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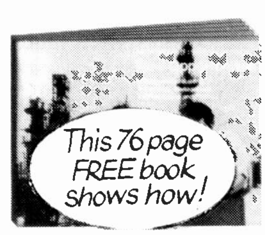

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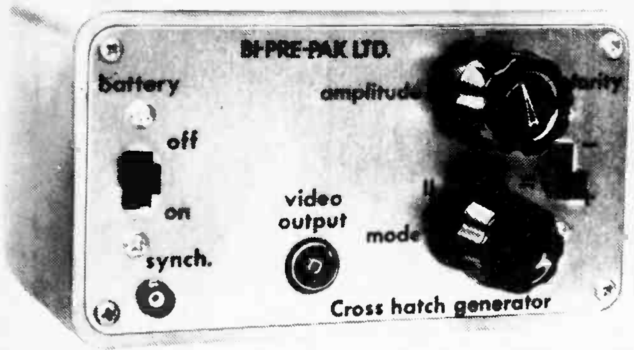

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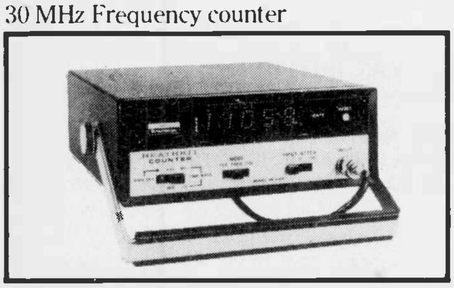

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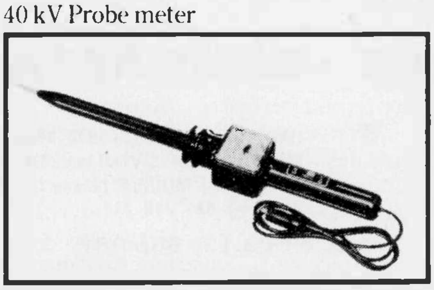

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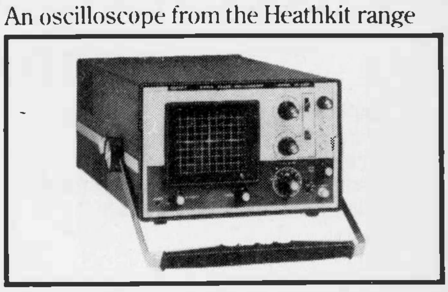

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Television

SOME HISTORY

Once upon a time TV setmakers would produce a new chassis each year. It would be ceremoniously unveiled at the annual Earls Court Radio Show, and the manufacturer would quite justifiably talk about his *new* range of models. At one point in time in fact it was common to find a new range of chassis each year – and we're talking about the days long before colour! There would be the standard chassis, a fringe one with extra i.f. gain, gated a.g.c. and flywheel sync, a plus f.m. radio chassis, and maybe a sort of hybrid in which bits and pieces from the other chassis would be rearranged to give what was called a transportable model. The set designers of those days – in the mid-fifties – certainly went to town: if there was a standard and a fringe chassis, you could be reasonably sure that they would have little in common. Looking back to the early fifties, there were over thirty separate companies producing TV sets in the UK, some in a very small way. Remember Ace, Champion (they even had different chassis for their 12in. and 17in. models!), McCarthy and Spencer-West, to name a few at random? From this point in time it appears as a strangely parochial world, safe from any possible competition from abroad since no one else was interested in producing sets for our 405-line system, and though competitive rather inefficient. The subsequent periodical slumps each took their toll of individual setmakers – sometimes quite large ones, Murphy becoming part of Bush, Ekco being swallowed up by Pye, and so on. Many large electrical/electronics companies left the field altogether: it seems odd now to recall that companies such as English Electric, EMI, Ferranti and Plessey were once forces to be reckoned with in the TV setmaking business. Each pulled out during one or other of the successive market declines.

It's a totally different world today, with the few UK setmakers left – eight of them actually, though a couple of newcomers put in a brief appearance during the great colour TV boom – producing chassis that stay in production year after year. Take the largest, Thorn. Their 1500 single-standard monochrome chassis was introduced back in 1969 and is still going strong. Even their final dual-standard monochrome chassis, the 1400, introduced in 1967, is still in production (recently BEABed) to cater for those still with only v.h.f. transmissions available. Their first single-standard colour chassis, the 3000, was also introduced in 1969 and still shows no signs of coming to the end of its production run.

The situation is similar with our other setmakers. The Philips G8 colour chassis first appeared in 1970 for example, while Rank's A823 chassis appeared a year earlier, in 1969. These have changed quite substantially over the years however – in fact the current G8 chassis shares hardly a single panel design with its earliest predecessors. A great deal of engineering skill has in recent years been put into the design of new-generation panels using the latest i.c.s but nevertheless capable of being interchanged with earlier designs. It seems in fact that the reverse process has also operated: that some earlier panels were designed before certain key components became readily available but on the basis of compatibility once these components went into production in the required quantities and could be obtained at the right price.

A service engineer regularly dealing with a particular chassis will soon become acquainted with the various versions and will be able to see at a glance what he's got to deal with. The spares position is probably more confusing, with masses of panels some of which will interchange while others won't, and most of which have horribly unrememberable numbers (because computers see things rather differently from you and I, unfortunately!). Our regular contributors have rather a hard time of it, trying to avoid writing articles consisting mainly of "if it's the early version . . . , but if on the other hand . . .". Sometimes indeed one yearns for the simpler days when a chassis was just one design and belonged to a particular year – even if it did require an hour to be able to reach the component you suspected and take a measurement, and another half hour to carry out the subsequent replacement!

In spite of panel confusion and the fact that the computer has taken upon itself the duties of stock supervision, things are not too bad today however. Reliability is increasing, and most of what's in a set is readily accessible. It's a pity that setmakers still do silly things, like using under-rated components and assembly methods that result in faults due to stresses and strains. But then we're all human – except for the computer, and so far it can't design a TV chassis!

teletopics

MONO PORTABLES

First a new model from Rank, the Bush BM6510 12in. mains-battery portable. This uses an imported chassis and has some resemblances to the earlier TV350. It would appear that the UK produced TV312/V1230 (Murphy) is now out of production. There are two i.c.s in the BM6510: an SN76666N takes care of the intercarrier sound channel while the entire field timebase is in a KC581C which has an integral heatsink. One small point we've not come across before is the use of a 6MHz ceramic filter as an acceptor trap in the emitter circuit of the video driver stage to remove the intercarrier signal from the vision channel. The recommended price of the new model, including loop aerial, battery lead and VAT, is £89·95.

A manufacturers' modification that could cause confusion to service engineers is changeover from the use of a germanium pnp line output transistor to a silicon npn type instead. This has occurred in several sets, the latest being the Thorn 1591 14in. chassis – from schedule E onwards. These sets can be identified by the schedule label and a "silicon NPN line o/p" label attached to the line output transistor heatsink. Slight changes are needed (see Fig. 1) in the collector circuit of the driver stage due to the higher base current requirements of a silicon output transistor. In addition a shunt efficiency diode (W18) has been added and R143 provided to damp the secondary winding of the driver transformer T2 so that the transistor does not turn on during the flyback period as a result of ringing – its value has to take into account the transistor's switch off requirements.

Thorn also point out that due to supply problems it has not always been possible to fit the usual tolerance line flyback tuning capacitor C109. Where it has not been possible to use the original type the value of the parallel flashover protection capacitor C106 has been adjusted to suit. To ensure adequate width and e.h.t. it is important to keep to the original pairings. This applies to both the 1591 and 1590 (12in.) chassis.

A new version of the 1591 chassis has been introduced. This is the 1593 chassis used in the 14in. HMV Model 2841. It's basically similar to the 1591 except for the user control positions and lead lengths and a different type of battery socket.

Amongst other sets that have changed from a germanium pnp to a silicon npn line output transistor during the production run is the Indesit T12.

There has been another announcement from Sinclair about their oft promised miniature TV set with 2in. c.r.t. The latest plan is that this will go into production in the second half of 1976.

TV CABINET KITS

One problem about constructing your own television receiver is finding a way of housing it so that it is domestically acceptable and safe for family use. Forgestone Colour Developments Ltd. have come forward with a

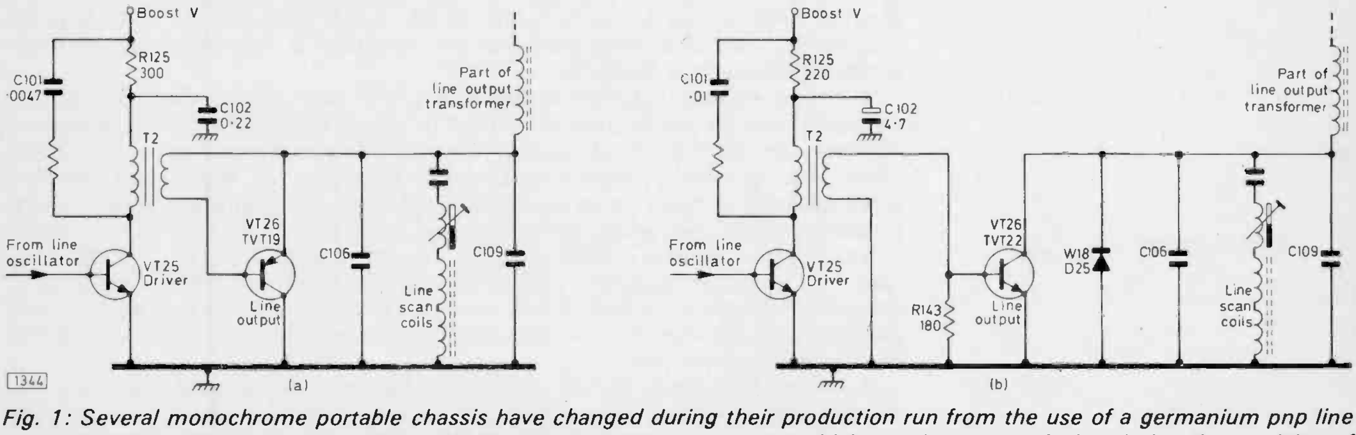
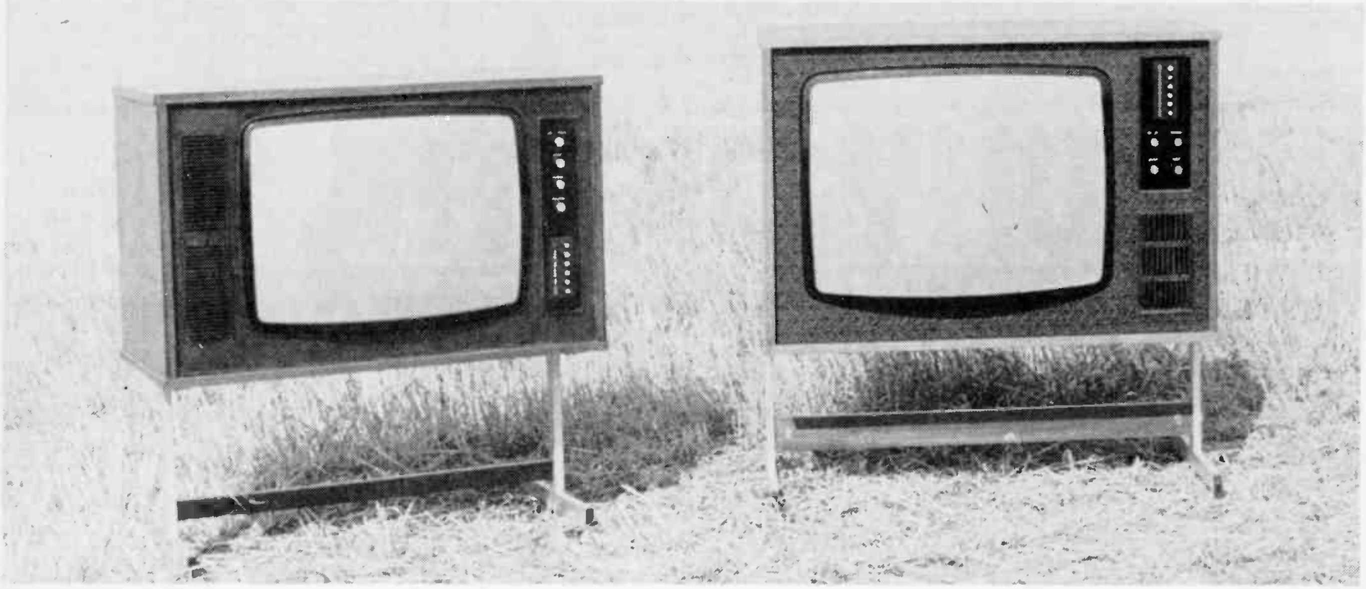


Fig. 1: Several monochrome portable chassis have changed during their production run from the use of a germanium pnp line output transistor to the use of a silicon npn line output transistor, a point which could cause confusion during the servicing of such sets. The drive circuit has to be modified to cater for the greater base current of an npn transistor. (a) the pnp line output transistor circuit used in earlier versions of the Thorn 1591 chassis; (b) the npn line output transistor circuit used in schedule E versions of this chassis and the new 1593 chassis.



Cabinet kits (22in. and 26in.) from Forgestone. You have to obtain your own wood from the local DIY store – otherwise you'd have to pay VAT at 25% on it! The c.r.t. is simply bolted on to the front fascia, at the back.

solution – the 22in. and 26in. Cabinet Kits shown in the accompanying photograph. The kits consist of a decorative front fascia including loudspeaker grille and control escutcheon, a black engraved control panel, knobs, printed panel mounting clips and cabinet back cover. The c.r.t. mounting bolts form an integral part at the rear of the front fascia – in fact the c.r.t. simply bolts on to it. The cabinet is then easily constructed using veneered board and corner blocks (not included) which are readily available from most DIY shops. The price of the 22in. kit is £16·25 and of the 26in. kit £17·50, including carriage and VAT. The stands shown are available extra if required. Enquiries to: Forgestone Colour Developments Ltd., Ketteringham, Wymondham, Norfolk NR18 9RY. The period style Jacobean reproduction cabinet as featured in recent Forgestone advertisements is still available and is also being offered with kit and tube as a complete package deal.

REVISED PANEL

As if to confirm our comments on the leader page, a modification note has just come in detailing alterations to the decoder panel fitted to the latest production versions of the Rank A823AV 90° single-standard colour chassis. The gated a.c.c. subpanel incorporating transistor 3VT12 and its associated components has been deleted, the circuit reverting to the non-gated a.c.c. stage used in the previous version of this panel (Z180). The second harmonic rejector coils associated with the SL901B demodulator i.c. have also been deleted, along with their tuning components. The new panels are compatible with the previous versions and can thus be interchanged.

TRANSMITTER NEWS

Eitshal (Outer Hebrides): The service from this transmitter, to Lewis and coastal areas in some parts of Sunderland and Ross and Cromarty, will be delayed following an accident while the aerial was being erected. The aerial crashed from a hundred feet and the damage is beyond repair.
Keelylang Hill (Orkneys): The ITV transmitter is now in operation on channel 43, carrying Grampian Television programmes. Group B receiving aerials should be horizontally mounted.
The Wrekin (Salop): ITV (ATV programmes) channel 23, BBC-1 channel 26 and BBC-2 channel 33 transmissions are now in operation. Group A receiving aerials should be horizontally mounted.

The following relay stations are now in service:
Bridport (Dorset): ITV (Westward Television) channel 41, BBC-2 channel 44, BBC-1 (South West) channel 51. Receiving aerial group B.
Campbeltown (Strathclyde): BBC-1 (Scotland) channel 57, ITV (Scottish Television) channel 60, BBC-2 channel 63. Receiving aerial group C/D.
Carnmoney Hill (Co. Antrim): BBC-2 transmissions have been added on channel 46.
Chartham (Kent): BBC-1 channel 21, ITV (Southern Television) channel 24, BBC-2 channel 27. Receiving aerial group A.
Coniston (Cumbria): BBC-1 (North West) channel 21, ITV (Granada Television) channel 24, BBC-2 channel 27. Receiving aerial group A.
Crieff (Tayside): ITV (Grampian Television) channel 23, BBC-2 channel 26, BBC-1 channel 33. Receiving aerial group A.
Icomb Hill (Gloucestershire): BBC-1 (Midlands) channel 22, ITV (ATV) channel 25, BBC-2 channel 28. Receiving aerial group A.
Kirkconnel (Dumfries and Galloway): BBC-1 channel 58, ITV (Scottish Television) channel 61, BBC-2 channel 64. Receiving aerial group C/D.
St. Thomas (Exeter): ITV (Westward Television) channel 41, BBC-2 channel 44, BBC-1 channel 51. Receiving aerial group B.
Whitewell (Lancashire): BBC-1 (North West) channel 57, ITV (Granada Television) channel 60, BBC-2 channel 63. Receiving aerial group C/D.

All the above relay transmissions are vertically polarised.

REPLAY ONLY PHILIPS VCR

With the growing number of pre-recorded videocassettes available, Philips have decided that it is an appropriate time to introduce a playback only version of their VCR. This is known as the N1460 and the suggested retail price is £346·09.

WHY DIGITAL?

TV TEST EQUIPMENT REVIEW

PART 1

E. TRUNDLE

IT is not often that a completely new type of test instrument comes along to do a job which a more traditional type of instrument has done satisfactorily for so many years. The digital multimeter is one such, and the first question the technician might ask is why he should part with £60-200 for a DVM when the Avo 8 and similar analogue multimeters have been quite adequate for all his requirements in the past.

In a word, the answer is accuracy. Even the most inexpensive DVM is accurate to 0·5% on d.c. voltage ranges. This is about five times better than a high-class moving-coil multimeter, while on a.c. ranges the superior accuracy of DVMs is even more marked. A high-class digital instrument such as the Solartron 7040 is fifty times as accurate as a conventional multimeter on many ranges.

The need for this degree of precision might well be questioned in view of the fact that many equipment manufacturers quote voltages to an accuracy of 10% in service data. While this was true of valved receivers where a few volts (or even tens of volts!) meant little between friends, modern precision transistorised equipment is a different kettle of fish. Even in domestic entertainment equipment, manufacturers are now calling for accuracies of 1% for certain adjustments; and when measuring transistor electrode potentials, the millivolts you can't see with a pointer and scale are of paramount importance.

Analogue to Digital conversion

While this survey is intended as a guide to the characteristics and capabilities of modern test equipment rather than a technical treatise, the idea of converting an analogue signal (voltage) into digital form for display is a relatively new one, and an account of the technique may be of interest. There are several ways of achieving A-to-D conversion, but the most common method in the sort of instrument that concerns us here is the dual-ramp technique.

The heart of the A-to-D converter is the integrator, formed by R, C and the inverting amplifier in Fig. 1. The measuring cycle (see Fig. 2) starts with S1 in position A. In practice, S1 is of course an electronic switch, its control being derived from the clock oscillator.

The unknown input voltage charges C via R, the amplifier providing a high input impedance and ensuring a linear charging law. After a fixed time *T1*, called the ramp-up time, the charge on C will have reached a certain level *V* proportional to the unknown input voltage. S1 now goes to

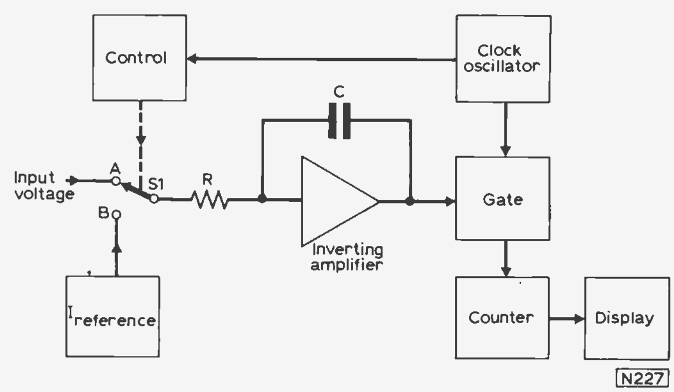


Fig. 1: Basic block diagram of a dual-ramp d.v.m. The clock oscillator is an accurate source of timing pulses, and S1 is an electronic switch, i.e. a transistor junction. The I reference is derived from a stable zener diode.

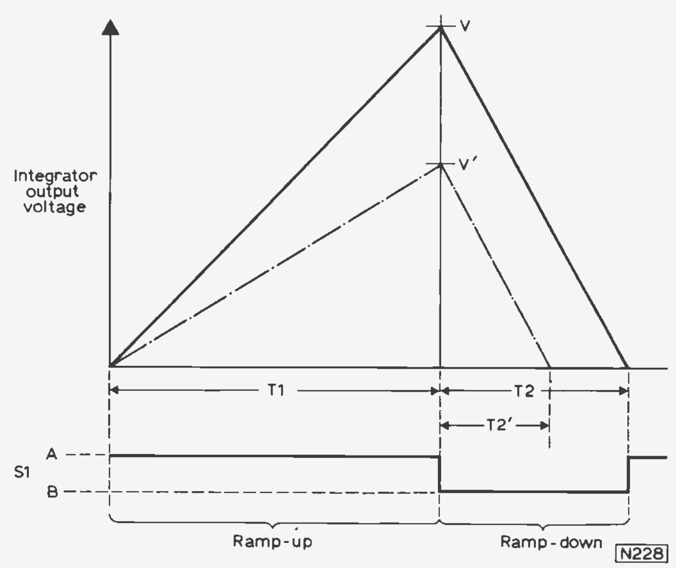


Fig. 2: The dual-ramp integrator cycle. Capacitor C charges to V volts from the input voltage during T1, and is discharged at a constant rate during T2. T2 is thus proportional to V. The broken line represents integrator output with a lower voltage input V'. Note that the angle of the ramp-down slope is constant.

position B, and the capacitor is discharged by a current from the I reference source. Its polarity is opposite to that of the input in order to discharge C back to zero, and being an accurate source of constant current, discharges C in linear fashion.

The time during which C is discharging is called the ramp-down time, and because the discharge current is constant and fixed at a predetermined level, the slope of the ramp-down is always the same. It follows therefore that the time taken for C to discharge to zero will be proportional to the charge originally held in it, so that the duration of the ramp-down is an accurate representation of the input voltage.

The output of the integrator is applied to a gate which opens during the ramp-down period, passing clock pulses into the counter. The number of pulses accumulated in the counter is thus determined by the ramp-down time, which as we have seen is proportional to the unknown input voltage.

The counter divides successively by ten, the outputs being passed to the display driver stages, which sort out the counter output pulses and energise the individual segments of the display digits and the decimal points.

The dual-slope integrator will obviously only work with a d.c. input voltage, and over a limited range. In these respects, it is similar to the movement of an ordinary analogue pointer instrument, so that the DVM follows multimeter practice in that all inputs are scaled to one or two d.c. voltages, which are analagous to the f.s.d. of a meter movement. Current inputs produce a voltage across a shunt resistor, and a.c. inputs have to be rectified. The precision rectifier used may work on the mean value or true r.m.s. of the applied input waveform. All DVMs are calibrated in terms of r.m.s., so that the rectification characteristic is unimportant unless the input waveform departs from sinusoidal form. "Rectifier" is rather a common expression, and the more snobbish term "a.c. to d.c. converter" is commonly used.

Many aspects of DVM design have necessarily been omitted from this brief account. In spite of their relative complexity, DVMs are quite reliable, and manufacturers' after-sales service is generally excellent.

Input Impedance

An advantage the DVM shares with the valve voltmeter and its transistor counterpart is high input impedance, resulting in negligible circuit loading. Modern transistor and i.c. circuitry operates at very low power levels, and the application of a 20kΩ/V multimeter is often sufficient to mop up all the milliwatts going, just to drag the pointer across the scale!

Overload Protection

A common worry for first-time users of DVMs is the question of overload protection. Who can claim never to have popped the cutout button on the Avo, or wrapped the pointer of some ill-fated (and hopefully inexpensive) oriental meter around the right-hand stop? The answer here is that it is very difficult to damage a DVM by overload. In most designs, a robust diode is used for overload protection, shunting away overload currents. In turn, this diode is protected by a fuse which blows on severe overload.

As an example of the confidence which may be placed in this, one manufacturer's representative suggested we try to blow up his instrument in any way possible after our evaluation. "Switch to 10mV d.c. and connect the probes to raw mains" said he. With some trepidation, we took him up on this, and the instrument amiably winked at us before blowing the fuse, which was easily accessible. It is true to say that the only way to "fix" a DVM is with high pulse or e.h.t. voltages accidentally applied.

Ranges and Polarity Indication

For each mode of operation, fewer ranges will be found on a DVM compared with a conventional multimeter, although the total range of measurement for a DVM is greater. This is because with digital readout, the accuracy is much less dependent on the ratio between the indicated reading and "full scale deflection". Which is another way of saying that the DVM has a much longer effective scale length than an analogue meter. The resolution, and hence accuracy, is thus enhanced and the amount of range-switching required during fault investigation is much reduced. The fact that automatic polarity indication is given means that for most applications, the "low" input lead can be firmly clipped to chassis throughout the hunt.

Portability

A digital instrument is slimmer and lighter than a full-specification analogue multimeter, and decidedly less fragile from a physical point of view. A seldom-realised advantage conferred by a digital meter is that readout accuracy is unaffected by the position or angle of the instrument. A harassed field engineer crouched in a corner behind a wobbly TV set would testify to this one!

Disadvantages

On the debit side, the test current on the resistance ranges of most DVMs is not sufficient to bias on a semiconductor junction, which means that a DVM cannot generally be used for a rough check of transistors and diodes in the same way as an ordinary multimeter. For the same reason, electrolytic capacitors cannot be tested on resistance ranges. For field work, the necessity to find a mains supply or replace batteries is inconvenient.

All DVMs work on a "sample and hold" principle, which means that the readout updates several times per second. While this is alright for most applications, an eye-boggling display akin to a fruit machine results if the quantity being measured is intermittent or fluctuating.

Practicalities

With the increasing complexity and sophistication of equipment finding its way to the service bench the DVM, hitherto regarded as a luxury and rather in the status symbol category amongst the servicing fraternity, is now becoming a necessity. Excellent instruments are available from about £60 upwards, and a representative selection of currently available types is reviewed below.

With digital multimeters, as with most things, you only get what you pay for, and while most makers market one or more instruments in several quite clearly defined price groups, specifications and facilities differ little between manufacturers in a given price range. The following reviews and specifications are intended more as a guide to the classes of instrument available in each price range than a *Which?* hunt. Each instrument had a period with an audio bench/field technician, followed by a week or two on the colour bench in the workshop, so that all conditions of service were encountered.

WHY DIGITAL?

Advance Alpha II

This is an inexpensive, light and compact 3-digit DVM which operates from mains or battery. The makers have thoughtfully provided a front-panel mounted brightness control with which to conserve battery life. Battery prices have rocketed lately, and the nominal 25 hours life can be extended considerably by using low display brightness levels. This instrument is eminently suitable for field work, and the probes provided are of the prodclip type, which are ideal for use on crowded printed boards. These excellent prods, by their nature, wear quickly, but similar replacements are available in the RS Components range.

The range switches are reminiscent of a conventional multimeter, and very easy to operate. The plastics case is probably more rugged than it looks, but on our review model the bottom and back covers had the unfortunate habit of parting company with the rest of the case. The overload protection fuses, especially the 1·5A current overload fuse are rather inaccessible. The battery check facility is most useful, one position of the range switch being reserved for this; the battery voltage is read out directly. ●

Abridged specification

D.C. VOLTAGE

Range	Input Z	Accuracy
1000mV	10MΩ	±0·2%, ±1 digit
10V	11MΩ	
100V	10MΩ	±0·5%, ±1 digit
1000V	10MΩ	

Safe overload: 1000V (350V on 1000mV range).

A.C. VOLTAGE

Range	Input Z	Accuracy
1000mV	10MΩ/75pF	
10V	11MΩ/75pF	±1%, ±2 digits
100V	10MΩ/75pF	
500V	10MΩ/75pF	

Frequency range: 40Hz–20kHz (upper limit 1kHz on 100V and 500V ranges).
Safe overload: 500V (350V on 1000mV range, up to 2kHz).

D.C. CURRENT

Range	Full-scale volts drop	Accuracy
100μA		
1mA	1V	
10mA		±0·5%, ±1 digit
100mA		
1000mA	1·2V	

Overload protection: 1·5A fuse.

Further details are available from Advance Electronics Ltd., Instrument Division, Roebuck Road, Hainault, Essex IG6 3UE. Telephone: 01-500 1000.

A.C. CURRENT

Range	Full-scale volts drop	Accuracy
100μA		
1mA	1V	
10mA		±1·5%, ±2 digits
100mA		
1000mA	1·2V	

Frequency range: 40Hz–20kHz (upper limit 2kHz on 100μA range).
Overload protection: 1·5A fuse.

RESISTANCE

Range	I TEST	Accuracy
100Ω	10mA	
1000Ω	1mA	
10kΩ	100μA	±1%, ±1 digit
100kΩ	10μA	
1000kΩ	1μA	
10MΩ	0·1μA	±2%, ±1 digit

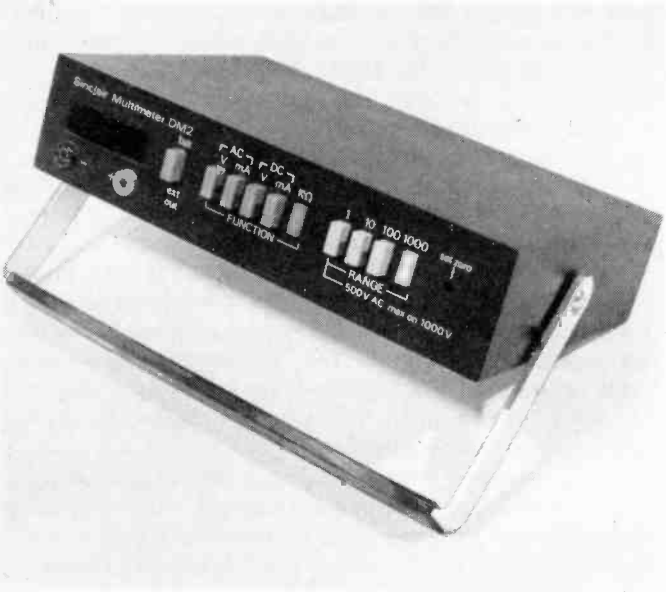
Safe overload: 10V, above which a 100mA fuse operates.

GENERAL

Display: 3 digit, 999 maximum, seven-segment l.e.d., 8mm (0·3in) high digits.
Overrange capability: 20% on all ranges except 500V a.c.
Polarity indication: Automatic, blank or "–".
Power supply: A.C. mains: 100-125 or 200-250V, 45-65Hz. Battery: the mains p.s.u. may be replaced by a PP9 giving about 25 hours life.
Size: 63 x 125 x 175mm (2·5 x 5 x 7in).
Weight: 0·9kg (2lbs) approximately.
Accessories available: Ever-ready carrying case.
Price: £57 (plus VAT).

WHY DIGITAL?

Sinclair DM2



This is one of the least expensive DVMs on the market, yet it has most of the facilities and specifications of its more pricey counterparts. Function and range selection are by push-buttons. The case is extremely rugged, being made of cast aluminium. The power source is an internal PP9.

The instrument gives the impression of indestructibility both electrically and mechanically. Our only reservation here is that the selector push-button switches look similar to those used in domestic equipment. Trouble with these is not unknown, and replacement would be a major job. Miniature prodclips are provided, and the same remarks apply to these as for Alpha II.

Overload fuse accessibility is reasonable, but still involves removal of the case bottom. External access to the fuses would have been more practical; a five-minute sortie into the instrument following accidental overload is frustrating for a field engineer in the middle of a service call.

Resolution on voltage ranges is down to lmV, and a 10MΩ resistance range is available (without decimal point) by releasing all range switches.

At the price, this DVM represents very good value for money, and the author can vouch for the speed and efficiency of Sinclair's after-sales service should it ever be required. ●

Abridged specification

D.C. VOLTAGE

Range	Input Z	Accuracy
1V	100MΩ	±0·3%, ±1 digit
10V 100V 1000V	10MΩ	±0·5%, ±1 digit

Safe overload: 1000V (350V on 1V range).

A.C. VOLTAGE

Range	Input Z	Accuracy
1V 10V	10MΩ/40pF	±1%, ±2 digits
100V *1000V	10MΩ/40pF	±2%, ±2 digits

Frequency range: 20Hz–3kHz (upper limit 1kHz on 1000V range).
Safe overload: 500V (300V on 1V range).
* Maximum input on a.c. voltage is 500V.

D.C. CURRENT

Range	Full-scale volts drop	Accuracy
†100μA	1V	±2%, ±1 digit
1mA 10mA 100mA	1V	±0·8%, ±1 digit
1000mA	1V	±2%, ±1 digit

Overload protection: 1A fuse.

