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MARCH 1976

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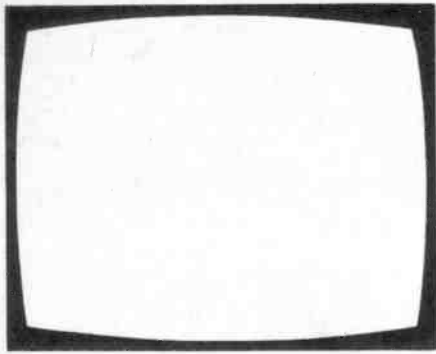
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Television

SERVICING
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1976

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CORRESPONDENCE

All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", Fleetway House, Farringdon Street, London EC4A 4AD. All other correspondence should be addressed to the Editor, "Television", at the same address.

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BACK NUMBERS

We regret that we are unable to supply back numbers of *Television*. Readers are recommended to enquire at a public library to see copies. Requests for specific back numbers of *Television* can be published in the CQ Column of *Practical Wireless* by writing to the Editor, "Practical Wireless", Fleetway House, Farringdon Street, London EC4A 4AD.

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".

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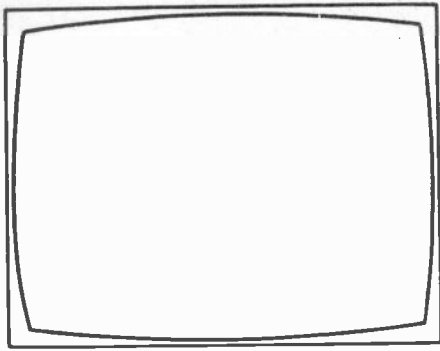
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FAULT HISTORY

When you read about stock TV set faults and have to attend to an endless stream of defective receivers it's easy to come to the conclusion that the reliability of TV sets is poor. But what about all those you don't see or read about – the vast majority of which are working away without giving any trouble? The average TV set works five hours a day and goes on doing so day after day and year after year. What should perhaps be surprising is that they do so, uncomplainingly and with such a low fault rate. After all, there's plenty in them to go wrong!

Evidence from a number of sources indicates that the reliability of TV sets has been steadily increasing. The worst periods were undoubtedly when the earlier all-valve dual-standard monochrome chassis appeared on the scene and then, not long after that, the initial dual-standard colour chassis appeared. Both had failure rates of four or five times a year per set. The failure rate with modern solid-state colour sets is now down to about one fault a year and, as you would expect, is even less with solid-state monochrome chassis. The changeover to solid-state techniques was not all that easy going initially however. In the early days many devices, particularly line and video output transistors, were prone to early death. It seems that the lessons have been learnt however, since improved devices have been introduced for the more critical circuit applications.

In view of this increased reliability it is perhaps surprising that we can still talk about stock faults. Yet such things continue to exist, and seem to be of two varieties. Writing in *The Radio and Electronic Engineer* recently Dennis Heightman, Group Technical Director of Thorn Television Rentals Ltd., commented that "most failures are due to batch problems with various parts brought in from outside suppliers, e.g. power transistors, i.c.s, tuners, hybrids, e.h.t. multiplier units, electrolytic capacitors, wound components and the like". This explains the sort of stock fault that suddenly puts in an appearance in some areas but causes disbelief in engineers in other areas since they never encounter it. But there is also the traditional stock fault that turns up everywhere sooner or later and is due to the fact that a particular component is not really up to its job. Les Lawry-Johns had something to say on this subject in his column's 21st anniversary piece last September. The increase in set reliability suggests that these are on the decline however. One area that does continue to give trouble is the e.h.t. tripler. Strange things seem to occur in these apparently so simple devices. Whether it's lack of balance due to leakages in the diodes and capacitors or whatever is hard to say, but many have rather a poor name.

Could increased reliability mean that the service engineer will eventually be left with nothing to do? It depends to some extent on the length of life the public decides to expect from TV sets. We have to consider not only modern sets in the prime of life. With all electronic equipment the failure rate with time follows a bath-tub curve – high during the initial "burn in" period, very low for a long "normal life" period, then rising exponentially as age sets in. The initial very brief burn in period can be and is taken care of by factory soak testing. Ageing occurs when insulation begins to break down, corrosion attacks joints and metal fatigue affects mechanical contacts. People will put up with an ailing set for just so long: eventually they get fed up with its unreliability – and the bills. For many sets however there then follows what can be called a recycling period, as enthusiasts or those with more technical ability than cash decide to coax the last out of them. This coaxing of sets around ten years old is quite a familiar business, with valves being swapped around and various other forms of transplantation being carried out. What we don't know yet is how this will develop with solid-state sets: there's undoubtedly a lot here that experience has yet to teach us. But stock faults of one form or another will inevitably remain to plague those involved in this sort of work – simply because some components, especially those that operate under stress conditions, break down more often than others.

We have noticed a tendency amongst some of those concerned with training to consider that talk of stock faults is indicative of lack of professionalism. They seem to think that the expert diagnostician should at all times rely on skillful systematic testing. But most TV faults can be caused by quite a number of defects, and it seems more professional, to us at any rate, to pounce first on the known weak spots. There are also many faults that simply can't be found by following a theoretical test schedule – because theory doesn't tell you for example that insulators can start to conduct!

To sum up, the public is now benefitting from a marked increase in receiver reliability. But faults must eventually appear, and the skills and experience of the trade will continue to be needed.

Applications are invited from television or electronic engineers, preferably with writing experience, to fill the post of

TECHNICAL EDITOR

Applicants should have a sound knowledge of receiver techniques, including colour, be conversant with modern components and devices, and be willing to do some practical work. Details in writing, stating salary, education and experience, to:

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teletopics

MAKING SERVICING PAY

In the last investigation into the subject carried out by the Radio and Television Retailers Association (RTRA) it was estimated that the average net loss made by members on their servicing operations was 23.5%. Though not unexpected this is nevertheless an alarming figure, representing an inability on the part of the trade to cost its servicing operations and to run them on an efficient basis. With the continuing deep recession on the sales side, losses of such magnitude on the servicing side obviously cannot be sustained and it is likely that many dealers will be taking a careful look at their servicing operations. You can't undertake servicing successfully unless you have skilled engineers backed by adequate equipment and stocks. If a small undertaking cannot support such a set-up it is much better to investigate the possibility of having servicing subcontracted out. It seems quite likely in fact that more dealers will in the present difficult times be considering joint servicing operations.

In view of the situation the RTRA has issued new recommended minimum servicing charges. The suggested charge for a call within a six mile radius, for a repair, or an estimate whether accepted or not, is now £4.75. The suggested charge for the first hour of a workshop service is £5.25, and £4.75 for subsequent hours. Additional charges are suggested for collection and delivery, and all these figures are without VAT. One dealer has commented that he doubted whether these "very reasonable" figures would in fact be widely charged and claimed that he is able to run his servicing operation without loss on the basis of £3.50 per call or hour in the workshop. "Without loss" is a curious way of looking at it though: the more efficient organisations aim to make a profit on their servicing activities. It seems nevertheless that some discretion is necessary. Even in these days of inflation to charge over a fiver for a simple repair seems steep and is hardly the way to create goodwill.

The costs of running a service department, of replacement parts and panels, plus the horrendous 25% VAT that has to be slapped on top, have many implications. Will some people buy new sets rather than pour out money to keep older sets going? Will safety be affected, with defective sets given a thump to keep them going rather than being taken in for attention? Modern, BEABed sets are unlikely to be a hazard since the multiplicity of fuses, protective devices and safety techniques mean that they are unlikely to continue in operation if seriously defective, but with your old banger – and there are plenty of them around

– the safety problem is very real. One likely consequence is a growth of "unofficial" back-room servicing. There is nothing intrinsically wrong about this provided that whoever is doing it has some idea of what they are about. The complexity of many modern circuit techniques is likely to leave most "dabblers" completely baffled however.

Field servicing in particular is becoming very expensive to run in view of the high costs of vehicle operation. As a result of these escalating costs a two-tier rental/repair system has been suggested, with a substantially lower charge to those who bring their sets in and collect them. If specialised "service depots" serving the public became popular one wonders whether sales and servicing would tend to become largely separate operations, as in the motor industry.

On the trade scene generally, a recent estimate has it that there are now some 600,000 colour sets in stock in the UK waiting to be sold. Since this represents more than four months' sales at the present rate, it looks as if production cut backs may have to be increased further. Meanwhile the cost of financing so much stock places a considerable burden on all sections of the industry.

POOR COLOUR SALES HIT BBC

The BBC's financial position has been badly undermined by the decline in colour television set sales. With the present £10 difference between monochrome and colour television licences, the BBC loses £1m of revenue for every 100,000 by which colour licences fall below expectations. Another thing the Chancellor overlooked when upping VAT on TV to 25%!

Following a profit of £ $\frac{3}{4}$ m in the year to March 1974, the BBC turned to a deficit of nearly £19m by March 1975. The present plan is to reduce this to £10m in the year to March 1976 and to hold the loss at this level for a further year – the licence fee is not due for revision until 1977. In order to do so the BBC is having to make cuts in its services, for the first time in its 53 year history, and is understood to be postponing capital expenditure.

THE COLOUR CRT FIASCO

The question of what's wrong with the UK economy has been asked by many people in many different walks of life. Perhaps a look at the utter mess which has developed in the colour c.r.t. field will throw some light on the problem. Basically, we've had the colour set market bobbing up and down like a yo-yo as a result of tax/credit policy changes

introduced by successive governments. A vast demand was unleashed which led to the phenomenal 1973 boom year when over two and three quarter million colour sets were sold. Then came successive clamp-downs. When the final figures for 1975 appear they will be likely to be around the 1.6 million mark (they stood at just over 1.3 million at the end of October). How do you go about planning production against a background such as that?

For the setmakers the problem has been difficult enough, but for the colour c.r.t. manufacturers – just two of them in the UK, Thorn and Mullard – it has been disastrous. The reason for this is that c.r.t. production is much more capital intensive. While TV sets are assembled, with a fair manual content in the work involved and in quite a number of plants of varying size, colour c.r.t.s have been produced in just two highly automated and very expensive plants. A setmaker can reduce his labour force and close down plants yet still keep going, but for the c.r.t. makers there are no such options. Thus with demand falling well below capacity and no export prospects – since every c.r.t. producing country has excess capacity – the losses on c.r.t. manufacture mount rapidly. The consequence of all this has been the closure of Thorn's Skelmersdale plant, leaving Mullard with a monopoly of UK manufacture. Hard market economics you say? But compare this with what happens in Japan, which provides the major competition for the UK industry. The ultimate irony here is that the Japanese ministry for industry has been studying the feasibility of helping Japanese c.r.t. manufacturers to start manufacture of colour tubes in the UK! The main intention is to overcome an import ban should this be imposed. But the thing to note is the cooperation between industry and the ministry, a characteristic of the development and success of Japanese business. The government assists industry in its planning and development – both in the home and export markets. In the UK the two sides seem perpetually to pull in opposite directions. There seems to be a moral here somewhere.

VIDEO

The well known Philips N1500 videocassette recorder is to be superseded by a modified version, Model N1501, which will include stop motion. The recommended price is expected to be about £550 including VAT. Meanwhile the present Model N1500 seems to be on offer at various shops at quite substantially reduced prices – around the £375 mark. This seems very reasonable for such a sophisticated piece of equipment.

Nordmende's video system which enables super-8mm film to be shown on any television set – the connection is via the set's aerial input socket – has now been introduced on the UK market by Nordmende distributors Vessco Vision and Radio (Unit 4, Blackwater Way, Ash Road, Aldershot, Hampshire GU12 4DL). The unit is known as the CCS (Colourvision Controlled Speed) and handles both monochrome and colour material. Each machine will drive up to five television sets. The system is based on a flying-spot scanner and continuous film motion. It is designed for use with Bell and Howell film cassettes but a simple adaptor enables open reels of super-8 film to be used. Threading is automatic through the pinchwheel and roller film transport system to the take up spool. The film drive is silent in operation and can be switched to give rapid forward or reverse wind. The film speed is servo controlled and switchable between 16 $\frac{2}{3}$ or 25 frames per second. The playing time is up to half an hour per film – depending on film thickness and the type of sound track used. Individual

frames can be held to give a still image without damage to the film. The Customs and Excise have ruled that as the machine is intended primarily for industrial/educational use the lower VAT rate of 8% applies. At this rate the recommended price of the machine is £946.

Video is likely to remain a rather expensive hobby until the arrival of videodiscs, but in the present market conditions that looks as if it will be some way into the future – the discs are cheap but until players can be produced on a large enough scale to bring unit costs down the system will not be an economic proposition. It's worthwhile nevertheless summarising the present situation.

Three different approaches have been adopted. The first was the Teldec system devised by Decca and Telefunken. It is the only system to have been marketed so far, though only in Germany. The flexible disc is supported on an air cushion, the groove depth being varied so as to carry an f.m. signal which is extracted by means of a pressure-sensitive ceramic transducer. A detailed description of this system was given in our December 1971 issue. The second system was pioneered by Philips, though other companies are known to be working on similar lines. This uses a laser beam to scan the disc. The modulation varies the light reflected from the disc, and this is detected by a phototransistor. Our June 1974 issue carried a detailed account of the Philips system. The third system comes from RCA. In this a tantalum-strip, capacitance-sensitive pickup runs in a constant depth groove. The modulation consists of troughs of varying size and spacing beneath the groove – this gives the capacitance variations.

One major limitation of the Teldec system is its playing time of ten minutes per side of each disc. The playing time of the RCA and Philips discs is half an hour per side. The speed used in both the Teldec and Philips systems is 1,500 r.p.m., with two interlaced fields for each disc rotation. A substantially lower speed is used in the RCA system, 450 r.p.m., with eight fields per disc rotation. The groove density is 5,500 per inch in the case of the RCA system, 7,000 per inch in the case of Teldec and 12,700 with the Philips disc.

LOCAL TV'S TROUBLES

The steady decline of local TV continues in the face of the present economic situation. Originally, some four years ago, five cable TV operators were licenced to provide local programmes in addition to relaying off-air transmissions. The idea was to assess the demand for and the possibilities of such services. Sheffield Cablevision, which only recently was claiming a daily audience of 26% of the 100,000 available viewers, has now followed the Bristol and Wellingborough operations in closing down its local channel. The operation at Swindon, run by an EMI subsidiary, continues throughout the week but the Greenwich Cablevision operation, the first to commence a local service, is now restricted to a couple of hours each weekend.

Local TV operators feel that community television could have been financed had they been allowed to operate the local service in conjunction with a pay-TV service – pay features, for which viewers would have had to pay by a coin in the slot meter, could have been relayed on the same channel following the local programmes.

It's unfortunate that an interesting experiment has been allowed to get into such a state. It seems that once the Annan committee had been set up to advise on future services the government was unwilling to give any further encouragement to local TV.

TV RECEIVING AERIALS

PART 1

Pat HAWKER

THE picture seen on any television receiver depends ultimately on the quality of the signals supplied to its aerial socket. The signals must be sufficient to provide a good signal-to-noise ratio; they must be at roughly the correct impedance; and they must be "clean" – be free as far as possible from unwanted interference whether locally generated or from a distant television station, or from "ghost" signals resulting from multipath transmission. In addition, for the UK u.h.f. system the aerial needs to respond equally well to all four channels in the local groups (ITV, BBC-1, BBC-2 and the still unallocated fourth channel "P4"). A further consideration may be less evident: the signals should not be so strong as to overload the receiver and cause problems due to cross-modulation and intermodulation within the receiver (or any external preamplifier). These requirements all impose problems for the aerial designer.

The UHF Network

For u.h.f. the BBC and the IBA have joint planning standards and are building a network of co-sited transmitters. By the end of 1975 the u.h.f. network for all channels amounted to some 200 transmitting stations, providing coverage to over 95.5 per cent of the population. The effective radiated power (e.r.p.) and coverage pattern of each channel at a given site are normally the same, and indeed in many cases are from the same four-channel aerials.

The present network includes some 45 high-power main stations of which four are rated at 870-1000kW e.r.p. and most of the others at between 100-500kW e.r.p. The 150 or so lower power local relay or gap-filling stations vary from 10kW e.r.p. right down to about 10 watts (0.01kW) e.r.p. This means that there can be a variation of power by a factor of 100,000 times between different transmitters!

The present planning criterion is that there is a need for a relay when a "gap" is detected comprising 1000 or more people who could be served from one location. Later this figure may be lowered to 500 or so.

The economic consequences of the need for large numbers of gap-filling relays at u.h.f. are significant. Whereas Crystal Palace, with a service area of more than ten million people, represented a cost per potential viewer per channel of about 3p, many of the smaller relays for a few thousand potential viewers represent a cost of between £2-£20 per potential viewer. If the service is to be extended to "pockets" below 1000 there is clearly a need to develop lower-cost transmitting installations.

Field Strength

The u.h.f. coverage areas, as defined by the broadcasters, are based on a field strength for Band V of 70dB with

reference to 1mV/m (i.e. just over 3mV/m). For Band IV the usual boundary is 65dB and for local relays it may be 70dB or even 80dB depending on the anticipated amount of co-channel interference.

These field strength figures represent the electric field in the direction of polarisation produced by the transmission at the measuring location, and are conventionally expressed in millivolts per metre. Thus they do not represent the input voltage appearing across the feeder socket, which is what an installation engineer will usually measure.

Reception Limits

With modern transistorised tuners it is possible, in the absence of interference, to obtain satisfactory reception in areas where the field strength is significantly below 70dB – in practice to about 62dB measured at a height of 30ft. This does not mean however that the service areas of stations can always be assumed to be extendable by using more sensitive aerials or receivers. Increasingly, the limiting factor is the strength of other co-channel stations (or sometimes adjacent channel stations since the selectivity of receivers is not usually sufficient to reject the adjacent channel): as the number of transmitting stations increases, their coverage will be increasingly *interference limited* rather than limited by the signal strength produced by the wanted station.

Signal Voltage Required

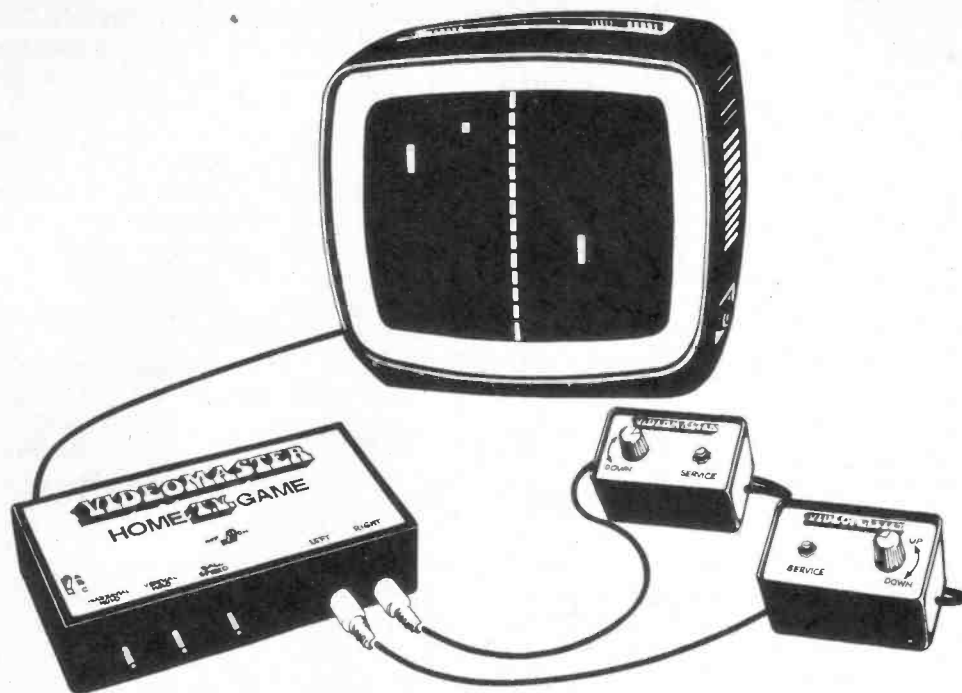
For good colour reception on a modern receiver the voltage measured across the feeder needs to be about 750 μ V or more; 500 μ V or a little less may provide tolerable reception however, and possibly down to about 300 μ V in the case of monochrome receivers.

What Determines Signal Voltage?

This voltage depends on: (1) The frequency of the signal. (2) The gain of the aerial. (3) The loss in the feeder cable. (4) The field strength of the signal. (5) The height of the aerial.

The voltage developed by a dipole element decreases inversely with frequency. For example, a Band I dipole will develop from a given field strength about 15 times as much signal voltage as a high Band V channel dipole. An alternative example is that a Band III dipole provides as much signal at a given field strength as a 16-element Yagi array on Band V.

This is why the effective radiated power of u.h.f. transmitters, and the gain of u.h.f. receiving aerials, have to be so much higher than at v.h.f. On the other hand, because of the shorter physical dimensions it is easier to obtain high



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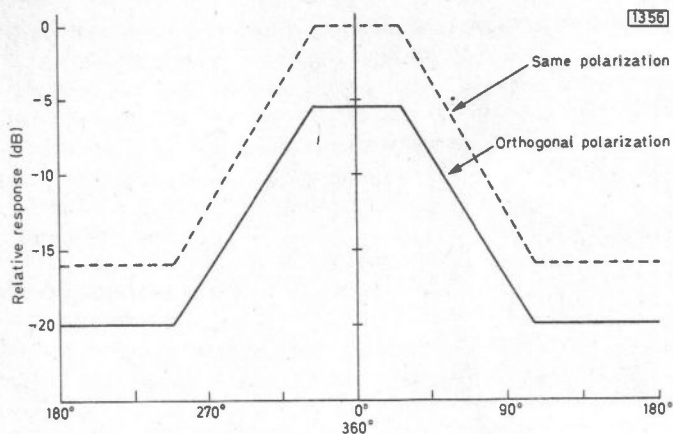


Fig. 1: Recommended minimum aerial directivity and polarisation discrimination for u.h.f. reception. Performance to this standard is assumed by the broadcasting authorities when planning the service areas of u.h.f. transmitters.

aerial gain at u.h.f., both for transmission and reception.

Height gain is important: normally one obtains about $\frac{1}{2}$ dB gain for every foot higher, for heights between about 25 and 35ft. In other words the same aerial will provide about 5dB more signal at 35ft than at 25ft.

It is important to note that the frequency of a high Band V channel is almost double that of a low Band IV channel. Apart from the extra voltage that will be developed by a Band IV dipole element, frequency also has an important bearing on feeder dielectric losses – they increase with frequency.

Directional Characteristics

It's not always appreciated that the planning of the u.h.f. transmitter network took into account the directional characteristics of the receiving aerial in reducing the strength of signals arriving from other than the required direction. It was assumed that, even in the heart of the service area, directional aeriels capable of reducing signals $\pm 60^\circ$ off direction by 15dB, with the response beginning to fall off at $\pm 20^\circ$, would be used.

It is also assumed that all receiving aeriels will provide discrimination against signals of orthogonal polarisation (i.e. vertical polarisation when the required signal has horizontal polarisation and vice versa), as indicated in Fig.1.

The UK system is planned on the basis of both horizontal and vertical polarisation, usually with the main stations using horizontal polarisation while the local relays use vertical polarisation. This is why the broadcasting authorities look askance at suggestions of using helical receiving aeriels (which theoretically respond equally to signals having any plane of polarisation). With professional aeriels, as used for rebroadcast purposes, it is generally possible to achieve some 30dB polarisation discrimination, using Yagi or log-periodic designs, but some tests carried out by the IBA have indicated that domestic aerial designers find some difficulty in meeting the CCIR specification in this respect.

Bandwidth

Because many aerial arrays, such as the Yagi, are inherently narrowband systems, it is generally not practicable to expect a single aerial design to cover effectively all the channels in Bands IV and V. For this reason the 44 u.h.f.

channels available in the UK were divided into nine standard groups, with the two outermost of the four channels in a given area spaced by ten channels. This represents a required bandwidth of 88MHz. It was recognised however that some exceptions would have to be made to these standard groups, and that there would be a need for a wider band aerial for Band V. Initially five aerial groups were designated, A, B, C, D and E. Group A covered Band IV, groups B, C and D covered segments of Band V, while group E was a wideband aerial covering all Band V but usually providing lower gain than groups B, C or D. Subsequent practical experience however showed that a single Yagi design could provide satisfactory results over the channels previously assigned to groups C and D, hence the new classification group C/D.

The present groupings are as follows:

Aerial Group	Channels	Approximate frequency range	Colour coding
A	21-34	470-585MHz	Red
B	39-53	615-735MHz	Yellow
C/D	48-68	685-855MHz	Green
E	39-68	615-855MHz	Brown

Aerials not based on the Yagi array are not always restricted in bandwidth. Log-periodic and backfire designs for example are marketed in the UK for broadband operation. It should be noted however that with Yagi arrays the groups conform quite closely to what can be achieved and that performance usually falls off quite rapidly beyond the specified limits.

Receiving Relay Stations

For the broadcasters the most difficult situation is where a main station is received with difficulty and a local relay is subsequently built. Many viewers will have put up aeriels suitable for reception of the main station and are puzzled when there is no improvement, or reception turns out to be worse, from the local relay. They overlook the fact that their aeriels are now of the wrong polarisation, wrong channel group and are often pointing in the wrong direction! If the new relay is on a higher channel it is likely that the directivity of the receiving aerial will be affected: the directors will be electrically too long and may well act as reflectors. The array may well have almost random directivity in these circumstances, as suggested in Fig.2, derived from measurements made by Antiference Ltd.

When changing from a main to a relay station, the polarisation and direction of the aerial should always be changed: it will also often be necessary to change the aerial

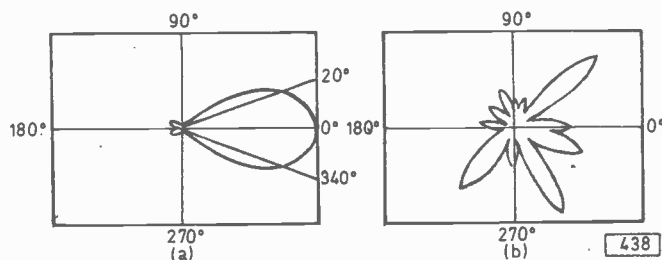


Fig. 2: Polar diagrams showing what can happen when a Yagi aerial of the wrong group is used. (a) Response of an 18-element group C/D aerial correctly used on channel 59; (b) response of an 18-element group A aerial on channel 59, showing loss of gain and almost random directivity.

itself, although a high-channel aerial can sometimes be used at lower frequencies without greatly affecting the directivity, though giving reduced gain.

Feeder

A good low-loss coaxial feeder cable in perfect condition will usually attenuate an 850MHz (top of Band V) signal by about 5dB per 50ft, or 3dB in Band IV. Cables intended for v.h.f. use may easily lose 20dB of signal in Band V: some in poor condition may virtually lose the signal altogether. It's possible to achieve lower losses in thicker cables (the $\frac{1}{2}$ in diameter cable used by broadcasters for rebroadcast receivers may have a u.h.f. loss of only 1dB per 100ft.).

Since the cost of feeder cable increases very rapidly with quality, it may not always be cost effective to use the best low-loss cable. If thin cables are used however, it should be appreciated that many decibels of signal will be lost in a long cable run.

Local Conditions

In planning an aerial installation it is also necessary to appreciate that significant variations of u.h.f. signal strength can occur in a given area. In particular, very marked differences will be found in areas where there are standing-wave patterns due to signals arriving from direct and indirect paths, including ground reflection, or where there is attenuation of signals by local hills or buildings. While signals theoretically fall off with distance from the transmitter according to the inverse square law (double the distance, quarter the signal), in practice there will be a considerable spread of signal strength along a road or street: 10dB is quite usual; 20dB not uncommon; and occasionally up to 40dB on a particular channel. The most pronounced differences are often found near the transmitter; as you reach the fringe areas the differences tend to level out.

Attenuation by an intervening hill will also tend to be very pronounced close to a transmitter and most serious where the hills are rounded: where there is a sharp ridge to the intervening hill a degree of "knife-edge propagation" will help.

An interesting – fortunately rather rare – cause of variable reception can occur in coastal districts where signals are received across tidal waters. The phase between the direct wave and the indirect wave reflected from the sea will change with the state of the tide. A more common problem is that of hedge or tree foliage which may cause seasonal variation of signals.

Aerial Selection

Since a considerable spread of signal strength is to be found even quite close to a transmitter, a low-gain aerial may be installed in a favourable situation but only a few houses away the installation engineer may have to use every trick of the trade to pull in a good picture – and possibly with a change of season he may have to return to check up due to deterioration of reception on one or more channels.

Reputable aerial and cable manufacturers go to considerable trouble to ensure that their designs meet the specifications. Feeder losses in data are those of a new cable before it has been exposed to months of bad weather however, while aerial elements deteriorate due to corrosive atmospheres. Not unnaturally, manufacturers prefer to present polar response diagrams drawn to linear rather than logarithmic scales: it makes the diagram look much cleaner,

with only insignificant looking side lobes. Unfortunately in the real world with interference problems we need to think in logarithmic terms. Very few makers now indulge in the old trick of quoting gain with reference to an isotropic rather than a dipole element (this automatically adds 2.1dB to the gain).

Yagi Arrays

The vast majority of television receiving aerials are based on the Yagi-Uda technique first described some 50 years ago. The Yagi array provides high gain for a given size. It comprises a dipole element plus a series of parasitically-excited elements forming directors and reflectors. With the spacing used in practice the reflector element is a little longer than the dipole while the directors are a little shorter.

Despite the enormous use of the Yagi aerial, and the detailed analyses that have been published on its operation, it is doubtful whether any u.h.f. television arrays are designed on purely theoretical considerations. Because there are so many interrelated variables most designs are based, to some extent at least, on cut-and-try techniques.

How much gain can be achieved with a Yagi? It depends on the total number of elements, but there is a law of diminishing returns (see Fig. 3). Doubling the number gives roughly an extra 3dB gain. So whereas a 10-element array may give about 10-11dB gain, 20-elements will give 13-14dB, and 30-elements up to 16-17dB – assuming virtually perfect efficiency. In practice very few single-boom arrays can be expected to give more than about 12-16dB. A few manufacturers claim up to 18dB, but most users would be fortunate to achieve more than about 16dB from an installed aerial.

The effectiveness of the Yagi array depends upon very small differences of phase, which is notoriously a fickle and frequency-conscious characteristic. It achieves high forward gain, but at the cost of significant side and back lobes.

On the credit side is the small and convenient structure of the Yagi array, and its ability to withstand damage without too seriously affecting performance. The Yagi array provides directivity and gain by narrowing the main acceptance lobe in both the horizontal and the vertical planes. The pattern is not as clean as one would like however, with many secondary lobes. The low impedance at the dipole terminals is indicative of an array that may be affected by nearby metalwork, making it far from ideal as a loft aerial.

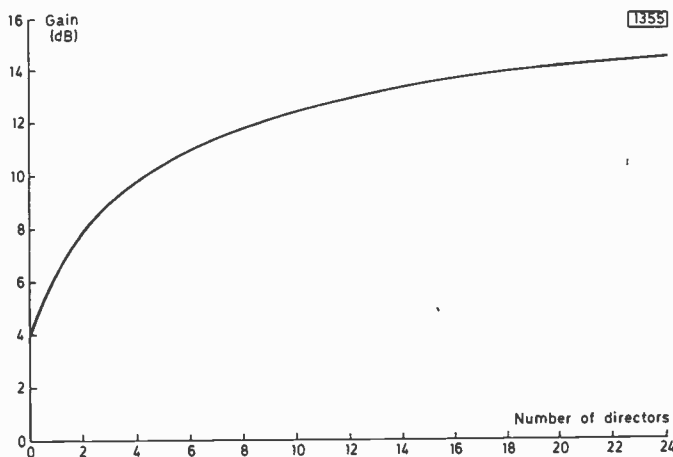


Fig. 3: The gain of a Yagi array varies with the number of directors used, but the law of diminishing returns applies. This graph shows how difficult it is to achieve gains much greater than about 14dB.

