's sufficient signal to "load up" the a.g.c. line. First ensure that one side of the contrast control has h.t. applied to it, then check the EF184 and EF183 i.f. valves and if necessary their associated biasing and feed components.

RANK A823 CHASSIS

After one to two hours, depending on conditions, three pictures appear across the screen, i.e. the line speed alters. At the same time the brightness falls, and this is sometimes followed by a total loss of raster. The normal picture returns if the set is switched off and left to cool down for ten minutes or so.

As you say, the line frequency is changing when the fault occurs. Suspects, in order of likelihood, are as follows: the flywheel sync discriminator diodes 5D2/3 (type ITT2002); 5C14 (50μF) which decouples the supply to the reactance multiplier stage; 5C17/18/20 in the oscillator tuned circuit (especially if of the polystyrene type); 5C16 which feeds back to the base of the reactance multiplier transistor 5VT4; and the transistor itself. This may seem a lot to choose from, but if you arm yourself with a hair-drier and a can of aerosol freezer you should be able to locate the defective component very quickly.

THORN 8000 CHASSIS

The set has developed the habit of "clicking" at the back of the set as the picture starts to collapse – it doesn't collapse fully, then immediately rights itself. It does this intermittently, sometimes several times during an evening, and may then go for a whole day without doing it again. I've checked the printed board in the vicinity of the field output transistors VT410/11, but can find no obvious cracks or dry soldered joints.

Intermittent field collapse on this chassis has been traced to the field output transistor emitter resistors R457/8, R460 (the RG field balance control) being intermittent, the current amplifier, driver and output transistors VT408-411 as well as the joints you mentioned, particularly at the collector connections of the output transistors. Check also the plugs and sockets on the timebase and power panels. A meter and scope would be invaluable in tracing the cause of this trouble.

VIDEO STREAKING

I have the same problem with a couple of monochrome sets, one fitted with the Philips 210 chassis, the other a set in the Bush TV161 series. The trouble is a horizontal band of grey associated with any peak white areas of the screen, a football for example. It matters not how many or how large the areas are, the band is always there.

The trouble can be due to a low-emission c.r.t., but can also be due to a low-emission video output valve (both these chassis use a PFL200) or more often due to deterioration of the resistors in the anode, screen grid and cathode circuits or the electrolytics in the latter two departments.

PYE 697 CHASSIS

To start with the focus was poor, then the picture went off. A replacement boost diode restored the picture, but after about three hours the focus was again poor and there's an intermittent upwards twitch at the bottom of the picture.

The focus problem should be resolved by checking the resistors associated with the focus control – R234 (5·6MΩ) in series with it and R510 (100kΩ) on the c.r.t. base, slightly widening the spark gap associated with pin 9 on the c.r.t. base if necessary. This assumes that the picture is of normal size. The field twitch is usually due to the field charging capacitors C253 and C254, the bootstrap capacitor C256 or the field driver transistor VT25 – assuming that there are no dry-joints or blobs on the field timebase panel. Check the RG field symmetry control RV40 if the convergence twitches too.

THORN 1590 CHASSIS

The trouble with this portable is that the brightness cannot be turned down. The sound is perfect, but there's only the faintest picture. The video output transistor has been replaced, but this has made no difference.

The most likely cause of the trouble is C111 (1μF) which is near the line output transformer. It's the reservoir for the HT4 rail which supplies the video output transistor. If this turns out to be in order check the video driver transistor VT6 and the 100μF electrolytic C51 in the contrast control circuit.

TEST CASE

187

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.

The owner of a Grundig 717 colour receiver selected this particular model because of its good sound quality and the ease of connecting an external speaker system to further improve the reproduction. The model has two speaker units, one connected directly across the secondary of the audio output transformer and the other connected in series with a capacitor to provide a high-pass characteristic, this unit responding mainly to the higher frequencies. A DIN socket is provided for connecting an external speaker system. It incorporates a switch so that when the DIN plug of the external speaker is plugged in one way round the internal units are disconnected, but when plugged in the other way the internal and external speakers are driven together.

