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TELEVISION

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Servicing PAL decoders

Measuring teletext eyeheight

TELEVISION

January 1978

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this month

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BF158	0.19
BF159	0.24
BF160	0.27
BF163	0.27
BF164	0.14
BF167	0.23
BF173	0.21
BF177	0.28
BF178	0.24
BF179	0.28
BF180	0.30
BF181	0.34
BF182	0.29
BF183	0.29
BF184	0.23
BF185	0.29
BF186	0.30
BF194	0.09
BF195	0.09
BF196	0.09
BF197	0.10
BF198	0.15
BF199	0.14
BF200	0.28
BF216	0.12
BF217	0.12
BF218	0.54
BF219	0.12
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BFT43	0.24
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BFX85	0.27
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OC26	0.40
OC28	0.60
OC35	0.45
OC36	0.58
OC38	0.43
OC42	0.45
OC44	0.18
OC45	0.18
OC46	0.35
OC70	0.22
OC71	0.28
OC72	0.35
OC74	0.35
OC75	0.35
OC76	0.35
OC77	0.50
OC78	0.13
OC81	0.20
OC810	0.14
OC82	0.20
OC820	0.13
OC83	0.22
OC84	0.28
OC85	0.13
OC123	0.20
OC169	0.20
OC170	0.22
OC171	0.27
OA91	0.05
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R2008B	1.79
R2010B	1.59
R2305	0.38
R2305/BD222	0.37
SCR957	0.81
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TIP32A	0.36
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T1590	0.19
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TELEVISION

An Increasingly Versatile Device

The domestic television set used to be simply the thing that reproduced the programmes transmitted by one or other of the three programme networks – unless you happened to be connected to one of the wire systems that have experimented with local TV and pay TV at various times. But have you noticed what an increasingly versatile thing the TV set is becoming?

The first major extension to the domestic TV set's possibilities came with the VCR, enabling you to record off-air or replay prerecorded tapes. Domestic VTR systems have – at a price – been with us for roughly a decade now, but till the advent of the easy to handle VCR most low-cost VTR systems were intended for use with monitors, with the signal interconnections at video and audio frequencies.

Then came TV games, first found in the pubs and amusement arcades, later appearing in compact, relatively inexpensive packages for home use. The significant point here was the entry of digital techniques on the domestic TV scene. On the broadcast side, digital techniques had been making a substantial contribution to operations for some years, starting with the BBC's sound-in-syncs system (1969) in which the TV sound signal is compressed, converted to digital form and inserted in the line sync pulse period, and culminating with the IBA's famed DICE, which provides electronic standards (lines, fields, colour) conversion by converting the signals to digital form, processing them, then converting them back into analogue form. Rather far from TV games you might think, but it's all part of the same process – the increasing impact of digital techniques on the world of television.

In fact the technology of TV games has evolved considerably since their first appearance. We described many of the basic TV games techniques in a series which started in July 1974. The approach then was to employ a fair number of standard digital i.c.s to build up the circuitry required. But why not go about it in the same way as the calculator manufacturers? It didn't take long for the semiconductor people to see this new possibility for using their l.s.i. technology. This made it a relatively simple matter to provide a range of games with just a single i.c. – the basis of the present generation of TV games. Add a second i.c. and the whole thing comes up in glorious colour. But it doesn't end there. The talk now is of adopting microprocessor technology and making the system programmable, so that an almost unlimited range of games of varying degrees of complexity can be played. The favoured system seems to be to use prerecorded cassettes to provide the various programmes. And once you do that, you can extend the system to all sorts of other uses – teaching systems and so on. In fact you've made the TV set into part of a home computer installation – as we outlined in *Teletopics* last month.

It's not impossible then to imagine some "viewers" using their TV sets for games, instruction and VCR use, while keeping up to date with teletext news and getting extra information via the PO's Viewdata system – and never watching a transmitted programme at all! We've come a long way then from the days of the TV set as a goggle box.

Teletext decoders and TV games are already being built into a few sets. What other digital innovations can we expect in TV sets? One now well established use of digital techniques is to provide all electronic channel selection. The varicap tuner simply asks to be controlled in this way, and the system lends itself readily to remote control operation. Once you're controlling the tuner and generating various signals digitally there are other things you might as well do. Like flashing the selected channel number on the screen, or the time (coming shortly in *Television*!). Sets which do this sort of thing have been available on the Continent for some while now. The latest development along these lines is the picture within a picture – a reduced size picture from another channel being inserted in the corner of the main display, so that you can watch two programmes at once or see when to change over to a programme due to start on another channel. This involves some interesting digital processes – you've got to lose lines, and compact the video information by reading it into a memory at one speed and reading it out at another, in effect operating at two standards simultaneously while keeping both in sync (remember how difficult it has sometimes been to keep a set in sync on one standard!).

There's only one thing that prevents a space-age TV installation in every home: cost. But the cost of electronic hardware has a habit of falling dramatically once production has achieved a certain level. TV games are already commonplace, and teletext decoders will become a lot cheaper once specialised i.c. modules for the purpose go into large scale production. From this point in time, it already seems that one can regard the days when the TV set simply displayed one of the programmes available as the age of steam TV.

FRONT COVER

Our front cover shows – amongst other things – an ITT CC781 26in. television receiver incorporating ITT's 30 channel remote control system. A unique feature of this receiver is that the remote control unit functions both outside the set and also when inserted in its housing in the set. The latest version of this consolette model incorporates ITT's new brighter colour tube (see *Teletopics* this month). Our thanks to ITT for their assistance with photography.

Teletopics

BRIGHTER CTV TUBE

ITT have developed a new version of the 20AX tube giving approximately 70% greater brightness for a given beam current. Three factors have contributed to this improvement: the use of a new red phosphor gives an 8% increase; the shadowmask has been redesigned with wider slots; and by making the faceplate glass lighter the transmission factor has been increased from 52 to 68%. The geometry of the shadowmask has been adjusted to avoid the wider slots causing impurity – in the new computer-aided design the pitch of the slots (distance between them) is progressively increased towards the sides of the screen. The tubes are interchangeable with standard 20AX types, and are to be fitted first on a new luxury ITT receiver, Model CC781/BT – the trade price of this will be about £5 higher than the existing model CC781. The development work was done by ITT's German TV setmaking subsidiary Schaub Lorenz. Because the tube requires less drive, the focusing is improved while tube life is likely to be greater.

TOP JOB FALLS VACANT

One of the top jobs in TV engineering in the UK has fallen vacant with the surprise resignation of Howard Steele as the IBA's Director of Engineering. Mr. Steele has accepted an invitation to become Managing Director of Sony Broadcast, which is being set up by Sony to promote the sale of their broadcasting and video equipment in Europe. Howard Steele leaves the IBA at a time when their u.h.f. transmitter network is nearing completion and ILR has been established.

PHILIPS DEMONSTRATE VIDEODISC SYSTEM

Philips recently gave the first public demonstration of their VLP (video long play) video disc system in the UK. Test marketing of the system in the USA is to start in the Autumn of 1978, and the introduction of the system on the European market is suggested as "not earlier than late 1979". Development is proceeding, but the reproduction as shown is not yet up to the standard achieved with video-cassettes. The system was described in some detail in our June 1974 issue. Briefly, the signal is recorded on the disc in the form of a track of pits which vary in frequency and length, i.e. frequency modulation is used. The track is scanned by a laser beam which, when reflected, is modulated by the signal. Detection is then simply by means of a phototransistor. The advantage of the system is the cheapness of the disc. The main technical problem lies in ensuring that the beam follows the recorded track, since there is no mechanical contact between the disc and the scanning head: this means that a fairly complex servo control system is required.

NEW TANDBERG COLOUR CHASSIS

Tandberg's new CTV3 colour chassis, which uses the 20AX tube, is now in production and, as you would expect from this firm, has a number of interesting technical features. The RGB output stages for example use complementary (pnp/npn) transistor pairs, while the class B field output stage uses complementary Darlington pair transistors. The decoder consists of a TDA2560 for chrominance and luminance signal amplification and a TDA2522 demodulator/reference oscillator/PAL switch i.c. (that's the one that uses an 8·84MHz crystal), plus a TBA530 for RGB matrixing. The i.f. section is taken care of by just one i.c. – a TDA2541. But as with most modern chassis the most interesting part is the power supply, which consists of yet another variation on the switch-mode theme. A simplified block diagram is shown in Fig. 1.

The well known TBA920 serves as sync separator/line oscillator, its line frequency output being applied to the base of the line driver transistor Q725. The driver transformer T725 has two secondaries, one of which drives the line output transistor while the other drives the switch-mode power supply. The first section of this consists of a sawtooth generator. The output from this is one of the two inputs to the comparator section, the other input being a d.c. voltage proportional to the regulated 160V h.t. rail voltage. The comparator consists of a differential amplifier, with the two inputs applied to the bases of the two transistors. The sawtooth input switches one transistor on, the other then switching off, and in consequence a squarewave output is obtained. The point at which the switchover occurs depends on the d.c. input from the voltage sensor, so the differential amplifier acts as a pulse width modulator, providing a variable mark-space ratio squarewave output. This is fed via a three-transistor driver to the base of the series chopper transistor Q735. When this switches on, the reservoir capacitor C738 is charged via the chopper transformer T726. When Q735 switches off, the charging current is maintained by the collapsing field around the primary winding of T726. Two secondary windings feed separate rectifiers to produce regulated 24V and 230V lines.

The current limiter is included to reduce the charging current when the set is switched on. Should Q735 go short-circuit the crowbar thyristor operates and blows F725. Normal overvoltage operation occurs whenever the 160V line rises to 180V. The crowbar thyristor then discharges C738, the circuit resetting itself once the overvoltage has been removed.

At switch on Q725 is forward biased by the potential divider network feeding its base, and in consequence a start up supply is generated in its emitter circuit to get the line oscillator going.

RELAY TRANSMITTER OPENINGS

Berwick-upon-Tweed (Northumberland) BBC-1 channel 21, ITV (Border Television) channel 24, BBC-2 channel 27. Receiving aerial group A.

Dartmouth (Devon) ITV (Westward Television) channel 41, BBC-2 channel 44, BBC-1 channel 51. Receiving aerial group B.

Kingsbridge (Devon) BBC-1 channel 40, ITV (Westward Television) channel 43, BBC-2 channel 46. Receiving aerial group B.

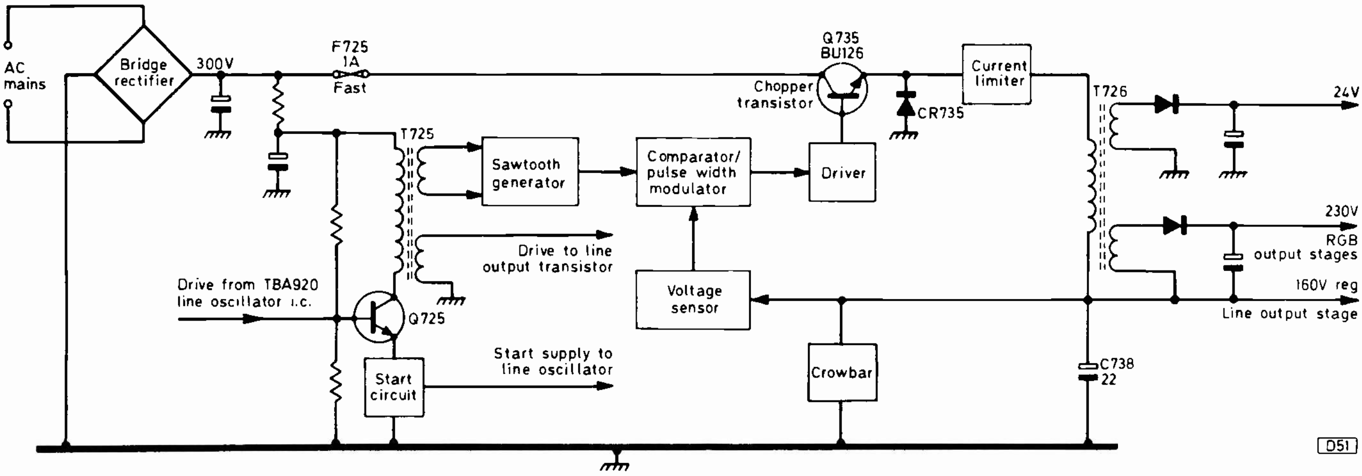


Fig. 1: Block diagram of the switch-mode power supply circuit used in the new Tandberg CTV3 colour chassis.

Llandyfriog (Dyfed) BBC-Wales channel 22, ITV (HTV Wales) channel 25, BBC-2 channel 28. Receiving aerial group A.
Llangeinor (mid Glamorgan). Coverage extended to cover the Ogmore Vale.
Newcastle (Northern Ireland) BBC-1 channel 55, ITV (Ulster Television) channel 59, BBC-2 channel 62. Receiving aerial group C/D.
Okehampton (Devon) BBC-1 channel 39,BBC-2 channel 45, ITV (Westward Television) channel 49. Receiving aerial group B.
Ramsbottom (Manchester) BBC-1 channel 48, ITV (Granada Television) channel 56, BBC-2 channel 66. Receiving aerial group C/D.
Strabane (Northern Ireland) BBC-1 channel 39, BBC-2 channel 45. Receiving aerial group B.
Troon (Strathclyde) BBC-1 channel 58, ITV (Scottish Television) channel 61, BBC-2 channel 64. Receiving aerial group C/D.
Woodbridge (Suffolk) BBC-1 channel 58, ITV (Anglia Television) channel 61, BBC-2 channel 64. Receiving aerial group C/D.

All these transmissions are vertically polarised.

VIDEO

The JVC Video Home System (VHS), which is one of the main contenders in the current US videocassette battle, is to be launched in the UK early next year. The advantage of the system is that it provides up to three hours' recording on a low-price ½in. cassette. In addition to JVC, Akai, Hitachi, Mitsubishi, National Panasonic and Sharp are producing VHS machines. The bandwidth extends to 3MHz, and the tape speed is 2·34cm/sec.

The 1978 edition of the Video Yearbook has been published by Blandford Press Ltd., Link House, West Street, Poole, Dorset BH15 1LL. The cost is £7·95, or £8·45 inclusive of post and packing from the publishers. It's a substantial work of 440 pages, with over 700 companies' products and services analysed in some 1,400 separate entries, and is edited by Angus Robertson, Assistant Editor of *Video and Audio Visual Review*. Thoroughly indexed by subject and company, and with a comprehensive list of European importers and distributors, this publication should prove invaluable to those dealing with video equipment from day to day. There's useful general information as well, including international TV standards, standard connectors, and data on camera tubes and lenses.

A short course of nine lectures on Video Recording is being held at the South London College (Knights Hill, London SE27 0TX). The course starts on January 17th and the fee is £6. It's intended for radio and television technicians and engineers and video recording enthusiasts.

MORE CONTROLS GO

Two more of the preset controls with which we have become so familiar in colour chassis are on their way out. The tighter beam position tolerance of the 20AX system means that vertical and horizontal shift controls are no longer necessary – you won't find them in the Philips G11 chassis for example, or the Tandberg CTV3 mentioned above. A slight degree of horizontal shift can be provided by means of the line hold control.

SOLUS ENTERS COMPONENTS MARKET

Solus (Electronics) Ltd., well known as suppliers of valves and c.r.t.s, has entered the components market, offering a comprehensive range of i.c.s and the ITT range of e.h.t. triplers. There are Solus depots at Kirkwood Road, Cambridge CB4 2PF; Walkley Lane, Heckmondwike, Yorks; and 69 Carron Place, East Kilbride.

Letters

HALF MAINS VOLTAGE?

I think I can clear up some of the "half mains voltage" mystery where (see Letters, November) a bridge rectifier is connected across the mains supply. If the reservoir capacitor is ignored, the chassis waveform (D) will consist of negative-going half cycles. It can be calculated that these will have an r.m.s. value of 169·5V with a 240V mains input (the r.m.s. value of a half-wave rectified sinewave is given by $\sqrt{\frac{1}{2}(V^2)}$, where V is the r.m.s. input voltage, and this of course is the principle behind d.c. heater chains). If the effect of the reservoir capacitor is now taken into account, the bridge rectifier conducts during only a small portion of the mains cycle, the chassis floating during the remainder of the cycle. This probably accounts for T. I. Birnie's strange waveforms.

This doesn't answer the main question, i.e. how dangerous is the chassis potential? I would point out however that although the r.m.s. value is only 169·5V the same peak voltage as for the mains exists. – **A. G. Jarvis,** *New Romney, Kent.*

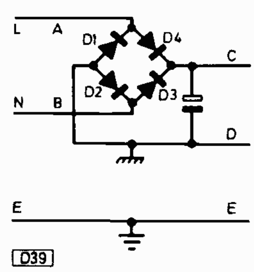


Fig. 1.

Editorial comment: We have received a number of letters making the same point, that due to the presence of the reservoir capacitor the chassis is clamped at earth potential by D2 (see Fig. 1) during the short period when D4 and D2 conduct on the positive-going peak of the mains input waveform, while on the negative-going peak when D1 and D3 conduct the chassis will be at the peak mains voltage (D1 on). During the rest of the mains cycle, when the bridge is non-conductive, the chassis floats. The chassis is as much a shock hazard as the mains live lead since the peak voltage on it exceeds 300V. Our thanks to all those who have written to us on this subject. Incidentally, Mr Birnie comments that the waveforms included with his original letter were measured on a hybrid Luxor receiver in which an unstabilised 250V h.t. line is produced by a bridge rectifier connected directly across the mains.

VCR EXPERIMENTS

I was interested to see in the December issue two long letters commenting on my articles on various experiments with VCRs: one of the purposes of writing them was to evoke useful ideas from readers. I'll certainly be trying Mr. Hammond's ideas of using Thixofix and changing over the cassette rollers. Other ideas are welcome!

As for the professional/amateur business, I can see no reason why "amateurs", who may be paid electronics engineers though not engaged full-time in work on VCRs and allied equipment, should not try out experiments. On the contrary. Once a company has designed a product such as a VCR, it's not going to give it much further thought – it will go on to the next model. Since the original Philips N1500, we have had the similar N1501, the different N1502, and now the totally different N1700 with its two-hour playing time. I've successfully converted an N1500 to skipped-field operation, and found it much more useful with the longer playing time. True, there's a slight disturbance at the top of the screen, due to the colour disturbance mentioned in the correspondence last month. Much more serious from my point of view, however, is the problem of rewinding, which takes twice as long. A two-speed motor would solve this if a suitable one could be found.

If an N1502 was converted to using slant heads it would play for two hours. It wouldn't be able to play its original tapes of course, even if the speed could be altered by means of a switch, since the new heads are different: but I don't see that this precludes conversion by an enthusiast for his own purposes. I've recently been told that the mechanical dimensions of the slant heads are the same as the ordinary ones, so replacement should be possible. Whether the electrical characteristics are the same remains to be seen. If they are, or the differences can be compensated by modification, conversion should not prove too difficult.

Philips have a real problem. A Japanese machine running at 3·3cm/sec (about half the speed of the N1700) is due out next spring, at a cost expected to be around £650. If Philips change their system once again, there will be justified concern amongst those who have purchased the N1500, N1501, N1502 or N1700, only to find them made obsolete by a four-hour "N1900". In my opinion therefore Philips may well find it worthwhile introducing official ways of converting their machines to give longer playing times – and also to offer a duplicating service by selected dealers so that existing tapes can be copied at the lower speed.

I was interested to note that new drums and guides cost £350. Since working machines can sometimes be bought for this price, presumably a machine with worn-out drums and guides has virtually zero value. It would make a useful source of parts for experimenters, however, or could alternatively be used as a rewind only machine to save head wear on rewind. – **J. de Rivaz, B.Sc. (Eng.),** *Harlow, Essex.*

BUSH TUNING KNOBS

In his article on the Rank A823 chassis R. W. Thomson mentions the problem of wear on the tuning knobs used on various Bush sets, stating that the only cure is replacement. I have managed to repair these knobs however by using two self-tapping screws inserted about a quarter of an inch from the end of the knob, screwing them in so that they protrude sufficiently to locate with the spindle lobes. The set on which this was done has been in use for ten years without giving any more of this trouble. I hope this tip will be of help to others – note that a small pilot hole must first be drilled, otherwise the knob will split. – **K. Colwell,** *Consett, Co. Durham.*

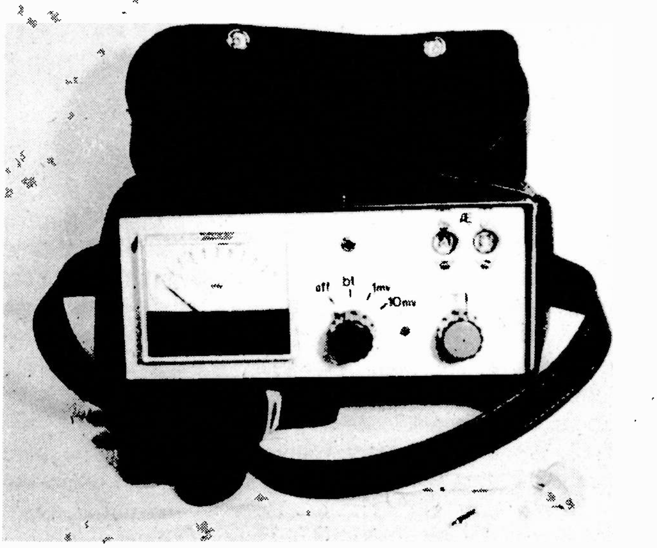
Editorial note: To comply with current safety standards, the screws should be recessed and insulated using a blob of Araldite.

WAVY VERTICALS

In the *Your Problems Solved* section of last September's issue the problem of wavy verticals on the top one third of the screen on sets – some new – fitted with the Decca 30 series chassis was raised. The problem is due to the line output transformer core being oversaturated. This did unfortunately happen on brand new receivers, especially if the contrast control setting is a little on the high side. In very bad cases, where more than the top 3cm. of the scan is wavy, a replacement transformer should be fitted – the Mullard AT2055/00 is the preferred type. It seems strange that the problem did not seem to show itself in the earlier 10 series chassis. – **Peter L. Corder,** *Brixham, Devon.*

Test Report: The Vorta VSM470 Field Strength Meter

Roger Bunney



THE writer has used a Wolsey MC661C field strength meter for over a year and has found it a useful and accurate tool for making aerial and amplifier measurements (see *Television,* October 1976). Quite recently the opportunity arose to test and evaluate the recently introduced Vorta VSM470 field strength meter. The writer accepted this with enthusiasm and great interest, if not with slight reservation: the Vorta meter is about half the price of the Wolsey unit, and since the latter is excellent value thoughts arose as to the quality and accuracy of the budget-produced Vorta!

As the illustration shows, the Vorta meter is compact, simple to operate, and the readings are easily read from the scale which is calibrated in equal divisions up to 10. Battery access is via a screw lid at the rear of the unit, two PP6 batteries being required. The connections within the rear compartment are made by snap-on connectors. With practice the batteries can be quickly fitted but I must confess to finding it difficult initially to insert the PP6s into the compartment.

The panel control adjacent to the meter gives one position for a battery check in addition to the two ranges of field strength reading – 1mV and 10mV f.s.d. The only other control is for tuning, with channel indication through a small window. To allow a greater accuracy over the complete tuning range of the u.h.f. tuner (a standard u.h.f. tuner is fitted) there are two coaxial sockets, one for group A and B inputs, the other for group C/D. The reason for the twin sockets is to compensate for the non-linear characteristics of such tuners, with a tendency for reduced gain as frequency increases. A small jack socket is fitted to allow for audio monitoring of the sound/vision carrier, a deaf-aid type earpiece being supplied.

The case is of metal, the front panel being sprayed white and the cover a hammer finish blue. The leatherette carrying case allows for a complete "hands-off" operation in difficult locations. The crystal earpiece allows sufficient audio drive to identify a specific signal.

Since my Wolsey meter was to hand and of proven accuracy it was possible to carry out comparison checks with a known value signal and compare with the display on the Vorta. The manufacturers state that the accuracy is ±6dB, dependent on battery level. In practice the variation was much less than this, and where variation did occur the Vorta meter tended to read low. Since the low readings made were of a low order and well within specification the writer considered the performance in this respect acceptable.

Further tests were made at several points along the tuning spectrum with a 6dB pad inserted (to reduce the displayed reading by half). In both ranges the reduced readings were extremely accurate. Comparison readings between ranges also gave complete accuracy, and the meter was satisfactory in every way regarding scale accuracy and reading.

The lowest detectable reading was about 150-200μV (two meters were tested). As a basic u.h.f. tuner is employed, feeding two i.f. stages, the selectivity is wide and will tend to spread over immediately adjacent channels when tuned to a strong local signal. Since it's assumed that the meter will be used for either distribution system work (with 1mV reference level) or for aerial installation within conventional service areas (where high signal levels are generally experienced) however the 150μV threshold is not important.

The circuit includes five transistors, two of which are in the tuner unit, and the consumption is some 30mA maximum. Battery life is quoted as a minimum of 12 hours for continuous operation and 20 hours for intermittent use. The steel-cased unit, with its integral battery supplies, weighs 5lbs (2·3kg) and is 8in. wide, 3½in. high and 6in. deep.

With a meter produced for a basic purpose, to give a relatively accurate measurement with the ease of portability, it's perhaps unfair to criticise the threshold input signal level: it isn't a laboratory instrument, but a competitively priced field strength meter for use in medium to high signal strength areas by aerial engineers. The unit fulfils the need for an inexpensive instrument which is essential for the serious engineer, a tool to be used at each installation to confirm that a minimum signal is available.

One thing I would criticise however is the battery requirements. Two PP6 batteries are expensive (£1.12 at the time of writing) and I would have preferred to have the meter powered from a single cell, if nothing more than the cost factor. The crystal earpiece is rather fragile, and under the outdoor rigours of everyday aerial erection is likely to suffer damage, specifically where the lead enters the plastic ear housing. A better monitoring headset can be purchased however since the jack is a standard miniature type.

Having used the meter over a period of time I consider that for the price (approximately £65 trade, excluding VAT) the meter is extremely good value, robust and relatively accurate. Ease of handling whilst being able to read the scale in the "hands-off" mode when atop the chimney, without excess weight pulling around the neck, makes it highly suitable for use in the very competitive aerial rigging field, where speed is essential to maximise profit whilst ensuring a high degree of engineering precision and quality.

Enquires relating to the VSM470 "Silverline" field strength meter should be made to Premier Industries (Cheltenham) Ltd., 343-345 High Street, Cheltenham, Glos. GL50 3HS. ■

The Bermuda Triangle

Les Lawry-Johns

MOST people have heard of this mysterious tract of the western Atlantic, where things and people disappear without a trace. It seems that they are either sucked down or sucked up into another world. In any event, they're never seen again in this one. Wouldn't it be handy if we had easy access to this vortex, where we could dump certain things which cause us so much heartache? Wouldn't it be nice if we could dump certain people there who. . . . What's this all about you may ask?

Well, it's about several things really. Take the name Bermuda to start with. Ultra used it years ago when they were Ultra and not Thorn. Then a Bermuda was a monochrome TV set in a slim light wood cabinet with a gold surround with or without motorised tuning. In other words, you knew what it was and give and take a little what you could expect. The fact that there might have been a Bermuda radiogram was of little moment.

Now however a Bermuda can mean anything from five or six different colour models, say ten different monochrome sets, to a bar of chocolate. You may rightly say that the name was never meant to be anything other than a brand identification, and that there is a model number. Of course, of course. But you try telling that to the dear old lady who says that the picture has gone off her wireless and that she only watches the home service.