What are the possible alternatives? There are a surprisingly large number, although relatively few are available on the market.

The Log-periodic Aerial

One that is available – and indeed is fairly widely used – is the log-periodic aerial. This type of aerial is a more recent development than the Yagi-Uda. Although superficially resembling a Yagi array, it differs in that all the elements act as dipoles – rather than being parasitically excited – while the dimensions follow a logarithmic progression. It is an inherently wideband system, but unfortunately at any given frequency only part of the structure is contributing to the gain. As a result the gain in relation to the number of elements is significantly less than can be achieved with a Yagi array. A 20-element log-periodic aerial provides a comparable gain to a 9-10 element Yagi: maximum gain is usually about 8-9dB. The polar diagram is smoother however, with fewer side lobes and a good front-to-back ratio; it usually provides at least 25dB (and sometimes over 35dB) discrimination against orthogonally polarised signals. It is rather less likely to be affected by near-by objects.

It is a good aerial to use therefore in a main service area where ghosting is a problem; or where it may be difficult otherwise to achieve good balance between the different channels. It is also a useful design for caravaners seeking an aerial suitable for all channels; or for long-distance enthusiasts when mounted on a rotator (the lack of high gain may be partly compensated by using a masthead amplifier). A disadvantage is that it is more expensive to manufacture and tends to require rather stronger supports.

The Backfire Aerial

In 1960, H. W. Ehrenspeck in the United States proposed the use of a backward-firing technique in conjunction with Yagi aerials and a large plane reflector. The basic idea was to mount a Yagi pointing away from the transmitter but looking into a large plane reflector sheet. The theory was that the wave would travel twice through the director chain so that this would have a double effect. Later he indicated that a reflector shaped in the form of a large saucepan lid was more effective, and still later he proposed a modified structure termed the short backfire aerial. In this a large saucepan-lid type reflector (about 2λ in diameter) was used with a dipole element mounted in front and in front of this a small disc-type reflector. In this later form it has been developed as a wideband u.h.f. television aerial (announced in the UK by Telerection Ltd. of Weymouth).

The claimed forward gain is about 13dB, or roughly the equivalent of a 20-element Yagi, but with a much shorter boom; an additional 2dB gain is obtained by adding a director chain in front. The aerial thus provides similar wideband properties to the log periodic (a single unit covers all channels in Bands IV and V) but with significantly more gain.

Little published information has appeared on the measured characteristics of this aerial, while its side-lobe performance and docility relative to a log periodic have yet to be independently assessed.

A Band IV design for home construction appeared in the February 1973 *Television*, using chicken wire mesh for the 2ft by 4ft rectangular reflector plate which had a 3-inch turned up edge. This was stated to provide a gain comparable to a 22-element Yagi, but did not cover Band V channels.

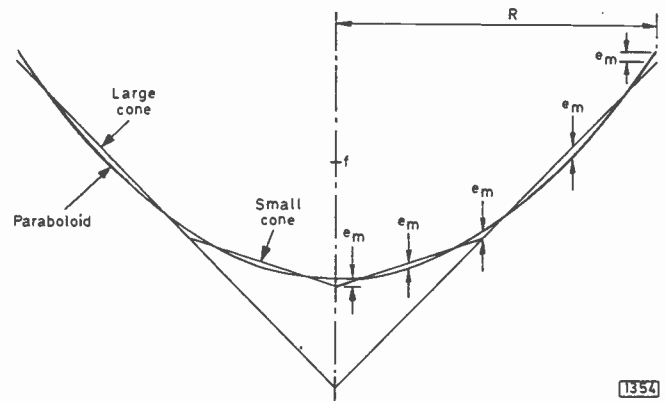


Fig. 4: Principle of the polyconic reflector, showing how little difference there can be between two cones, one mounted inside the other, and a true paraboloid reflector.

Proposals have been made for a backward-firing log-periodic aerial but no practical designs for u.h.f. television have appeared.

Conical Reflectors

Another aerial using a large reflector, but avoiding the mechanical problems of a large paraboloid, uses a conical reflector which is much less difficult to produce than the doubly-curved surface of a paraboloid.

Unlike a true paraboloid, the conical reflector can be readily fashioned from a flat piece of metal or mesh. It takes advantage of the fact that significant departures, in terms of wavelength (typically up to $1/16\lambda$), are possible from a true parabolic reflector before the gain or directivity are seriously degraded. A single cone reflector can achieve this order of accuracy up to about $3\frac{1}{2}\lambda$ radius, representing a 3ft radius on Band IV. Such a design with a suitable dipole element could theoretically provide a gain of about 15-16dB.

By constructing a conical reflector comprising two shallow cones, one fitted inside the other, a close approximation to a large parabolic reflector could be constructed, keeping within the $1/16\lambda$ criterion to a diameter of 14λ , almost 30ft on Band IV – a miniature Goonhilly in the back garden! See Fig. 4.

Long-wire Aerials

Neglected by the television enthusiast, but a well established practice in h.f. communications, is to achieve gain, directivity and good bandwidth by using aerials many wavelengths long. Surprisingly, such aerials are seldom used at u.h.f. where they would be of more convenient size.

The "queen" of such aerials is the rhombic, and it is worth recalling that the original experimental Post Office television links between London and South Wales were based on v.h.f. rhombics. Again possibly the only reported instance of the reception of Band I television from the UK in Australia was effected by means of a large rhombic aerial – and a lot of patience.

Details of a tapered matching arrangement to enable a rhombic aerial to be used with standard coaxial cable have been published and the technique seems worthy of investigation to provide a broadband high-gain aerial, particularly where this is for one fixed direction only.

The only form of long-wire aerial ever marketed for television reception (Band I) in the UK was an EMI "tilted wire" design of the very early fifties. It's said that this aerial never proved popular because it did not look like a televi-

sion aerial, an important consideration at that time when part of the appeal of television was to keep up with (or pass) the Joneses.

The tilted-wire aerial was not as simple as it may have appeared: it was based on a capacitively-loaded, terminated long-wire design. Just as you can shorten a dipole element by loading it inductively, so you can lengthen it by adding a series of capacitors: the capacitors can be formed by using twin wires having overlapping sections. In doing this the aerial acquires some interesting new properties, different from the multi-lobe pattern of a long terminated wire. The stretched element has just one main lobe, conical about the wire, with a beam width depending on the degree of "stretching". Such a wire also has a greater bandwidth than the conventional long-wire aerial. These techniques have not so far been exploited for u.h.f. television reception but seem worthy of investigation.

Long-range Reception

There are two main forms of long-range television reception. First there is the body of enthusiasts who exploit tropospheric ducting and sporadic E to receive signals in the UK from Continental Europe. Secondly there is the viewer who may be in an area not yet covered by a particular service or who wants to be able to achieve reliable reception of particular ITV regional programmes. Of the two, it is the second group that imposes the more stringent requirements since such viewers will not be satisfied for long with a grainy, noisy picture or one that is crawling with co-channel patterning: the DX enthusiast on the other hand is often extremely happy if he can briefly identify a distant transmitter no matter how sub-standard the picture may be.

Earlier we noted that the problem is increasingly not that of receiving the wanted signals but of rejecting unwanted ones.

A very perceptive, forewarned viewer will generally just be able to notice interference on a channel when it is about 55dB weaker than the wanted signal. This means that with a 70dB wanted signal, interference need be only 15dB (reference $1\mu\text{V}/\text{m}$) which is very weak indeed.

Fortunately the situation is not as bad as that. A protection ratio of 45dB is tolerable, and very few viewers would notice that degree of interference. If the two transmitter frequencies are slightly "offset", another 10dB or so can be readily tolerated, 30dB difference being acceptable. The offset system depends on knowing which stations are likely to cause interference, and this may not be relevant in the case of a viewer who is outside the planned coverage area. Every time a new station comes on the air there is the possibility that some out-of-area viewers will find that their "bonus" reception is spoilt by unwanted patterning permanently on their picture.

The main weapon in combatting co-channel interference is good directivity in order to cut down the unwanted signal (always assuming that the two signals are not arriving directly along the same bearing). If there are a number of unwanted signals the best plan is usually to concentrate directivity into a single sharp lobe beamed at the wanted station. Where there is one interfering signal it may be preferable to "null" it out, sometimes by swinging a Yagi so that the signal from the unwanted direction comes in at one of the nulls rather than a sidelobe, even if this means reducing the pick-up of the wanted station.

A more sophisticated system is to use two aerials carefully phased to achieve the required null. Perhaps the most advanced system of this type is one being developed by the IBA for reception of Stockland Hill on Alderney to

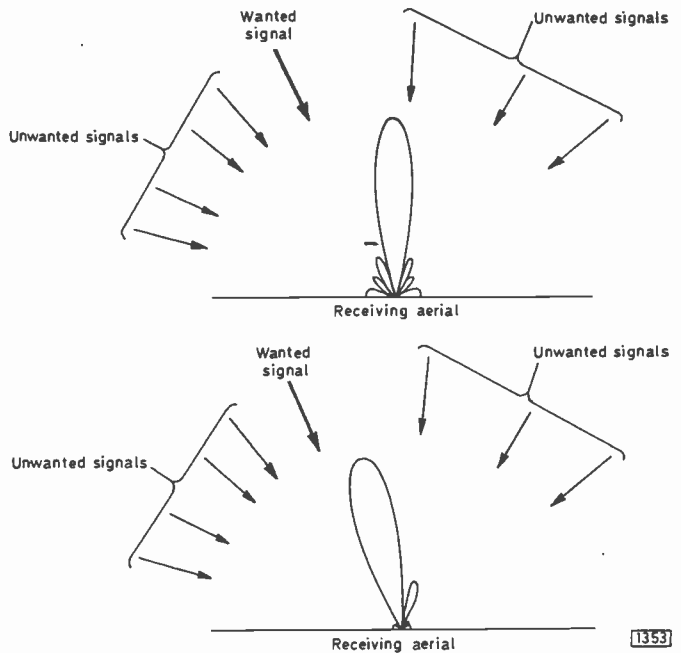


Fig. 5: Principle of the adaptive aerial array, which can be computer controlled so that the response adjusts to receive the minimum of unwanted signals – note that this condition may not always be the same as adjustment for maximum pickup of the wanted signal.

provide a programme feed for the Channel Islands. This will use a computer-controlled adaptive array which will be automatically steered to insert nulls to correct for a changing pattern of co-channel interference over the long sea paths, notoriously subject to tropospheric ducting. In other words it is hoped that the array will adapt its pattern to place nulls in those directions where unwanted signals are having most effect on the signal-to-noise ratio of the wanted transmissions from Stockland Hill, automatically providing the best possible signal-to-noise ratio. This project has yet to be completed but laboratory trials are extremely promising. See Fig. 5.

As an indication of what could be achieved by way of reliable long-distance reception in the era before there were many television stations an exhibition in Lyons, France in about 1947 provided daily demonstrations of television received from Alexandra Palace over 400 miles away. This was by means of an enormous "cigar" aerial.

Some very large receiving arrays are used in Canada by cable television operators to pick up stations in the USA. Some arrays measure 270ft wide by 60ft high and achieve gains of 40dB in Band III. A few systems use two such arrays spaced by up to about 100 wavelengths to achieve diversity reception. It is claimed that at distances of up to about 150 miles pictures with a signal-to-noise ratio of better than 30-35dB are received for 99% of the time: this of course without the aid of anomalous propagation.

CONTINUED NEXT MONTH

THYRISTOR TESTER

Television, June 1975

It has been brought to our attention that a number of errors occurred in the circuit board layout, Fig. 2 on page 347. Diode D3 should be reversed, i.e. its cathode should be connected to the junction of C1 and R7. Transistors Tr1 and Tr2 should be shown as pnp types. The circuit diagram, Fig. 1, is correct.

Servicing the THORN 8000 8000A 8500 chassis

Barry F. PAMPLIN

PART 3

THE field and line timebase circuits are assembled on a single board at the right-hand side of the chassis whilst the convergence circuits are mounted on a printed panel which slips over the neck of the c.r.t. The line output transistor, line output transformer and e.h.t. rectifier are all mounted on the main chassis framework, under the c.r.t. flare.

As in the previous articles each circuit will be described, its operation explained and the stock faults noted, starting this month with the line timebase and concluding next month with the field timebase.

Line Sync and Oscillator Circuits

The circuit of the flywheel sync and line oscillator stages is shown in Fig. 1. Positive-going sync pulses at the base of VT405 are inverted and applied to the flywheel discriminator diodes W405-6 via C424. Reference pulses from the line output transformer are integrated by R411/C426 to produce a sawtooth waveform and fed to the discriminator via the blocking capacitor C425. R418 and C419 provide the necessary reference signal phase shift to ensure that zero output from the discriminator corresponds with a centrally positioned picture. The error

signal at the output is fed via a filter and anti-hunt circuit to the base of the reactance transistor VT404 which is connected in shunt with the oscillator between L405 and C418.

Transistor VT403 is connected in a conventional sinewave oscillator circuit, the frequency being determined by L405/C415/C416/C442 and the inductive reactance of VT404. Capacitor C442 is a NTC type to provide compensation for thermal drift in the other components. The feedback required between the collector and base of VT403 to ensure oscillation is provided by R412 and L405 (which provides the necessary phase reversal) together with the capacitive tap formed by C415/C416. The output from the oscillator transistor is taken from its collector, across R410, and consists of positive-going squarewaves of some 5V amplitude.

Faults in the flywheel sync and line oscillator circuit are not common. Those that do occur give rise to entirely predictable symptoms. Line sync troubles are usually due to diodes W405/6, as also is offset lock – with the picture locked off centre. Complete absence of line sync, with good field lock, is usually due to a fault in VT405 or absence of the reference pulses fed to the discriminator.

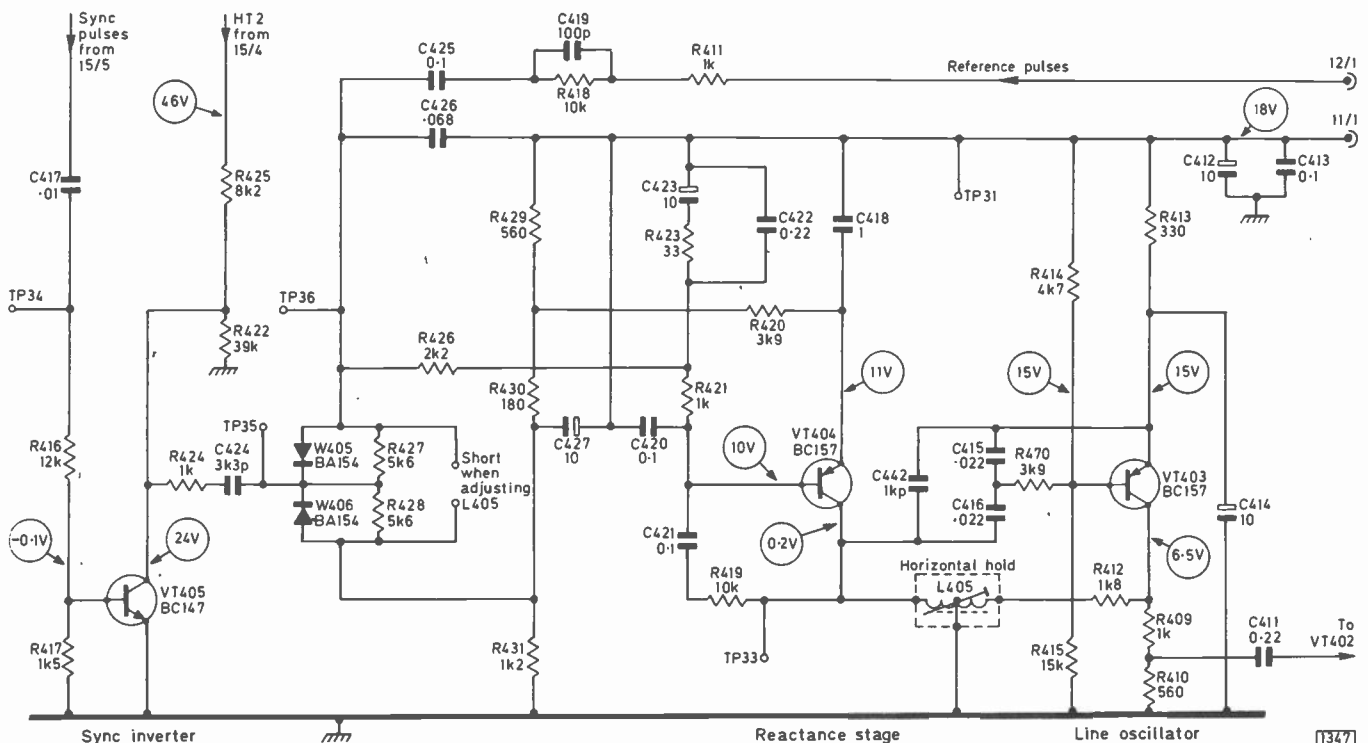
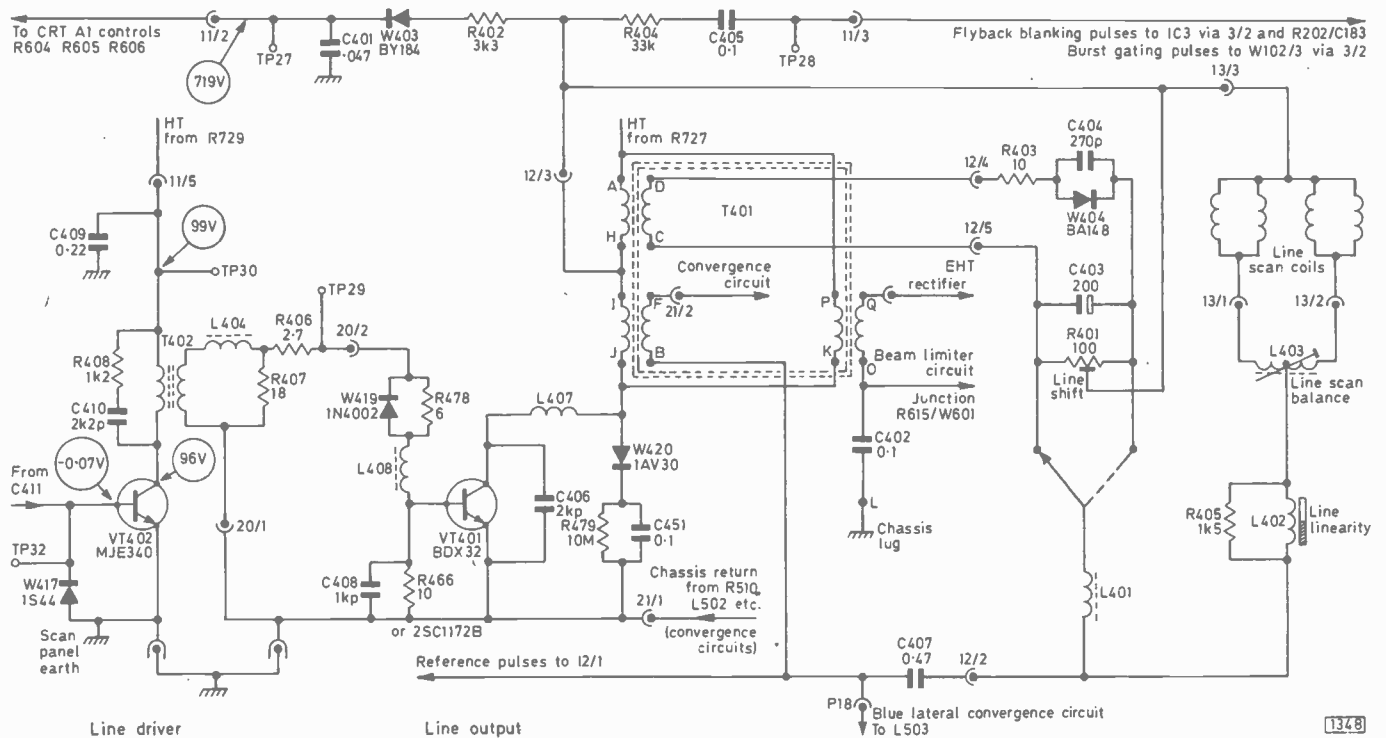
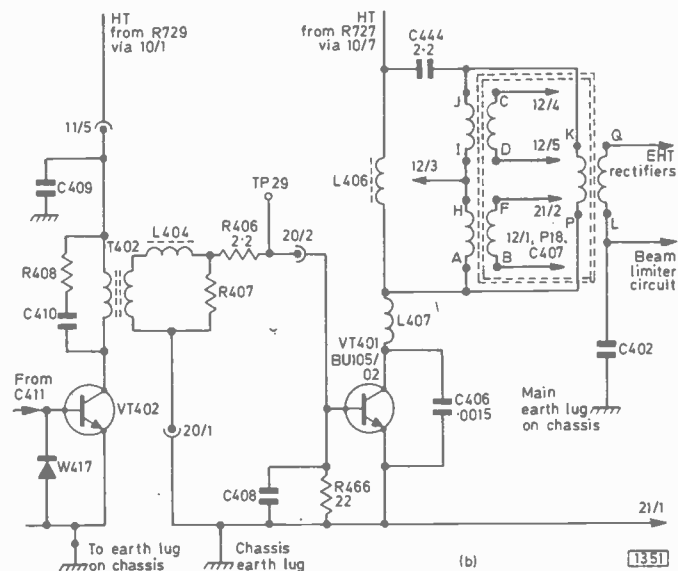


Fig. 1: The flywheel sync and line oscillator circuits. In earlier 8000 chassis C445 (0.001µF) is connected across R470.



134B



1351

Fig. 2: (a) Line driver and output stages, 8500 chassis. (b) Differences in the 8000/8000A chassis. To improve the reliability of the BU105/02 line output transistor C444 was changed from 0.47 μ F to 2.2 μ F and R406 from 1 Ω to 2.2 Ω or 2.7 Ω . C410 changed from 6800pF to 2200pF to improve the stability of the drive conditions. See also Fig. 5.

Complete lack of line oscillation is usually either the oscillator transistor VT403, broken wires on L405, or C414 leaking. Intermittent frequency changes are best checked with a freezer spray, but the usual culprits are the two transistors VT403 and VT404 or one of the capacitors C423, C421, C416 or C414 in order of suspicion.

Line Oscillator Adjustment

The procedure for setting up the line oscillator is to connect a shorting link between the test points adjacent to L405 and adjust the core of L405 for a floating picture. If the picture sets up correctly but will not lock when the short is removed the sync diodes should be checked by substitution.

Drive and Output Circuits

The output from the collector of the line oscillator is a.c. coupled by C411 to the base of the driver transistor VT402 (see Fig. 2). Diode W417 provides d.c. restoration. The driver operates from the main 180V h.t. rail and the line drive is developed across the primary of transformer T402.

R408 and C410 damp out the high-voltage spikes caused by the collapse of the flux in the transformer. The pulses appearing across the secondary winding are fed to the base of the line output transistor VT401 which is thus switched on and off at line frequency.

At the end of the forward scan VT401 is cut off and the energy stored in the scanning yoke charges C406. This produces the line flyback pulse. On the negative half cycle the collector-base junction of VT401 conducts, allowing a linear decay of current which produces the first part of the scan – in effect the base collector junction of VT401 acts as an efficiency diode. Before the current falls to zero, VT401 is switched on to provide the current for the rest of the scan.

Two secondary windings on the line output transformer feed the e.h.t. rectifier and the line shift circuits respectively. The e.h.t. is derived from winding Q-L, using a simple half-wave rectifier. The “earthy” end of the winding is returned to chassis via a beam limiter arrangement – see later. Winding D-C feeds a simple half-wave rectifier (W404) which produces the shift potential across C403. Choke L401 keeps scanning current out of the shift circuit whilst R401 allows the degree of shift to be adjusted.

S-correction is provided by C407 and line linearity adjustments can be made with L402. Terminal I on the transformer provides feeds for the A1/focus diode W403 and also line frequency pulses for the flywheel sync circuit and the burst/line/field blanking circuits.

Although the circuit description above applies specifically to the 8000 series chassis, the differences on the 8500 are minor. Instead of a BU105/02 transistor, the 8500 uses a BDX32 (or 2SC1172B) which has a higher current gain and rating. Some additional components are introduced in the base circuit to reduce the drive level with

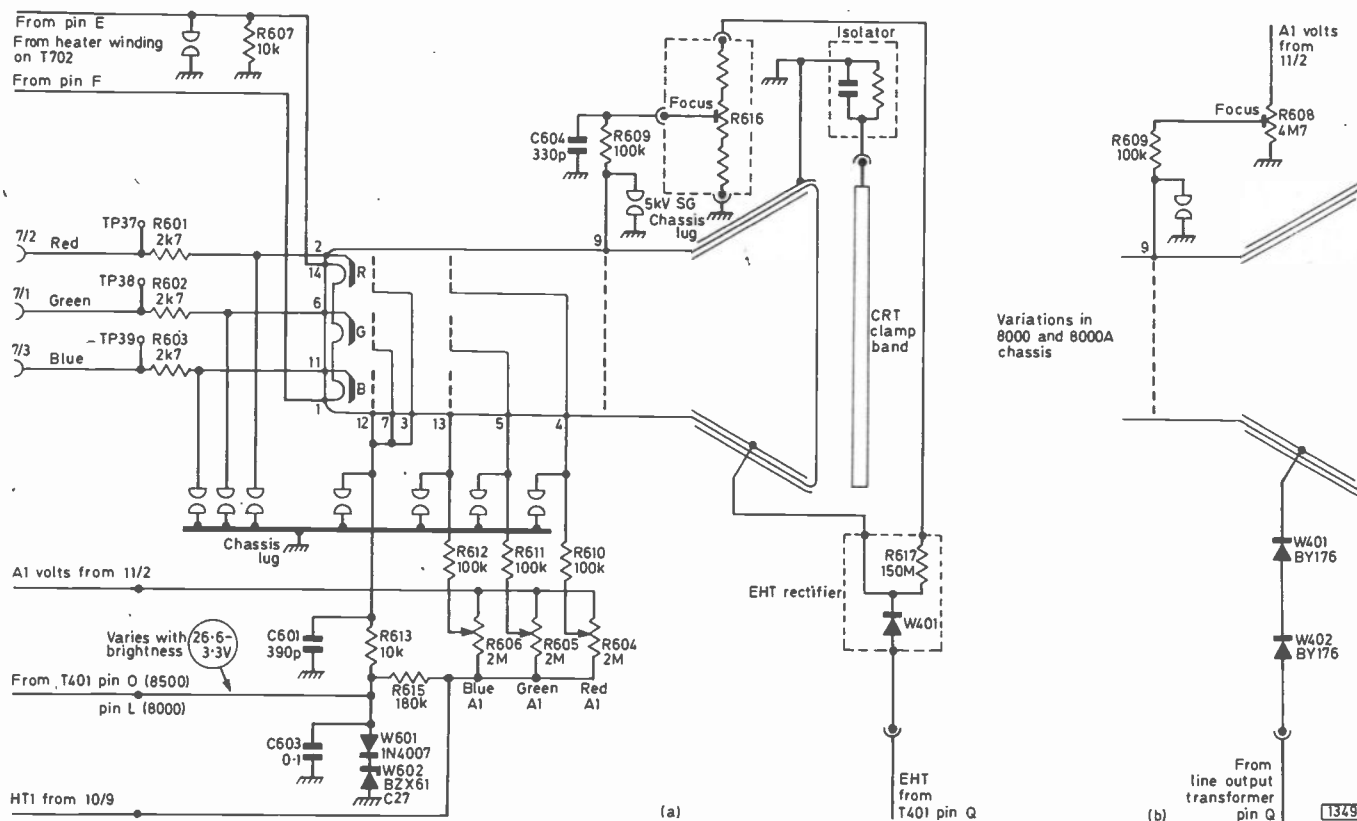


Fig. 3: (a) The c.r.t., e.h.t. and beam limiter circuits used on the 8500 chassis. (b) Differences on the 8000/8000A chassis.

the transistor on and alter the rate of charge carrier extraction when the transistor is cut off. Some additional transient protection components are added across the line output transistor to protect it from flashovers. All the extra bits are mounted either on the transistor heat sink assembly or the desaturation coil bobbin – the 8500 does not use a desaturation choke (L406). The other main difference between the 8000 and the 8500 is that the focus arrangements are revised. The 8500 uses a thick film focus control connected as a potential divider network across the e.h.t. – this means that the e.h.t. tray used in the 8500 is different from that found in the 8000. The line output transformers are not interchangeable, due to differences in the turns ratios.

Line Output Stage Faults

Faults in the line output stage are frequent – especially failure of the transistor in the 8000 chassis and of the e.h.t. tray in the 8500 chassis. Both these faults usually trip out the thermal switch, giving “dead set” symptoms. A quick check to ascertain whether the trouble is the transistor or the tray is to unplug the tray input lead from the line output transformer: if this action stops the tripping, the tray is faulty.

When faced with a set which has damaged its line output transistor some care is needed to make sure that the replacement transistor is not killed off in the same way. First of all there is the possibility that the failure has occurred because the h.t. rail has gone too high as a result of a fault in the power supply – usually the thyristor W703 going short-circuit. The first check therefore should be a simple resistance check between the anode and cathode of W703. If it reads less than 50kΩ in each direction it should be replaced.

The next check should be a visual one of the mains dropper. A bare wire link on this unit is prone to short out

R727, and this will cause failure of the line output transistor.

If these checks suggest that the trouble is not due to the power supply but to a fault in the line output stage the next step to take is to add some extra resistance in the h.t. feed to keep any fault current to a safe level. For the 8000 chassis a 560Ω 15W resistor is suitable whilst for the 8500 chassis a somewhat lower value, say 220Ω 15W is suitable. As an additional precaution, the set e.h.t. control on the power board should be set fully anti-clockwise before switching on after line output transistor replacement.

Having taken these precautions, switch the set on and check the h.t. voltage across the smoothing block C704. If the voltage here is in excess of 150V there is a fault in the power unit and this must be cleared before proceeding further.

If all is well, adjust the set e.h.t. control to provide an h.t. rail of 170V. The series resistor present will cut down the width of the raster, but it will be possible to see whether things are working properly or not. If a raster is not obtained, check for base drive to VT401, check VT401 and the e.h.t. tray, and finally check for faults in the scan yolk and line output transformer.

Once correct operation has been obtained the limiting resistor can be removed and the set e.h.t. control readjusted. The method of resetting this control recommended by Thorn requires measurement of the peak collector voltage on VT401. The author's practice is to set the control to get just sufficient width when viewing the test card. This ad hoc approach may offend the purist, but it does minimise the number of call backs!

Having dealt at some length with what is undoubtedly the most common source of “no e.h.t.” we will now consider the other stock troubles. Complete lack of drive, or intermittent drive, or lack of width with centre foldover can be caused by that most temperamental of transistors the MJE340, here used as the driver (VT402). No drive can

also be the result of the d.c. restorer diode W417 having an internal short. If absence of drive is due to VT402, W417 or a fault in the line oscillator circuit, the line output transistor will be cold.

Failure of the c.r.t. first anode supply rectifier W403 and its associated series resistor R402 is not uncommon. The rectifier tends to go short-circuit, cooking the series resistor. This event is immediately obvious since a number of components mounted higher up on the board than the resistor get a black coating as a result. A short-circuit reservoir capacitor C401 will have the same effect.

If you find the shift control burnt out, check the a.c. blocking coil L401.

The component which perhaps fails most frequently on the line timebase panel is R404, a 33kΩ, 1W resistor which feeds line-frequency pulses to the decoder. As mentioned last month, the symptom will be no colour or intermittent colour. The resistor is usually found to be on the point of disintegration. Later boards are fitted with a wire-wound resistor in this position, and this type is recommended for replacement purposes on earlier boards.

Beam Current Limiting

The importance of an efficient beam current limiting circuit cannot be over emphasised. Excess beam current drastically reduces tube life and causes e.h.t. tray failures, quite apart from the more obvious picture size regulation problems.