Further details are available from Sinclair Radionics Ltd., St. Ives, Huntingdon, Cambs. Telephone: St. Ives (0480) 64646.

A.C. CURRENT

Range	Accuracy
1mA 10mA 100mA	±1·5%, ±2 digits
1000mA	±2%, ±2 digits

Frequency range: 20Hz–1kHz.
Overload protection: 1A fuse.

RESISTANCE

Range	I TEST	Accuracy
1kΩ	1mA	±1%, ±1 digit
10kΩ	100μA	±1%, ±1 digit
100kΩ	10μA	±1%, ±1 digit
1000kΩ	1μA	±1%, ±1 digit
†10MΩ	0·1μA	±2%, ±1 digit

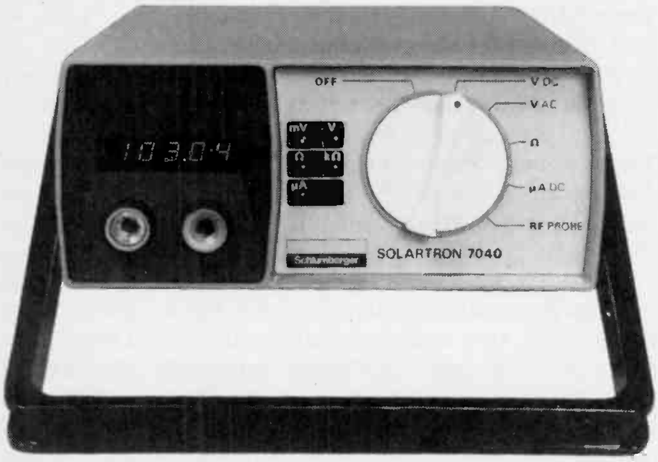
Overload protection: 50mA fuse.
† Additional ranges obtained by special switching combinations.

GENERAL

Display: $3\frac{1}{2}$ digit, 1999 maximum, seven-segment l.e.d., 8mm (0·3in) high digits.
Overrange capability: 100% on all ranges except 1000V d.c. and a.c.
Polarity indication: Automatic, blank or "–".
Power supply: Internal PP9 dry battery gives up to 60 hours use. Sockets for external stable 9V d.c. supply at 70mA.
Size: 56 x 225 x 155mm (2·2 x 8·8 x 6·1in) excluding knobs, feet and handle.
Weight: 1kg (2·2lbs) excluding battery.
Accessories available: Ever-ready carrying case. Mains converter.
Price: £59 (plus VAT) including test leads and battery.

WHY DIGITAL?

Solartron 7040



This is the most exotic DVM reviewed here. Its appearance is deceptive, because it is superficially similar to portable instruments in the low price range, and its display digits are actually smaller. A glance at the price and specification will show however that this is a different class of instrument altogether, being fully automatic in operation, without any sort of range switching.

The single front panel control is set to the function required, and all range selection is carried out automatically within the instrument, which samples the input voltage and selects the appropriate range. The decimal point is automatically placed, and a separate panel display indicates the units (V or mV; Ω or kΩ etc.) being displayed. The click of a relay is the only indication of this process, which is almost instantaneous. The nett result is that without touching the meter, the probe can be moved from an f.e.t. drain terminal carrying 20μV to a 900V boost line, both voltages being read to an accuracy of better than 0·05% As is to be expected, accuracy is generally very high.

Input impedance is exceptionally high on low d.c. voltage ranges where it really matters, and the overload fuse is easily get-at-able, being an extension of the positive input socket. It is difficult to fault this meter in any way, but the maximum d.c. current capability of 1mA is barely adequate for servicing work, and a.c. current ranges would have been appreciated, even if the accuracy were not as high as on the other functions. The smallness of the l.e.d. display has been previously mentioned, but what it lacks in size is compensated for in brightness!

The instrument case looks like ordinary plastic, but is made of tough polycarbonate material. It is not proof against a hot soldering iron, however! A smart carrying case comes as standard, and at the risk of being accused of having a thing about probes, I would say that the pointed probes and large crocodile clips provided are impractical for use on modern crowded printed panels. If the instrument were mine a pair of miniature prodclips as previously mentioned would be quickly substituted!

Abridged specification

D.C. VOLTAGE

Nominal Range	Input Z	Accuracy
100mV	1000MΩ	±0·02%, ±2 digits
1V	1000MΩ	±0·02%, ±1 digit
10V	1000MΩ	±0·02%, ±1 digit
100V	10MΩ	±0·03%, ±1 digit
1000V	10MΩ	±0·03%, ±1 digit

Safe overload: 1000V.

A.C. VOLTAGE

Nominal Range	Input Z	Accuracy
100mV	1MΩ/100pF	±0·2%, ±10 digits
1V	1MΩ/100pF	±0·2%, ±4 digits
10V	1MΩ/100pF	±0·2%, ±4 digits
100V	1MΩ/100pF	±0·2%, ±2 digits
700V	1MΩ/100pF	±0·2%, ±2 digits

Frequency range: 40Hz–10kHz.
Safe overload: 1000V.

D.C. CURRENT

Nominal Range	Full-scale volts drop	Accuracy
10μA	1mV	±0·05%, ±3 digits
100μA	10mV	±0·05%, ±1 digit
1mA	100mV	±0·05%, ±1 digit

Overload protection: 50mA fuse.

RESISTANCE

Nominal Range	I TEST	Accuracy
1kΩ	100μA	±0·05%, ±3 digits
10kΩ	100μA	±0·05%, ±1 digit
100kΩ	100μA	±0·05%, ±1 digit
1MΩ	1μA	±0·05%, ±1 digit
10MΩ	1μA	±0·25%, ±2 digits

Safe overload: 200V.

GENERAL

Display: 4½ digit, 10999 maximum, seven-segment l.e.d., 4·5mm (0·18in) high digits.
Overrange capability: The autorange circuit automatically selects the correct range for the display.
Polarity indication: Automatic, blank or "–".
Power supply: A.C. mains: 100-250V, 50/60Hz, 2·5VA. Battery: optional accessory.
Size: 57 x 138 x 178mm (2·3 x 5·4 x 7in) excluding handle.
Weight: 1·1kg (2·5lbs).
Accessories available: A.C./D.C. current shunt. Low level resistance unit. R.F. probe. Battery pack with integral charger, giving approximately seven hours life per charge.
Price: £260 (plus VAT) including carrying case and test leads.

Further details are available from The Solartron Electronic Group Ltd., Farnborough, Hants GU14 7PW. Telephone: Farnborough (0252) 44433.

The basic instrument is mains powered, although a clip-on battery pack is available. This and its price rule it out for field work, and its place is definitely on the bench. A range of clip-on accessories are available to extend resistance and current ranges, and to provide an r.f. measuring facility. With these, the 7040 could form the basis of a versatile and accurate workshop measurement system to meet all present and future requirements. ●

Philips PM2522

This instrument is in the middle of the price range of the models here reviewed, and might be described as a bench meter suitable for field work. Unfortunately, our review model was available to us for only three days, so that we were unable to put it through the mill as thoroughly as the others! The panel layout is functional and unambiguous, range selection being carried out by eleven rugged push buttons. A clip-on cover protects the front panel controls during transit, this facility being notably absent from the other DVMs we tried.

The extended resistance range (up to 20MΩ) is an advantage over comparable instruments. The usual upper limit of 10MΩ on resistance ranges of DVMs intended for service work is barely adequate, especially when it is remembered that a transistor analogue VOM quite commonly reaches up to 100MΩ or more. A unique feature is the hold control, which will "freeze" the reading for as long as it is depressed. This is useful when tracing intermittent faults, and for experimental work involving calculations.

This meter shares with the Solartron the socket-mounted protection fuse making fuse replacement a simple operation. The probes supplied with the instrument are large and hairy, and are quite capable of shorting out several components on a printed board simultaneously. It seems strange that so many manufacturers fit stone-age test prods to their space-age instruments. Philips are famous for their miniscule printed boards (as witness their portable cassette machines). These test-prods are quite incompatible with such assemblies. ●

Abridged specification

D.C. VOLTAGE

Range	Input Z	Accuracy
0·2V, 2V, 20V, 200V	10MΩ/60pF	±0·1% of range, ±0·1% of reading
1000V	10MΩ/60pF	±0·2% of range, ±0·2% of reading

Safe overload: 1000V d.c. or 600V a.c.

A.C. VOLTAGE

Range	Input Z	Accuracy
0·2V, 2V, 20V, 200V, 600V	10MΩ/60pF	±0·5% of range, ±0·5% of reading

Frequency range: 30Hz–30kHz (upper limit 100Hz on 600V range).
Safe overload: 500V d.c. or 600V a.c.

D.C. CURRENT

Range	Full-scale volts drop	Accuracy
0·2mA, 2mA, 20mA, 200mA	250mV	±0·25% of range, ±0·25% of reading
2000mA	600mV	±0·25% of range, ±0·25% of reading

Overload protection: Diodes plus 2·5A fuse.

Further details are available from Pye Unicam Ltd., Philips Electronic Instruments Dept., York Street, Cambridge CB1 2PX. Telephone: Cambridge (0223) 58866.

A.C. CURRENT

Range	Full-scale volts drop	Accuracy
0·2mA, 2mA, 20mA, 200mA	250mV	±0·25% of range, ±0·25% of reading
2000mA	600mV	±0·25% of range, ±0·25% of reading

Frequency range: 30Hz–1kHz.
Overload protection: Diodes plus 2·5A fuse.

RESISTANCE

Range	I TEST	Accuracy
0·2kΩ, 2kΩ	1mA	±0·3% of range, ±0·2% of reading
20kΩ, 200kΩ	10μA	±0·3% of range, ±0·2% of reading
2MΩ, 20MΩ	100nA	±0·3% of range, ±0·2% of reading

Safe overload: 250V.
Note: The forward resistance of diode junctions can be checked on the 2kΩ range.

GENERAL

Display: $3\frac{1}{2}$ digit, 1999 maximum, seven-segment l.e.d., 8mm (0·3in) high digits.
Overrange capability: None.
Polarity indication: Automatic, blank or "–".
Power supply: A.C. mains: 110 or 220V, ±15%.
Battery: optional accessory, eight hours life per charge.
Size: 95 x 235 x 280mm (3·75 x 9·25 x 11in).
Weight: 2kg (4·4lbs) approximately.
Accessories available: E.H.T. probe. A.C. current transformer. D.C. current shunt. R.F. probe. Rechargeable battery pack.
Price: £140 (plus 8% VAT) including test leads and front panel cover.

WHY DIGITAL?

Heathkit IM-2202

The Heathkit IM-2202 is a compact instrument with a very respectable specification. On switching it on for the first time our reaction was "Oh, aren't they big?" Shades of the Bishop and the actress, but we refer here to the display digits. In point of fact the digits, at 14mm (0·55in) high are the same size as those in several other instruments we looked at, but somehow the presentation makes them seem larger.

Time did not permit us to assemble the kit ourselves, so Heathkit kindly arranged for the supply of a specially ready-built model for the purposes of review. A lot of electronics is packed into the small case, with two parallel printed circuit boards. While the layout is "tight" when fully assembled, for servicing or calibration one board can be withdrawn.

The printed boards themselves are high-quality glass fibre. The fact that both sides are printed is not detrimental from the assembly or servicing viewpoint because the holes

continued on page 201

Abridged specification

D.C. VOLTAGE

Range	Input Z	Accuracy
100mV	50MΩ	±0·5%, ±1 digit
1V	500MΩ	
10V, 100V, 1000V	10MΩ	

Safe overload: 1000V (300V on 100mV and 1V ranges).

A.C. VOLTAGE

Range	Input Z	Accuracy
100mV, 1V	10MΩ/120pF	±1%, ±3 digits
10V, 100V, 750V	10MΩ/60pF	

Frequency range: 40Hz–1kHz (upper limit 10kHz on the 100mV range).
Safe overload: 750V (250V on 100mV and 1V ranges).

D.C. CURRENT

Range	Full-scale volts drop	Accuracy
100μA, 1mA, 10mA	100mV	±0·5%, ±1 digit
100mA	150mV	
1000mA	300mV	±1%, ±1 digit

Overload protection: Shunt diodes plus 3A fuse.

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

A.C. CURRENT

Range	Full-scale volts drop	Accuracy
100μA, 1mA, 10mA	100mV	±1%, ±3 digits
100mA	150mV	
1000mA	300mV	±1·5%, ±3 digits

Frequency range: 40Hz–10kHz.
Overload protection: Shunt diodes plus 3A fuse.

RESISTANCE

Range	I TEST	Accuracy
100Ω, 1kΩ	1mA	±0·5%, ±1 digit
10kΩ	0·1mA	
100kΩ	1μA	
1000kΩ	10μA	

Overload protection: Blocking diode for positive inputs; shunt diode plus 30mA fuse for negative inputs.

NOTE
All accuracies quoted above are using internal references. Calibration using external laboratory standards can approximately halve the maximum errors.

GENERAL
Display: $3\frac{1}{2}$ digit, 1999 maximum, seven-segment planar, 14mm (0·55in) high digits.
Overrange capability: 100% on all ranges except 1000V d.c. and 750V a.c.
Polarity indication: Automatic, "+" or "–".
Power supply: A.C. mains: 110-130V or 220-260V, 50/60Hz, 5VA max. Batteries: internal nickel cadmium, eight hours life per charge. Alternatively, internal dry batteries give up to two hours life for zinc/carbon or up to six hours life for alkaline.
Size: 76 x 210 x 203mm (3 x 8·25 x 8in) overall (handle folded to rear).
Accessories available: None.
Price: £127.78 (plus VAT) in kit form, including test leads and rechargeable battery.

Preventing 'Call-Backs'

Vivian CAPEL

DOUBLE-FAULTS and second-services are not all to be found at Wimbledon! They also crop up in the service engineer's life, with about the same effect on his morale as they have on a star tennis player. They are known by different names: second-service, come-back, bouncer and so on. Whatever the name, the practical result is that a further fault is reported within a few days of the initial repair having been carried out. Whether the new trouble has any connection with the previous fault makes no difference to the owner: the engineer is blamed for doing an inefficient job, and time and petrol must be used on a call for which in most cases no charge can be made. An engineer getting more than his share of come-backs can also expect to be on the carpet from the boss!

Second-services can be divided into two categories: those related to the original repair, either the same fault returning or trouble arising from some carelessness in making the repair; and faults having no connection with the original trouble, occurring coincidentally soon afterward. The latter may sometimes be due to physical disturbance of the wiring and panels. In both cases it is possible to take certain steps when making a repair to minimise the possibility of later trouble.

Defective Soldering

Let us take the first type of second-fault, those arising from the original repair. Of these, perhaps faulty soldering is the most likely cause. Whilst every engineer worth his salt knows how to solder and makes perfect joints 99% of the time, there are occasions when the odd bad joint gets by. The chances of this increase enormously when adverse conditions in a customer's house such as a too friendly dog, a youngster with an avid interest in the spares box, poor light and restricted space have to be coped with.

Perhaps the best advice is to try to take things calmly and not to rush the joint. Don't take it for granted that the wire ends of the component are clean enough to solder. If they've been in the spares box for a long time they may well not be. Tin them first before fitting and any reluctance for the solder to run will soon be observed. When in a hurry, pretinning is often omitted, reliance being placed on the existing tinning on the wire.

Another example of undue haste is attempting to solder before the iron is hot enough. This usually has dubious results. It is good practice on an outside service to connect and switch on the iron as soon as diagnosis indicates that a component may need to be changed. It can then go on heating while the final stages of diagnosis are being carried out and the replacement made ready. This is not necessary if a low-voltage, rapid-heating iron is used.

After soldering, the joint should be examined for any of the usual tell-tale signs of a bad take; also for any blobs bridging over to an adjacent print-run. The excess wire is then cropped off, but this could constitute a potential hazard if it is allowed to fall among the components on the panel or one of the others. Always hold the wire to be cut off using thin-nosed pliers or tweezers so that it can be removed safely (see Fig. 1). The same principle applies to any excess solder that may be liberated in the soldering operation: take care to remove it out of harm's way.

Whether soldering in the customer's home or in the workshop, one thing to guard against when making a joint is interruptions. It is all too easy to fit a component or make a mechanical connection and then have one's attention distracted or be called away before actually soldering. On returning, you may believe that the joint has been completed and since there is a physical contact the set may well work. So it's reassembled and a good foundation is laid for a second call.

Before leaving the subject of soldering, mention should be made of the panels with print on both sides such as those used in GEC sets. It can be very difficult to make reliable joints with these because the wire of the component must pass through and be soldered on both sides, but on the component side the print is usually obscured by the components and even if partially visible cannot be reached with the soldering iron without damaging the component or an adjacent one. All that can be done is to solder on the non-component side and hope that the solder runs through the hole and takes on the other side as well. To facilitate this, tags and wires should be well tinned and the panel supported horizontally, not vertically, with the component side underneath. Sufficient solder should be fed to the joint to run through and make a joint on the underside – but not too much so that it makes a large blob and thereby introduces the risk of a short. If the component is not mounted touching the panel but standing off by a few millimetres it may be possible to observe the joint afterwards beneath the component and so check whether it is sound.

Care with Wiring

Any fresh or replacement wiring that may need to be fitted must be carefully routed. There are several hazards here. The wiring must not be strained across any sharp edge, either in the service or operating position of the panel.

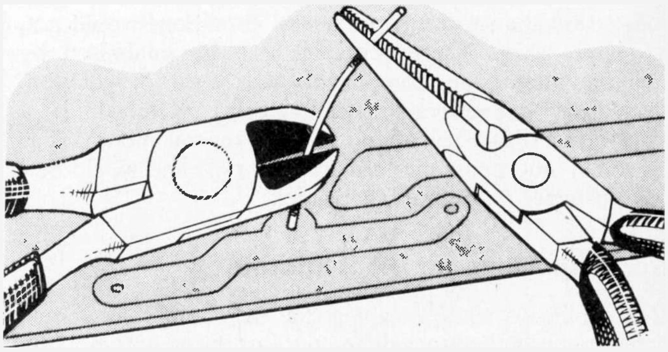


Fig. 1: When cropping excess wire from a joint on a printed panel, hold the free end to prevent it falling down into the chassis where it may cause a short-circuit.

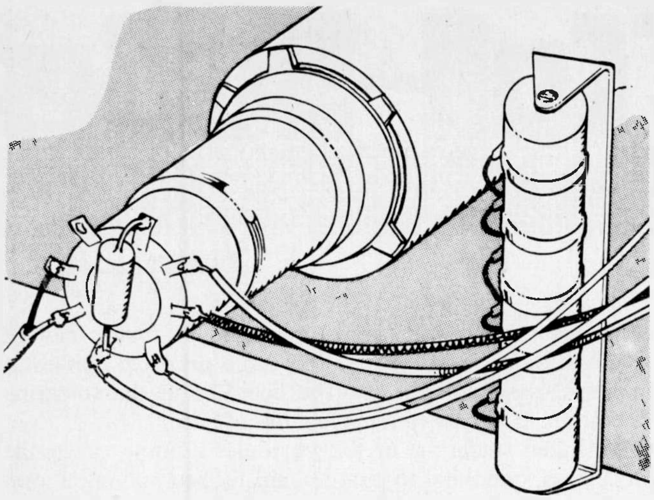


Fig. 2: Tube base leads caught around the mains dropper: make sure that all wiring is routed clear of power resistors and sources of high pulse voltages.

Plastic insulation softens with heat, and it would be just a matter of time before the edge penetrated and if metal shorted to the inner conductor.

A major hazard is hot components. Wiring must be positioned to avoid wirewound resistors as these nearly always dissipate power in the form of heat – hence their choice. In particular the mains dropper is a danger, and wires should be kept well away from it (see Fig. 2 for example). If any rewiring must be done it is worth remembering that solid-core conductors, although not so reliable where a lot of flexing is involved, will stay put far better than stranded wires.

Another danger area is near sources of high pulse voltage. So wiring and components near the line output transformer should be carefully positioned away from the transformer windings or e.h.t. rectifier. Conversely, a pulse carrying lead such as that going to the anode of the e.h.t. rectifier must be kept clear of low-potential points such as the transformer screening can. The insulation may prevent actual arcing, but corona that may affect the picture or sync could occur and eventually lead to breakdown of the insulation.

Replacement Components

A possible source of trouble can be the replacement components themselves. Transformers that have been kept in the van in summer heat or winter damp may well breakdown after a short period of use. Electrolytic capacitors deteriorate with age if unused, so any that have been in the spares box for a long time may well give trouble when eventually fitted. The same is true of workshop spares, but the same environmental conditions would not, we hope, exist. These problems can be minimised by ensuring that such components are used in rotation, electrolytic capacitors especially being watched. If a transformer has been in the van for several months it is obviously not a common replacement type and would best be transferred to the workshop stock.

Cure the Fault, not the Symptom!

It should go without saying that the actual fault should be put right on the first call and not just the symptom, but it is possible to overlook possibilities when time is short and the work load heavy. For example, the complaint of bottom compression may be cured by fitting a new PCL805 field timebase valve. The demise of the old one may have been hastened by a decreased value cathode bias resistor however, and before long the new one will go the same way. The same principle holds for sound output valves.

Repair-induced Faults

The repair can sometimes be the indirect cause of further trouble. In the days of valve h.t. rectifiers, it was not uncommon to fit a replacement and find shortly afterwards a fault caused by a leak in a capacitor on the h.t. line or an interelectrode leak in a valve. The reason was that these components were already ailing and the increased h.t. finished them off. Although the silicon rectifier may have eliminated this sort of trouble, a similar effect may be encountered in line output stages when a replacement line output valve or boost rectifier results in increased boost voltage. The boost capacitor, e.h.t. rectifier, or even the line output transformer can succumb. While nothing much can be done to avoid this, the customer should be warned of the possibility.

Check Potential Trouble Spots

We now turn to faults that are not connected with the repair initially carried out. A common source of trouble is dirty valve pins which make intermittent contact and produce a variety of symptoms depending on the circuit affected. Slight movement of a valve while servicing a set may shift the contact of the holder socket to a heavily oxidized pin area. Thus an intermittency not previously present may develop. Either several or no valveholders may be affected in this way, probably due to the different atmospheres in which sets have to operate. It is good practice therefore to rock a few of the valves gently in their holders after the repair is completed: any noise or disturbance symptom produced should be taken as an indication that most if not all the other valves are similarly affected. A more vigorous rocking with a circular motion until any disturbances noticed subside should then be carried out with all valves (except the line output and boost valves), thus cleaning the pins by friction with the holder. Do not displace the valves too far from their upright position or the strain on the pins may crack the glass at the base. And don't rock them so vigorously that the printed board is damaged. Should any valves not respond to this treatment a smear of silicone grease on the individual pins should do the trick.

Another potential source of trouble is the system switch in dual-standard receivers. With all programmes now receivable on u.h.f. in most areas, the switch is never used in the majority of such sets and so does not get the self-cleaning action needed to maintain good contact. Rapidly switching it back and forth a few times may well prevent a call-back.

Preset controls often become noisy, or the track may be worn just at the point of optimum setting. These too can produce intermittent faults if disturbed. A squirt of cleaning fluid and a few rotations will serve to silence a dirty track, but little can be done with a worn component other than replace it. Where the setting is not critical the control can be adjusted off the worn section.

Watch out for hold controls right up at one end of their travel. The picture may be locked due to a strong sync signal but the timebase may be off frequency and a slight further component value alteration may put it beyond the locking range. It is worth checking this therefore otherwise the point of no return may be reached in a very short time, resulting in a second-service.

Loose plugs are another possible cause of intermittent faults. It's wise to check i.f. plugs and inter-panel plugs and sockets. Though probably already loose, the disturbance arising from a repair may make matters worse and produce fault symptoms soon afterwards.

A quick visual inspection of the panels is always a good policy. Discoloured resistors indicate overheating, and although the fault may not at present be having any noticeable effect on the picture it is most likely to get worse quite soon and cause trouble. A touch with the finger after the set has been running a few minutes should reveal whether or not the resistor is running too hot – but be careful. A check with the ohmmeter should then show whether the value has changed. (Beware of parallel circuits though: it may be necessary to disconnect one end of the resistor.)

Another thing to look for is electrolytic capacitors with swollen ends or which exude white powder. These are potential sources of trouble even if they are not defective now, and the smaller wire-ended ones should be replaced. The large multiple reservoir and smoothing types are expensive and an exact replacement may not be to hand: some discretion as to whether to change them is necessary therefore. Small swellings may not presage imminent catastrophic failure, but at least inform the customer of the possibility just in case.

Replacing the Back

The uninitiated may not think that replacing the cabinet back could have much effect on the working of the set. The experienced engineer knows otherwise! Tube base and other wires can be displaced, pressure may be applied to parts of the panel, and control spindles of presets may be (and often are) dislodged. Apart from all this, the set's internal temperature immediately rises several degrees above what it was with the back off. So it is not surprising that a set can be repaired and adjusted to give a perfect picture, then found to have one or more faults when the back is replaced. The moral is: in addition to fitting the back with care, always try the set again for a few minutes afterwards. To replace the back and leave the set without another try is asking for trouble.

Mains Plug Wiring

One final point to watch, and one very rarely checked, is the wiring of the mains plug. In most cases this will have been done by the owner, and a right mess some of them make of it! Apart from incorrect connections due to the stupid colour coding now used (brown always seems to suggest earth – there was no question where the red went), there is often an excess of bare wire, with whiskers straying dangerously close to the other pin connections, and sometimes plain loose connections. All this may not give trouble while the set is plugged into the customer's outlet socket. But if the set has to be taken to the workshop the plug may dangle on the end of the lead whilst being transported and after being plugged in and out of the workbench supply anything can happen. So your second-service reputation could be at the mercy of a bungler's wiring! It is worthwhile whipping the plug cover off and having a look inside, especially if the appearance of the cable as it enters the plug gives reason to doubt the nature of the fitting.

It may not be possible to eliminate second-services completely, but with care they can be greatly reduced. ■

next month in Television

● **TV RECEIVING AERIALS**

It is surprising how often the aerial is overlooked, since the results obtained from a receiver depend on the quality of the signal fed to its aerial socket. In the past there has been rather a lot of confusion about aerial performance and what exactly is required. Pat Hawker goes into the subject from an essentially practical viewpoint, describing what you can expect from the various types of aerial in use, and the requirements of different, types of receiver in different geographical situations.

● **UP-DATING WITH A TRIPLER**

Many older colour sets with a GY501/PD500 e.h.t. arrangement give trouble due to ageing in this part of the receiver. A simple solution is to use a tripler instead, dispensing with the line output transformer overwinding and thus increasing the reliability of the stage. Hugh Cocks explains how to go about this.

● **COLOUR FAULTS**

John Coombes deals with the Z584 decoder panel used in the Rank A823AV colour chassis, explaining common faults and how to tackle them.

In addition he describes his experiences to date with the Mitsubishi CT200B colour receiver.

● **WHAT SCOPE?**

In the second instalment of his series on test equipment E. Trundle considers what the TV serviceman requires of an oscilloscope and reviews six suitable instruments.

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CEEFAX/ORACLE reception techniques

Steve A. MONEY T. Eng. (CEI)

PART 8

HAVING examined the methods by which the output video signal can be generated for individual letters or graphics symbols, we are now in a position to investigate the output control logic which will regulate the production of the text display on the television screen.

There are several options open to the designer when selecting an output logic system. The final choice depends upon which type of character generating ROM is used, which type of memory system is used to store the page of data and whether the display is to be monochrome or colour.

Apart from controlling the shifting of the dot pattern from the character generator circuit to produce a video signal, the logic must also control the transfer of data codes from the page memory to the symbol generator circuits so that the proper dot patterns are produced at the correct times in the picture scan to give the desired display of text on the screen. When a colour display is required, the control commands which define the colour of the symbols must be decoded and used to produce control signals for the RGB amplifiers in the display system.

Subtitles and newsflashes transmitted via the teletext system are usually inserted into blanked out "boxes" in the normal picture display. To deal with these boxed displays the logic system must control a video switching circuit which blanks off the normal picture signal and substitutes the character dot patterns at the point in the scan where the box is to be inserted. We shall be dealing with the detailed operation of this box display system for newsflashes and subtitles in a later article.

A typical block diagram for the output control logic system is shown in Fig. 44. Here it is assumed that the decoder uses a 5 × 7 format character generator ROM. By modifying the logic arrangement it is possible to cater for the ROMs with a 7 × 9 dot format and also character rounding logic may be added. In this article some of the possibilities for the output logic are examined.

Dot clock

Perhaps the best place to start is by looking at the clock used to shift the dot pattern out of the character generator output register to produce a video signal. The frequency of this dot clock is determined by the type of character generator ROM used and by the desired format of the page layout on the screen.

Suppose that the character generator in use has a 5 × 7 dot matrix. The symbol will usually fill the whole 5-dot width of the matrix, so in order to leave a space between adjacent symbols it is usual to allow for a single blank dot between characters. Thus for each character space there will be a total of six dot spaces. Here it must be remembered that during any one line scan we shall display only one of the rows of dots in the character matrix.

There are forty symbols in a teletext row so there must be 240 dot positions allowed for in one line scan. In the 625-line system the total time period for a single line scan is $64\mu s$ of which some $12\mu s$ are used for synchronisation and blanking leaving the remaining $52\mu s$ for the picture display. In many receivers the line timebase is set to give a slight amount of overscan so that the part of the scan displayed on the screen may represent only 48 to $50\mu s$ of the line scan period. On the teletext display it is usual to have a small margin at each side of the text so we might choose a period of say $40\mu s$ in which to display the row of forty symbols. The six dots for each symbol space must therefore be scanned in $1\mu s$ so the frequency of the dot clock needs to be 6MHz.

Increasing the frequency of the dot clock would cause the letters to be compressed horizontally whilst a lower clock frequency will have the effect of spreading out the letters and reducing the size of the margins.

Choice of frequency

To avoid having wavy edges to the characters the clock should preferably be a harmonic of the line scan frequency. A frequency of 6MHz exactly would be the 384th harmonic of the line frequency. The lowest frequency likely to be useful is 5MHz which is the 320th harmonic of line frequency. This latter frequency would give virtually no margins at either side of the text.

When a character generator having a 7 × 9 format is used there will be eight dot spaces per character if one blank dot is allowed between characters. This gives a total of 320 dot spaces in the row. To accommodate these in the line scan period requires the use of a dot clock with a frequency of some 7MHz. Fortunately the clock used for decoding the received data signal has the frequency 6·9375MHz and this could make a convenient dot clock. In some types of decoder however this clock may not operate continuously since it may be produced by means of

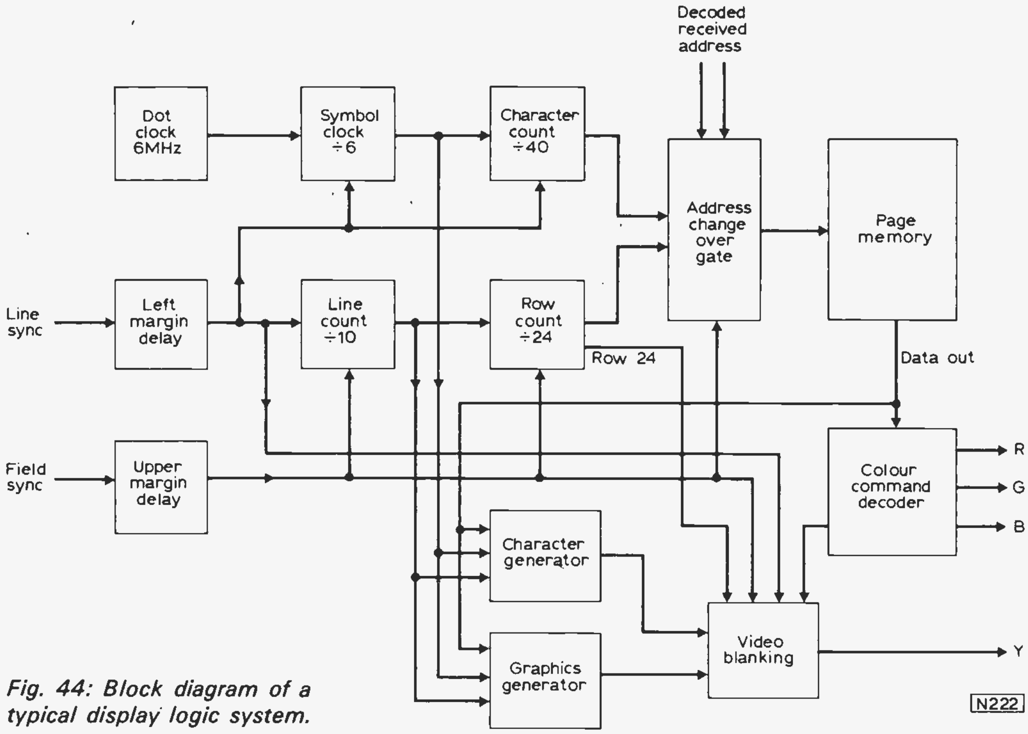


Fig. 44: Block diagram of a typical display logic system.

a high Q tuned circuit triggered by the incoming data signals. In such cases a separate, continuously running 6·9375MHz clock would be required.