Vision was operating normally, but the owner was worried about a tizzly kind of distortion from the internal speakers – this was much more troublesome on low-level than high-level sounds. It was discovered that prior to the trouble the receiver had been used for a long period with an external speaker system of the hi-fi variety, plugged in so that the internal speakers were disconnected; that this external speaker system had since been sold, hence the reason for returning to the internal speakers; and that the viewer was particularly keen on good quality sound.

The audio amplifier consists of a pair of transistors in a version of the super-alpha configuration to present a high input impedance to the output from the TAA640 intercarrier sound i.c. The power output is approximately 2W into the internal 5Ω speakers.

Low-level listening confirmed the complaint, but at higher sound intensities the quality became normal. All voltages in and around the audio circuits measured normally, and there appeared to be no serious fault with the i.c. or the transistors. With an external speaker plugged in the fault was not present, so it was concluded that the internal speakers were the cause of the trouble. But after replacement exactly the same problem remained! What was the most likely cause of the fault? *See next month's* Television *for the answer and for a further item in the* Test Case *series.*

SOLUTION TO TEST CASE 186
– Page 440 last month –

In the CVC5 chassis there's an OA91 diode in shunt with the field sync feed circuit and in series with the cathode of the triode section of the PCL805 field timebase valve. The diode is provided with a little forward bias through a 5·6MΩ resistor, and as a result clips the unwanted line pulses during the scanning stroke. When the negative-going field sync pulse arrives at the triode cathode, the multivibrator action is "triggered" since the pulse drives the cathode towards the grid potential. When this happens the OA91 is held in conduction by the triode current. Since the diode was found to be short-circuit, the field sync pulses were being short-circuited to chassis. (An open-circuit diode would result in field collapse of course.)

Bottom cramping is generally caused by incorrect field output stage biasing. In the CVC5 chassis the bias is provided by a 390Ω resistor in the pentode cathode circuit. It's decoupled by a 250μF electrolytic (C247f). The resistor itself was in order, the trouble being due to the 250μF electrolytic exhibiting a degree of insulation intermittency. Replacing this capacitor cured the trouble.

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TELEVISION JULY 1978

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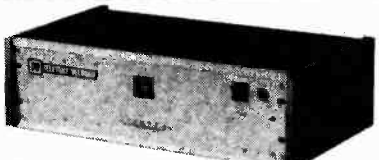

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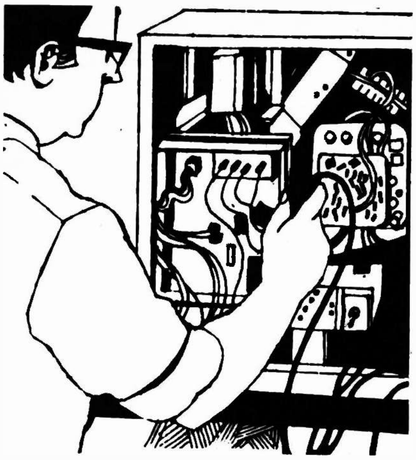

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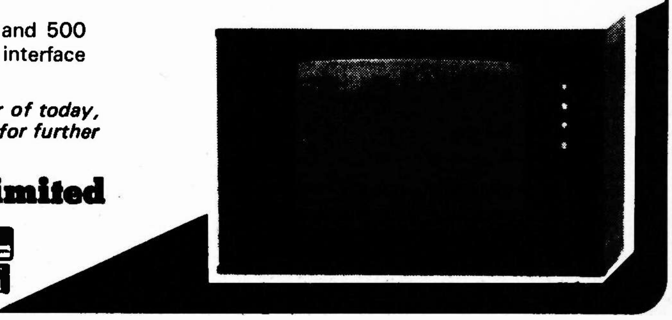