The beam current limiter used in these chassis consists of a circuit connected between the e.h.t. winding "earth" and

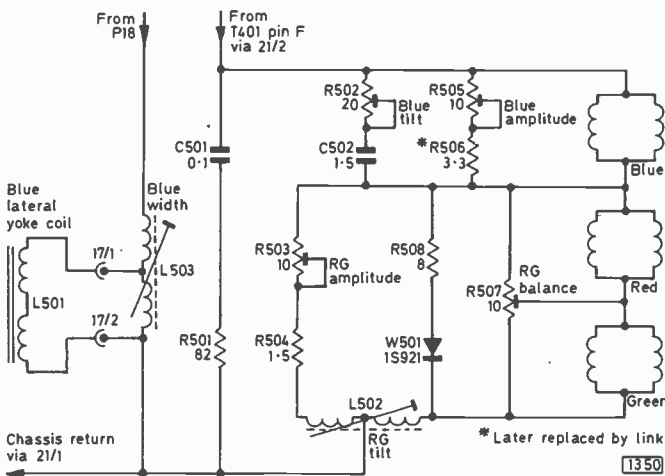


Fig. 4: The horizontal convergence circuit.

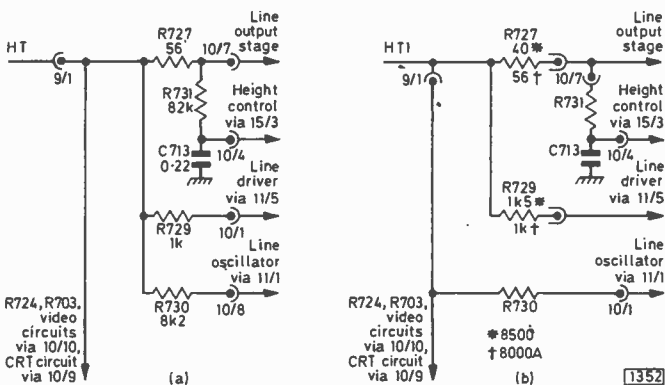
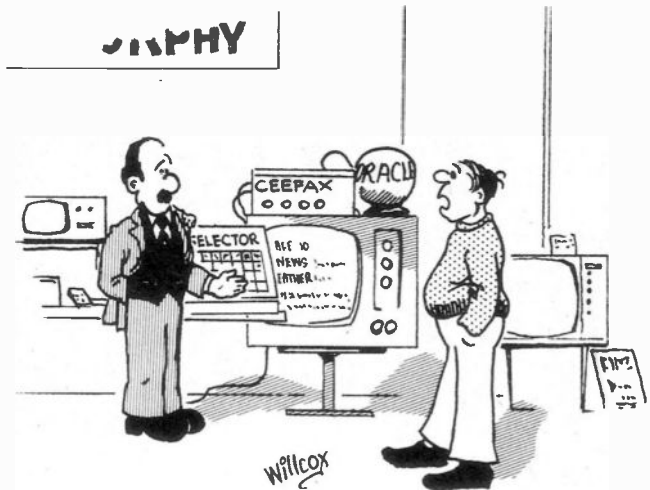


Fig. 5: Power resistor arrangements. (a) Earlier arrangement used on the 8000 chassis. (b) Arrangement used in the 8000A and 8500 chassis.



"That's all very well, but will I be able to get ITV?"

chassis — see Fig. 3. The two diodes W601 and W602 carry the e.h.t. return current to chassis and are also connected to the h.t. rail via R615. This arrangement generates a nominal 27V bias supply for the c.r.t. grids, corresponding to a current of 1mA through the diodes in opposition to the e.h.t. current. If the beam current increases beyond this figure the bias from the h.t. line is overridden and the c.r.t. grids move negatively, offsetting the beam current change. W601 prevents the grids being clamped to chassis potential when W602 becomes forward biased. C603/R613/C601 form a simple filter network for the grid bias supply. The beam current limiter components are mounted on the c.r.t. base assembly. The circuit has not given us any trouble.

Horizontal Convergence Circuit

The line convergence circuit is shown in Fig. 4 and is connected in series with the scan circuit. Connected in parallel with the convergence circuit is the network C501/R501 which ensures that the convergence circuit appears substantially resistive to the line output stage.

Coil L503 provides a series or shunt inductance with the blue lateral coil L501 to enable the blues at the right and left hand sides of the raster to be adjusted. A two-pin reversal plug allows for correction in either direction.

Line scan current flowing in the R/G amplitude control R503 produces a sawtooth voltage which drives a parabolic correction current through the red and green convergence coils to provide adjustment at the left-hand side of the screen. L502 provides control of the sawtooth component and permits adjustment at the right-hand side of the scan. The R/G difference control R507 adjusts the proportionate level of the parabolic currents whilst L403 (Fig. 2) adjusts the proportionate level of sawtooth — together, these controls enable bowing and crossing to be eliminated along the centre horizontal line. W501 clamps the sawtooth to prevent static shift being caused by dynamic convergence adjustments.

The level of the correction current in the blue radial convergence coils is set by the blue amplitude control R505. The level of parabolic correction is set by R502, the blue tilt control.

Faults in the line convergence circuit are usually caused by intermittent controls. R505 is the main culprit, and should be replaced with a metal case unit. R502 can also give trouble. R506 often goes intermittent and can be safely removed and replaced by a link, as may R504.

WHAT 'SCOPE ?

TV TEST EQUIPMENT REVIEW

PART 2

E. TRUNDLE

BEFORE the advent of colour television, the oscilloscope was a comparatively rare animal in the television workshop. Those establishments which boasted a 'scope usually had either a huge and heavy machine with a vaguely military air and enough knobs to do justice to the average aircraft flight deck, or a small 3MHz job which required a great deal of knob-twiddling to maintain a usable display. The author's particular pride and joy ten years ago was a Hartley Model 13a MK II – no less – whose quota of throbbing valves made a good substitute for a central heating system and whose performance was in many ways inferior to that of the most inexpensive modern scope.

Domestic equipment is becoming more sophisticated with every month that passes, and as more equipment, such as VCRs, electronic games, Teletext decoders and so on, enters the realm of the service technician, the need for a respectable oscilloscope has never been greater. There is no lack of instruments to choose from, and the wealth of literature and specifications available from the many manufacturers in this field can be confusing. It is hoped that this article will assist in making a choice of instrument, and put into perspective the relative merits of the various parameters of oscilloscope performance.

While we have looked at these instruments mainly from the TV technician's point of view, there is much to interest the experimenter and amateur. The instruments chosen are a representative, though very small, sample of what is currently available in various price ranges, from a modest single-beam portable to a 25MHz dual-beam instrument.

As we said with regard to digital voltmeters, for a given price, performance varies little between manufacturers, and each model reviewed is not necessarily the most popular in its manufacturer's range, but is intended to be representative of the performance which may be expected from that class (and price) of instrument. When choosing an oscilloscope, the specification should be closely weighed against the price. A few extra MHz of bandwidth or a good trigger performance are worth any number of snide comments about plastic knobs and awkward carrying handles. All the models tested met their published specifications, in many cases with a handsome margin in hand. Some aspects of oscilloscope performance and their relevance to specific applications are set out below.

Bandwidth

The bandwidth of the Y-amplifier system sets the highest frequency which can be usefully displayed. Many instruments are incapable of producing a full-height display without distortion at high frequencies, and when

approaching the full bandwidth of the scope in use, it is wise to restrict the display height to half the screen diameter. Bandwidth is inversely proportional to rise time, which is the time (usually measured in nanoseconds) which the amplifier takes to lift the output from 10% to 90% of its final level when presented with a voltage step input. It follows that for accurate measurement of pulses with fast rise and fall times, a good bandwidth is required. Frequencies higher than 5MHz are rarely required to be measured in television equipment, so that a 3db bandwidth of 8 or 10MHz is adequate. Some CCTV systems embrace a bandwidth of 10 or 12MHz.

In circuits where impedance is higher than a few tens of ohms, the input capacitance of the oscilloscope and input lead are significant at video frequencies, rendering necessary a divider probe, usually with an attenuation factor of 10:1. This effectively reduces the gain of the scope to one tenth of its rated figure, so that a Y-sensitivity of 10mV/cm may be regarded as the minimum required in a versatile instrument.

Dual or Single-Trace?

A true dual-beam c.r.t. with two guns or a beam-splitter plate is rare in our price range, and all the dual-trace instruments reviewed here have a single beam which is electronically switched on a time-multiplex basis to form two traces. A single-trace model is adequate for field work, but the versatility of a dual-trace instrument amply repays the extra cost, and for bench use is almost indispensable.

Apart from the obvious applications of dual-trace oscilloscopes, much time can be saved when tracing intermittent faults, where one beam can monitor the input signal to a suspected stage, while the second beam displays its output. Even if the fault occurs only momentarily, the stage can be checked at a glance. Another example of the uses to which dual beams can be put is the setting up of c.r.t. drives where RGB drive is employed. By superimposing traces, luminance drive can be initially set to be exactly equal for each gun. Space does not permit a full account of the advantages of dual-trace operation, but as experience is gained these will become obvious, and a dual-trace instrument is earnestly recommended.

Overload Protection

Modern oscilloscopes invariably have field-effect transistors in the input stage, and these are protected by diodes which bypass harmful overloads to ground. As with DVMs it is true to say that an oscilloscope can only be damaged through overload in circumstances of gross carelessness, especially where the usual $\times 10$ probe is in use.

WHAT 'SCOPE ?

Triggering Facilities

All oscilloscopes for general applications have provision for triggering or synchronising the timebase from the displayed pattern. Usually, positive or negative flanks can be chosen, and models specifically designed for television service often have a built-in sync separator, which permits the display of composite (picture and sync) waveforms without external triggering. This is convenient, but where the displayed waveform does not have any particular triggering pulse (burst-blanked chroma, for instance) external triggering is necessary.

A trigger pulse at the line rate can be obtained by the simple expedient of hanging a clip-lead near the line output stage of the receiver, and selecting external positive trigger on the 'scope. External triggering at field rate usually requires a physical connection to the field timebase circuit, preferably from a low impedance point and via an isolating capacitor of about $0.1\mu\text{F}$. External triggering from either timebase has the great advantage of providing a rock-steady trace irrespective of the display height, and even on a 'scope with good trigger facilities, external triggering is recommended for this reason.

E.H.T.

At first sight, the e.h.t. at which an oscilloscope c.r.t. operates is nobody's business but the manufacturer's, but this is not so in practice. It is becoming increasingly common to operate an oscilloscope in a "strobe" mode, in which a specific television line or group of lines is examined. As each line occurs only once per picture, the duty-cycle of the spot is very small, and the display correspondingly dim. The same remarks apply to normal oscilloscope operation in which a large amount of X-expansion is applied. When the intensity is wound up to compensate, the trace becomes defocused.

At the 1-2kV e.h.t. level of inexpensive instruments this effect is a great handicap, and the 5-6kV found in more sophisticated models results in a brighter and sharper trace under strobe conditions. When an oscilloscope is used as a television picture monitor, a high e.h.t. provides a sharp and crisp picture.

X-Y Displays

While all of the oscilloscopes we looked at have an "external X" facility offering a degree of amplification to the X-input signal, several are true X-Y instruments, in that calibrated control over the X-amplifier is offered. The most common use of X-Y displays is in frequency determination by Lissajous figures, in which the gain of the channels is relatively unimportant. An application of X-Y displays which deserves wider recognition is decoder alignment by the vectorscope technique. Phase-shift measurement is also possible with the X-Y facility, but at high frequencies the phase-shift of the amplifiers becomes significant. The intrinsic phase shift is unimportant where the X and Y amplifiers (and probes) are matched.

Z-Modulation

Brightness modulation (also known as Z-modulation, being a "third axis" of the display) is seldom used in television receiver servicing, but the facility is usually provided, and can be used for frequency determination

as an alternative to Lissajous figures. The sweep is run at a known speed, and the unknown frequency is injected via the Z-modulation input. Counting the resulting "bright-ups" enables the unknown frequency to be determined.

As mentioned in connection with e.h.t. voltages, it is quite feasible to use an oscilloscope as a TV picture monitor. The horizontal sweep generator is locked at line frequency, and the Y-amplifier fed with a field sawtooth. Having thus set up the raster, the video waveform is fed in via the Z-modulation input. The higher the e.h.t. the better for this application, and the oscilloscope makes a very convenient viewfinder for a CCTV system.

Timebases

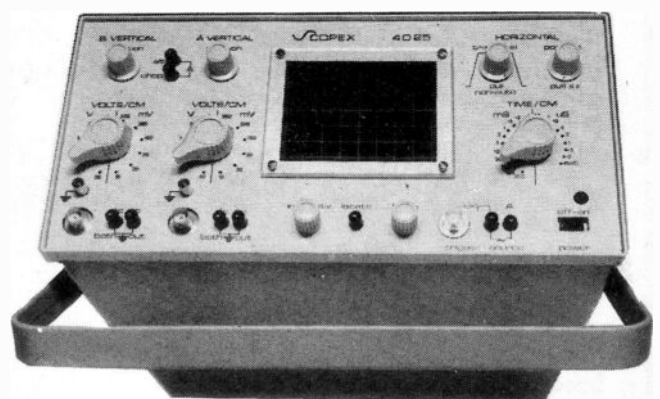
There are few pitfalls in the timebase department for the intending purchaser of an oscilloscope. Most makers provide adequate coverage of required sweep rates, and the usual X-expansion factor of about five exploits the full capability of the display system anyway.

Probes

Mention has already been made of probes in connection with Y-amplifiers. Most manufacturers market inexpensive divider probes for use up to 50MHz. A particularly good design of probe came our way from Scopex ("Uniprobe"), which is switchable between $\times 1$ and $\times 10$. This avoids tedious head-changing, and was found particularly convenient, especially with instruments of low Y-sensitivity. It is essential that any probe is set up in accordance with the maker's instructions before use. This is done by adjusting the probe trimmer for optimum response on a suitable squarewave. Such a test signal is available on the front panel of many instruments.

Auxiliary Outputs

Many instruments provide a sawtooth output at sweep rate which is essential if the scope is ever to be used in conjunction with a wobulator. A "probe-test" output is sometimes provided, which greatly eases the probe-equalization adjustment. Another useful feature is a calibration output derived from an internal diode. This takes the form of a squarewave at mains frequency, and provides a quick check of Y-gain.



The Scopex 4D25 dual trace oscilloscope, reviewed overleaf.

WHAT 'SCOPE ?

Scopex 4D25

The Scopex 4D25 is the most exotic oscilloscope which came our way for review. It has the advantages over everyday oscilloscopes of wider bandwidth, higher e.h.t. and a signal delay line. The 4 inch c.r.t. is no bigger than it ought to be for this class of instrument.

Y amplifiers

Basically, it is the Y amplifier characteristics which account for the cost of this 'scope. Risetime is 15ns, and bandwidth extends to 25MHz (-3db). A 200ns delay line is incorporated in the Y amplifier, which facilitates observation of the trigger flank where the timebase is internally triggered. The fast risetime is very useful for pulse observation, and the enhanced bandwidth makes this 'scope suitable for the exacting requirements of professional CCTV service work, as well as everyday TV service.

One small criticism concerns the Y attenuator switch, which has no stop at the top end. When examining large waveforms, it is easy to flip the switch beyond the 50V/cm position, which re-sets the 'scope to 10mV/cm, and that could be nasty! The selection of chop or alternate modes for Y display is left to the user. The usual d.c.-a.c.-earth switch is provided for reference purposes.

Timebase

A 20-position switch selects a wide range of sweep speeds, and external X deflection is catered for by a rear socket. A minor gripe concerns the absence of a suitable pulse output for probe compensation adjustment, rendering

it necessary to rig up a separate squarewave generator. A single $\times 5$ X-expansion facility if provided, which is adequate for most purposes, but no variable sweep speed control is fitted. The high e.h.t. of 6kV means that where the X-expansion facility is in use, the display is brighter and clearer than an ordinary service oscilloscope. This is particularly appreciated when examining a television field line-by-line.

The beam-locate facility gives a bright defocused trace, so that when the beam is absent due to a combination of control maladjustments, it can be brought into location.

Trigger

As this instrument is not designed specifically for television service, the TV technician might be excused for thinking that the trigger facilities are barely adequate. A single trigger-level control is provided, which caters for both polarities of trigger pulse, with a push-for-auto facility. Trigger sources may be selected from "vertical A", 50Hz mains, or external. No TV sync separator is incorporated, which means that examination of composite waveforms at field rate requires a trigger feed from the set's field timebase. The timebase cannot be triggered at all from the B vertical channel, which is a minor irritation for TV service work.

This instrument, which weighs 20 lbs, is not suited, by price or specification, for field service, but would be an asset to any workshop, especially where a wide range of electronic equipment is serviced in addition to colour receivers. ●

Abridged specification

VERTICAL DEFLECTION SYSTEM (Dual trace)

Deflection factors: 10mV/cm-50V/cm in a 1-2-5 sequence.

Accuracy: $\pm 3\%$.

Bandwidth: D.C. (2Hz on a.c.)-25MHz (-3dB).

Rise time: 15ns.

Input impedance: 1M Ω /27pF.

Operating modes: Channel A only. Alternate between channels. Chopped between channels at 100kHz.

Special features: Signal delay. Trace locate button.

HORIZONTAL DEFLECTION SYSTEM

Sweep speeds: 200ns/cm-200ms/cm in a 1-2-5 sequence.

Accuracy: $\pm 3\%$.

X Expansion: $\times 5$ ($\pm 5\%$).

External X input: 1V/cm (200mV/cm on $\times 5$).

Bandwidth: D.C.-500kHz.

Input impedance: 1M Ω /15pF.

Special features: Sweep ramp output.

TRIGGERING

Sources: Channel A. External. Supply frequency.

Sensitivity: Internal; 3mm from 10Hz-10MHz, 10mm at 25MHz. External; 300mV from 10Hz-10MHz, 1V at 25MHz. (Input impedance 1M Ω /30pF).

Controls: Combined polarity and level/auto bright line on-off.

GENERAL

C.R.T.: 4 in, p.d.a. mesh. **E.H.T.:** 6kV.

Graticule: Ruled, 6 \times 8cm.

Power supply: A.C. mains 105-125 or 210-250V, 50-60Hz, 35VA.

Size: 153 \times 312 \times 435mm (6 \times 12.25 \times 17.13 in).

Accessories available: Probe kit. Protector muff.

Price: £225 (plus VAT).

Further details are available from Scopex Instruments Limited, Pixmore Industrial Estate, Pixmore Avenue, Letchworth, Herts SG6 1JJ. Telephone Letchworth (046 26) 72771.

WHAT SCOPE ?

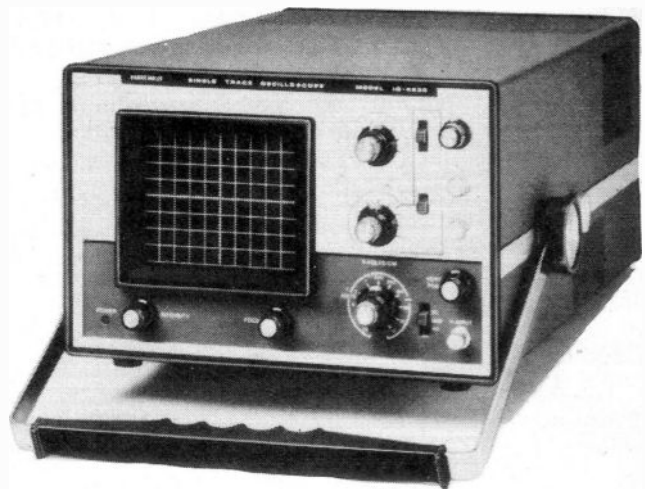
Heathkit IO-4530

Heathkit products need little introduction to many readers of this magazine, and a vast range of kits is available from Heath, covering the whole spectrum of electronic equipment. Several oscilloscopes are listed amongst the test equipment, and the instrument chosen has a versatile combination of laboratory and TV service features. The IO-4530 is basically a 5 in 10MHz single-beam scope, with X-Y and TV trigger facilities.

Construction

The kit was assembled by a colleague of the author's, a TV service technician with little previous experience of assembly or test equipment. Heathkit manuals are famed for their lucidity, and the company's claim that their kits can be built by anyone is quite true. The manual consists of a series of steps, aided by diagrams, which take the constructor right from unpacking the carton to final test. Each step is ticked-off with a pencil as construction proceeds, and the system is as near foolproof as anything can be. Certainly, no problems are anticipated for regular readers of *Television*.

On unpacking the kit, we were pleased to see that the printed circuit boards were of glass-fibre, as is used in professional test equipment. We were a little dismayed by the fact that the board has print on both sides, having had experience of the printed boards used by a well-known maker of radio and TV products, who shall remain nameless! Closer examination showed, however, that the "plated-through-holes" technique had been used, so that it was unnecessary to solder component leads to both sides of



the board, and in fact the manual specifically advises against this. Much use is made of integrated circuits in this instrument, and all nine in the IO-4530 are pluggable. This is a useful feature if failure of an i.c. is suspected, as two types are used three times over in this particular model, facilitating substitution.

The components used in the instrument are mainly of American origin, and the transistors and i.c.s have type numbers which are strange indeed to British eyes! In the unlikely event of replacement being required however, these are readily available, along with other specialized parts, from the Heath factory in Gloucester. With the exception of the precision resistors used in the input attenuators, virtually all the resistors used are $\frac{1}{4}$ W types, and we would have been happier to see oxide or film resistors in place of the carbon composition types supplied. Test equipment is expected to last many years, and the higher stability of the

Abridged specification

VERTICAL DEFLECTION SYSTEM (Single trace)

Deflection factors: 10mV/cm-20V/cm in a 1-2-5 sequence, plus uncalibrated 2.5:1 variable control.

Accuracy: $\pm 3\%$.

Bandwidth: D.C. (2Hz on a.c.)-10MHz.

Rise time: 35ns.

Input impedance: 1M Ω /38pF.

HORIZONTAL DEFLECTION SYSTEM

Sweep speeds: 200ns/cm-200ms/cm in decade steps, plus uncalibrated 10:1 variable control.

Accuracy: $\pm 5\%$.

X Expansion: $\times 5$ ($\pm 2\%$).

External X input: 20mV/cm-2V/cm in decade steps, plus uncalibrated 10:1 variable control.

Accuracy: $\pm 3\%$.

Bandwidth: D.C. (2Hz on a.c.)-1MHz.

Input impedance: 1M Ω /40pF.

Special features: Full X-Y mode facilities.

TRIGGERING

Sources: Internal. External. Supply frequency.

Sensitivity: Internal; 5mm from d.c. - 5MHz, 10mm at 10MHz, 15mm at 15MHz. External; 500mV r.m.s. from d.c. - 5MHz, 1V r.m.s. at 15MHz. (Input impedance 1M Ω /40pF).

Controls: Polarity. Level.

GENERAL

C.R.T.: 5 in. E.H.T.: 1.4kV.

Graticule: 8 x 10cm ruled.

Power supply: A.C. mains 110-130 or 220-260V, 65VA.

Size: 162 x 325 x 488mm (6.4 x 12.8 x 19.2 in), excluding handle.

Weight: 11kg (24 lb) approximately.

Accessories available: Probe kit. Demodulator probe.

Price: £198.14 (plus VAT).

Further details are available from Heath (Gloucester) Ltd., Bristol Road, Gloucester GL2 6EE, telephone Gloucester (0452) 29451, or from the London Heathkit Centre, 233 Tottenham Court Road, London W1P 9AE, telephone 01-636 7349.

WHAT 'SCOPE ?

latter types would have enhanced the long-term performance. In all conscience, it must be said that the resistors and capacitors are generously rated, minimising the risk of drift or breakdown.

Once the amendments and corrections to the manual had been made, construction went ahead. To avoid the risk of mistakes, a leisurely pace was adopted, and about thirty-three hours work was found necessary on this particular instrument. When assembly had been completed, a careful visual check was made, followed by the "cold" ohmmeter check detailed in the Heath manual. This ensures that no fireworks occur on switch-on.

Calibration

The big moment having arrived, we switched on, and made the preliminary adjustments of voltage stabilisers and pre-sets. When we arrived at the procedure for setting up the X amplifier, we were unable to balance the output stage, and close examination revealed a "splat" of solder on the board in the region of the X amplifier. This was carefully removed, but it was found that the X amplifier still refused to respond to adjustment. We resisted the temptation to apply normal fault-finding techniques, and turned instead to the excellent fault-finding chart in the Heath manual.

Two or three voltage readings later, we arrived at a certain transistor whose electrode voltages were very strange. The offending transistor was removed from the board and checked. It proved faultless, but when replaced on the printed board, we found that it had been incorrectly positioned during assembly! No harm was done, and the X amplifier then set up perfectly.

The rest of the calibration was easily carried out. Two setting up procedures are given, one using a special calibrator marketed by Heath, while the other calls for such exotic equipment as a squarewave generator with 100V output and 1MHz range. A high-impedance voltmeter is called for in either case. While 1MHz-100V squarewave generators do exist, they are not in the "common-or-garden" category, and purchase of the calibrator (Model IOA-4510-1) is necessary to set up the instrument adequately. Obviously, any electronic equipment needs careful setting-up to give of its best, but in the case of test equipment, whose primary function, after all, is measurement, accurate calibration is of the essence. The importance of careful setting-up with the correct gear cannot be over-emphasised.

Performance

Although many of the parameters had been covered during calibration, we checked that the instrument met its published specifications regarding bandwidth, sweep speed accuracy and so on, and no problems arose. The 'scope was immediately pressed into service on the colour TV repair bench, and proved itself equal to all servicing requirements.

The front panel layout is clear and functional, and as on most current oscilloscopes, the number of control knobs is kept to a minimum, resulting in an uncluttered appearance. The 5 in. round c.r.t. gives a respectable 10 x 8cm display area, but the relatively low e.h.t. of 1.4kV on a c.r.t. of this size gives a rather subdued trace, especially if one is used to working with a 4 or 5kV 'scope. This effect is most noticeable, of course, at the higher sweep speeds, and especially when using the X-expand facility.

Y amplifier

Coverage is from 10mV to 20V/cm, which with a x 10 probe (not supplied with the kit) gives a range of 100mV to 200V/cm. A variable control gives coverage between ranges. The amplifier is capable of providing a trace 6cm high at 10MHz.

Timebase

Seven pre-set sweep speeds are provided. The ranges thus available are necessarily coarse, switching up a decade per step, and control between ranges is provided by a fine speed control. Pulling the fine speed control knob expands the X deflection by a factor of five, and the range of speeds available is quite adequate.

X amplifier

The X-Y mode is selected on an eighth position of the Time/cm switch, and X input is by way of a standard BNC socket, permitting the easy use of a second probe. The X gain switch has six positions, giving three decade ranges d.c. coupled, and the same three ranges a.c. coupled. Greater versatility would have been achieved with six ranges and a separated a.c.-d.c. coupling switch.

The X amplifier bandwidth extends to 1MHz (-3db), so that phase comparison at high frequencies is not possible. This oscilloscope lends itself well to vectorscope applications, in which colour decoder adjustments can be made with consummate accuracy. Vectorscope principles and alignment procedure were fully described by E. J. Hoare in his excellent series on PAL colour, the relevant article appearing in the April 1972 issue of *Television*, page 252.

Trigger

Three trigger modes are possible, and the TV position selects a passive sync separator which provides satisfactory locking of composite signals at field rate. Much attention has been paid to the trigger circuitry in this design, and no less than four digital i.c.s are involved. Certainly, the trace can be solidly locked under all circumstances.

Conclusion

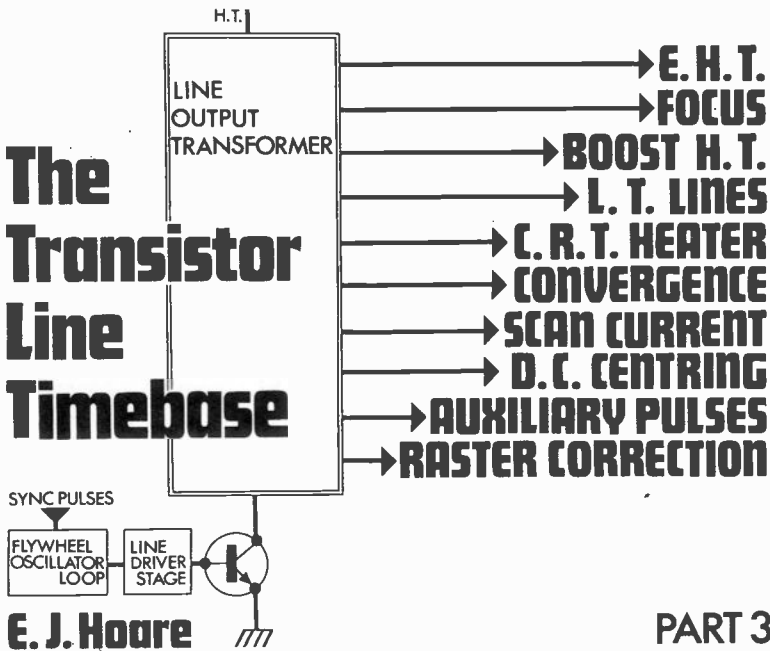
The finished instrument is quite comparable with commercial 'scopes having similar specifications. The weight of 24lbs is a little excessive for regular TV field work, but the rugged handle-cum-stand greatly assists portability.

It is undeniable that the price of the kit is rather high when compared with similar factory-made instruments from other manufacturers, but there is much more to building a Heath kit than producing a first-class piece of equipment. As an introduction to electronics, both theoretical and practical, a kit is ideal, especially in view of the excellent circuit description in the manual. Who can put a price on the feeling of satisfaction and pride in a job well done when the completed instrument stands glistening on the bench? ●

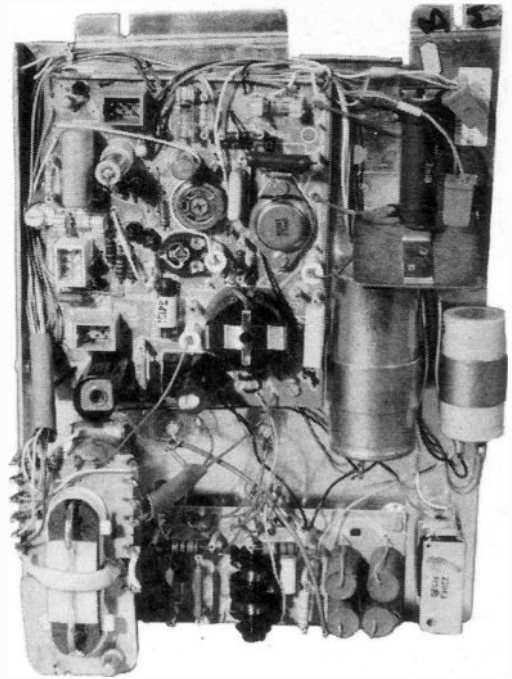
NEXT MONTH

Reviews of four more oscilloscopes, the D54 and D61 by Tequipment, the Advance OS240 and the Hameg HM270.

The Transistor Line Timebase



PART 3



TRIPLERS are one of those strange things often referred to (sometimes quite correctly!) as electronic black boxes. It is safe to assume that most readers are content to leave them well alone. If you don't even know for certain what's inside, it's difficult to work out quite how they operate. Let's take this up and try to remove any mystery that may be attached to them.

One basic tripler circuit is shown in Fig. 19. The precise arrangement varies slightly between different versions and makes, but the principle of operation remains much the same. Line flyback pulses of about 8kV are supplied to the tripler circuit from the overwinding on the line output transformer, and the capacitors in the circuit charge up in a succession of pumping actions. It takes quite a large number of line scan cycles therefore before all the capacitors have charged fully and 24kV or so is developed across C5, the c.r.t. anode capacitance. Between each voltage pulse, charges flow between the capacitors until C1, C2, C3 and C4 all have a potential difference of 8kV across them. The next 8kV input pulse superimposed upon these charges then charges the final capacitor C5 to 24kV to give the required e.h.t. output. Let us examine the process in greater detail.