Symbol clock

After the set of dots for one character have been shifted out of the character generator circuit the pattern for the next character in the row must be set up ready for scanning. This requires two operations. First the data code for the new character must be selected from the main page memory and presented to the character generator ROM. Secondly, when the new pattern has appeared at the output of the ROM it must be transferred in parallel to the shift register ready for scanning. These operations will happen once during each character period which will be once for every six dot-clock cycles. Thus we need a new clock, which we shall call the symbol clock, whose frequency is a sixth that of the dot clock.

Usually the transfer of new data into the output shift register is arranged to occur during the blank dot space between adjacent characters. The precise arrangement of the clock circuits will depend upon the type of shift register device being used at the output of the character generator.

Some shift registers are arranged so that every operation is initiated by the clock input. A separate mode control input determines whether the clock pulse will cause data to be parallel loaded into the register or whether the data in the register is shifted along by one stage. This type of operation is known as synchronous operation. In other types of shift register, the load operation is totally independent of the clock pulses so that as soon as a load input signal is applied the register will immediately be loaded with new data from its parallel inputs.

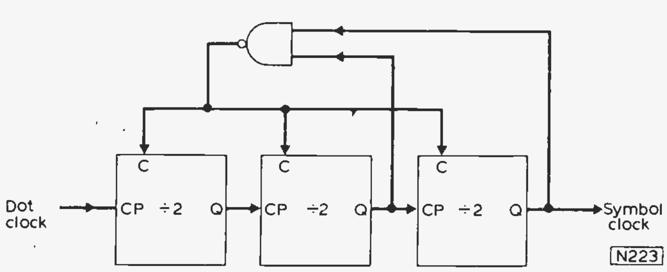


Fig. 45(a): Divide by six counter for symbol clock divider.

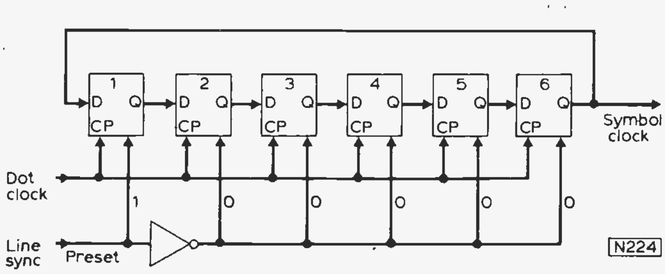


Fig. 45(b): A symbol clock divider using a shift register.

Binary counter

A simple binary counter circuit can be used to produce the symbol clock as shown in Fig. 45(a). Here a three-stage binary counter is arranged to act as a divide by six counter. Normally the three stages of the counter could have eight output states giving the binary numbers from 0 to 7 (000 to 111). In the circuit shown the count operation runs normally for the first five pulses counting from state 0 up to state 5 but on the sixth pulse a reset action occurs. The counter momentarily takes up state 6 with the second and third stages both at 1 but the gate detects this condition and its output goes to 0. The gate output resets the counter directly to the 0 state at which point the gate output is again at 1. The reset action occurs almost instantaneously so the counter effectively goes directly from state 5 to state 0 on the sixth clock pulse. The overall result is that the counter gives a count down of six on the input clock so that the input stage gives one cycle for every six input clock pulses.

An alternative approach to the generation of the symbol clock is to use a six-stage shift register as shown in Fig. 45(b). At the start of the line scan this register is set up so that there is a 1 in the first stage and 0s in the other five stages. When the dot clock is applied the 1 shifts along the register and the stage it leaves is reset to 0. Thus there will be a single 1 state moving along the register. When the 1 reaches the sixth stage it is recirculated back into the first stage again ready for the next pass through the register.

Since the 1 state circulates through the register once for every six clock pulses, each stage of the shift register will produce one pulse for every six clock pulses to give an effective divide by six action on the dot clock. One advantage of this circuit is that it can produce six different timing points in the character scan according to which stage the symbol clock output is taken from.

For use with a 7 × 9 format character generator the symbol clock can be generated either by a simple three-stage binary counter or by an eight-bit shift register to give a division by eight on the dot clock frequency.

Character count

In order to be able to extract the data for the next character in the row from the page memory we must increase the memory address by one. Usually the memory address can be conveniently separated into two components, one being a count representing the character position in the row, and the other being the row address. The character count address will be a number running from 0 to 39 covering the forty characters in the row and this is obtained by simply counting off the characters as they are scanned.

The character count is produced by a six-stage binary counter which is driven by the symbol clock. The counter is set to 0 at the start of each scan line and then counts from 0 to 39 as the characters are scanned.

After the fortieth character has been loaded into the character generator and then scanned out, the video signal can be blanked off to produce the right-hand margin of the display. At the same time the dot and symbol clocks may also be gated off until the next line scan. To provide a margin on the left-hand side of the picture the video is blanked and the dot and symbol clocks stopped for a short period after the start of the line scan. At this time the character count is held at the 0 position.

Line count

Each symbol on the screen will contain several lines of dots. After scanning the first row of dots for all of the symbols in the text row the character generator must be set up for the second row of dots. This is done by means of a row address input to the character generator ROM. The address is usually a four-bit binary coded one which may be used to select up to 16 rows of dots in the character matrix. This row address signal is easily produced by counting off the lines as they are scanned.

First we must determine how many scan lines can be used to display one row of characters. In a 625-line system there are only $287\frac{1}{2}$ active lines during each field scan, the rest being used for field sync and blanking. There are 24 rows of characters in a teletext page so the greatest number of scan lines we can use for a row will be eleven. This will give 264 lines for the text and about twelve blank lines at both top and bottom of the screen for the margins. Most decoders are likely to use ten lines for a row of characters since this simplifies the logic required.

A four-stage binary counter can be used to produce the four-bit row address signal for the ROM. This counter is clocked by the line synchronising pulses and is set up to divide by ten by using a feedback gate arrangement. Where the characters have a 5 × 7 format there will be three blank lines between the rows of characters. If both upper and lower case letters are displayed then the tails of some of the letters may extend one or two lines down into these spacing lines.

Some character generators such as the Motorola 6571 use an address count which runs backwards from 15 down to 0 as the symbol is scanned from top to bottom. This can be derived from the normal counter by simply inverting the four output signals so that 0 (0000) becomes 15 (1111).

Line buffer

When a random access memory is used for storing the page of data it is quite easy to call up the sequence of symbol codes for a row of text and then to repeat this sequence on the following nine line scans since the store locations can be selected in any order by applying the appropriate address codes.

Where the page memory uses the shift register system an awkward problem presents itself. After the data for a row of text has been read out of the memory it will not be available again until all of the data for the other rows has been shifted through the memory. Normally this means that the data for any particular row is available only once during each field scan. To recirculate the complete page of data during the line flyback period would not be practicable since this would involve clock frequencies far beyond the capability of existing shift register memories.

A solution to this problem is to use a line buffer memory which will contain the data for just one row of characters. This might be a shift register seven bits wide and forty stages long so that it can accommodate the forty character codes for a row of text. This memory will need a recirculation loop so that data is not lost after readout.

The buffer memory is loaded from the main page store during a blank line just before the row of text is to be displayed. During the next nine line scans the data is read out and recirculated to produce the character display. This process repeats for each row of text displayed.

Sometimes a line buffer memory may be used with a random access page memory since it can ease the timing problems produced by delays in the response of both the page memory and the character generator ROM.

Row address

To call up the data for a new row of text from the main page memory a row address must be applied to the store system to tell it which row of text is required. This row address will be a five-bit binary number running from 0 to 23 to select the 24 rows on the page. When the page store is a random access type this row address will be combined with the character count address to produce a final binary address code which goes from 0 to 959.

The row address is generated by a five-stage binary counter which is incremented each time a row of text has been scanned completely on the screen. The output from this counter is a binary number from 0 to 23.

To produce the upper margin on the display the first few lines of the field scan are blanked and during this period the row count is held at 0. After the last row of text has been displayed the video signal is blanked until the end of the field scan to produce a lower margin to the page display.

Colour selection

For a colour display a series of commands are used to define the colour of the symbols displayed. In the article on graphics generator circuits we saw that these colour commands are transmitted as part of the shift codes controlling the selection of either alphanumerics or graphics symbols.

To identify these shift commands bits 7, 6 and 5 will always have the pattern 001. Although bit 4 selects the alphanumerics or graphics mode it plays no part in colour selection. Bits 1, 2 and 3 define the states of the red, green and blue video channels respectively as shown in the table.

BIT 1 (RED)	BIT 2 (GREEN)	BIT 3 (BLUE)	SYMBOL COLOUR
0	0	0	CODE NOT USED
1	0	0	RED
0	1	0	GREEN
1	1	0	YELLOW
0	0	1	BLUE
1	0	1	MAGENTA
0	1	1	CYAN
1	1	1	WHITE

N226

If bit 1 is set at 1 whilst bits 2 and 3 are both at 0 the red channel alone is selected and the text following this command will be displayed in red. Similarly if either bit 2 or bit 3 alone is set at 1 the symbols will be displayed in either green or blue. When both bits 1 and 2 are set at 1 the result will be a yellow (red + green) display. Other combinations of two bits at the 1 level will produce cyan (blue + green) and magenta (red + blue) symbols. If all three bits are at the 1 level the result will be white text.

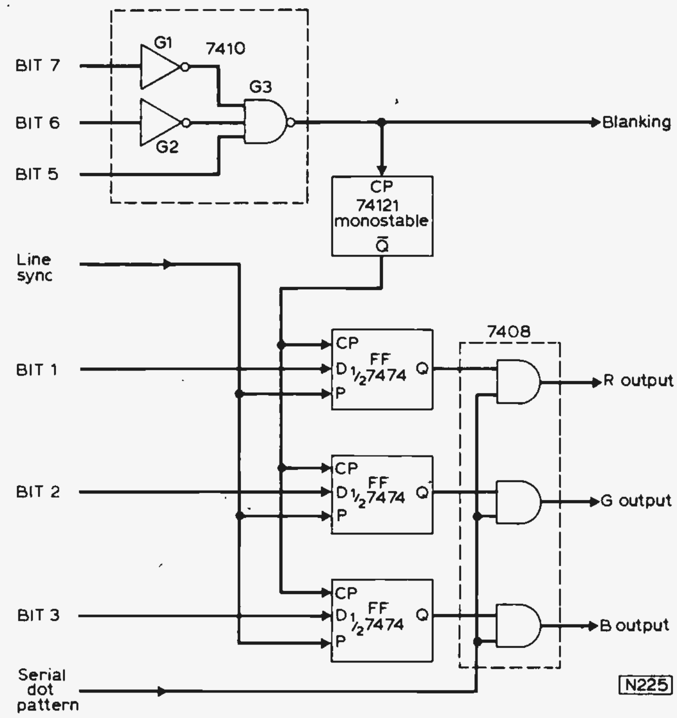


Fig. 46: Colour decoding logic.

Colour command decoding

A typical system for decoding these colour commands is shown in Fig. 46. Here gates G1, G2 and G3 are used to detect the 001 combination of bits 7, 6 and 5 when a control code is being read out. The output from gate G3 is used to control the blanking circuits so that the symbol space occupied by the control command is displayed as a blank. At the same time this signal triggers a monostable circuit which produces a loading pulse for the colour selection circuits. The state of bits 1, 2 and 3 during the control command is stored in three flipflop circuits which in turn produce the red, green and blue control signals for the video amplifiers. These three flip-flops are clocked by the pulse from the monostable circuit when a control command is detected. Once set up, the state of the colour commands will be held until either a new code is received or the end of the scan line is reached.

Since most text is likely to be displayed in white it is assumed in the teletext system that all rows start with white alphanumeric text selected. This removes the need to insert a control code at the start of every row of text. To produce this action the three output flipflops are set to the 1 state at the start of each line by presetting them with the line sync pulse.

The actual application of the red, green and blue control signals will depend upon the precise arrangement of the video circuits in the receiver or display used. In many cases the signals will simply be gated with the dot pattern signal to produce RGB drive signals as shown in Fig. 46.

TO BE CONTINUED

LONG-DISTANCE TELEVISION

ROGER BUNNEY

NOVEMBER has been something of an anti-climax following the dramatic Tropospheric opening during late October. A near record mail has told the full story of the latter event however. It was certainly the best period for reception by this propagation mode since the mid-1960s. The duration and intensity of the opening was such that a long article appeared in *Broadcast*, a weekly magazine circulating widely amongst studio personnel. This mentioned that "a tiny group of dedicated enthusiasts were delighted with the freak conditions which caused interference to television pictures in England and Wales last week . . . ," and that "DXers were pleased with the tropospheric scatter which resulted in enhanced reception. Troposcatter is apparently to be expected as a general rule in the season of mists and mellow fruitfulness at this time of the year."

Well, personally I am indeed delighted that our hobby is gaining recognition, albeit somewhat notoriously. An old friend, Eddie Evans, wrote to *Broadcast* the following week, expanding on TV DXers' delights and aspirations.

The opening started on October 24th and gradually increased in intensity and distance, reaching a peak on the 27th. By the 30th it had completely disappeared. TVP (Poland) was noted in East Anglia on Band III channels R8, 9, 10, 12, also 25, the signals "being steady for most of the day". This report came from Clive Athowe on the 26th. There were greater things for him on the 27th however, with TVP channels R10 and R12 at fair strength during the period 2042-2051 and, breaking over TVP, signals from TSS (USSR). These latter were strong enough to be able to read the captions. After some research the transmitters turn out to have been Tallin ch. R12 (TSS-2) and Riga ch. R10. This seems to be a record distance for Band III tropospheric reception in the UK, some 990 miles in the case of the ch. R12 signal. Apart from this spectacular reception – for which our congratulations – Clive received a vast number of other stations: RTVE (Spain) on channels E22 and E24 (the latter Madrid), CLT (Luxembourg), DFF (East Germany), SR (Sweden), NRK (Norway), TVP (Poland), DR (Denmark), Switzerland and ORF (Austria). Clive sums up by saying that he's never seen a Trop opening like it!

Others too did very well. Hugh Cocks (Devon) received many of the signals Clive received, though not TSS, and again saw the mystery WDR-1 signal between channels E5 and E6. David Martin from Shaftesbury – a good location, being an old Dorset fortress town atop a hill – noted similar signals including ORF in Band III (ch. E8). An interesting signal received here was Caen (France) ch. E28, radiating the first chain card but with "Mont Pincon" across the centre of the card and "2nd Chaine" at the bottom – the lettering apparently looked as though it was hand printed.

James Burton-Stewart in Milton Keynes received almost a hundred new stations, including what he initially thought to be Tele-Monte-Carlo on ch. E35. A letter to them however brought the reply that they were radiating the PM5544 card at the time, not the EBU bar that James received. This does confirm that they are operating on ch. E35 – the letter states that they are using system G with a 30kW transmitter directed easterly from their Mont Agel, Monaco site. We subsequently received pictures from Michele Dolci (Italy) confirming all this.

We could go on for pages reporting on this opening. To conclude for the moment however Jonathan Brisley (Peterborough) sent in a very interesting report of his reception, including NDR (West Germany), TDF (France) and RTL (Luxembourg). Jonathan, who is only 15, uses a modified 405-line Ekco model for v.h.f. reception and a Baird set for u.h.f. reception. He ends up: "yesterday in fact TF1 (France) was at times a better signal than Yorkshire!"

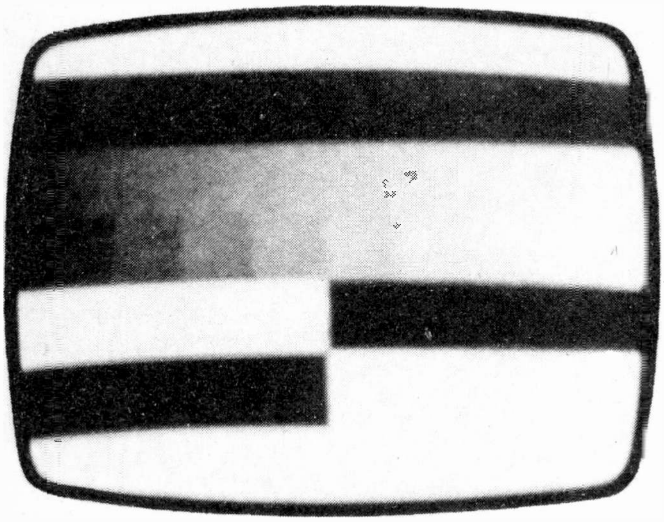
Monthly Report

The amount of news this month makes it impossible to include a log of the month's reception here. The situation was, briefly, as follows. The Leonids Meteor Shower didn't produce many good pings this year, at least not whilst I was looking. There was an uplift in Sporadic E reception, a Guy Fawkes day opening bringing in JRT (Yugoslavia) on ch. E4 and RTVE (Spain) chs. E2, 3 and 4 – interesting to note that the ch. E4 card carried the identification "Zona Sur" and was the older version, i.e. not the latest colour card. Another good SpE opening occurred on the 11th. Signals were received from the east, with TSS (USSR) ch. R1 twice and ch. R2, TVP (Poland) ch. R2, CST (Czechoslovakia) ch. R1, MTV (Hungary) ch. R1 and TVR (Rumania) ch. R2. And yet more SpE on the 18th, with TSS R1, TVP R1, and CST R1 and R2. For the rest of this month there was some short-duration SpE and an increase in MS (Meteor Shower) reception. The Trops remained quite dead.

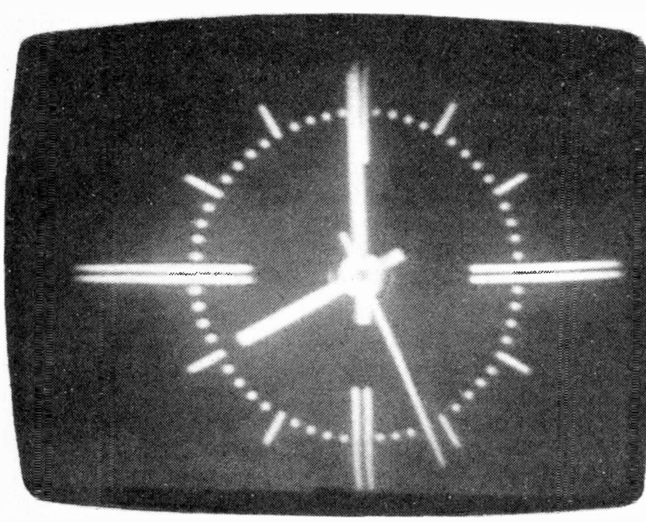
News Items

France: Paris Tour-Eifel is now radiating first chain test transmissions (SECAM) on ch. E25, from 1200 local time. Regular programme transmissions are expected to start by the end of the year (1975).

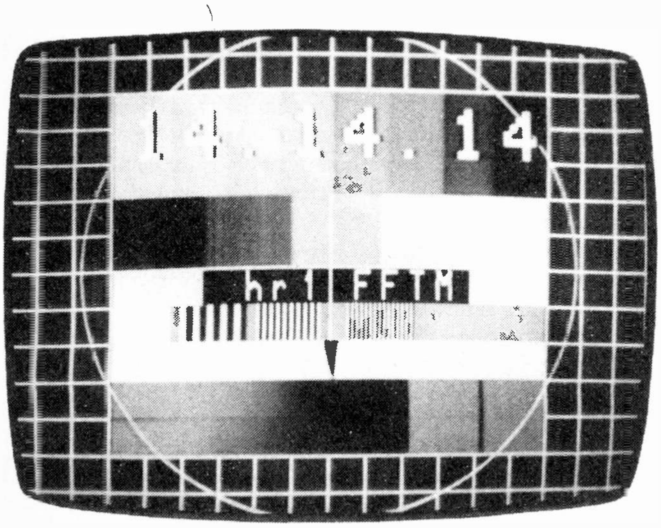
Holland: There has been much speculation about the future of the Lopik ch. E4 transmitter. At last there is some definite news. Two new ch. E4 transmitters are to be installed next year (1976). The problem has been that the standby transmitter produces considerable harmonic radiation, though the main unit is understood to be in good order. The new NOS identification on the EBU bar is "AVVC-HVS", standing for Audio Video Verbindingen Centrum, Hilversum. The new PTT Hilversum relay tower is apparently now in full use for both sound and vision – previously the sound link went via a telephone switching centre. NOS programmes for "guest workers" are as follows: Saturday at 1845, five minutes in Morroccan; Sunday 1855-1900 in Turkish; Tuesday 1845-1850 in Spanish. Thanks Peter Vaarkamp for this information.



The new blockboard pattern as used by Hungary MTV-1.
Photograph courtesy Hetesi Laszlo.



The Bulgarian Television clock.
Photograph courtesy Clive Athowe.



The Fubk test card with digital clock.

Hungary: A new test pattern is being radiated by the ch. R1 Nagykanizsa transmitter. It's already been received in the UK.

Poland: The TVP-1 and -2 chains are using a caption featuring a large "1" or "2". This is very similar to the CST (Czechoslovakia) caption. Care is required therefore when logging weak MS signals from this direction. A new first chain transmitter is being installed at Rusinovo – a second chain transmitter will follow in 1976. The channels to be used are not known. There is to be a new transmitter too for CST-2 at Svatobor Hill in West Bohemia. CST-1 is at present available to over 90% of the population.

USSR: The Moscow Central TV service is now being transmitted in the Turkman Republic in addition to local programmes. Leningrad-2 is being transmitted from two new transmitters at Tikhvin and Slantsy. The Moscow Central service is also being transmitted from Panifilov in the remote Dzhungarskiy Alatau Mountains.

Eire: Thanks to RTE and Paul Duggan (Cork) we now have detailed information on the establishment of the second TV network there. All new main transmitting stations will be installed by the end of December 1976. Most will be in existing sites. The two new ones will be at Kern Hill, Longford – covering Canan, Monaghan and Longford – and at Three Rock Mountains, covering the County Dublin and County Louth areas. The transmitters themselves are being supplied by NEC (Japan). The proposed frequencies, subject to international agreement, are as follows:

Station	*TV1*	*TV2*
Kippure	ch. H	?
Mt. Leinster	ch. F	ch. I
Mullaghanish	ch. D	ch. G
Maghera	ch. B*	ch. H
Truskmore	ch. I	ch. G
Longford	Band V	Band V
Dublin (Three Rocks)	Band IV	Band IV
Monaghan	ch. D ?; Band V	Band V
Moville	ch. D ?; Band IV	Band IV
Letterkenny	Band V	Band V
South Midlands†	UHF	UHF

*With reduced area
†This is a long-term project

Algeria: A second service, in colour, is to be established. RTA-2 will be used for entertainment purposes while the existing monochrome RTA-1 service will be an educational channel.

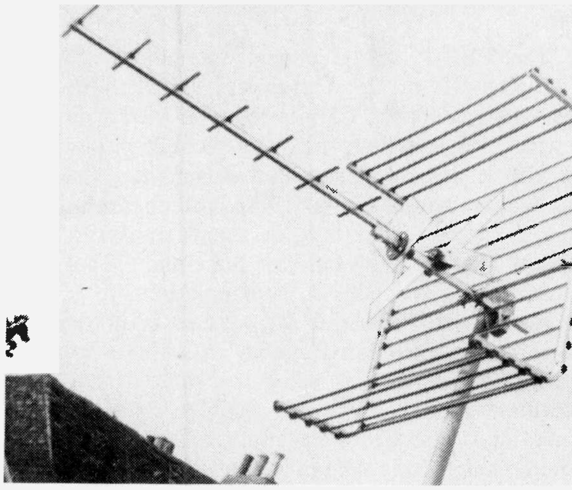
Nigeria: New transmitters are to be installed at Funtua and T'sanni during 1976, to extend the North Central States TV Service. Transmissions will be in Band III and the masts will be over 300ft.

Arabian Gulf: A third high-power transmitter is to be opened on the West Coast of Qatar, and a long term plan for a second service in this state is under discussion. A new TV network using SECAM colour is being established in Southern Saudi Arabia. The transmitters will be at Abha, Jazan, Khamis, Mushayt and Najran.

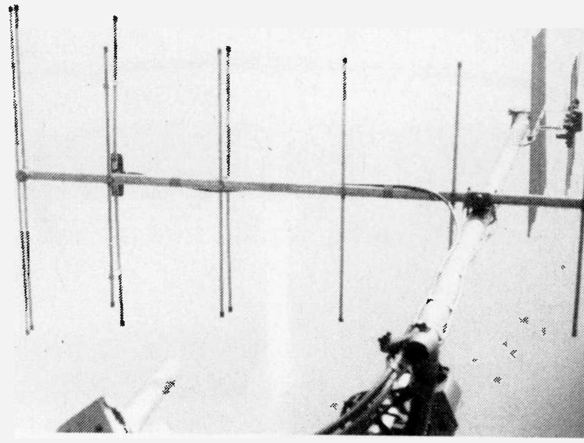
Libya: We understand that a microwave link is being established so that Libyan TV can be viewed in Malta: under a reciprocal agreement Maltese TV will be available in Libya.

Bulgarian TV

Clive Athowe visited Bulgaria recently and has sent comments on the TV situation there. BT opens at 1650 local time and closes between 2240-2340. The final



The new Telerection Short Backfire wideband u.h.f. aerial.



The modified wideband Telerection Band III array.

programme is intended for tourists and lasts for an hour: news is read in Russian, French, German and English – in a different language each night. We assume that this is a summer operation, since the programme was called "Summer '75". The only test card he saw was type G – with only the identification "G". The TV sets are of mainly Russian manufacture, and the aerials "look home-made". While in Rumania and Czechoslovakia Clive noticed that the transmitters are guarded by troops with machine guns and that there are plentiful "no photography" signs. This seems to be typical in the Eastern bloc.

Visit to Indonesia

On the other side of the globe George Palmer has been visiting Indonesia on the freighter Neptune Beryl. Equipped with two receivers, aerials and other gear, he was able to receive many stations in Indonesia, Malaysia, Singapore and Australia. During the voyage he received – while at sea off Florese – a Chinese transmission on ch. R1. This was in the late evening and the distance was over 2,800 miles. I assume it was a case of TE hop reception. Signals from over 2,500 miles were seen several nights later. George is in need of a piece of equipment with which I'm sure someone will be able to help – all costs would be covered and a payment made. This is a Schmidt optical unit with corrector plate – the type used in projection TV sets some years ago. Let me know if you have such a unit laying dormant somewhere and would like to dispose of it.

Book Review

I recently obtained a copy of *Installing TV and FM Antennas* by Leo G. Sands, published by Foulsham-Tab Ltd. at £1.75. Basic theory is covered along with the installation of aerial structures and supports. The main interests to me were the illustrations of US arrays and the techniques used there – a typical installation is concerned with several signals, often from different directions. There is information on lattice masts, cables, rotors, preamps and signal splitting/CATV. The book is written for the North American market however and although there is an explanatory section for UK readers at the beginning I would recommend the book for general interest only.

Aerials

We have recently received for evaluation one of Telerection's new back-fire aerials. This is a wideband u.h.f. array with quite reasonable gain. We are going to mount it at 55ft and then give it a series of lengthy tests. A report will follow later. The basic aerial consists of a cavity resonator – the active element to which the feeder is connected being interposed between a small front reflector and a large rear reflector. The gain is relatively flat over Bands IV/V, and with the addition of a director chain – an optional extra – the polar response is clean and the gain is increased. The basic unit is quoted as having a gain of 13dB, rising to 15dB on addition of the seven-element director assembly. Beamwidth between –3dB points is 34° at 820MHz, 42° at 630MHz and 52° at 540MHz. The front-back ratio is always greater than 20dB.

During the summer I took the opportunity to modify the wideband Band III Telerection M10X array on my mast, adding a twin-element reflector and first director – the accompanying photograph shows the modification and the wideband dipole, which resembles the familiar twin-element Tru-Match systems.

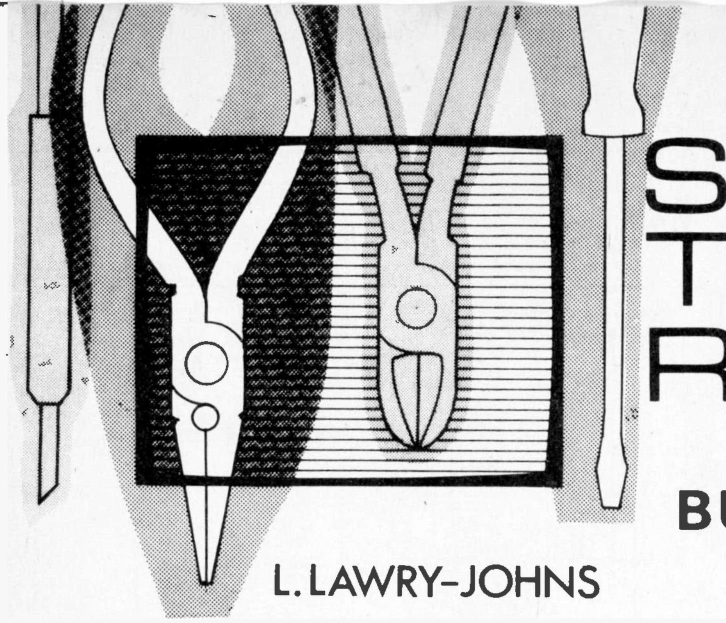
From our Correspondents

Bernhard Lindenberger (W. Germany) has written to tell us that the Hessischer Rundfunk has been using the PM5540 pattern for its first chain since July 1974. This is used during the morning period until the Fubk pattern takes over at 1300 local time. At times the Fubk pattern carries a digital clock (see photograph). During 1976 the polarisation of the Gottelborner Hohe ch. E2 transmitter is to be changed from vertical to horizontal: this station transmits the Saarlandischer Rundfunk first programme.

Hugh Cocks reports a small Aurora on Sunday, November 9th at 1630, with rumble and buzz reaching up to the l.f. end of ch. B7. Hugh also noted the RAI programme "Telegiornale" on ch. E2 recently: this was not cross-modulation from a strong ch. IA transmission. The signal was obliterated for a period by a Swiss ch. E2 test card, but then returned. It seems that RAI have a ch. E2 relay at Campione D'Italia in Switzerland, running at only 42 watts!

ATS-F Satellite

Finally this month we can confirm that signals have been received in Europe from the ATS-F TV satellite. Only the professional broadcasters, using dish arrays, have managed so far. Photographs look very promising: a full report will follow next month.



SERVICING TELEVISION RECEIVERS

BUSH TV161 SERIES

L. LAWRY-JOHNS

It is well over five years since we last featured a servicing article on the Bush TV161 (Murphy V1910) series. Subsequently a number of modifications were made to the basic chassis and several common faults have shown themselves. Another article is more than justified therefore.

Among the models covered by this article are the later TV191D, TV193D, TV183D, TV186D, TV183S and TV186S. This is in addition to the TV171 (5, 6 and 8) and the original TV161 (5 and 6). Some of our remarks can also be applied to the earlier TV145 and TV148, but only in a general sense: actual components and their values must be checked against the relevant service manual or sheet. The same chassis appear in contemporary Murphy and Defiant (CWS) models.

Panel Defects

As time goes by it becomes necessary to include the panel itself when looking for faults. In fact severe deterioration of the panel accounts for a large number of field timebase faults, some sound output troubles and the occasional line output fault. By deterioration we mean failure of the insulation property of the material as well as the tendency for cracks to develop in the tracks. As this insulation failure is usually caused by heat over a period of time, it occurs around the valve bases, usually the PCL85 (PCL805). It is not uncommon for the panel to ignite, leading to quite a nice little burn up on the timebase (right side) panel which can be damaged beyond repair. Usually however there is some initial arcing which calls attention to the set before the conflagration starts – quite apart from the picture not appearing normal. The weak points are around the valve base, particularly between pins 5 and 6. This can result in other tracks in the vicinity being damaged so that a general clean up job is necessary. It's important to cut away all affected parts of the panel, but apart from this it is always a good idea whenever work has to be done in the area (say remaking the connections to the cathode pins 3 and 8 when intermittent field operation is the complaint) to put a slot in the panel between pins 5 and 6 to prevent arcing.

This business of panel conduction can result in much fruitless fault tracing where all relevant components check out o.k. but the fault remains. The trouble is due to leakage either between valve pins or from a pin to an adjacent track, resulting in various field timebase faults in the case of the area around the PCL85 and sound faults around the PCL82. So be warned and be prepared to drill a few well chosen holes: even if you don't strike oil you may overcome a difficult linearity or sound stability problem.

The other trouble spot is around the PL504 line output valve control grid, where a leak robs the valve of its line drive and leads to it overheating.