"Hallo, I want you to come and look at my wireless. The picture has just gone off."

"Yes, so has everyone else's, there's a power cut on. Your light has gone out as well, hasn't it?"

"No it hasn't. It's not as bright as it used to be and the man downstairs says it's the battery, but I don't believe him because it has been perfectly all right for months."

"No dear, we don't mean your torch, we mean the electric light, the one with the switch on the wall."

"I don't use that when I'm watching the wireless."

So you see, it's difficult to find out what it is you are supposed to go and service, even when there isn't a power cut on.

A Brilliant Band of Colour

Not that this was the case when Mr. J phoned to say that his Ultra colour set was doing funny things. We knew only too well which model it was since we'd sold it to him only a few days earlier. His description was alarming. After the set has been on for say two hours, there is an occasional brilliant band of colour across the screen, of such short duration that it's difficult to describe. Arriving on the scene hotfoot, with another new Ultra lurking in the back of the van, we studied the displayed picture for some time before the condition showed.

A brilliant blob of primary red with a slightly offset pure blue shot across about half way down the screen, with the picture still visible above and perhaps below although it was difficult to say for sure.

"There you are," said Mrs. J. "I told you it was red and green."

"I only saw red and blue," said Mr. J.

When it happened again, I too saw a green area. I also saw complications. To me this was a tube fault which would probably clear itself if left on long enough, but we had already registered the tube in the customer's name for the four year warranty and he didn't want his set doing funny things for any length of time. So we collected it and left the other new one.

To confirm our suspicions, we rang Thorn. After a time a nice young man with a slightly bored voice (who blames him, talking to confused engineers all day long) said that they'd had this trouble with new 9000 models (our's was an 8800) and that the new tube was having a short lived freak out (our expression, as we are not very technical) and that this was sending a spiky waveform back to the decoder which responded by creating the condition described. He said it would not occur with the colour off therefore. If we were worried, remove C194 (1μF, IC5 pin 5 to IC4 pin 11 – PAL switch drive coupling capacitor) from the decoder panel and fit a 12kΩ resistor in its place. If that didn't do it, replace IC4 (reference oscillator i.c.) or IC5 (demodulator/matrix/PAL switch i.c.). Thank you we said, in a subdued voice, and hung up. We're still waiting for the effect to recur so that we can put in a 12kΩ resistor and know whether the trouble has cleared, but it won't happen for us as yet. We'll report our findings later.

Varying Size Picture

This then was one point of our Bermuda triangle. The next was a 14in. Ultra portable with the Thorn 1591 chassis. The complaint was that the picture would decrease in size, going darker at the same time and with the sound reducing in sympathy. Obviously the supply line was falling to a low point and then recovering, only to fall again. This could be due to several causes, so we first checked at the body (collector) of the AD149 regulator transistor where we found that as expected the voltage was rising to the normal 11·5V and then slipping quickly down, to about 8V, then recovering in a fluttery sort of way. On test the AD149 proclaimed its innocence, as did the 10Ω wire wound resistor in parallel with it. We then moved down to VT22 (see Fig. 1) which samples the 11·5V supply line and reports its findings to the regulator transistor which should respond accordingly.

VT22 should have 5V at its base when the supply line is 11.5V, and this 5V is initially set up by the preset control R104. The transistor and its associated components seemed to be in order when checked with the ohmmeter, so we switched on again and checked for the 5V at the VT22 base. The 5V was anything but 5V (but didn't exceed it). The

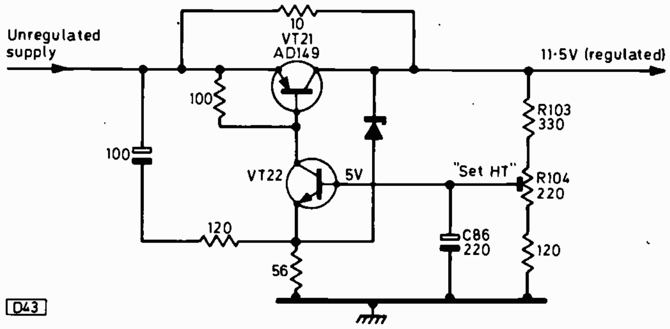


Fig. 1: L.T. regulator circuit, Thorn 1590/1591 chassis.

possibilities were that R103 was varying in value, that C86 had varying leakage, or that there was a similar leakage between the base and emitter of VT22.

At his point we noticed that the panel surface in this area did not present its normal appearance. It was slightly darker. We investigated with a finger and carefully examined said finger. It appeared to be oily. With ruthless efficiency, we cleaned off whatever it was. Some devilish fluid straight from the triangle no doubt. Wherever it had come from (no leakage from electrolytics), once it had gone the voltage remained stable.

Motorway Madness

The third Bermuda came by way of Derek who seems to have acquired the knack of getting himself involved in the most embarrassing situations without even trying. You may remember our account in the November issue where he got himself washed in a car wash and subsequently doused by a pint of bitter in Harold's (never a dull moment) bar. His latest escapade was the result of trying to do a good turn for his friend Derry. It appears that Derry had had a late night out in London and had caught the last train back, more by luck than management. However, his luck didn't hold out because as soon as he got aboard he fell asleep and didn't wake up until the train arrived at its final destination, having stopped at every station down the line including the one where Derry should have parted company with it.

So there was Derry, some twenty-five miles from home and no more trains to play with. To his added discomfort only a few silver coins jingled in his pocket and, wherever his folding money was, it wasn't where it should have been. There was only one thing for it. His pal Derek would have to be consulted. Good old reliable Derek. Snug and warm in bed when the phone rang in the early hours. "Help," said Derry.

"I'm acoming for you son," said Derek sleepily. So saying he tumbled out of bed and put on his slippers. Still clad in his pyjamas and without so much as a dressing gown, he started up the mighty engine of his Renault and thundered off down the motorway towards the stranded Derry who by now was again sound alseep in the railway waiting room.

Scantily clad as he was, Derek sat in his nice warm car and tooted his rather loud horn to call Derry to his side, waking up the slumbering population at large.

Beating a hasty retreat back up the motorway, they were some ten miles from home when the car broke down. Many things were tried that night, things which would cause ordinary men to turn pale. But it was of no avail, the car would not start.

Without saying anything to Derry who still tinkered, Derek set off along the hard shoulder to the nearest breakdown phone, still in his pyjamas and slippers and presenting an unusual sight to the occasional motorway users as they rushed by.

I heard all this when Derek was again helpful when his neighbour's set broke down and he struggled in with it.

"It's a Bermuda colour set," puffed Derek. "The chap who usually looks after it for them has had a nervous breakdown so I said you'd do it for them in no time."

"Thanks," I said, putting down the reader's query which had been puzzling me for the last half hour before closing time.

It just had to be a 3500 to round off the day as it were, and it had to be the last bit of the mysterious triangle.

Taking the back off and switching the set on produced no rustle up of e.h.t. Checking on the beam limiter board, where all good boys start, showed about 60V at one end of R907 (1·5Ω to chassis, where the voltage should be 1·3V). Did it just die, or was it killed?

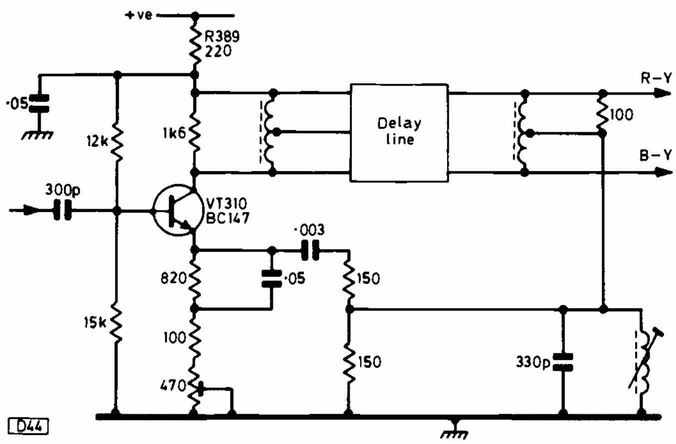


Fig. 2: Chroma delay line driver stage, Thorn 3500 chassis.

With nervous apprehension we bridged it with a suitable wirewound, having first checked for shorts and unhooked the tripler. There were no fireworks, and the voltage drop was now about right. After fitting the replacement resistor with a flick of the hand and the soldering iron, we switched on again and cautiously advanced the tripler clip to the nipple. A fair spark and a rustle up showed that all was well. The resistor had just died then.

"You've got a picture," said Derek.

"I'm not surprised," I replied in my most superior manner.

"Is it supposed to be in colour?"

"Oh, I supposed they've been twiddling the knobs," I desperately hoped.

They hadn't. All the twiddling in the world wouldn't produce the slightest vestige of the required variation of the screen's triads. With sinking heart we swung up the convergence board to expose the decoder panel. What's this then? A replacement chroma delay line, apparently fitted in haste or in desperation.

As I was checking this area, Derek volunteered the information that the previous repairer had had any amount of trouble with the colour or absence of it, had carried out a lot of work to the detriment of both his health and happiness, but had finally succeeded and had then retreated to his doctor, sitting in the waiting room staring vacantly into the distance.

It appeared then that disturbing the set had disturbed something on the decoder board. Turning the set on its side to expose the under side of the decoder board, we chased up a few blind alleys before finally arriving at the delay line driver VT310 where we should have started. No voltage anywhere. Investigation showed R389 (see Fig. 2) to be open-circuit and discoloured. Replacing this 220Ω resistor brought back colour (albeit wrong), and as we could find no reason for the failure we concluded that the original delay line had had an intermittent short in it which had caused the colour to fail and had driven the other poor fellow up the pole before he found out what was wrong and replaced it. Unfortunately, he had not checked the effect of this on the supply resistor and had not questioned his luck further once the new delay line had resulted in glorious colour.

Lowering the set down to its proper level brought back natural colour. Raising it 45° caused the faces to turn a funny colour (not really green). We again checked around but could find no loose cores or the like, and once again we had to conclude something. We concluded that the c.r.t.'s shadowmask was loose and took up its correct position when the set was likewise. So there!

Measuring Teletext Eye Height

Harold Peters

MOST articles on teletext to date have concerned themselves with the system and its decoding. Rightly so, as the concept is difficult to grasp and learning about it provides an admirable incentive for many of us to begin learning about digital techniques. The other part of the story, getting the signal out of the computer and into your set, has thus been somewhat neglected. This could possibly be because at the time of writing there are a few features which have not been finalised.

If you slowly attenuate the signal fed to a set fitted with a teletext decoder the analogue portion – the picture – progressively worsens as the noise increases, until somewhere in the region of an input level of 30-40μV on a good modern set colour is lost, followed by syncs and sound limiting.

The teletext signal behaves rather differently. Pages are read in quite merrily until somewhere around 300μV when the decoder suddenly starts to write scribble. "Suddenly" is a bit of an exaggeration, as you get a little warning. As the signal begins to worsen, characters missed on the first read in are put right later. Nevertheless the transition from legibility to scribble is far more abrupt than the analogue picture would suggest.

Also, in some places a perfectly "clean" looking picture is belied by a teletext signal reading a large number of errors – usually due to a reflection picked up by the aerial, or introduced by a mismatched downlead or distribution system. In communal systems the choice of programmes by neighbours can also affect legibility.

Then again, some transmitters radiate a slightly cleaner signal than others. Like lead poisoning, all these effects can be cumulative. The broadcasters are fully aware of these shortcomings and are very active in their correction.

The Teletext Test Signal

A difficulty arises from the snag mentioned previously. Because the digital and analogue signals are received differently, it is not possible to assess the goodness of the teletext signal by reference to the insertion test signals radiated on lines 19 and 20 (for details of these see our supplements in the April and May 1976 issues of *Television*). As most transmitters are regulated by sampling these two lines of signals and applying the required correction, often automatically, it came as a disappointment to find that the teletext signal had a mind of its own. So what was needed was a test signal of its own.

There is on line 20 an extended burst of subcarrier which sits immediately underneath the staircase-with-burst on line 19. Comparison of the two in a delay line matrix will show the presence of chroma-luminance crosstalk. Modern techniques have made the extended burst on line 20 redundant however, as a suitable comparison can now be made to a stable oscillator locked to the burst on the sync pulse back porch.

On the BBC test signal transmissions this extended burst has been replaced by a teletext test signal. It consists of half a row of standard characters on line 20, with their complementary characters on line 333 – the other matching line of the field. For example if line 20 carries 0101001, line 333 carries 1010110 in the same time interval. Thus if an oscilloscope is triggered to gate out and overlay the two lines, a symmetrical teletext waveform will be presented. Because it doesn't dance about like the two active teletext lines, it can be observed and measured; and if your scope can pick out the "pulse and bar" waveforms you can do it too.

As far as the broadcaster is concerned automatic means will be used to regulate things. But with even simple equipment it is possible to check the waveform's most important parameter – the "eye height".

If you look at an active teletext line with an oscilloscope you will find it too "busy" to permit accurate observation. You will notice however that the 0 baseline and the 1 peaks are not always at the same height for all characters. It seems to depend on the number of similar bits in the byte, and on whether they are bunched together or not. The only part of the signal which can be used reliably by the decoder therefore is the central portion through which all the transitions pass fully, and on a twinkling teletext line this appears to be about two-thirds of the total height.

If you transfer your attention to the test signal on line 20 (BBC), where a stationary signal is presented, you will notice – especially with an expanded trace – that some of the transitions from 0 to 1 and back do not quite make even the average level. They can easily introduce errors in the decoding therefore.

The amplitude of the excursion from 0 to 1 is called the "eye height", and is expressed as a percentage of the level attainable if no distortion existed. It's measured from the midpoint between 0 and 1 and multiplied by two. Laboratory measurements are done by means of a lissajous figure, using the teletext clock as the X deflection source, and because this is locked to the test line a stationary pattern of ellipses ("eyes") will result.

The parts of the signal which fail to make the mean amplitude are called the "worst eye height", and usually throw up a character error. A "concealed worst eye height" is one that cannot be spotted without considerable trace expansion, or without taking an oscillogram of it – we venture to assert that if this is the first time you have heard those terms it won't be the last.

Pulse Distortion

The teletext bit rate is 6·9 megabits. When a 101010... sequence such as the clock run in is transmitted it corresponds to a 6·9/2 = 3·45MHz squarewave leaving the computer. Without modification, this would generate harmonics well outside the 5·5MHz video passband of our TV system. The teletext signal uses the "non-return-to-zero" (NRZ) type of bit, so a succession of 0s followed by a succession of 1s, e.g. 000111, will appear as a squarewave three times as long, i.e. 3·45/3 = 1·15MHz. Between these two examples, the various teletext bits will contain frequencies which occupy the entire video bandwidth and more.

The "more" is filtered out by changing the pulse shape from a squarewave to a raised cosine, but to resolve what

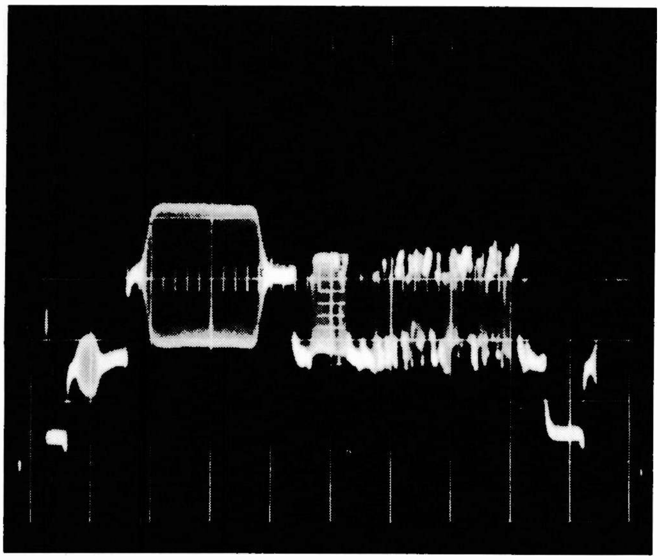


Fig. 1: BBC line 20, with the teletext test signal replacing the extended burst previously present.

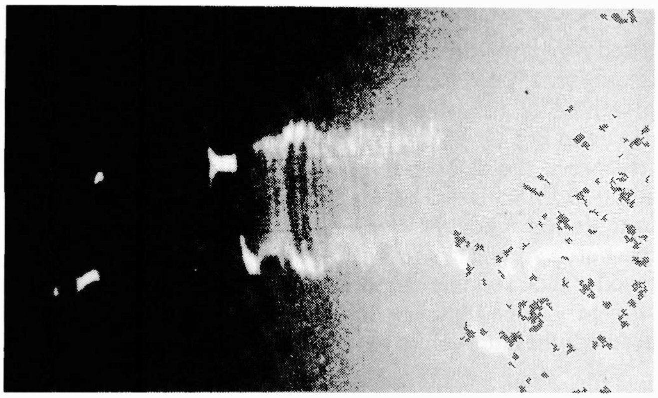


Fig. 2: Lines 20 and 333 superimposed, showing the complementary nature of the teletext test signals.

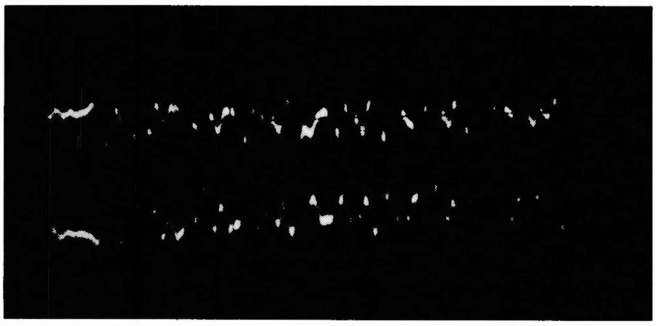


Fig. 3: Portion of the trace in Fig. 2 expanded: examples of worst eye height can be seen on close examination.

remains without distortion the group delay characteristics of the transmission system must be beyond reproach.

Transmission links between the programme source and the provincial transmitters lose and restore the d.c. component of the TV signal many times en route: this can tilt the teletext signal in places, producing errors. At the transmitter itself, the use of vestigial sideband carrier shaping for bandwidth economy produces "quadrature distortion" of narrow width pulses. This is due to phase shifts imparted to the higher frequency sidebands by the vestigial shaping circuits, and the effect is to broaden an erect pulse (010) and to narrow an inverted one (101), giving as you would expect a selective impairment to the teletext signal – this passes unnoticed on the analogue picture. To make matters worse, a good many of the smaller u.h.f. transmitters obtain their signals off air from the local main station, so there could be a double dose of quadrature distortion by the time the television receiver gets the signal.

One way of overcoming these difficulties is to pass the teletext signal through a regenerator at the transmitter or switching centre. This extracts the signal from the TV waveform, cleans it up and puts it back in again. The original purpose of a regenerator was to permit Oracle to continue to be received during commercial breaks when the local station "opts out" of the national chain. This has led to the current pastime of watching Oracle only when the ads appear: there's a moral there somewhere.

Receiver Requirements

At the receiver, the i.f. response should be carefully tailored to reduce group delay to a minimum. Particular attention must be paid to the slope about the carrier. This means that with a vision i.f. of 39·5MHz the 39MHz point should be as many dBs up from the carrier as the 40MHz point is below. The worst offender when it comes to bending the slope about the carrier is undoubtedly the 41·5MHz trap for adjacent sound – this is normally designed to be very deep in order to kill off any 405-line channel 1 sound which may be hanging about.

Digital experts assert that the only i.f. strip capable of doing the job properly and consistently is one using a SAW (surface acoustic wave) filter, and only then if it's followed by a true synchronous demodulator. The trouble with most current SAWs is that their 41·5MHz rejection is only about 40dB. This rules them out until the 405-line system is finished, because in some channel 1 areas, such as SE London, 60dB of trapping is barely sufficient. Unfortunately a trap of this depth will begin its roll-off just after the vision carrier, spoiling the aforementioned slope. SAWs can also show a pronounced tilt at the top of the passband and yet be within specification, so possibly there is virtue yet in a carefully aligned conventional i.f. strip.

Distribution systems at the receiving end, especially if they have one or two unterminated outlets, can induce reflections which are imperceptible on pictures but which can reduce the teletext display to looking somewhat like a jolted scrabble board.

Decoding Margin

In addition to the topics outlined, noise adds further impairment to the teletext signal: it "shakes up" the eye height display as it were. The sum of the errors due to bad eye height and noise is called the "decoding margin".

Getting Optimum Results

If decoding difficulties are experienced and the decoder itself has been eliminated as suspect, try to assess the eye-height of the received signal. Make sure your aerial is efficient, providing signals which are free from ghosts, and that any distribution system is correctly terminated. Check the set's overall alignment carefully, and if you can do it with confidence reduce the depth of the 41·5MHz trap if you are away from channel 1. Try for a rounded top to the i.f. response, to cut down ringing effects. Do this at a level corresponding to your incoming signal, because the performance of i.f. strips varies enormously with applied a.g.c. – and when yours was made they didn't know you were going to get teletext so they aligned the strip in a compromise manner to suit all signal levels. ■

PAL Decoder Servicing

A. Denham

DESPITE ten years of colour transmissions in the UK, not a great deal of practical information on servicing PAL decoders has been published. Before we get around to faults however we should outline briefly what happens in the decoder. There are various ways in which the PAL colour signal can be decoded, but the block diagram in Fig. 1 shows a very widely used arrangement and brings out the main processes involved. This decoder configuration was used in many discrete component decoders – for example those in hybrid Decca, Pye, GEC and Rank sets.

The chrominance signals are modulated on to a 4·43MHz subcarrier within the 6MHz vision channel bandwidth. Suppressed subcarrier modulation is used, in order to minimise interference on monochrome receivers. This leaves only the sidebands therefore, which are restricted to about ±1MHz, i.e. within a bandwidth of roughly 3·43-5·43MHz. The sidebands are present only when a colour signal is being transmitted of course, and are large only when deeply saturated (i.e. strong) colours are present. This again helps to minimise interference (patterning) on monochrome reception.

Because the subcarrier is suppressed at the transmitter, to be able to demodulate the signal it's necessary to regenerate in the decoder a carrier which is synchronised *both in frequency and phase* with the suppressed subcarrier. For this purpose a stable (i.e. crystal) oscillator is included in the decoder, and it's locked by means of a phase detector circuit which is fed with a synchronising signal. This signal takes the form of a burst of ten cycles of the transmitter subcarrier, transmitted during the back porch period of the signal, i.e. immediately after the line sync pulse.

The chrominance signal consists of two colour-difference signals, B–Y and R–Y, which at the transmitter modulate the subcarrier in quadrature – the principle is exactly the same as recording left- and right-hand signals in stereo systems. The quadrature (i.e. 90° phase difference) relationship of the two signals enables them to be separated in the decoder. The third colour-difference signal required, G–Y, is obtained by adding together in a matrix circuit proportions of the detected R–Y and B–Y signals – this is possible because of the mathematical relationship between the three signals. Adding these three signals to the luminance (Y) signal gives us the three primary-colour signals (red-green-blue) required to produce a full colour display on the c.r.t. screen.

A complication with the PAL system is that the polarity of the R – Y signal is inverted on alternate lines, i.e. R – Y on one line becomes – (R – Y) on the next one transmitted. This is done to enable the effects of spurious phase shifts to be compensated for in the decoder's signal processing circuitry (by the delay line and the chroma matrix circuit), but means that the polarity of either the signal itself or the reference signal fed to the R – Y detector has to be reversed on alternate lines. This has to be done in synchronism with the polarity reversals carried out at the transmitter of course, and for this reason the phase of the burst signal is swung through ±45° on alternate lines (see Fig. 2), giving rise to a 7·8kHz ripple signal at the burst detector output. This ripple is then used to effect the necessary synchronisation.

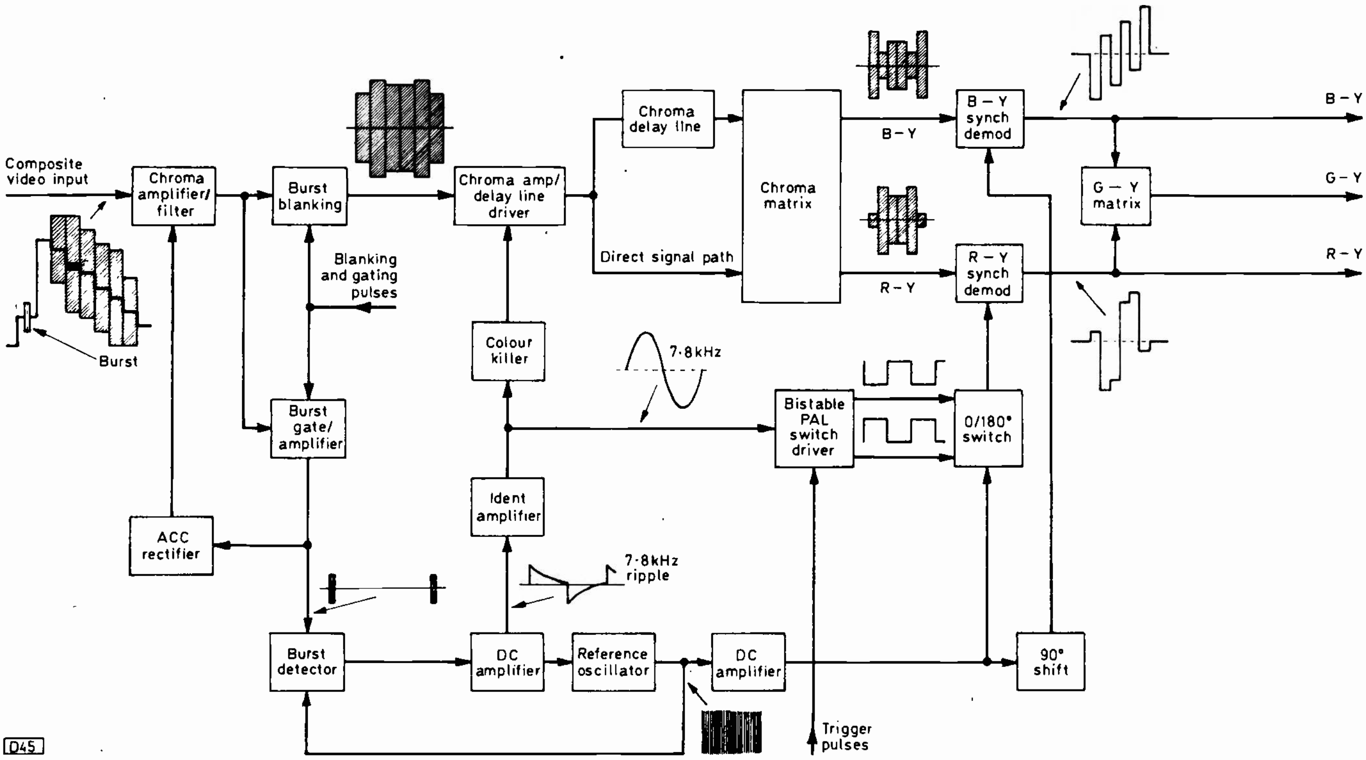
Returning to Fig. 1, you will see that certain waveforms have been included in order to show the type of signal present in the different parts of the decoder. The input consists of the detected composite video signal, which is first filtered so that only the h.f. portion, containing the chrominance signal, is passed to the following stages. The output from the first chroma amplifier, to which a.c.c. (automatic chrominance control) is almost always applied, is fed via the burst blanking section (where the burst is removed) to a further chroma amplifier, and also to the gated burst amplifier. This latter stage conducts only when gated on during the back porch period by a shaped, delayed line flyback pulse, so that the burst only is amplified and presented to the burst detector. A typical arrangement is shown in Fig. 3: VT1 has no fixed forward bias, conducting only when the delayed flyback pulse appears at its base. In addition to being fed to the burst detector (which is of the synchronous variety) the signal appearing at the collector of the burst amplifier can be detected by a simple half-wave rectifier diode whose output is smoothed to provide an a.c.c. voltage – since the burst is not modulated, this signal is an accurate measure of the received chroma signal strength.