To do this in a way that is easy to follow we will split the circuit up into small stages and discuss each in turn, though in reality the whole process occurs simultaneously of course.

When a flyback pulse occurs at point A, C2 charges to 8kV via diode D1. The pulse ends, the voltage at A falling to zero. D1 cuts off leaving C2 charged. Note that C1 does not charge since its plates are shorted together by diodes D1 and D2.

The next step is that D2 conducts and C2 shares its charge with C1. This leaves both capacitors charged to 4kV. The following pulse restores the charge across C2 to 8kV. At the end of the pulse the two capacitors again share the total charge, ending up charged to 6kV. The process continues until both capacitors are charged to 8kV.

Now consider C3. When a pulse comes along the anode of D3 will see 8kV plus the 8kV charge on C1, i.e. 16kV. As one plate of C3 is connected to C2 however the voltage applied across C3 is $16 - 8 = 8$ kV. C3 charges to this potential, the plate at the junction with D3 then being at 16kV above chassis potential.

The same process occurs with C4. With no pulse present the anode of D4 is at 16kV and the junction of C1 and C4 is at 8kV. Charge is transferred therefore from C3 into C4, leaving C3 at less than its original 16kV. Charge will also flow from C1 and C2 as C3 discharges. After a few successive pulses however C1, C2, C3 and C4 will all have charged so that each has a potential difference of 8kV across its plates.

We now have 16kV with respect to chassis on both sides of D4, being the sum of $8 + 8$ kV on C1 and C4, and $8 + 8$ kV on C2 and C3. After a few successive pulses C5 charges to 16kV and when the next pulse arrives at A the voltage applied to C5 will be $16 + 8$ kV so that C5 charges to 24kV.

This, as we said earlier, is a progressive cycle of events, each capacitor receiving a share of the charge from each successive pulse at point A. When e.h.t. beam current flows in the c.r.t., more charge has to be transferred through each capacitor and the conduction level of the input pulse falls from the tip to a point lower down - as illustrated in Fig. 18(c). Inevitably, the e.h.t. voltage falls, though not unduly so if the pulse is a broad one as given by fifth harmonic tuning. In other words, the e.h.t. will have a low source impedance.

Focus potential

Another important feature is that a line timebase has to provide a focus potential adjustable, for normal colour

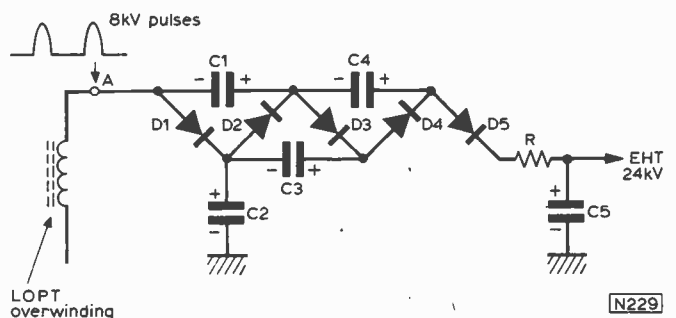


Fig. 19: A tripler circuit. The resistor R is included to protect the line output transistor against the effect of c.r.t. flashovers, a typical value is 47kΩ with silicon multiplier diodes.

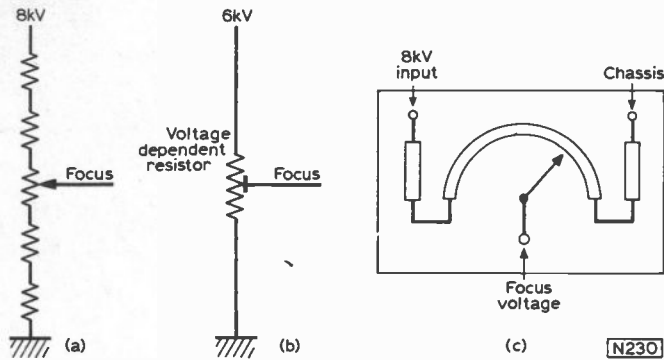


Fig. 20: Three ways of obtaining a variable source of focus voltage.

- (a) A high voltage potentiometer and resistor chain.
- (b) A rod-form voltage dependent resistor with sliding contact tapping point.
- (c) A printed thick-film resistive potentiometer.

picture tubes, over the range 4-5kV. The 8kV generated to drive the tripler is a useful source of this voltage and is available at the upper plate of C2. This 8kV d.c. can be fed to a potential divider from which the required focus voltage can be tapped. There are several ways of doing this, as shown in Fig. 20.

Basically all that is required is a resistive divider network. High-voltage resistors capable of withstanding several kV are not easy to make however. Some chassis use special quality 1W carbon resistors in series with a 1kV potentiometer to provide a suitable tapping range, as shown in Fig. 20(a). The same idea is shown in Fig. 20(b) but in this case the high-voltage capability is provided by a single voltage-dependent resistor (v.d.r.) in rod form. A sliding contact is fitted so that the appropriate voltage level can be tapped off. The action of a v.d.r., which is a constant voltage device, is helpful in reducing focus voltage changes caused by changes in the focus electrode current. This is small, being in the range up to $\pm 20\mu\text{A}$, but with a source resistance of several megohms the voltage drop can easily exceed 100V, at which level changes in focusing quality become visible on the c.r.t. screen. A v.d.r. has a low source impedance, reducing this effect.

The device shown in Fig. 20(c) is of more recent origin. It consists of a thick-film resistive potentiometer. The resistive track is printed on to an alumina substrate plate and then fired. The result is a glassy deposit having a very stable resistance: it can easily be made of suitable length to overcome insulation problems. The track is in the form of an arc, and a metal wiper makes contact in a similar way to an ordinary potentiometer. Several different makes are in use.

Convergence

There is not a great deal which can be said about convergence since the requirements depend on the particular combination of c.r.t. and deflection yoke used. At one time tubes and yokes were to a large extent interchangeable, but unhappily this is no longer so. We now have 90° and 110° delta gun tubes, 90° and 110° in-line gun tubes, and a corresponding variety of convergence systems. We also have both wide and narrow necked tubes. This is a very unfortunate state of affairs, and most of the burden falls on the shoulders of service engineers who have to become familiar with many different types of circuits and adjustment procedures.

One fundamental point which is worth mentioning is that some circuits are voltage driven while others are current driven. Voltage driven circuits are fed with a pulse from a tap on the line output transformer: current driven circuits are effectively in series with the scanning circuit and carry some part of the actual scan current. The latter arrangement is preferable in general since any change in scanning current, however caused, is directly reflected into the convergence circuits, resulting in a corresponding change in the convergence correction. The convergence quality may change less therefore with changes of h.t. voltage or e.h.t. beam current loading which result in variations in picture size.

Auxiliary pulses

Just as a reminder of how the line timebase affects or controls so many other circuits in a television receiver, consider the variety of uses served by the line flyback pulses. In addition to e.h.t. and l.t. generation, focus voltage supply, convergence circuit feed in some sets and the c.r.t. heater supply, there is flyback blanking, sync separator gating, a.g.c. gating, flywheel sync reference sawtooth, flywheel gating, burst gating, burst blanking, PAL switch triggering, RGB signal d.c. clamping, and the generation of a boost h.t. supply for the c.r.t. first anodes

Raster correction

The last major function of a line timebase is raster correction. In a monochrome receiver the need for correction arises from the fact that in order to get good spot quality at the outer edges of the screen the magnetic deflection field has to be shaped in a way which results in pincushion distortion of the raster. This distortion is easily corrected to an acceptable degree by carefully positioning permanent magnets mounted on or near the deflection yoke.

Matters become rather more complicated in a colour receiver however. As before, the yoke must be designed so as to avoid distortion of the beams near the outer edges of the picture, i.e. deflection defocusing. But there are two further requirements. First, the magnetic field of the yoke must be such that whatever their angle of deflection the three beams still appear to originate from the same point in space, known as the deflection centre. This is essential if the beams are to approach each hole in the shadowmask from the correct direction so that each beam lands properly on its own phosphor dot in each dot triad in order to give perfect purity.

The other problem concerns convergence. The three beams are significantly spaced apart as they pass through the deflection field. If this field has the wrong magnetic flux distribution each beam will be deflected by a different amount and the degree of misconvergence will vary from point to point. Furthermore, and perhaps more importantly, the misconvergence may have a characteristic that is impossible to correct using conventional circuits.

These considerations govern the distribution of the magnetic deflection field, and it is impossible to achieve good spot shape, good purity and satisfactory convergence without having to accept a significant amount of raster distortion. A compromise is essential therefore, and fortunately the raster distortion can be corrected fairly easily.

Correction transductor

Pincushion distortion consists of an inward curve on all four sides of the picture. The distortion at the top and bottom edges is known rather expressively as a N-S error

and that along the two sides as an E-W error. A raster transducer corrects these errors in two ways.

Let us consider the E-W direction first. The pincushion distortion arises from the fact that the line scan width is too great at the top and bottom of the picture compared to the centre part. Since in general it is easier to reduce a scanning current than to increase it, an obvious approach is to find some way of adding inductance in series with the line deflection coils whilst the c.r.t. beam is scanning the upper and lower parts of the picture. An alternative approach is to add inductance in parallel with the deflection coils to bypass some of the scanning current instead of simply reducing the total current. The latter technique is easier to apply in practice, and is done by means of a transducer.

A transducer is a transformer with windings on two or more limbs, arranged in such a way that the magnetic flux generated in one winding interacts upon the flux generated by a second current flowing in another winding. A typical arrangement is shown in Fig. 21(a). It will be seen that one pair of windings is in parallel with the line scanning coils while a separate winding is in series with the field scanning coils.

The line and field scanning currents flowing in their respective windings generate magnetic flux in the core of the transducer, as shown in Fig. 21(b). The line windings L1 and L3 have a comparatively high inductance, and only a small proportion of the scan current flows through them therefore so that they don't load the line scan circuit significantly. The flux generated by these windings cancels in the centre limb of the core, and is thus confined to the outer limbs as shown.

In the absence of any field scanning current, i.e. when the c.r.t. beam is on the horizontal axis of the picture, the only effect of the transducer will be to reduce very slightly the width of the line scan – due to the shunting effect of L1 and L3.

Field scan current

Now consider the situation when the field current begins to build up and deflect the line scanning towards the bottom of the raster. Current in winding L2 generates flux as shown in Fig. 21(c). This tends to cancel the flux cutting winding L3, and to augment the flux in L1. The transducer is so designed that this extra flux in L1 begins to saturate the core, so the inductance of windings L1 and L3 begins to decrease. As their inductance falls, more of the line scanning current flows through this circuit and less through the deflection coils. The picture width is thus reduced as the field current in L2 increases, which is just what we want in order to correct the E-W pincushion distortion.

Reverting to the original condition when the line scan was at the centre of the raster, it will be seen that since the flux from windings L1 and L3 cancels in the centre limb no e.m.f. will be generated in L2. Thus no transformer action takes place. As the field current builds up however and one limb starts to saturate, the flux generated by L1 and L3 will not be equal and will not cancel in the centre limb. Thus a line frequency current is injected into the field deflection coil circuit. This current is integrated by capacitor C in Fig. 21(a) to form a parabola, adjusted in amplitude by the choice of value of R, and its phase corrected by the variable inductor L4.

The effect of these parabolic line frequency components superimposed on the sawtooth field scanning current is to increase this current every time the c.r.t. beam approaches the beginning and end of the horizontal scan. Furthermore these line frequency components are zero at the horizontal axis of the picture, when no field current is present, and

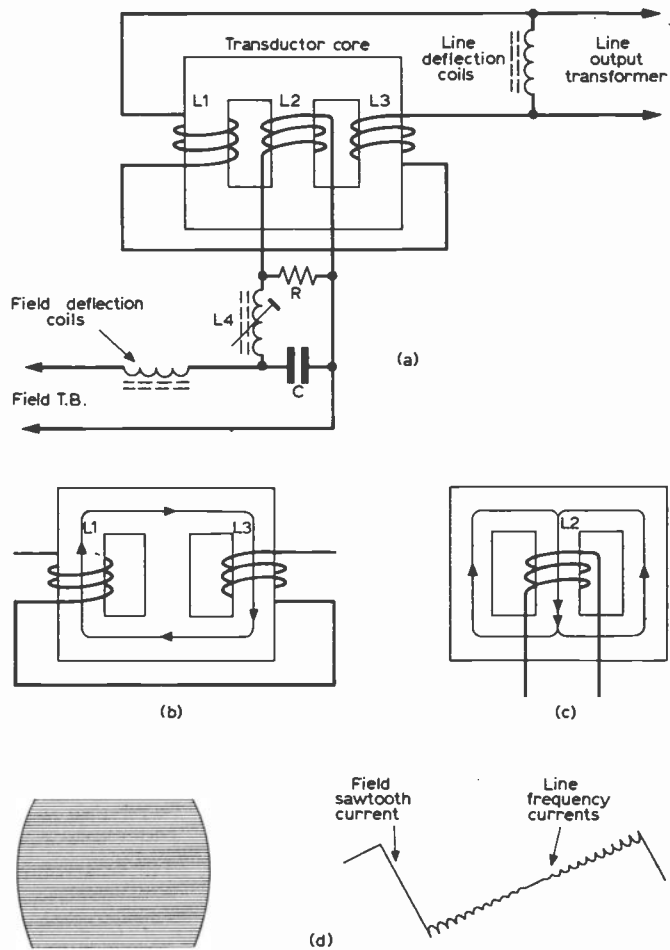


Fig. 21: Operation of the raster correction transducer.

- (a) The transducer circuit.
- (b) Flux path generated in the core by L1, L3, connected in parallel with the line deflection coils.
- (c) Flux paths generated in the core by L2, connected in series with the field deflection coils.
- (d) The line scanning current is modulated at field frequency, as shown by the raster, while the field scan current is modulated by the line frequency parabola, as shown by the waveform.

maximum at the top and bottom of the picture when the field current is at maximum. In this way line-frequency modulation of the field current corrects the NS pincushion distortion.

Both line frequency modulation of the field current and field frequency modulation of the line scanning current are illustrated in Fig. 21(d). The net effect is that a raster with appreciable pincushion distortion can be corrected within acceptable limits without the need to add any undue complexity to the circuitry. It makes it possible to achieve good overall picture quality, avoiding the need to make unsatisfactory compromises in the design of the c.r.t. and the deflection yoke.

The use of a single transducer in this way is found in nearly all 90° colour chassis. More complex techniques are necessary to correct pincushion distortion when 110° scanning is used. The basic principle of modulating the field scan at line frequency and the line scan at field frequency is still used however.

Practical problems

What we are talking about here are the kind of problems that arise when a circuit diagram is translated into a

complete receiver chassis. We have already mentioned the interference generated by fast switching pulses in the line driver stage. These have harmonics in the i.f., v.h.f. and u.h.f. bands. When these are picked up in the receiver's signal circuits they are modulated on to the picture information, producing vertical lines of interference. Such problems vary both in nature and magnitude between different designs, and we can do no more than list a few typical ones to show what can happen.

First, a few basic points. Any spurious vertical line on the picture is caused by an occurrence at *line* frequency. Similarly, though we are not really concerned with these in this series of articles, any stationary horizontal line is caused by an effect at *field* frequency while any horizontal line moving vertically is caused by some disturbance at *mains* frequency.

Line frequency interference

Interference at line frequency is generated by fast switching transients in the line driver or line output transistors, or by the high-voltage line flyback pulses themselves. Any of these effects can be coupled into other circuits by magnetic or electric fields, or by impedances common to both circuits. If line frequency currents flow in a conductor shared by the field oscillator circuit for example, line frequency components will be added to the field sync pulses and bad interlace will be an almost inevitable result. Furthermore, it is not generally realised that line pulses added to the field oscillator or driver stage outputs can still cause bad interlace even when the field sync pulse triggering is correct.

It is a basic principle of good chassis layout that the complete line timebase should be kept well away from the field timebase in particular, and the tuner and other signal circuits in general. The entire line timebase and all circuits carrying line frequency currents, including electrolytic smoothing capacitors, should if possible be returned directly back to the receiver input neutral point. In fact this is a good principle to follow for most other circuits as well. How many cases of buzz on sound in experimental receivers have been traced to chassis return connection shared by both the sound and the video output circuits? The video information gets injected into the low-level audio stages and is thus superimposed on the wanted sound. This principle is illustrated in Fig. 22.

Line flyback pulses picked up in the line synchronising circuits appear as spurious sync pulses occurring at the wrong time. The result is displacement of the raster in a horizontal direction, somewhat like "tearing" but usually in a rather more regular pattern. A common cause is poor routing of cable harnesses so that leads carrying line pulses

are too close to leads or circuits associated with the sync separator, reactance stage or line oscillator.

Another problem is interference injected into the mains supply by the receiver. Thyristors used in stabilised h.t. supplies generate fast switching waveforms with harmonics extending up to radio frequencies. The other principal source is the line timebase. Once again it helps to keep the timebase and its leads well away from the mains input circuits, but in all cases it will be necessary to decouple the mains input with a capacitor. This has to be a special quality paper, or paper plus foil, capacitor suitable for permanent connection across the mains, and commonly has a value of around $0.33\mu\text{F}$. Ordinary foil capacitors must not be used because of the risk of failure, which could result in fire due to the large amount of energy available at this point.

Another set of problems arises in the highly specialised area of line output transformer design and construction. The particular difficulties occur in connection with harmonic tuning and the structure of the e.h.t. overwinding. Early designs, going back many years now, were untuned and the overwinding was simply a complicated wavewinding about 5mm wide and perhaps 20-30mm tall. This was usually impregnated with wax, and difficulties arose caused by loose turns which fell out of place and shorted across to other parts of the winding at a different pulse potential. Wavewindings can be completely correct at only one particular diameter, and tall windings caused many problems.

Modern transformers use layer windings throughout, with plastic foil interleaving, and are impregnated with very carefully chosen organic resins to achieve high standards of insulation and durability. Harmonic tuning requires that the overwinding has particular values of leakage inductance, self-capacitance and stray capacitance. The width of the winding, the choice of interleaving, and the diameter of the bobbin all play important parts in this. The leakage inductance can be controlled in several other ways. Usually it has to be increased. This can be done by placing the overwinding on top of the primary but with quite a large gap in between. Another technique is to put the overwinding and primary winding on opposite limbs of the core. This may increase the leakage inductance too much, but correction is simple. If a separate small winding is placed close to the overwinding and connected to suitable taps on the primary the coupling, and hence the leakage, can be adjusted to the required amount. Further control of the leakage is achieved in some chassis by adding a choke in series with the coupling winding. If necessary the choke can be adjusted for optimum harmonic tuning.

Achieving correct harmonic tuning and e.h.t. voltage

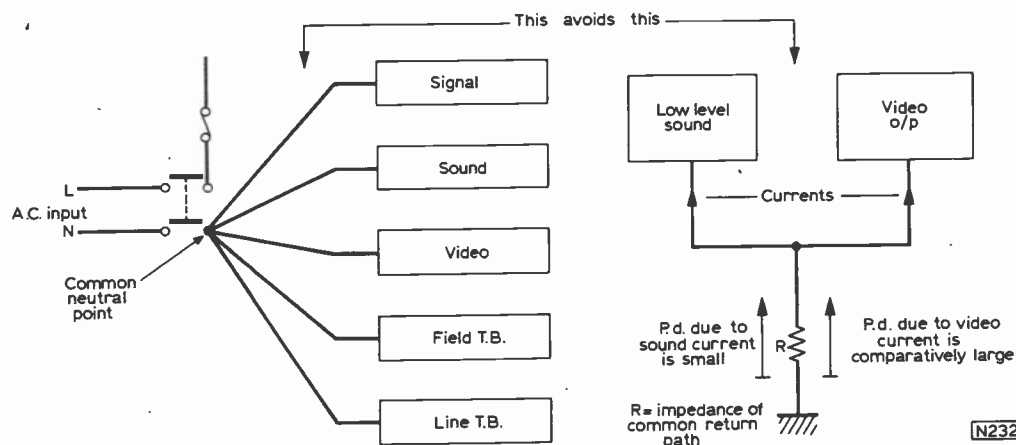


Fig. 22: Preventing large currents injecting voltages into low level circuits via a common return path.

calls for a great deal of expertise based on experience and sophisticated production machinery. When one realises that line output transformers must be wound to very tight tolerances in order to maintain correct tuning, e.h.t., scanning current, pulse voltages for the c.r.t. heater and l.t. supplies, and give up to ten years or more of reliable service, while being manufactured at the rate of thousands a day it is a little daunting. And yet this is carried out as a matter of routine. Clearly not the province of the home constructor!

Flashovers

Whenever a new receiver design is produced one of the basic problems to be overcome is that of flashovers. The principles involved were described in some detail in past issues – see *Television*, November 1970 and February 1971. Just as a reminder, note that when a flashover occurs energy is coupled into the deflection yoke. The line scan coils usually lie on the inside of the yoke, closest to the tube neck, so they receive most of the energy. This is transferred down the deflection coil leads to the line output transformer circuit and into the transformer windings. The line output transistor and any l.t. rectifier diodes are at risk and precautions are usually necessary therefore.

Once again this is a case where the home constructor does not have the facilities to be able to sort out the problems properly. The simplest and most effective measure is to add 1-2kV sparkgaps to each of the leads connected to the line scan coils. The circuit must be studied carefully, and if the leads are connected to the h.t. line via the transformer windings, as is usually the case, (i.e. there is a d.c. path from the scan coils to the h.t. line) the sparkgaps must be connected by short leads to a convenient point at h.t. potential. This prevents fuse blowing caused by sudden discharge of electrolytic capacitors through the arc.

Care must also be taken to ensure that generous insulation, or wide spacing between printed conductors, is provided at all points in the deflection circuit path. If this is not done, secondary flashover to other conductors can occur, and the flashover energy can be coupled into circuits far removed from the original source.

When a flashover occurs the c.r.t. capacitance of about 2,000pF is almost completely discharged. The line output transformer instantly sees a nearly short-circuited load, and large peak currents and voltages can occur in the line output transistor. The use of fifth harmonic tuning tends to reduce these effects, while the anti-breathing resistor in series with the h.t. feed and the resistor in the e.h.t. supply line (see Fig. 19) also help to keep the current and flyback voltage within acceptable limits. Fortunately, flashovers seem to be much less prevalent in the latest tubes, and although precautions are essential in commercial designs the home constructor can afford to take the risks that lack of testing facilities impose upon him.

BEAB testing

All commercial receivers have to comply with the safety requirements of BS415 in order to get BEAB certification. This again is an area where a great deal of testing and expertise is necessary in order to achieve the high standards of safety required. A line output transformer commonly handles about three-quarters of the entire energy used by a television receiver. This is because apart from its functions of e.h.t. and scan current generation it also acts as a d.c. to d.c. convertor for the l.t. supplies. Very careful fusing and other forms of protection must be built into the receiver to cater for all possible fault conditions.

One of the requirements of BS415 testing is that all components except those passing certain stringent quality tests have to be short-circuited and open-circuited in turn. Furthermore all air clearances and surface creepage paths less than those specified in a table of voltage and insulation requirements have also to be short-circuited. Thus an enormous number of tests have to be carried out, many of these causing overheating. Each failure has to be investigated and the appropriate action taken to overcome the effects of the fault.

Every receiver design is different, so there are no standard cures. All we can do therefore is to list some of the more common preventive measures as examples of the ways in which such problems can be tackled. As a starting point, individual circuits can be fused, and each h.t. and l.t. source is nowadays normally fitted with its own glass fuse as a general precaution. These are only partially effective unfortunately, as reliable protection can be obtained only if the fault current is about three times as large as the fuse rating. The normal load current should not be more than about three-quarters of the fuse rating because otherwise spurious fuse failure will occur due to premature ageing. Thus the fault current must be about four times the load current if fast fuse action is to be guaranteed.

Unfortunately, many fault conditions have to be catered for where the ratio of fault current to load current is much smaller than this. A useful protection technique here is to use in the circuit a proprietary type of fusible resistor in which a spring contact is released when the solder holding it melts. This kind of device will operate satisfactorily when the current ratio of fault to normal conditions is about two times, i.e. a power (or heat) ratio of four times.

If the increase in current is less than about twice, it is very difficult to provide any fusing protection. Some component, usually a resistor, is almost sure to get hot and cause overheating of a printed panel due to conduction of heat down the leads from the body of the component. The cure here is to space the resistor away from the panel by at least half an inch, and to add extra areas of cooling copper on the board underneath. Sometimes two resistors can be connected in series to share the heat and spread it over a larger area thus reducing the temperature.

Glow switch

Somewhat more basic techniques can be employed by devising means of turning off the power supply when a circuit fault is sensed. Some sets incorporate a neon glow switch fitted across the h.t. line. This strikes when the h.t. line rises too much, applying a short-circuit via a bimetallic strip contact as a result of which the mains fuse blows. Apart from a power supply fault a common cause of high h.t. voltage is failure of the line output transistor, since this removes most of the h.t. load.

Another technique is to add a sensing circuit to the line output transformer-derived l.t. supply. If the l.t. supply falls, due for example to a fault in the line output transformer circuit, the stabilised power supply is either shut down or made to reduce the h.t. to a safe value. Yet another variation on the same theme is to apply a sensing circuit to a critical point in the receiver and arrange so that the base of the line driver transistor is short-circuited. This renders the complete line output circuit inoperative and also shuts down the l.t. and boost supplies derived from it. Care must be taken to ensure that this removal of h.t. loading does not result in an unacceptable rise in the h.t. voltage – thus replacing the original fault with a new one. The cure can sometimes be worse than the disease! ■

COLOUR FAULTS

John Coombes reports on the RRI two-i.c. decoder panel and the Mitsubishi Model CT200B

RANK Z584 DECODER PANEL

DURING the long and still continuing production run of the Rank 90° single-standard colour chassis several decoder/RGB output panels have been used. The initial one was the A807 which employed a single i.c. (type SL901). The subsequent Z180 panel employed two i.c.s but was interchangeable with the earlier panel. The Z584 panel was a development of the Z180, using high-level saturation control and a gated a.c.c. circuit. The most recent panel is the Z971 which is BEAB approved but is compatible with the Z584. Most sets seem to be fitted with the Z584 panel dealt with in the notes below. The circuitry of the Z180 and Z971 panels is almost identical however so the notes apply equally to these. They do not in the main apply to the earlier A807 panel because of the large amount of discrete component circuitry used on this panel in place of the second i.c. The Z584 and Z971 panels are not compatible with the A807.

The two i.c.s used in the later panels are the SL901B which acts as chrominance demodulator and matrix to provide low-level RGB output signals, and the SL917A which includes the burst and reference signal (in conjunction with an external crystal) circuits, the colour killer, the PAL switch, and also provides some of the chrominance amplification – the first two chrominance amplifier stages are on the i.f. panel.

For a detailed description of the decoding operations carried out in the SL901B and SL917A i.c.s see the November 1971 issue of *Television*.

SL901B Circuitry

The SL901B i.c. does not cause too many troubles. It can be responsible for the disappearance of the R–Y signal or sometimes the B–Y signal; for intermittent loss of one colour (check by applying freezer); for a bright green picture; and has also been known to result in a negative picture with no colour. There are other causes of most of these faults however. To clear the i.c., check the voltages at the appropriate pins.

The SL901B can also be responsible for loss of the luminance signal. This is a.c. coupled via 3C43 from the luminance delay line 3L16 to 3VT3, which is d.c. coupled via the subcarrier rejector 3L15 to pin 11 of the SL901B. After passing through an integrated emitter-follower the luminance signal emerges at pin 10 (note incidentally that the pin connections to the SL901 used in the earlier A807 panel are not the same) where a brightness clamping pulse is added to it: it is then coupled back into pin 9 of the i.c. via 3C37. If the voltages at pins 11 and 10 are incorrect, first check 3VT3 before suspecting the i.c. If the voltages in this stage are correct but those at pins 10 and 11 of the i.c. are incorrect the i.c. is usually faulty.

A common cause of loss of luminance however is the electrolytic coupling capacitor 3C43 being open-circuit. Another possible cause is 3VT10 going open- or sometimes short-circuit.

Another fault in this area is when the electrolytic

capacitor 3C30 which decouples pin 2 of the SL901B goes short-circuit, removing the correct voltage (2.25V) from this pin. This results in a change of colour, usually towards green and blue.

SL917A Circuitry

Turning now to the SL917A and its associated circuitry, it must first be said that in view of all the functions carried out here there is no room for error. The voltages and signal levels must be correct. No colour is a common fault caused by this i.c. The first step however should be to check that the voltage (11V) applied to the supply pin (19) is present. If not, turn attention to the emitter-follower stabiliser transistor 3VT2 (BC148). This can go open-circuit, removing the supply to pins 19, 7 and 9 (5V) of the i.c.

Other faults can occur in the emitter-follower stabiliser circuit. Its collector resistor 3R13 can go open-circuit: its emitter voltage then falls to about 3V and the colour goes. 3C16 can become leaky: 3VT2 then saturates, the 11V supply is no longer stable and the decoding becomes erratic. This latter fault can also occur due to a defect on the power supply panel where the 18V zener diode 8D1 which stabilises the 18V decoder supply can go open-circuit: the supply line then rises to 20V.

Returning to the SL917A and the fault no colour, check that the chrominance input is present at pin 14. If so and the supplies are correct but there is no chroma output (pin 18) either the i.c. is faulty, the delay line 3DL1 is open-circuit or 3RV3 is defective or incorrectly set. Another common cause of no colour is when 3C10 goes short-circuit, removing the correct 2V at pin 3. Remember that if the voltages around the i.c. are within the correct limits, the i.c. is cleared of suspicion.

A green and blue picture is very often caused by 3C17 which decouples pin 9 going open-circuit. Incorrect setting of the identity control 3RV4 can result in a green and purple picture.

A component which can cause various odd troubles is diode 3D1. This controls the operation of the burst gating pulse generator circuit 3T1/3C7 – it's switched off by a positive-going line flyback pulse applied to its cathode, following which the tuned circuit rings to produce the negative-going burst gating pulse required at pin 10 of the i.c. Wrong colour on the screen, with a very grey stripe down the left-hand side, occurs when this diode goes open-circuit: when its reverse resistance falls there is again no colour over a stripe on the left-hand side of the screen, with colour reversal over the lower part of the picture.