Having disposed of a panel or two we can go on to the more conventional fault conditions and their cures.

Mains Input Circuit

The mains input is first taken to the on/off switch, which can hardly be held up as a shining example of everything a good switch should be. It's often the cause of non-operation or sometimes intermittent operation. You know the sort of thing: "We switched it off the other night, I switched it on the next morning, and nothing happened. I told the missus and she switched it on. Well bugger me if it didn't come on all evening. But it wouldn't work this morning, not even for her." The on/off switch is usually the culprit – it sits on the back of the volume control. When you replace it, don't forget to earth the metal body of the control. Failure to do this results in an annoying background hum (often mistaken for an open-circuit electrolytic).

From the on/off switch the live mains is taken to the lower right side fuse (the neutral going direct to chassis). The other side of the fuse is filtered to chassis by an $0{\cdot}1\mu$F capacitor (250V a.c. or 1kV d.c.) and feeds the junction of two diodes 3SR1 and 3SR2. 3SR1 is the h.t. rectifier and 3SR2 the heater circuit dropper.

Trouble Spot!

Now this is where the really common troubles start and where a lot of good sets have been ruined.

The heater circuit diode is connected to the right side section of the mains dropper and this has no connection with the other two sections. This right side section has a value of 156Ω. When the valve heaters fail to glow after the set has been switched on, and the mains fuse is found to be intact and is at mains potential, this section will be found open-circuit and must of course be replaced. If a section of around 150Ω is properly fitted the set will continue to function as before – no better, no worse. But there are two points here! The section must be around 150Ω and it must be properly fitted. The first is by far the most important.

All too often the set is repaired in the house by a busy engineer who may not have the correct value dropper section in his kit. He either doesn't know the correct value or he can't be bothered to make it up with two other

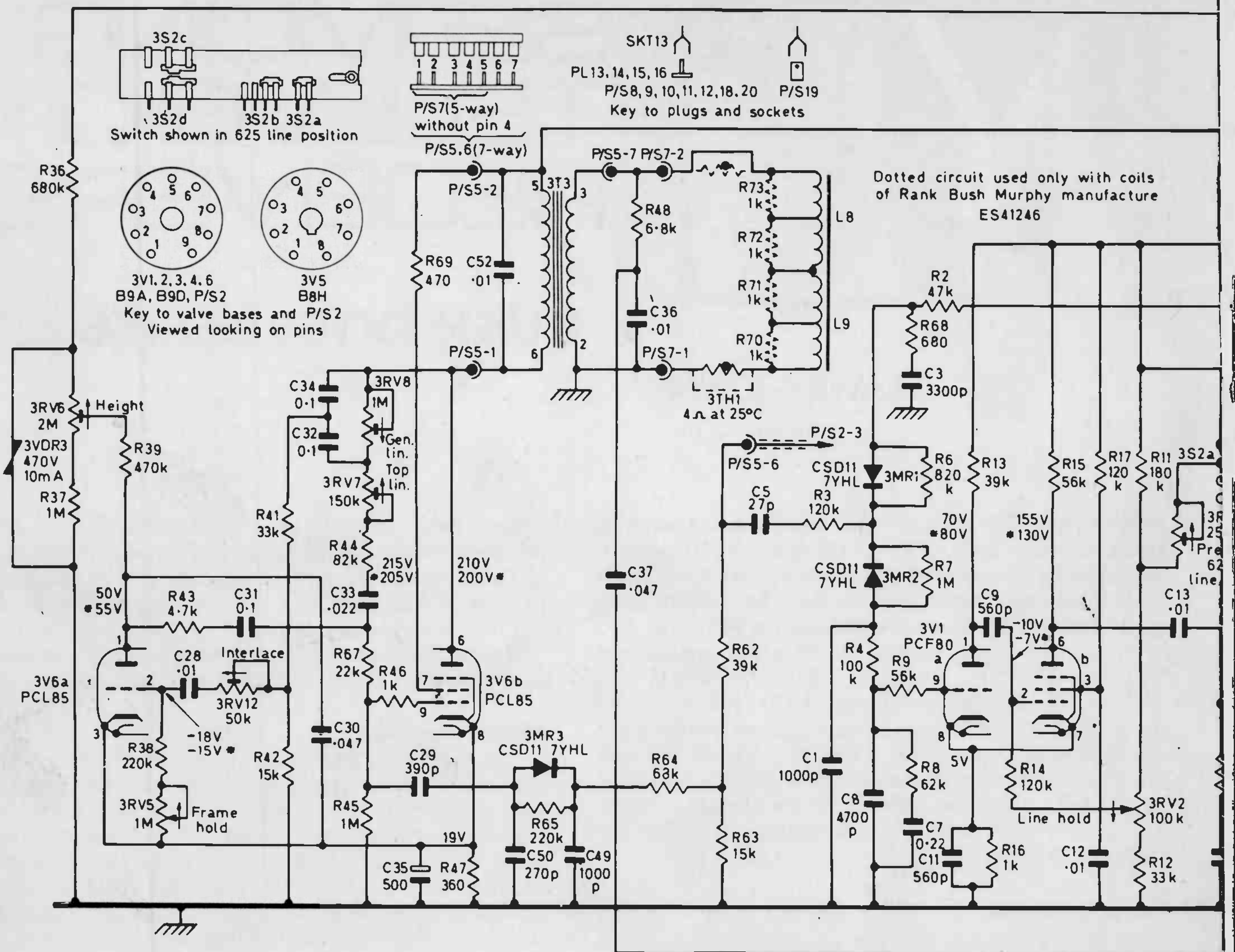


Fig. 1: Circuit of the power supplies and timebases, Bush TV161 series. Voltages marked with an asterisk apply to 625-line o

sections. He shunts a convenient resistor across the defective one therefore and the set works to the satisfaction of the customer. All concerned are happy for a while until the set fails again – if the set owner is lucky this will be in only a short while – probably because of valve failure. When the set is this time repaired, in addition to the replacement valve (or whatever) the wrong value dropper may be spotted – because the valve and tube heaters will appear to be glowing too brightly – and the correct dropper section may be fitted. If the owner is unlucky, either the set may not go wrong for some time or when it does fail the wrong value dropper may not be attended to even though its presence may be known. In this case the excess heater current will have ruined the tube (and the valves to boot) and the set will probably have to be written off because of the cost of the repairs necessary.

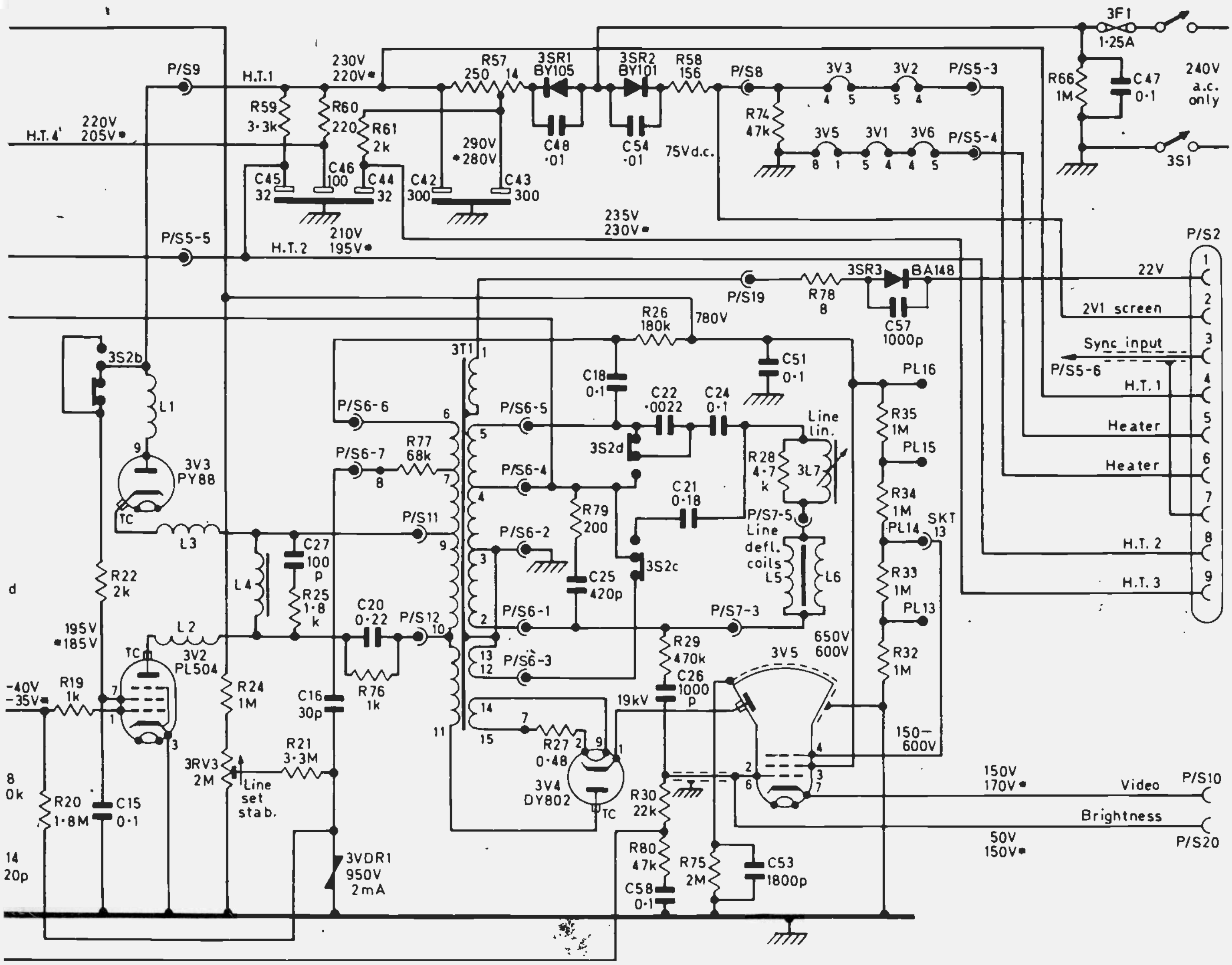
We hear a lot about the qualifications required of service engineers, but which piece of paper certifies that the qualified person has consideration for the customer and the conscience to do every job the way he knows it should be done? These qualities are infinitely more important than the ability to pass technical examinations, and apply to most professions. Near us is a garage where a lot of mechanics are employed. The man most sought after by the regulars to attend to the awkward faults, and who can always be relied upon to do a good job, is the man with the least paper qualifications. Sorry to ramble on a bit there, let's get back to that all important dropper section.

We have made the point that the right value (give or take a few ohms) has a profound effect upon the life of the set. But proper fitting is also important. If a replacement is simply wired across the tags, it will do the job it is intended to do but will dissipate heat up on to the boost capacitor(s) mounted on the lower right side of the panel. This increased heat is not conducive to reliability. The replacement section should be fitted on the reverse side, with longer wires through to the tags.

Still on the subject of the heater circuit supply, it will be noted that there is a 47kΩ resistor (3R74) on the bottom centre of the panel. This may present a somewhat less than bright appearance. Indeed it may have seriously reduced in value, sufficiently in fact to present a virtual short-circuit thus blowing the supply fuse. The set will apparently work without it, but it functions as a load resistor so that if a valve heater goes open-circuit the heater line does not rise excessively (remember there is an electrolytic on this line, decoupling the screen grid of the sync separator). It does therefore serve a purpose.

The HT Supply

The h.t. rectifier 3SR1 connects to the 14Ω section of the dropper. This serves as a surge limiter and often becomes open-circuit leaving the set inoperative but with the valve heaters still glowing. This is an easy one, but just one word of warning. Very similar symptoms are present when the



ration. Single-standard Models TV183S and TV186S used an almost identical chassis but with the system switching removed.

250Ω (left side) section goes open-circuit. In this case however the reservoir capacitor 3C43 is left charged through the 14Ω section and is quite happy to discharge itself through you if you are unwise enough to start wiring in another dropper section after merely turning the set off. Always discharge the 14Ω tag to chassis through a resistor (say with the new dropper section) – jabbing a screwdriver to chassis will produce a lovely violent spark but will not do the screwdriver or the capacitor much good (even this is better than letting the damn thing discharge itself through you however).

Here again the wrong value section is often found to have been fitted at some time. The correct value of 250Ω should not be departed from to any extent. A lower value will raise the h.t. voltage and impair the smoothing.

The smoothing is carried out by a large 300 + 300μF electrolytic can (3C42/3) and a smaller 100 + 32 + 32μF can (3C44-6). The tags of these capacitors do not always make good electrical contact with the lead-out rivets, and poor smoothing can often be cured with a hammer and chisel or a similar but less crude method of improving the contact. When bashing about like this don't forget to bash the main earthing tag (the one with the braid to it).

Sound Circuits

As usual, if there is trouble in an i.f. channel it is generally the final stage, 2VT6 in this case. There should be about 11V from its emitter to chassis.

The majority of the faults occur in the output stage however, the PCL82 being the first suspect. Check the pentode cathode resistor 2R71 (680Ω) if the valve has been running into grid current.

Unfortunately, the most difficult fault to overcome is instability due to conduction through the panel. Cutting away the affected section may clear this but a simple part remedy is to accept that the instability is due to positive feedback and deliberately introduce some negative feedback to counteract it. A convenient way of doing this is to cut out the electrolytic capacitor 2C78 in the cathode circuit. This action introduces current feedback as the resistor 2R71 is then unbypassed, and is enough to stabilise the condition.

In the event of hum check the cable plugs and sockets and also the HT3 (sound output stage h.t. supply) smoothing electrolytic capacitor 3C44 (32μF) in the main block. As intimated earlier, this may require only a more positive contact between the lead-out tag and rivet.

The triode section of the PCL82 has its own cathode decoupling electrolytic (2C75, 50μF), and this can also give trouble. The symptoms are distorted sound on u.h.f., low sound on v.h.f. The latter is due to the fact that the sound a.g.c. on this system – there's none on u.h.f. of course – comes from pin 8 of the PCL82 and is smoothed by 2C75.

CONTINUED NEXT MONTH

AC THEORY
A step by step approach

Ian SINCLAIR

Part 4

Resonant circuits have applications other than as loads for selective amplifiers. A line output transformer for example acts as a resonant circuit to provide the line flyback action when the active devices in the stage are cut off.

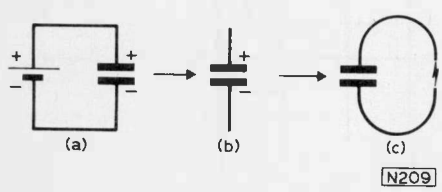


Fig. 1: (a) A capacitor stores electric energy in the form of an electric field. (b) The field remains when the capacitor is disconnected from the voltage, until . . . (c) A closed circuit is set up, when the charge moves as a flow of current.

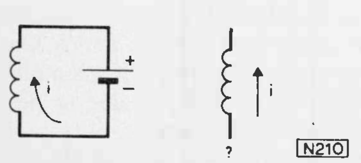


Fig. 2: An inductor stores energy in its magnetic field. What happens when the circuit is broken?

An inductor with a steady current flowing through it is a store of energy, the energy being stored in the magnetic field around the inductor. A capacitor stores energy when voltage is applied across it; the energy being stored in the electrostatic field. When we disconnect a capacitor from a voltage supply, the energy remains stored until we short circuit the plates of the capacitor together. The opposite charges on the two plates then neutralise each other, and the stored energy is released as the heat and light of a spark (Fig. 1).

We cannot do precisely this experiment with an inductor, as we cannot disconnect an inductor from a circuit without disturbing the stored energy (Fig. 2). Why not?

Because the stored energy depends on the current flowing, and this stops when we disconnect. Note that the capacitor and inductor are *complementary*: what a capacitor does with voltage an inductor does with current. Change of voltage on a capacitor causes current; change of current in an inductor causes voltage.

Immediately we disconnect an inductor, we are releasing its energy. When we *shorted* a capacitor, we released its energy in the form of a current; when we *open circuit* an inductor we release its energy in the form of voltage.

In each case the energy is converted into heat and light in a spark unless we use it up in some other way. The principle here is that of Faraday's Law, because the change of current (to zero) in the inductor induces a voltage which (by Lenz's Law) opposes the change and tries to keep the current flowing.

Difficulty is sometimes experienced in remembering what the polarity of the voltage at any point in an inductive circuit will be when the circuit is broken, see Figs. 3 and 4.

One easy way to work this out is to consider that when the switch in Fig. 3(a) opens, the inductor sees a rapid increase towards infinity in the resistance of the external circuit. In an effort to maintain the original current flow, the coil applies a rapidly increasing induced voltage across the now-open switch (Fig. 3(b)) but, unless the gap between the switch contacts is small enough to flash over, no further current can flow.

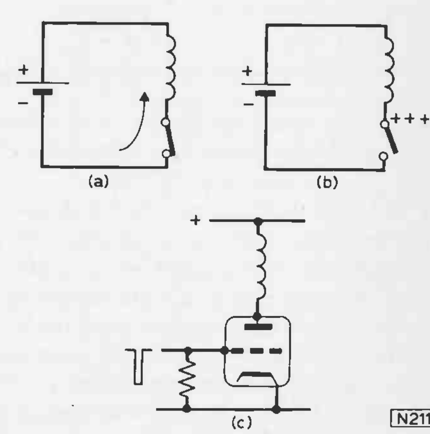


Fig. 3: When an inductive circuit is broken, a high voltage is induced in the inductor.

The top end of the coil is still connected to the positive supply line in Fig. 3(b), so the induced voltage across the coil is reversed compared with the original applied voltage. This corresponds with the situation when an alternating voltage is applied to an inductor, where applied and induced voltages are 180° out of phase. The voltage appearing across the open switch is of the expected polarity, but very much higher than the supply voltage.

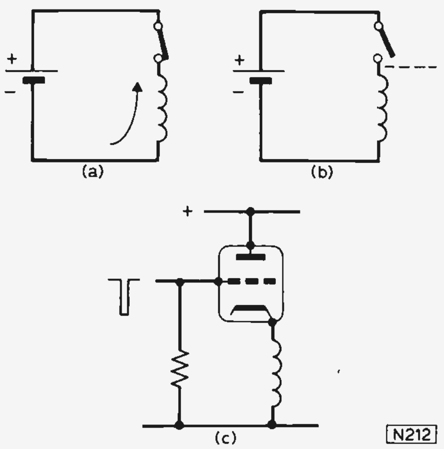


Fig. 4: Moving the switch to the opposite end of the inductor does not alter the circuit action, only the polarity of the induced voltage. This will always be opposite to the voltage that was applied.

In Fig. 4 the switch has been transferred to the opposite end of the inductor but the same argument still holds. In this case a large negative voltage appears at the free end of the coil.

What will be the polarities at the anode in Fig. 3(c) and the cathode in Fig. 4(c) when each valve is cut off by a suddenly applied negative voltage at the grid?

Fig. 3(c), anode positive; Fig. 4(c), cathode negative.

This is how a line output transformer can be used to generate e.h.t. When the line output valve or transistor cuts off at the end of the scan, the stored energy in the transformer windings causes a high positive voltage to appear at the anode or collector, as the case may be.

This is not in itself sufficient to provide e.h.t., being about 5-7kV in a valve and about 300V in a transistor stage, but if another winding is connected in series and on the same core, as in Fig. 5, the induced voltage will be stepped up by transformer action. We can take this voltage and rectify it to use as e.h.t. The extra portion of winding on the line output transformer is known as the OVERWIND.

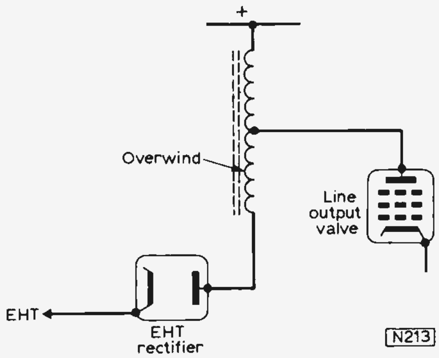


Fig. 5: Basic principle of e.h.t. generation by the line output stage.

Why does a shorted turn in a line output transformer cause so much trouble?

There is only a limited amount of energy available from the scanning process, and most of it will go to supplying current into the short circuit rather than voltage to the overwind.

Now let us look at the circuit of Fig. 6. A steady current is flowing in the inductor of a parallel resonant circuit and through the valve. If the current is cut off suddenly by the valve, we would expect a negative pulse of voltage at the cathode, but in fact we find that the circuit oscillates. The energy of the inductor is transferred smoothly to the capacitor, and back again, for some time. This type of behaviour is called RINGING.

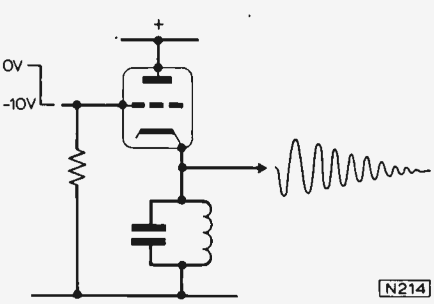


Fig. 6: A simple ringing circuit. Note how the amplitude of the oscillations decreases.

What is the frequency of the wave produced?

The resonant frequency of the parallel tuned circuit.

Oscillators, though they seem to exist in dozens of different forms, are all based on ringing circuits. If we start a parallel resonant circuit ringing, the amplitude of the oscillations gradually decreases, as shown in Fig. 6, because the energy which is being exchanged between the inductor and the capacitor is gradually lost as heat, dissipated in the circuit resistance.

If, by some means, we can supply energy to make up for this, the oscillations will continue as long as we keep up the supply of energy. An oscillator consists of a ringing circuit plus a source of energy and some method of delivering that energy to the ringing circuit.

What happens if we supply more energy than is needed?

The amplitude of oscillation will keep increasing until something, such as bottoming of an amplifier, happens to limit it.

All oscillators can be thought of as comprising a ringing circuit, an amplifier with positive feedback, and a power supply, see Fig. 7. When the circuit rings (as it does when the voltage is applied), the oscillations are amplified and fed back in phase, so that their energy is added to the original. The amplitude of the oscillations then rapidly increases until they are limited by some other factor.

If the amplifier bottoms or saturates, the amplification becomes zero at that point, so that the supply of energy is cut off. This is the usual method of stabilising oscillation, and it implies that the output of such an oscillator will not be a perfect sinewave. Generally the less amplification is used, the less we have to rely on heavy bottoming or saturation and the better the sinewave quality. This is specially noticeable when low-Q circuits are used, as in RC oscillators, e.g. phase-shift oscillators.

Other methods of limiting the amplitude of oscillation include thermistors, voltage sensitive resistors, clipping diodes, etc. – all NON-LINEAR devices, i.e. graph of output voltage against input current is not a straight line.

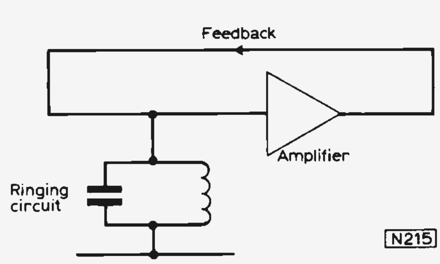


Fig. 7: General circuit of an oscillator as a ringing circuit plus an amplifier with positive feedback. The ringing element can be a series LC circuit, a quartz crystal or an RC circuit.

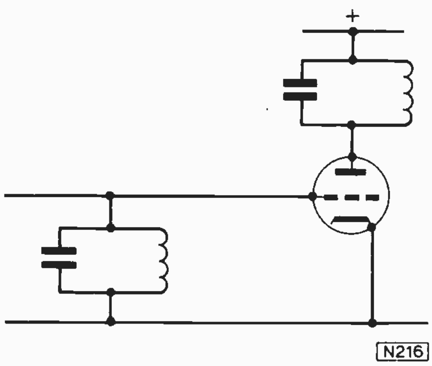


Fig. 8: How can this circuit oscillate?

In a circuit (Fig. 8) consisting of a triode valve with a tuned circuit in the grid and a similar tuned circuit (same resonant frequency) in the anode, oscillation takes place. Why?

There is feedback through the internal capacitance between anode and grid. This provides only 90° of phase shift, but each tuned circuit can provide another 45° and still be very close to resonance, so that the full 180° phase shift is achieved and the amount of energy fed back can be enough to keep the oscillations going.

Two important TV applications require the use of PHASE DETECTORS, which give an output whose voltage (or current) depends on the difference between the phase of a reference wave, usually locally generated, and the signal waveform. Line flywheel sync circuits are one example of such phase-detecting circuits.

What is the reference signal in this case, and what is the locally generated waveform?

In this particular case, the local signal is the line timebase waveform, and the reference is the incoming line sync pulse.

Consider a line oscillator. If its natural frequency is not exactly line frequency or if it has shifted in phase, then its phase will differ from that of the incoming sync pulse. If we can compare the two and obtain an output voltage proportional to the difference, we can use this voltage to correct the oscillator. The greater the phase difference, the greater the correction voltage we shall require.

What would happen if the voltage became less as the phase difference increased?

It would be impossible ever to lock the timebase.

If we take a sample of the line scan voltage waveform from the line output transformer or the scan coils it will look roughly as shown in Fig. 9(a). The start of the linear scan (the point marked with a star) should coincide with the trailing edge of the line sync pulse, represented in Fig. 9 (b).

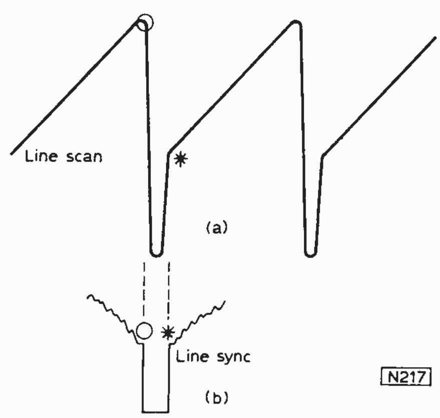


Fig. 9: Relative timing of line scan and line synchronising pulses.

To produce a circuit which will correct the frequency and phase of the line oscillator with sufficient accuracy, we need to modify the waveforms somewhat. Usually, the scan waveform is integrated to produce a sawtooth, whilst the line sync pulses are differentiated to provide short sharp gating pulses. Some designs reverse these processes, but the general principle is the same. Fig. 10 shows a typical circuit and the waveforms obtained.

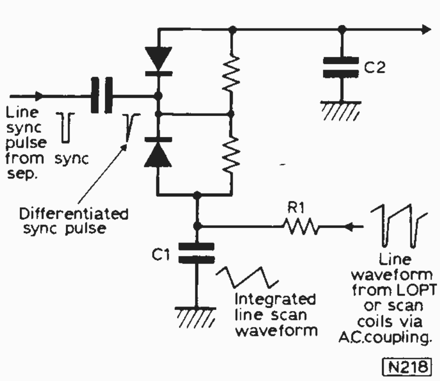


Fig. 10: A typical flywheel line sync circuit.

The line waveform is integrated by C1, R1, producing a sawtooth across C1. The negative-going line sync pulse switches on the diodes, passing a sample of the sawtooth during the flyback period to capacitor C2, charging it to a voltage whose polarity and value will depend upon the phasing of the two inputs. The output of the phase discriminator will not necessarily be zero volts for zero phase error.

What will be the direction of the change in output voltage if the line oscillator frequency starts to fall?

The output voltage will become more positive, since the sawtooth will be sampled earlier in the flyback period.

We have a similar, but more stringent synchronisation problem with the colour subcarrier. We need, within the receiver, a generator running at 4·433MHz whose frequency and phase is exactly synchronised to the master oscillator at the transmitter or studio. Only very slight errors in phase can be tolerated. For this circuit, we use a crystal-controlled oscillator, but the same idea of comparing the output with an input derived from the transmitted signal is used.

What must this input from the transmitted signal be?

A few cycles of 4·433MHz in the correct phase.

The reference signal is transmitted during the time in the line flyback blanking period when the voltage is normally at black level (the "back porch"). A few cycles of 4·433MHz sinewave are transmitted during this time; this is known as the COLOUR BURST. The problem now is to separate this burst signal from the video, the sync and also from the chroma signal which is at around the same frequency. Part of a typical circuit capable of achieving this is shown in Fig. 11.

A flyback pulse from the line output transformer is applied to an *LC* ringing circuit. This ringing circuit is arranged to have a natural frequency such that the first positive swing occurs at the time that the colour burst is received, and it is this swing that biases the transistor on.

What is the purpose of the resistor across the tuned circuit?

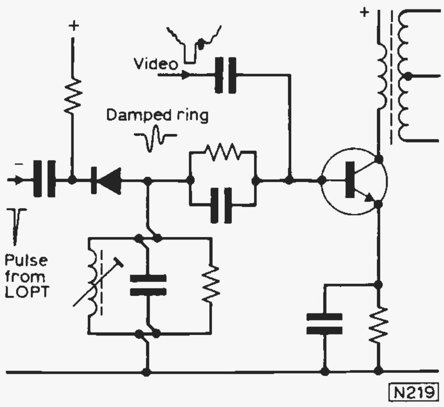


Fig. 11: A typical circuit for gating out the line-by-line colour burst for use by the burst detector.

It damps the oscillatory ring quite heavily, so that no more oscillations occur after the first positive swing.

Having gated the colour burst out of the composite video waveform, it must now be applied to some circuit which will suitably lock the reference oscillator. A type of phase-sensitive detector used for this purpose is shown in Fig. 12.

The 4·433MHz signal from the reference oscillator is fed to T2, whose secondary winding has one end returned via diodes D1 and D2. These diodes conduct only on the tips of alternate half-cycles of the burst signal from T1, being biased off for the rest of the time by the charge built up on the series capacitors.

Here we have another sampling action. The two diodes act as a switch in series with T2 secondary, allowing a sample of the reference oscillator sinewave to be passed once each cycle to the d.c. amplifier controlling the oscillator. Capacitor C smooths the samples to provide the required steady voltage. The waveforms for this circuit are shown in Fig. 13, the shaded band representing the time during which the sample is taken. It should be apparent that this circuit will lock the reference oscillator 90° out of phase with the incoming burst.

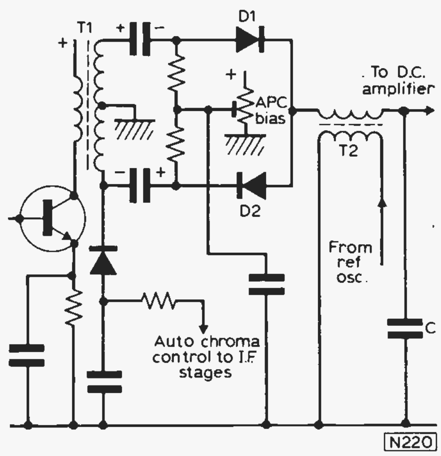


Fig. 12: A burst detector circuit. This phase sensitive detector produces a control voltage to lock the receiver's reference oscillator to that at the transmitter.

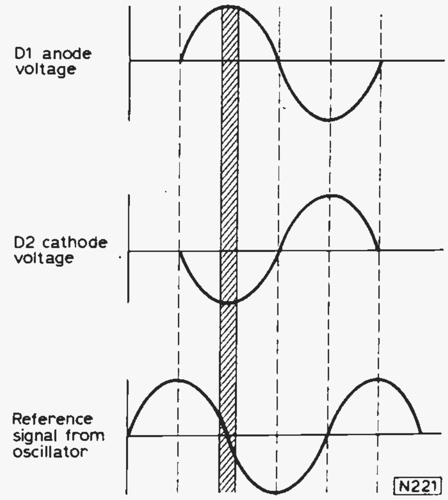


Fig. 13: Waveforms of the circuit of Fig. 12. The reference oscillator runs 90° out of phase with the incoming bursts.

This type of phase detector is used in the PAL receiver to perform other functions. The voltage across one arm of the discriminator transformer T1 is proportional to the received amplitude of the colour burst signal. This voltage can therefore be rectified and used as a type of a.g.c. bias, called AUTOMATIC CHROMINANCE CONTROL, which is applied to the chrominance amplifiers to maintain the correct ratio of chrominance to luminance signal, and to ensure a constant level of colour burst signal to the phase discriminator, despite changes in tuning or received signal strength.

WHY DIGITAL?

continued from page 184

are plated through. The i.c.s are pluggable, which is a welcome feature. In our forthcoming oscilloscope review we comment on a Heathkit instrument which we built, and many of the comments made there apply also to this kit.

A DVM is by definition a precision instrument, and the question of calibration of the completed kit is an interesting one. As the specification shows, two figures are quoted for accuracy, one using built-in references, the other using laboratory standards for calibration. Considerable ingenuity has been used in working out the calibration procedure, one sequence involving a watch, which in terms of percentage error is as accurate as any electronic laboratory standard! If the calibration instructions are followed to the letter, the home constructor can confidently expect to achieve the quoted accuracy.