Subcarrier Regeneration

The process of separating the burst signal is critically dependent on the timing of the gating pulse from the line timebase. It will be appreciated therefore that if there is any tendency for the line timebase to drift the result will be reduced burst output or burst plus some chroma signal, and since the reference oscillator may then go out of lock the colours may break up – if there's no burst at all the colour killer won't operate, so there will be no colour output from the decoder. This is one of the reasons why colour sets use a stable (sinewave) line oscillator controlled by a flywheel sync circuit. In a few older sets the gating is done by a delayed sync pulse rather than a delayed line flyback pulse in order to overcome the problems produced by line timebase drift.

Sticking with this signal path, it's common next to find a d.c. amplifier and then the reference oscillator itself. This consists of a crystal oscillator with a varicap diode incorporated in its tuned circuit so that its precise phase and frequency can be controlled by the output from the burst detector. The burst detector compares the phase of the bursts and the reference signal, and produces a control potential proportional to the difference. Well, not quite, things are a little more complex. The type of detector used produces zero output when the two signals fed to it are in quadrature. Since the average phase (see Fig. 2) of the transmitted bursts is along the –(B –Y) axis, this means that the oscillator phase locks along the R – Y axis. A 90° phase shift further along in the decoder gives us a signal with the correct phase for demodulating the B – Y chroma signal.

Now let's ponder what we have just said: we said *average* phase, since as we mentioned earlier the transmitted bursts



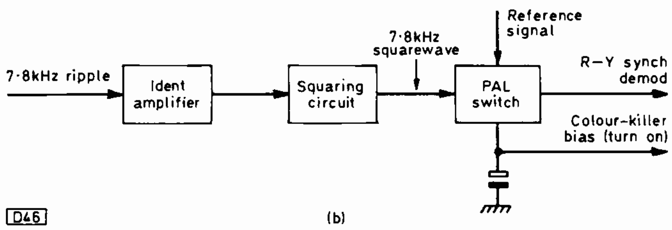


Fig. 1: (a) A common PAL decoder arrangement, with the waveforms present in the various circuits. The signal waveforms are applicable with a standard colour-bar input.

(b) The decoder in the Thorn 3000/3500 chassis differs as shown here from the arrangement depicted above: there is no bistable, the ident signal being squared and used to drive the PAL switch directly. The colour-killer bias is obtained from the PAL switch. This decoder was produced in very large numbers.

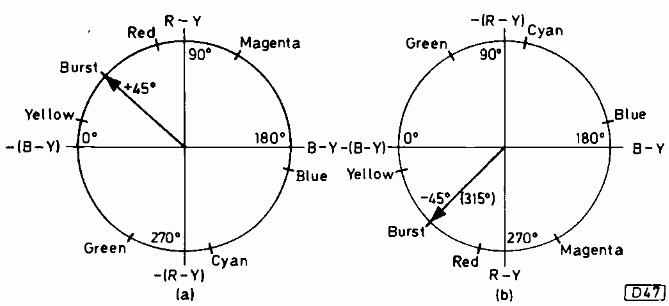


Fig. 2: Phasor diagrams for lines with a non-inverted R−Y signal (a), and with an inverted R−Y signal (b). Note how the phase of the burst signal shifts by ±45° about the −(B−Y) axis: this is used by the decoder to identify which lines have non-inverted and which have inverted R−Y signal components.

are phase shifted by ±45° on alternate lines to provide a synchronising signal to control the switching necessary to get the correct polarity R − Y signal on each line. The reference oscillator control loop does not respond to this line by line alternation – its time constant is too long. But since the phase detector produces an output whenever the two inputs to it are other than 90° apart this means that it will produce a ripple signal output (see Fig. 4) at half line frequency (7·8kHz). This is amplified by the ident amplifier to produce a 7·8kHz sinewave which is used to synchronise the R − Y switching and can be rectified to provide the colour-killer action (no bursts means no colour, so the colour-killer, which usually consists of a rectifier plus smoothing, produces no output to bias on one of the chroma amplifier stages).

The reference oscillator output is usually fed to an emitter-

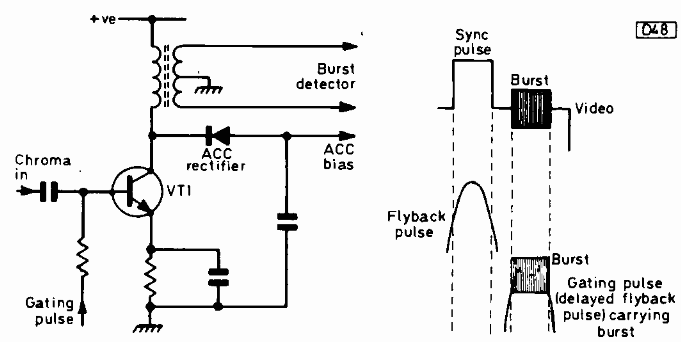


Fig. 3: Typical burst gate/amplifier circuit, with a.c.c. rectifier. The gating action is depicted on the right.

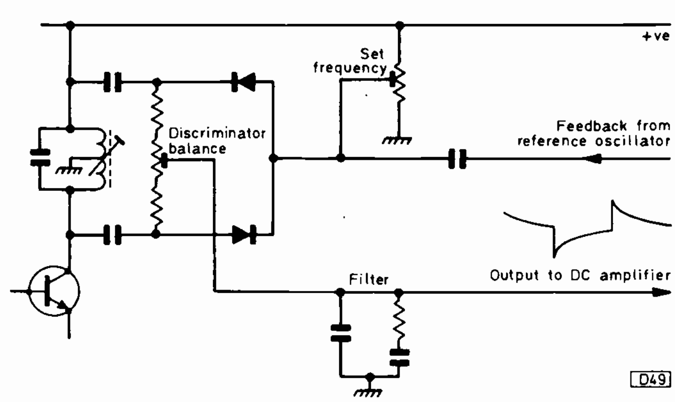


Fig. 4: Typical burst detector circuit.

follower (see Fig. 5) which acts as a buffer, preventing the load stopping the oscillator or affecting its frequency.

The reason for including a colour-killer is to ensure that the chrominance channel is not operative during a monochrome transmission. If it was, noise generated in the chroma channel could result in coloured interference on the screen.

PAL Switch

We have seen that the phase of the reference oscillator's output is locked to the R – Y axis. Because of the polarity reversals of the R–Y signal on alternate lines however the reference signal fed to the R – Y synchronous demodulator has to be reversed on alternate lines in sympathy. For this reason it's fed to the R – Y detector via an 0/180° switch: this is driven by a bistable multivibrator which is triggered by line frequency pulses. Since the bistable outputs are at half line frequency, the switch will give 0° signal shift on one line and 180° signal shift (this equals signal polarity reversal) on the next. The whole operation is synchronised by the 7·8kHz output from the ident amplifier, this output in turn being controlled by the phase alternation of the transmitted bursts.

Chroma Signal Channel

To turn now to the chroma signal path, the output from the chroma amplifiers is fed directly to the chroma matrix circuit (add and subtract circuits) and also to the same circuit via a 64μsec (one line period) delay line. In consequence, the matrix receives the transmitted signal and also the equivalent signal from the previous line. Due to the polarity alternations of the R–Y signal, the add and subtract circuits in the matrix separate the R–Y and B–Y components of the chroma signal, at the same time converting the effect of any spurious phase shift to a slight reduction in saturation (a slight reduction in colour intensity is barely noticeable, whereas an actual colour change is).

Briefly, the adding and subtracting operation is as follows:

	Add	Subtract
Received signal	(R – Y) + (B – Y)	(R – Y) + (B – Y)
Delayed signal	– (R – Y) + (B – Y)	– (R – Y) + (B – Y)
	2 (B – Y)	2 (R – Y)
		(change sign and add)

Nothing is ever quite what it seems however, and in practice we get R – Y from the add circuit and B – Y from the subtract circuit. This is due to the fact that the delay line introduces a further 180° shift in the system.

Synchronous demodulation then provides R – Y and B – Y video signals, and as mentioned earlier a further matrixing process provides us with the third colour-difference video signal. Add the luminance video signal to these and we get R, G and B video signals to drive the c.r.t. cathodes (RGB drive). Alternatively, feed Y to the c.r.t. cathodes and the colour-difference signals to its grids and let the tube do the adding to give red, green and blue at the screen (colour-difference drive).

It's obviously important to keep the d.c. conditions at the c.r.t. right, since differential drift between the channels will produce wrong colours. It's for this reason that clamp circuits are so widely used in tube drive circuitry.

There is a great deal of difference in detail between different decoders. One decoder which differs radically from the usual pattern is that used in the Rank A823 series of solid-state receivers. This does without the reference oscillator and its a.p.c. loop, using the amplified bursts themselves to drive a tuned circuit which provides the required subcarrier – slightly more elaborate phase shifting circuitry is required, since the subcarrier thus produced will be in phase along the –(B–Y) axis. This decoder has been described in some detail recently however (see the November 1977 issue) so we won't go over the same ground here. More recent receivers use chipped decoders, but since most of the circuitry is hidden away in the little black lozenges fault finding consists in general of deciding which i.c. is most likely to be at fault and checking pin voltages – except for the complication that so many of the faults in these decoders are intermittent.

No Colour

The first thing to do when confronted with no colour is to check whether the chroma amplifier controlled by the colour killer is receiving bias – the controlled stage varies from decoder to decoder, but it's generally the second chroma amplifier. If the bias is present, the colour killer, ident amplifier, the burst channel and the first chroma amplifier are working. The fault therefore lies either in the following chroma circuitry or in a break in the feed between the reference oscillator and the synchronous demodulators (which will provide an output only when both the chroma and the reference signal inputs are present) – the reference oscillator itself must be operational since if it's not working there will be no burst detector output.

If there's no bias, provide some, i.e. override the colour killer. This is generally done by connecting a resistor of about 22kΩ between the l.t. rail and the base of the controlled stage. Amongst the exceptions, in the Philips G6 chassis remove the PCC85 valve on the decoder panel, remembering that this will affect the a.c.c. as well; in the Philips G8 chassis connect TP26 to TP80 (25V); in the Decca 30 series chassis link TP205 and TP206 – in the earlier 10 series do the same thing by linking the emitter and collector of TR214; in the Bush A823 and its derivatives turn the ident control fully clockwise; in ITT hybrid receivers the output from the ident amplifier is used to enable, i.e. bring into action, the bistable circuit, the colour killer switch-on bias being obtained by smoothing the squarewave output at the collector of one of the bistable transistors, thus in the absence of the ident signal the bistable stops switching and one collector will be high and the other low, with no colour killer bias.

Having overridden the colour killer, observe the result on the screen. A series of horizontal bands of colour across the screen, i.e. unsynchronised colour, indicates that the reference oscillator is working but is not locked. The ability to change the oscillator frequency by adjusting the set frequency or a.p.c. bias control – or whatever it's called in the particular set – will indicate that the d.c. amplifier and the varicap diode in the oscillator circuit are in order, so thought must then be given to the burst channel. The possibilities here are that the timing of the gating pulse is wrong or that it's absent, that one of the transistors (there are generally two) is defective, or that the burst detector isn't working – wherever possible use a scope to eliminate guesswork and make life easier.

If normal colour is obtained on overriding the colour killer, interrupt the signal a few times. Red/green changeover indicates lack of ident signal. Check the ident circuit and the tuning of the coil. No colour change suggests that the colour killer circuit is defective. There's generally a rectifier with a reservoir capacitor and maybe a transistor which switches on/off for colour/monochrome.

No colour, or a very faint pink or green tint with no other

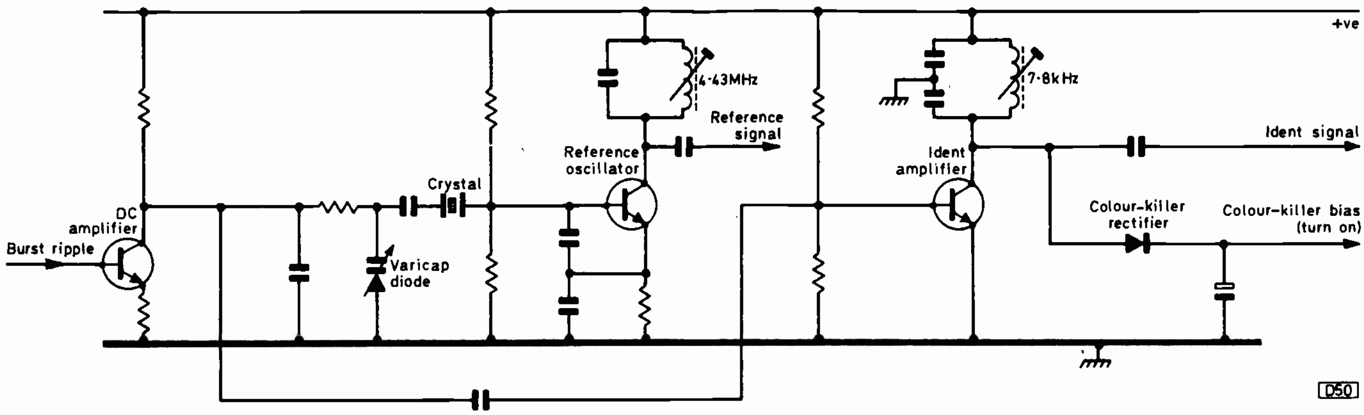


Fig. 5: Typical crystal reference oscillator and ident amplifier circuits.

colour visible, after overriding the colour killer usually indicates a duff oscillator and/or following buffer transistor or, very unlikely, that both chroma demodulators have failed.

No colour at all can also indicate a fault in the first chroma amplifier or on the i.f. strip – many sets have a separate chroma detector here plus sometimes one or two chroma amplifier stages. If there's a plug and socket connection between the i.f. strip and the decoder panel (Thorn 3000 chassis for example) take a look at the print around the area of the plug: this can often be the cause of intermittent colour. Again, a scope check will reveal all.

A faulty reference oscillator is quite a common fault, in many decoders due to suspect capacitors. Use good quality capacitors here and make sure that you use the correct type if the transistor itself has to be replaced.

Blinds

So much for no colour: other things can and do occur! For example, Hanover blinds – the reds look yellow at a distance. Look closely at a red raster. If alternate lines are red then green the bistable is playing games. If one line is o.k. but the next is desaturated red the alignment of the chroma delay line/matrix circuit is incorrect (for correct operation, the direct and delayed signals must be of identical amplitude and phase, and there are generally adjustments for this purpose). If the R – Y polarity switch is opening on alternate lines only you get a red line followed by a black one.

Incorrect Colours

The cause of incorrect colours depends on the symptoms and the type of set, particularly on whether colour-difference or RGB tube drive is used. More or less permanent red/green changeover on Pye and GEC hybrid receivers is frequently due to one of the capacitors in the ident tuned circuit, while on the earlier Bush single-standard (A823 chassis) sets it may be incorrect setting of the ident phase control.

Owing to production changes, many sets with replaceable decoder panels may have had the video drive output pin connections changed over, which doesn't do much for the colour! For good colour, the alignment of the burst stage(s) is critical in most sets.

With colour-difference drive, the cathode drive presets or tag connections may have been wrongly set to compensate for other faults: this adjustment has the maddening effect of upsetting the grey-scale tracking no end.

Lack of one colour usually means that one of the output stages has failed, though it could always be the tube of course. You might have to check right back to the demodulators however, or the G – Y matrix in the case of no green.

If the grey scale is drastically wrong, check the c.r.t. first anode voltages. If colour-difference drive is used, check for around 100V at the c.r.t. grids and 200V at the cathodes. If one of the former voltages is wrong, check the appropriate triode clamp circuit: if one of the latter is incorrect, trace through the cathode drive chain (Korting sets have a habit of losing 1·5kΩ resistors on the tube base panel due to c.r.t. flashovers). If RGB tube drive is used, all three grids should be at the same voltage, normally around 20V, while a correctly biased cathode will be at around 150V – higher and the related colour will be off, lower and that colour will be poorly if at all defined and excessively bright, possibly with flyback lines. Many RGB circuits use d.c. coupling and d.c. feedback, which can mean of lot of checking. Work out what will turn off the stage, and try applying the famous crossed screwdriver technique between the base and emitter of each accessible transistor to find out which one produced no difference.

Miscellaneous Faults

The luminance channel can produce odd faults. The small wirewound luminance delay line can go open-circuit, removing the luminance altogether, or the earth lead on it can come adrift with the result that there's no delay, i.e. the luminance signal arrives before the chrominance signals, the luminance signal shifting to the left to produce the effect of a coloured ghost.

Flyback suppression in sets using a PL802 luminance output pentode is usually carried out in its cathode circuit. Faults here can cause, surprise surprise, flyback lines, or can result in the PL802 being cut off.

If you don't know what no luminance looks like, the next Pye hybrid receiver you come across turn the contrast right down and the chroma right up and you'll see the effect.

Varying colour can be caused by an a.c.c. fault. On some sets, e.g. the Rank A823 series, there's an a.c.c. amplifier. Faults here will often produce great colour variations from cold to hot running.

Finally, a note about decoder variations. We pointed out earlier the unusual fact that failure of the bistable in ITT hybrid receivers will result in no colour. Failure of the bistable will also remove the colour, though for different reasons, in the Rank A823 series. The latter is an unusual decoder, and when dealing with it it's essential to proceed in a logical manner, following the signals through the relevant stages. ■

TV Teletext Decoder

Steve A. Money, T.Eng.(C.E.I.)

It has been found that problems can be experienced with the teletext decoder i.f. board under adverse signal conditions, due to signals from the data recovery section getting coupled back into the i.f. section. The effect produced is severe interference on the displayed picture and an unacceptable level of errors in the text mode – unless a strong signal is being received.

The problem has now been investigated, and after extensive testing the conclusion reached is that the trouble is due to common coupling through the earthing tracks of the printed board. The effects can be eliminated by adding several wire links between earthing points in the i.f. and the data recovery sections of this board. Details are as follows.

First, cut the earth track between the junction of R3 and C3 and the can of L3. To restore IC4's earth connection, connect a wire link between the earthy end of R38 and a point on the central earth track near IC5 and VR3. Use a second wire link to join the i.f. section earth track at a point under L1 to the central earth track near R31. Two further links between these two earth tracks are needed: these are taken from each end of the wire link across the end of IC5 to points on the i.f. earth track at each end of the SW150 SAW filter. The wire link itself should be removed, and C19 moved from its present position and connected directly across pins 2 and 11 of IC5, on the print side. Also, connect an 0·1μF ceramic capacitor directly from pin 13 of the TDA440 i.f. i.c. to the i.f. earth track running between the i.c.'s pins, and another from the 12V end of R17 to the central earth track nearby. It is obviously convenient to mount these on the print side.

Variations in the characteristics of TDA440 i.c.s produced by different manufacturers may result in a mean d.c. signal input to the data slicer i.c. IC5 such that potentiometer VR3 cannot be adjusted for proper slicer operation. Reducing the value of R15 to 470Ω should cure this condition.

In some cases it may be found that the tuner a.g.c. delay control VR1 does not allow the correct crossover point to be reached. If this occurs, increase the value of VR1 to 10kΩ.

Some smearing of the text display may be experienced due to the loading effects of the sound extraction circuit C16/CF1/R38. Reducing the value of C16 to 100pF should improve the text display in this respect. Lower values for C16 may produce excessively noisy sound in the text display mode however.

It should be noted that for reliable operation in the text mode a good input signal is essential, and an aerial input level of the order of 1-2mV is likely to be necessary. This represents a good colour picture on a standard receiver. The signal must be free of reflections, and orientated for optimum reception on all three channels if the signals on all three channels are to be decoded correctly.

If the modulator is unable to handle the video signal without overmodulation, the value of R19 should be increased to 390Ω.

When the decoder is used in the TV mode some picture degradation may be experienced since there is a tendency for some cross coupling between the video and text signals in the switch panel and in the cables feeding the video signal to the modulator. This results in a slight grainy pattern on the displayed picture under some conditions. To eliminate the effect, the junction of R14 and VR3 should be connected to chassis when the decoder is used in the TV mode – this can easily be done by making use of one of the spare switchbanks on the TV/Text switch on the switching board.

To protect the ZTK33B 33V voltage regulator on the i.f. panel when testing or servicing the decoder, it's recommended that a 100kΩ resistor is added directly across C4 on the power supply panel. This ensures that if the i.f. board is plugged in with the decoder switched on the ZTK33B does not receive a voltage spike which may damage it.

There was an error on the tuner layout modification diagram (Fig. 5, page 597, September) for conversion to modulator use. The link between R13 and R21 should be shown connected to the other side of the printed track break made at the R20/R21 end. ■

Off-screen photographs of reception via the TV Teletext Decoder: left, in the text mode; right, in the picture mode.

The Television MONOCHROME PORTABLE RECEIVER

Part 4

Keith Cummins

ASSEMBLING the printed board is not a particularly difficult task, but it's important to remember that success at switch-on depends almost entirely on the constructor thoroughly checking the board after completion. Particular attention should be paid to i.c.s, transistors, diodes and electrolytics. The power transistors Tr1 and Tr2 should have some heatsink compound smeared on before bolting to the heatsinks. Incidentally, the unmarked capacitor immediately below R3 on the board layout shown last month (Fig. 8) is C4 and is larger than the outline shown. Use a miniature pluggable type (e.g. Siemens).

Cabinet Construction

The next task is to construct the cabinet, using the cabinet kit specified (see components list in the November issue) or the diagrams shown overpage. The main cabinet frame, including the front panel is simply glued together using a proprietary wood adhesive and left to cure overnight. It is worthwhile tying the frame during curing to ensure that it sets without distortion.

The support struts can either be glued into place at the same time or after the main frame has been completed. For those readers using the kit, remove excess glue before curing to ensure a good finish. The speaker and tuning head bezels are then glued into place and the speaker, tube and tuning head fixed to the cabinet.

The prototypes used an aluminium bracket to hold the rectifier, electrolytics, battery socket and fuses. This is mounted on the cabinet base, at the left-hand side. Constructors may, however, wish to use alternative methods to secure these components.

Interconnections

Next, earth the c.r.t. aquadag to the main earthing point at the reservoir capacitor. A spring is the preferred way of doing this, but other methods may be used such as coaxial cable with the outer sheath removed. One end is looped round the top right-hand tube securing bolt, then run diagonally across the tube, ending up at the power supply. An additional wire secured to the bottom left-hand tube securing bolt is attached to the braid or spring to provide sufficient pull to ensure good contact with the tube bulb.

The board is then connected to the tuning head, volume and brightness controls, l.e.d.s, power supply and e.h.t. socket on the tube. Connect the leads from the board to the tube base socket, but do not initially connect the socket to the tube. Make the necessary interconnections to the mains switch, battery socket, reverse polarity indicator and fuses.

At this point we must again emphasise the importance of checking. It is a good idea to check through the leads, making sure they end up in the right places. If everything appears to be in order, check to see that no obvious short-circuits exist – using an Avo on the ohms range.

Setting up

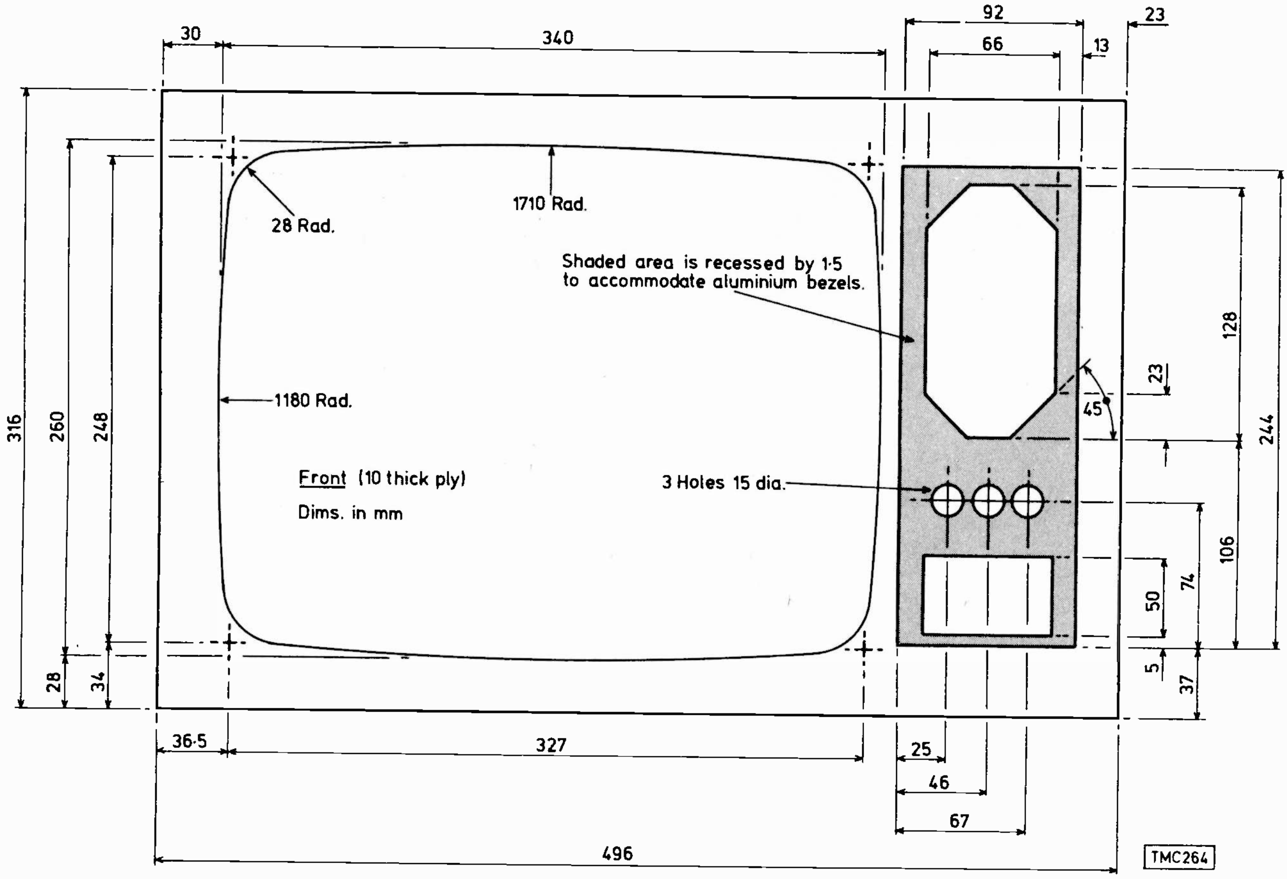
Now we come to the setting up procedure. Set all potentiometers about halfway, including the volume and brightness controls. Connect the receiver to the mains, and adjust RV3 for +11V measured at the collector of Tr1. If the fuse blows, the voltage was initially too high, thus firing the crowbar thyristor.