Chroma Stages on the IF Panel

No colour can also be due to a fault in the chrominance amplifier stages on the i.f. board. There are two stages of amplification here, 2VT8 (BC158) and 2VT9 (BC148), plus a stage 2VT7 (BC148) which is used to invert the a.c.c. voltage and provide for a preset colour control when the Z584 decoder panel is used or provide the main, low-level colour control action in conjunction with the earlier Z180 decoder panel. 2VT8 often goes open-circuit base-to-emitter

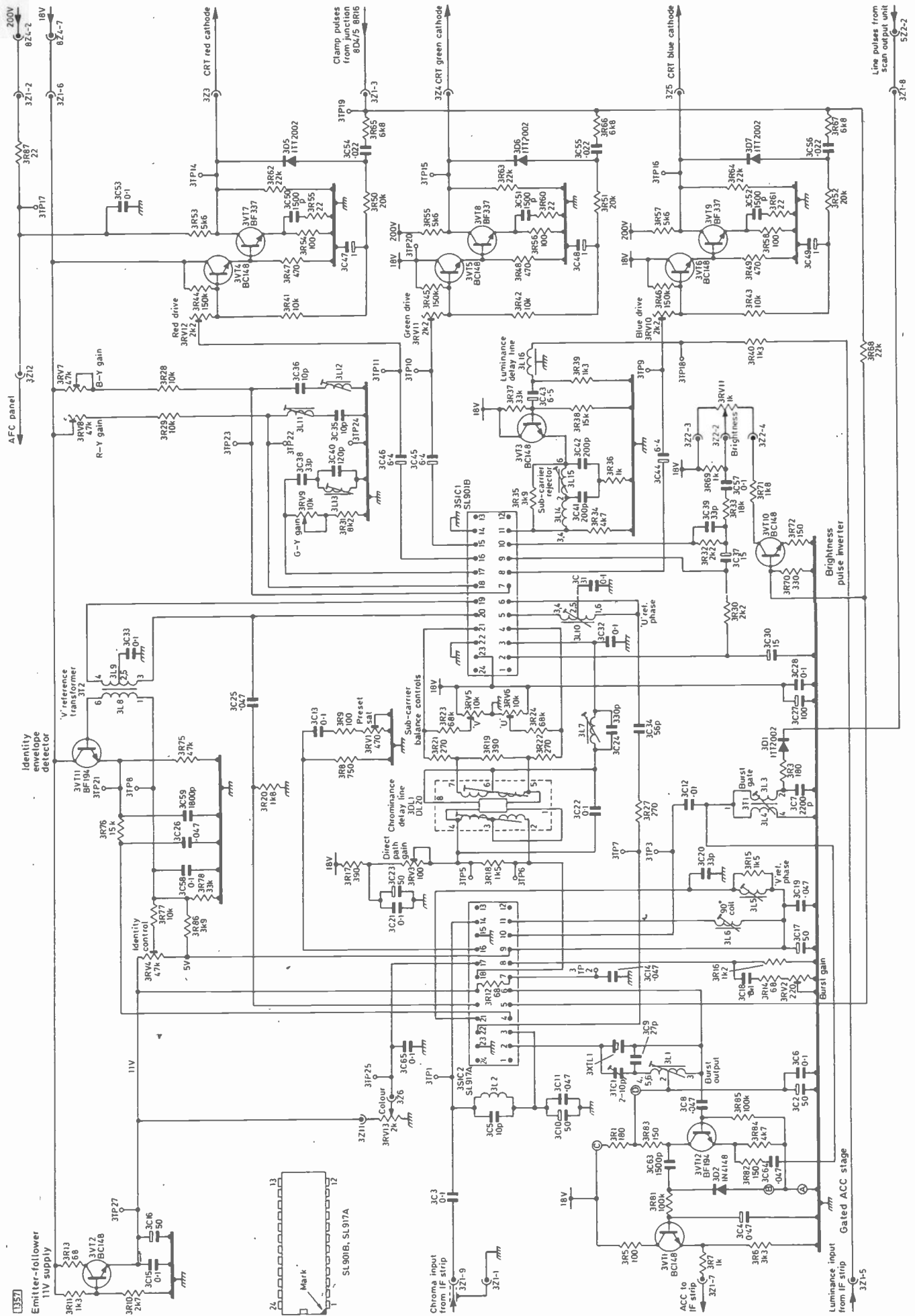


Fig. 1: Circuit of the RRI Z584 decoder. The gating section of the a.c.c. circuit -3V172 and its associated components, which are mounted on a small subpanel - is not incorporated in all decoders. The circuit reference number 3RV11 is used twice - note when ordering replacements.

to cause no colour, while the tantalum 1 μ F capacitor 2C49 which decouples the supply to 2VT9 can go short-circuit with the same result. Another occasional cause of no colour is the chroma input coupling capacitor 3C3 on the decoder panel going open-circuit.

Back to the SL917A

Colour drop out on the Z584 decoder can result from incorrect adjustment of the preset controls. The correct operation of the ident switch and colour killer in the SL917A depend on the voltage at pin 4 of the i.c. – this is produced by 3VT11 which detects the V reference subcarrier output from pin 20. If the voltage at pin 4 is too high, the ident switch doesn't operate correctly and the result is desaturated colours of the wrong phase: if the voltage is too low there will be no colour due to the colour killer coming into operation. The reference subcarrier level is determined by the setting of the preset colour control 2RV6 on the Z582 i.f. strip used with the Z584 decoder. To check whether the subcarrier level is correct, measure the U reference subcarrier output at pin 22 (3TP7). This should be roughly 600mV: less will reduce the range between correct colour and no colour, more can result in wrong phase colours. The ident control 3RV4 is then adjusted for correct ident circuit operation. What all this amounts to is that with the Z584 decoder/Z582 i.f. strip combination there are two preset colour controls, 2RV6 on the i.f. board and 3RV1 on the decoder panel plus the user colour control 3RV13: use

VOLTAGE DATA

The following voltages were taken under normal operating conditions, using a 20k Ω /V meter. The i.c. voltages should be within the limits shown. When making measurements take care that adjacent pins are not short-circuited – this can ruin the i.c. It is best to take measurements from the adjacent print areas.

Pin	3SIC1 (SL901B)		3SIC2 (SL917A)	
	Nom. V	Limits	Nom. V	Limits
2	2.25	1.8-2.6	0.58	0.32-0.77
3	5	4.5-5.5	1.98	1.5-2.2
4	5	4.5-5.5	At least 300mV above pin 9	
5	7.2	6.5-7.8	0.29	0.26-0.34
6	7.2	6.5-7.8	17.3	16-18.4
7	12.8	9.8-14	10.15	9.1-11.8
8	6.6	3.5-9.0	7.2	5.6-9.4
9	2.25	1.8-2.6	5.2	4-6.6
10	0.7V below pin 11		3.5	2.7-4.5
11	5	4-6	5.2	4-6.6
14	Chassis		1.98	1.5-2.2
15	6.6	3.5-9	Chassis	
16	6.5	3.5-9	8.2	5.83-10.4
17	12.8	11-14	Depends on 3RV13	
18	12.7	9.8-14	13.7	11-16
19	7.2	6.5-7.8	11.25	10-13
20	7.2	6.5-7.8	9	7-11.8
21	5	4.5-5.5	5.2	4-6.6
22	Chassis		4.6	3.27-6.09
23	18	17-19	Chassis	
Transistor	Emitter V	Base V	Collector V	
3VT1	2	2.6	18.5	
3VT2	12	12.6	14.75	
3VT3	5	5.6	18.6	
3VT4/5/6	1.5	2.1	18.7	
3VT7/8/9	1.4	2	105	
3VT10	0.2	0.3	15.9	
3VT11	5.5	6.25	18.6	
3VT12	1.7	-0.1	17.6	

3RV1, not 2RV6, to preset the chrominance level.

If the voltage at the bistable trigger pulse input pin 5 of the SL917A is incorrect the operation of transistor 3VT10 should be checked. If this is o.k. suspect the i.c. – again the symptom is no colour.

The RGB Circuits

The RGB circuits are quite conventional. Lack of one colour is most often due to the relevant output transistor 3VT7 (red), 3VT8 (green) or 3VT9 (blue) being defective. The driver transistors 3VT4 (R), 3VT5 (G) and 3VT6 (B) can go open-circuit to remove the appropriate colour. The clamp diodes 3D5 (R), 3D6 (G) and 3D7 (B) can go short-circuit to cause an all red, green or blue picture respectively, leak to cause an excessive amount of the appropriate colour, or go open-circuit to cause absence of the appropriate colour. The clamp circuit feedback resistors 3R50 (R), 3R51 (G) and 3R52 (B) can go open-circuit to give a bright red, green or blue picture – sometimes intermittently due to a dry-joint.

MITSUBISHI MODEL CT200B

The Mitsubishi Model CT200B is a 20in., solid-state receiver using colour-difference c.r.t. drive. Though it decodes the PAL transmissions, it does not employ a conventional PAL decoder. The chrominance delay line is instead used to convert the PAL signal to an NTSC type signal, a diode switch selecting direct and delayed signals on alternate lines. Some cunning circuitry is used to ensure that the switching is synchronised so that correct rather than reversed colours are displayed.

One of the most common faults we have had with this set is failure of the channel selector buttons. The selector unit must be replaced when this occurs.

There are slider type colour and tint controls on the front user control panel. Both these controls can give trouble. Loss of colour is often due to the 500 Ω colour control VR671. The cause is dust on the carbon track, but a replacement control is advised. The same trouble (dust) occurs with the 2k Ω tint control VR672, the symptom in this case being green or red faces. Replacement of the control is usually necessary. If the tint changes frequently and the tint control itself is not faulty, correct colour will be obtained by readjusting the noise level preset control VR609 (1k Ω) on the decoder panel.

The other cause of no colour we have come across is the second chroma amplifier transistor Q603 (2SC710) on the decoder panel. This goes open-circuit base-to-emitter.

A common fault is low brightness due to lack of luminance signal, the result of the third video amplifier transistor Q204 (2SC711) on the decoder panel going short-circuit. This transistor is connected as an emitter-follower.

As you would expect, field collapse is generally due to failure of the field output transistor Q451 (type 2SC642, 2SC1151 or 2SC936) which is on the deflection output panel. The situation can be misleading however since although the voltages are wrong the transistor can give correct resistance readings. The correct voltages are 148V collector, 0.7V base and 0.3V emitter.

The only sound trouble we have had is distortion at low volume control settings. This is due to the loudspeaker.

We have had a lot of intermittent faults on this set due to the panel edge connectors. Such troubles clear when the contacts are cleaned and sprayed with contact grease. ■

Up-dating with a Tripler

Hugh Cocks

THE e.h.t. section of the writer's old Decca dual-standard Model CTV25 colour receiver had been a source of increasing annoyance since the set had been bought ex-rental a year previously. For the first three months it worked well, then the GY501 e.h.t. rectifier valve base began to conduct, causing a great deal of trouble. Various other problems then began to show up, most of which were cured for a short while by using damp-start spray.

One night however sinister noises were heard coming from within the X-ray screening can, and the picture shimmered and vanished with a terrible smell of burning plastic. Rather than replace the offending items it was decided to see whether an e.h.t. tripler could be installed. This is a much neater unit than the unsightly X-ray can and much less heat is given off inside the cabinet, benefitting the set in general.

Circuit Changes

The modifications carried out were as follows. First the e.h.t. overwinding on the line output transformer was removed completely, the input to the tripler being taken from the line output valve anode tap on the primary winding (see Fig. 1). The most accessible point is the a.c. side of the TV6.5 focus rectifier, below the PD500 valve base - this is connected directly to the line output valve anode.

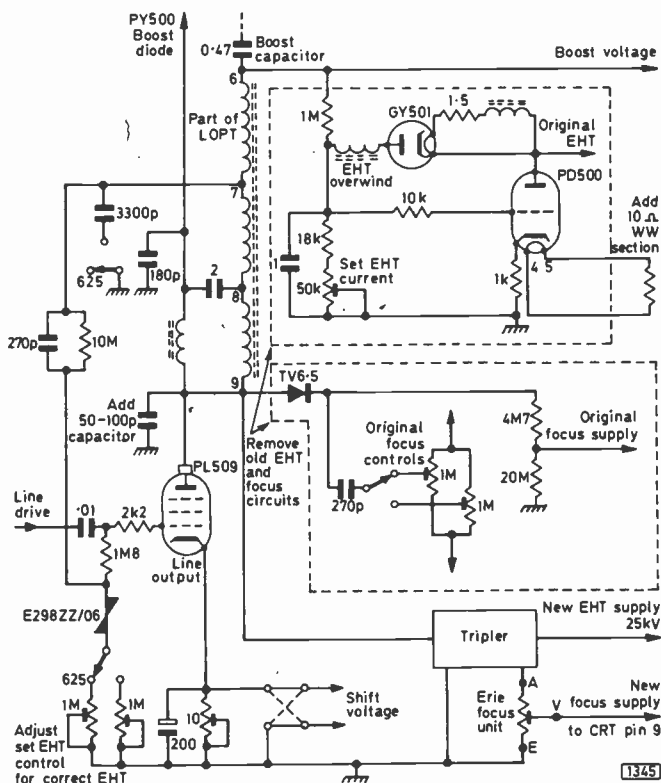


Fig. 1: Modifications carried out to the e.h.t. and focus supply circuits to enable a tripler to be used.

When experimenting initially it was found that the existing focus circuit had inadequate range. The focus supply was obtained from the tripler therefore, using an Erie focus potentiometer (available from Manor Supplies). The control has four pins at the rear, labelled A, B, V and E. E goes to chassis, A is the input from the tripler, V should be connected to the c.r.t. via the existing screened cable, and B is a test point which should be insulated.

This arrangement gave good focus and correct e.h.t. (24-25kV) but the width was found to be short by about half an inch on each side. This can be overcome by connecting a low-value pulse ceramic capacitor of 50-100pF from the top cap of the line output valve to chassis. In the prototype this capacitor took the form of six inches to a foot of mains flex, one side going to the top cap and the other to chassis. The first set tried needed a foot, another subsequently modified required only six inches. It depends no doubt on the condition of the line output valve, and a certain amount of experimentation with different lengths/values may be needed.

The PD500 shunt stabiliser valve is removed altogether, a 10Ω dropper section being wired under the valve base to maintain heater line continuity.

The tripler used was an ITT TS25/11ATZ since it was the cheapest available. This has since been increased in price however and several other cheap models are now on the market. They will no doubt work just as well.

In the writer's case the modifications were carried out for less than £5, which makes sound economics if the line output transformer overwinding should go.

Physical Arrangements

The tripler was mounted in the CTV25 astride the PD500 valve base. Two holes must be drilled carefully on each side. It is advisable to remove the chassis from the set when doing this, otherwise the static convergence will drift somewhat! Don't forget to connect the thin yellow lead (ITT tripler) to chassis. The tripler should be kept at least 20mm clear of the metalwork.

The focus unit was mounted on the edge of the cabinet, using its two right-hand side screw holes. If the chassis has to be removed at any time the leads are simply unplugged from the unit. Make a cut-out in the back cover so that final adjustment of the focus can be made.

Results

The two Decca CTV25 models modified in this way have been working for six months now without giving any trouble. Although the modification has been tried on only the Decca chassis, it will no doubt work just as well with other early colour chassis, for example the Pye 691 which has a very similar line output stage. In fact I thoroughly recommend the change when trouble shows up inside the X-ray can of sets with an all-valve e.h.t. section.

CEEFAX / ORACLE

reception techniques

Steve A. MONEY T.Eng.(CEI)

PART 9

Up to now it has been convenient in this series of articles to assume that the signal presented to the input of the teletext decoder is an exact replica of the original transmitted signal. While this may be true in some very good signal areas it is likely that for the majority of viewers the signal will have been affected to some extent by noise, interference and distortion before it finally arrived at the decoder input.

Normal picture and sound signals are also affected by noise and interference in much the same way but there can be a significant deterioration in the signal quality before the viewer will consider the picture or sound to be unacceptable. One has only to look at the quality of the picture on the average home receiver to realise this. Noise will give grainy pictures whilst interference produces dots and streaks on the picture but fortunately the viewer's brain is able to ignore most of these unwanted results and can still interpret the picture quite accurately. As a result the interference, although it may be slightly annoying, need not affect the viewer's enjoyment of the programme being received. Similarly the human hearing system can be remarkably tolerant of unwanted signals and is often able to filter them out to leave the desired message clear.

With a data transmission system, such as teletext, even small levels of interference or distortion in the received signal can have quite disastrous effects upon the displayed text unless suitable precautions have been taken to deal with errors in the received data. This is a problem which has been encountered in all digital data transmission systems since the early days of telegraphy. Over the years various techniques have been developed to deal with such transmission errors.

Error protection

Error protection techniques can range from relatively simple error detection systems up to the extremely complex computer processing arrangements used for cleaning up the television pictures transmitted back to earth from spacecraft on missions to the moon and planets. For teletext two levels of error protection are used. First for text data the symbol codes used are designed to permit the detection of single-bit errors in the data code received. For the more vital parts of the data, such as the row and page address codes, a rather more complex protection scheme is used which apart from detecting the errors also permits correction of single-bit errors.

In this article the principles involved in coding the transmitted signals and the techniques employed for the detection and correction of errors in the received signals will be examined.

Symbol errors

Let us see what happens if an error occurs in one of the symbol code words. Suppose the letter being transmitted is the capital 'R'. This is represented by the code word 1010010 (see Fig. 47). Here the bits have been written using the normal convention for binary numbers with the most significant (bit 7) first. For a correctly received code the symbol displayed will be 'R'.

Detected code							Displayed symbol	
Bit	7	6	5	4	3	2		1
	1	0	1	0	0	1	0	R
	1	0	1	0	0	1	1	S
	1	0	1	0	1	1	0	V
	1	0	1	1	0	1	0	Z
	1	1	1	0	0	1	0	r
	1	0	1	0	0	0	0	P
	1	0	0	0	0	1	0	B
	0	0	1	0	0	1	0	Blank (following symbols are set to graphics & green)

N246

Fig. 47: The effect of received symbol code errors. The incorrect digits are shown circled.

Now suppose that one of the received bits of the code word is in error. First let us assume that the final 0 in the code has been changed into a 1 by a noise pulse. Now the decoded word will be 1010011 which corresponds to the letter 'S'. As a result 'S' is displayed instead of 'R'. If one of the other 0s in the word were changed to a 1 the resultant displayed symbol could be either a 'V', a 'Z' or the small letter 'r'.

An alternative error possibility is that one of the 1s in the word could be lost and decoded as a 0. This could result in the letter being displayed as a 'P' or 'B'. If the most significant bit becomes a 0 however a rather more drastic

effect occurs. The word now becomes 0010010 which does not represent a symbol at all but is a control code which selects the graphics mode. Now the symbol space is left blank but the rest of the row of text is displayed as graphics symbols which will be unintelligible. At the same time the colour of the symbols for the rest of the row is changed to green. The effects of these code errors are summarised in Fig. 47.

Apart from those cases where an illegal shift code is produced, the presence of one or two symbol errors in a row of text may not be serious. Suppose the message of the line of text is "The grass was green". If the 'r' of the word "green" is incorrectly decoded the letter may be displayed as a 'z' but it will still be obvious to the viewer that the displayed word "gzeen" should be read as "green". On the other hand if the 'r' in the word "grass" were similarly affected the displayed word could now be interpreted as either, "glass", or "grass". Both versions would produce a sensible message although the meaning is totally different for each case.

Parity check

One method of detecting errors in a digital system is to add an extra check bit to the symbol code. When the new code is suitably processed an error in one of the bits of the received word can be detected. The extra bit is usually referred to as the parity check bit. When the parity bit is added a teletext symbol code word becomes eight bits long.

The operation of this simple error check arrangement is quite straightforward. Parity checks can be either "odd" or "even". For teletext an odd parity check is used. With an odd parity check the state of the parity bit is chosen so that the total number of 1 bits in the complete word is an odd number.

Suppose (for simplicity of explanation) the code word is four bits long. Three bits are used for the message and the fourth bit is used for the parity check. The resultant set of transmitted code groups will be as shown in Fig. 48. In all of these words there are either one or three bits at the 1 level to give the required odd parity condition.

At the receiver a circuit can be used which checks the number of 1s in the received word and indicates if the total is even or odd. Suppose the word 0100 is being sent and that, due to a noise pulse, one of the 0 bits is converted into a 1. This makes the total number of 1s even and the checking circuit will indicate that an error has occurred. Similarly one of the 1 bits in the word could be lost and detected as a 0 which would also produce an even parity condition and indicate an error. Unfortunately this simple check cannot indicate which of the bits is incorrect or whether it has been changed from 1 to 0 or vice-versa.

When an error is detected it can be arranged that the received word is not loaded into the page memory. At the same time the symbol space can either be blanked or the symbol already stored at that position in the memory can be displayed. If the symbol code is correctly received on the next transmission of the selected page then it will be stored and eventually the whole page of text will be displayed correctly.

If two bits of the received code are in error it is likely that the parity check will indicate that the data is correct since the errors may cancel one another as far as the parity check is concerned. Thus if reception is badly affected by noise or interference some errors will get past the parity check system and be displayed on the screen. For most reception conditions however the simple parity check is adequate to produce reasonably accurate text displays.

It would be possible to use an even parity check on the data transmission. In this case the number of 1s in the code is made even by the state of the parity bit. An advantage of the odd parity check is that for an eight-bit word, as used in teletext, there must always be at least one 1 or one 0 in the word since if all of the bits were at 1 or all at 0 an error state exists. Thus there must always be at least one transition from 0 to 1 or from 1 to 0 during the word period and this can be used to ensure synchronisation of the decoding bit clock at least once during each word period.

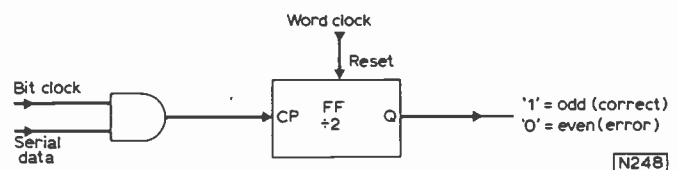
Parity testing

Having seen that the addition of a parity bit to a code word will enable us to detect errors in the received data let us now look at practical methods by which error conditions can be detected.

Code	Bit 1 '4'	Bit 2 '2'	Bit 3 '1'	Bit 4 parity
0	0	0	0	1
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

N247

Fig. 48: A four-bit odd parity code.



N248

Fig. 49: A parity checking circuit based on a divide-by-two counter.

Perhaps the simplest method of carrying out a parity test is to count up the number of 1s in the received word and to detect if the total is even or odd. A possible circuit for this purpose is shown in Fig. 49. Here the flip-flop is connected to act as a divide-by-two counter. At the start of the serial input word the Q output of the flip-flop is set at 0. The clock input for the flip-flop is gated with the incoming signal so that each time a 1 bit occurs in the serial input a clock pulse is applied to the flip-flop. At the end of the eight bits of the word the Q output of the flip-flop will be set at 1 if there was an odd number of 1 bits in the word and at 0 if the number of 1s was even. Thus if Q is at 1 the word is correct while if Q is at 0 there is a parity error. This process is repeated for each word in the serial input signal. The parity condition can be transferred to another flip-flop and held there whilst the first flip-flop checks the state of the next received word. The output from this second flip-flop can then be used to control whether the data is written into the page memory or not.

Using gates

Although a simple counter type parity check circuit can be used, the more popular technique uses an array of gates to perform the parity test operation. In this case the parallel

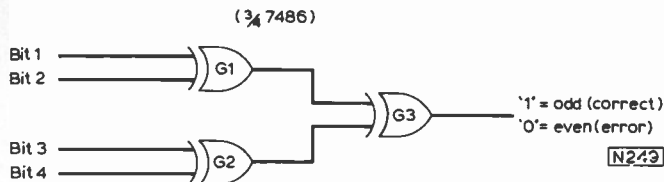


Fig. 50: A parity checking circuit using three EXCLUSIVE OR gates.

data is fed into the gate array and the test is carried out on all bits of the word simultaneously. A basic arrangement for carrying out an odd parity test on a four-bit data word is shown in Fig. 50.

In this circuit the four bits of the word are dealt with as two pairs. Each pair of bits is fed to the inputs of an EXCLUSIVE OR gate (G1, G2). With this type of gate the output will go to 1 when only one of the two inputs is at 1. This condition represents an odd parity state for the pair of input bits feeding the gate. If both bits are at 1 or both at 0 the output of the gate is 0. This corresponds to an even parity condition for the two input bits. Thus the gates G1 and G2 will indicate even or odd parity for each pair of bits in the word.

The outputs from gates G1 and G2 are passed to the inputs of another EXCLUSIVE OR gate G3. If both pairs of bits have odd parity there will be a total of two bits at 1 in the complete word, one from each pair of bits. This gives an overall parity state which is even so there must be an error in the received word. Both inputs of G3 are at 1 so the output is 0 to indicate a parity error.

If only one pair of bits gives odd parity the other pair must be either both at 1 or both at 0. Thus the total number of 1s in the word must be one or three and the overall parity must be odd. The output of gate G3 is a 1 to indicate correct data. If both pairs of bits give even parity the overall parity will be even and the output of G3 goes to 0 to indicate an error condition.

For an eight-bit data word the principles involved are the same but the gate array needs to be larger to deal with the extra data bits.

74180 Parity circuit

An eight-bit parity circuit requires quite an array of gates but fortunately this type of circuit is common in data processing systems and some integrated circuit manufacturers have produced special devices to carry out this parity checking function. One typical device is the 74180 which can be used for generating or testing parity conditions for data words up to eight bits wide with either odd or even parity operation.

The use of a 74180 for testing the parity condition of the symbol data words in a teletext decoder is shown in Fig.

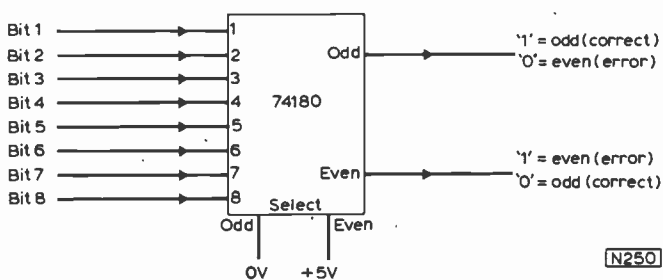


Fig. 51: The 74180 parity test integrated circuit.

51. The eight data bits of the received word are fed to inputs 1 to 8 of the 74180 whilst the odd/even select inputs are connected to 0 and 1 as shown to select the odd parity mode.

When an odd parity condition exists in the input data word the odd output of the 74180 will go to 1 and its even output will go to 0 to show that correct data has been received. When a parity error occurs the odd output will go to 0 and the even output to 1. This signal can then be used to prevent the writing of the data word into the page memory.

Error correction

So far we have considered the effect of errors in the display caused by incorrect symbol codes. A much more serious problem exists if errors occur in the row or page address codes. If a row address is wrong the line of text will be displayed in the wrong position on the screen and one or two such errors can reduce the display to complete chaos. Similarly a page code error will result in the wrong page being displayed. Obviously, more effective protection is needed for this address data.

Code	Bit position and state							
	1	2	3	4	5	6	7	8
0	1	0	1	0	1	0	0	0
1	0	1	0	0	0	0	0	0
2	1	0	0	1	0	0	1	0
3	0	1	1	1	1	0	1	0
4	0	0		0	0	1	1	0
5	1	1	0	0	1	1	1	0
6	0	0	0	1	1	1	0	0
7	1	1	1	1	0	1	0	0
8	0	0	0	0	1	0	1	1
9	1	1	1	0	0	0	1	1
10	0	0	1	1	0	0	0	1
11	1	1	0	1	1	0	0	1
12	1	0	0	0	0	1	0	1
13	0	1	1	0	1	1	0	1
14	1	0	1	1	1	1	1	1
15	0	1	0	1	0	1	1	1

N251

Fig. 52: Eight-bit Hamming code words for teletext.

One method of providing better protection of the data is to add more parity check bits to the code word and, by careful choice of the coding process, it becomes possible not only to detect errors but, in the case of single bit errors, to correct them also.

The teletext system uses an eight-bit Hamming code pattern for the address words. This type of coding was developed at the Bell Telephone laboratories in America for the transmission of data over telephone lines and radio links. In the eight-bit Hamming coded word only four of the bits are used for the message, with the other four bits providing four separate parity checks on the data. In the teletext system alternate bits of the word are used for parity and message. Bits 2, 4, 6 and 8 convey the message whilst bits 1, 3, 5 and 7 are the parity check bits. Fig. 52 shows the set of sixteen code words for the possible combinations of the four message bits.

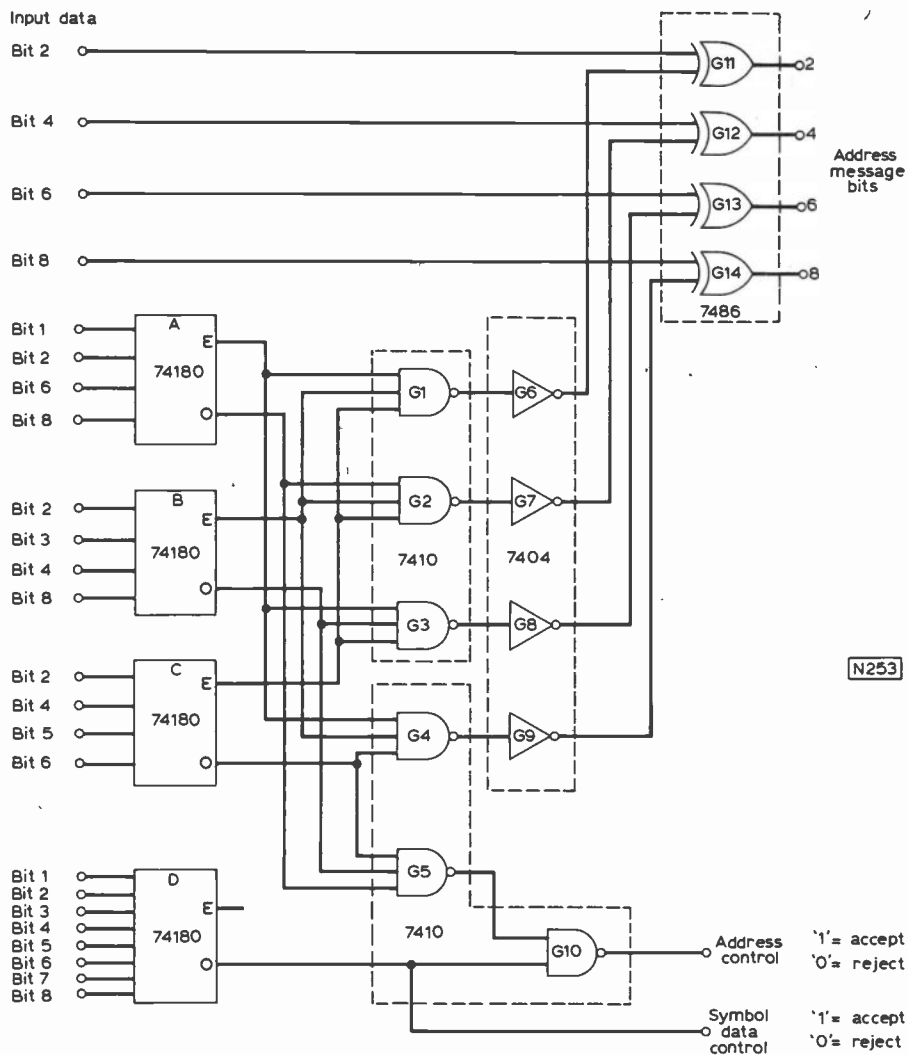
Three of the parity checks are carried out on groups of four selected bits of the data word. The first, which we shall call check A, is carried out over bits 1, 2, 6 and 8. Check B works with bits 2, 3, 4 and 8 whilst check C is made on bits 2, 4, 5 and 6 of the word. The fourth parity check (D) is

Parity check				Action needed
A	B	C	D	
1	1	1	1	Data is correct
0	1	1	1	Reject data
1	0	1	1	" "
0	0	1	1	" "
1	1	0	1	" "
0	1	0	1	" "
1	0	0	1	" "
0	0	0	1	" "
1	1	1	0	Invert bit 7
0	1	1	0	Invert bit 1
1	0	1	0	Invert bit 3
0	0	1	0	Invert bit 8
1	1	0	0	Invert bit 5
0	1	0	0	Invert bit 6
1	0	0	0	Invert bit 4
0	0	0	0	Invert bit 2

1 = parity test correct
0 = parity test failed

N252

Fig. 53: Hamming code tests and required action.



N253

Fig. 54: Error detection and correction logic for eight-bit Hamming code words.

made on all eight bits of the word in the same way as for the symbol code words. All four of these checks are for the odd parity condition. Fig. 53 shows the sixteen possible results of the four separate parity checks and indicates the required acceptance, rejection or correction action to be carried out on the data.

Obviously if all four checks are correct the data is perfect and can be passed on to the rest of the decoding system. If check D is correct but one of the other checks fails there must be two errors in the data and since it is not possible to discover which bits are wrong the data is rejected.

When check D fails the states of the other three tests will indicate which bit of the word is incorrect and this bit of data can be inverted to make it correct before the data is passed on for further use. In practice only four of these corrections need be considered in the teletext system. These four are the corrections of the message bits of the word since the parity bits 1, 3, 5 and 7 have no function apart from checking the validity of the data.