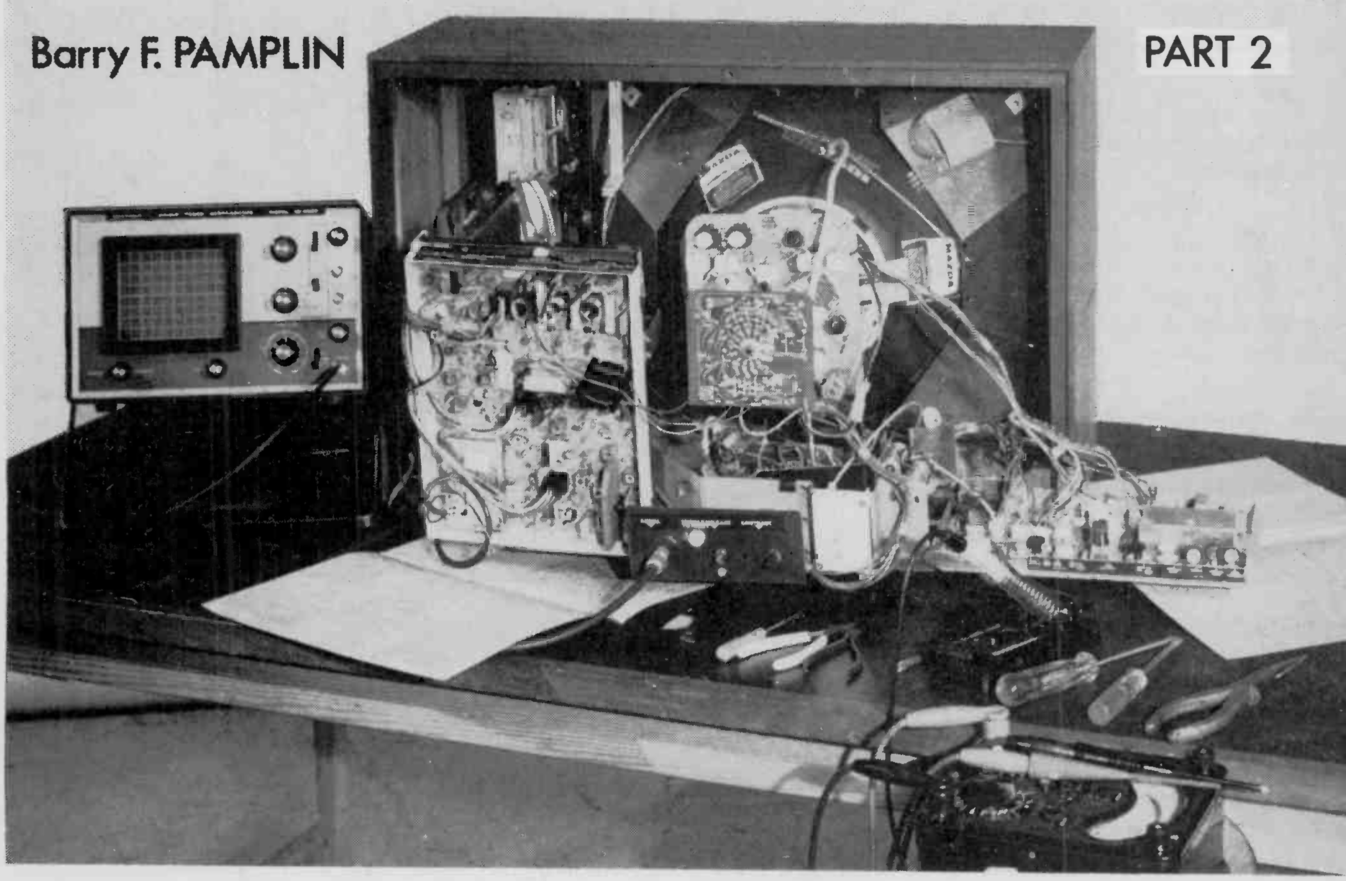
In everyday use, the meter was not found wanting in any respect once we had replaced the "cudgels" supplied with miniature prodclips. On the resistance ranges, a 2 volt potential is present across the test prods, so that this is one DVM which is capable of testing semiconductor junctions, a great bonus in general servicing. The rotary selector switch has a nice positive action, and the 26 ranges provided cover a very wide span. There had to be a snag; when a fuse is blown due to accidental overload, the guilty operator has to do his penance by removing no less than eight screws in order to dismantle the injured meter and replace the fuse. In the cloistered world of instrument design laboratories, no doubt such sins as accidental overload never occur, but lesser mortals, and especially your author, have been known to get through as many as four fuses in a busy week! On the credit side, the power supply arrangements are very commendable, consisting of four rechargeable Ni-Cad cells which power the instrument for up to eight hours. These are automatically charged when the meter is re-connected to the mains. This arrangement seems to give the best of both worlds of economy and portability.

With its versatile power supply and its junction testing capability, this instrument is equally suited to bench or field use. A protective carrying case would have been a useful accessory.

Servicing the THORN 8000 8000A 8500 chassis

Barry F. PAMPLIN

PART 2



Two types of tuner unit have been fitted to the chassis under discussion, the 12588 variety (incorrectly referred to as 12558 last month) which may be identified by a small printed panel mounted on the rear of the tuner, and the T221 with no external panel. The two types are both physically and electrically interchangeable but use different types of knobs.

The tuner units themselves have proved to be reliable, but the same cannot be said of the earlier versions of the aerial isolator assembly. These separated into two non-repairable halves at the slightest tug on the aerial lead. When faced with this problem there is the understandable temptation to use a pair of coaxial plugs and a coupler as a temporary measure. This must be resisted at all costs as it can easily lead to the outer of the coaxial cable being live if either the mains wiring is reversed or the live side of the mains on/off switch becomes permanently made due to the contacts welding together – a not uncommon experience with the push-push type of switch used on this chassis.

IF/Chroma/RGB Panel

The following notes refer to panel type PC642 which is fitted to the majority of 8000/8500 chassis. It contains the i.f., chroma and video drive circuits and is a large panel mounted on the left-hand side (viewed from rear) of the chassis. The contents of this board are shown in block form in Fig. 1.

Each section shown in Fig. 1 will be dealt with in turn. Note particularly the use of i.c.s for vision and sound detection and for chroma processing. The whole board is powered from the stabilised 25V line – which shoots up to 45V if the stabiliser transistor on the power board goes short-circuit! Fig. 5 shows the position of the various test points. (Our photos show panel PC651.)

The IF Strip

The circuit of the vision i.f. strip is shown in Fig. 2. Most of the i.f. and adjacent channel filtering is carried out in the base circuit of VT101. Specifically, C103/4/L101 form a 41·5MHz adjacent sound channel rejector, C105/L102 reject at the sound carrier frequency (33·5MHz) whilst C106/8/L104 reject the channel 1 vision carrier signal at 45MHz.

The three transistor amplifier stages are tuned to form a broadband amplifier with the appropriate response. L105 is tuned to 38·9MHz, L106 to 34MHz and L107 to 37MHz.

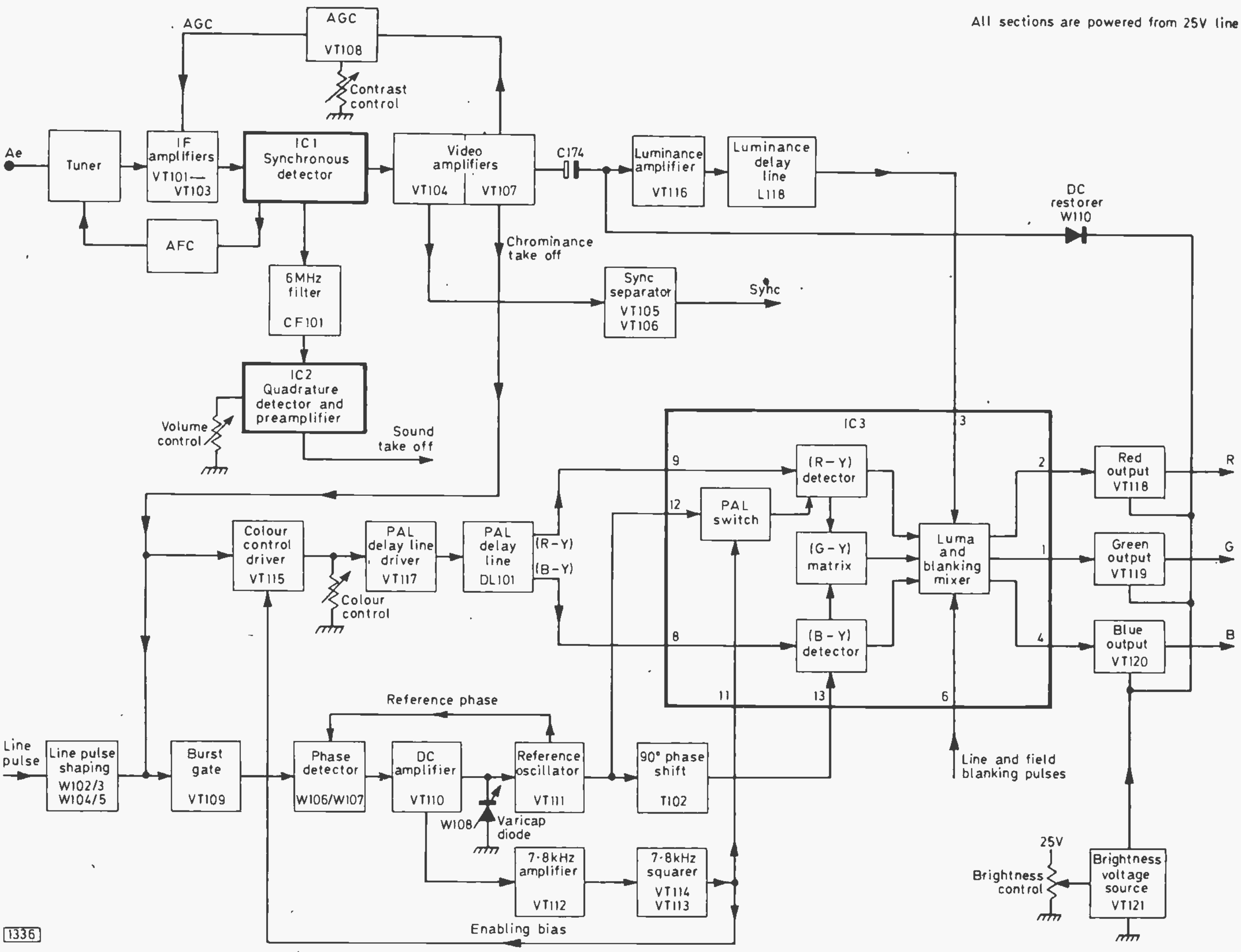


Fig. 1: Block diagram of the i.f./decoder/RGB output panel.

The vision carrier position is set by fine adjustment of L105 and L103 whilst tilt adjustment can be provided by detuning L107.

A.G.C. is applied directly to the first transistor VT101 and indirectly via VT101 emitter to VT102. The a.g.c. sense is positive-going for reduced gain (forward a.g.c.) and the signal at the i.f. strip output – at TP1 – is of the order of 30-50mV.

Generally speaking the circuit gives little trouble. Most faults seem to be associated with VT101, C110 and C115.

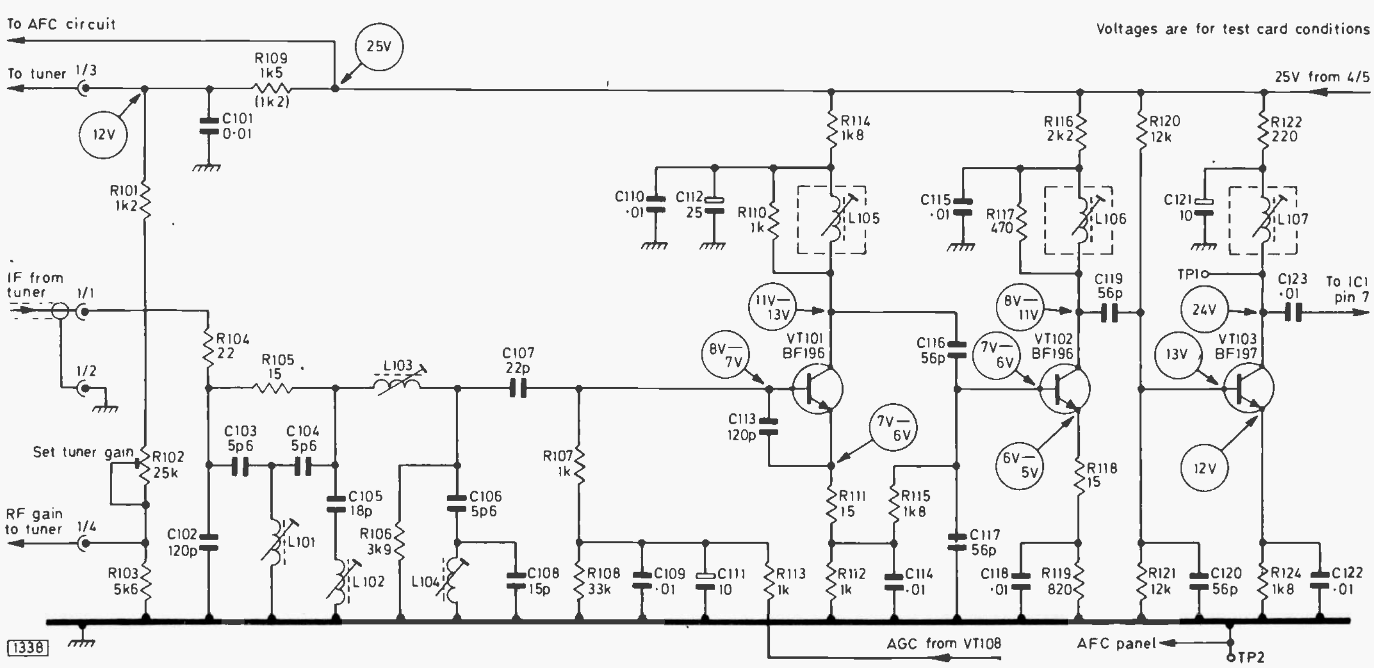


Fig. 2: Circuit of the i.f. amplifier.

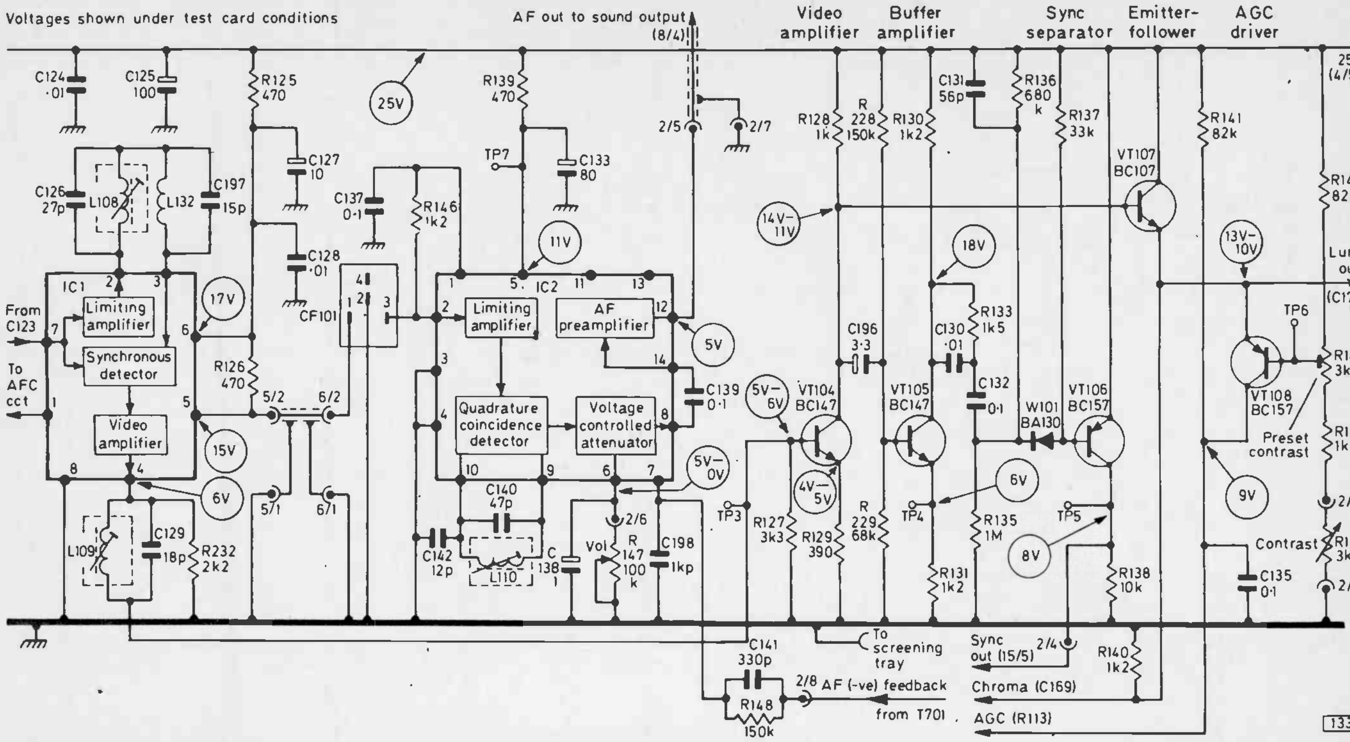


Fig. 3: The video detector (IC1), intercarrier sound (IC2), sync separator and a.g.c. circuits. Negative feedback from the secondary of the sound output transformer T701 is fed to pin 7 of IC2 via R148/C141: the tap on T701 was omitted in Fig. 3 last month.

No signal symptoms are more likely to be due to a.g.c. troubles than i.f. troubles. Intermittent contrast changes have been traced to the electrolytic C112.

Detector, Sync Separator & AGC

The output from the i.f. strip is fed to the circuit shown in Fig. 3. IC1 is a low-level video detector providing a negative-going output at pin 4 and a positive-going output at pin 5.

The signal at pin 5 is fed via the 6MHz ceramic filter CF101 to the intercarrier sound channel IC2 which provides from pin 12 an a.f. signal for driving the output stage. Negative feedback is applied to pin 7. The volume control – there have been several different arrangements – is connected between pin 6 and chassis.

The video signal at pin 4 of IC1 is fed via the 6MHz rejector L109/C129 to the video inverter VT104. The forward bias for this transistor is generated within the i.c. The output from the collector of VT104 feeds the sync

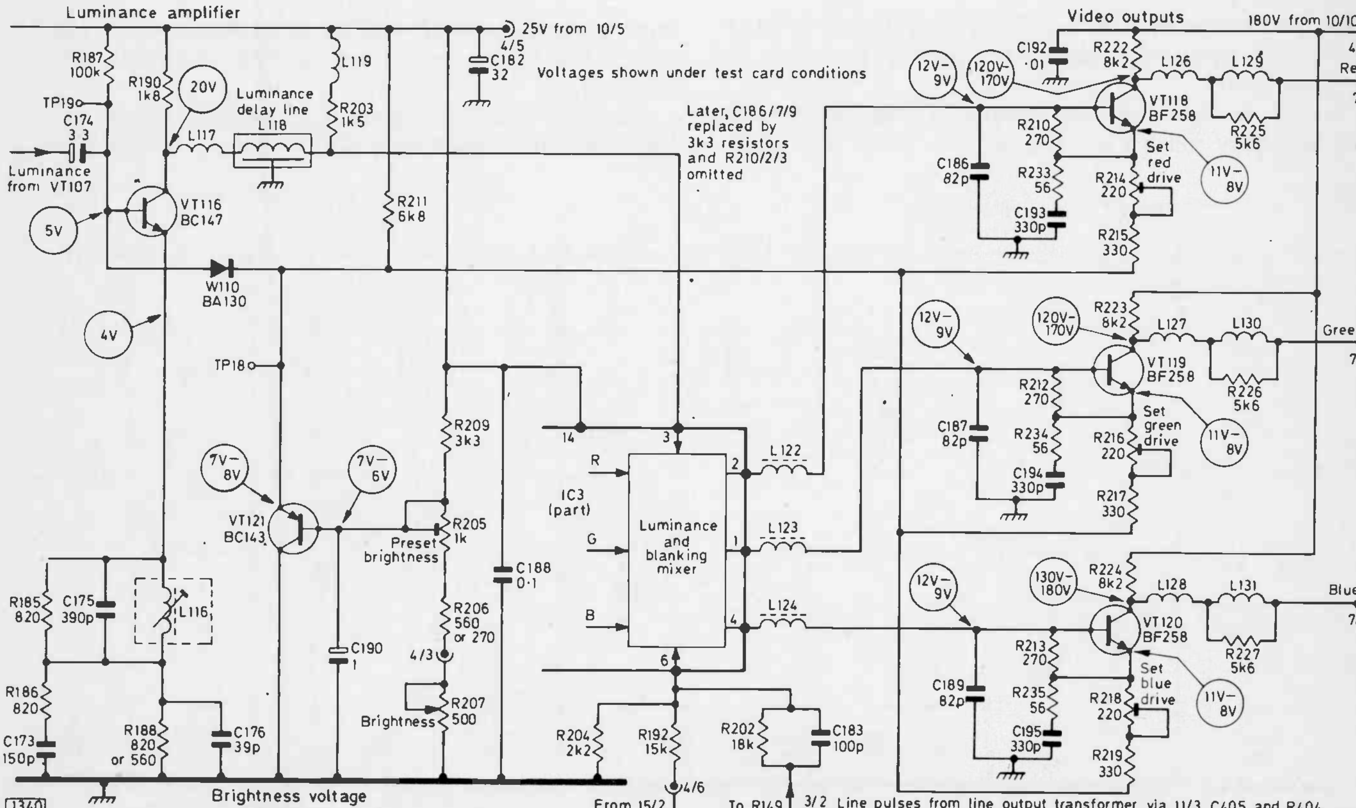


Fig. 4: The luminance, RGB output and brightness circuits.

buffer VT105 and the emitter-follower VT107. The output from VT107 consists of a 3V peak-to-peak signal for driving the luminance amplifier.

Also connected to the output of VT107 is the a.g.c. driver VT108. R141 together with R113 and R108 (see Fig. 2) form a potential divider to control the forward bias applied to the first i.f. transistor VT101. With no signal present this stage is biased for maximum gain and VT108 is cut off by the reverse bias from the potential divider R142-R145. With video signals present, the tips of the positive-going sync pulses at the emitter of VT107 cause VT108 to conduct, increasing the charge on C135. The voltage across this capacitor is applied to the first i.f. transistor to reduce its gain. The contrast control R145 together with the preset R143 enable the circuit conditions to be adjusted to suit local reception conditions and customers' preferences.

Returning now to VT104, its output is also coupled via C196 to the inverting amplifier VT105 which reverses the polarity of the signal to make it suitable for driving the sync separator. Negative-going sync pulses at the collector of VT105 cause W101 and VT106 to conduct and positive-going sync pulses appear across R138.

Fault Finding in the Signal Stages

Fault finding in these circuits is simple enough if a logical approach is adopted. Faults can be considered under four headings.

Picture OK, Sound Faulty

Assuming that the sound output stage on the power panel (see first article) has been checked and found to be o.k. the trouble will be due to IC2 or its associated circuit. First check for an 11V supply at pin 5 (TP7). If this is present the voltage on the other pins should be checked and compared with those given in Fig. 9. Any voltage outside the limits shown makes the i.c. suspect. Other components which occasionally give trouble are CF101 and C140. Check also the screened lead and its terminations feeding the filter. In cases of poor sound check that L110 is tuned for optimum results.

No Sound or Vision: Poor Sound, Vision

Assuming that a signal exists at the input, pin 7, of IC1 the first step is to check whether video is present at pin 4. A simple check is to measure the d.c. potential here. If the voltage is about 7V falling to about 5V when the aerial is plugged in it can be assumed that IC1 is o.k. If the i.c. is suspected the voltages on all pins should be checked against those shown in Fig. 9. Assuming that the voltage on supply pin 6 is correct, an incorrect voltage elsewhere on the i.c. will usually mean that it is faulty.

Sound OK, No Vision Signal

This indicates trouble around VT104 or VT107. A check on the transistor voltages will enable the fault to be located.

Sync Troubles

Weak or absent sync is usually the result of a flashover killing VT105 or VT106, or C196 being defective. Video getting into the sync (pulling on captions etc.) is usually the result of a fault in IC1, especially if accompanied by video smearing. When the circuits are operating correctly the sync output at TP5 consists of positive-going sync pulses of 15-20V amplitude.

RGB Circuits

The video output circuitry is shown in Fig. 4. The signal present at the emitter of VT107 is a.c. coupled via C174 to VT116. The emitter circuit of this transistor includes a subcarrier rejection filter L116/C175 to reduce chroma patterning and to gain compensation at 1·2MHz, needed because of a dip at this frequency in IC3. The output from VT116 passes via the luminance delay line L118 to the chroma processing i.c. IC3 where it is used to provide information for the RGB drive circuits.

Because of the a.c. coupling to VT116 it is necessary to provide d.c. restoration and this is achieved by diode W110 which conducts on the sync pulse tips to restore the charge on C174. The restoring voltage applied to the diode is obtained from the brightness control transistor VT121 which is positioned in the earth return of the three output transistors.

Brightness Circuit

The operation of this circuit is worth considering in some detail since because of the d.c. feedback via W110 a fault developing in any part of the loop will disturb the d.c. levels all round it. The base of the brightness control transistor VT121 is connected to a potential divider network across the 25V supply. The potential applied to its base is controlled by the setting of the brightness control R207 and the preset R205. The base voltage of VT121 determines its emitter voltage, and thus controls the mean collector voltages of the RGB output transistors VT118-VT120. In addition to this however, the setting of the brightness control also affects the drive to the bases of the output

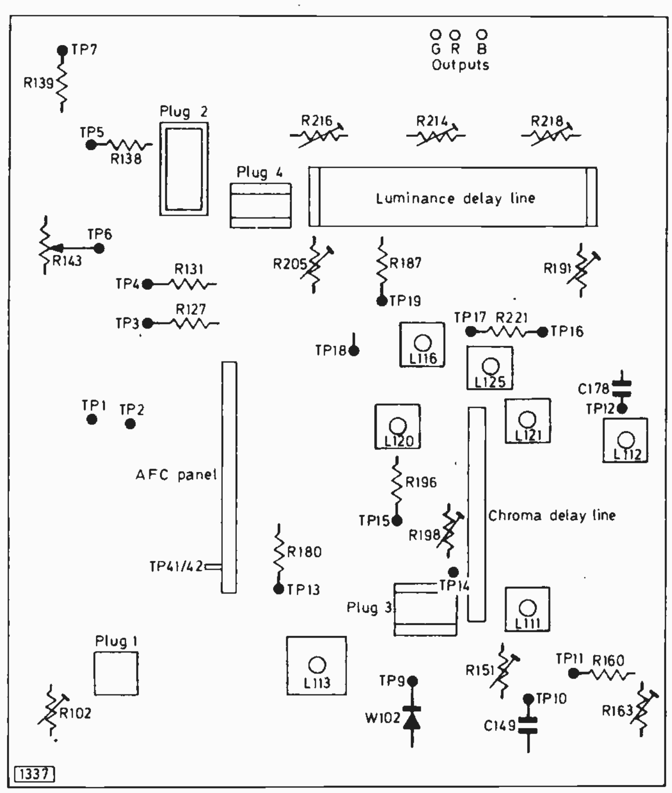


Fig. 5: Positions of the i.f. and decoder test points and preset controls on the panel.

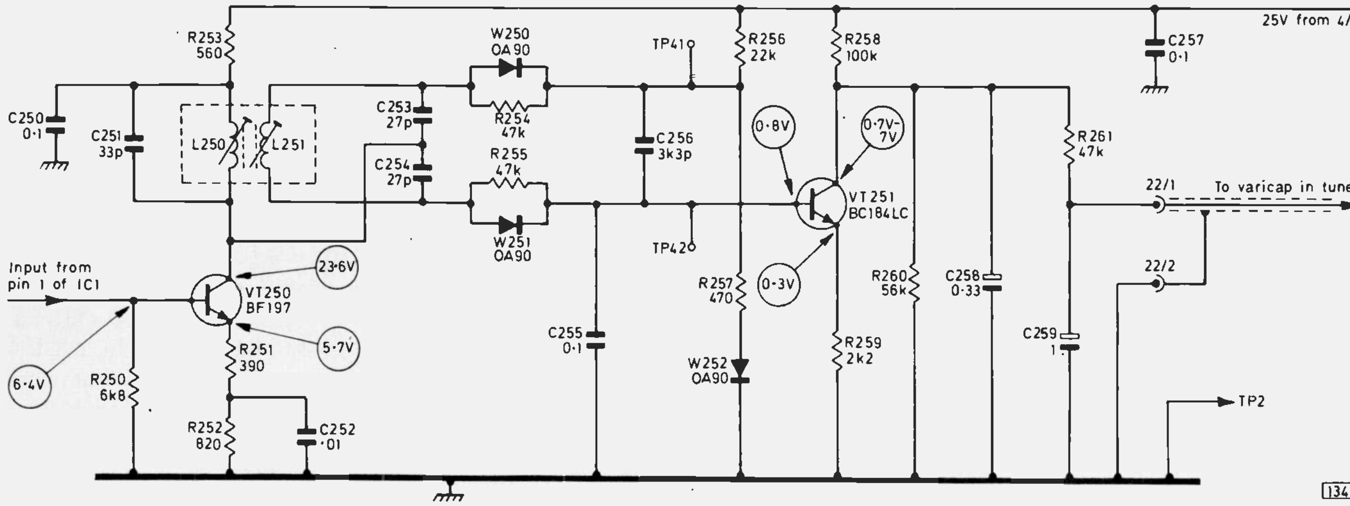


Fig. 6: The a.f.c. subpanel circuit.

transistors because of the d.c. coupling from VT121 emitter via W110, VT116 and IC3.

Luminance and RGB Faults

Fault-finding in any closed loop poses problems. Faults affecting one colour only (absence or excess of a colour in the grey scale) will usually be due to faults in the relevant output transistor or IC3; brightness faults affecting all guns however will usually have their root either in the feedback loop or the flyback blanking circuit. When checking such faults it is worth bearing in mind that anything removing the forward bias from VT121 will tend to cut off all the guns (i.e. no raster). Two common causes are C190 developing a leak or VT121 becoming faulty in some way. W110 going open-circuit would have the same effect, as could a fault in VT116.

Faults in IC3 causing a loss of luminance are rare – as mentioned later, the more usual trouble in this department is loss of one colour. The key to checking the i.c. for proper performance is, as always, to check all the pin voltages – see Fig. 9. A very high voltage on pin 6 of IC3 usually means that W103 in the burst gating circuit has developed a leak.

Video with multiple ghosts usually indicates luminance delay line trouble, although similar troubles can be due to IC1. Absence of the luminance is generally due to VT116 being defective or C174, L117, L118 or L119 being open-circuit.

Automatic Frequency Control

The a.f.c. panel is a separate unit mounted on to the main board. The circuit, shown in Fig. 6, is conventional and consists of an i.f. preamplifier followed by a discriminator and d.c. amplifier to provide a correction signal for the varicap diode in the tuner.

To set the circuit up the discriminator output is removed by shorting together TP41 and TP42, the tuning adjusted for optimum performance, the short-circuit removed and the core of L251 then adjusted to restore optimum performance.

Failure of this circuit is uncommon: most troubles are due to one of the transistors or one of the discriminator diodes.

Burst & Reference Oscillator Circuits

The circuit arrangement of the burst channel and reference oscillator is shown in Fig. 7. Chroma and burst

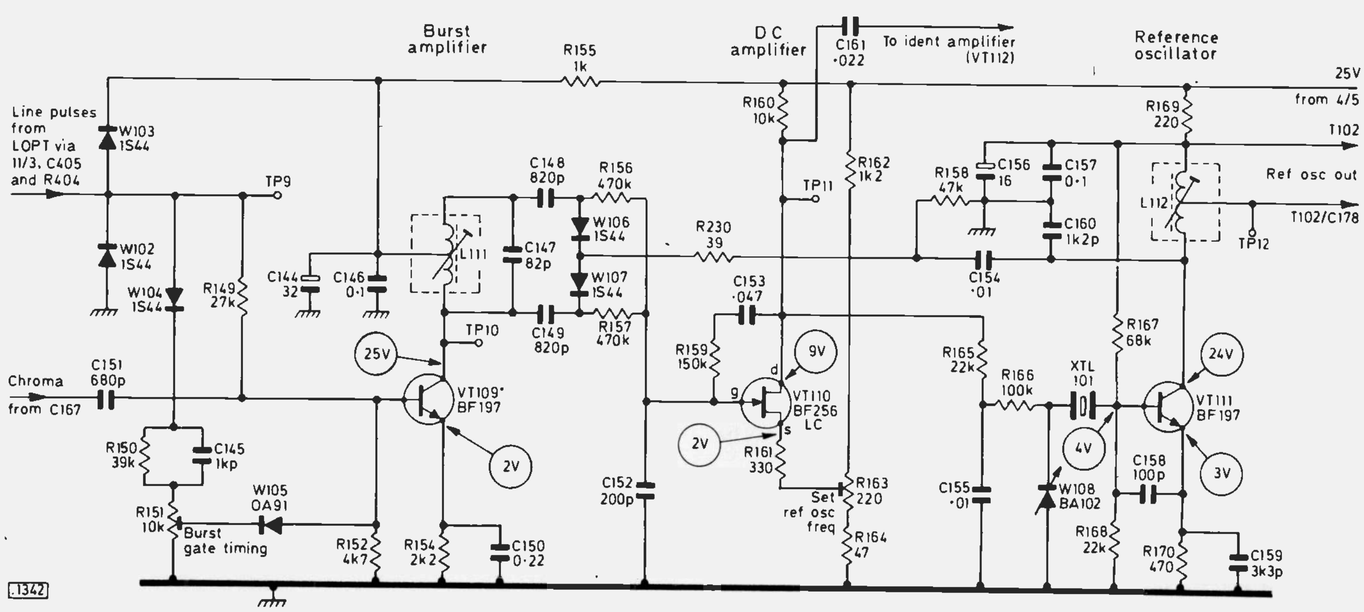


Fig. 7: The burst channel and reference oscillator circuits.