If all is well, the line whistle should be heard. Check that the scan-derived power supplies are available, including the boost voltage. Expect about +25V on the positive side of C5, +95V on the positive side of C8, and +550V on pin 6 of the tube. These are representative values only, and will vary according to the sample of line output transformer used.

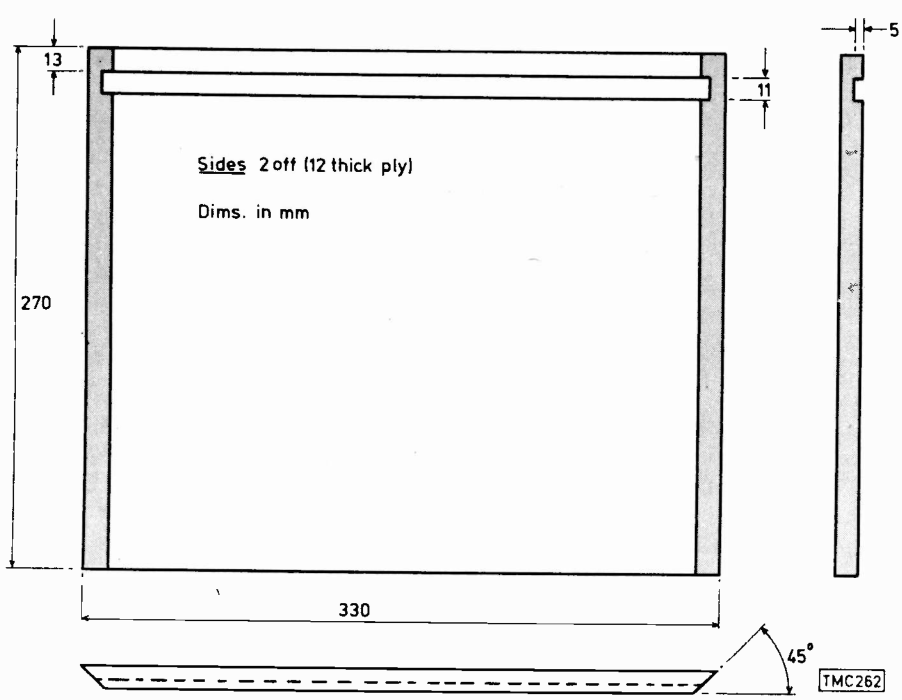
Fit the tube base. The tube heater should now be alight. Recheck the +11V rail (easily measured from the case of Tr1 to earth) and reset RV3 if necessary. During this period some illumination of the screen may occur. Adjust the brightness control to keep any illumination at a reasonable level. Check that −5·6V appears across D22.

Next, check that the stabilised +32V supply has appeared across the TAA550 (IC101). A hiss should now emanate from the speaker. The scan coils must now be orientated so as to "square up" the raster, making sure that the coils are up against the neck of the tube. Tighten the securing screw on the scan coils, but expect to make some small final adjustments later on.

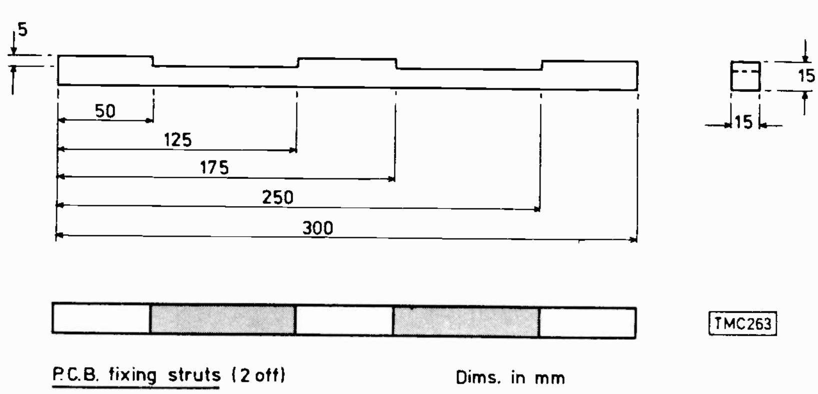
If a good aerial signal is available, connect it to the receiver input via a 12 or 18dB attenuator (depending on whether the signal is average or very strong). Depress a



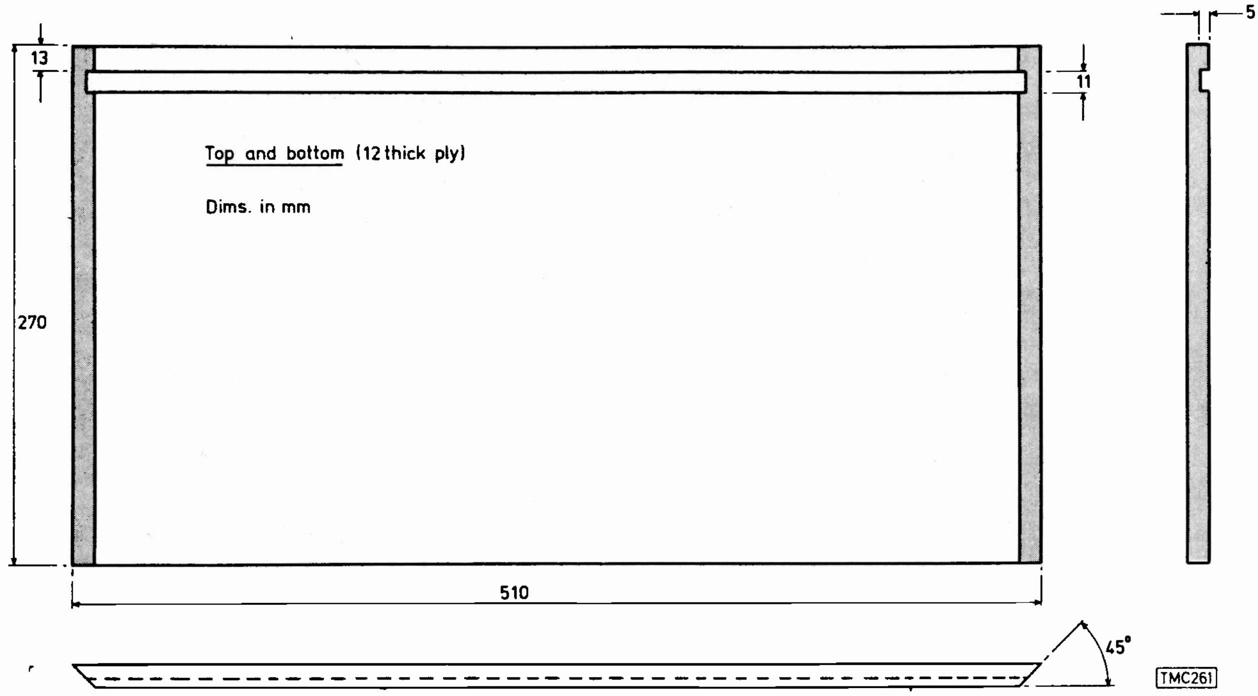
↑ *Front view of cabinet.*



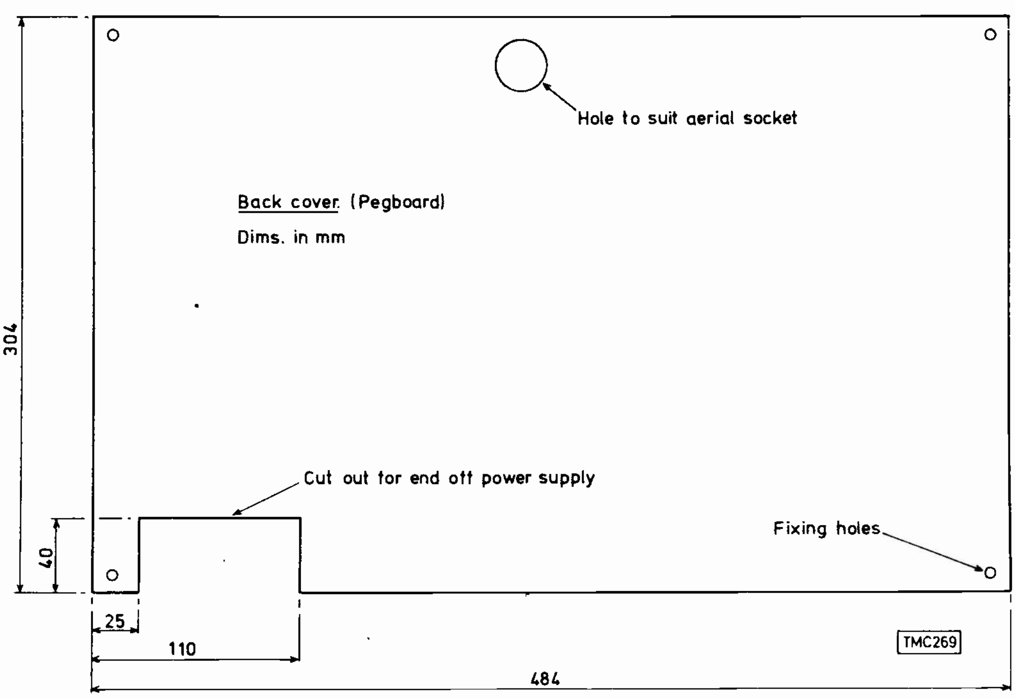
← *Cabinet side panels.*



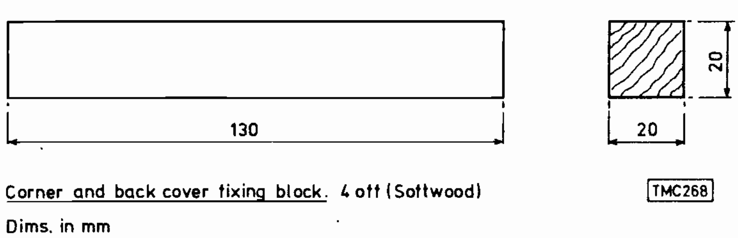
→ *Printed circuit board fixing struts.*



↑ *Top and bottom panels.*



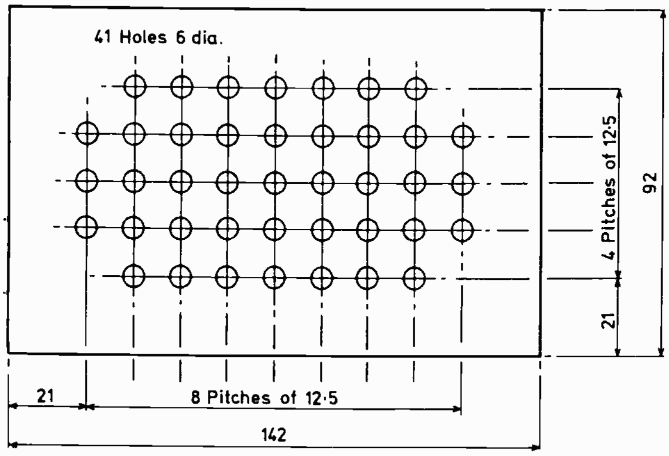
→ *Receiver back cover.*



← *Fixing blocks.*

tuning button and try to locate a channel. At this stage, buzz on sound will occur (possibly with the sound in the background) and the screen should show a line-slipped picture. Adjust RV4 to obtain correct line hold, and RV5 to lock the field. Readjust the tuning if necessary, and recheck RV5 for best interlacing.

Remove the attenuator and adjust RV8 for correct vision without overloading (evidenced by rolling, bent verticals, etc.). Finally, adjust RV9 for a normal contrasted picture in conjunction with the brightness control. Refit the attenuator to check that the a.g.c. system operates. The picture should be more grainy, but not reduced in contrast. Picture height

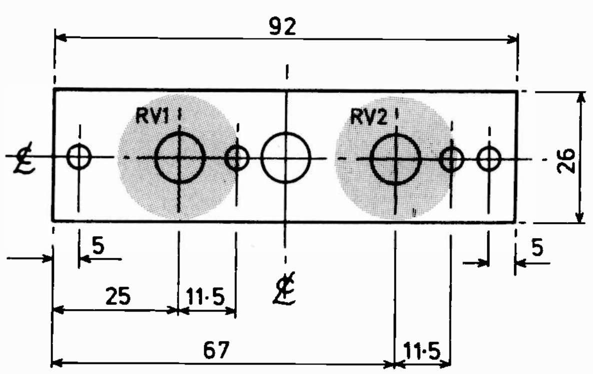


Speaker bezel. Aluminium alloy 1 thick. TMC265

Dims. in mm

Speaker grille.

Control mounting bracket.



Potentiometer bracket TMC267

Aluminium alloy 1·5 thick

4 Holes 4dia.

3 " 9·5dia.

Dims. in mm

and field lineality can now be adjusted, preferably on a test card.

If the width is inadequate, shunt C11 with a 4n7 400V polyester capacitor. Note that the field is slightly underscanned when first switching on, but rapidly reaches its correct amplitude.

Adjust the core of L8 for correct sound. Finally, the i.f. output core in the tuner may be adjusted on a test card for optimum definition. Ensure that this adjustment does not noticeably reduce receiver sensitivity. The vision selectivity and gain/demodulator modules are prealigned and the cores of any coils in these modules should not be adjusted under any circumstances.

The other tuner buttons can next be set to the appropriate channels, and the receiver is then completely set up. If used on an aerial system delivering more than 1mV, we recommend the permanent use of an attenuator to avoid cross-modulation in the tuner.

Fault Finding

If the 1·5A fuse blows, ensure that the output from the regulator is +11V. If this value cannot be obtained, then the regulator section is faulty. Under these conditions, the crowbar operates due to an abnormally high output voltage from the regulator. A blown mains fuse usually indicates failure of the bridge rectifier.

Tuning drift is usually caused by a defective TAA550. Horizontal flashing dark lines accompanied by tuning difficulties will normally be traced to a tuner fault.

No picture with correct sound and a blank raster probably means that Tr11 has developed an open-circuit emitter-collector.

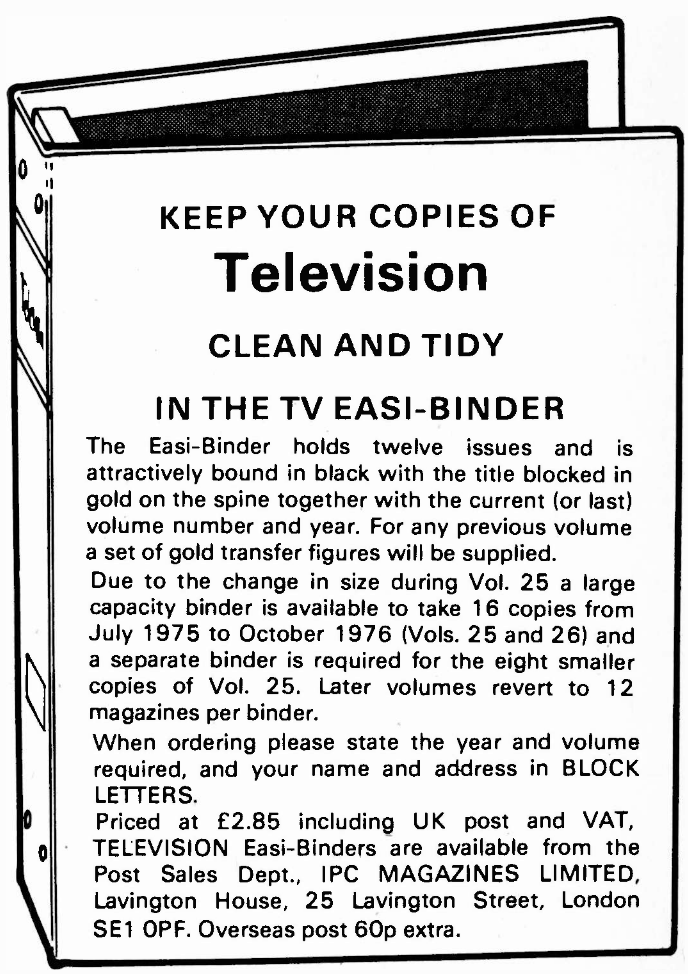
No grain or hiss indicates a defective tuner, i.f. module, or Tr7.

Complete field collapse can be caused by RV6 going open-circuit, or by a defective TBA800 or perhaps the SN76544N (field section).

Defective diodes fed from the line output transformer to produce the scan-derived supplies will cause heavy damping of the line output stage, giving rise to no brightness, low +11V rail and overheating of Tr2. This can be most confusing to someone not familiar with the situation. Note that an in-circuit check of the diodes is not always adequate – a 50kΩ reverse resistance can cause trouble and will only be read accurately if the diode is removed from the circuit. The above comments also apply to a defective e.h.t. rectifier.

Good Luck!

We hope that the last remarks do not cause clouds of gloom to gather. We are confident that with careful construction *and checking,* preferably with constant reference to the circuit diagram, constructors will not experience difficulties with this receiver. It is our firm belief that the design will provide many trouble-free viewing hours. ■



30-Channel Remote Control

Part 1

T. E. Barrett

IT is several years since Thorn, Philips, ITT and Rank introduced TV sets incorporating simple ultrasonic remote control, enabling sequential channel changing, sound muting and switching the set off from the comfort of one's armchair. As is so often the case however, the UK setmaking industry tends to lag behind its European counterparts when it comes to introducing new ideas and technology. A number of continental sets have been imported (notably from Germany and Scandinavia) which have taken the principle considerably further – direct (non-sequential) channel selection, proportional control of colour, volume, brightness (and contrast in some instances), an 'ideal' command which sets the brightness, colour and volume to preset values giving a 'normal' display. In addition there is an 'off' facility, although this is normally treated as 'standby' – the set is virtually switched off except for the remote control receiver section and is switched on again when any one channel is selected.

For reception of teletext, this type of remote control becomes almost obligatory, since the number of customer controls is considerably increased – page selection, TV/text switching, auxiliary function switching, e.g. newsflash, update, mixed display, etc. ITT and Thorn have recently introduced up-market sets with 30 channel remote control systems based on two i.c.s manufactured by ITT Semiconductors. Although Mullard and others are in the process of offering alternative remote control systems to setmakers, this is the only one currently employed and is therefore the one we have chosen as the basis for this article. We shall first of all look at the principles of operation, as illustrated by the ITT and Thorn circuits.

The i.c.s in question are the SAA1024 which is used for the transmitter, and the SAA1025 receiver. They are both CMOS types and can be used in conjunction with either ultrasonic or infrared transmitter/receiver systems, although we shall concentrate on the former.

The transmitter

The SAA1024 comprises an oscillator, a variable and a fixed frequency divider, an encoder and command error protection. The 30 ultrasonic transmission frequencies, which lie in the 33-44kHz range, are derived from the frequency of an oscillator controlled by a standard 4·4336MHz crystal, with the aid of a variable frequency divider operating on the "blanking" principle. First of all the i.c. divides the oscillator frequency by two. Then the variable frequency divider blanks out 1-30 pulses from each 128 2·2168MHz pulses depending on the command given.

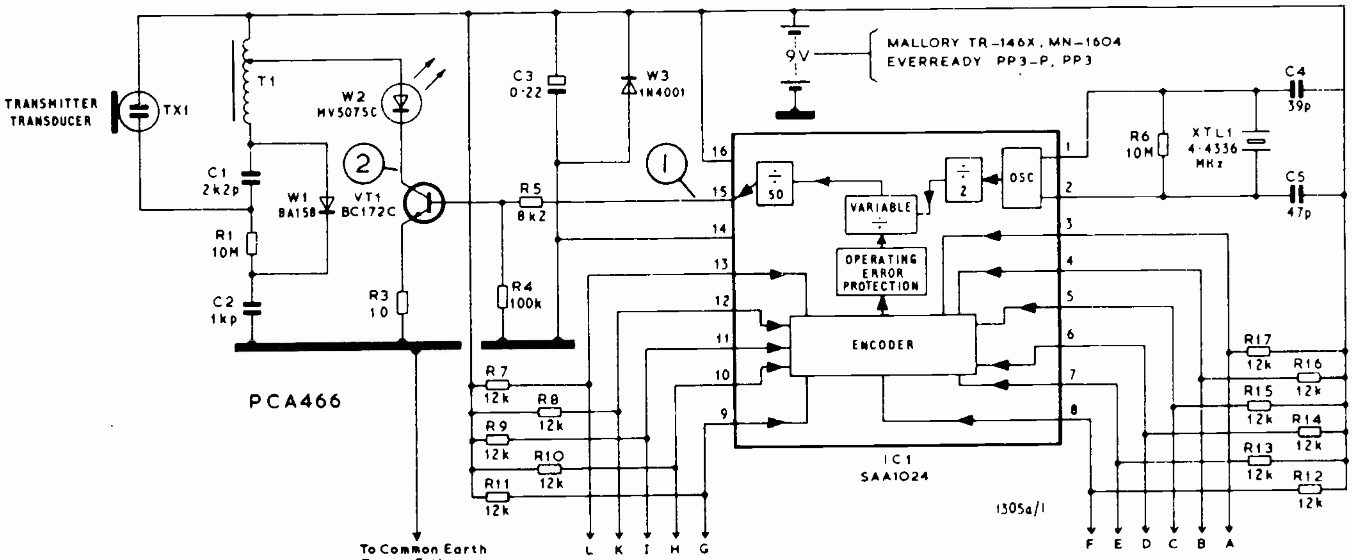
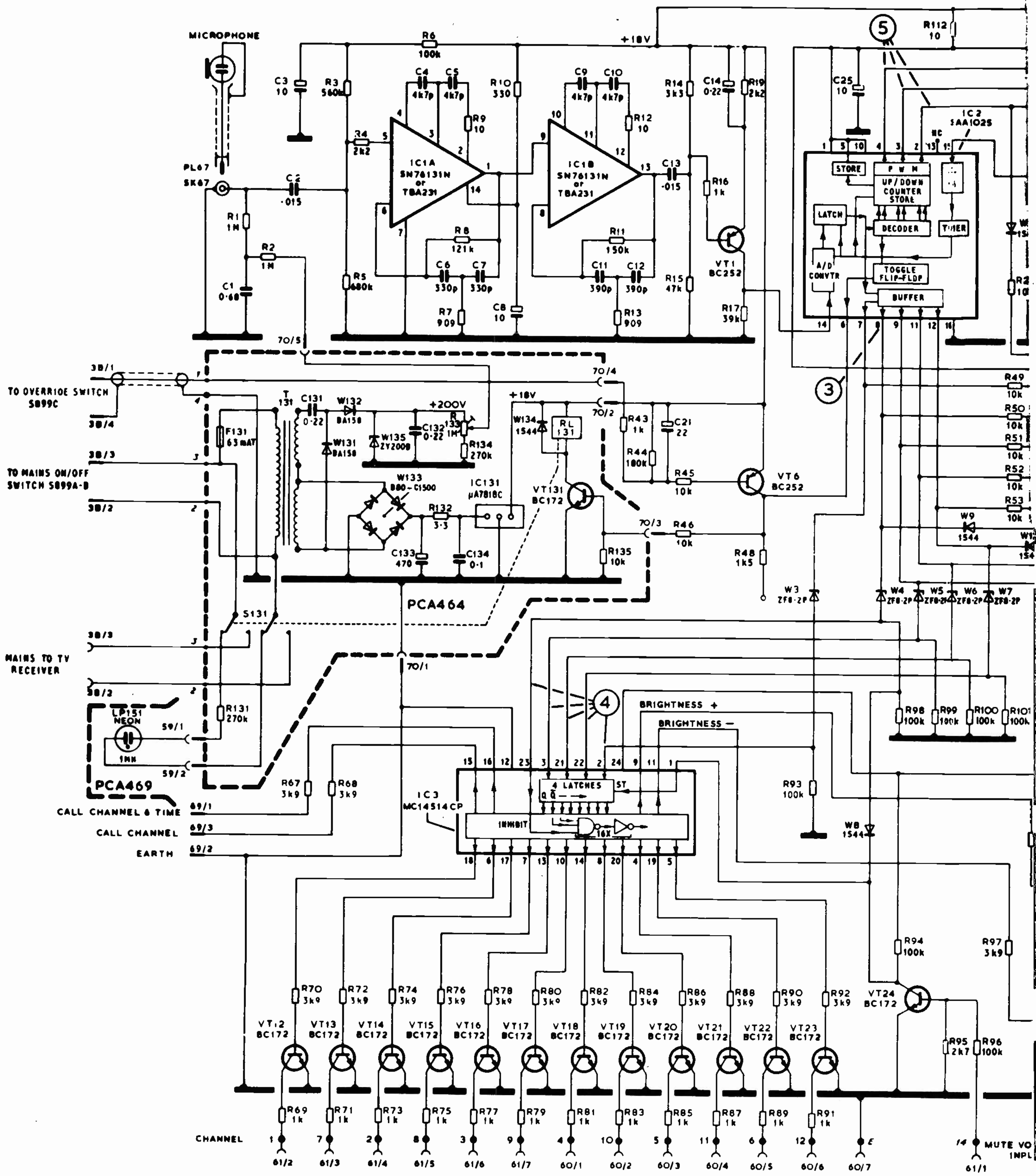


Fig. 1. Circuit diagram of Thorn's transmitter using the SAA1024.



This frequency is further divided by 50, providing the 34-44kHz output which is coupled to the transducer. Error protection is incorporated in the i.c. and this disables the oscillator and keeps the variable frequency divider fixed whenever more than one command is given.