Data correction logic

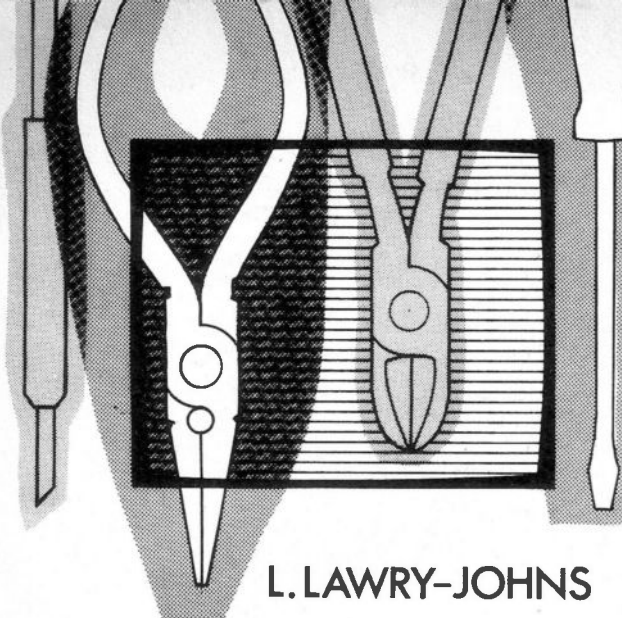
The basic logic arrangement for the detection and correction of errors in a teletext decoder is shown in Fig. 54. Four separate 74180 parity checker circuits are used to carry out the four parity checks on the data word.

Parity checker D is used to check the overall data for odd parity and its odd output will be 1 when the test is successful. This signal is fed to the symbol code circuits to control writing of data into the page memory.

When the odd output of one or more of the other 74180s goes to 0 to indicate that one of these tests has failed the output of gate G5 will go to 1. If parity check D was correct gate G10 operates and its output will fall to 0 to indicate that the address data should be rejected.

Gates G11 to G14 are used to complement the message bit 2, 4, 6 or 8 when a single error occurs. Suppose we consider bit 2. According to the rules given above, when bit 2 is wrong all four parity checks fail. In fact we need not bother about check D since if the other three checks have failed and D is correct the data would be rejected anyway. Thus the even outputs from 74180 circuits A, B and C are gated together in gate G1 to sense the condition when all three checks have failed. When this happens the three even outputs of the 74180s will be at 1 and gate G1 output will be at 0. This signal is inverted by G6 and fed to one of the inputs of EXCLUSIVE OR gate G11. The other input of this gate is fed by bit 2 of the input data signal. When the output of G6 is at 0 the bit 2 signal is unaffected by G11 and is reproduced at its output. If the output of G6 goes to 1 however the EXCLUSIVE OR gate will act as an inverter for the bit 2 signal. Since the input state of bit 2 must have been wrong anyway the output of gate G11 will be the correct state for bit 2 of the data signal.

The correction of the states of bits 4, 6 and 8 of the input signal are carried out in a similar way to that of bit 2 by testing for the appropriate combinations of parity checks A, B and C. The address signal produced at the outputs of gates G11 to G14 will now be correct and can be passed to the rest of the decoder.



L. LAWRY-JOHNS

SERVICING TELEVISION RECEIVERS

BUSH TV161 SERIES

continued

The Line Output Stage

Lack of sound and vision is not necessarily due to loss of h.t. The sound and vision signal stages use transistors and the supply for these is derived from the line output stage. So if the line output stage doesn't work, precious little else can.

It is an unfortunate fact that a high proportion of line timebase faults are caused by a defective line output transformer. Reader's letters often express concern that a new transformer fails within a few days. "What is causing it" they cry, "nothing" our stern reply. "Stick another one in and hope for the best - or try another source of supply". We find that the transformers supplied by our advertisers have a far better chance of survival, being of different construction. If there is doubt, leave the set on for a while, switch it off, and feel the transformer windings. If they are warm the transformer is at fault. This presupposes that valves have been checked and the top cap is off the DY802 e.h.t. rectifier. During the production runs of these various models different transformers have been used with revised connections. If the replacement does not have the cable form supplied, it is essential to wire the tags according to the leaflet supplied as the coloured leads may not go to the tags in the same order as the original. If the new transformer does not work, look to the tag connections first rather than seek a fault elsewhere. If the transformer is supplied with the wiring loom however it is quite on the cards that the new transformer is defective (we had three in a row and began to doubt our diagnosis: as the overwind was running hot without the DY802 connected however there was nothing else to suspect and the next one was o.k.).

Despite this tirade, there are several other common causes of line output stage failure where the line output transformer is not suspect. As is well known, the boost capacitor (3C18) is very often the cause of trouble in most makes of set. In most, the capacitor is returned to the h.t. rail. Thus little harm results when it goes short-circuit, and the fault can be identified by the simple procedure of lifting the top cap off the PY800, PY88 or whatever (make sure it's a PY88 in these sets though) when the stage will start up instead of being dead. This is because the supply is present through the shorted capacitor and the efficiency diode is no longer damping the stage. In some sets however, and this range is among them, the boost capacitor (sometimes two in parallel) is returned through the line output transformer windings to chassis. So a short-circuit boost capacitor will present an intolerable overload to the

efficiency diode (PY88) which will get a little hot up about it and either become red hot or blow its top along with the supply fuse.

When the mains fuse is found blown there is a definite drill to follow. This can save a lot of time. If the fuse is blackened, check the mains filter capacitor (3C47) which is wired from one end of the fuse holder to chassis. If this is in order, check the back-to-front resistance of the h.t. diode, then the h.t. line for shorts and check from the top cap of the PY88 to chassis (this latter fault, discussed above, will not blacken the fuse but may cause it to fail). If there is a short from the top cap of the PY88 to chassis, the boost capacitor is certainly short-circuit. This is on the right, at the bottom of the panel (some early chassis use two 0.1 μ F capacitors: only one may be short-circuit and this can simply be removed).

Note whether repairs previously carried out on the dropper have involved resistors being wired immediately under the boost capacitor. If so, a new capacitor may not last very long. If the droppers are to be left where they are, put the capacitor on the print side of the panel, away from the heat as there is a heat deflector on this side.

If the PL504 line output valve and perhaps the PY88 appear to be overheated this could well be due to lack of line drive. In this case one tends immediately to suspect the PCF80 line oscillator, and in some cases the suspicion is justified and a new valve solves the problem. In fact however the valve is not often the cause and in the case of the dual-standard versions the trouble need be nothing more than the system switch not locating properly. If this is not so, a touch on the line hold control may bring things to life and there may be more to this than meets the eye. The hold control could be defective: it could be and it sometimes is.

More often however the timebase functions all the time while the picture is in lines but fails at the point where it should lock. To prove this, pull out the aerial plug: the timebase could well start up only to fail again when the aerial plug is replaced (i.e. when the sync pulses are applied). The reason for this is that one of the two flywheel line sync discriminator diodes (3MR1/3MR2) is defective, leading to a lopsided action which kills the line oscillator. Usually this will happen only in those models using a three diode block (a small black block mounted half way up the right side). Later models use three separate diodes with their attendant resistors and these rarely give trouble.

Since the block type normally goes open-circuit it is quite in order to fit separate replacements on the print side

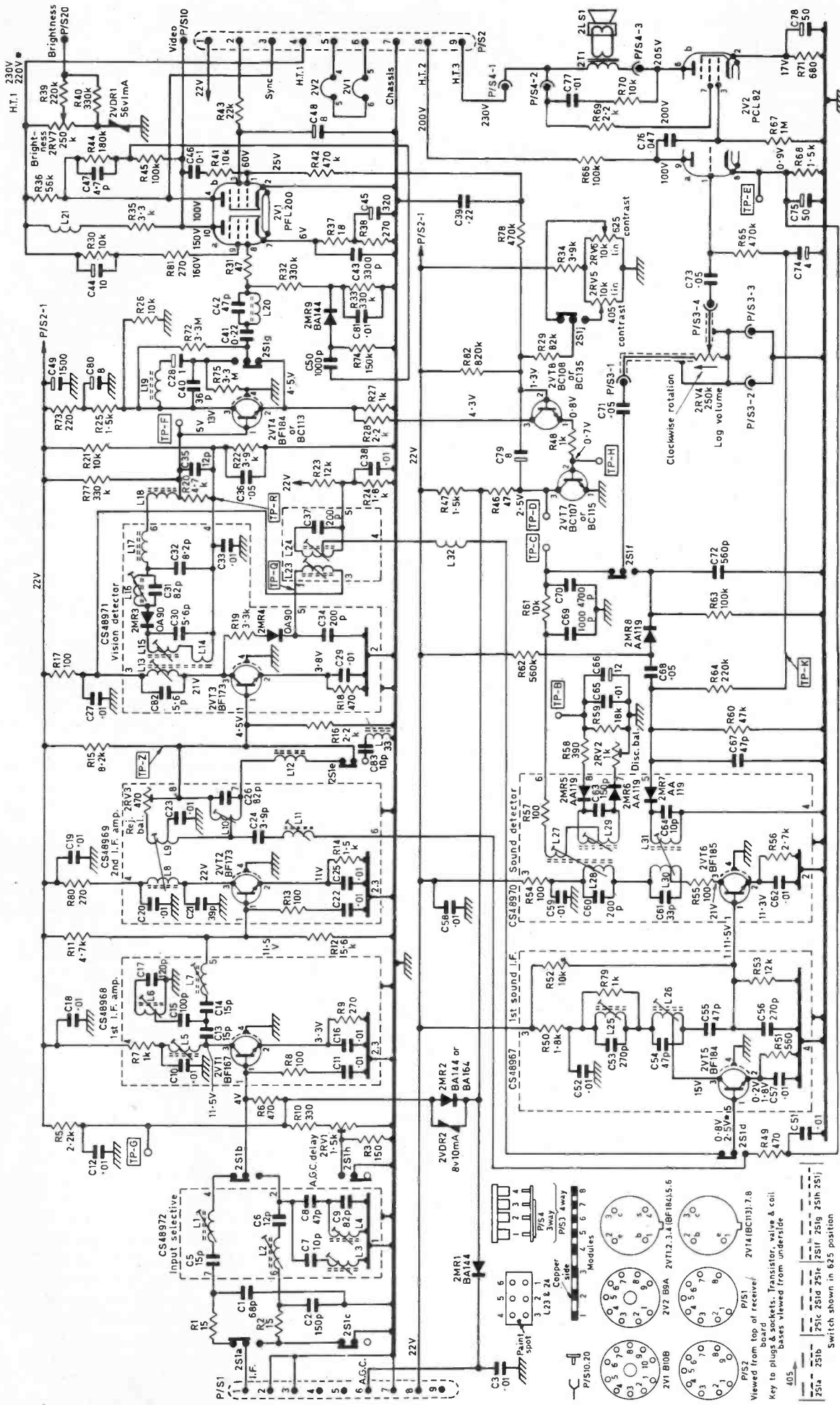


Fig. 2: Circuit diagram of the receiver panel (type A583).

Modifications: The circuit above includes all modifications introduced in the receiver stages. The following modifications are incorporated in later versions of the main chassis/timebases (see circuit diagram last month - Fig. 1). R2 changed to 68K Ω , R6 and R7 changed to 470K Ω and R69 changed to 1K Ω . In addition 3MR1/2/3 become separate BA144 diodes with 18K Ω resistors added in series with the anodes of 3MR1 and 3MR2. In the later 20 and 24-in. Models TV191D and TV193D the smoothing electrolytics 3C42/3/4/5/6 are in a single can.

leaving the block still in position. The upper and lower two tags nearest the centre of the block are the field sync diode (3MR3), leaving three connections for the line sync diodes. This means that the replacement pair of diodes have their "positive" or marked ends joined and soldered to the other (outer) top contact with the free ends one each to the two remaining bottom contacts (centre and outer). Suitable diodes are BA144 or similar, ideally with a 15-20k Ω resistor in series with each.

Another cause of line output stage failure is the PL504's screen grid feed resistor 3R22 (2k Ω , 5W). If this is found to have gone open-circuit it is as well to check the PL504 and the associated decoupling capacitor 3C15 while you are about it.

Lack of width is generally simply the PL504 losing emission. Resistors to check however are 3R20 and 3R21.

Two things can happen to the line linearity coil damping resistor 3R28. It can go open-circuit, resulting in vertical striations on the left-hand side of the screen. More serious however is what happens when the connections between the coil and the panel become dry-jointed. 3R28 then has to handle the line scan current. The result is smoke and a firework display and no picture of course.

No Picture

When these sets come in with a no picture complaint we tend to leap at the line output stage but quite often find this to be working and e.h.t. obviously present. A quick check on the tube base voltages may reveal that although the cathode (pin 7) and grid (pins 2 and 6) voltages are reasonably near each other at the full brilliance setting there is no voltage at pins 3 or 4 where one would normally expect to find about 600V (at least in the case of pin 3).

This leads us back to the centre left of the timebase panel where 3C51 (0.1 μ F) decouples the first anode supply and where 3R26 (180k Ω) is likely to be feeling the effects of dropping about 800V. The capacitor will be found shorted and its removal will restore almost normal working except for the left side of the screen being lighter than the rest. This will be evened out when the new capacitor (0.1 μ F, 1kV or more) is fitted. It's a very common fault and one to be anticipated if the repair of any number of these sets is handled.

There are the occasions when not only is the e.h.t. present but also the first anode supply at pin 3 shows a healthy reading. It's then that one must expect to find the grid voltage at pins 2 or 6 very low, or perhaps the cathode voltage (pin 7) high (maybe over 200V). If the grid voltage is low or absent it could well be that movement of the brilliance control will restore a too bright raster which of course indicates a defective control. If the cathode voltage is high the probability is that the PFL200 video amplifier is not drawing any current, either because the valve is defective or because something is wrong with the valve base (possibly the cathode return pin 7 to chassis) or the voltage supply to pin 9 (screen grid). The base of the PFL200 can be plagued with improper contacts, cracked tracks etc. as can that of the PCL805 base on the other panel and the PCL82 lower down on the same panel. A cut away and clean up job is often necessary around the PFL200 base.

This leads to other considerations: if the video output stage biasing is inadequate, the picture will be too bright and the contrast poor. This happens when the cathode decoupling electrolytic 2C45 goes short-circuit, or 2C50 in

the black-level clamp circuit leaks thus putting a positive voltage on the control grid pin 8.

Alternatively 2C45 may dry-up, introducing l.f. negative feedback. We shall return to this.

The Field Timebase

It's in the field timebase that failures occur most regularly. The PCL805 (PCL85 in earlier versions) is not the most reliable valve in the universe but it is often not the cause of the troubles which can beset this part of the set. A regular complaint is that the field intermittently collapses to a white line across the screen. Sometimes a thump on the cabinet will restore the picture, or most picturesque of all "it always comes back on when I go to the lavatory". Armed with this fascinating snippet, one can immediately go to the PCL805 valve base and resolder pins 3 and 8. If that doesn't do it, check the tracks from the pins (all pins, but most often 2 and 9) to other parts of the panel as cracks can occur at more than one place. "You did it only last week and now it's gone again". Breaks in the heater circuit tracks in this area often account for a "no heaters glowing" condition.

Unfortunately, the more service is given, i.e. the more the panel is disturbed, the greater the chance that fresh faults will develop. We do stress the point however that most of the above is at the moment more to be expected in earlier models which have had a few years service under their belts and is not to be expected in more recent versions (single-standard ones etc.).

Another item which never gave trouble but now – with the passage of time – does is the 33k Ω resistor 3R41, a small component just over the interlace control. Stubborn hold control troubles are often solved once this one has been spotted. Another possibility here is the field sync pulse coupling capacitor 3C29 (390pF).

Severe bottom compression is often due to the cathode decoupler 3C35 (500 μ F electrolytic) either drying up or having poor contact to its lead-out tag. The negative end on dual-standard models is taken to the metal lug next to it. Since 3C35 decouples both cathodes, there is likely to be lack of height as well as bottom compression. The 360 Ω cathode bias resistor 3R47 doesn't often change value but should be checked as routine (top compression can result if it goes higher than 400 Ω).

Another cause of serious bottom compression is 3C33 (0.022 μ F) in the linearity feedback loop. The linearity presets can change value or go open-circuit at one end, and 3C32 and 3C34 (both 0.1 μ F) can be defective, all giving poor linearity.

3C52 (0.01 μ F) across the field output transformer primary winding can go short-circuit, resulting in complete field collapse of course. A replacement should be rated at 1.5kV.

Poor Sync

Whilst poor sync can be due to failure of the diodes half way up the right side panel, it is more often due to a fault in the PFL200 circuit on the left side panel. The valve can be at fault, but the associated components need to be checked, particularly the 8 μ F sync separator screen grid decoupler 2C48. If this is a white one the chances are that one end will be found powdery and loose, denoting its demise. This will result in line pulling and generally poor sync.

As you all know of course, the sync separator screen grid supply in these sets comes via 2R43 from the junction of 3R58-P/S8 in the heater circuit. The idea is that in the

event of the heater diode going short-circuit a.c. appears at the sync separator screen grid and sync is lost, calling attention to the situation before further damage is caused.

Poor sync should not be confused with sync crushing due simply to excessive contrast overloading the video stage.

Electrolytic Troubles

Going back to electrolytics, 2C44 and 2C45 in the video section of the PFL200 circuit can also dry up. In the case of the cathode decoupler 2C45 the consequences are lack of contrast and poor sync. We saw previously what happens when it goes short-circuit. In the case of the screen grid decoupler 2C44 the symptoms are smeary vision and weak sync. 2C48 is more often the cause of weak sync than the other electrolytics in this area however.

In the preceding video phase-splitter stage 2VT4 the v.h.f. coupling electrolytic 2C28 can be defective resulting in weak, poor quality vision on this system.

The Signal Stages

Very few sets are now used on the 405-line system, so we will not consider this mode of operation as it affects signal stage faults. We also assume that the raster is present on the screen and is controllable.

The most common signal fault is complete lack of same, with no background mush or noise. If there is vision and sound noise, the probabilities are that there is a tuner fault, that the buttons are not tuned in (blame the kids) or that there is an aerial fault (either the missus has knocked out the plug whilst cleaning or the nice fellow next door has cut your aerial cable). We are concerned however with a blank raster and no sound.

The most likely cause is the i.f. strip and the most likely offender the final i.f. amplifier transistor 2VT3 (BF173 or a later equivalent). This is not so difficult to trace as one might think since the can is easily pulled off and the transistor connections can be identified with a little close scrutiny after which the emitter voltage can be measured – across 2R18 – and the transistor cold tested. It's possible to get a rough idea of the situation without removing the can by measuring the voltage across 2R17, the collector feed/decoupling resistor (the voltage drop should be about 0.75V). This assumes of course that there is a 22V feed line to the panel from the line output stage: the mauve lead coming down from the cable form feeds 3R78 which connects to the BA148 rectifier diode 3SR3 which converts the waveform to 22V d.c. and hands it on to PS2/1. If the voltage is absent the resistor could be open-circuit or the plug disconnected (gremlins).

If the voltage is present however and the transistor is passing current go down a bit and check the second i.f. transistor (there should be approximately 2V across 2R80 or if the can is off about 11V across 2R14).

If these voltages are present someone has turned the contrast right down or there is a fault in the a.g.c. circuit – simply because the first i.f. transistor 2VT1 rarely gives trouble and is more likely to be turned off than to be faulty.

The Tuner Unit

Funnily enough, the main trouble with the tuner is not actually the tuner. Probably the main complaint is that the knobs won't tune. This is due to wear on the plastic which either won't rotate the spline or slips over enough to stop

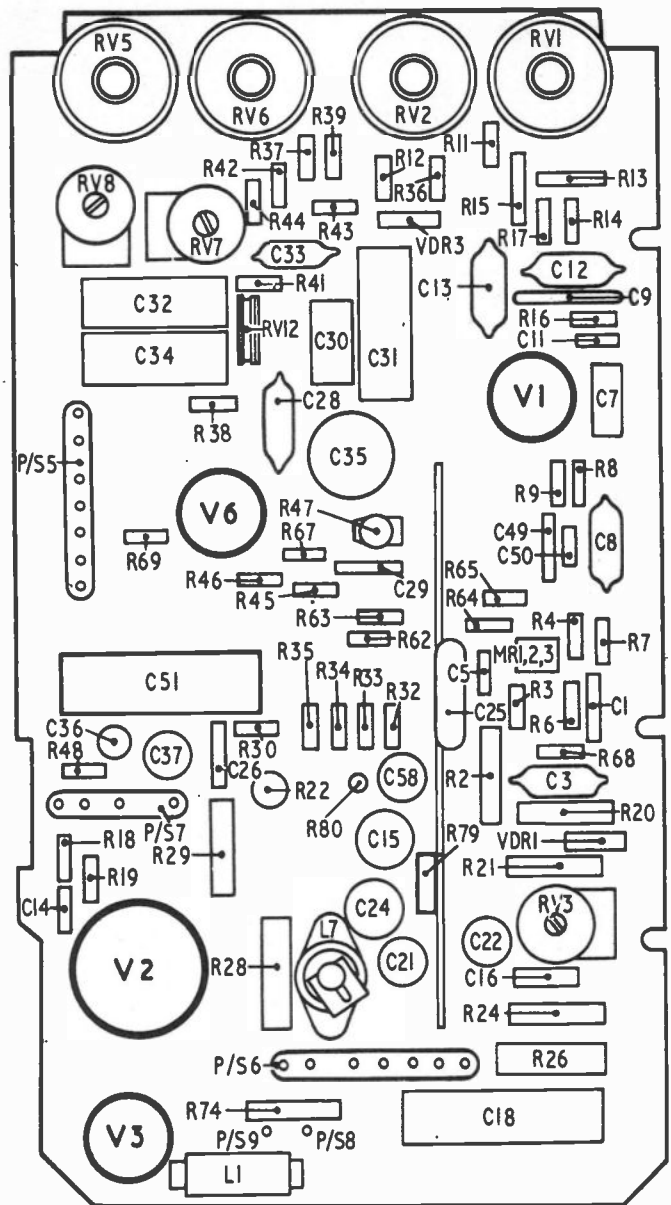


Fig. 3: Timebase panel (A634) component layout.

the spindle engaging the clicker. This latter complaint is easily cured by pushing a close fitting washer on the spindle to butt up against the spline. The knob then pushes up against the washer and the wear is taken up.

If the star shape in the knob has worn round there is little one can do other than fit new knobs.

The other trouble is that the nylon bushes split and won't follow the thread of the spindle. These can be reassembled and the crack mended, using a soldering iron, until replacements can be obtained. Variations will be found in the type of tuner fitted, and these remarks don't apply to all.

Component Prefixes

In the text of this article we have followed the manufacturer's service literature in using the component reference number prefix 2 for components mounted on the i.f. panel and 3 for timebase and power supply components, i.e. 2R2 is on the i.f. panel (see Fig. 2) and 3R2 on the timebase panel (see Fig. 1 last month). To simplify the diagrams however these prefixes have been omitted.

LONG-DISTANCE TELEVISION

ROGER BUNNEY

Satellite Reception "First"

EVERY so often something really exceptional occurs in the field of long-distance television reception. The "something" I have to report this month opens up a completely new field for DX-TV enthusiasts. I had originally intended to draw attention to the report in the latest *EBU Review* about reception in Europe by certain EBU broadcasting members of the ATS-6 satellite which is in synchronous orbit over Central Africa providing educational television programmes to the Indian subcontinent. This reception was at fair quality and I shall return to it later. For us however the more significant thing is that an active DX-TV enthusiast – who is also licenced for amateur television transmission – has succeeded in receiving the satellite in the UK on home constructed equipment. This reception was by Steven Birkill of Sheffield. His letter was detailed and accompanied by several off-screen photographs of satellite reception.

ATS-6

Just to recap, the ATS-6 satellite transmits towards India from orbit at 860MHz, with an e.r.p. of 160kW at the 3dB points within the target area. The aerial reflector assembly consists of a 30ft mesh parabola supported by flexible aluminium ribs. SITE (Satellite Instructional Television Equipment) provides the programmes, which are intended to provide educational self-help for Indian villages. The villages are provided with communal receiving installations. Further information, together with a coverage map, was given in the November 1973 column.

The main reception problem is that f.m. is used for the video modulation. Very little information is available to help one build a suitable demodulator. The frequency used, 860MHz, is just at (or off) the top of the range covered by our u.h.f. tuners, but slight oscillator adjustment and reapeaking of the other tuned circuits will enable 860MHz to be brought in. Steve is certainly to be congratulated on his reception, which so far as I know is the first in the UK using home built equipment.

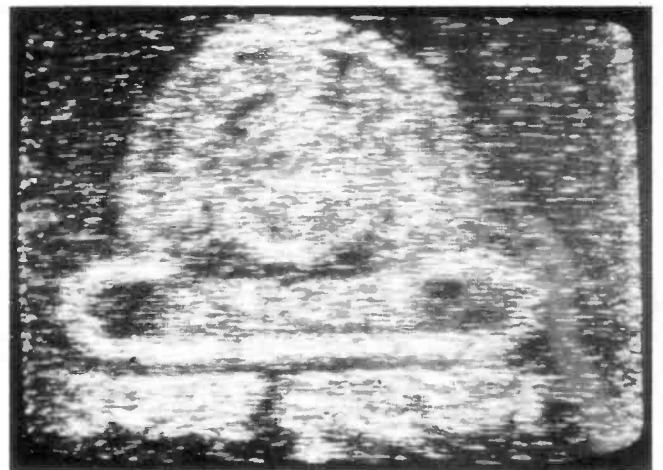
Receiving Equipment

In his letter Steve comments that he thinks readers would like details of "what is perhaps the most modest station capable of receiving pictures from the ATS-6 satellite in the UK." He continues as follows:

"Since we are some 13° off beam (2.6° to 3dB points) we should see the fourth sidelobe of the satellite's radiation pattern. This is likely to be 30dB, perhaps nearer 40dB, below the main lobe, putting the average DXer – not

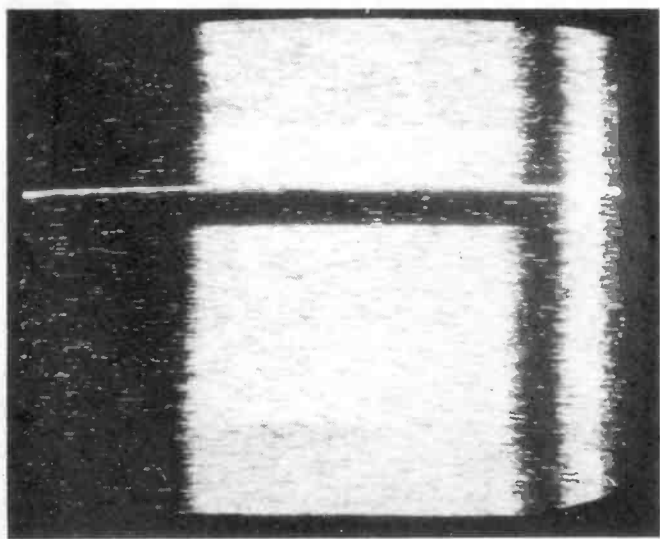
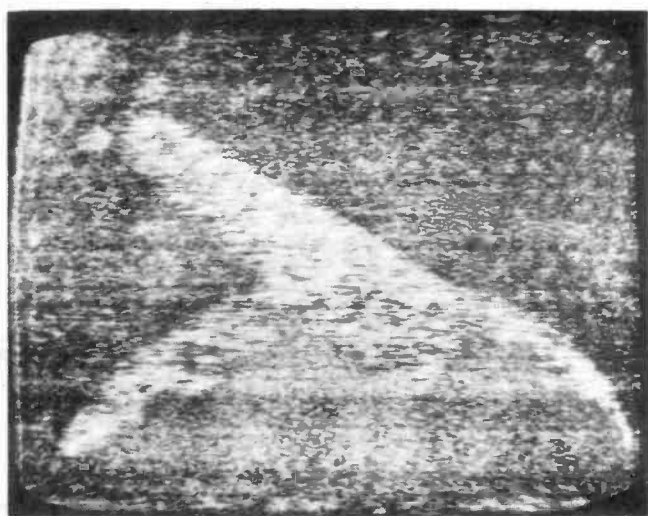
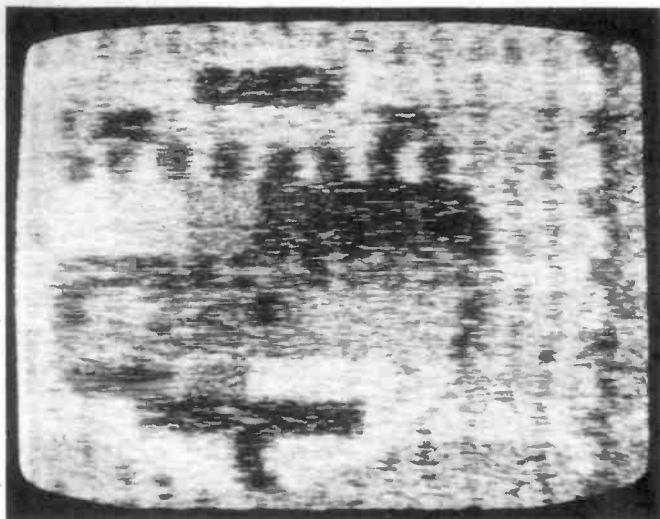


The All India Radio identification slide as received from the ATS-6 satellite by RAI in Italy. See item "Professional Techniques".



The same identification slide as received by Steve Birkill in Sheffield, using home built equipment.

equipped with 60ft dishes or parametric amplifiers! – at quite a disadvantage. The kind of gain one can achieve will generally be less even than that provided by a standard Indian community installation, say 20-25dB from a 5 or 6ft



The three photographs above show, from top to bottom, the ATS-6 test card (surprisingly the PM5544), a representation of the ATS satellite beaming its programmes towards India, and a pulse and bar test pattern from ATS-6. These were all taken by Steve Birkill in mid-December last year.

dish or from stacked Yagis. With a suitable head amplifier transistor however we can attain a 3dB noise factor and from there on we must trade off bandwidth against signal-to-noise ratio until the f.m. threshold is reached or exceeded.

My present receiving system consists of a 5ft paraboloid with dipole and disc feed into a DC5402-BF180 cascade head amplifier. The signal from this is taken via a 5MHz bandpass filter centred at 860MHz to a standard u.h.f. tuner. The i.f. output, at 35MHz, then goes to an NE561B phase-lock loop demodulator i.e. whose output is fed to a standard 625-line monitor. The signal strength is such that the f.m. threshold is reached (carrier/noise about 10dB) when the loop bandwidth is restricted to about 2MHz. I hope to improve on this shortly with a threshold extension demodulator. Sound subcarriers are outside this bandwidth of course.

Results

From the UK the ATS-6 satellite appears at about 20° elevation, bearing 135°. The received signal strength shows little or no variation from day to day. Polarisation appears to be in the vertical plane, and constant. This is the start of satellite broadcast DX – a worthy project for the enthusiast!"

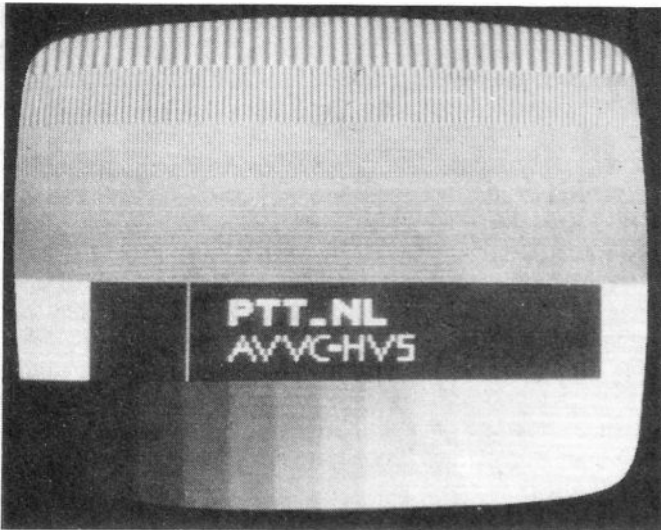
I have included this extensive quote from Steve's letter since the subject is so very important. The photographs, some of which are included this month, clearly show the signal strength. We look forward to hearing how the new demodulator works out and in the meantime I am enquiring amongst contacts in the USA in an effort to turn up any circuit information etc. that may help others to enter this field.