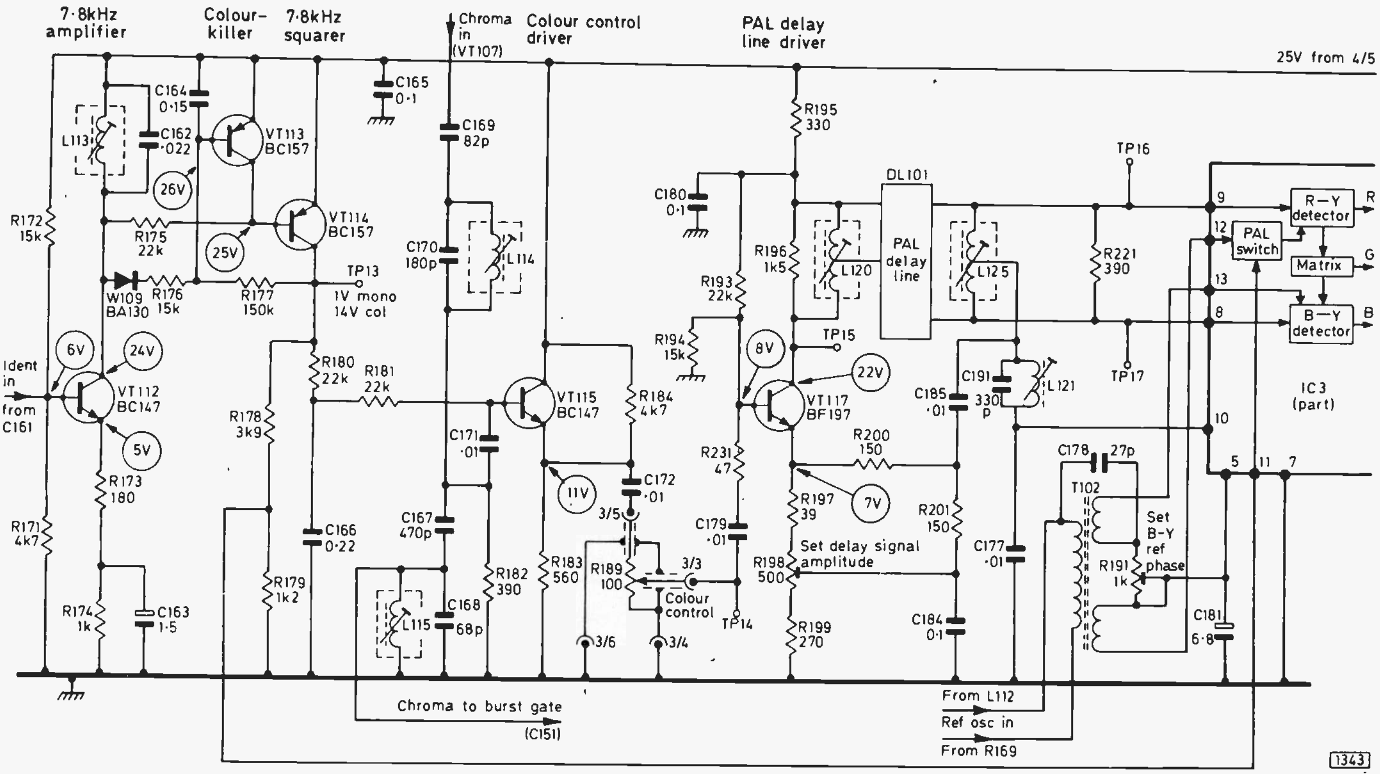


Fig. 8 The ident and chroma signal stages.

signals are fed to the base of VT109 via C151 while line gating pulses are applied to the same point via a clamping and delay circuit. The positive-going line pulse is clamped between chassis and the 25V line by W102 and W103 and then applied via the potential divider R149/R152 to the base of VT109. It also forward biases W104 and allows C145 to charge via R151. The time-constant of this network is such that the voltage across R151 rises and then falls to a point where its value is lower than that of the line pulse on the base of VT109. The exact timing can be adjusted by R151 to ensure that VT109 cuts off at the end of the burst period. VT109 is held in the cut-off state during the active line period by the charge on C150. This holds the emitter positive until the next gating pulse arrives.

When all is working correctly in this circuit the output at the collector of VT109 is clean bursts of some 20-25V amplitude. These are applied in opposite phase to the two burst discriminator diodes W106 and W107 whose mid-point is fed with a signal from the reference oscillator. The output from the discriminator appears across C152 and consists of a d.c. signal proportional to the difference in phase between the burst and the reference signal plus a "swinging burst" ident signal at 7·8kHz. This combined signal is fed to the high-impedance f.e.t. transistor VT110 which amplifies the d.c. variation and feeds it to the reference oscillator control varicap diode W108 to pull the oscillator into lock with the burst. Resistor R163 feeding VT110 source allows the circuit conditions to be set up for correct operation. The ident signal is extracted from VT110 drain and fed via C161 to the ident amplifier.

The reference oscillator itself is based on VT111 and is quite conventional. The frequency is controlled by the crystal XTL101 and the output is extracted from the collector load coil L112.

Faults

Now for the servicing problems. A complete absence of colour often means a complete absence of line pulses to gate VT109 due to R404 (on the timebase panel) having cooked and dropped out of the board. R404 can also go high-resistance or even vary in resistance, causing intermittent colour loss. If the fault causing no colour is actually on the decoder panel however it is likely to be due to a defect in the circuits under consideration. Any of the four diodes in the base circuit of VT109 can fail producing, as an alternative to no colour or unlocked colour, such pretty effects as no colour at the start of the scan or random patches of colour which look just like a purity fault.

VT109 has a tendency to go open-circuit as does VT110. Other components with a history of trouble are C144, C154, C160 and R163. The reference oscillator transistor VT111 sometimes fails to "go" for no obvious reason although changing it produces a cure. The other components to suspect are the decouplers C156 and C157, the crystal and the varicap diode W108.

If all these potential troubles seem a nightmare you're quite right – the more so since many of them show up intermittently rather than as "solid" faults. The author's personal approach is explained later.

Ident and Chroma Circuits

The circuit of the ident and chroma amplifier stages is shown in Fig. 8. The swinging burst ident signal is applied to the base of VT112 whose collector load circuit L113/C162 produces a 30V peak-to-peak 7·8kHz sinewave. This signal is rectified by W109 and applied to the reservoir capacitor C164 to provide a turn *off* bias for transistor VT113 which otherwise holds VT114 non-conductive.

The amplified ident signal is also applied to the base of VT114 which saturates on the negative half cycles and cuts off on the positive half cycles, producing a squarewave output at its collector. This signal, after attenuation by R178/R179, is used to drive the PAL switch in IC3. It's also applied to the low-pass filter R180/C166 which extracts the d.c. component (about 13V) and uses it as a turn-on bias for the first chroma amplifier VT115.

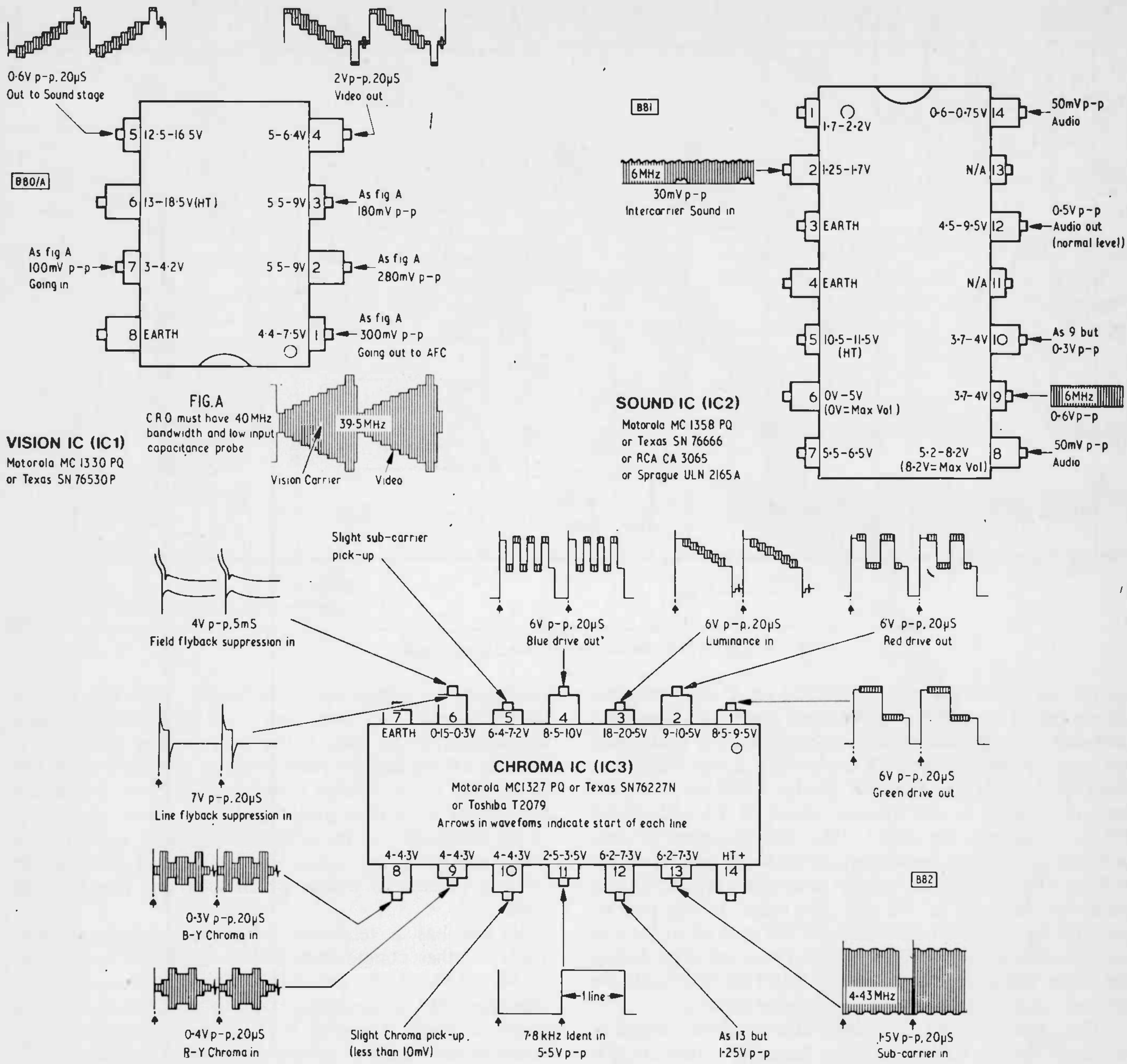


Fig. 9: Voltages and waveforms associated with the three i.c.s. Courtesy Thorn Consumer Electronics.

In the absence of the ident signal VT113 is switched on by the bias provided via R177, its collector voltage rising and thus increasing the potential at the base of VT114 so that VT114 turns off. VT114 collector voltage falls to about 3V and there is insufficient bias to turn on VT115 – thus no chroma can be passed on. Obviously W109 is a key component. If it goes open-circuit there is no colour.

From this circuit description it can be seen that the simplest way to override the colour-killer circuit is to short out the base-emitter junction of VT113.

The composite video signal at the emitter of VT107 (Fig. 3) is applied via an intercarrier sound rejector L114/C170 and a chroma acceptor circuit L115/C168 to the base of VT115. This transistor is connected as an emitter-follower, providing a low-impedance signal for feeding the colour saturation control R189. The output from this control feeds the base of the delay line driver VT117. VT115 tends to overheat, causing colour fade out.

The output at the collector of VT117, about half a volt in amplitude, is fed to the PAL delay line. The direct signal needed for R–Y and B–Y signal separation is taken from the emitter of VT117. The preset resistor R198 controls the stage gain so that the direct and indirect signals can be proportioned correctly. Phase control is provided by L121. The R–Y and B–Y signals appearing at the ends of the termination coil L125 are fed to pins 9 and 8 respectively of IC3. The three colour signals appear at pins 2 (red), 1 (green) and 4 (blue) of IC3.

The reference oscillator signals for IC3 are provided via the transformer T102 whose secondary feeds pin 12 (R – Y detector) and 13 (B–Y detector). Adjustment of the B–Y reference signal 90° phase shift is controlled by R191.

Chroma Section Fault Finding

Without doubt most of the troubles that occur on the composite i.f./chroma/video panel are to be found in the chroma sections, and unless a systematic approach is adopted fault-finding can be very time consuming.

In practice most of the faults are intermittent and since many of the components are mounted end-on on to the board contact cannot be made from the front of the panel. Although the board hinges out, it cannot in fact be hinged far enough to gain access to the rear because of the length of the three leads feeding the RGB signals to the tube base. Anyone contemplating serious work on this panel should make up extensions for these leads therefore.

Intermittent or No Colour

What is said here applies equally to no colour, intermittent colour and intermittent saturation. Note that when dealing with intermittent faults a lot of time can be saved by judicious use of a freezer aerosol and a hairdryer. The test points are shown in Fig. 5.

(1) Check that you have 25V at pin 5 of socket 4 and check that R404 on the timebase panel is o.k.

(2) Tune in a colour signal and set the preset R163 to obtain 2V at VT110 source. If it won't set to this value, leave it set midway on its track. Set R151 to the middle of its track.

(3) Check the voltage at TP13 (VT114 collector). If less than 2V continue to step (4). If about 14V proceed to step (8).

(4) Using an oscilloscope, check for burst – about 20V amplitude – at TP10 and for reference oscillator signal – about 8V amplitude – at TP12.

(a) *No burst:* Before suspecting the gating circuit, check that gating pulses are present (about 25V amplitude) at TP9 and that chroma is present at the base of VT109. If both these signals are present the fault is in the circuit associated with VT109, with the transistor itself as the most likely suspect.

(b) *No reference signal:* Conventional fault-finding works here. The three most likely culprits are VT111, C160 and the crystal. Crystal failure is not common in modern decoders: the 8000/8500 chassis however seem to be plagued with crystals that go off frequency. The result is that as the reference oscillator control R163 is adjusted the display gets nearer and nearer to the lock-in point and then the colour cuts out. This is because the d.c. correction needed to pull the crystal in is more than the f.e.t. can provide. The author has met this countless times on the 8000/8500 chassis and never encountered it on another chassis.

(5) If the burst and reference oscillator circuits are functioning correctly the next place to check with the 'scope is TP11. This should reveal rather noisy, low-amplitude ident pulses. If these cannot be found check VT110 and the components associated with W106/W107.

(6) Having established the presence of ident pulses at TP11 check that they are arriving at the base of VT112 and then check for a nice clean 30V peak-to-peak sinewave at the anode of W109. An input to VT112 with a poor or absent output usually indicates a dud VT112 or an open-circuit C163. Very occasionally L113 or C162 develop faults. If the signal at the anode of W109 is present but low in amplitude try peaking it up with the core of L113. If all else fails, check that W109 is o.k.

(7) Having obtained a decent ident signal, the next point to check is that there is 14V at TP13. If not, change both VT113 and VT114. They have a nasty tendency to go wrong in unison!

(8) Having got 14V at TP13, no colour symptoms must be due to trouble in the chroma amplifier, the delay line driver, or IC3. A check with the 'scope at each base and collector is the quickest approach, though in practice the culprit is usually either one of the transistors, R198 open-circuit or troubles with C171 or C180. Complete colour failure caused by IC3 is almost unknown and is always accompanied by obvious video trouble as well.

Having obtained colour on the screen it may be necessary to reset the various preset controls associated with the decoder in order to obtain proper operation. The setting of these is dealt with at the end of this article.

Hanover Bars at Extreme Right or Left

A fault encountered several times is green hanover bars on red areas at the extreme left or right of the picture. This is usually due to the PAL switching taking place during the active line period, and can be overcome by adjusting L113. In some cases however a satisfactory setting cannot be obtained: as soon as the effect is moved off one side of the screen, it appears at the other. This fault is due to a defect in IC3 as a result of which the PAL bistable operates at an uneven mark-space ratio. The only cure is to replace IC3.

Integrated Circuit Trouble Shooting

The three integrated circuits used in the 8000/8500 circuit all cause trouble from time to time. The symptoms are as follows:

IC1 – No sound, no picture; low sound and smeared picture; line sync pulling.

IC2 – No sound; blurred sound; caption buzz; background noises.

IC3 – One or more colours missing or excessive; hanover bars; poor line or field blanking; poor or excessive brightness.

When one of the i.c.s is suspected, it is important to be as sure as possible that it is faulty before removing it from the panel. This is best done by checking the voltage on each pin and comparing it with the data given in Fig. 9. If an incorrect voltage which cannot be accounted for by outside components is found, the i.c. should be changed.

Setting Up the Presets

R102 (tuner gain): Set to give maximum gain without overloading.

R143 (preset contrast): Under normal operating conditions and with the main contrast control at minimum, set for 2·5V across R140 (peak-to-peak measured with a 'scope).

R205 (preset brightness): Connect an 0·1μF capacitor between TP1 and TP2. Turn the main brightness control to minimum. Disconnect the red drive lead to the c.r.t. base and connect meter to the red output pin on the panel. Set R205 for a reading of 125V (if R206 is 560Ω) or 135V (if R206 is 270Ω).

R214, R216, R218 (RGB drive controls): Aim to keep these controls fully anticlockwise, but adjust as necessary to remove colouration from highlights.

R198, L121, L120, L125 (delay line/matrix circuit): Trim to obtain minimum hanover bars on a colour display.

R151 (burst gate timing): With set displaying colour bars, turn control fully clockwise to lose colour. Next rotate slowly until locked colour appears, then turn a further few degrees.

R163 (oscillator frequency): Attenuate aerial signal until picture just fails to lock, then set control for best colour lock under these conditions.

NEXT MONTH: THE LINE TIMEBASE

LETTERS

UHF MODULATOR

I have come up against a problem with the varicap u.h.f. modulator featured in your April 1975 issue. This is in making the oscillator section track with the other stages. Careful instructions were given for trimming well up the band, using R13, but there was no mention of padding which seems necessary since no amount of trimmer adjustment will alter the oscillator frequency when the tuning voltage is zero. In fact the oscillator cannot be got much below 500MHz unless the mechanical constants of the circuit are attacked. C18 seemed a good starting point since this is the nearest thing to a padding capacitor, but only about 2pF will be tolerated here before the oscillator dies, and the frequency reduction is only about 10MHz per pF. The solution I found was to remove L17 and replace it with the now redundant L14, which is the right size for the signal frequency. Since the new loop is taller, the coupling to L16 is impaired and to secure reliable oscillation this latter coil must be bent over until it lies inside the new L17. It's also worth while reducing the take-off coupling by moving L18 farther from L17 – up to a point reducing the coupling actually increases the drive, proving that it was overcoupled. It is now possible to track the modulator right through the band. I particularly wanted the low channels in order to avoid using a full 30V tuning supply.

I was also unhappy with the a.c. coupling to VT1 base. The 6·2V zener diode seemed to have little clamping effect, and if you switch from crosshatch to grey-scale ramp the result is sync cramping due to the differing mean signal values. D.C. coupling is simple to arrange if you have a 1V video signal with the sync tips clamped to earth. The circuit I have used is shown in Fig. 1. VT4 is an emitter-follower which also gives the first 0·7V of the required level shift. VT5 is a *V*be multiplier whose voltage drop is set by the new VR1. R29 can be either the terminating resistor at the cable impedance or 100kΩ or so if one's signal is of high impedance. – **M. T. Hawkins** *(Farnborough, Hants).*

E. Trundle comments: I have not had an opportunity to try the suggested modifications, but have no doubt about their efficacy – indeed I am using something broadly similar, with a further modification for sound injection. Much thought was given to padding and to d.c. coupling or restoration when the idea was originally conceived, but it seemed wise to keep the tuner modifications to the bare minimum in order to ensure repeatability of results. U.H.F. equipment can be unpredictable when no test gear is available – and we can't assume that all readers will have this. The three prototypes tracked well down to about channel 30 or lower, so it was decided not to incorporate padding. Where, as in your case, the full 32V tuning range is not available, this point is obviously more important.

Regarding d.c. coupling, the 6·2V zener diode is more a convenient method of deriving bias than a clamp, because it "clamps" to a high impedance. If full black-level performance was to be incorporated it was felt essential to a.c. couple and then d.c. restore since the modulator was intended to work with any source of video. Some sources have the video sitting on a standing d.c. voltage – I have such a camera here, an early Murphy one! The obvious solution seemed to be to couple via a large value capacitor and hang a zener from the 12V line to set the initial bias. This is satisfactory, but tolerances in zener diodes and tuners will affect the results obtained. In controlled conditions such as you have your suggested modification is ideal, but for general knockabout service I feel that the emitter-follower input stage would be rather vulnerable: with the input leads going straight to the base-collector junction of the transistor, an accidental coupling capacitor discharge for example could exceed the junction's breakdown voltage.

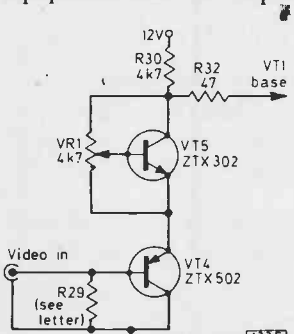


Fig. 1: Circuit used by M. T. Hawkins to d.c. couple a 1V video signal with its sync pulses clamped to earth to the u.h.f. modulator. The emitter-follower VT4 also provides the first 0·7V of the required level shift, the rest being provided by the amplified diode VT5 whose voltage drop is set by VR1.

PARANORMAL FAULTS

I've been carrying out some investigations over the last couple of years into TV receiver faults which seem to have a paranormal basis. It is common knowledge that there are some cases where faults described in great detail by the viewer cannot be reproduced in the presence of the engineer and fail to show up during a workshop soak test. In some cases these mysterious troubles stop as quickly as they start, while in others they are resolved by the dealer cancelling the rental contract on the basis that the viewer concerned is just awkward or unreasonably critical. Whilst many such cases have quite logical explanations a few, on closer examination, seem to be the result of some interaction between the receiver circuits and a particular person or place.

From a scientific viewpoint there is nothing remarkable in this since the human body is a generator of many electrical signals while a TV set is a piece of equipment specifically designed to respond to electrical signals – and minute ones at that.

In an effort to ascertain whether these matters occur widely and whether they are recognised as paranormal it would be appreciated if any *Television* readers with experience of such matters could provide a summary and send this to the undersigned. – **Barry F. Pamplin** *(208-210 Strand Road, Preston, Lancs. PR1 8U5).*

"TELEVISION" COLOUR RECEIVER

I read with interest your comments on recurring problems with the decoder in the Television colour receiver. The following comments may help.

First, the triggering of the bistable circuit. Erratic triggering seems to be due to the original design, with 4·7kΩ cross-coupling resistors and 1·5kΩ collector load resistors. This means that whichever transistor is conducting is very hard on. With negative triggering pulses, the entire base current of some 4mA has to be absorbed by the trigger pulse before the loop action can take place. I have overcome this problem entirely satisfactorily by adding germanium anti-saturation diodes in the collector circuit of each of the bistable transistors. These hold the conducting transistor just out of saturation so that the trigger pulse can easily turn off the transistor which is on. The diode cathode is connected directly to the associated transistor's collector while its anode goes direct to the base.

Secondly, reference oscillator locking. I think that your comments on spreads on the exact value of L2 are correct. Rather than removing L2 and C13 as your reader suggests however it may be preferable to adopt the solution which *Wireless World* and some setmakers have used in their implementation of the original Mullard circuitry – otherwise the varicap diode D4 may not be operated at its optimum recommended by Mullard of 6V. The solution is to remove C14 from the circuit and provide adjustment by making L2 adjustable instead. Some circuits have a small fixed capacitor (1 to 3·3pF) in place of C14. The *Wireless World* specification for L2 is 120 turns 42 s.w.g. scramble wound on a Neosid 722/1 former, with a long 4 × 0·5 × 12·7 core and winding length $\frac{1}{4}$in. The inductance range provided by this is 52-133μH and gives enough equivalent negative capacitance to tune out the standing capacitance of diode D4. The adjustment procedure is the same as you give, with L2 instead of C14 adjusted for 6V at Tr3 collector when the oscillator is active. – **I. H. Banner** *(Marlow, Bucks).*

CLICKS: FERGUSON MODEL 3821

In "Your Problems Solved", October, the problem of a click some twenty minutes after this set was switched off is raised. I've serviced many of these sets and it's my opinion that the click is not due to a fault but is simply caused by expansion and contraction of the plastic cabinet. – **R. S. Weller** *(London SE9).*

TRAINING

I notice in a recent "Teletopics" (August) that you refer to the problem of training service engineers for the industry, and that the "Train for Tomorrow" committee expressed reservations about the length and relevance of the City and Guilds course. I feel sure that this committee is expressing a "round the table" view based on imagination rather than fact. Had they investigated this problem thoroughly they would have found that there are few drop-outs on the "Mechanics" course, a fact which any college enrolment and course completion figures will show.

The complete title of the course is "Radio, Television *and Electronics* Mechanics", and it is not intended to be narrow in content at the early stages. Surely a committee with the title "Training for Tomorrow" will have read the government publication "Training for the Future" and appreciated from this the advantages to both the student and the economy of a broadly based technical education? The rapid technological development occurring in the industrial and domestic electronics industries is a clear indication that education should not be narrowly based since this would lead to greater difficulty in adapting to change. It is difficult to understand how a group representing the industry's training view should express opinions which show that they fail to appreciate the value of training and education in the long term, and seem interested only in producing bodies capable of a limited function but available for immediate use. This is taking "Training for Tomorrow" too literally!

Your own opinion about cutting the course to two years should also be examined more closely. To complete the day-release course in half the present time would mean a total of 480 hours' tuition and at six days per week and eight hours per day this is approximately ten weeks. Surely you are not suggesting that customer confidence will be improved by the introduction of "ten week wonders"?

Constructive criticism of existing courses is welcome, but bear in mind that *training* is the responsibility of the industry and not the City and Guilds. – **R. J. Bailey,** *Senior Lecturer, Department of Engineering, Cardonald College of Further Education, Glasgow.*

May I as a lecturer in charge of radio and television courses reply to your editorial in the November issue? With reference to your comment on the two-tier system of radio and television courses as at the moment, I would just say that the 272 standard is unattainably high for the average TV service apprentice. Most of the brighter lads will have already been creamed off for industry. I'm afraid that the educational standards of the lads who work for the majority of small TV shops is appallingly low.

Along with poor educational standards there is the general lack of motivation, many of the students having little or no interest in radio and television as a hobby etc. – maybe one in twenty will buy say a copy of *Television.* It is surprising how many see the trade as just a job, not realising the amount of dedication required if progress is to be made in their career.

Progress on the 222 Mechanics' course is painfully slow. Even after three years, knowledge of essential basic principles is sadly lacking and any growth in practical skill in fault-finding has been severely stunted by the trade's traditional reliance on "stock faults", "panel pushing" and wholesale replacement of large numbers of components in a blanket operation. Even competence in soldering techniques cannot be guaranteed at this stage.

The City and Guilds examinations are very basic at this level, with very little complexity, yet many fail or just manage to scrape through. The mind boggles at what will happen at Part III level, with some of the more abstract ideas of colour principles introduced. I'm sorry to say that with the present class of trainee servicemen in the trade we have our work cut out to achieve some sort of success even at Mechnics level.

The Technicians' course with its emphasis on mathematics at an early stage and mainly academic approach to radio and television is just not geared to the requirements of the trade. Even supposing a bright lad attains the Technicians' Certificate it is unlikely that his salary will be commensurate with his new found status of "Technician", and inevitably he will migrate to another branch of electronics commanding better salaries.

As a result of demand from the trade we are now running in Leicester a practical television training course which runs alongside and complements the 222 Mechanics' course – but with the emphasis on the practical side of television. This in some ways makes up for what the trade considers to be the shortcomings of the 222 course.

My own opinion is that there should be a course lasting maybe five years, consisting of theory and practice of television alone. The course would become progressively more involved, introducing complex circuit techniques and colour. The lad who could not make the grade would drop out earlier in the course, the better calibre lads progressing to the end to be rewarded with a certificate that really means what it says. In other words, a return to a course somewhat on the lines of the old Television Servicing course (48). – **F. L. Whitehead,** *Electrical Engineering Department, Charles Keene College of Further Education, Leicester.*

FAULTS ON GEC HYBRID COLOUR RECEIVERS

T. SUCKSMITH

IN the September 1975 issue of *Television* John Coombes outlined the more common faults on this chassis. The following supplementary information has been gathered while in the employment of a large rental company which owns a considerable number of these receivers.

Double-sided Print

A feature of the GEC range of receivers is the double-sided printed circuit board, and if one doesn't wish to learn the hard way care must be taken when components are removed from the board. Clearing holes of solder makes component replacement easy! Connections are made on the printed circuit board between the upper and the lower print, so watch out for dry-joints.

Mains Fuse Blown

The mains filter capacitors C61 and C62, the h.t. rectifier D51 going short-circuit, the PL509 line output valve top cap flying lead shorting to the heat shield, the fifth harmonic tuning capacitor C53 short-circuit and C403 on the output panel short-circuit are the most common components to go faulty and blow the mains fuse, in the order written. C403 decouples the screen grid of the PCL86 audio output valve.

Overload Cutout Tripped

When the overload cutout has tripped, pressing the reset button will, if you are lucky, fail to bring results, and you may proceed armed with the knowledge that your meter will lead you to the fault, be it the tripler, valves PL509 or PY500, lack of line drive, or the overload cutout itself.

Unfortunately and all too often, normal operation will start when the reset button has been pressed, thus leaving the conscientious engineer in a dilemma as to what to do next. After all, it could be any one of the faults mentioned for the reset failing to start, but occurring intermittently. A non-technical bash at valve changing may sometimes bring to light the faulty beast, but if not careful examination of the resistors in the line oscillator stage may well give a clue. Charred resistors indicate failure of the line oscillator. The resistors to look at (see Fig. 1) are: R514, R511, R513 and R516. This sinewave line oscillator circuit uses Sufflex capacitors, and it is good policy to replace these as well as the line timebase valves and any discoloured resistors. The Sufflex capacitors are: C509 (820pF), C507 (2,200pF) and C512 (680pF). These capacitors must be replaced with similar Sufflex capacitors: other types are not stable enough in this circuit. If this procedure is followed, the likelihood of your having to return to an irate customer is greatly reduced. But if you do, start thinking in terms of the line output transformer and tripler.

Brightness Faults

With any television set, the place to start looking for a brightness fault is at the tube base, taking voltage measurements to check that the bias conditions are correct. The first anode voltage should vary between 400-700V, the cathode should be 100V more positive than the grid voltage, and the e.h.t. at the final anode should be correct. If these conditions are obtained, the fault lies within the tube. The c.r.t. grid circuit is reliable as far as brightness faults are concerned, and faults on the output panel, i.e. around the PL802 and the three PCL84s, are easily located with a meter. If the brightness control varies the voltage at PC7 between −2 and −5V the fault lies on the output panel.