The Thorn 4200 series chassis uses the SAA1024 in its transmitter circuit and this is shown in Fig. 1. In this particular application, only 24 out of the possible 30 channels are used. Operation is as follows. Each of the inputs A to L are normally at supply potential. A command is transmitted whenever one of inputs A to E is earthed simultaneously with one of inputs F, G, H, K or L. Output is from pin 15. As this pin must not have a d.c. voltage greater than −0·3V with respect to earth, a buffer stage using VT1 is used to drive the transducer. Since the transducer used is a capacitive type it must be polarised and also requires a high peak-to-peak driving signal. The output from VT1 passes through a light emitting diode (W2) which serves as a battery condition indicator. It is then coupled to the transducer via auto-transformer T1. This provides a pk-pk driving voltage of between 340 and 380V, depending on the frequency. The transducer is polarised by the action of

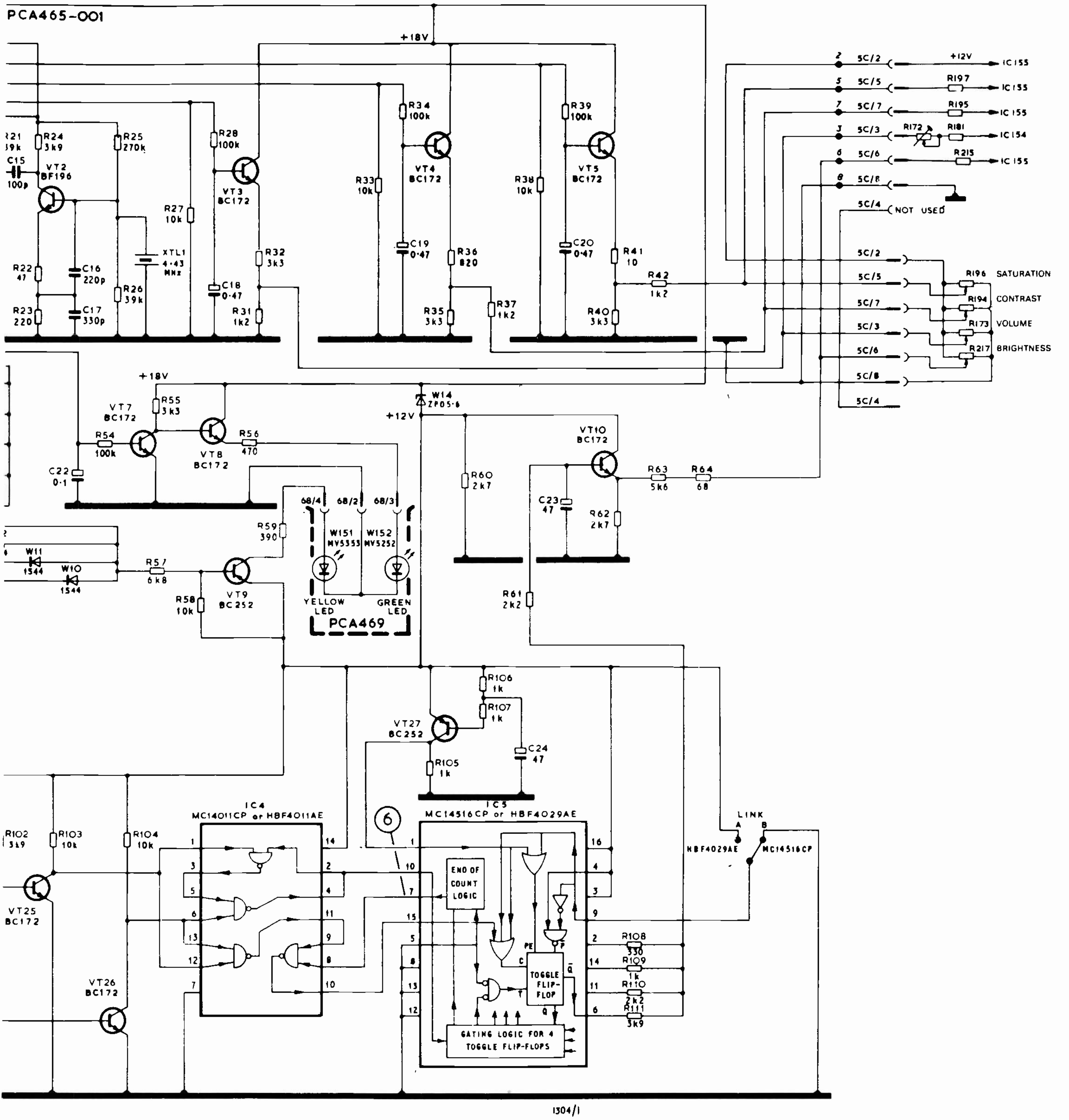


Fig. 2. Thorn's receiver circuit used in the 4200 series chassis.

diode W1 which conducts on positive peaks, charging C2. C1 acts as a d.c. blocking capacitor. W3 protects the i.c. against incorrect battery connection.

Standing current of the complete circuit is less than 10μA, obviating the need for an on-off switch. Whenever a command is being transmitted, the current consumption is between 35 and 45mA.

Fig. 3 shows the 24 commands provided by the Thorn transmitter, together with the control inputs which must be earthed to activate the particular command, and the transmitted frequency.

The receiver

The receiver section of the system uses i.c. type SAA1025. Referring to the Thorn circuit given in Fig. 2, the ultrasonic signal is picked up by the transducer, which is polarised from the 200V rail provided by T131, via R1 and R2. The signal is then passed to a cascade amplifier built around a TBA231 pre-amplifier i.c. The circuit is designed by the use of selective negative feedback to have a bandpass response of 30kHz to 46kHz.

The output from the pre-amplifier is passed to transistor

TRANSMITTER

	COMMAND	CONTROL INPUTS EARTHED	APPROX. FREQUENCY OUTPUT (kHz)
1	Standby	H and E	33,95
2	Sound Mute	L and E	34,29
3	Colour +	G and E	34,64
4	Colour –	F and E	35,33
5	Contrast +	A and F	36,02
6	Contrast –	B and F	36,72
7	Volume +	C and F	37,41
8	Volume –	D and F	38,10
9	Call Channel	G and A	38,79
10	Call Channel and Time	K and A	39,14
11	Brightness +	H and D	43,64
12	Brightness –	L and D	43,99
13	Channel 12	B and K	39,83
14	Channel 11	B and G	39,49
15	Channel 10	D and G	40,87
16	Channel 9	D and K	41,22
17	Channel 8	L and B	42,60
18	Channel 7	H and B	42,26
19	Channel 6	G and C	40,18
20	Channel 5	K and C	40,53
21	Channel 4	A and L	41,91
22	Channel 3	A and H	41,56
23	Channel 2	C and H	42,95
24	Channel 1	C and L	43,30

Fig. 3.

VT1 which amplifies and limits the sinewave to produce a squarewave output which is fed to the input pin of the SAA1025.

The crystal-controlled oscillator VT2 provides an accurate and stable clock frequency for the i.c. In the i.c., the 4·4336MHz signal from the oscillator is amplified and drives a clock generator consisting essentially of a flip-flop and an 8 by 1 divider, producing a two-phase clock signal with a pulse duty factor of $\frac{3}{8}$ to $\frac{5}{8}$ at 277kHz. Connected to the clock generator is a 3200 by 1 divider which delivers pulses with a 23·1ms spacing for control purposes and for determining the measuring time. The ultrasonic signal is passed through a pre-amplifier and then synchronised with the operational clock signal. The signals thus obtained are fed to the circuit which measures the duration of the cycle. If this measurement reveals too long or too short a cycle the sequence control is reset and the measuring cycle re-started.

On a second path, an 8 by 1 pre-divider is controlled by the synchronised ultrasonic signals. This divider determines the channel spacing. The command counter is connected to this pre-divider and, together with the test circuit, forms a 7 bit binary counter. The test circuit ensures that the 5 bit command counter performs three complete counts before the result is evaluated. This excludes the possibility that frequencies which are fractions or multiples of useful frequencies produce wrong commands. The command counter comprises a 5 bit register whose contents are compared with the result of the repeat measurement before a command can be evaluated.

All commands are delivered in coded form via the input/output control system to outputs A to E in the form of negative going pulses of 23·1ms every 184ms – approximately 5Hz. These pulses are present *only* when a command is being issued. The input/output control system ensures also that the command counter is set when commands are produced directly at the input of the TV set.

A switch on 'normalisation' arrangement ensures that all counters and storage devices are set to the desired initial positions when the supply voltage is switched on. This can only happen when both clock pulses operate correctly. The digital/analogue (D/A) control system recodes the commands so that the latter can be used to set the storage devices of the D/A converters accordingly.

The basic clock for the D/A output signals is generated by a chain counter which divides the operational frequency by 31. In this way the 30 available pulse duty factors of the D/A squarewave output signals are determined. The three storage devices consist of five flip-flop stages in each case which can be set in the parallel mode. The information contained in the chain counter is compared with the stored signals by means of EXCLUSIVE OR elements. In the case of coincidence the 'RS' flip-flop is set, and reset, every time zero is passed in the chain counter. In this way, three squarewave output signals are obtained having the same frequency determined by the chain counter, their pulse duty factors being fixed by the information contained in the storage device. The latter is changed by parallel conversion in conjunction with information from the chain counter.

The D/A output signals on pins 2, 3 and 4 are used to control volume, contrast and colour. Upon the command to increase volume, for example, the pulse duty factor is increased: i.e. the length of time the pulse is on increases with respect to the length of time it is off. The pulses are integrated by R28 and C18 and an average DC level is reached dependent upon the pulse length. This is applied to the base of VT3 thus turning the transistor on. VT3 is arranged as an emitter follower or current amplifier, which, dependent upon its conduction, causes a greater or lesser voltage at the junction of R31, R32. The range of operation for the volume control is approximately 2V. The contrast and colour controls work in the same way, their range of operation being 6·3V and 6·7V respectively.

The 5 bit pulsed outputs at pins 7, 8, 9, 11 and 12 of the SAA1025 are coupled to the inputs of IC3 – a 4-line to 16-line latch decoder – via 8·2V zeners to ensure that the input seen by IC3 is at or below 12V. Two of the outputs IC3 (pins 9 and 11) are used to operate the fourth analogue

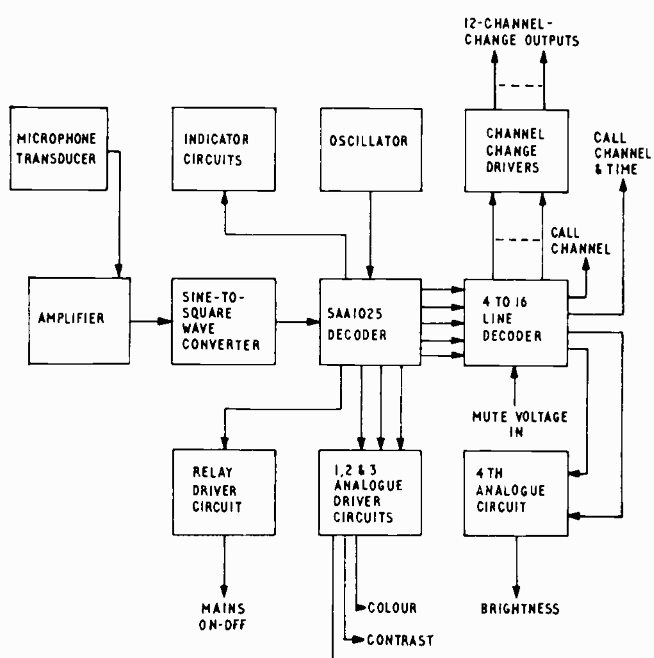


Fig. 4. Block diagram of the receiver used in the Thorn 4200 chassis.

channel for brightness control, whilst the remaining 14 are used for channel changing and to call the channel number or channel-and-time display on the screen. For the latter two functions, additional circuitry is obviously required but this is outside the scope of this article.

Pin 8 of IC2 is connected to the inhibit input of IC3 and the latter will only operate when the inhibit input falls to 0V. This only occurs during Channel changing, Brightness + or –, Call channel and Call channel-and-Time commands.

The SAA1025 has only three proportional controlled outputs. In order to provide a remote facility for the brightness control, a 16-step binary up/down counter, IC5, is used to generate a variable d.c. output. The binary coded outputs of pins 2, 14, 11 and 6 of IC5 are added together by the resistor network R108 to R111 and passed via the integrating network R61, C23 to emitter follower VT10 to give the controlling voltage swing, which in this case is approximately 10V.

Maximum d.c. output (corresponding to minimum brightness) is obtained when pins 2, 14, 11 and 6 of IC5 are all at 11·5V. Maximum brightness is obtained when these pins are at 0V giving minimum d.c. output from the circuit.

At switch-on, the output voltage sits at approximately half-way. This is achieved by the reset circuit VT27 and pin 1 of IC5. When pin 1 is driven to rail supply, the voltage conditions on pins 3, 4, 12 and 13 are transferred to the output pins 2, 14, 11 and 6 so that pins 2 and 6 are at 11·5V and pins 11 and 14 are at 0V. At switch-on VT27 conducts, taking pin 1 to the rail supply. As C24 charges up, VT27 turns off, and pin 1 drops to 0V.

When the 'sound mute' command is transmitted, pin 2 of IC2 falls to 0V, VT3 turns off thus muting the sound. When the same command is repeated, the squarewave output at pin 2 returns to its previous mark-space ratio so that the volume returns to its original level.

The voltage on pin 6 of the SAA1025 is normally 18V when the set is operating. Actuating the 'standby' command triggers the mains flip-flop in the i.c. after a delay of 0·7 seconds. The voltage on pin 6 then drops to zero, turning off VT131. Relay RL131 is thus switched off thereby interrupting the mains supply to the set. Note that the remote control section is independently powered, so that when a channel is selected, the set reverts from standby into an operational mode.

For channel changing a positive output from IC3 of at least 60ms duration is required, but as the pulse output of IC3 consists of 23ms pulses every 180ms, pulse stretching is necessary. This is achieved by using the sound mute pulse which is given out from the channel change i.c. and lasts for 400ms. This pulse turns on VT24, thus pulling down the voltage to the strobe input of IC3. If the inhibit line (normally held down for 23ms) was to go high, IC3 would cease to give an output. W8 is therefore included so that whilst VT24 is on, the inhibit line is also held down. Positive-going pulses of 400ms duration appear at the channel change outputs of IC3, switching on the appropriate output transistor, which in turn causes the required channel to be latched.

Next month we shall have a look at the ITT interface circuitry and provide some fault finding tips.

TV Servicing: Beginners Start Here...

Part 4

S. Simon

HAVING considered how the display tube operates, we must consider how it's provided with the supplies it requires.

The cathode and grid don't present any problems. They are concerned with the signal voltage swings, and a basic difference between them of around 100-150V is all that's required. In a mains powered set this is available from the normal h.t. supply line, which is typically a little over 200V. The more astute (awkward?) reader may ask what about a 12V portable? To this we offer the sage advice: hang on a bit.

The problems come because the first anode and focus electrodes of a monochrome tube require anything from 400V to around 1kV, while the e.h.t. nipple (cavity connector to be precise) requires about 18kV (18,000V). How to obtain these voltages, and how this has been done from the earliest times up to the present, is quite a story which we can go over only briefly. To understand this part of the subject of television receiver design is to understand very nearly the whole lot however, so it's worth careful attention.

Early Designs

In the original designs of the late thirties and early forties the usual approach was to obtain all the supplies from the mains. C.R.T.s were of triode construction, i.e. with no first anode and focus electrodes, focusing being done by a magnet or an electromagnet. The e.h.t., then of the order of 5-10kV, was obtained by transforming the mains voltage up to the required value, then rectifying it with the conventional type of half-wave rectifier described earlier in this series, with a reservoir capacitor, smoothing resistor and smoothing capacitor.

Now a transformer which will step 200V up to say 2,000V needs roughly a turns ratio of 10 to 1, which is a lot of copper wire if nothing else. 10kV needs 50:1 and the mind boggles at the thought of the size of the thing and the insulation required to keep this sort of potential under control. A fraction of this would kill you, as the impedance of the supply is low and it's thus happy to push current through almost any resistance without strain. Designs of this type demanded and got the greatest respect therefore. The weight of the type of transformer required was considerable, and the cost would now equal almost the total cost of the whole receiver.

A valve rectifier was employed, with reservoir/smoothing capacitors of about $0{\cdot}1\mu F$: they were larger than the present day electrolytics having say a total capacitance of $1{,}000\mu F$ at 300V. These capacitors were also lethal weapons, and there was often associated with them a chain of series connected resistors going to chassis in order to provide a discharge path when the set was switched off (discharging them with a screwdriver blade was simply not on). The snag for the serviceman was that the resistors often went open-circuit, leaving the capacitors charged up. This again was not nice. From the design point of view however there was an advantage: a string of resistors connected from say a 10kV source to chassis means that one or more lower voltages can be tapped off and used for other purposes – provided there is no current demand. This idea (tapping off, not the transformer) has been in use recently in colour sets for focusing, where the requirement is generally in the region of 4·5kV.

Back to the transformer however. This is obviously an expensive way of going about things, although a well regulated supply is obtained, i.e. no variation in the size of the picture when the brightness control is advanced. The point of this comment will become clearer when we get deeper into the type of e.h.t. supply that's been in general use since the very early approaches were dropped.

Transformer Action

Other means of developing the high voltages required were not long in putting in an appearance, since there is no reason why using the 50Hz a.c. mains should be an efficient way of doing things. We've already explained how a transformer works: the rising and falling current through one winding results in the build up and collapse of a surrounding magnetic field, and if another winding is in close proximity current will flow through it in sympathy – in fact a corresponding voltage will be developed across it, current flowing only if there is a circuit connected across the winding. At low frequencies (slow rise and fall) the core the coils are wound on must be fairly heavy, but at high frequencies the core has to be of different and lighter construction.

Shorting Turns

Let's pause for a moment to consider what we've just said. We pointed out that current flowed only when there is a closed circuit for it to flow through. From a servicing point of view, and after all this is the whole point of these articles, one of the more awkward faults that has to be contended with is when a whole stage refuses to work although all the components except the transformer are in order. "Shorted turns in the transformer" is the phrase we then so often hear. If a winding has a large number of turns you see, there is a chance that at some time the insulation at a particular point will break down. This represents a closed circuit of the unofficial variety, i.e. a short-circuit, and the result is overheating and heavy damping of the efficiency of the stage – maybe enough to stop it working altogether. Considering the small size of the windings, and the very high voltages which may be rapidly rising and falling in the transformers used for some purposes, it is perhaps surprising how reliable many of them are.

The Line Output Transformer

What we are leading up to is the thing called the line output transformer, undoubtedly the most important component in any TV set (unless you call the c.r.t. a component). It will be remembered that in order to deflect the scanning spot from one side of the screen to the other and then back again – at a much faster rate – what we require is a sawtooth waveform. During the longer portion of the sawtooth waveform applied to the deflection coils the spot is driven evenly across the screen, then with the rapid reversal of the waveform the beam is returned to where it started (though down a little due to the field scanning). The line output transformer operates by means of this building up and collapsing of fields, but whereas the mains frequency is 50Hz the frequency required to give 625-line deflection is 15,625Hz.

Oscillations at this frequency can be produced by a transformer in conjunction with an amplifying device such as a valve, with one winding used for feedback from the output (anode) circuit to the input (control grid) circuit. In fact a few line timebases a good many years ago did operate like this. The practice for many years however has been to use a separate oscillator to produce a timing waveform, and to use this to control the closing of a switch which when closed allows current to flow through the primary winding on the core of the line output transformer. All line output stages use a transformer: most field output stages do, though many solid-state ones don't. Line output stages are what we're on about here however.

We've current flowing in an oscillatory manner – first in one direction, then in the other – through the primary winding of this transformer, at 15,625Hz. Wind other windings on the same core and they will have voltages induced across them, the voltages depending on the number of turns wound on the core. This means that if we have a number of windings, each feeding a rectifier of some sort, we can supply lots of circuits with different voltages, the whole lot being derived from the same source. In addition, the rapidly collapsing magnetic field at the end of the scan can also be put to good use, suitably rectified and smoothed. Thus the line output transformer, originally there simply to deflect the beam across the face of the tube via the scanning coils, can become a maid of all work, capable in fact of supplying all the other power supply requirements of the set if required to do so.

You'll remember that we started off this month with tube supplies, and the need for an e.h.t. voltage of say 20kV. From what we've just been saying it should be obvious that if we add to the line output transformer a winding with enough turns we will, with a rectifier and smoothing circuit, get the e.h.t. we require. The rectifier changes the 15·650kHz a.c. applied to it into a rippled d.c., the reservoir capacitor – in the form of the inner and output coatings of the c.r.t., with the c.r.t. glass forming the insulation between, as we saw last month – smoothing out the ripples. This is the way in which the e.h.t. is generated in TV sets, whether it's 12kV for a small-screen portable, 20kV for a large screen monochrome set, or 25kV or so for a three-gun colour tube.

EHT Regulation

The current requirements of colour tubes are greater, so the arrangements are rather more complex. For a start, it's important that the supply is reasonably stable – the actual voltage has a profound effect on the size of the picture, so it must not be allowed to vary much despite the tube current altering as the picture swings from black (no current) to peak white (maximum current). If the e.h.t. voltage falls, the acceleration applied to the beam will also fall. The line and field deflection circuits will then have a greater effect, and the result will be a large, defocused picture. This is what we meant when we mentioned regulation earlier.

EHT Triplers

Some monochrome sets and most colour sets use a more complicated method of e.h.t. rectification. This consists of a series of rectifiers, each with its reservoir capacitor returned to the high voltage point in the immediately preceding section of the chain: this provides a multiplying action, enabling a smaller e.h.t. winding on the transformer to provide say 8kV which is tripled up to 24kV. A disadvantage is the greater number of components involved – all nowadays in a common plastics encapsulation – since this increases the chances of a breakdown. A refinement of this system is to incorporate the rectifiers inside the winding, relying on the insulation between the windings to provide the capacitance required. This is a technique used on only a few of the most recent colour sets, though the basic idea is not new.

This then is how a suitable supply for the final anode of the c.r.t. is obtained.

Focus Supply

The focus electrode of a monochrome c.r.t. is not very critical so far as the voltage applied to it is concerned, and in fact it's not uncommon to find three taps provided for this purpose, one connected to chassis (zero voltage), one to the h.t. line (about 200V), and another to the same point as the first anode (say 900V). The tapping which gives the best focus is selected. How a supply of around 800V-1kV is obtained is something we'll be getting around to in a minute.

The focus voltage for a colour tube is a different matter. This is generally critical, at around 4·5kV. One method of obtaining this potential is to connect a series of resistors between the e.h.t. supply and chassis, with a variable control somewhere along the chain where the voltage lies between say 4kV and 5kV. This control enables the focus to be adjusted. The resistors in the chain must be of very high value, as must the control itself. The system works quite well so long as each resistor remains at its specified value. This doesn't always happen however, the result being a blurred picture if one or more of the upper end resistors goes high in value, thus reducing the focus voltage, or arcing across the protective focus electrode spark gap if a resistor between the control and chassis increases in value so that the focus voltage becomes excessive.

An alternative approach is to use an e.h.t. tripler with a tapping which provides a suitable supply for the focus control network. The resistors can then be of lower value – though they still tend to go "high".

Other methods, for example using a separate rectifier fed from a suitable point on the line output transformer, have been used in the past but the two just mentioned are the most commonly encountered ones.

CRT First Anode Supply

Finally then to the supply required by the first anode of

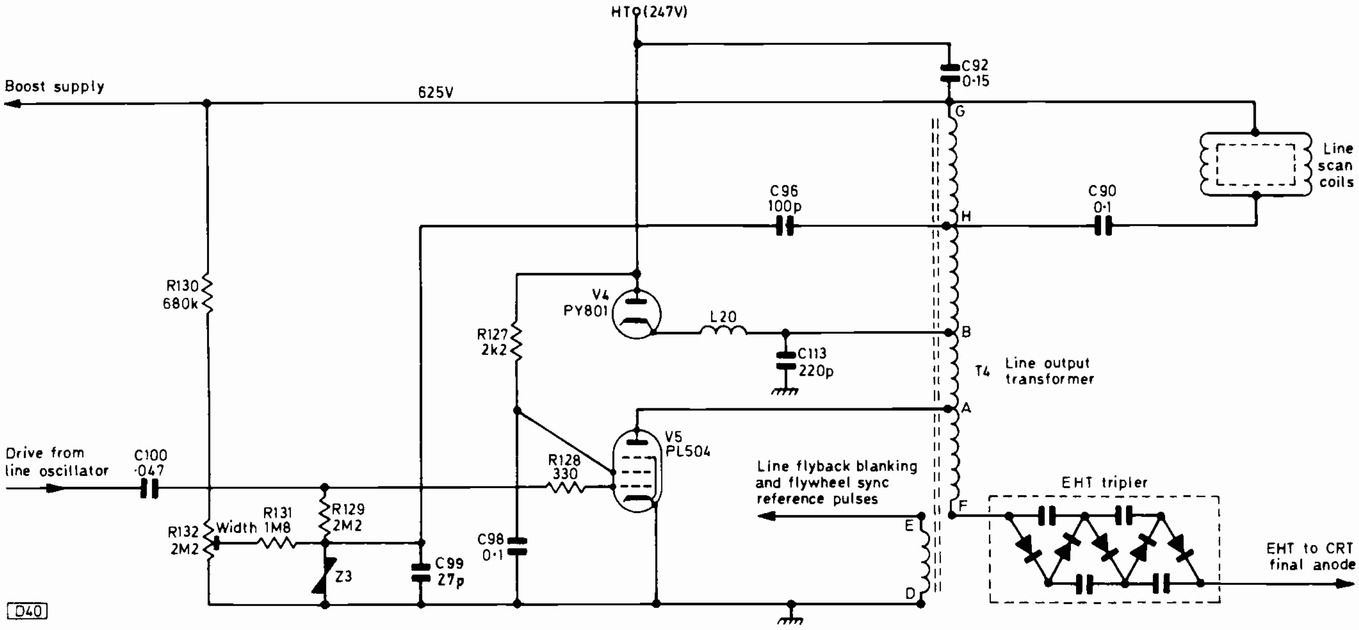


Fig. 1: The line output stage circuit used in the Thorn 1500 chassis.

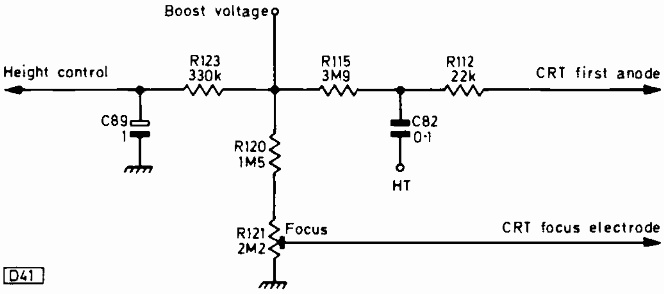


Fig. 2: The feeds taken from the boost rail (other than the width circuit feed shown in Fig. 1.). The height control forms part of the field charging circuit.

the c.r.t. For large screen tubes this is around 8-900V, and as you may have guessed we obtain it once again from the line output transformer. This is not done in quite such a straightforward manner as the supplies we have considered so far however, and seeing how it's obtained will take us into the operation of the line output stage in some depth. Here goes then, sticking for the time being to the valve type of line output circuit used in monochrome receivers.

At the end of the line scan the line ouput valve is cut off by the waveform applied to its grid. The magnetic field that built up around the primary winding of the line output transformer during the scan then rapidly collapses, producing a fairly high-voltage positive pulse. In early days this was sternly damped down as it was considered to be very undesirable. It soon became evident however that it could be exploited in ways that increased the efficiency of the line output stage. Since this pulse determines the flyback time – the collapsing field after the forward line scan is responsible for returning the beam to the left-hand side of the screen – its duration is important and must be carefully controlled. This is done by making use of the capacitance of the transformer (all that insulation between the windings): in fact the transformer is constructed so that it forms a resonant tuned circuit when the line output valve is cut off. Now with a tuned circuit, the positive-going pulse will be followed by a negative-going one and this oscillatory action will continue – unless something is done to stop it. What's done is to add a diode which conducts as soon as the circuit tries to swing in the negative direction. It has been known by many names, for instance the damper diode since it damps the circuit at the end of the flyback pulse, or the efficiency diode since its conduction results in a controlled decay of the still present magnetic field, the action of the diode increasing the efficiency of the circuit because the controlled decay provides the initial part of the forward scan (often roughly half the scan), or again as the boost diode since in doing this it charges a capacitor to a voltage well above that of the h.t. line. And with this boost voltage we have what's required for the c.r.t. first anode. In fact we've now seen how all the voltages required by the c.r.t. are obtained.

Practical Circuit

It's time to look at a practical circuit, and as in previous instalments we are taking as our example the Thorn 1500 chassis. The circuit of the line output stage is shown in Fig. 1. The first thing you might notice is that the line output transformer T4 is not the simple type we saw previously (T3, Fig. 4, page 42) used in the field output stage, with separate primary and secondary windings. The only separate winding here is the small one E-D used to provide pulses for line flyback blanking and for the flywheel sync circuit (we'll come to that in due course). The primary winding is A-G, section H-G of this same winding acting as the secondary which drives the line scan coils (via C90). This type of transformer is known as an auto-transformer, and enables the transformer core to be reduced in comparison to what would be required with separate primary and secondary windings. It's a convenient technique where the voltage transformation required is small. Section A-F is the e.h.t. overwinding: it steps up the flyback pulse at A and feeds it to the e.h.t. tripler for rectification.