Professional Techniques

Meanwhile, professional broadcasting authorities elsewhere in Europe have been conducting experiments into reception of the ATS-6 satellite. In Italy, RAI has been monitoring signals at the Monza measuring station. Initially a parabolic reflector some 2.5m in diameter (gain 21dB) followed by a 3MHz bandpass filter centred on 860MHz has been used, feeding into a commercial sideband u.h.f. amplifier (Kathrein VBD63, gain 22dB and noise figure 3dB). This gives a 30µV output signal across the 50Ω load. The signal is then fed to a field-strength meter and also, via an f.m. video demodulator, a picture monitor. The AIR station identification signal received is illustrated in an accompanying photograph, indicating the quality of the reception. To improve upon this, RAI apparently intend to change shortly to a 4m parabolic dish.

A meeting to discuss the results from the present series of ATS-6 receptions in Europe has been held recently by the EBU. Apart from RAI and the EBU, NOS (Holland), TDF (France) and BRT/RTB (Belgium) are cooperating in these tests. Encouraging results have been reported. The TDF station uses a 4m dish and a circularly polarised feed into a Micromega parametric amplifier (bandwidth 3-4MHz at the 3dB points). This gives a gain of 20dB with a 1.5dB noise figure. The average field strength is 3µV, rising at times to 6µV.

There is considerable scope for the experimenter therefore. All being well we hope to be able to provide some practical information so that more enthusiasts can try to achieve this type of reception. Finally, I'm sure you will endorse my congratulations to Steve on his magnificent work.



The new EBU pattern identification for the NOS. Photo courtesy Ryn Muntjewerff.

Reception During December

In view of the dramatic achievements reported at some length above I am again omitting the monthly log. Not that there has been very much to report. There has been some Band I meteor scatter reception, and on the 9th there was a small SpE opening which brought in Scandinavian stations. Hugh Cocks reported an unusual SFB (Berlin) reception on ch. E7 via MS, while on the 23rd he experienced a Tropospheric opening which was confined to longer distance reception – Switzerland, East Germany etc. – with just a glimpse of Austria at both v.h.f. and u.h.f. The 28th produced another Trop opening, with many French, West and East German signals. One new transmitter received here was from Switzerland on ch. E35. Two mystery signals have been seen lately on ch. E4, the well-known PM5544 card and the Fubk card, both with no identification. These appeared during the morning: any ideas?

News Items

India: It is hoped that the current ATS-6 satellite transmissions mentioned above will continue after the coming summer when the present agreement between NASA and the Indian government expires.

Bulgaria: A second service was started last September. The first transmitter is at Botev Peak. A further three transmitters due to come into operation by the end of the year should give 30% coverage – 100% coverage by the first service is hoped for by 1980. A new TV centre is under construction at Sofia.

Greece: There is a new transmitter on the Ikaria Isles, operating on ch. E6.

Morocco: A new Band III transmitter at Tarfaya opened last September.

Tunisia: A new Band III transmitter at Le Kef, Casbah, opened last September.

North Yemen: The country's first transmitter opened recently at San'a.

Poland: By the end of the year the transmitters at Zielena Gora, Gorzow and Poznan will be transmitting TVP-2. There is a new 90ft mast extension for u.h.f. arrays at the Jemielowo transmitter.

USSR: A fourth channel has come into operation in Kiev, relaying Moscow-2 and -3 programmes. The other channels carry Moscow-1, Kiev local and the regional service.

Nigeria: A contract to bring colour TV (PAL system B) to the NW has been awarded to RCA. There is to be a new studio complex at the state capital of Sokoto. The nearby transmitter will have a 1,000ft mast, providing omnidirectional coverage of the NW. There is to be a further transmitter carrying this service at Gusau.

EBU Listings

Greece: Thessaloniki ch. E30, 1,000kW horizontal.

Switzerland: Uetliberg ch. E3 reduced from 160kW to 60kW e.r.p.

Hungary: Nagykanizsa ch. R1, 60kW vertical (MT-1). Tokaj-2 ch. R26, 450kW horizontal (MT-2). The Budapest ch. R1 mast is listed as 80m high, the Pecs-1 ch. R2 mast as 125m and the Tokaj-1 ch. R4 mast as 96m with e.r.p. increased from 8kW to 80kW.

From Our Correspondents . . .

Clive Athowe (Norwich) has seen TVP using the PM5544 pattern with the identification "TVP-NTD" – it will be recalled that TVP's PM5544 pattern has a darker than normal background. It appears that NRK (Norway) has dropped the use of the Fubk pattern during the day, using the PM5544 pattern with the identification "NORGE" at the top and "NRK" at the bottom instead. During the recent Leonids meteor shower Clive received Switzerland ch. E7 for a full twelve seconds (November 20th). He reports Band I reception from RTVE (Spain) on December 10th, on all channels, and from Scandinavia on the 11th. These were both SpE openings.

Keith Hamer (Derby) reports that WDR-3 is now using vertical light bars at close down, and Garry Smith (Derby) has actually received WDR-1 using this pattern at close. Some confusion remains as to whether RTVE is transmitting in colour or monochrome. It seems to me that the Spanish authorities must be testing colour at certain times, but several enthusiasts with colour equipment comment that they have been unable to bring in colour even on very strong signals.

Des Walsh (Co. Tipperary) reports the demise of a communal aerial system at Waterford. U.H.F. signals from Presely some 110 miles away had been piped around the area. Originally a 100ft receiving mast with two long Kathrein Yagi arrays had been used, but this didn't give too reliable reception. Subsequently a 200ft mast carrying 32 Wolsey Colour King aerials was constructed, giving an improved signal. Des writes: ". . . this morning residents near the 250ft hill awoke to find the mast no longer in sight. It had collapsed during the night." This is one of the longest paths in the Republic for a piped off-air system and has caused some headaches. There can be spectacular fading at times. Slow Tropo fades over a period of hours depend on widespread weather conditions, short term fades can be at a cycle of anything up to ten a minute, and there are also very rapid flutter fades often as fast as field rate, appearing as a band of noise on the signal travelling up or down the picture. Des reports u.h.f. transmitters at Three Rocks, Dublin at 10kW e.r.p., and at Cairn Hill, Longford at 800kW e.r.p. on ch. 40 (RTE-1) and ch. 46 (RTE-2).

Kevin Jackson (Leeds) reported a quite magnificent log during the excellent Trop opening at the end of October. Signals received included a Swiss ch. E32 50W relay.

Our Australian friends are now in the middle of their SpE season which by all accounts is a good one, with double-hop signals being experienced by most of them. Even Band III signals have been seen, and double-hop reception from mid Malaya has been experienced in Perth,

Improving the I.F. Response

Recently I set about tackling the problem of strong-signal spread present in one of my DX receivers. The symptom was that when tuning in to channels adjacent to a strong local one – in particular the local ch. B3 transmitter which is only 24 miles away – the local signal would tend to spread due to a form of overloading within the i.f. strip. One method of preventing the problem would be to use a narrowband notch filter. With strong signals present on many channels during a good SpE opening however the problem is likely to present itself over the entire Band I spectrum. Much better to improve the i.f. selectivity and reduce the overloading problem – particularly when using high-gain (30dB) aerial preamplifiers. For this purpose the Philips vision selectivity panel type U800 which forms part of the i.f. strip used in the G8 chassis but is available separately on the surplus market (from Manor Supplies) seemed ideal. It was originally featured in the magazine in the signal-strength meter project by Caleb Bradley in the December 1974/January 1975 issues. The unit contains a transistor i.f. preamplifier stage with associated i.f. filtering and shaping coils.

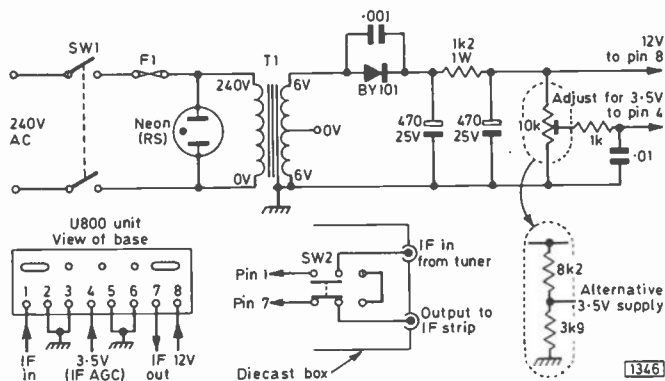


Fig. 1: Connections and power supply arrangements for the Philips U800 panel. The mains transformer can be an Eagle MT6, or any similar 6-0-6V 100mA (approx.) component.

Accordingly, several units were purchased. Two of these – to feed the two main receivers – were fitted in a suitable diecast box and powered from an integral 12V supply (see Fig. 1). The unit worked immediately when switched on. Alignment of the four coils in each unit was simplicity itself – merely peaking for best results with a very weak signal being received. The coils gave a very definite peak, and no difficulty should be experienced with alignment. I fitted subminiature two-pole, two-way toggle switches in the unit so that the amplifiers can be bypassed.

The improvement is quite dramatic. It's possible to tune to ch. E3 vision with only the vaguest suggestion of the presence of the local ch. B3 vision. The high frequency side of the local channel was similarly cleared, and ch. R2 is no longer lost in the ch. B3 i.f. image. The amplifier provides a small gain, of the order of 6dB.

The biasing arrangement used for pin 4 of the unit can be the same as that described by Caleb Bradley, or alternatively a simple potential divider network can be used.

next month in Television

SPECIAL SUPPLEMENT: TV TEST PATTERNS & SIGNALS

The all-electronic PM5544 test pattern has become an internationally accepted standard, designed to provide a comprehensive check on all aspects of a colour TV system. All this will be described along with the variant used by the BBC and also the three basic sets of colour bars. Part 2 in May will be concerned with the test signals transmitted during the field blanking period.

● SPECIAL EFFECTS GENERATOR

This versatile yet economic design provides horizontal and vertical wipes, square corner to corner wipes in any direction, switchable square insert of adjustable size in any of the four corners, simple switching between two cameras, and fades. The mixer and effects sections are separate and can be built on their own if desired.

● SERVICING FEATURES

Les Lawry-Johns on servicing the GEC Junior Fineline portable. More on the Thorn 8000/8500 series. Dewi James reports on some foreign set faults.

● MOSFET IF PREAMPLIFIER

If an i.f. preamplifier is required the use of a MOSFET confers a number of advantages. A practical circuit is given based on the RCA 40673.

● TV SOUND TUNER

A convenient way of obtaining a TV sound signal for feeding to a hi fi system is to modify a TV tuner to give a sound signal output at around 102MHz which can then be fed to the aerial socket of a Band II tuner. M.A. Harris describes how to go about this.

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AAC THEORY

A step by step approach

Ian SINCLAIR

Part 5

We can carry information on an a.c. wave by **MODULATING** it. Modulation means changing the wave in some way related to the information we want to carry.

One of the earliest and simplest ways of modulating this a.c. wave or **CARRIER** is to start and stop it in some sequence such as the Morse code, see Fig.1. This can be done by putting a morse key in some part of the circuit carrying signal or carrying the operating voltage to a signal stage. **DEMODULATION** is the opposite process to modulation; getting back the information which has been carried by a modulated carrier wave.

In the case of a sinewave modulated by Morse code, demodulation is quite simple. How is it done?

Rectify and smooth - see Fig.2.

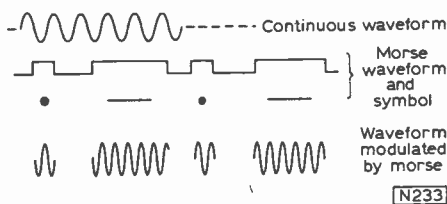


Fig. 1: Modulation of a carrier wave by on/off keying to produce Morse code characters.

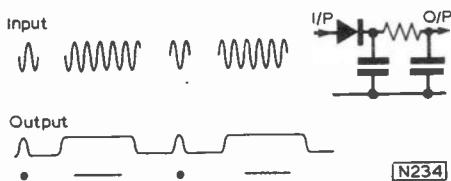


Fig. 2: Demodulation of Morse code characters. A suitable load resistor must be connected across the output capacitor.

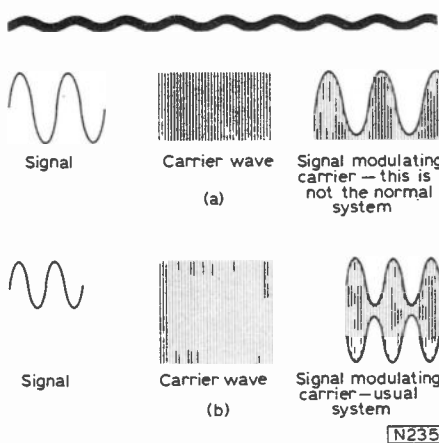


Fig. 3: Amplitude modulation by a sine-wave signal. (a) Asymmetric modulation. (b) Symmetrical modulation.

We are usually more interested in speech, music and video information. When these are converted into electrical form by means of microphone or TV camera, they become a.c. waveforms much more complicated than the "stop-go" waveforms of Morse code. The main difference between them is their bandwidth; speech can be transmitted successfully with a band ranging from about 120Hz to 2kHz, music needs about 50Hz to 10kHz and video information on the UK 625-line system a range from d.c. to 5.5MHz.

One way of modulating such waveforms on to a carrier (an a.c. sinewave of much higher frequency which can be easily transmitted) is **AMPLITUDE MODULATION**. This is done by making the amplitude of the carrier wave depend on the voltage of the modulating wave. The asymmetric modulation shown in Fig.3(a) is, in fact, the most difficult to achieve. An

easier method is to modulate symmetrically, as in Fig.3(b).

This is straightforward **amplitude modulation**, easy to produce and to transmit. How do we demodulate this?

The circuit of Fig.2 would be suitable. Rectify by a diode and pass through a low-pass filter to remove the carrier frequency and leave the modulation.

Another way in which information can be modulated on to a sinewave is **PHASE MODULATION**. We change the phase of a sinewave carrier in such a way that the phase shift in degrees represents the amplitude of the modulating wave. A signal modulated in this way has a phase which, compared to an unmodulated wave, is moving backwards and forwards at the frequency of the modulating signal (Fig.4).

What information do we need before we can demodulate such a signal?

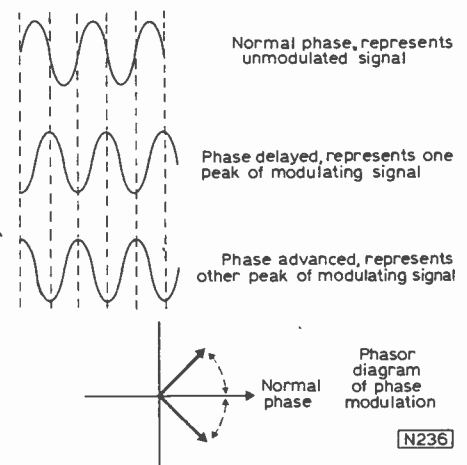


Fig. 4: Effects of phase modulation.

The phase of the unmodulated wave, to use as a reference.

The amplitude of a wave can be modulated without changing its phase, and its phase can be modulated without changing its amplitude. Because of this, we can modulate two sets of information on to one wave. The situation is not quite so perfect as it might seem, for if the wave is passed through any circuit which introduces distortion of phase or amplitude (and most do), then one of the modulating signals will interfere with the other, a problem called cross-modulation.

What circuits are most likely to cause cross-modulation?

Amplifiers, filters, detectors.

In the case of a colour television transmission the colour information is transmitted as an extra signal within

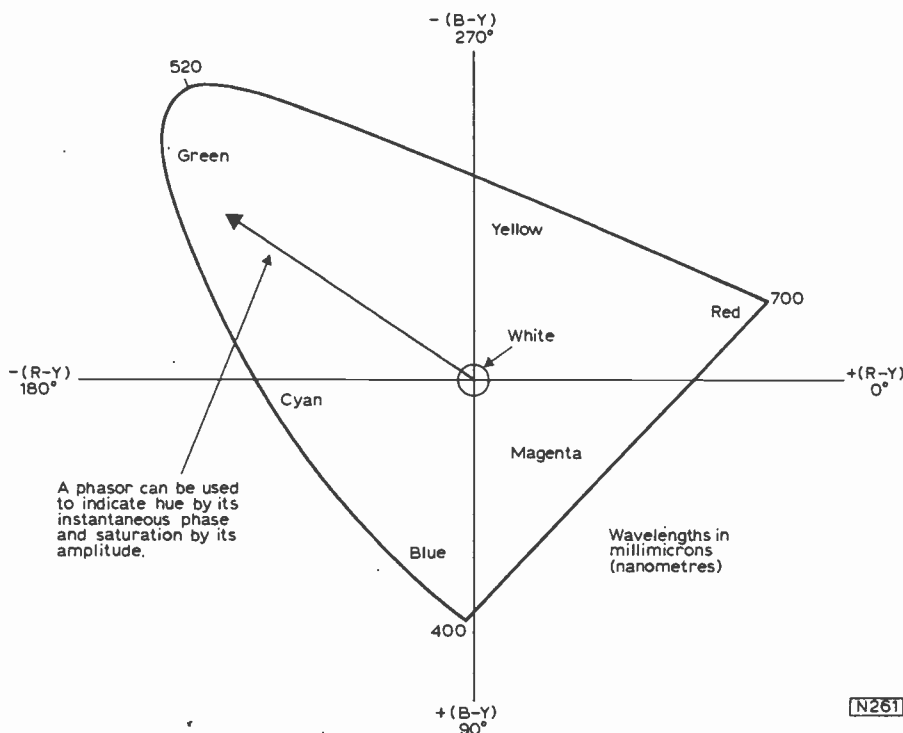


Fig. 5: The standard chromaticity diagram plots around the edge colours in accordance with their wavelength (there is no predominant wavelength in the magenta area which consists of a mixture of red and blue light radiation). The centre represents white light which is a mixture of all the colours. Individual colours become more vivid or "saturated" - i.e. less mixed with other radiation - towards the outer part of the diagram. A phasor can be used to indicate hue and, by its amplitude, degree of saturation. For this purpose the colour subcarrier is modulated in phase and amplitude. Detecting it briefly once each cycle by means of a synchronous detector provides the information required on hue and saturation. No subcarrier = white light (suppressed carrier modulation is used to provide this condition). By convention, 0° represents the $R - Y$ colour-difference signal and 90° the $B - Y$ colour-difference signal. Signals of 180° and 270° phase represent $-(R - Y)$, i.e. a colour-difference signal representing cyan/green, and $-(B - Y)$, i.e. a greeny yellow, respectively. Note that the detected colour-difference signals may have either a positive or a negative value - as may be required to increase or decrease the drives to the appropriate c.r.t. guns.

the u.h.f. channel bandwidth. It is modulated on to a subcarrier of 4.43MHz - at the high frequency end of the vision channel. The subcarrier frequency is chosen so that the sidebands (see later) of the colour subcarrier and the monochrome vision subcarrier interleave - this is possible because of the line structure of the picture information.

The colour information required by the receiver is HUE, which is the precise colour (i.e. green, red, etc.) and SATURATION, the strength of the colour (whether a pale shade or a vivid colour). The subcarrier is so modulated that its phase is proportional to hue and its amplitude to saturation. Where there is no colour, there is no subcarrier, because the subcarrier by itself is not transmitted. See Fig. 5.

If the subcarrier is not transmitted, how do we demodulate?

We have to generate a copy of the subcarrier at the receiver.

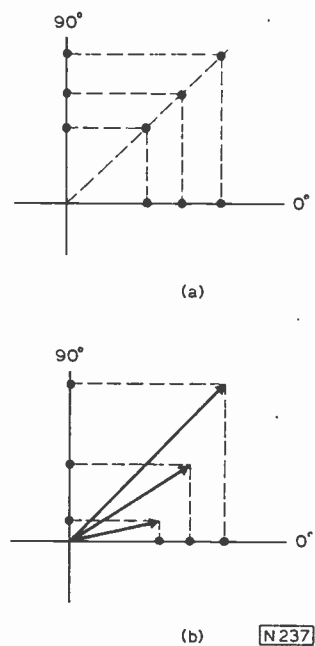


Fig. 6: (a) Equal amplitude modulation of two quadrature subcarriers produces a resultant which is also amplitude modulated. (b) Different amplitudes of modulation of the two quadrature subcarriers produces simultaneous amplitude and phase modulation of the resultant.

Modulating a wave directly in both phase and amplitude is difficult. Fortunately, there is another method of achieving this. If we take a subcarrier and amplitude modulate it with a voltage, then add to it another carrier (which can also be amplitude modulated) of the same frequency but 90° different in phase, we end up with a signal which is modulated both in amplitude and in phase, and we can demodulate by a similar method.

The voltages which are used for modulation represent the colour-difference signals; signals which are the difference between the colours present and the brightness that comprises a monochrome transmission.

The phasor diagram of Fig. 6 helps to make this more clear. If we represent one carrier by a horizontal line and the other by a vertical line (because they must be 90° apart), we can see that the effect of adding them is to produce a single signal which is modulated in both phase and amplitude.

What is the subcarrier modulation for a white signal?

Zero, since white has no colour.

The two colour-difference signals transmitted are $B - Y$ and $R - Y$. ($Y =$ the

brightness, i.e. monochrome signal). To avoid overloading the transmitter they are reduced in amplitude in the proportions $0.493(B-Y)$ and $0.877(R-Y)$ prior to the modulation process. These two signals are referred to as U and V respectively.

All colours can be obtained by mixing in various proportions the three radiated light primary colours red (R), blue (B) and green (G). The colour camera uses three tubes along with optical filters to obtain signals proportional to the R , B and G content of the scene. The basic Y signal is obtained by adding them together: $R-Y$ and $B-Y$ are obtained by inverting the Y signal and adding it to the R and B signals respectively.

Why is a G-Y signal not transmitted?

It can be obtained by mixing the other two in certain proportions.

We demodulate the composite ($U + V$) signal by adding the missing subcarrier in the correct phase, and detecting the signal during the peaks of the

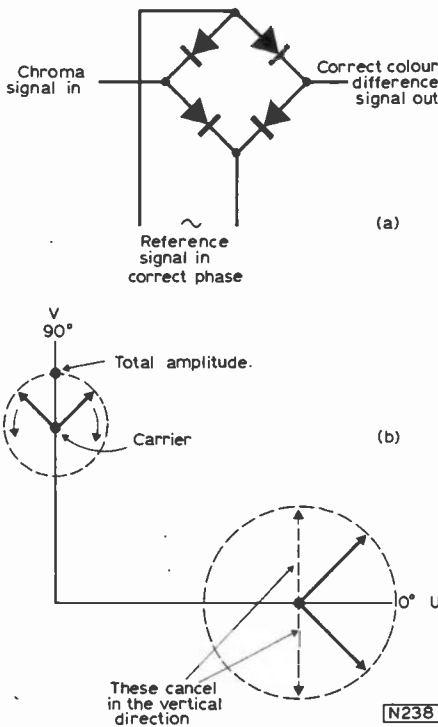


Fig. 7: (a) A bridge demodulator circuit. (b) We represent an amplitude modulated signal by a pair of arrows (length = average amplitude) revolving in opposite directions. One single arrow would represent phase modulation. The resultant of the arrows adds to the carrier to give the total amplitude of signal, indicated by the dot.

subcarrier. This must be done by two separate detectors, one for the U signal and one for the V signal. A suitable detector is the bridge type shown in Fig. 7. Imagine the U and V signals represented by phase arrows as shown, with each pair of arrows revolving in the dotted circle.

If we now add the subcarrier in the correct phase for U demodulation we can obtain an output proportional to the amplitude of the U signal. The signal detected is actually the sum of the added subcarrier and the resultant of the phase signals. Note that demodulation occurs only at the peak of the added subcarrier: as a result the V signals cancel out, no matter what their amplitude.

What is the difference between this and the V demodulator?

The V demodulator uses a subcarrier whose phase is 90° different from that of the U demodulator. As a result, V is detected and the U components cancel.

In the PAL system the V signal is inverted on alternate lines. The purpose of this is to compensate for phase errors which inevitably occur in the overall camera to receiver link and which would result in incorrect colours in the received picture. These phase changes can be caused by atmospheric effects, by reflections, by changes of circuitry (as when a camera feeds into a longer cable), etc.

By inverting the V signal every line, a phase error which (for instance) causes a shift in the direction of red on one line will cause a shift in the opposite direction on the next line. This in itself produces some error cancellation in the viewer's eye, but results in a coarse pattern (the Hanover Blind) when the phase errors are large. A better method is to average the signals from alternate lines. This means that it is necessary to be able to store the signal for $64\mu s$ (the line scan period) and this is the function of the delay line in the PAL receiver.

So far we have dealt only with single sinewaves, but we frequently find in electronic circuits that more than one sinewave may be present at any one time at a point in the signal path. When the signal path consists of resistors, capacitors or air cored inductors; components in which the output is exactly proportional to the input, then the two signals remain independent of each

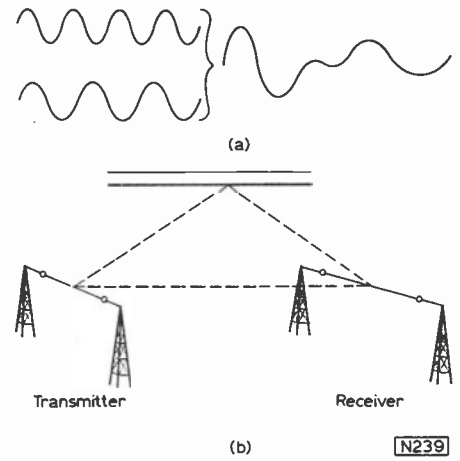


Fig. 8: (a) Two sinewave signals very close in frequency "interfere", giving a signal whose amplitude rises and falls at a frequency equal to the difference between the two signal frequencies. (b) Interference also takes place when a signal can reach a receiver via several paths of differing length.

other unless they are very close in frequency.

If two signals are very close in frequency, then interference takes place, and the received signal rises and falls in amplitude at a rate equal to the frequency difference between the signals (Fig. 8). This is common in radio reception when a wave reaches a receiver from two directions: the frequencies are the same, but the phase of one is altered by the different path.

Why does the amplitude vary in this case?

The phase change is seldom constant, since the wave is being reflected from ionised layers in the atmosphere which are continually altering.

To mix signals of different frequencies effectively, we must pass them through a system in which the output is not perfectly proportional to input. This is called a non-linear system because the graph of output against input is not a straight line. Most amplifiers have some non-linearity (Fig. 9); unbiased or over-biased stages

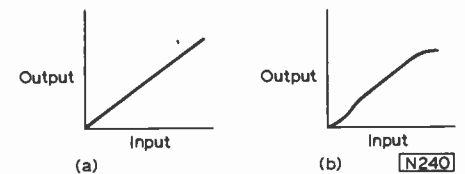


Fig. 9: (a) A perfectly linear system has a graph shaped like this when we plot output against input. (b) Practical systems may have graph shapes like this. Only a small portion is linear.

and diodes have very considerable non-linearity. Non-linear stages in a circuit have the effect of mixing signals, producing new signals at frequencies which are not present in the original.

Why do the signals which must be present in space not mix at the input stage of any receiver, producing a jumble?

We select by tuning the input, and then select further by more tuning at later stages.

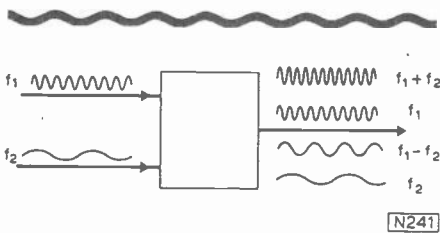


Fig. 10: Mixing two signals produces other signals at the sum and difference of their frequencies.

In a mixer stage, two signals are presented at the input. At the output, we can detect four signals, Fig.10; two of them simply the signals which we applied at the input, but the other two at different frequencies. One is at a frequency which is the SUM of the two at the input, and the other is at a frequency which is the DIFFERENCE of the two frequencies at the input. If one of the input signals is MODULATED, then the sum and difference signals will be modulated too.

What is the main application of this effect?

In the SUPERHETERODYNE (superhet) principle of reception now universally used, where the incoming signal is transformed to a lower fixed frequency (the Intermediate frequency) which is more easily handled.

In addition, however, there is some modulation of the higher frequency by the lower frequencies (Fig.11) and some high frequency ripple on the lower frequency output. This effect, often undesirable, is called cross-modulation, and is common when a mixture of signals is passed through an amplifier which is not very linear. In some cases, the frequencies produced by cross-modulation are outside the bandwidth of the stages which follow demodulation, and so can be ignored; in other cases very great care has to be taken to avoid cross-modulation.

In colour TV receivers, where is cross-modulation most dangerous?

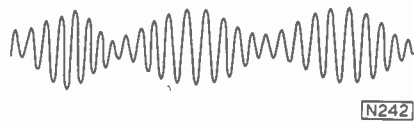


Fig. 11: Cross-modulation in a mixer or other non-linear circuit produces amplitude variation in f_1 or $f_1 + f_2$. (Effect exaggerated for clarity.)

When it affects the U and V components of the colour subcarrier. Though this is not such a hazard with the PAL system, the effects are still noticeable.

We often want to produce modulation deliberately, as this is the way in which information is carried by a wave. Amplitude modulation is carried out by making the amplitude of the carrier wave vary with the amplitude of the signal to be carried. The output, seen on an oscilloscope, is the familiar modulated waveform; if we filter out and detect each frequency present we find, in the case of one sinewave modulated by another sinewave, three main components: the carrier itself, a frequency which is the sum of carrier and signal frequencies and a frequency which is the difference of the carrier and signal frequencies, see Fig.12. These extra frequencies are called SIDEBANDS.

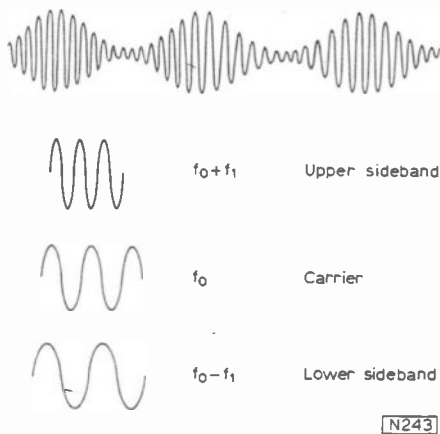


Fig. 12: Sinewave amplitude modulation by a signal at frequency f_1 produces sidebands at sum and difference frequencies.

What will be the sidebands of a 470MHz carrier modulated by a 5MHz signal?

465MHz and 475MHz.

Note that amplitude modulation is, in theory at least, a completely linear process, and only the three signals mentioned emerge. In practice, no modulator is perfect and there will be outputs, usually small in amplitude, at frequencies equal to twice, three times, four times, etc. the frequency of the carrier and the signal. Mixing, however, being a non-linear process, produces strong signals at these other frequencies, and is therefore less suitable as a means of modulating unless the unwanted products can be removed or balanced out in some way. For this reason, non-linear elements such as diodes are used for modulation only in special circuits such as BRIDGE MODULATORS in which the unwanted signals can be cancelled out.

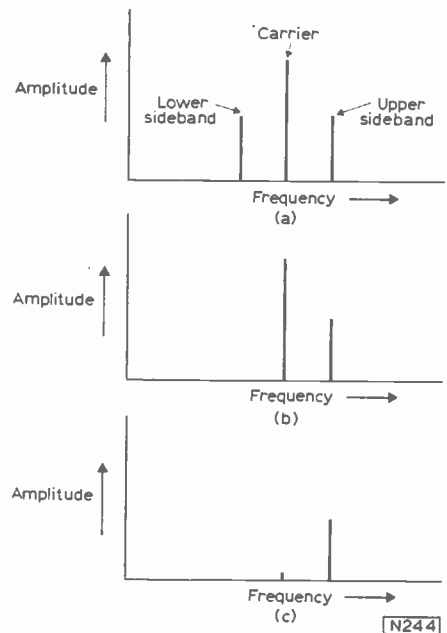


Fig. 13: Frequency components produced by amplitude modulation using a single sinewave signal. (a) Double-sideband. (b) Single-sideband (Upper sideband). (c) Single-sideband, suppressed carrier (Upper sideband).