Beam Limiter

Most brightness faults occur on the timebase panel however. The circuit (see Fig. 2) consists of two l.t. rectifiers (one positive and the other negative), two associated reservoir capacitors (C527 – C528), a resistive network terminating at the brightness control, a beam limiting transistor (Tr535), and, on the output panel,

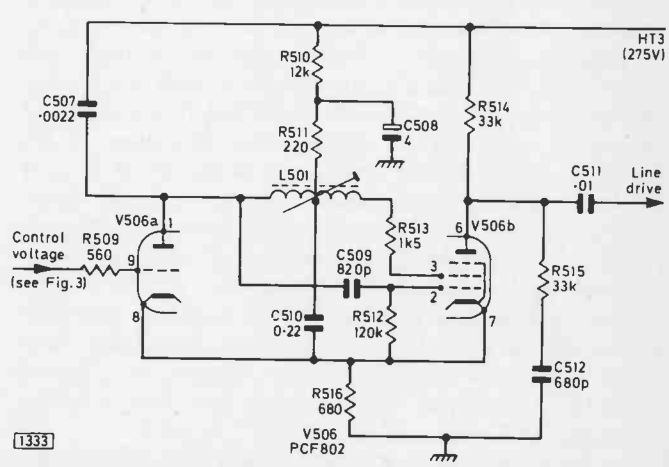


Fig. 1: The line oscillator circuit. The line output stage circuit was shown in Fig. 2, page 518 of the September issue.

smoothing capacitor C406 plus R405 and D401. Diode D401 d.c. restores the luminance signal to the level set by the brightness control. Beam limiting takes place when the beam current approaches 1·2mA. This results in the cathode voltage of the PL509 rising to about 3·2V which in turn switches on Tr535: collector current flows, and the charge on C406 moves in a negative direction thus raising the tube cathode voltage via the PL802 luminance output valve.

Checking the Beam Limiter Circuit

Fault finding in this circuit is fairly straightforward. First check for 20V on C527 and 20V negative on C528. Low voltages here indicate open-circuit reservoir capacitors and zero voltages indicate short-circuit diodes. Next check the emitter voltage of Tr535 as this determines the level at which beam limiting occurs. If the collector and base voltages are low (yes!), suspect C529 of being open-circuit. This will give the fault condition of lack of brightness as the transistor will conduct on the peaks of the positive flyback pulses appearing at the cathode of the PL509. R532, R533 and R535 can change value. C406 open-circuit causes brightness flutter, and D401 faulty causes field roll or field movement as the contrast control is advanced.

Line Sync Faults

The collector feed for the sync separator transistor Tr109 on the i.f. panel is via the sync transformer L500 and the potential divider network R500/R501 on the timebase panel (see Fig. 3). R500 and R501 frequently change value, giving the fault symptoms weak line synchronisation and line pulling. The luminance signal input to the base of the sync separator transistor is taken from the collector of the luminance emitter-follower Tr108, via C135. Tr108 often fails, causing a series of faulty components. These are: Tr109 going short-circuit since it is no longer biased back, R500 falling to a virtual short-circuit, and if the receiver is left switched on in this condition the sync discriminator transformer L500 will pass excessive current resulting in shorted turns.

Sudden lowering of the line frequency is caused by C508

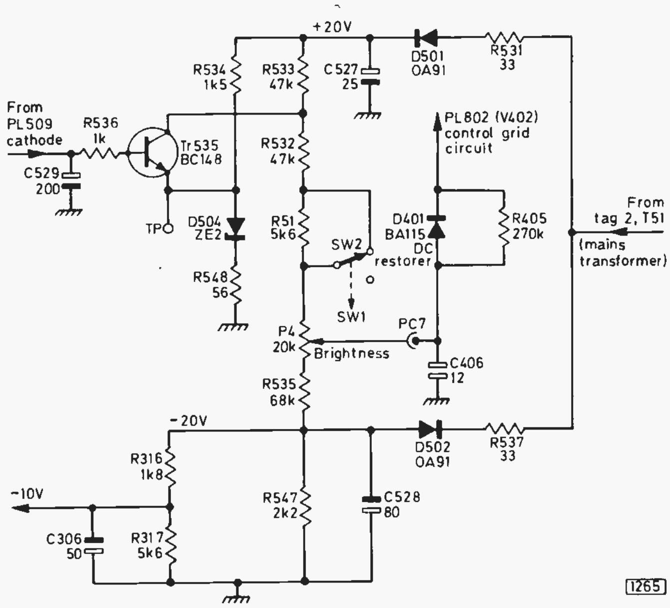


Fig. 2: The brightness control, luminance d.c. restorer, and beam limiter circuitry. Diode D501 was shown the wrong way round in the September issue.

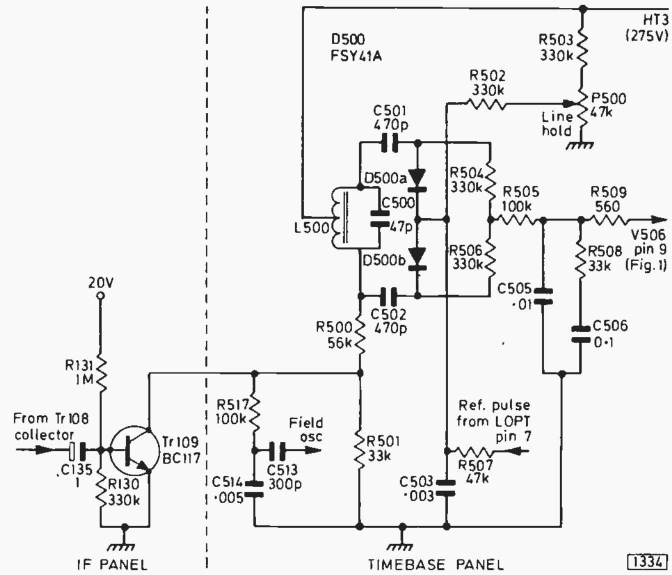


Fig. 3: The sync separator and flywheel line sync circuitry.

(4μF) going intermittently open-circuit, while gradual line frequency drift is usually caused by one of the sync discriminator diodes in the FSY41A. Other components which give this trouble are: C501, C502, C503 and R507.

Line Timebase

Width linearity cramping as the brightness control is advanced is caused by C512 (see Fig. 1) going open-circuit.

On occasions the line oscillator coil has had shorted turns when C509 has been faulty. This kills the line oscillator of course and results in line output stage overheating.

Field Timebase

There is nothing unusual about the PL508 field output stage. It has two h.t. feeds to itself, the HT2 line which supplies its anode circuit and the HT4 line which supplies its screen grid. The smoothing resistors are R64 through which both feeds are taken and R65 for the HT4 supply. A faulty PL508 can cause these resistors to go open-circuit – they are mounted on the h.t. capacitor block.

The height stabilising v.d.r. (VDR500, type E298CD/A258) in the oscillator circuit carbonises causing a virtual short-circuit. This occurs more often than the boost feed decoupling capacitor C519 going short-circuit. In either case the associated feed resistor R526 makes a nasty mess of the printed circuit board.

A thin horizontal white line moving up or down the picture is a common fault on earlier receivers. It's due to pick up in the PL508's control grid circuit and the cure is to add a 680pF capacitor from the junction of R523/R524/R525 to chassis.

Intermittent field jitter can be caused by any of the preset resistors but is quite often due to dry-joints in the output stage. Check both the timebase and the raster correction panel.

Hum

Hum on the chrominance and luminance information usually indicates a faulty l.t. smoothing block, while hum on the edge of the raster, on the sound, or field breathing indicates a faulty h.t. smoothing block. Before changing either block, valves should be temporarily substituted (in particular the PCF802, PL802 and the PCL84s) as heater-to-cathode leaks cause similar effects.

Tuners

Intermittent low gain and intermittent failure to select channels can be the result of earthing springs failing to make contact through loss of tension or solidified grease. Ideally the earthing springs should be removed, the grease removed from the tuner, and new springs replaced.

The aerial isolating capacitors crack causing low gain.

The IF Panel

A conventional transistor i.f. strip is used, with sync-tip a.g.c. and a diode switch to delay the application of a.g.c. to the tuner. A.G.C. faults are usually due to the a.g.c. amplifier Tr113, the a.g.c. detector diode D102 or the luminance delay line driver Tr107 – the a.g.c. detector is driven from the collector of this transistor via the set a.g.c. control P100.

The luminance delay line L115 occasionally goes open-circuit (no luminance) or open-circuit at its earth connection. The latter fault results in a double-image effect accompanied by ringing – due to the luminance signal running up and down the delay line.

Colour Faults

Fault-finding in the colour-difference amplifiers is easy because of the nearly identical operation of the three stages. Thus valves can be swapped and if the fault then appears in a different colour the offending valve can be replaced. If one of the stages is known to be working correctly it can be used as a reference for the voltages in the other stages, thus giving rapid fault-finding. Failure of all three stages, giving no colour, occurs when C423 (4μF) goes short-circuit. This removes the screen grid voltage from the three stages and results in the common feed resistor R416 burning out.

If the customer complains that the picture goes green intermittently, first check the c.r.t. red first anode control P613, then check for a dry-joint where the R–Y output pentode's cathode bias resistor R423 is connected to earth (the earth rail runs between the colour-difference amplifiers and the luminance output stage). Faulty valve bases are often mistakenly blamed for this and other dry-joint faults on the output board. The use of switch cleaner fluid should be avoided as this tends to cause tracking between adjacent print tracks.

Loss of one colour can also be caused by one of the spark-gap capacitors on the c.r.t. base panel going short-circuit. These capacitors (C801-C803) can also be the cause of one colour dropping off at the right-hand side of the screen (end of scan). This can best be detected by operating the set white switch and then using the first anode supply switches to observe the output from each gun separately.

The Decoder

Loss of either R–Y or B–Y output from the decoder can be simply proved by swapping the missing colour-difference signal to a known working output stage – i.e. swap the connections to PC9 and PC11. Voltage checks can then be made in the suspected module (can M93604 or M93605). If these appear to be in order movement of the module and the chrominance delay line may reveal a dry-joint.

Tackling Loss of Colour

The following procedure should be followed to trace loss of colour to the faulty section of the decoder:

(1) Check for colour turn-on bias at the base of the second chrominance amplifier – there should be 3-6V at Tr319 base. If this is present the fault lies either in this stage or the coupling to it (burst blanking circuit etc.) or in the following circuits – check the delay line driver Tr320, that the positive and negative l.t. supplies are reaching the R–Y and B–Y preamplifiers Tr321 and Tr323 and that the screen grid supply to the colour-difference amplifiers on the output panel (see above) is present, i.e. check R416 and C423.

(2) If the colour turn-on bias is not present, i.e. the voltage at Tr319 base is negative, over-ride this by turning the colour threshold control P304 fully anti-clockwise and strapping a 27kΩ resistor from the l.t. line to the junction of resistors R384, R385 and R386.

(3) If there is still no colour the fault must lie in either the first chrominance amplifier (Tr318) circuit, the reference oscillator circuit – including the burst channel – or the colour-killer rectifier circuit (see below).

(4) If colour comes up but is unsynchronised, check whether the set oscillator frequency control P302 varies the colour through lock. If it doesn't, the fault is either the burst detector diodes D307/D308, the d.c. amplifier Tr327, the varicap diode D305 or the 4·43MHz crystal.

(5) If the set oscillator frequency control does vary the colour through lock the fault lies in the burst channel. It will be accompanied by excessive colour due to lack of a.c.c.

(6) Voltage checks in the fault area will quite often track down the defective component: if not, further investigation with an oscilloscope will be necessary.

Common Decoder Faults

Common faults are as follows: The Sufflex capacitors C322-C326 inclusive in the reference oscillator circuit cause intermittent or no colour. Other causes of no colour are the reference signal emitter-follower Tr329 going open-circuit between its base and emitter, a dry-joint by the phase comparator transformer T307 and, becoming increasingly more common, a faulty crystal.

Poor decoder alignment (will not align) accompanied by intermittent colour is usually caused by the reference signal emitter-follower Tr329 having a short-circuit base-emitter junction.

Intermittent poor colour (colour pairing) is caused by C344 in the delay line circuit.

Streaks of lines containing Hanover blinds is commonly caused by leakage in the bistable synchronising diode D313 (OA91) – this causes intermittent incorrent bistable operation. The steering diodes D314 and D315 in the bistable circuit can fail, causing Hanover blinds.

The colour-killer rectifier reservoir capacitor C352 (12·5μF) can go open- or short-circuit, giving no colour in either case.

Low colour can be due to faulty transistors, to L301 or C336 in the collector circuit of the second chrominance amplifier Tr319, or to poor i.f. alignment. ■

NOISE~CANCELLING SYNC SEPARATORS

S. GEORGE

THE negative vision modulation system used for 625-line transmissions has one disadvantage, that random noise pulses are of the same polarity as the transmitted sync pulses, i.e. they are both positive-going. And being similar electrically, they both have the same effect on the sync separator.

Noise has little effect on field synchronisation for two reasons. First, the integrating capacitor which builds up the field sync pulse absorbs noise and the line sync pulses, while secondly the field generator can be synchronised only by pulses which occur during the final 10-15% of the forward scan. Since application of the field sync pulse instigates the flyback, the field generator is immune to all but the most mammoth noise pulses.

First class line sync is vital in a colour receiver, since pulses from the line timebase are used for control purposes in the colour decoder. Many colour sets incorporate a noise-cancelling sync separator arrangement, therefore, providing an output unaffected by the presence of noise pulses. Some monochrome sets, particularly those of continental origin, also incorporate this feature, an example being the Indesit Model T24EGB recently covered by Les Lawry-Johns – see later.

Distinguishing Noise Pulses

It is possible to distinguish between noise pulses and sync pulses because they differ from each other in several respects. Noise pulses have a much wider bandwidth, they are usually of greater amplitude, and they are irregularly shaped. Obviously the latter difference is not much help, since no simple circuitry could differentiate between the differing waveforms. The other two characteristics make it possible to remove noise from the sync separator's output however.

Bandwidth Discrimination

A gating circuit based on the greater bandwidth of noise pulses requires at least one tuned circuit. This approach is rather rare therefore, the only example which comes to mind being that used in a number of B and O colour receivers. The vast majority of sets that incorporate a noise-gated sync separator use one which operates on the basis of amplitude discrimination. These circuits vary quite widely, but before examining some examples let's take a look at the bandwidth type of gate used in B and O colour chassis prior to the recent 3500/4000/5000 series. The version shown in Fig. 1 is used in the 90° chassis.

Tr2 is the sync separator itself, and is conventional save that its emitter is connected to chassis via transistor Tr4 which is forward biased by R7 and thus saturates whenever Tr2 is switched on by a sync pulse. A signal from the final i.f. stage is fed to the 39·5MHz trap which is connected in series with rectifier D1 and the combination C1/R1/R2. The trap rejects the nominal i.f. signal, including the sync pulses. In the absence of noise therefore D1 produces negligible d.c. output. Noise pulses, having a bandwidth greatly in excess of that of the trap, result in the diode producing an appreciable voltage at the junction of R1 and R2. When the voltage at this point reaches 0·7V, Tr3 will conduct and its collector voltage will fall from the normal level of 4·5V set by the potential divider R5/R6. This negative-going pulse is fed to the base of Tr4 via C8, ensuring that Tr4 cannot conduct. In consequence the positive-going noise pulse at the base of the sync separator Tr2 does not result in a pulse output from the stage, since Tr2's emitter is in effect open-circuit.

Amplitude Discrimination

The amplitude-discriminating type of noise-cancelling circuit is far more common since it generally requires just a transistor and a handful of other components. Our first example of this type of circuit is shown in Fig. 2 and is used in the Mitsubishi Model CP140B. The composite video-plus-sync signal passes from the luminance emitter-follower

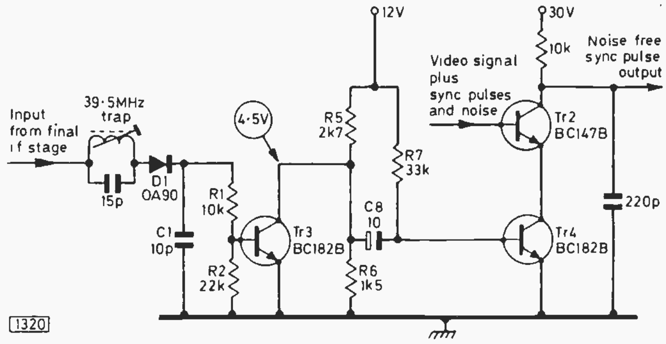


Fig. 1: This circuit, used in 90° B and O colour sets, distinguishes noise by its wider bandwidth. In the presence of noise, D1 and Tr3 conduct, ensuring that Tr2 and Tr4 remain cut off.

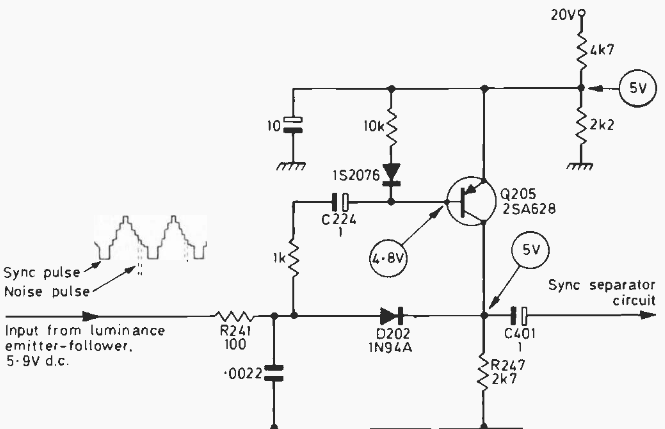


Fig. 2: Simple amplitude-discriminating circuit used in the Mitsubishi Model CP140B. Q205 conducts in the presence of noise, reverse biasing D202.

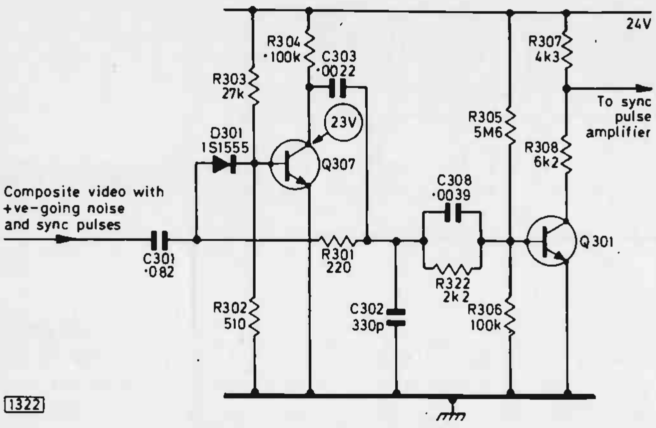


Fig. 3: Circuit used in the Toshiba Model C81B. Q307 conducts in the presence of noise, producing a negative output pulse to cancel the noise pulse in the feed to Q301.

to the sync separator circuit via R241, D202 and C401: the vision information is positive-going while the sync and noise pulses are negative-going. In the absence of a high-amplitude noise pulse, D202 is forward biased since its anode is positive with respect to its cathode. The bias on Q205 is such that it is normally cut off and just cut off when the sync pulses appear at its base. When a high-amplitude noise pulse appears at its base however it's driven into conduction. The resultant current flow through R247 increases the voltage at the cathode of D202, cutting it off. In consequence a harmless positive-going pulse passes to the pnp sync separator instead of the negative-going noise pulse.

Toshiba Circuit

The noise canceller used in the Toshiba Model C81B is shown in Fig. 3, together with the sync separator. In this case the video information is negative-going while the sync and interference pulses are positive-going. Thus an npn sync separator (Q301) is used, fed via C301, R301 and the parallel *RC* differentiating network C308/R322 which sharpens the sync pulse input to Q301. The voltage developed at the junction of the potential divider R302/R303 is such that D301 and the noise-cancelling transistor Q307 are both normally cut-off, Q307's collector voltage being equal to the l.t. rail voltage – the reading of 23V shown is due to the current drawn through R304 by the measuring instrument. A high-amplitude noise pulse will

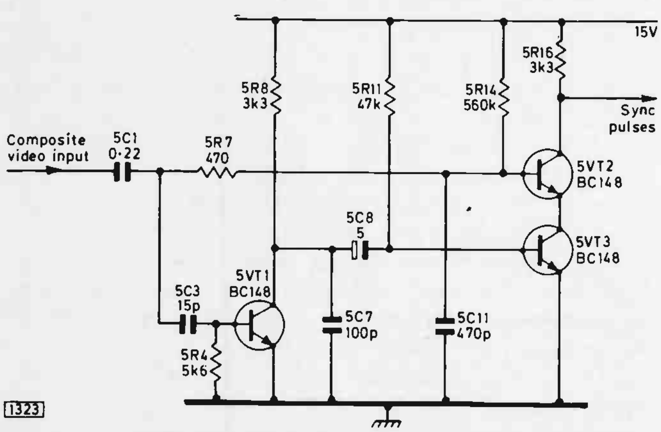


Fig. 4: This circuit, used in the Rank Z504 scan drive panel, discriminates between noise and the sync pulses by the higher amplitude and greater bandwidth of the former, 5C3 and 5R4 forming a high-pass filter.

pass via D301 to the base of Q307, driving it on. The negative-going pulse thus produced is fed via C303 to the sync separator feed circuit, cancelling the original positive-going noise pulse.

Amplitude/Bandwidth Gate

Noise-cancelling circuits have not been too common in UK produced sets. Fig. 4 shows the circuit used in later versions of the 90° Rank colour chassis however – those fitted with the Z504 scan drive panel. The sync separator 5VT2 is fed with the composite video signal, with positive-going sync and noise pulses, via 5C1 and 5R7. As usual, when the sync pulse arrives the sync separator is driven fully on and the charge built up on the coupling capacitor (5C1) then holds the transistor cut off until the next sync pulse arrives. 5R14 applies slight forward bias to the transistor to ensure that it saturates even when the video drive is low. The buffer resistor 5R7 also acts with 5C11 as a low-pass filter to remove chrominance signal components and snow-type noise on weak signals, reducing "chrominance pull" and "picture ragging" respectively. The emitter of 5VT2 is returned to chassis via 5VT3, which normally switches on whenever 5VT2 conducts since its base is forward biased by 5R11. The noise-cancelling action is carried out by 5VT1 and 5VT3. 5VT1 is normally cut off since it is without forward bias. High-amplitude noise pulses pass via 5C3 to the base of 5VT1 however, switching it on. The input to 5VT1 also discriminates between noise pulses in another way since 5C3 and 5R4 form a high-pass filter. Noise pulses are characterised by their h.f. components and thus pass via 5C3/5R4 to 5VT1 base. When 5VT1 conducts, a negative-going pulse is applied via 5C8 to 5VT3 base to hold it cut off. Since the sync separator's emitter is then effectively open-circuit, it too is held cut off. The result is no sync separator output in the presence of noise pulses. 5C7 is incorporated to compensate for delays in the sync separator circuit, while the value of 5C8 is large to prevent 5VT3 remaining cut off during sustained interference bursts. In later production versions of this panel the noise-cancelling circuit was removed: Rank say that the video limiting in the receiver circuits made it unnecessary.

Sync and AGC Protection

Another example from a UK produced chassis is shown in Fig. 5. This circuit was used in early versions of the ITT CVC5 colour chassis. Here the video signal, again with positive-going sync and noise pulses, passes from the video emitter-follower T22 via R322 to the sync separator and a.g.c. circuits. The noise-cancelling transistor T40 is normally non-conducting, but switches on when a high-amplitude noise pulse appears at its base. The resultant voltage drop across R322 inverts the noise pulse fed to both the sync and the a.g.c. circuits so that it has no effect on these stages. R325 and C234 prevent sync pulse blocking during the receiver's warm-up period.

Integrated Circuits

The types of circuit we have been describing are likely to fall out of use since the sync separator circuits in the latest i.c.s generally have an integrated noise-cancelling circuit. For example, in the commonly used TBA920 sync separator/line oscillator i.c. the sync separator is reached at pin 8 while a noise-cancelling circuit is available at pin 9. Rank in their 110° Z179 chassis prefer to carry out noise-

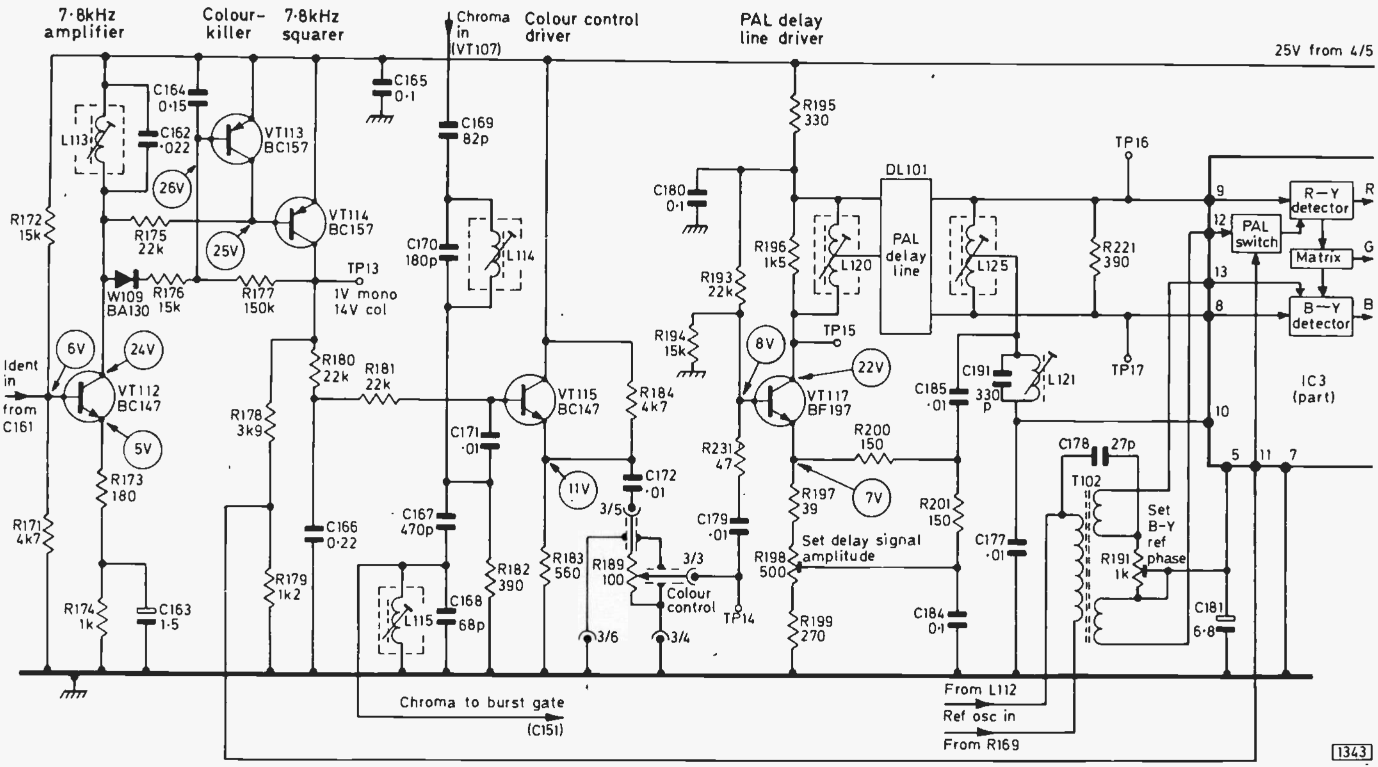


Fig. 8 The ident and chroma signal stages.

signals are fed to the base of VT109 via C151 while line gating pulses are applied to the same point via a clamping and delay circuit. The positive-going line pulse is clamped between chassis and the 25V line by W102 and W103 and then applied via the potential divider R149/R152 to the base of VT109. It also forward biases W104 and allows C145 to charge via R151. The time-constant of this network is such that the voltage across R151 rises and then falls to a point where its value is lower than that of the line pulse on the base of VT109. The exact timing can be adjusted by R151 to ensure that VT109 cuts off at the end of the burst period. VT109 is held in the cut-off state during the active line period by the charge on C150. This holds the emitter positive until the next gating pulse arrives.

When all is working correctly in this circuit the output at the collector of VT109 is clean bursts of some 20-25V amplitude. These are applied in opposite phase to the two burst discriminator diodes W106 and W107 whose mid-point is fed with a signal from the reference oscillator. The output from the discriminator appears across C152 and consists of a d.c. signal proportional to the difference in phase between the burst and the reference signal plus a "swinging burst" ident signal at 7·8kHz. This combined signal is fed to the high-impedance f.e.t. transistor VT110 which amplifies the d.c. variation and feeds it to the reference oscillator control varicap diode W108 to pull the oscillator into lock with the burst. Resistor R163 feeding VT110 source allows the circuit conditions to be set up for correct operation. The ident signal is extracted from VT110 drain and fed via C161 to the ident amplifier.

The reference oscillator itself is based on VT111 and is quite conventional. The frequency is controlled by the crystal XTL101 and the output is extracted from the collector load coil L112.

Faults

Now for the servicing problems. A complete absence of colour often means a complete absence of line pulses to gate VT109 due to R404 (on the timebase panel) having cooked and dropped out of the board. R404 can also go high-resistance or even vary in resistance, causing intermittent colour loss. If the fault causing no colour is actually on the decoder panel however it is likely to be due to a defect in the circuits under consideration. Any of the four diodes in the base circuit of VT109 can fail producing, as an alternative to no colour or unlocked colour, such pretty effects as no colour at the start of the scan or random patches of colour which look just like a purity fault.

VT109 has a tendency to go open-circuit as does VT110. Other components with a history of trouble are C144, C154, C160 and R163. The reference oscillator transistor VT111 sometimes fails to "go" for no obvious reason although changing it produces a cure. The other components to suspect are the decouplers C156 and C157, the crystal and the varicap diode W108.

If all these potential troubles seem a nightmare you're quite right – the more so since many of them show up intermittently rather than as "solid" faults. The author's personal approach is explained later.

Ident and Chroma Circuits

The circuit of the ident and chroma amplifier stages is shown in Fig. 8. The swinging burst ident signal is applied to the base of VT112 whose collector load circuit L113/C162 produces a 30V peak-to-peak 7·8kHz sinewave. This signal is rectified by W109 and applied to the reservoir capacitor C164 to provide a turn *off* bias for transistor VT113 which otherwise holds VT114 non-conductive.

The amplified ident signal is also applied to the base of VT114 which saturates on the negative half cycles and cuts off on the positive half cycles, producing a squarewave output at its collector. This signal, after attenuation by R178/R179, is used to drive the PAL switch in IC3. It's also applied to the low-pass filter R180/C166 which extracts the d.c. component (about 13V) and uses it as a turn-on bias for the first chroma amplifier VT115.

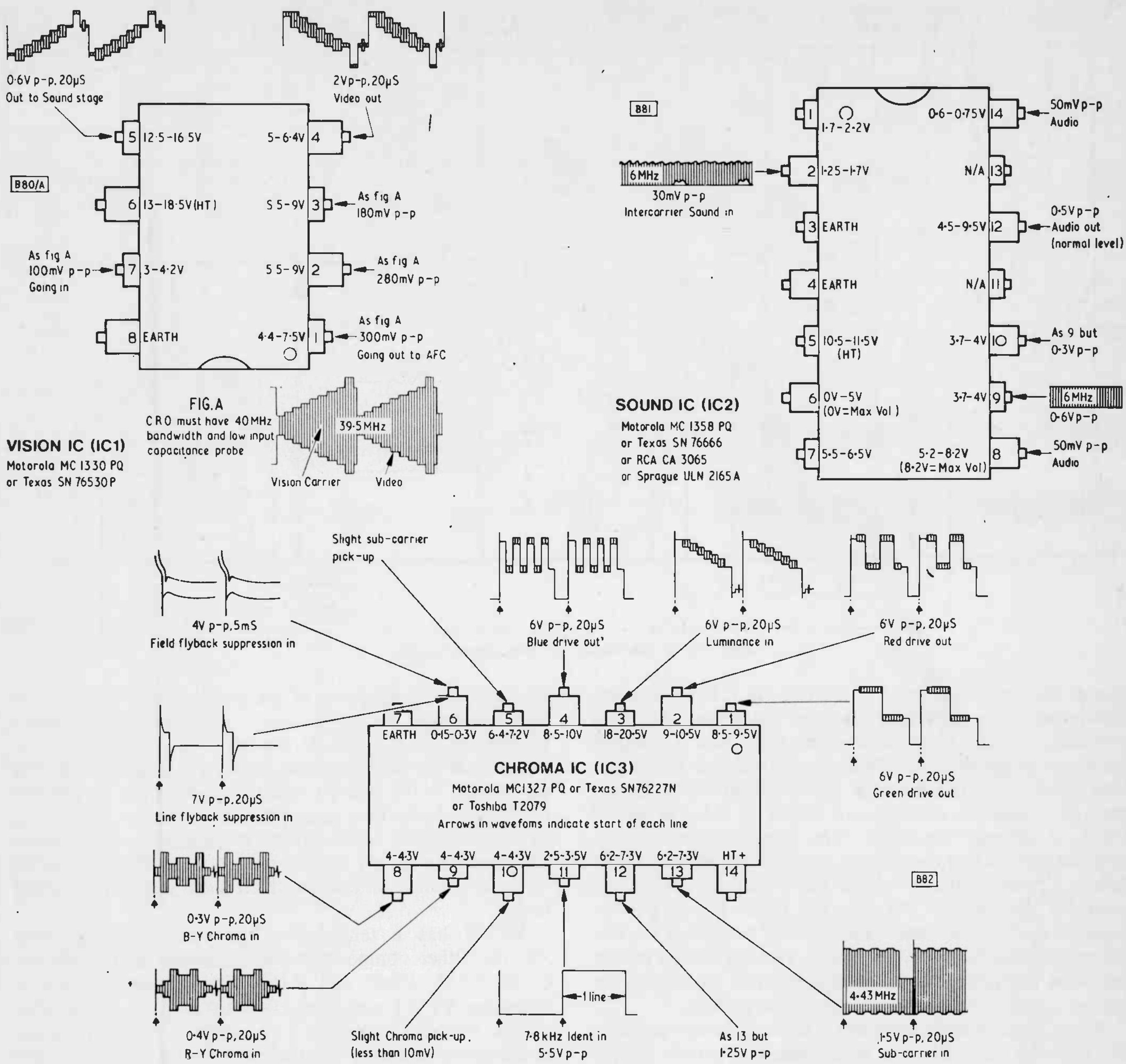


Fig. 9: Voltages and waveforms associated with the three i.c.s. Courtesy Thorn Consumer Electronics.