Returning to our theme of supplies, the boost rectifier is V4 and the capacitor which it charges to provide the boost voltage, 625V in this case, is C92. As in other sets, the boost voltage is used for several purposes: to supply the c.r.t. first anode and focus electrodes, to provide a feed to the width control, and also to feed the field timebase's charging circuit (see Fig. 2).

While on about tube supplies and operation, there's another aspect worth mentioning. The tube's beam current is concentrated so as to form a very small scanning spot. Now due to the capacitive action of the c.r.t.'s inner and output conductive coatings, the e.h.t. remains even when the source of the e.h.t. is removed. If the line timebase suddenly fails and the height control is fed from the boost rail, there will be no deflection of the spot which will thus remain at the centre of the screen until the e.h.t. is discharged – long enough perhaps to burn away the phosphor at this point, leaving a permanent "burn spot" at the centre of the screen. Steps must be taken therefore to prevent this. Fig. 2 shows the boost line feeds not shown in Fig. 1. C89 across the feed from R123 to the height control will retain a charge when the boost voltage falls, maintaining the vertical deflection for a short time – enough to deflect the spot while the e.h.t. is discharging. In order to prevent the spot lingering in the centre of the screen when the set is switched off, the e.h.t. capacitance must be quickly discharged while the scans are collapsing. This is done by arranging for the tube to be driven hard on when the set is switched off. One requirement in doing this is to maintain the first anode voltage: C82 is provided for this purpose – in addition to smoothing this feed.

It's also as well to point out that the leads from the deflection coils on the tube neck are often taken to the field and line output stages via a single plug. If this is accidentally left disconnected, there will be no deflection and the spot will remain at full concentration in the centre of the screen (since the line timebase will be working the tube will be receiving its full supplies). The tube would almost certainly be damaged under these circumstances. To avoid this, designers often include on the plug a loop which completes the h.t. feed to the line output stage. Thus if the plug's off there's no supply to the line output stage and thus no e.h.t.

Line Output Stage Operation

With this rough idea of tube supplies, let's take a closer look at the line output stage and its operation. The line output valve (Fig. 1) is V5 and is driven by the sawtooth waveform from the line oscillator, fed to its control grid via C100. The first important point to make is that V5 does not act as an amplifier, amplifying this sawtooth. In fact the sawtooth simply determines the time at which V5 switches on – roughly halfway through the scan. Switches on: that's the important point. V5 is actually switched on suddenly from "off" to full conduction, and when this happens it effectively earths one end of the line output transformer's primary winding – point A. Now the other end of the primary, G, is connected to the boost voltage. When you do this – connect an inductance across a voltage source – you get a linearly increasing current flow through the winding. In other words, once V5 switches on a sawtooth current waveform is developed across the line output transformer – both the primary section A-G and the secondary portion H-G. A corresponding current flows via H-G, the line scan coils and C90, and as a result the beam is deflected from the centre of the screen to the right-hand side. What happens next is all that flyback business we've been referring to. This starts when the drive from the line oscillator reverses, switching V5 off. The magnetic field which has been built up during the forward scan now collapses, and as a result a large positive pulse appears at point A. Naturally V4 is now cut off as well, since its cathode is positive with respect to its anode. As we mentioned earlier, T4's primary winding along with the built in capacitance (due to the heavy insulation) is constructed so as to form a tuned circuit, and this determines the amplitude and duration of the pulse. The effect of the pulse so far as the scan coils are concerned is to deflect the spot very rapidly to the left-hand side of the screen. Since the line output transformer is now undergoing a controlled oscillation, the next thing is that the voltages at B and A will tend to move negatively. But of course when this happens V4 will conduct once more and provide its damping action.

The next thing is to get the spot from the left-hand side of the screen towards the centre, at which point the line output valve is switched on again. At the end of the flyback there is again a magnetic field around the line output transformer's primary winding. This collapses, but does so in a slow, linear manner due to the damping action of V4. The decaying current provides the first part of the forward scan, deflecting the beam from the left-hand side towards the centre of the screen. At the same time a charge is built up on the boost capacitor C92, the voltage at point G rising to 625V.

The astute reader will point out that if collapsing fields induce voltages in nearby windings, won't there be interaction between the field and line deflection coils since they are mounted close together? There would, but this is a problem the designer has to sort out.

Scan Correction

So much for the basic action, now let's look at some of the details. C90 is the scan-correction capacitor, required because with a comparatively flat-faced c.r.t. (you wouldn't want to sit and look at one with a spherical face, would you?) the spot has to travel over a much greater distance at the start and end of the scan than at the centre for a given deflection angle. The action of C90 therefore is to speed up the scan at the sides of the screen and slow it down at the centre: its value is chosen so that its charging characteristic gives the required effect.

Harmonic Tuning

C113 (it's C95 on the smaller c.r.t. versions of the chassis, with a value of 180pF) is the harmonic tuning capacitor. A further complication! Briefly, the shape of the e.h.t. pulse appearing at point F can be tailored by adding a further oscillation to the waveform present during the flyback. C113 in conjunction with the leakage inductance between the primary winding and the e.h.t. overwinding form a tuned circuit which resonates during the flyback to provide the required oscillation – at the third harmonic of the flyback frequency if a half-wave e.h.t. rectifier is used, thus increasing the amplitude of the pulse applied to the rectifier, or, as here, at the fifth harmonic since with a tripler the maximum amplitude input pulse is less important than having a pulse with a flat top to compensate for the poorer regulation inherent with the use of voltage multiplication.

This capacitor is of particular interest to service engineers since it's often the cause of breakdown. When it goes short-circuit, the boost diode is connected directly between the h.t. line and chassis. A very heavy current flows, and in consequence R124 in the h.t. line (go back to Fig. 1, page 40) flies open, breaking the circuit and directing attention to the part of the circuit responsible. The diagnosis is helped by the appearance of the capacitor, which is wired in an obvious position on the line output transformer and as a rule presents a blackened appearance when it has failed. Even if it looks innocent, the fault is easy to trace using an Ohmmeter which will show a very low reading from the PY801's cathode (its top cap connection) to chassis instead of the reading of about 1MΩ which should be recorded. Why about 1MΩ? Look at Figs. 1 and 2 and you will see that the only direct paths between the PY801's cathode and chassis are via R130/R132 and R120/R121. Since these are in parallel with each other, the effective resistance is somewhat over 1MΩ. Note that these tuning capacitors must be of the type rated to withstand the high-voltage pulses present in this part of the circuit.

Correct Tripler Type

Fig. 1 shows the way in which the series connected e.h.t. multiplying rectifiers and their reservoir capacitors are arranged. The e.h.t. tray, as it's known, is clipped to the side of the line output transformer. The only point to be stressed here is that there are many different sorts of tripler (and in smaller screen versions of this particular chassis a doubler is used instead), as indeed there are of line output transformer. So it's vital to use the correct e.h.t. tray and the correct line output transformer.

Alternative Circuit Arrangements

This is a very simple line output transformer indeed. We could for example complicate matters by winding a few turns on it to supply the c.r.t. heater, or another winding to supply say 20V which when rectified and smoothed would form a suitable supply for the transistor circuits in the set. In fact there are all sorts of things which can be done, all of which damp the transformer which has to be designed therefore to take the extra load. You will also find that the windings can be arranged in various different ways (see Fig. 3), which may involve one side of the boost capacitor or the line scan coils being connected to chassis for example. So when fault finding it's important to have the appropriate circuit so that the effects of defective components can be appreciated.

Defective Boost Capacitor

For example, if the boost capacitor is returned to chassis the effect if it goes short-circuit will be the same as if C113 in Fig. 1 goes short-circuit. The PY801 or whatever will have suffered a trying time, and there'll be either an open-circuit fusible resistor in the h.t. supply or a blown fuse. Failure of the boost capacitor – going short-circuit – is in fact one of the most common faults in valve line output circuits. The effect is to damp the circuit so heavily that it fails to operate and there's no e.h.t. and thus no raster. Other effects, such as for example the presence of a blown fuse, depend on how the circuit is arranged.

Width Stabilisation

Coming back to our Thorn 1500 circuit however, the next thing to look at is the width circuit – in fact the width stabilising circuit. This arrangement has been in common use in valve line output stages for many years. A sample line flyback pulse is fed by C96 to the voltage-dependent resistor Z3. This is an interesting device which we've not come across before in this series. It is what it's called – a resistor whose value changes when the voltage across it changes. When the positive-going flyback pulse appears at H, it's fed to Z3 via C96. This high positive voltage results in Z3 instantaneously falling to a low value, and in consequence C96 collects a negative charge. At the end of the pulse Z3 resumes its high-resistance condition and the negative charge on C96 is retained. This negative charge is part of the bias applied to the line output valve, being linked to its control grid via R129. Since the bias voltage thus obtained is dependent on the amplitude of the flyback pulse, the operation of the stage is stabilised: if the pulse increases in amplitude, so the bias increases and the output is pulled back to compensate. The initial bias is set by a small cancelling voltage tapped from the width control, which is fed via R130 from the boost line. R132 is called the width control here: in other chassis you will find the corresponding preset labelled in other ways, e.g. set boost, set stab., or line drive. As we shall see shortly, C100 also plays an important role in biasing the line output valve.

If each component in the width circuit behaves itself and keeps its original value the circuit is self-adjusting. If the resistance of the resistors rises however the width will decrease. It's very common for R130 or its counterpart in other chassis to do just this. If the value of R130 falls to any extent the width will first increase and then the control R132 will be damaged, necessitating the replacement of both R132 and R130.

If C96 goes short-circuit the whole circuit will be heavily damped and the result will be no e.h.t. The v.d.r. will overheat and probably melt its own solder, the panel in the vicinity of Z3 and C96 being damaged. It's surprising however how much punishment this type of v.d.r. will take: you'll usually find that it's prepared to go on functioning happily after the mess has been cleared up.

Some Common Faults

Another important component is R127 which supplies the line output valve's screen grid. It's nearly always 2·2kΩ or a very similar value and is usually of the wirewound type, since these are less likely than carbon ones to change value when subjected to heat over a period of time. The line output stage fails to operate when R127 goes open-circuit – a frequent fault – since the valve cannot function without voltage on its screen grid. The clue is that the line output valve – and the boost diode – will be cool. For most other faults which remove the e.h.t./raster they will be hot, often very hot.

For example, lack of a line drive signal from the oscillator will leave the line output valve conducting heavily. The clue this time is that it will be excessively hot. You may say that since the signal from the line oscillator switches it on, shouldn't the line output valve remain off in its absence? This would happen in fact in the equivalent transistor circuit, but to stick with our PL504 it must be explained that when a valve is operated in a switching mode like this it generates a bias voltage at its control grid. When it's switched into heavy conduction, some control grid current will flow: as a result, the input coupling capacitor C100 will acquire a negative charge. This is part of the bias that holds the valve cut off before it's switched on – you will notice that there's no cathode bias. If there's no switching action there's no bias save the small positive one via the width circuit, and the two valves sit there passing a hefty current and doing nothing other than getting hot. Apart from the heat therefore the clue to this state of affairs is the lack of a negative voltage at the control grid of the line output valve. Depending on the particular circuit, you should record a negative voltage in the region of –40V to –80V if the drive from the line oscillator is present and C100 is in order – if it's "leaky", i.e. its insulation is defective, the result will be the same as with lack of drive from the line oscillator. This is a not uncommon fault in some chassis.

What else commonly goes wrong? We've talked about shorting turns in the line output transformer (though this particular transformer doesn't often fail), short-circuit harmonic tuning, boost and feedback pulse capacitors, and

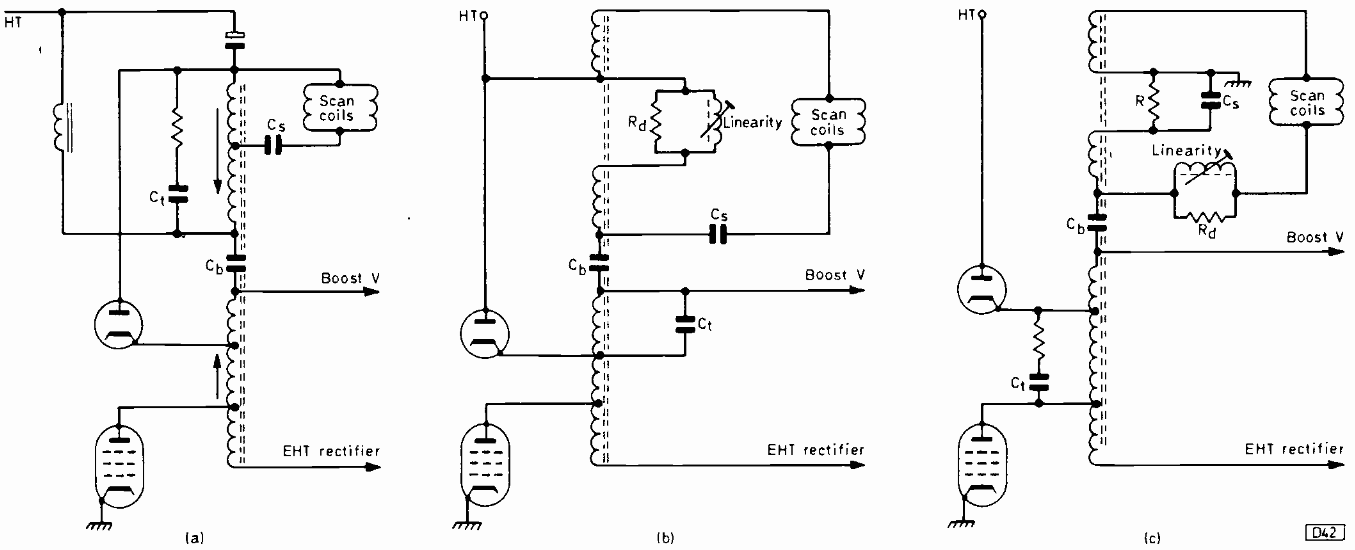


Fig. 3: There are many alternative ways of arranging the line output transformer windings: some typical arrangements are illustrated above. (a) The desaturated line output transformer circuit. Here the boost capacitor Cb is connected between sections of the primary winding, with the anode current of the two valves flowing in opposite directions through the windings as shown by the arrows. The idea was to cancel the magnetic flux arising from the d.c. component, thus increasing the efficiency of the transformer. (b) In this example (Philips 210 and 300 chassis) there is no d.c. flowing in the top section. As in (a), one side of the line scan coils is returned to the h.t. line. (c) Another variant (a Mullard transformer). This time there is a d.c. connection from one side of the scan coils, also from one side of the boost capacitor, to chassis. In each example Cb is the boost capacitor, Cs the scan correction capacitor and Ct the harmonic tuning capacitor.

resistors changing value or going open-circuit. Naturally the valves can be responsible for no e.h.t. The other main, indeed frequent, cause of trouble is the e.h.t. rectifier. Triplers often short at some point internally, damping the circuit so that there's no e.h.t. Separate half-wave rectifiers lose emission or go short-circuit thus removing the e.h.t. Note that with a thermionic (valve) rectifier there's a heater winding which can be the cause of the trouble (it's wound on the line output transformer, just a single turn usually, and the insulation can break down), and that there's often a small-value resistor (an ohm or two) in series with the heater. It is sometimes formed of resistance wire, and is generally hidden away in the insulated base mounting. If it goes open-circuit the rectifier fails to light up of course.

A common fault is when the picture balloons and disappears on advancing the brightness control – maybe accompanied by lack of width at low brightness settings. This apparently strange situation is caused by the e.h.t. voltage falling when the e.h.t. current rises, i.e. as the brightness control is advanced the beam current increases but, as the e.h.t. voltage falls, so the deflection fields have a greater effect on the beam so that the raster expands and may disappear completely, leaving a blank screen. Things to check are the valves, the resistors in the width circuit, the tripler if one is used in the chassis concerned and, unfortunately, the line output transformer – to find out why the line output stage is operating inefficiently. The resistors can be checked with your meter, but by checking the other items we mean substituting known good ones, so you start with the least expensive items, the valves, and hope you won't have to go on to the transformer.

Incidentally, if the line output stage shows any signs of life don't attempt to measure the voltage at the anode of the line output valve or the cathode of the boost diode – the flyback pulses will put a quick end to the meter's action.

The e.h.t. tripler can be responsible for another sort of trouble. Basically there are two kinds, those using silicon diode rectifiers and those using selenium ones. As the selenium ones break down they can produce what has been described as a "shimmering" effect all over the picture. The chassis we have been using as our example is prone to this trouble. Lack of width with or without width variations is another of the faults these e.h.t. trays can cause. When they – the selenium ones – break down there is an unmistakable clue: the awful stink (there's no point in being polite about it) they give off.

The astute reader may have noticed that we've said little about the scan coils themselves. That's because they don't often give trouble. They can however. If there's an open-circuit connection the result, since there's e.h.t. but no line deflection, is a vertical white line down the centre of the screen. Not common this, though it is sometimes encountered in small-screen transistor portables due to the scan coil coupling/scan correction capacitor being defective. It can also be found in those few older colour sets which have separate e.h.t. and line deflection circuits. But we seem to be wandering into the more obscure corners of the servicing scene. More often (but not that often) shorting turns develop in the coils. You should be able to diagnose by now what happens: the line output stage is heavily damped, and there's no e.h.t.

There are two basic methods of providing line linearity correction: by means of a "sleeve" which is inserted between the scan coils and the neck of the c.r.t., or by means of an adjustable damped coil connected in series with the scanning coils. We mention this simply because the damping resistor connected across such linearity coils is prone to go high in value or open-circuit, with the result that the coil is shocked into oscillation by the flyback pulse and produces vertical striations across the screen – mainly on the left-hand side. The Thorn 1500 chassis uses the linearity sleeve method of compensation.

On older sets which do not incorporate width stabilisation of the type we described earlier (there are still many such sets around) lack of width could be due to inadequate output from the line oscillator stage, due to the valve losing emission.

We've come a long way in this part, from tube supplies to valve line output stages and what goes wrong with them and finally to mention of the line oscillator. We shall have more to say on this subject next month.

CONTINUED NEXT MONTH

LONG-DISTANCE TELEVISION

ROGER BUNNEY

MANY will recall the excellent tropospheric conditions during October 1975, when signals were received from a great many European countries at both v.h.f. and u.h.f. I'm glad to be able to report on another excellent spell of tropospheric reception, thanks in part to a slow moving ridge of high pressure combined with fog.

Here in the south, conditions would improve during the early morning period – particularly reception from West Germany – a peak being reached around midday. Signals, in both Band III and at u.h.f., were then maintained until the late evening. Strangely, during the early morning period u.h.f. reception above ch. E40 was best, with no evidence of W. German signals in the group A spectrum. Most unusual! The W. German u.h.f. stations seemed to fade away during the late evening, with completely dead conditions on switching on early the following morning, even Lille ch. E21 leaving much to be desired.

Those in East Anglia did even better. Clive Athowe reports as follows. Friday 14th, many W. German u.h.f. stations from southern W. Germany, and in the evening CST-2 (Czechoslovakia) on ch. R36. Saturday, Swiss u.h.f. signals and reception from Grunten (S. Germany). Sunday, improved conditions with signals from Norway, including a 300W relay on ch. E10! Monday, many Swedish second chain u.h.f. signals, plus TVP (Poland) ch. R12. Tuesday, another first in the UK, Finland ch. E7 Turku at approximately 960 miles; also TVP chs. R10, 12 and 29. The other outstanding signal logged was TSS (USSR) ch. R29 in the late afternoon. This is another first, the transmitter believed to be near Riga. Our congratulations to Clive!

During the following week there was a lot of Sporadic E reception, particularly around the midday period, starting on the 17th with TSS/TVP chs. R1 and 2. Here in Romsey good signals were logged on the 18th from TSS (R1/2), TVP (R1), CST (R1), SR (Sweden, E2), and NRK (E2). The 20th again produced TSS ch. R1 at exactly 12.00.

Hugh Cocks (Devon) and I received fair signals from RTVE (Spain) on chs. E2 and 4, Hugh also receiving JRT (Yugoslavia) chs. E3, 4.

Altogether an excellent mid-October period, in part compensating for the rather poor results during the Orionids meteor shower on the 21st. The early morning period on the 24th gave good long-duration MS signals from Sweden and Finland on chs. E2, 3 and 4.

A new identification slide in use by DFF (East Germany) has been noted. It consists of a light grey raster with the letter T at the top left-hand side and "Cottbus Canal 4" in the centre.

I've been off the air most of the month while arranging a DX-TV room, and have been fully operational only during the past few days.

In Brief . . .

Ryn Muntjewerff (Holland) reports that SWF (Sudwestfunk, W. Germany) is now using transmitter identifications on their FUBK test cards; e.g. FSW = Feldberg Schearz-Wald; HKF = Haarktkopf etc. . . . The NRK PM5544 test pattern has been seen with an unusual identification "Feil Pa Lyden" – Peter Vaarkamp tells us that this indicates a fault on the sound channel . . . Brian Fitch (Scarborough) reports that a new private TV station is in operation in the Rome area, on ch. E67, and is transmitting programmes in English.

News Items

Bahrain: Bahrain TV has increased its e.r.p. recently. The coverage now extends throughout the Gulf and includes part of Saudi Arabia. The e.r.p. has been guessed at approaching 100kW.

Liberia: An expansion of the Liberian Broadcasting Corporation's TV service has been announced. Pye TVT are to provide the colour equipment for a new studio centre at Monrovia, covering the capital and the surrounding area. Two 1kW v.h.f. transmitters will be installed near Monrovia.

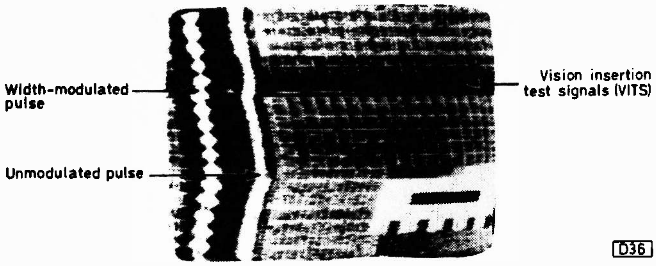
Ghana: Ampex has received several orders for the supply of colour equipment. This will be for PAL operation, and it's expected that the first colour transmissions will be from an international sporting event at Accra in March 1978.

Czechoslovakia: A new transmitter is under construction at Cerna Hora, Krkonose Mountains, to bring the first and second chain programmes to East and Central Bohemia. The second chain Mt. Klet u.h.f. transmitter came into operation in July.

Holland: Gosta van der Linden has written regarding my comments on the possible closure of the Lopik ch. E4 transmitter. Apparently the Directoraat Radiozaken has stated that "there are *no* plans to change the channel E4 for Lopik-1 programmes". No mention is made of the ch. E37 transmitter to replace the E4 one although a DX enthusiast (Tonne van Dalen) has actually received ch. E37 from the direction of the Lopik tower! All very strange. Apparently when the standby ch. E4 Lopik transmitter is in use a strong harmonic is present on ch. E2. At the time of typing Philips have no test transmissions on ch. 60 from Waalre: when in operation these are radiated between 0800-1600 GMT.

Satellite News

In early 1976 we reported on Steve Birkill's reception (the first in the UK) of the ATS-6 satellite with Indian programmes. Steve has recently been making preparations



Unlocked test card received by Steve Birkill from the USSR's Statsionar-2 satellite, showing the width-modulated pulse carrying the sound signal in the line sync period and the VITS in the field blanking period.

TSS-4 programme commencement received by Steve Birkill, from Moscow via the Statsionar-2 satellite.

for 12GHz TV reception (delayed due to the failure of the first OTS satellite at launch). In the course of his experiments however Steve has successfully received strong signals from the USSR Statsionar-2 satellite, relaying TSS-4 programmes from Moscow to the Far East. Statsionar-2 is at 35°E (similar to ATS-6), and the signals are being received using an 8ft. dish with a scaled version of a 12GHz horn, a 2in. circular waveguide and a circular polariser. The head amplifier uses an HXTR-6101 microwave transistor.

The TSS-4 programmes are carried for about four and a half hours daily (1700-2130 BST): at other times an unmodulated carrier is radiated. Although no attempt has been made to resolve the sound channel, this should prove simple to recover since it's transmitted as a width-modulated pulse during the line flyback blanking interval. The accompanying photograph shows the pulse modulated with a tone: the other pulse has never been seen modulated. This unlocked shot also shows VITS in the field blanking period. Our congratulations to Steve on this quite remarkable reception, and we look forward to hearing of further successes with the forthcoming OTS experiments at 12GHz.

From our Correspondents . . .

Kevin Jackson (Leeds) has been successful with lightning scatter reception at v.h.f. A thunderstorm on September 24th produced several strong coincident bursts of signal from RTB (Belgium) on ch. E3. Previously his only successes had been at u.h.f. He heard the RSGB announce that Auroras had occurred on the 13th, 18th, 19th and 20th September: apparently the 20th gave the best results.

Will Bate (Bridgnorth), having recently retired, has

Eight foot ex-radar dish used by Steve Birkill for satellite reception.

modified a Bush TV125 and TV135R for TV-DX and will shortly start aerial erection. Will worked for RGD for nearly 30 years, leaving to work part time with a Bridgnorth radio/TV concern as a service engineer until he reached 70. We are hoping he will send in his observations and reflections on almost 55 years in radio and TV. I'm sure this will be of great interest.

Following my comments on low v.h.f. coverage, Frank Lumen (Glasgow) has put into use an old Hallicrafters S.36A receiver. This covers 27-144MHz in three bands, and has a.m/f.m. facilities. Frank also says that Scottish v.h.f. and s.w. DXers meet at his home (2 Ormonde Drive, Netherlee, Glasgow) at 1430 on the 1st and 3rd Saturday of each month. He is seeking a secondhand Labgear upconverter – please contact him direct.

Finally, if there's a DX TV enthusiast in the North Midlands area who would like a Bush TV99B (export type v.h.f./u.h.f.) as used by S. Birkill in the 1960s, ring 07415 (Ecclesfield) 63259. It's free but must be collected.

Unusual Aerials

Mike Allmark and Kevin Jackson spent some time in 1975/6 experimenting with wire aerials for Band I reception. One of the successful projects was a Vee Beam: this consists (see Fig. 1) of a certain number of wavelengths of wire terminated in a balun and then the 75Ω coaxial cable. The length of the wire determines the gain of the system, and the apex angle varies with the length. A table showing gain with different lengths of wire leg is included in Fig. 1.

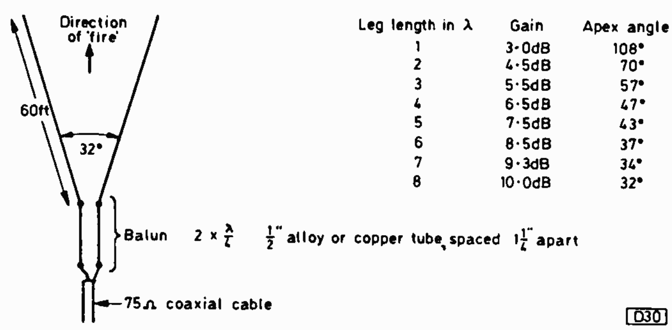
Another unusual aerial, which I spotted in an American mail order catalogue, is shown in Fig. 2. It's claimed to give total frequency coverage from 40-700MHz with no trimming or other matching adjustment. The upper elements are 20in. and the vertical ones 55in. It's called a "wideband discone monitor antenna", and retailed at $15.95. We'd be interested to hear from anyone who has had any experience of aerials of this type.