We do not always want the complete output of an amplitude modulated signal. All the information which is carried is, in fact, carried by the sidebands, and each sideband carries all the information, the other being "spare". The carrier contributes nothing to the information, it is convenient only as a fixed frequency to tune for the sake of detection.

A lot of effort and ingenuity has gone into systems which remove the carrier frequency - giving suppressed carrier modulation, or remove one sideband - giving single sideband transmiss-

sion, or do both – giving single sideband suppressed carrier signals (Fig.13). For systems where the carrier is suppressed, a carrier of the same frequency (and, for some applications, the same phase) has to be generated within the receiver so that detection can take place.

Where, in TV, is a suppressed carrier system used?

To transmit the U and V colour components. The missing subcarrier is regenerated at the receiver and kept in phase by the short bursts of carrier signal which occur during the back porch of the line sync pulse.

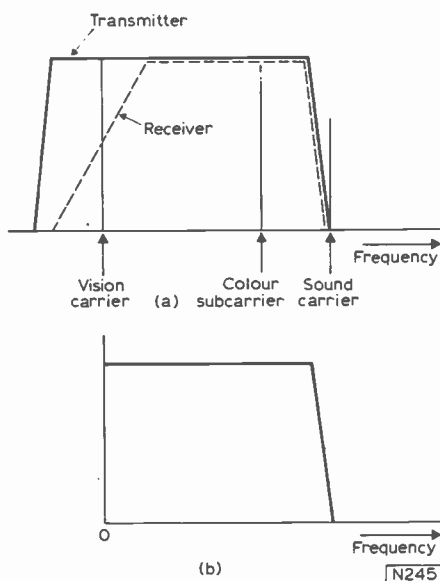


Fig. 14: (a) Idealised vision channel frequency response curves for TV transmitter and receiver in a vestigial sideband modulated system. (b) Resulting overall video response curve.

The TV signal is particularly greedy for bandwidth, with vision modulation frequencies extending up to over 5.5MHz in the UK 625-line system. Full double sideband operation would mean each channel occupying about 12MHz.

To conserve spectrum space, a system known as VESTIGIAL SIDEBAND operation is used, dispensing with most of the lower sideband. To dispense with the carrier would involve too much complexity at the receiver, along with severe problems at the transmitter. For the same reasons, the complete elimination of the lower sideband is undesirable.

The idealised frequency responses of the vision channels of the transmitter and receiver are shown in Fig.14(a). The falling receiver response at the low frequency end is introduced to counteract the increased transmitter sideband energy at the lower modulating frequencies, where the modulation is effectively double sideband. The resulting overall video response curve is as shown in Fig.14(b), a level response being obtained down to virtually zero frequency (d.c.).

Note that the bandwidth required for the colour signal is much less (only ± 1 MHz) than that required for the basic brightness (Y) signal. This is because the bandwidth is determined by the finest detail it is desired to reproduce, and the human eye is far less sensitive to colour variations than to brightness detail changes. Double-sideband modulation is used for the colour signal, with the sidebands interleaved between those of the brightness signal.

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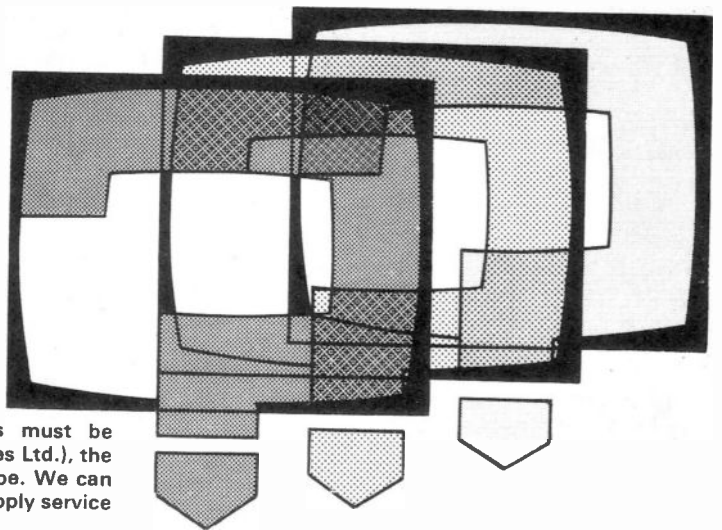
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HMV 2711

On fitting a replacement video board in this set I noticed that the clamp pulse phase coil L205 and its damping resistor R227 are missing, a shorting link being connected in their place. Is this an error or a modification? The manual shows these components and gives instructions for setting up the coil.

This is a modification which has been introduced by the manufacturers. Your replacement board should work without any problems. (Thorn 3500 chassis.)

PHILIPS G22K250

The brightness deteriorates slowly over a period of weeks until viewing is impossible. When the very dim stage has been reached there are frequent instantaneous but small brightness changes in either direction, the c.r.t. cathode voltage is appreciably higher than the correct figure at maximum setting of the brightness control, while the voltage at the brightness control slider (connector pin A7) is low and does not vary with adjustment of the brightness control. Replacement of the beam current limiter transistor Tr5569 (BC147) completely cures the fault, but the whole sequence of events then starts again – the transistor has been replaced three times in as many months.

The beam limiter senses the voltage developed across the wire-wound resistor R5563 (1.8 Ω) which is in series with the line output transistors. Replace this resistor, the OA91 clamping diode (D5544) via which the output from this circuit is taken and the 1 μ F capacitor C5577 which smooths the output. Then reset the beam current limiter control R5565 as described in the manual. (Philips G8 chassis, with earlier line scan unit.)

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TELEVISION MAR. 1976

ITT CK701

There is no raster, just a horizontal white line across the centre of the screen. A new PCL805 field timebase valve has been fitted without making any difference.

The most likely cause of the trouble is that the sync diode D46 (OA91) which is connected from the cathode of the triode section of the PCL805 to chassis has gone open-circuit – but check first that the service switch has not been disturbed. If D46 is found to be intact check the voltages around the PCL805 and then check the capacitors in the cross-coupling network from pin 6 to pin 2 of the PCL805, and C248 in the other cross-coupling network (ITT CVC5 chassis.)

ULTRA 6818

Every time the set is switched on a horizontal white line appears across the screen – i.e. field collapse. Sometimes a picture appears after a few minutes, but at other times the white line remains. I have checked the components in the field timebase circuit and looked for loose connections, but everything seems to be in order.

An intermittent fault of this type is usually due to a hair-line crack or break in the print on the panel. Inspect it carefully with a good magnifying glass. If the break is not apparent try measuring the tracks with the meter switched to a low-resistance range. This is a slow job, but there is no quick answer to this type of trouble. (Thorn 1591 chassis.)

DECCA CS2213

The picture on this set varies from brilliant to dull. The c.r.t. cathode voltage is 90V when the picture is brilliant, 135V when the picture is just discernible and the contrast control inoperative.

The RGB output channels incorporate feedback clamps, with the clamping level set by the brightness control: we suggest that you first check the 1 μ F capacitor C265 which decouples the slider of the brightness control. The beam limiter circuit could be causing the trouble: eliminate this by earthing the PL509 line output valve's cathode (pin 9) when the picture is dark. If the trouble is here, check C434 which decouples the PL509's cathode and C69 (50 μ F) which decouples the beam limiting feed on the i.f. panel. If these points are clear, check the voltages in the luminance stages – TR7, TR201 and TR202 – when the fault is present. (Decca series 10 chassis.)

FERGUSON 3701

The set works well except for the fact that the picture is displaced to the right (looking at the screen) by about half an inch. The horizontal shift control on the line timebase board is at one end of its travel but the board does not appear to be overheating or otherwise defective.

Positive and negative voltages are applied to each end of the line shift control from rectifier circuits fed from windings on the line output transformer. Check the two rectifier diodes (W6 and W7), the reservoir and smoothing electrolytics (C26/7/8/9), the filter resistors (R23 90 Ω , R24 60 Ω) and the shift control itself. (Thorn 2000 chassis.)

EKCO CT252

The line output transformer burnt out but after being replaced, along with the PY500A efficiency diode, the set worked normally for a while. The following fault then developed. The bottom half of the picture is normal, but from the middle up the scan lines get farther apart with pale spaces between groups of lines. Towards the top the spaces become white lines, getting wider.

This keeps on happening on these chassis. The trouble is almost certainly RV41 (50 Ω) in the pincushion distortion correction transistor circuit. It doesn't seem to be adequately rated, and burns out. Try replacing it with a fixed 10 Ω wirewound resistor. (Applies to Pye group 691, 693 and 697 chassis.)

DECCA CS2611

When the set has first warmed up a perfect colour picture is present. After about five minutes however a bright blue band appears at the top of the screen and then runs down to the bottom, then repeating only this time the band is about twice as deep – about 2in. When this second band reaches the bottom of the raster and disappears the whole picture turns to a greeny-yellow for about two minutes. Then the blue band appears at the top of the picture for the third time and again runs down the raster. When it reaches the bottom, a perfect colour picture appears. After about five to ten minutes the whole sequence is repeated. The set then works perfectly for a couple of hours or more.

First check that there are no dry-joints in the blue channel – around TR207 and TR208. Also check that the track of the blue drive control VR241 is in good condition. If the fault is still present, suspect the blue output transistor TR208 (BF179), the emitter-follower TR207 (BC148), the input coupling electrolytic C214 (4 μ F) and the blue clamp diode D205 (BA145) – in that order. (Decca series 10 chassis.)

OSCILLOSCOPE CONNECTIONS

There are two controls on my oscilloscope (Heathkit 10-18U) providing preset horizontal sweep frequencies. I wish to set these up to the television line and field frequencies but am unsure where to obtain suitable waveforms for the oscilloscope's vertical input. The television receiver available is a Ferguson Model 3800.

Your set is fitted with the Thorn 1500 chassis. Pins 1 and 2 (control grid) of the PL504 line output valve will provide you with a 200V peak-to-peak waveform at line frequency, while pin 1 (triode anode) of the PCL85/PCL805 field timebase valve will provide you with a 110V peak-to-peak sawtooth waveform at field rate.

BUSH TV161U

The fault is lack of line hold. Adjustment of the hold control gives a flickering picture which collapses to a squiggly bright line down the centre of the screen. The collapse occurs very rapidly and the sound changes in this condition. The only sort of picture that can be locked is one superimposed on another, with wide spaced lines and a black line horizontally through the centre of the screen. When the control is fully anticlockwise there is no picture at all. With the control half way the screen seems to be just blacked out and the sound is very quiet. All valves have been changed for known good ones without making any difference. Both line hold controls (405 and 625) seem to be fairly new.

What is happening is that the line synchronisation range is so far out that the output from the line timebase is falling to next to nothing. The sound is affected since the transistor stages are operated from a supply which is obtained from a rectifier fed by a winding on the line output transformer. It is very likely that the flywheel line sync discriminator diodes are faulty. They are encapsulated, along with the field interlace diode, in a five-leg block on the timebase panel. The circuit reference is 3MR1/2/3, type U14548/1 or CSD11-7YHL, though three separate silicon diodes can be used instead. The line oscillator itself is the PCF80 which is connected as a cathode-coupled multivibrator. Possible faults here are the anode load resistor of the triode section (3R13, 39k Ω) or the screen grid feed resistor (3R17, 120k Ω) of the pentode section.

NATIONAL TC85G

On dark backgrounds there is a white smear to the right. This is also present to some extent with dark elements – particularly horizontal bars of any sort, on a white or yellow background. The result is a peculiar transparent effect. Examination of the picture reveals very little actual ghosting.

This Japanese set uses colour-difference c.r.t. drive and it seems likely that the trouble is in the luminance channel. In particular we suggest you check the 1 μ F electrolytic capacitor C317 which couples the signal to the base of the luminance emitter-follower transistor TR301, and C314 (4.7 μ F) which decouples this transistor's collector. We assume that the aerial is providing a clean signal and that the i.f. alignment has not been disturbed.

FERGUSON 3802

The trouble with this set is lack of line and field sync. The 30FL2 sync separator and PCL805 field timebase valve have both been replaced. Renewing the sync separator's screen grid decoupling capacitor made a slight improvement, but after a few hours the set reverted to its earlier fault condition. Could the flywheel sync diodes or the width v.d.r. have anything to do with the fault, and how does one test a v.d.r.?

The fact that both the field and line sync are affected means that the trouble is most likely to be in the sync separator circuit, and on this chassis the trouble is almost certainly due to R44 (47k Ω) which is the upper resistor of the potential divider feeding the sync separator's screen grid. It changes value regularly because it is inadequately rated. Fit a 1W or 2W replacement. The width v.d.r. has nothing to do with the fault. The only simple way to check a v.d.r. is by substitution. (Thorn 1500 chassis.)

PAM 5141

The problem of sound but no picture was cured by valve replacement in the line output stage. Now however the picture width varies as the brilliance control is adjusted, and there is a lot of flashing on the screen. When looking at the scan assembly in the dark, flashes can be seen around the c.r.t. neck.

The width problem is probably due to poor e.h.t. regulation: a new DY87 e.h.t. rectifier would cure this. If not, check the voltages around the width ("set e.h.t.") circuit and the controls for burn spots. The flashing is probably due to arcing around the line output transformer. Completely cleaning the c.r.t., the line output transformer and associated components and treating with Halfords anti-static spray ("ignition sealer") often cures this trouble. (Pye 11U series.)

been erected on a ten-foot pole attached to the chimney stack and that the coupling to the receiver was through semi-air-spaced low-loss coaxial cable.

Thinking that the aerial installation had perhaps deteriorated in some way (water in the feeder cable for example) the technician made his trip to the site with a u.h.f. signal strength meter. The channel mostly used by the viewer was BBC-2, and a visual test on this certainly confirmed the attenuated colour, while also revealing a mild lack of definition of the test card frequency gratings, particularly the higher frequency ones. Changing in turn to the other two channels, the colour on these was far less attenuated though it was still insufficiently vivid at the maximum setting of the saturation control.

The aerial signal at the vision carrier of all three channels was not less than $400\mu V$; in fact on BBC-2 it was veering more towards $600\mu V$. With the colour turned right off, the picture signal-to-noise ratio was not perfect but was fair considering the distance from the transmitter and the signal voltage presented to the receiver.

A quick check with the service manual revealed that a similar symptom can result from incorrect adjustment of the automatic chroma control (a.c.c.) preset or incorrect amplitude of the reference signal at the chroma demodulators. The preset should be adjusted for 4.2V at the cathode of the a.c.c. diode, using an electronic voltmeter with diode probe. Not having such an instrument at hand the technician nevertheless made exploratory adjustments to the preset, eventually improving the colour though not adequately on BBC-2. The receiver was then transported back to the workshop for detailed attention.

On the workshop aerial system the colour on all three channels was more than adequate, and for optimum colour balance it was necessary to retard the saturation control. Similar results were obtained on the technician's home aerial.

On returning the receiver to the viewer it was discovered that the trouble started after the next door neighbour took delivery of a brand new colour TV system, including a new fringe-area aerial.

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



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

A GEC Model 2040 colour receiver had been working satisfactorily for several years at a location towards the limit of the accepted service area but in a fairly elevated position with a reasonable signal field. Then came the complaint that while the picture was "bright" and the sound loud and clear, the colour in the picture was significantly less vivid than hitherto and it was now necessary to set the saturation control to maximum – even so the colour was weak. Referring back to the installation statistics, the technician given the task of resolving this problem discovered that a fringe-area type u.h.f. aerial had

SOLUTION TO TEST CASE 158 (Page 219 last month)

Since the line scan coils are fed through a saturated reactor type linearity control, and since this control was found to have minimal effect during the fault symptom, a suspect would be the coil of the control. Testing by bypassing this component failed to eliminate the intermittent effect however – in fact the fault became less intermittent after taking this action. The dashes suggested discharge in a wound component, and since the linearity of the scan was impaired when the fault was present the most likely item to be causing the fault was the scan coils themselves. These were subsequently found to have intermittently shorting turns on the line section, a replacement yoke completely curing the trouble.

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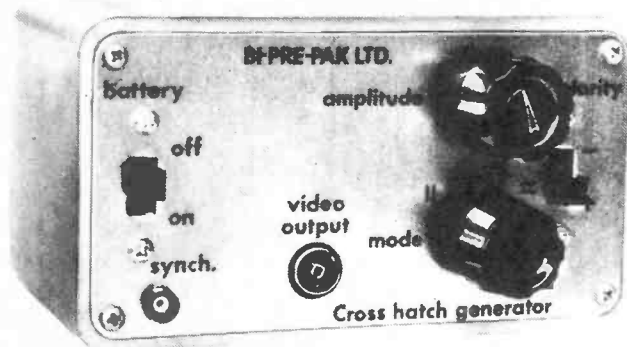
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TRANSISTORS, ETC.		Type Price (£)	Type Price (£)	Type Price (£)	Type Price (£)	DIODES	LINEAR	DIGITAL	ZENER DIODES
Type Price (£)	Type Price (£)					Type Price (£)	INTE-GRATED CIRCUITS	INTE-GRATED CIRCUITS	400mW 3.0-33V 12p each 1.3W 3.3-100V 18p each
AC107 0.35	BC177 0.20	BF241 0.22	MPSU56 1.26	2N3133 0.54	2N3134 0.60	AA113 0.15	CA3045 1.35	7400 0.20	E295ZZ
AC117 0.24	BC178 0.22	BF244 0.18	MPSU55 1.26	2N3232 1.32	2N3235 1.10	AA119 0.09	CA3046 0.70	7401 0.20	E295ZZ
AC126 0.25	BC178B 0.22	BF255 0.45	OC26 0.38	2N3250 1.02	2N3250 1.02	AA129 0.20	CA3065 1.90	7402 0.20	/01 14
AC127 0.25	BC179 0.20	BF256 0.45	OC28 0.65	2N3254 0.28	2N3254 0.28	AA143 0.10	MC1307P 1.19	7404 0.24	P354 all 8
AC128 0.25	BC179B 0.21	BF258 0.69	OC35 0.59	2N3323 0.48	2N3323 0.48	AAZ17 0.12	MC1310P 2.94	7406 0.45	E295ZZ
AC141 0.26	BC182L 0.11	BF259 0.93	OC42 0.55	2N3391A 0.23	2N3391A 0.23	BA100 0.15	MC1352P 0.82	7408 0.25	/02 14
AC141K 0.27	BC183 0.11	BF262 0.70	OC45 0.32	2N3501 6.99	2N3501 6.99	BA102 0.25	MC1353P 0.82	7410 0.20	E298CD
AC142 0.20	BC183K 0.12	BF263 0.70	OC70 0.32	2N3702 0.13	2N3702 0.13	BA110U 0.30	MC1355P 0.82	7411 0.25	/A258 7
AC142K 0.19	BC183L 0.11	BF273 0.16	OC71 0.32	2N3703 0.15	2N3703 0.15	BA115 0.12	1327PQ 1.01	7412 0.28	E298ED
AC151 0.24	BC184L 0.13	BF336 0.35	OC72 0.32	2N3704 0.15	2N3704 0.15	BA141 0.17	MC1330P 0.76	7413 0.50	/A258 6
AC152 0.25	BC186 0.25	BF337 0.35	OC73 0.51	2N3705 0.11	2N3705 0.11	BA145 0.17	MC1351P 0.75	7414 0.28	/A260 6
AC153K 0.28	BC187 0.27	BF458 0.60	OC75 0.25	2N3706 0.10	2N3706 0.10	BA148 0.17	MC1352P 0.82	7415 0.50	/A262 6
AC154 0.20	BC208 0.12	BF459 0.63	OC76 0.35	2N3707 0.13	2N3707 0.13	BA154 0.13	MC1355P 0.82	7416 0.45	/A265 6
AC176 0.25	BC212L 0.12	BF596 0.70	OC81 0.53	2N3715 2.30	2N3715 2.30	BA155 0.16	1358PQ 1.85	7417 0.30	/P268 6
AC178 0.27	BC213L 0.12	BF597 0.15	OC81D 0.57	2N3724 0.72	2N3724 0.72	BA156 0.15	MC1496L 0.87	7420 0.20	E298ZZ
AC187 0.25	BC214L 0.15	BFR39 0.24	OC139 0.76	2N3739 1.18	2N3739 1.18	BA157 0.25	MC3051P 0.58	7425 0.37	/05 7
AC187K 0.26	BC238 0.12	BFR41 0.30	OC140 0.80	2N3766 0.99	2N3766 0.99	BAX13 0.06	MFC	7430 0.20	/06 6
AC188 0.25	BC261A 0.28	BFR61 0.30	OC170 0.25	2N3771 1.70	2N3771 1.70	BAX16 0.07	4000B 0.43	7440 0.20	
AC188K 0.26	BC262A 0.18	BFR79 0.24	OC171 0.30	2N3772 1.90	2N3772 1.90	BA172 0.11	MFC	7441 0.85	
AC193K 0.30	BC263B 0.25	BFT43 0.55	OC200 1.30	2N3773 2.90	2N3773 2.90	BB104 0.52	4060A 0.70	7445 1.95	
AC194K 0.32	BC267 0.16	BFW10 0.55	OC200 1.30	2N3773 2.90	2N3773 2.90	BB105B 0.52	MFC6040 0.91	7447 1.30	
AC194K 0.32	BC267 0.16	BFW11 0.55	ON236A 0.65	2N3790 4.15	2N3790 4.15	BB105G 0.45	NE555 0.72	7450 0.20	
AC194K 0.32	BC267 0.16	BFW16A 1.70	ORP12 0.55	2N3819 0.35	2N3819 0.35	BB110B 0.45	NE556 1.34	7451 0.20	
AC194K 0.32	BC267 0.16	BFW30 1.38	R2008B 2.05	2N3820 0.49	2N3820 0.49	BR100 0.50	SL414A 1.91	7454 0.20	
AC194K 0.32	BC267 0.16	BFW59 0.19	R2010B 2.95	2N3823 1.45	2N3823 1.45	BY100 0.22	SL901B 3.84	7460 0.20	
AC194K 0.32	BC267 0.16	BFW60 0.20	TIC44 0.29	2N3866 1.70	2N3866 1.70	BY103 0.22	SL917B 5.12	7470 0.33	
AC194K 0.32	BC267 0.16	BFW90 0.28	TIC46 0.44	2N3877 0.25	2N3877 0.25	BY126 0.16	SN	7472 0.38	
AC194K 0.32	BC267 0.16	BFX16 2.25	TIC47 0.58	2N3904 0.16	2N3904 0.16	BY127 0.17	76001N 1.45	7473 0.44	
AC194K 0.32	BC267 0.16	BFX29 0.30	TIP29A 0.49	2N3905 0.18	2N3905 0.18	BY133 0.23	SN	7474 0.48	
AC194K 0.32	BC267 0.16	BFX30 0.35	TIP30A 0.58	2N3906 0.15	2N3906 0.15	BY140 1.40	76003N 2.92	7475 0.59	
AC194K 0.32	BC267 0.16	BFX84 0.26	TIP31A 0.65	2N4032 0.43	2N4032 0.43	BY164 0.55	SN	7489 4.32	
AC194K 0.32	BC267 0.16	BFX85 0.26	TIP32A 0.67	2N4033 0.54	2N4033 0.54	BY176 1.68	76013N 1.95	7490 0.65	
AC194K 0.32	BC267 0.16	BFX86 0.26	TIP33A 0.99	2N4036 0.52	2N4036 0.52	BY179 0.70	SN76013	7491 1.10	
AC194K 0.32	BC267 0.16	BFX87 0.28	TIP34A 1.73	2N4046 0.35	2N4046 0.35	BY206 0.31	ND	7492 0.75	
AC194K 0.32	BC267 0.16	BFX88 0.24	TIP41A 0.80	2N4058 0.17	2N4058 0.17	BYX10 0.15	SN	7493 0.65	
AC194K 0.32	BC267 0.16	BFX18 0.53	TIP42A 0.91	2N4123 0.13	2N4123 0.13	BYZ12 0.30	76023N 1.95	7494 0.85	
AC194K 0.32	BC267 0.16	BFY40 0.40	TIS43 0.30	2N4124 0.15	2N4124 0.15	FSY11A 0.45	SN76023	7495 0.85	
AC194K 0.32	BC267 0.16	BFY41 0.43	TIS73 1.36	2N4126 0.20	2N4126 0.20	FSY41A 0.40	ND	7496 1.00	
AC194K 0.32	BC267 0.16	BFY50 0.25	TIS90 0.23	2N4236 1.90	2N4236 1.90	OA10 0.20	SN	74100 2.16	
AC194K 0.32	BC267 0.16	BFY51 0.23	TIS91 0.23	2N4248 0.12	2N4248 0.12	OA47 0.07	76033N 2.92	74121 0.60	
AC194K 0.32	BC267 0.16	BFY52 0.23	ZTX109 0.12	2N4284 0.19	2N4284 0.19	OA81 0.12	SN	74122 0.80	
AC194K 0.32	BC267 0.16	BFY57 0.32	ZTX300 0.16	2N4286 0.19	2N4286 0.19	OA90 0.08	76227N 1.46	74150 1.44	
AC194K 0.32	BC267 0.16	BFY64 0.42	ZTX304 0.22	2N4288 0.13	2N4288 0.13	OA91 0.07	SN	74151 1.15	
AC194K 0.32	BC267 0.16	BFY72 0.31	ZTX310 0.10	2N4289 0.20	2N4289 0.20	OA95 0.07	76530P 1.05	74154 1.66	
AC194K 0.32	BC267 0.16	BFY90 0.70	ZTX313 0.12	2N4290 0.14	2N4290 0.14	OA200 0.10	SN	74164 2.01	
AC194K 0.32	BC267 0.16	BLY15A 0.79	ZTX500 0.17	2N4291 0.18	2N4291 0.18	OA202 0.10	76533N 1.20	74192 2.05	
AC194K 0.32	BC267 0.16	BPX25 1.90	ZTX502 0.17	2N4292 0.20	2N4292 0.20	OA210 0.29	SN	74193 2.30	
AC194K 0.32	BC267 0.16	BPX29 1.70	ZTX504 0.42	2N4392 2.84	2N4392 2.84	OAZ237 0.78	76666N 0.90		
AC194K 0.32	BC267 0.16	BPX52 1.90	ZTX602 0.24	2N4871 0.24	2N4871 0.24	SZM1 0.22	TAA300 1.76		
AC194K 0.32	BC267 0.16	BRC4443 0.68	2N525 0.86	2N4902 1.30	2N4902 1.30	TV20 1.85	TAA320 0.94		
AC194K 0.32	BC267 0.16	BRY39 0.47	2N696 0.23	2N5042 1.05	2N5042 1.05	IN914 0.07	TAA350A 2.02		
AC194K 0.32	BC267 0.16	BRY56 0.40	2N697 0.15	2N5060 0.32	2N5060 0.32	IN914E 0.06	TAA435 0.85		
AC194K 0.32	BC267 0.16	BR101 0.47	2N706 0.12	2N5061 0.35	2N5061 0.35	IN916 0.10	TAA450 2.70		
AC194K 0.32	BC267 0.16	BSX19 0.13	2N706A 0.15	2N5064 0.45	2N5064 0.45	IN1184 0.92	TAA550 0.55		
AC194K 0.32	BC267 0.16	BSX20 0.19	2N708 0.35	2N5087 0.32	2N5087 0.32	IN1185 1.10	TAA570 2.02		
AC194K 0.32	BC267 0.16	BSX76 0.15	2N744 0.30	2N5294 0.35	2N5294 0.35	IN4001 0.05	TAA611A 1.70		
AC194K 0.32	BC267 0.16	BSX82 0.52	2N914 0.19	2N5296 0.57	2N5296 0.57	IN4002 0.06	TAA611B 1.85		
AC194K 0.32	BC267 0.16	BSY19 0.52	2N916 0.20	2N5298 0.58	2N5298 0.58	IN4003 0.07	TAA630Q 4.18		
AC194K 0.32	BC267 0.16	BSY41 0.22	2N918 0.42	2N5322 0.85	2N5322 0.85	IN4004 0.08	TAA630S 4.18		
AC194K 0.32	BC267 0.16	BSY54 0.50	2N930 0.35	2N5449 1.90	2N5449 1.90	IN4005 0.09	TAA661B 1.32		
AC194K 0.32	BC267 0.16	BSY56 0.80	2N1164 3.60	2N5457 0.30	2N5457 0.30	IN4006 0.11	TAA700 4.18		
AC194K 0.32	BC267 0.16	BSY78 0.40	2N1304 0.21	2N5458 0.35	2N5458 0.35	IN4007 0.14	TAA840 2.02		
AC194K 0.32	BC267 0.16	BSY91 0.28	2N1305 0.21	2N5494 0.85	2N5494 0.85	IN4148 0.05	TAA861A 0.49		
AC194K 0.32	BC267 0.16	BSY95A 0.27	2N1306 0.31	2N5496 1.05	2N5496 1.05	IN4448 0.10	TAD100 2.66		
AC194K 0.32	BC267 0.16	BT106 1.24	2N1307 0.22	2N6027 0.65	2N6027 0.65	IN5400 0.15	TBA120S 0.99		
AC194K 0.32	BC267 0.16	BT116 1.20	2N1308 0.26	2N6178 0.71	2N6178 0.71	IN5401 0.17	TBA240A 2.97		
AC194K 0.32	BC267 0.16	BU110 1.20	2N1309 0.36	2N6180 0.92	2N6180 0.92	IN5402 0.20	TBA281 2.28		
AC194K 0.32	BC267 0.16	BU108 3.25	2N1613 0.34	2SC643A 1.36	2SC643A 1.36	IN5403 0.22	TBA480Q 1.90		
AC194K 0.32	BC267 0.16	BU126 2.99	2N1711 0.45	2SC1172Y 2.80	2SC1172Y 2.80	IN5404 0.25	TBA500 1.99		
AC194K 0.32	BC267 0.16	BU204 1.98	2N1890 0.45	3N140 1.21	3N140 1.21	IN5405 0.27	TBA500Q 2.00		
AC194K 0.32	BC267 0.16	BU205 1.98	2N1893 0.48	40250 0.60	40250 0.60	IN5406 0.30	TBA510 1.99		
AC194K 0.32	BC267 0.16	BU207 3.00	2N2102 0.51	40327 0.67	40327 0.67	IN5407 0.34	TBA520Q 3.34		
AC194K 0.32	BC267 0.16	BU208 3.15	2N2217 0.36	40361 0.48	40361 0.48	IS44 0.07	TBA530 2.71		
AC194K 0.32	BC267 0.16	BU209 2.55	2N2218 0.60	40362 0.50	40362 0.50	IS310 0.45	TBA530Q 2.71		
AC194K 0.32	BC267 0.16	BU209 2.55	2N2219 0.50	40429 0.80	40429 0.80	IS920 0.07	TBA540 3.21		
AC194K 0.32	BC267 0.16	BUY77 2.50	2N2221A 0.41	40439 2.67	40439 2.67		TBA540Q 3.21		
AC194K 0.32	BC267 0.16	BUY78 2.55	2N2222A 0.50				TBA550Q 4.10		
AC194K 0.32	BC267 0.16	BUY79 2.85	2N2270 0.41				TBA560C 4.09		
AC194K 0.32	BC267 0.16	D40N1 0.45	2N2369A 0.42				TBA		
AC194K 0.32	BC267 0.16	E1222 0.55	2N2401 0.60				560CQ 4.10		
AC194K 0.32	BC267 0.16	E5024 0.20	2N2484 0.41				TBA570 1.17		
AC194K 0.32	BC267 0.16	ME6001 0.16	2N2570 0.18				TBA641 2.30		
AC194K 0.32	BC267 0.16	ME6002 0.17	2N2646 0.53				TBA673 2.28		
AC194K 0.32	BC267 0.1								