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EL509	2.50
EM80	1.00
EM81	1.00
EM84	1.00
EM87	1.45
EY51	0.80
EY81	1.50
EY83	1.50
EY87/6	0.45
EY88	1.00
EY500	1.45
EZ40	1.00
EZ41	1.00
EZ80	0.42
EZ81	0.45
GY501	1.40
GZ32	1.00
GZ33	4.00
GZ34	2.25
HN309	1.70
KT66	3.50
KT88	6.75
P61	0.60
PC86	0.80
PC88	0.80
PC92	0.65
PC97	0.75
PC900	0.65
PCC84	0.39
PCC85	0.47
PCC89	0.49
PCC189	0.60
PCF80	0.80
PCF82	0.45
PCF86	0.57
PCF200	1.55
PCF201	1.45
PCF801	0.49
PCF802	0.80
PCF805	2.25
PCF806	0.70
PCH200	1.20
PCL82	0.62
PCL83	1.20
PCL84	0.50
PCL86	0.85
PCL805	0.65
PFL200	1.35
PL33	1.00
PL36	0.80
PL81	0.49
PL81A	0.75
PL82	0.50
PL83	0.50
PL84	0.50
PL95	1.00
PL504	1.05
PL508	1.85
PL509	3.10
PL519	3.75
PY33/2	0.50
PY81	0.60
PY82	0.40
PY88	1.12
PY500A	2.05
PY800	0.60
PY801	0.60
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UAF42	0.70
UBC41	0.70
UBC81	0.55
UBF80	0.50
UBF89	0.39
UC92	0.50
UCC85	0.50
UCF80	0.80
UCH42	1.00
UCH81	0.60
UCL82	0.75
UCL83	1.00
UF41	0.70
UF42	1.00
UF80	0.40
UF85	0.50
UF89	0.52
UL41	0.90
UL84	0.90
UM80	1.00
UY41	0.70
UY85	0.70
U19	4.00
U25	1.00
U26	0.90
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1·6 Amp
2 Amp
2·5 Amp
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BF180 BF257 BC460
BF181 BF137 BF395
BF182 BC161 BC263B
BC300 BF185 BF273
AC128 15p EACH

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680/50v 220/63v
2200/50v
2200/10v
12½p EACH

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2N2222 BF195
2N3566
BF198 10p EACH

BF336 30p

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·01 MFD 1000v
·047 MFD 1000v
·47 MFD 630v
·0047 MFD 1000v
·0022 MFD 1500v
8p EACH

200+200+100M 325v 40p
470+470M 250v 40p
100+200M 325v 30p
200+200+100+32M 350v 70p
150+200+200M 300v 50p
800M 250v 20p
600M 300v £1.00
400M 400v £1.00
800+800M 250v 60p
300+300+100+32+32 300v £1
200+100+100M 350v 70p
100M 450v 25p
33/450v 25p
47M 450v 25p
680M 100v 25p
6800M 40v 35p
100M 350v 20p
22M 350v 20p
33000 10v 30p
15000 40v 50p

2·2/63v 10M 40v
220M 10v
2·2M 100v
22M 100v
4·7M 63v
5p EACH

Plessey Green Condensers
6800M 16v 1000M 50v
2200M 16v 1500M 25v
1000M 10v 1000M 10v
4700M 25v 1500M 40v
680M 63v 1000M 25v
1000M 63v 1500M 50v
3000M 16v 4700M 16v
330M 100v 1000M 16v
4700M 10v 100M 63v
1000M 63v
3300M 25v
1000M 40v
12½p EACH

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18 Kv BYF3123 Silicone 30p

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270PF 8Kv 330M 10v
1000PF 10Kv 330M 25v
1200PF 10Kv 330M 35v
1000PF 12Kv 330M 50v
160M 25v 330M 63v
220M 25v 470M 25v
1000M 16v 470M 35v
220M 35v 470M 40v
220M 40v 47/63
220M 50v 300PF 6Kv
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TBA530Q £1.00
TBA550 £2.00
SN76544N 50p
SN76640N £1.00
SAA570 50p
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RCA16573
40p PAIR

BU 204 Ex Panel
BU105 Ex Panel
BU208 Ex Panel
50p EACH

5A-300
TIC106 Thyristors
25p EACH

RCA40506 Thyristors 50p

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BD610
BD619
80p PAIR
MJE2955 50p
TIP2955 50p

BC188 10p

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