Wideband Amplifier

Frank Lumen (Glasgow) recently sent in an amplifier circuit (see Fig. 3) covering 25-1000MHz – ideal for TV DXing in Bands I, III and at u.h.f. The circuit (courtesy Siemens) is relatively simple and further information can be obtained from Siemens House, Windmill Road, Sunbury on Thames, Middx TW16 7HS. The transistors are type BFT66.

An Historical Conundrum

Andrew Parr has queried a point mentioned in the book "Bermuda Triangle" by Charles Berlitz. He quotes: "An unusual incident occurred in England on September 14th 1963. British viewers watching their TV programmes were surprised to see the pictures fading and being replaced by a broadcast from KLEE-TV, an American TV station broadcasting from Houston. The odd thing is that the programme in question had been transmitted several years previously, and the station itself was no longer in existence.

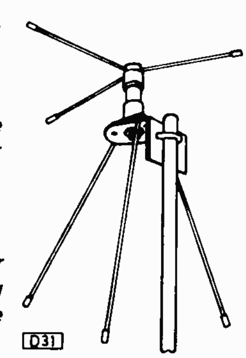


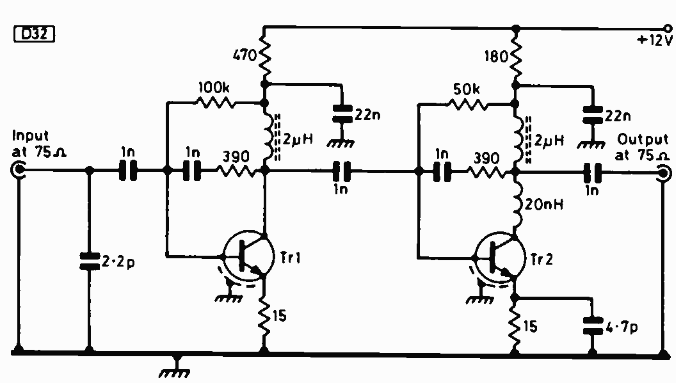
Leg length in λ	Gain	Apex angle
1	3·0dB	108°
2	4·5dB	70°
3	5·5dB	57°
4	6·5dB	47°
5	7·5dB	43°
6	8·5dB	37°
7	9·3dB	34°
8	10·0dB	32°

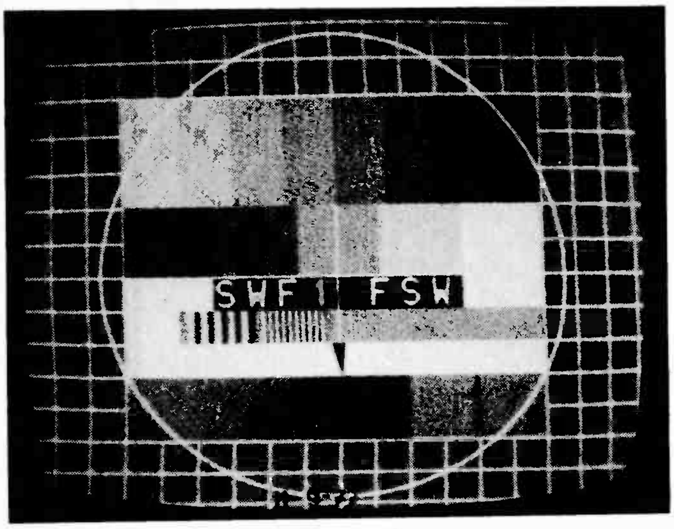
Fig. 1 (above): Mike Allmark's Vee Beam aerial.

Fig. 2 (right): Wideband discone aerial, noticed in a US mail order catalogue.

Fig. 3 (below): Wideband amplifier circuit suggested by Siemens, covering 25MHz-1GHz. The transistors are type BFT66 or BFT67.







SWF (W. Germany) FUBK test card carrying the transmitter identification FSW – courtesy Ryn Muntjewerff.

The problem was investigated by a firm called Atlantis Electronics of Lancaster, who were unable to find any solution". Andrew says he is dubious since Atlantis Electronics cannot be located and in any case he feels that the BBC wouldn't call in an outside organisation with the resources they themselves have.

Whilst checking back through some old WTFDA bulletins I came across an interesting article by Clarke W. Ingram entitled "The Strangest DX of all Time". He comments that a form of F2 layer propagation brought to viewers in England on September 14th 1953 a programme and identification from KLEE-TV, Houston. The signal appeared over a three-day period, making normal viewing impossible until September 17th when it disappeared. KLEE-TV operated on ch. A2 which corresponds to the UK ch. B3. The mystery deepens since KLEE-TV had been sold some three years earlier, and its successor KPRC-TV had not aired any slide or identification since the sale in 1950.

Despite considerable research by various authorities no reason could be found for the phenomenon, although some years later the United States "Project Ozma" (an organisation formed to carry out research into unusual signals from space) stated that it was a hoax by an unknown scientist. No futher information was forthcoming from Ozma.

My own feelings are that the phenomenon would be impossible by direct reception. For a start, a completely different transmission standard is used, while at this time of the then sunspot cycle the m.u.f. would be low, insufficient to support F2 layer propagation. Even if the signal had been reflected from a distant space source, the field strength would be minimal and quite insufficient to override a strong local signal. There has been enough comment on this incident in the past years however to suggest that something must have happened, although quite what remains most uncertain. Any comments?

New EBU Listings

Belgium: Egem ch. E46 1000kW e.r.p. horizontal, Genk ch. E47 200kW e.r.p. horizontal. Both carry second chain programmes.
Spain: Castropodame (6W 42N) ch. E21 200kW e.r.p., Cordoba (4W 37N) ch. E21 200kW e.r.p., Parada Del Sil (7W 42N) ch. E47 400kW e.r.p. All RTVE-2 with horizontal polarisation.

Servicing the Rank A823 Colour Chassis

Part 3

R. W. Thomson

THE 40V rail used to power the field timebase is obtained from a winding on the line output transformer. There are two series-connected rectifier diodes, 5D10/11, with 5C38 the reservoir capacitor. The actual voltage obtained depends on the h.t. supply voltage to the line output stage and on the width tapping selected, so if either is altered the 40V line should be checked and the field output stage balanced. Naturally should 5C38 be short-circuit or either of the rectifier diodes defective there will be no 40V rail and field collapse.

Field Oscillator Circuit

The field oscillator consists of the small four-layer (pnpn) semiconductor device BRY39 (5THY1). This is known as a silicon controlled switch. When it briefly fires it switches on the following transistor 5VT9 and in consequence the field charging capacitors 5C30/31 are discharged providing the field flyback. The BRY39 will conduct whenever its anode voltage is higher than the voltage at its anode gate – set here by 5RV3. It will then become an effective short-circuit. If the current flowing through it falls below the hold-on value, the device will switch off again. The point at which 5THY1 switches on is set by the timing components 5C29/5R41 – 5D7 is biased on by 5R40, holding the left-hand side of 5C29 at chassis potential: consequently the other side of 5C29 charges towards 40V via 5R41. When 5THY1 fires the current through, and voltage across, 5R42 switches 5VT9 on. The field charging capacitors, which are charged from the h.t. supply, are then discharged.

The conduction of 5THY1 discharges the timing capacitor 5C29, and the conditions at the anode of 5D7 at this time are such that it switches off. Once 5C29 has discharged, the current through 5THY1 is insufficient to hold it on. In consequence it switches off and as 5D7 is now once more forward biased the charging cycle is repeated. Synchronisation is effected by feeding a negative-going field sync pulse to the anode gate of 5THY1, so that it switches on just before the point at which it would conduct due to the charging of 5C29.

Field Driver and Output Stages

The positive-going sawtooth waveform generated across the field charging capacitors is fed to the base of the emitter-follower driver transistor 5VT10, which is thus driven towards cut-off. The positive-going sawtooth at its emitter drives 5VT12 which, in conjunction with 5VT11, provides the field output. 5VT11 is driven from the collector of 5VT12, which is the "prime mover" during the forward scan. 5VT11 provides a complex action during the flyback as a result of which the spot is returned from the bottom to the top of the screen – what happens is that the scan coils provide a half-cycle of oscillation in conjunction with 5C35, 5D9 conducting when the oscillation tries to swing negatively, thereby clamping the voltage at 5VT11's collector at 40V.

Scan Current Path

The scan current flows via the coils, 6RV2, the pin-cushion distortion correction circuit and 7C5 to the vertical convergence circuit, then to chassis.

Common Troubles

Most troubles in the field timebase are caused by the same few components. Field bounce, judder, poor lock and/or height fluctuations are nearly always eradicated if the field charging capacitors 5C30/31 and the output bootstrap capacitor 5C34 are replaced as a matter of course, although judder can be due to faults in the power supplies (see later). As mentioned in the first part, 2C37 on the i.f. panel can be responsible for poor locking: another possibility here is 5C5 (400μF) which decouples the supply to the sync separator. Field collapse is usually due to the BD131 transistors in the output stage, though absence of the 40V supply is occasionally responsible. Intermittent loss of field scan can generally be eliminated by resoldering the connections to 6L20 or replacing 6RV4 – these components are in the pincushion distortion correction circuit on the scan control panel.

Fault Summary

Other causes of field collapse are 5R54, 5R55 or 5R49 in the output stage going open-circuit, a defective driver transistor (5VT10) or faulty scan coils.

Lack of height can be due to leakage in 5VT10/11/12, 6RV4 having a defective track, 5C30/31 drying up or, occasionally, the scan coils. Check that the 40V line is not low. Another fault which has been traced to the scan coils is very intermittent (every few hours) field bounce.

Foldover at the bottom can be caused by 5C30/31 or 5D7; foldover at the top with bottom cramping indicates faulty output transistors; while 5VT10 and 5VT9 can also be responsible for foldover.

The small preset controls 5RV5 and 5RV6 often cause field bounce.

No field sync means that the sync separator transistor 5VT1 has failed. The field deflection current coupling capacitor 7C5 on the convergence panel can be responsible for intermittent field jitter.

Output Stage Adjustment

The working point of the field output stage is set by 5RV5 – there will be bottom cramping if it's incorrectly set. To adjust, first set the height, hold and linearity controls, then measure the rail voltage (approximately 40V) at 5Z1-4: divide the reading by two and add two, i.e. 40/2 = 20 + 2

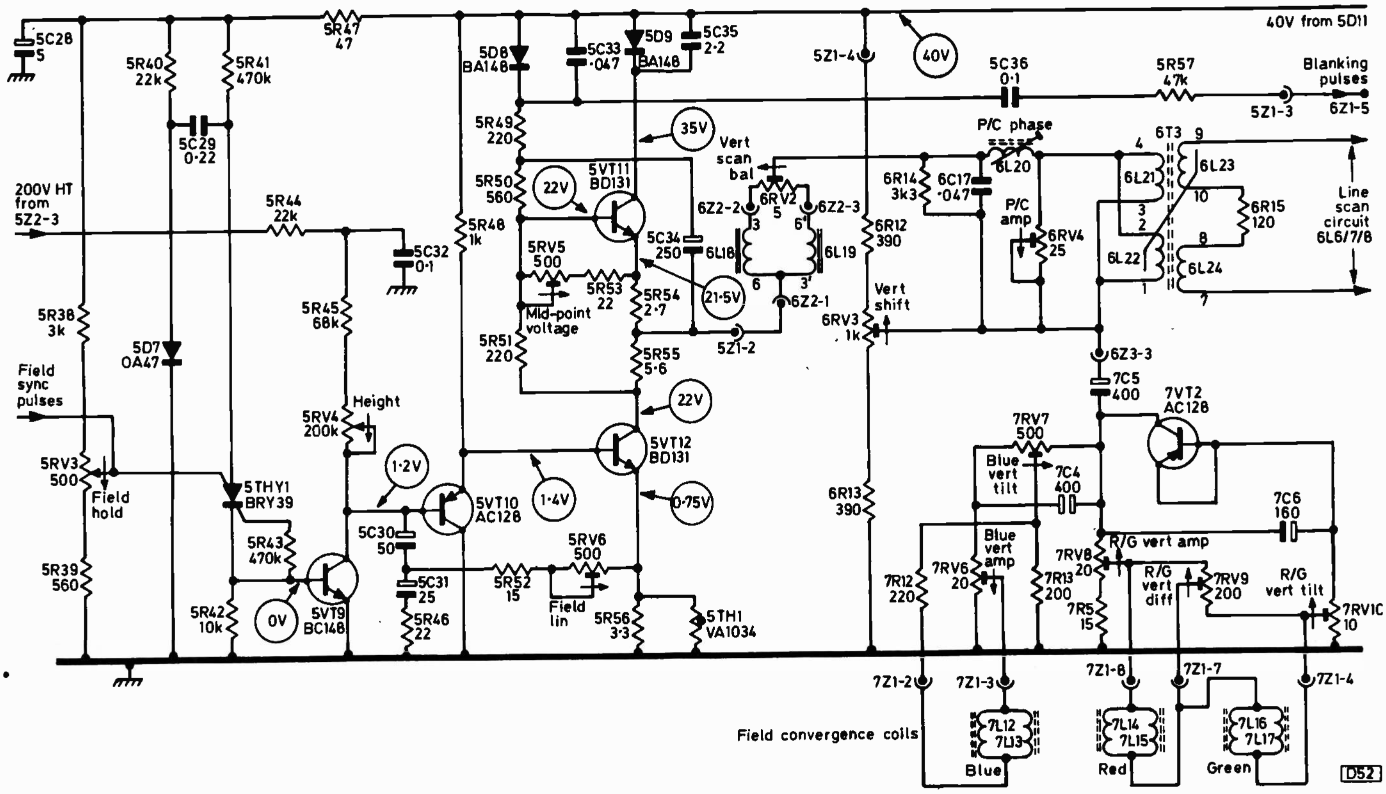


Fig. 8: The field timebase, vertical convergence and pincushion distortion correction circuits. Modifications: 5R46 later 18Ω, 6C18 0·1μF added between 6Z2-1 and chassis, 5D13 1N4148 added between the base and emitter of 5VT10, with its cathode to 5VT10's emitter, 5VT11/12 later changed to type 2N5496. See also Fig. 11.

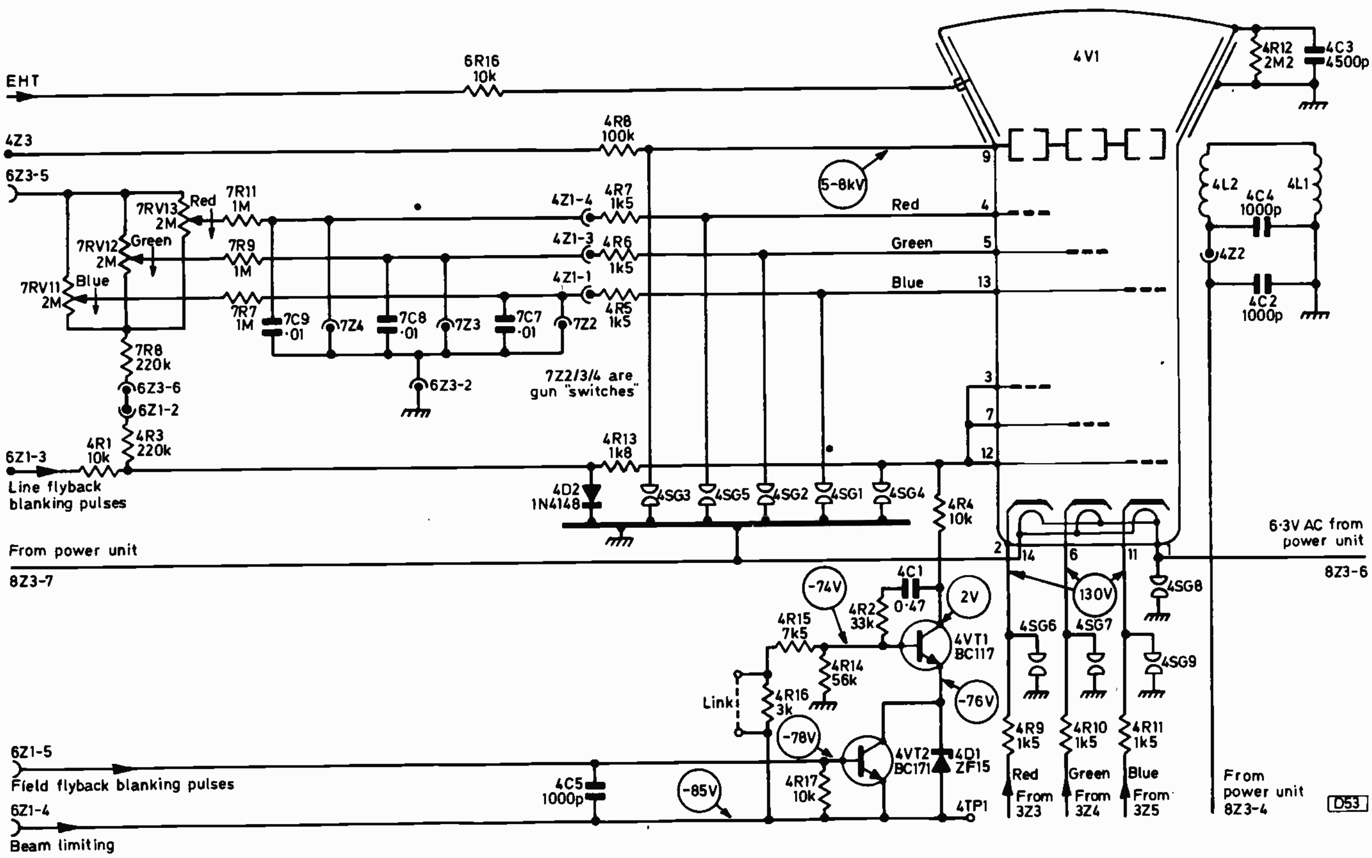


Fig. 9: C.R.T. circuitry.

= 22V, then set 5RV5 to obtain this voltage between 5Z1-2 and chassis.

CRT Base and Convergence Panels

There are two transistors, 4VT1 and 4VT2, on the tube base panel. They are concerned with beam limiting and field flyback blanking, and can become defective due to tube flashovers. The effect produced is flyback lines (of course) and sometimes a dull picture. 4R3 on the tube base panel goes high in value, with the result excessive brightness and poor grey scale since the first anode supplies become excessive. If it goes open-circuit however the beam limiter diode 4D2 is left without any forward bias and there is loss of brightness. 4R5/6/7 can go open-circuit, removing the appropriate first anode supply and thus the colour concerned from the display.

The latter fault also occurs of course should 7C7/8/9 on the convergence board go short-circuit or 7R7/9/11 or the first anode presets 7RV11/12/13 go open-circuit. Two other convergence panel faults have been mentioned previously – 7RV3 (reduced line scan as it burns up) and 7C5 (intermittent field jitter).

Brightness Pulse

Varying brightness with no brightness control action was a common fault in early sets, due to 8C11 which couples line-frequency pulses to the brightness circuit and the RGB clamps. It was subsequently up-rated, but this fault is still encountered occasionally. The associated clipper diodes 8D4/5 can become leaky, with the result that the brightness control has little effect.

Power Supply Panel

The power supply is the weakest part of the design and is responsible for the greatest number of faults on these sets. The mains transformer 8T1 (see Fig. 10) supplies the 6·3V for the c.r.t. heaters and feeds the l.t. bridge rectifier which provides the 18V, the two 20V and the 25V rails required by the decoder, the i.f. and the scan drive panels. The regulated h.t. supply for the line output stage, the RGB output stages etc. is provided by thyristor 8THY1 and the associated components. It's in this latter department that most troubles arise. Thyristors can do odd things: they can introduce peaks and troughs and all sorts of disturbances on the lines they are supposed to be regulating, and the device used here (BT106) provides its fair share of these.

Regulator Circuit Operation

The operation of the regulator circuit is fairly simple. 8C7 is charged via 8R10 during the positive-going mains half cycles, and when the voltage across it reaches the breakover voltage of the diac 8D3 this device conducts, providing a triggering pulse to fire the thyristor 8THY1. This happens during the latter part of the mains half cycle. 8VT1 provides the control action. A sample of the h.t. appearing at the output of the h.t. filter 8C9/8R15/8C10 is fed back via 8R9 to the base of 8VT1, which is also fed with a sample of the mains supply via the network 8R6/8R7/8RV1. In this way 8VT1 samples the h.t. line and the mains input, its collector voltage varying accordingly. This in turn controls the time 8C7 takes to charge sufficiently to fire 8D3.

LT Supplies

The only l.t. line which is stabilised is the 18V decoder supply. Early models use a Z3B180CF zener diode (8D1) for this purpose, later versions a type Z5D 180CF which is easily identified by its heatsink.

The BY164 bridge rectifier used in early sets was later abandoned in favour of four BY126s, a not entirely satisfactory arrangement since hum is often introduced by one of these diodes having a slightly higher than average forward resistance. Frequently one diode goes short-circuit, blowing the l.t. fuse 8F1. The Radiospares REC65 is a reliable replacement.

Thermistors

The VA1104 thermistor 8TH2 is there to prevent a destructive surge at switch on. It suffers eventually however, going open-circuit to remove the h.t. supply. If the disc's edges are at all chipped the device should be replaced. Leave the leads as long as possible to keep heat away from the board. In later models there's a ceramic mount under the thermistor, but even this isn't really high enough and it pays to use as much wire length as possible, folding the ends over under the board and soldering flat to the print.

The other thermistor in the power supply, 8TH1, is of the positive temperature coefficient variety and operates in the normal way with 8VDR1 and 8R5 to provide degaussing each time the set is switched on. The main trouble here is that 8R5 goes up in a cloud of smoke if the set is switched on with plug 4Z2 or 8Z3 disconnected. Apart from this accidental occurence these components are trouble free.

Modifications

A number of modifications were made to the h.t. supply circuit – mainly shifting the temperature compensating zener diode 8D2 from 8VT1's base to its emitter circuit and one or two component value changes. The following changes should be made to the panel when servicing it:

Change 8R7 to 9·1kΩ, 8R10 to 68kΩ, 8R11 to 820Ω and 8R13 to 1kΩ (particularly useful, this one, in removing picture jitter). Add a second 68Ω resistor in parallel with 8R10, and move 8D2 to 8VT1's emitter circuit. There were more variations with the A823A/AV/B series, including the use of a 4EX581 trigger diode in position 8D3, with 8R12 increased to 47Ω, to further improve the performance regarding jitter.

Power Supply Faults

8R6 and 8R9 were prone to going high in value on early panels, but although their type was changed the latter ones aren't all that reliable either. The effect is high h.t. (sound but no raster due to the overvoltage circuit operating) and it pays to use 1W replacements. If 8R6 or 8R7 decrease in value the result is low h.t. – which can also be caused by 8VT1 being defective.

If rapid h.t. fluctuations occur, check 8D2 and 8D3 by replacement – also 8C7. If the trouble persists, check the reservoir/smoothing electrolytics 8C9/10, particularly if the receiver has seen some years' use. Low capacitance here can cause field jitter and intermittent field roll, 8C10 being the most common culprit in this respect. A small picture with ripple is another fault condition produced when 8C9/10 are in need of replacement.

Some fairly common faults are:

Mains fuse 8F2 blown, c.r.t. heaters not alight, due to 8THY1 being short-circuit. In this event check the condition of 8TH2. If 8THY1 is in order, check 8C5.

C.R.T. heaters alight, sound present but no raster, with the h.t. fuse 8F3 blown, check 6C3. If o.k., check 6C13 and 6R7 – if 6R7 is burnt, either 6C13 or 6D2 is short-circuit. If the same symptoms are present but 8F3 is o.k., check for voltage at either side of the fuse. If present, check at 8R17 which may be open-circuit or the wiring desoldered. If everything is in order here, check 6R9. If this has burnt up the e.h.t. tripler is short-circuit. If 6R9 is intact, check for

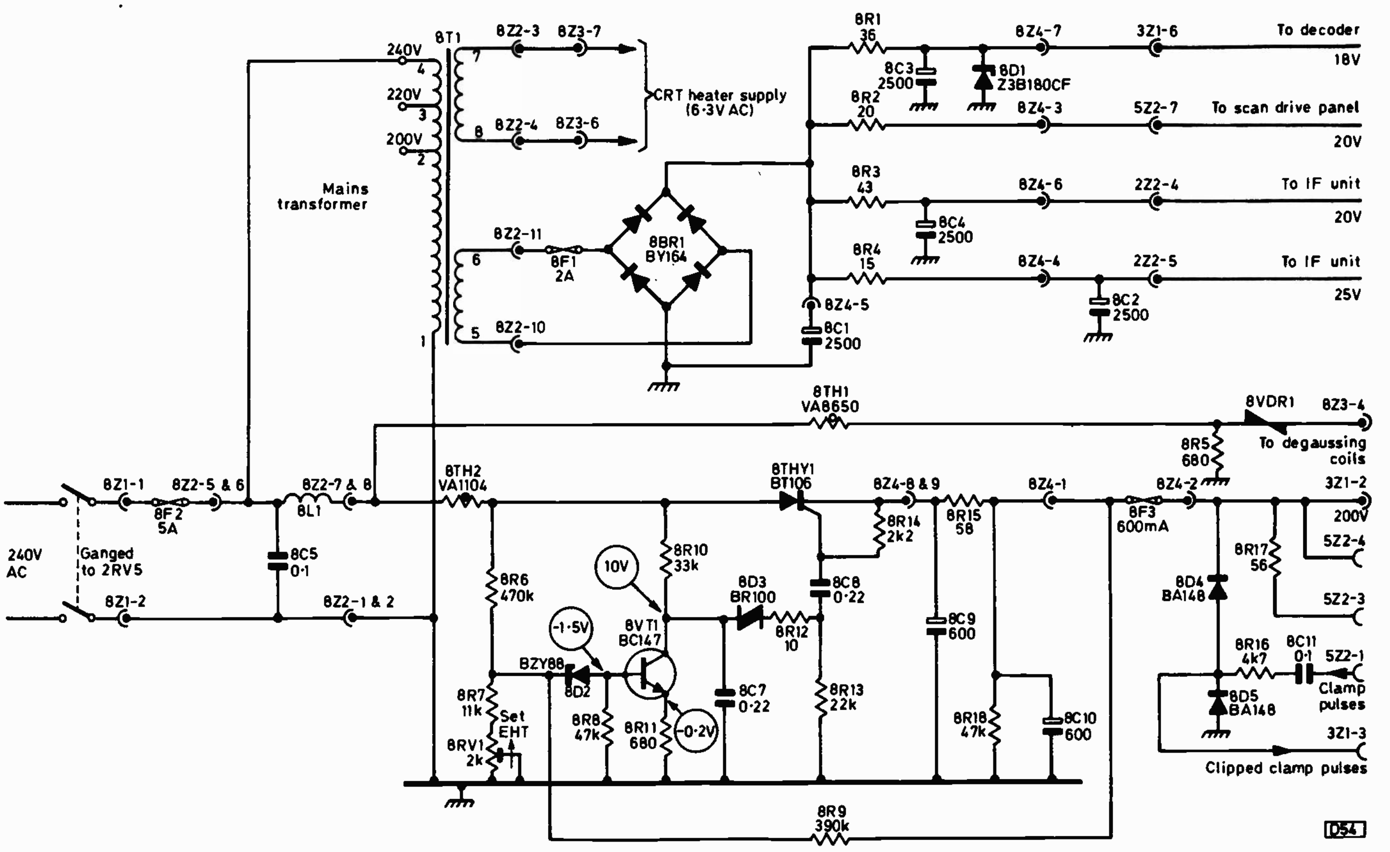


Fig. 10: The original power supply circuit. See Fig. 11 for modifications.

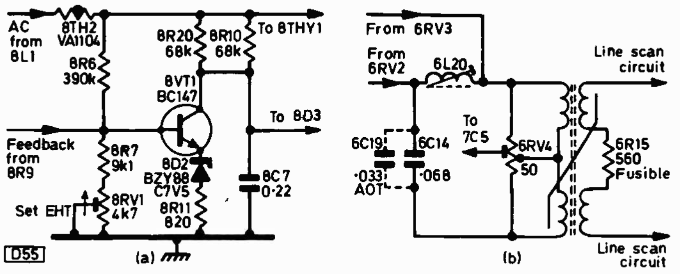


Fig. 11: Modifications (a) to the h.t. regulator circuit and (b) to the pincushion transductor circuit.

approximately 500V at pins 4, 5 and 13 of the c.r.t. If missing, either the tripler is open-circuit or the BD131 line driver transistor has died. It usually goes short-circuit, blowing the l.t. fuse 8F1, but sometimes goes open-circuit. As previously mentioned, check 5C25 and 5R35 if it has failed.

If there is no voltage at the fuseholder check for a.c. at the anode of 8THY1. If o.k. here, check for d.c. at 8R15. Absence of voltage here means that 8THY1 is open-circuit. Voltage at one side of 8R15 but not at the other means that it's open-circuit. When replacing 8R15/17, bend the tags backwards towards the rear of the receiver so that the soldered joints will not be over the heat rising from the resistors. It pays to make good mechanical joints to these resistors before soldering, as this is a common source of dry joints and intermittent loss of h.t., sometimes being the cause of 8THY1 failing.

Short 8THY1 life (sometimes very short, milliseconds!) can usually be traced to an intermittent or complete short in 8C9/10.

Failure of 8F1 usually means that 8BR1 is short-circuit. If not, check the BD131 on the timebase panel as mentioned above. With 8F1 open-circuit there's no sound or raster, the only signs of life being that the c.r.t. heaters are alight.

The l.t. smoothing resistors 8R3 and 8R4 sometimes increase in value, requiring replacement. If 8R4 is bûrnt, check whether there is a short-circuit transistor in the audio output stage.

8R2 is often found open-circuit, giving the sound but no raster symptom.

High h.t. can also be due to a defective thyristor.

A short-circuit 8D1 removes the colour.

If hum bars are experienced, make sure that the earthing screws of 8C1-4 are clean.

The mains transformer can be responsible for a dead receiver, i.e. no raster or sound and the c.r.t. heaters out, when it's primary winding goes open-circuit – but the h.t. will still be there to give you a shock!

8D3 can be troublesome, going short- or open-circuit to remove the h.t. supply or causing picture jitter when its forward resistance increases.

Decoder Tip

This brings us to the end of our faults survey on the original version of the A823 chassis, but here's a final decoder one. The phase of the reference signal fed to the R – Y demodulator in the i.c. on the decoder panel is set by transformer 3T3, whose earthy side is decoupled by the 100μF electrolytic 3C21. If 3C21 goes open-circuit, the phasing will be affected and the demodulation wrong. There will be a colour shift therefore, with red changing to muddy brown and green weak, along with poor definition. These symptoms can also be due to an ageing tube however, so when they're met it pays to check 3C21.

Acknowledgement

The assistance of John Coombes in the preparation of this article is gratefully acknowledged.

Your PROBLEMS solved

Requests for advice in dealing with servicing problems must be accompanied by a 50p postal order (made out to IPC Magazines Ltd.), the query coupon from page 160 and a stamped addressed envelope. We can deal with only one query at a time. We regret that we cannot supply service sheets nor answer queries over the telephone.

PYE DUAL-STANDARD COLOUR CHASSIS

When the set warms up there is a good raster for about a minute. It then collapses suddenly towards the centre of the screen. The same thing happens when the set is switched off and on again.

You should notice the condition of the PL509 line output valve when the scan collapses: if it becomes red hot you have either a defective PCF802 line oscillator valve or, more likely, a defective capacitor in the line oscillator circuit. Check the two small electrolytics (4μF) under the PCF802 base, also the 16μF h.t. feed decoupler. Then if necessary check by replacement the tuning capacitor C213 (2,200pF) and the feedback capacitor C214 (320pF).

PHILIPS 300 SERIES

There is a buzzing noise when the picture is light. The ITV picture is good, BBC-1 rather grey and BBC-2 very faint. There used to be a loud hissing noise when the aerial was disconnected, but now there's no noise at all. The 12V supply to the tuner is intact, and there's 1·5V on the a.g.c. line.

The trouble is likely to be due to a defective transistor in the i.f. strip, the most probable culprit being T2676, the BF197 transistor in the detector can A. Check the i.f. amplifier transistors, then if necessary follow up the low a.g.c. voltage by checking the a.g.c. amplifier transistor T2189 (BC158) and the associated components.

RANK A816 CHASSIS

The trouble with this solid-state monochrome set is that the tube heater (it's fed from the line output transformer) is not alight, there's no e.h.t., and the HT1 supply to the line output stage is low. The sound is o.k. The line output transistor and the shunt stabiliser transistor in series with its emitter have been replaced, also the SN76533N line generator i.c. The l.t. supply is correct, despite it coming from the line output transistor's emitter circuit.

The first thing to do is to find out whether there is excessive loading on the line output transformer. Disconnect in turn the e.h.t. rectifier 3D13, the line scan coils, and rectifiers 3D12 and 3D11. With one of these disconnected the HT1 should return to normal, indicating that the load has been removed. If this doesn't occur, the line output transformer is suspect for having short-circuit turns.

THORN 8500 CHASSIS

The problem is no picture, with very faint sound at maximum volume. There's a raster, but the brightness control has to be fully advanced and you can get only grey illumination. The set was working normally before this situation was discovered on switching on.

If you're lucky the MC1330 synchronous vision detector i.c. (IC1) will turn out to be the culprit. If not, you will have to check the voltages round all the transistors in the i.f. strip – VT101/2/3. Bear in mind that the voltages can be upset by leakage in the disc decoupling capacitors C109/114/119/122 as well as by defective transistors, and also by a fault in the a.g.c. system.

DECCA MS2400

The picture is perfect but collapses to a thin vertical line down the centre of the screen, at times varying from a few minutes to some hours after switching on. The line timebase valves seem to be operating normally. The ECC82 line oscillator valve has been replaced with no change. The set is o.k. again after cooling.

If the vertical line does not fade away to a blank screen after a few seconds the e.h.t. is present and this greatly narrows the field of search. The problem is likely to be due to a bad joint in the scan coil circuit. Check the plugs and sockets on the screened leads to the scan coils, and the connections to the scan-correction capacitor C137 and pins 4 and 5 of the line output transformer. It's possible that the dry-joint is present on the scanning yoke itself.

PYE 173 CHASSIS

There's a picture but no sound, the fusible resistor R55 in the HT4 line having gone open-circuit. No other fault can be seen, so before resoldering the resistor and replacing the PCL86 should any other checks be made?

These fusible resistors often go open-circuit on their own account, but before reconnecting it check the associated smoothing electrolytic C50 (32μF) and the output pentode's signal coupling capacitor C47 (0·01μF), either of which could be leaky. If the pentode's cathode bias resistor R54 looks new the valve is probably in order. If you still get no sound after reconnecting R55, suspect C43 (0·0015μF) which tunes the quadrature coil associated with the TBA480 intercarrier sound i.c.

PHILIPS 320 CHASSIS

The problem is that the field locks but bounces and jitters about an inch from the top of the screen. Altering the setting of the field control makes no difference – except that the picture will roll up and down normally of course. The picture is fairly well contrasted, and there is only a small improvement to the fault if the aerial signal is reduced or the set tuned. There is full height, and we are certain it's not a field timebase fault. Adjusting the contrast control makes no difference to the fault, which we think is in the a.g.c. circuit, though no trouble here has come to light. The tuner and the TAA550 stabiliser seem to be in order. We've had three sets with this fault!

We are inclined to agree that the fault is probably in the a.g.c. line, and suggest you try replacing the decoupling electrolytics C2207 (68μF) and C2222 (33μF). The a.g.c. bias is provided by the TBA550Q i.c., which is also the sync separator and field sync buffer. This chip could well be the offender therefore.

THORN 1600 CHASSIS

The problem with this solid-state monochrome set is sound but no raster (no e.h.t.). The BU205 line output transistor and the BF337 line driver transistor have been replaced. The HT1 line is very low at 67V instead of 185V, with the line driver transistor's collector voltage correspondingly low at 63V instead of 140V. The voltages in the line oscillator stage are correct.

The effect is likely to be due to something excessively loading or damping the line output transformer. Check the HT1 voltage while disconnecting each of the following in turn: the e.h.t. stick rectifier W35; the 32V supply rectifier W34; and the line scan coils. If the HT1 line returns to normal when any of these is disconnected, you've found the problem: if not, the line output transformer is suspect.

PYE 697 CHASSIS

The trouble with this set is colour drop out after five minutes or so. The colour can be restored by operating the tuner button, but again lasts for only about five minutes before going off again. Turning up the colour control makes no difference.

This trouble can usually be resolved by carefully adjusting the set a.p.c. bias control RV10 on the decoder panel, to give more reliable operation of the reference oscillator.

RANK A774 CHASSIS

The problem with this set is no raster (no e.h.t.), and no sound either since the transistor supply is obtained from the line output stage. The DY802 e.h.t. rectifier does not light up, and there is no line drive although there is no sign of overheating. A new EF184 line oscillator valve has been tried and the associated components all seem to be in order.

Since there is no line drive (negative voltage at the control grid of the PL504 line output valve) but at the same time no overheating or distress there are only two possible causes: either the PL504 is faulty, or its cathode (pin 3) is not returned to chassis.

PYE 713 CHASSIS

The set worked perfectly for some three years then one day after switching on the picture appeared as through being viewed through drizzly rain. In every other respect the sound and vision are perfect.

The fault is almost certainly due to a dry-joint in the i.f. filter/amplifier unit. The tuner is at the rear of the left side lower panel, and the unit to which we refer is of similar general appearance and mounted horizontally. Remove it and remake the soldered connections to L101/C106/L109/C113/C117/C120, lifting the capacitors slightly so that the solder clears the cement covering the lead-out wires.

WALTHAM W125

The trouble is lack of height, about half an inch at the top and bottom of the screen. There's no cramping at the bottom. If the VDR R338 which stabilises the h.t. supply to the height control is disconnected the height is excessive. I suspect the VDR: is there a UK replacement?

We don't suspect the VDR: disconnecting it should result in excessive height since the supply to the height control then rises. If you want to replace it (type SV560/10-13) however an E298CD/A258 (tag ended) or E298ED/A258 (leads) may be used. It's normal in these sets for the height to decrease slightly after a few weeks' use: if adjusting the height control doesn't cure, suspect R339 or R332 which are in series on each side of it of increasing in value.

THORN 3000 CHASSIS

I am having difficulty in setting up the decoder reference oscillator. When the wire links in the a.p.c. loop are arranged to let the oscillator free run, it oscillates when well off frequency. When R315 is adjusted to get near the correct frequency however the oscillator stops and colour is lost. This condition continues over a considerable range of R315's adjustment, the oscillator starting up again only when the control is well out of adjustment in the other direction. The crystal, the varicap diode, and the reference oscillator and emitter-follower transistors have been replaced and the tuning of the oscillator coil checked.

We feel that the trouble is in the burst detector circuit. Check the two diodes W302 and W303: they could well be out of balance. Measure their back-to-front resistances, or better still replace them. Check the burst detector driver transformer (L301) windings: we have found a high resistance spot on one on several occasions.

BUSH CTV25

Examination of the test card shows that the blue convergence is out, drooping at the left-hand side of the screen. No amount of convergence adjustment will cure this and the convergence potentiometers all seem to be in order.

Ensure that the 10Ω resistor 9R2 which shunts the blue convergence network is of the correct value, and that there are no dry-joints. Make sure that no wires have been raked off the blue (top) convergence coil on the c.r.t. neck. Finally suspect the capacitor (9C9) which tunes the blue horizontal shape coil.

PYE 67 CHASSIS

There is a good raster, but no vision or sound. The loudspeaker produces the normal hum. The final i.f. and the phase-splitter transistor have been replaced without success. R62 and R63 in the transistor power supply circuit at the end of the heater chain have overheated, while the reservoir/smoothing capacitors C62 and C63 have exploded! The transistor supply is about 24V.

We assume you mean 24V negative; the transistors in the i.f. strip have their emitters fed from a −18V rail. Since this voltage appears to be high you should check R61 (47Ω) which is in series with R62/R63, and the filter resistor R64 (110Ω). When you've got the supply line right, check the voltages across the emitter resistors R7, R12 and R18 in the first three i.f. stages: you should get a reading of 2-3V across these, i.e. with the supply line at − 18V you should read from 14·5-16V at the emitters. Check the base voltages, the transistors and then the a.g.c. circuit if these voltages are wrong.

ITT/STC VC2 CHASSIS

Optimum sound and vision tuning do not coincide: when the fine tuner is used to get optimum vision the sound is distorted and weak. The effect is the same on both v.h.f. and u.h.f.

This is often due to a weak r.f. input signal, perhaps because of a faulty aerial or inadequate field strength. If the picture is free of grain and snow however, realignment of the sound i.f. stages will be required.

GEC 2119

This set gave excellent reception until, while tuned to BBC-1 from Wenvoe, the picture suddenly broke up and disappeared and the sound changed to BBC-2 from Wenvoe or Mendip. I am now unable to receive the Wenvoe BBC-1 and HTV sound and vision signals, but can receive all the Mendip transmissions on any of the six touch buttons. I can get BBC-2, but am uncertain whether it's from Mendip or Wenvoe. The aerial system has been checked – and I live within a mile of the Wenvoe transmitter.

You will have to check the voltages at the tuner control panel (PC605). The channels are selected by precise voltages to and from this unit. There should be 190V at PL39-1. R676 leads from this point to PL38-4, and should be 15kΩ. PL38-4 feeds the voltage stabiliser (IC101, TAA550) which is on the i.f. panel, and this should provide a steady 33V to PL38-6 on the tuner panel via the preset control P101 (4·7kΩ). It's this 33V which is probably wrong. If so check R676 and the TAA550. If the 33V supply is correct however, suspect the ETTR6016Q i.c. on the tuner control panel.

TEST CASE

181

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

The symptom on an early GEC 2040 colour receiver was perfect monochrome and sound but no colour. This is a single-standard receiver (the same chassis with slight variations was also used in some of the early Sobell receivers) using bipolar transistors in the small-signal stages. The receiver was set up on the test bench, and the symptom confirmed. Even with the colour control at maximum, there was no sign of "confetti" (colour noise) on the background of the monochrome display. It was concluded that the colour killer was probably being held on for some reason.

The colour-killer control action takes place at the base of the second chroma amplifier transistor TR319 (BF194 – see Fig. 1). TR319's base is returned via R384/R386/P304 to a –10V line so that in the absence of a colour signal the transistor is cut off, preventing the chroma channel passing any signal. When a colour signal is received, the ident signal is rectified by diode D312, charging C352 to a positive voltage sufficient to overcome the negative bias via R386/P304. TR319 becomes conductive therefore, switching the chroma channel on.

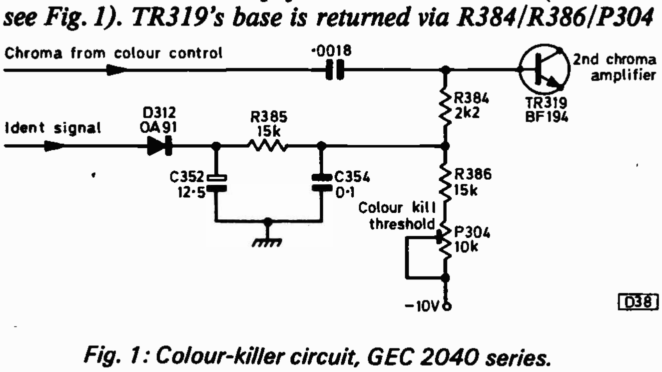


Fig. 1: Colour-killer circuit, GEC 2040 series.

Tests confirmed that the base of TR319 remained at a constant negative value regardless of the presence of a colour signal, and adjustment of the killer threshold preset P304 failed to change the conditions. In fact there was no positive potential present across C352.

While making tests in this circuit area the colour suddenly appeared and a positive potential was measured across C352, the killer threshold control then working normally. The receiver was switched off and allowed to cool down. On switch on, the symptom was just as before – no colour and no positive potential across C352!

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

SOLUTION TO TEST CASE 180
– Page 104 last month –

Since the static operating conditions of the suspect chroma amplifier stage in the ITT CVC8 chassis decoder in last month's Test Case appeared to be o.k., the technician concentrated on the components which would be more likely to affect the dynamic conditions, such as capacitors and inductors. One inductor and several capacitors are used. On bridging each capacitor in turn, it was found that a change of conditions occurred when the 4·7μF d.c. feed decoupler at the top of the inductor load was shunted by a replacement. This failed to cure the trouble completely however.

The capacitor was then removed, and the saturation fell virtually to zero. Applying the replacement electrolytic with the original *disconnected* solved the problem. Subsequent measurements on the faulty capacitor failed to expose any dramatic defect in the component. It still had a fair capacitance, and was apparently not leaky! Here then is another case where simply shunting a suspect component was insufficient to clear the fault condition. It also highlights the fact that a suspect capacitor can measure reasonably normally yet affect the working of a stage.

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TELEVISION JAN 1978

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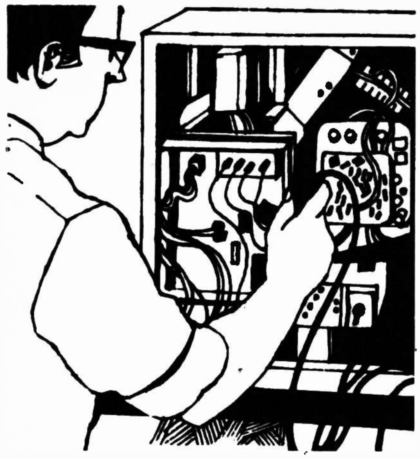

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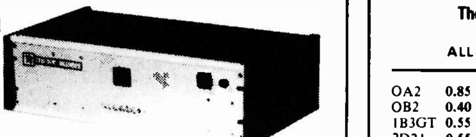

SPECIAL PRICE COMPLETE KIT

£220
+ £2 P & P.

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

Kit	Incl. PCB	Less PCB	P & P
POWER SUPPLY UNIT	£26.75	£23.80	£1.00
INPUT LOGIC CARD	£25.85	£16.05	20p
MEMORY CARD	£33.10	£25.20	20p
7 sockets for 2102 i.c.s. – extra £1.60			
DISPLAY CARD	£32.65	£24.65	20p
MOTHERBOARD etc. ex. mod.	£33.40	£28.50	20p
MODULATOR Pre-aligned and tested		£17.00	20p
I.F. CARD	£36.00	£30.00	20p
CABINET – Ready Punched		£22.35	£1.25

Components are also available separately:

Thumbwheel Switch – £7.00; Push Button Switch Assy – £4.20; 32 way Edge Connector – £1.95; 47K 20T Cermet Pot – £1.10; ELC1043/05 Tuner – £9.15; SAW Filter – £2.85; SFE6 OMA Filter – 93p. SL439 – £1.20; SN76660 – 85p; TDA440 – £3.40; LM710 – 58p; Illuminated Mains Switch – £1.40; Mains Transformer – £6.25 (+ £1.00 p & p). 7805 – £1.50; 7812 – £1.50; 2102 – £2.25; 74S262N – £16.00. Please add minimum 20p P & P.

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

Catronics
CATRONICS LTD. (Dept. 861),
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PHONE 6743
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OA2	0.85	6DT6A	0.85	30C17	0.90	ECF80	0.65	GY501	1.25	PY88	1.12
OB2	0.40	6E5	1.00	30F5	0.70	ECF82	0.50	GZ32	1.00	PY500A	1.56
1B3GT	0.55	6EW6	0.85	30L15	0.75	ECF86	0.80	HN309	1.70	PY800	0.60
2D21	0.55	6F1	0.80	30L17	0.70	ECH35	2.00	KT66	3.00	PY801	0.60
5CG8	0.75	6F6G	0.70	30P12	0.74	ECH42	1.00	KT88	6.75	PZ30	0.50
5R4GY	1.00	6F18	0.60	30P19	0.90	ECH81	0.55	P61	0.60	QQV03/10	2.00
5U4G	1.00	6F23	1.00	30PL1	1.25	ECH84	0.75	PC86	0.80	QV06/20	4.70
5V4G	1.00	6F28	0.85	30PL13	1.30	ECL80	0.55	PC88	0.80	R10	5.00
5Y3GT	0.65	6GH8A	0.80	30PL14	1.50	ECL82	0.50	PC92	0.55	R19	0.75
5Z3	1.40	6GK5	0.75	50CD6G	4.00	ECL83	1.50	PC97	0.75	UABC80	0.45
5Z4G	0.75	6GK6	2.00	85A2	1.40	ECL86	0.64	PC900	0.65	UAF42	0.70
6/30L2	0.90	6GU7	0.90	807	1.10	EF22	1.00	PCC84	0.39	UBC41	0.70
6AC7	0.70	6H6GT	0.50	5763	2.75	EF40	1.00	PCC85	0.47	UBC81	0.55
6AG7	0.70	6J5GT	0.65	AZ31	1.00	EF41	1.00	PCC89	0.49	UBF80	0.50
6AH6	0.70	6J6	0.35	AZ41	0.50	EF80	0.40	PCC189	0.60	UBF89	0.39
6AK5	0.45	6JU8A	0.90	DY51	2.00	EF83	1.70	PCF80	0.80	UC92	0.50
6AM8A	0.70	6K7G	0.50	DY86/7	0.45	EF85	0.45	PCF82	0.45	UCC85	0.45
6AN8	0.70	6K8G	0.50	DY802	0.50	EF86	0.50	PCF86	0.57	UCF80	0.80
6AQ5	0.68	6L6GC	1.75	E80CF	6.00	EF89	0.55	PCF200	1.35	UCH42	1.00
6AT6	0.60	6L7(M)	1.50	E88CC	1.20	EF91	0.70	PCF201	1.00	UCH81	0.50
6AU6	0.50	6Q7G	0.75	E188CC	4.50	EF92	0.70	PCF801	0.49	UCL82	0.55
6AV6	0.65	6SA7	0.70	EA50	0.40	EF183	0.45	PCF802	0.75	UCL83	1.00
6AW8A	1.15	6SG7	0.70	EABC80	0.48	EF184	0.45	PCF805	2.25	UF41	0.70
6AX4	0.75	6U4GT	1.00	EAF42	1.00	EH90	0.65	PCF806	0.70	UF42	1.00
6BA6	0.65	6V6G	0.50	EAF801	1.50	EL41	1.00	PCH200	1.00	UF80	0.40
6BC8	0.90	6X4	0.95	EB91	0.25	EL81	1.00	PCL82	0.54	UF85	0.50
6BE6	0.60	6X5GT	0.50	EBC41	1.00	EL84	0.41	PCL83	0.75	UF89	0.52
6BH6	1.00	9D7	0.70	EBC81	1.00	EL86	0.60	PCL84	0.46	UL41	0.90
6BJ6	0.75	10C2	0.70	EBF80	1.00	EL95	0.85	PCL86	0.65	UL84	0.54
6BK6A	0.85	10DE7	0.80	EBF89	0.40	EL360	2.50	PCL805	0.65	UM80	1.00
6BN8	1.00	10F1	0.67	EC86	0.84	EL506	2.00	PFL200	0.90	UY41	0.70
6BQ7A	1.40	10F18	0.65	EC88	0.84	EL509	2.50	PL33	1.00	UY85	0.70
6BR7	1.00	10P13	0.80	EC92	1.00	EM80	1.00	PL36	0.80	U19	4.00
6BR8	1.25	10P14	2.50	ECC33	2.00	EM81	1.00	PL81	0.49	U25	1.00
6BW6	3.50	12AT6	0.45	ECC35	2.00	EM84	1.00	PL81A	0.75	U26	0.90
6BW7	0.65	12AU6	0.50	ECC40	1.00	EM87	1.45	PL82	0.50	U191	0.50
6BZ6	1.50	12AV6	0.60	ECC81	0.48	EY51	0.65	PL83	0.50	U301	1.00
6C4	0.50	12BA6	0.50	ECC82	0.48	EY81	1.50	PL84	0.50	U404	0.75
6C9	2.00	12BE6	0.85	ECC83	0.48	EY83	1.50	PL802	3.20	U801	1.00
6CB6A	0.65	12BH7	0.55	ECC84	0.50	EY87/6	0.45	PL504	1.00	VR105	0.50
6CD6G	4.00	13D8	2.00	ECC85	0.50	EY88	1.00	PL508	1.30	VR150	0.75
6CG8A	0.90	19AQ5	0.65	ECC86	2.00	EY500	1.45	PL509	2.55	X41	1.00
6CL6	0.75	19G6	6.50	ECC88	0.72	EZ40	1.00	PL519	2.80	Z759	6.50
6CL8A	0.95	19H1	4.00	ECC807	2.80	EZ41	1.00	PY33/2	0.50		
6CM7	1.00	20P1	1.00			EZ80	0.35	PY81	0.60		
6CU5	0.90	20P4	0.84			EZ81	0.40	PY82	0.40		
6DE7	0.90	30C15	1.00								

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Will collect. Cash.

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DY802	50p	EF89	42p	PC86	63p	PCF805	POA	PL81A	53p	UBF89	40p
ECC81	45p	EF183	42p	PC88	63p	PCF806	75p	PL83	50p	UCC85	46p
ECC82	45p	EF184	42p	PC97	72p	PCF808	POA	PL84	48p	UCH81	50p
ECC83	45p	EH90	56p	PC900	50p	PCL82	54p	PL500 }	90p	UCL82	55p
ECC85	45p	EL41	70p	PCC84	35p	PCL83	70p	PL504 }		UCL83	60p
ECH81	53p	EL84	40p	PCC85	44p	PCL84	48p	PL508	£1.30	UF89	45p
ECH84	58p	EL509	£2.70	PCC89	50p	PCL85 }	62p	PL509	£2.20	UL41	75p
ECL80	52p	EM84	50p	PCC189	53p	PCL805 }		PL519	£2.80	UL84	52p
ECL82	48p	EY86/7	38p	PCF80	72p	PCL86	65p	PL802	£2.75	UY41	48p
ECL86	63p	EY500A	£1.50	PCF86	58p	PCL200	£1.40	PY88	58p	UY85	40p
EF80	33p	EZ80	40p	PCF200/1	£1.30	PD500	£3.25	PY800	50p	U25	60p
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ECC81	45p	PC88	85p	PCF808	£1.45	PL504	£1.30	6F23	60p	30PL13	£1.00
ECC82	50p	PC97	75p	PCH200	£1.25	PL508	£1.40	6F28	92p	30PL14	£1.20
ECL80	70p	PCC84	35p	PCL82	65p	PL509	£2.25	20P4	70p	30PL15	£1.10
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EF183	70p	PCC189	62p	PCL84	70p	PY81/83	50p	30C17	80p		
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