In the absence of the ident signal VT113 is switched on by the bias provided via R177, its collector voltage rising and thus increasing the potential at the base of VT114 so that VT114 turns off. VT114 collector voltage falls to about 3V and there is insufficient bias to turn on VT115 – thus no chroma can be passed on. Obviously W109 is a key component. If it goes open-circuit there is no colour.

From this circuit description it can be seen that the simplest way to override the colour-killer circuit is to short out the base-emitter junction of VT113.

The composite video signal at the emitter of VT107 (Fig. 3) is applied via an intercarrier sound rejector L114/C170 and a chroma acceptor circuit L115/C168 to the base of VT115. This transistor is connected as an emitter-follower, providing a low-impedance signal for feeding the colour saturation control R189. The output from this control feeds the base of the delay line driver VT117. VT115 tends to overheat, causing colour fade out.

The output at the collector of VT117, about half a volt in amplitude, is fed to the PAL delay line. The direct signal needed for R–Y and B–Y signal separation is taken from the emitter of VT117. The preset resistor R198 controls the stage gain so that the direct and indirect signals can be proportioned correctly. Phase control is provided by L121. The R–Y and B–Y signals appearing at the ends of the termination coil L125 are fed to pins 9 and 8 respectively of IC3. The three colour signals appear at pins 2 (red), 1 (green) and 4 (blue) of IC3.

The reference oscillator signals for IC3 are provided via the transformer T102 whose secondary feeds pin 12 (R – Y detector) and 13 (B–Y detector). Adjustment of the B–Y reference signal 90° phase shift is controlled by R191.

Chroma Section Fault Finding

Without doubt most of the troubles that occur on the composite i.f./chroma/video panel are to be found in the chroma sections, and unless a systematic approach is adopted fault-finding can be very time consuming.

In practice most of the faults are intermittent and since

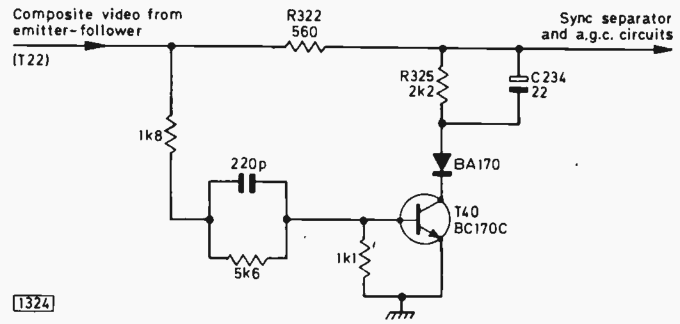


Fig. 5: This circuit was used in early versions of the ITT CVC5 chassis to remove noise from the feeds to both the sync separator and the a.g.c. circuits.

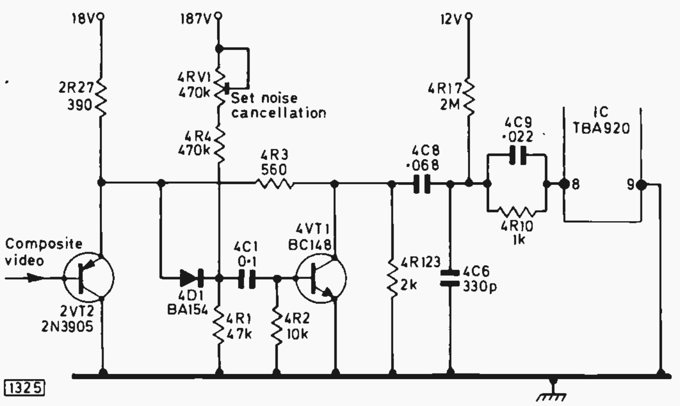


Fig. 6: Noise-cancelling circuit used in conjunction with a TBA920 sync separator/line oscillator i.c. in the Rank Z179 110° colour chassis.

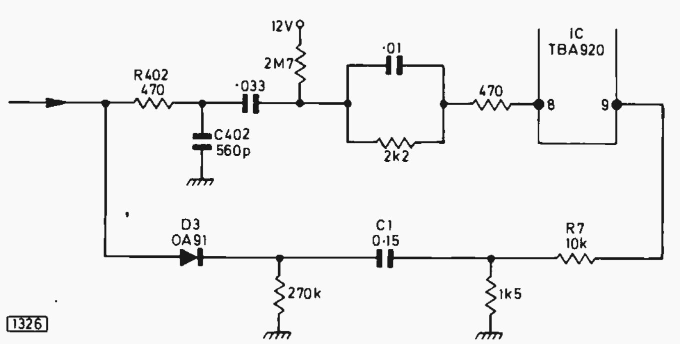


Fig. 7: In the Grundig 5010/6010 series the noise gate in the TBA920 is used to remove the effect of noise on the sync separator.

cancelling externally in the feed to pin 8 however. The circuit is shown in Fig. 6. The pnp emitter-follower 2VT2 provides a low-impedance drive which is fed to pin 8 of the TBA920 via 4R3, 4C8 and 4C9/4R10. The video is negative-going, the sync and noise pulses positive-going. Diode 4D1 is normally non-conductive because of the positive bias, set by 4RV1, applied to its cathode. A high-amplitude noise pulse will forward bias 4D1 however and pass via 4C1 to the base of the noise-cancelling transistor 4VT1 which then switches on, removing the positive-going noise pulse from the feed to pin 8 of the i.c.

Using the Integrated Gate

As with most chassis which use this i.c. – those produced by the Pye group for example – the noise gate input pin 9 is connected to chassis. An exception is the Grundig 5010/6010/5011/6011 range which uses the circuit shown in Fig. 7. The noise gate at pin 9 of the TBA920 appears to

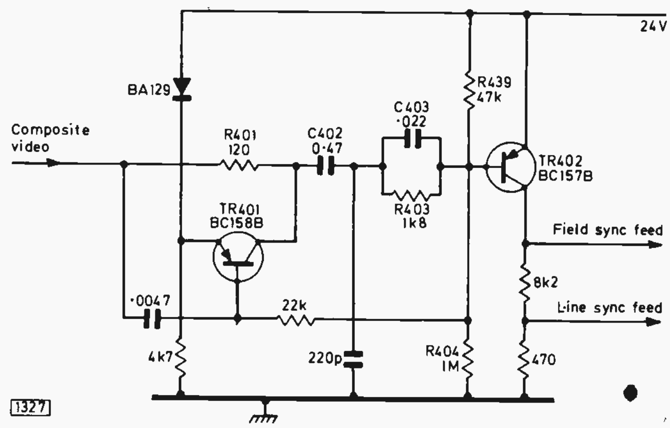


Fig. 8: Noise-cancelling circuit used in the Indesit Model T24EGB. TR401 acts as a clamp when driven into conduction by noise pulses.

the input as a 200Ω resistor feeding two diodes connected in parallel but in opposite polarity. The input impedance is thus very high up to ± 0·7V: beyond this figure one or other diode becomes conductive. The feed to pin 9 must consist of positive pulses separated from the video signal: diode D3 acts as a limiter while the *RC* components shape the pulse waveform. Note that in later production R402 was changed from 1kΩ to 470Ω, C402 from 270pF to 560pF and the 470Ω resistor added in series with pin 8 to protect the i.c..

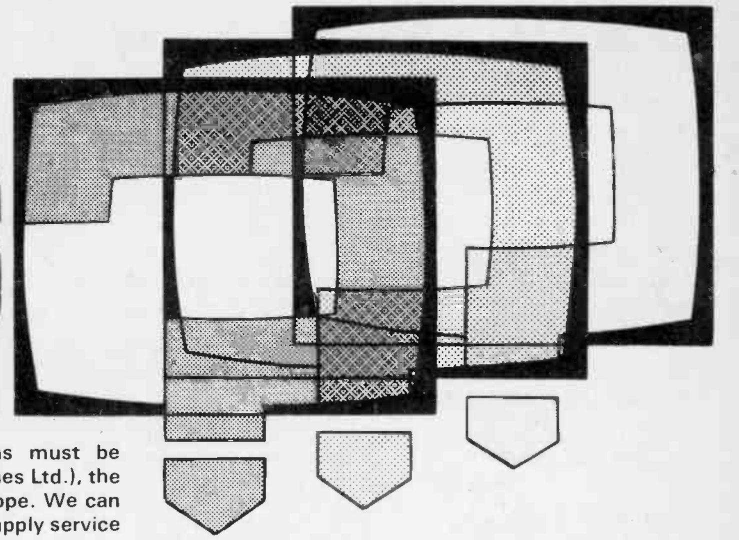
Clamp-action Noise Canceller

Finally, a slightly different arrangement used in the Indesit Model T24EGB which Les Lawry-Johns covered recently, see Fig. 8. Here the noise-cancelling transistor TR401 is arranged as a clamp. It is normally held non-conductive, the potential at the junction R439/R404 being higher than that at its emitter as a result of the action of the sync separator TR402. Both transistors are pnp types, so the composite video input has negative-going sync and noise pulses. A high-amplitude noise pulse will drive TR401 into conduction: it will then clamp the voltage at the junction R401/C402 to approximately the voltage at its emitter, about 23·4V, thus removing the negative noise pulse from the feed via C402 and the differentiating network C403/R403 to the base of the sync separator.

Servicing Aspects

There is not much to go wrong in these noise-cancelling circuits, and they rarely give trouble. If they do fail to function, a sustained noise pulse train will impair the line hold and, if the sync pulses are used to operate the burst gate in the decoder, chrominance information will reach the burst detector and upset the colour sync. Where a noise-cancelling circuit is suspected, any diodes and electrolytic capacitors present are the first things to check. If impaired line and field timebase locking suggests a sync separator fault, again the noise-cancelling circuit, if present, can almost certainly be discounted – this fault is usually due to the sync separator's base bias network. If in any doubt, the noise-cancelling circuit can easily be disabled. Where the noise-cancelling transistor shunts the video feed, as in Figs. 2, 5 and 6, simply disconnecting the transistor's collector will completely remove any effect it may have. In cases where the noise-cancelling transistor is in series with the sync separator's emitter lead, as in Figs. 1 and 4, it can be shorted out as a check. ■

Your PROBLEMS solved



Requests for advice in dealing with servicing problems must be accompanied by an 11p postal order (made out to IPC Magazines Ltd.), the query coupon from page 219 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.

ELIZABETHAN T12

The problem with this mains/battery portable set is sound but no e.h.t. The l.t. supply is present but there is no voltage at the collector of the 2SC508 line output transistor. It is difficult to follow the printed circuit and service data seems hard to obtain. Does the supply to the line output transistor go through the line output transformer?

A service sheet covering this set was published by *Electrical and Radio Trading*. It's number 1881, dated February 22nd 1973. The line output stage employs a diode and an electrolytic capacitor to provide a 19V boost rail from which the line output stage is operated. We have known the boost diode D404 go open-circuit to cause the fault you have on this set.

PHILIPS G25K512

This set suffers from total loss of picture and sound though the raster is still present when the aerial lead is removed and replaced, or sometimes when channel changing, or occasionally without external change. Picture and sound can be restored by switching the set off and then switching it on again thirty seconds later.

The symptoms suggest that the integrated tuner unit is faulty: an intermittent oscillator would behave thus. Before changing the oscillator transistor check the voltages on the tuner, looking for changes when the fault occurs. Ensure that all interconnecting plugs and leads are clean and making good contact. (Philips G6 chassis.)

ULTRA 6816

There is a black margin $\frac{1}{2}$in. wide at each side of the screen, also intermittent field roll which cannot be corrected by adjusting the field hold control.

The connection between these faults seems to be that the l.t. supply rail is low, so the area to check is around the regulator circuit. It should be possible to set the l.t. line to 11·8V by means of R104. There are two transistors in the regulator circuit: the sensing transistor VT22 should run cool while the series regulator VT21 (AD149) should feel warm. The base of VT22 should read 5V: if it does not check the transistor, zener diode W17 and the resistors (R103 and R106) in series with the set rail voltage control R104. The most likely cause of the trouble is one or other of the transistors. (Thorn 1590 chassis.)

BUSH TV105

After the set has been on for about ten minutes the picture starts to flutter, forming double pictures. This can be stopped by adjusting the top or overall field linearity controls, but the top of the picture is then elongated. The field timebase valves have been checked by substitution and the output stage cathode decoupling electrolytic replaced.

The 0·02μF capacitor connected between the two field linearity controls is often the cause of vertical fluttering and should be replaced.

FERGUSON 3813

The set came in with the complaint sound but no e.h.t. and the fusible resistor R124 was found to be open. On reconnecting this resistor there was still no e.h.t. though you could hear the line timebase whistle. Then after about five minutes the resistor went open-circuit again and the line whistle disappeared. The line timebase valves have been replaced.

When R124 goes open-circuit there is excessive current flowing in the line output stage. First check the third harmonic tuning capacitor – a component rated at 12kV working voltage is required here. Check that the negative drive voltage at the control grid of the PL504 line output valve is around −70V. If not try a replacement line oscillator valve (30FL2) and check whether the charging (C53) and oscillator timing (C52) capacitors are in order. The e.h.t. multiplier or the line output transformer could also be defective. (Thorn 1500 chassis.)

ALBA TD1420

On a predominantly white picture an irregular black band about an inch wide appears on the right-hand side of the screen. Part of the picture is pulled when this occurs.

We would suppose the fault to be somewhere around the PFL200 video-sync valve. Check that the screen grid feed resistor R2136 to the sync section (pin 3) is 330kΩ. It was originally 680kΩ but was changed to improve the sync performance. The PFL200 could be faulty, also the ECC82 (V2003) flywheel sync valve. Check the electrolytics in the video output stage – C2047 (20μF) and C2048 (250μF). Also check that the two drop-off resistors which provide the h.t. supply to the anode of this stage are present and of the correct value (1·8kΩ): they are mounted on the field timebase panel. (Philips 210 chassis.)

PYE 81

The trouble with this set is picture rolling on all channels. Adjusting the field hold control does not provide a cure. The PCL85 field timebase valve has been replaced.

Though only the field hold is affected the trouble could well be in the sync separator circuit where the most likely suspect is the high-value (4·7MΩ) resistor R125 which forms the upper arm of the transistor's base bias potential divider network. If all is well here, check the value of the 1·5MΩ resistor R108 in series with the field hold control. Note that the other half of the field oscillator consists of transistor VT6 (BC147). (Pye group 569 chassis.)

TEST CASE 158

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

A Grundig Model 717GB was presented to the workshop with the symptom of intermittent severe cramping at the right-hand side of the picture. The receiver was first investigated on site by the field technician, but owing to the long periods between the occurrence of the fault it was decided to take the set back to the "soak bay" at base. Perfect results were obtained on first switching on, and the display remained steady and completely free from horizontal nonlinearity for about two hours.

After this time there was a slight horizontal displacement of the picture, accompanied by a vertical column of short "dashes" at the left-hand side of the screen and muted crackling from the loudspeaker. The discharge effect at the left then worsened and suddenly the picture jumped into severe horizontal nonlinearity, with a reduction of scan at the right accompanied by severe compression. The left-hand side of the picture was less affected, and during the major fault condition the discharge effect at the left diminished.

One or two tests were made while the receiver was operating under the fault condition, including adjustment to the line linearity control, and it was found that this had virtually no effect at all on the symptom. While other tests were being contemplated, a sudden burst of discharge dashes occurred at the left of the picture, with crackling from the loudspeaker, the symptoms then clearing to leave a perfect picture!

The receiver uses a valve line output stage with the conventional boost diode and a tripler energised from an overwinding on the line output transformer. The line scan coils are fed from a winding on the line output transformer via a width inductor and saturated-reactor type line linearity inductor. Owing to the fault's intermittent nature, tests under the fault condition could not be carried out easily. The workshop technician decided therefore that the best way of tackling the problem was to check components by substitution in turn, running the receiver after each change. The primary and most vulnerable components in the line timebase were checked for a start – the PL509 line output valve and the PY500A boost diode.

Having in mind the exact nature of the fault symptom, which component would be most likely to be at fault? See next month's Television *for the solution and for a further item in the Test Case series.*

SOLUTION TO TEST CASE 157

(Page 163 last month)

When a transistor or a pair of transistors fails one is tempted to assume that the fault is in the devices themselves rather than in the associated circuitry. This spells danger, in power circuits especially, particularly when two transistors in a directly-coupled circuit are found to be dead. The trouble with the G8 chassis was that the field drive had failed and that the output transistors had been presented with a large turn-on bias from the driver stage. The cause was traced back to the oscillator circuit. The BRY39 field oscillator had failed in such a way as to leave the discharge and driver transistors cut off. This presented a high drive to the output transistors which in consequence went short-circuit.

It is wise therefore before changing a pair of burnt out output transistors in a directly-coupled circuit to check first that a drive waveform is present. The faulty devices (when they are shorting) must first be extracted of course, and it is then highly desirable to power the timebase section (without the output transistors) from an external high-impedance or automatically protected supply source, using an oscilloscope to monitor the drive signal. If there is no drive, obtain it before replacing the power transistors!

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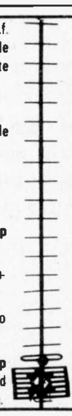

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SEND SAE FOR COLOUR TRIPLER LIST.

See separate Component. CRT and Transistor Lists. Many obsolete types available.
SAE with enquiries please. Please verify current prices

Overseas Post @ Cost. U.K. Post 7p per valve under £8.00 (max. 50p)

(Adjacent to Post Office) 6 POTTERS RD., NEW BARNET HERTS. Tel: 449 1934-5 any time.

STOP PRESS. PC92/96, PL95, PL519 available!

NOTE. Any excess paid will be refunded.

SOUTHERN VALVE COMPANY

P.O. Box 144, BARNET, Herts.

Telephone: 01-440 8641. Mail order only. Most leading makes. (subject to availability)
ALL NEW & BOXED VALVES

AZ31	72p	EM84	49p	PCL83	55p	UCC85	51p	30L1	44p
DY86/7	40p	EY51	52p	PCL84	52p	UCH42	80p	30L15	86p
DY802	46p	EY86/7	40p	PCL85	68p	UCH81	46p	30L17	80p
EB91	21p	EZ40/1	59p	PCL805	68p	UCL82	46p	30P12	86p
ECC81	39p	EZ80	38p	PCL86	55p	UCL83	64p	30P19	80p
ECC82	37p	EZ81	33p	PCL200	£1.25	UF41	75p	30PL1	92p
ECC83	37p	GY501	90p	PD500	£2.50	UF89	46p	30PL13	87p
ECC85	44p	GZ30	49p	PFL200	81p	UL41	80p	30PL14	92p
ECC88	52p	PC86	70p	PL36	67p	UL84	48p	30PL15	92p
ECH42	80p	PC88	70p	PL81	55p	UY85	37p	30P4MR	99p
ECH81	40p	PC97	44p	PL81A	60p	U25	80p		
ECH83	90p	PC900	54p	PL82	42p	U26	76p		
ECH84	57p	PCC84	44p	PL83	51p	U191	80p		
ECL80	57p	PCC85	48p	PL84	51p	6/30L2	80p		
ECL82	51p	PCC88	69p	PL500	88p	6BW7	75p		
ECL83	75p	PCC89	55p	PL504	88p	6F23	80p		
ECL86	46p	PCC189	58p	PL508	92p	6F28	75p		
EF80	33p	PCF80	44p	PL509	£1.80	6V6	52p		
EF85	41p	PCF82	55p	PL519	£3.10	10F1	75p		
EF86	57p	PCF86	64p	PL802	£2.25	20L1	92p		
EF89	35p	PCF200	98p	PY33	57p	20P4	98p		
EF183	41p	PCF801	55p	PY81/3	41p	30C1	44p		
EF184	41p	PCF802	60p	PY88	45p	30C15	86p		
EH90	62p	PCF805	90p	PY800	45p	30C17	88p		
EL34	90p	PCF806	60p	PY801	45p	30C18	86p		
EL41	64p	PCF808	90p	PY500	£1.10	30F5	86p		
EL84	38p	PCH200	86p	PY500A	£1.10	30FL1	78p		
EL90/1	48p	PCL82	41p	UBF89	44p	30FL2	80p		

We offer return of post service.

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

Post free over £10.

TRADE
Representative can call in S. Wales & West Country.

One valve post 7p, each extra valve 6p (maximum 45p). LISTS s.a.e. please.
ALL PRICES INCLUDE VAT.

PHILIP H. BEARMAN

6 POTTERS ROAD, NEW BARNET, HERTS. Tel: 01-449 1934/5

We offer a good range of new tubes which are all tested before despatch. Daily despatch, world wide, prices on application.

COLOUR TUBES
Carriage £2.30

A44/271X	**£62.00**
A49/11X	**£50.00**
A49/191X	**£62.00**
A49/192X	**£62.00**
A51/110X	**£58.00**
510DNB22	**£58.00**
A55/14X	**£58.00**
A56/120X	**£65.00**
A63/11X	**£80.00**
A63/200X	**£80.00**
A66/120X	**£75.00**

One year warranty.
Add £8 for 4 year guarantee.

110° prices usually as above. £5 allowed on old tube.

STOP PRESS
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REPRESENTATIVE
CALLS IN
MANY AREAS
ON REQUEST

(S. Wales & W. Country)

MONO TUBES
Carriage £1.15

TSD282	**£10.00**
MW31/74	**£3.50**
CME1201	**£12.50**
14" except 110°	**£5.13**
340ZB4	**£16.00**
17" except	
A44/120	**£6.35**
A47/14W	**£12.50**
AW47/91 rebuilds	**£8.00**
A50/120WR	**£16.50**
A59/23WR	**£17.00**
A61/120WR	**£19.50**

VAT included in all quoted prices.

Occasional seconds available cheaper, enquiries welcomed. Prices include VAT.

All prices subject to alteration due to circumstances beyond our control.

TELEVISION TUBE SHOP

NEW TUBES AT CUT PRICES

A28-14W Equivalent	**£15.00**
A31-20	**£19.50**
A47-11W/A47-18W	**£11.00**
A47-26W	**£13.50**
AW47-91/CME1903	**£9.50**
AW59-91/CME2303	**£12.00**
CME1201/A31-18W	**£13.50**
CME1202/A31-181W	**£13.50**
CME1220/A31-120W	**£14.95**
CME1420/A34-100W	**£15.50**
CME1520/A38-160W	**£16.50**
CME1601/A40-11W	**£12.50**
CME1602/A40-12W	**£13.50**
CME1713/A44-120	**£17.50**
CME1906/A47-13W	**£12.50***
CME1905/CME1907	**£9.50***
CME1908/A47-14W	**£9.50**
CME2013/A50-120	**£12.95**
CME2306/A59-13W	**£13.50***
CME2308/A59-15W	**£15.00**
CME2313/A59-23W	**£16.95**
CME2413/A61-120W	**£16.95**
TSD217/TSD282	**£7.50**

JAPANESE/USA TUBES

9AGP4 Equivalent		**£15.00**
190AB4	7"	**£14.00**
240AB4A	9½"	**£9.50**
230DB4/CT468	9"	**£15.00**
280TB4	11"	**£11.95**
CT507	11"	**£16.50**
310DMB4	12½"	**£13.50**
310DGB4	12½"	**£11.50**
340AB4	14"	**£15.50**
340RB4	14"	**£15.50**

*Types marked thus are fully rebuilt.

NEW COLOUR TUBES

A49-191X/120X	**£45.00**
A56-120X	**£60.00**
A66-120X	**£75.00**

NEW SCRATCHED COLOUR TUBES
20", 26" from **£35.**

All tubes guaranteed for 12 months.

Carriage/insurance £1 mono, £1.50 colour. (Northern Ireland £2.50).

Add 25% VAT to all prices.

TELEVISION TUBE SHOP
46/48 BATTERSEA BRIDGE RD., LONDON, SW11. Tel. 228 6859.

WE GIVE GREEN SHIELD STAMPS

TRANSISTORS, ETC.

Type	Price (£)
AC107	0.35
AC117	0.24
AC126	0.25
AC127	0.25
AC128	0.25
AC141	0.26
AC141K	0.27
AC142	0.20
AC142K	0.19
AC151	0.24
AC152	0.25
AC153K	0.28
AC154	0.20
AC176	0.25
AC178	0.27
AC187	0.25
AC187K	0.26
AC188	0.25
AC188K	0.26
AC193K	0.30
AC194K	0.32
ACY28	0.25
ACY39	0.68
AD140	0.50
AD142	0.52
AD143	0.51
AD149	0.50
AD161	0.48
AD162	0.48
AF114	0.25
AF115	0.25
AF116	0.25
AF117	0.20
AF118	0.50
AF121	0.32
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.35
AF147	0.35
AF149	0.45
AF178	0.55
AF179	0.60
AF180	0.55
AF181	0.50
AF186	0.40
AF239	0.40
AF279	0.84
AL100	1.10
AL102	1.10
AL103	1.10
AL113	0.95
AU103	2.10
AU110	1.90
AU113	2.40
BC107	0.12
BC107A	0.13
BC107B	0.14
BC108	0.12
BC108B	0.13
BC109	0.13
BC109C	0.14
BC113	0.13
BC114	0.20
BC115	0.20
BC116	0.20
BC117	0.20
BC119	0.29
BC125	0.22
BC126	0.20
BC132	0.15
BC134	0.20
BC135	0.19
BC136	0.20
BC137	0.20
BC138	0.20
BC142	0.30
BC143	0.35
BC147	0.13
BC148	0.12
BC149	0.14
BC152	0.25
BC153	0.20
BC154	0.20
BC157	0.15
BC158	0.13
BC159	0.15
BC161	0.48
BC167B	0.15
BC168B	0.13
BC169C	0.13
BC170	0.15
BC171	0.15
BC172	0.14
BC173	0.20
BC174B	0.26
BC176	0.22

Type	Price (£)
BC177	0.20
BC178	0.22
BC178B	0.22
BC179	0.20
BC179B	0.21
BC182L	0.11
BC183	0.11
BC183K	0.12
BC183L	0.11
BC184L	0.13
BC186	0.25
BC187	0.27
BC208	0.12
BC212L	0.12
BC213L	0.12
BC214L	0.15
BC238	0.12
BC261A	0.28
BC262A	0.18
BC263B	0.25
BC267	0.16
BC268C	0.14
BC294	0.37
BC300	0.60
BC301	0.35
BC303	0.60
BC307B	0.12
BC308A	0.10
BC309	0.15
BC323	0.68
BC377	0.22
BC441	1.10
BC461	1.58
BCY33	0.36
BCY42	0.16
BCY71	0.22
BCY88	2.42
BD115	0.65
BD123	0.98
BD124	0.80
BD130Y	1.42
BD131	0.45
BD132	0.50
BD135	0.40
BD136	0.46
BD137	0.48
BD138	0.50
BD139	0.55
BD140	0.62
BD144	2.19
BD145	0.75
BD163	0.67
BD183	0.56
BD222	0.78
BD234	0.75
BD410	1.65
BD519	0.76
BD520	0.76
BD599	0.75
BDX18	1.45
BDX32	2.55
BDY18	1.78
BDY20	0.99
BF115	0.20
BF117	0.45
BF120	0.55
BF121	0.25
BF123	0.28
BF125	0.25
BF127	0.30
BF158	0.25
BF159	0.27
BF160	0.22
BF161	0.45
BF162	0.45
BF163	0.45
BF167	0.25
BF173	0.25
BF177	0.30
BF178	0.33
BF179	0.33
BF180	0.35
BF181	0.33
BF182	0.44
BF183	0.44
BF184	0.26
BF185	0.26
BF194	0.15
BF195	0.15
BF196	0.15
BF197	0.17
BF198	0.20
BF199	0.25
BF200	0.35
BF218	0.35
BF222	1.08
BF224J	0.15
BF240	0.20

Type	Price (£)
BF241	0.22
BF244	0.18
BF254	0.45
BF255	0.45
BF256	0.45
BF257	0.49
BF258	0.66
BF259	0.93
BF262	0.70
BF263	0.70
BF273	0.16
BF336	0.35
BF337	0.35
BF458	0.60
BF459	0.63
BF596	0.70
BF597	0.15
BFR39	0.24
BFR41	0.30
BFR61	0.30
BFR79	0.24
BFT43	0.55
BFW10	0.55
BFW11	0.55
BFW16A	1.70
BFW30	1.38
BFW59	0.19
BFW60	0.20
BFW90	0.28
BFX16	2.25
BFX29	0.30
BFX30	0.35
BFX84	0.25
BFX85	0.26
BFX86	0.26
BFX87	0.28
BFX88	0.24
BFY18	0.53
BFY40	0.40
BFY41	0.43
BFY50	0.25
BFY51	0.23
BFY52	0.23
BFY57	0.32
BFY64	0.42
BFY72	0.31
BFY90	0.70
BLY15A	0.79
BPX25	1.90
BPX29	1.70
BPX52	1.90
BRC4443	0.68
BRY39	0.47
BRY56	0.40
BR101	0.47
BSX19	0.13
BSX20	0.19
BSX76	0.15
BSX82	0.52
BSY19	0.52
BSY41	0.22
BSY54	0.50
BSY56	0.80
BSY65	0.15
BSY78	0.40
BSY91	0.28
BSY95A	0.27
BT106	1.24
BT116	1.20
BU105/02	1.95
BU108	3.25
BU126	2.99
BU204	1.98
BU205	1.98
BU207	3.00
BU208	3.15
BU209	2.55
BUY77	2.50
BUY78	2.55
BUY79	2.85
D40N1	0.45
E1222	0.55
E5024	0.20
ME6001	0.16
ME6002	0.17
ME8001	0.18
MJE340	0.68
MJE341	0.72
MJE370	0.65
MJE520	0.85
MJE521	0.95
MJE2955	1.20
MJE3000	1.85
MJE3055	0.74
MPF102	0.40
MPS6566	0.21
MPSA05	0.47
MPSA55	0.50
MPSU05	0.66
MPSU06	0.76

Type	Price (£)
MPSU56	1.26
MPSU55	1.26
OC26	0.38
OC28	0.65
OC35	0.59
OC36	0.64
OC42	0.55
OC44	0.25
OC45	0.32
OC70	0.32
OC71	0.32
OC72	0.32
OC73	0.51
OC75	0.25
OC76	0.35
OC81	0.53
OC81D	0.57
OC139	0.76
OC140	0.80
OC170	0.25
OC171	0.30
OC200	1.30
OCP71	0.92
ON236A	0.65
ORP12	0.55
R2008B	2.05
R2010B	2.95
TIC44	0.29
TIC46	0.44
TIC47	0.58
TIP29A	0.49
TIP30A	0.58
TIP31A	0.65
TIP32A	0.67
TIP33A	0.99
TIP34A	1.73
TIP41A	0.80
TIP42A	0.91
TIS43	0.30
TIS73	1.36
TIS90	0.23
TIS91	0.23
ZTX109	0.12
ZTX300	0.16
ZTX304	0.22
ZTX310	0.10
ZTX313	0.12
ZTX500	0.17
ZTX502	0.17
ZTX504	0.42
ZTX602	0.24
2N525	0.86
2N696	0.23
2N697	0.15
2N706	0.12
2N706A	0.15
2N708	0.35
2N744	0.30
2N914	0.19
2N916	0.20
2N918	0.42
2N930	0.35
2N1164	3.60
2N1304	0.21
2N1305	0.21
2N1306	0.31
2N1307	0.22
2N1308	0.26
2N1309	0.36
2N1613	0.34
2N1711	0.45
2N1890	0.45
2N1893	0.48
2N2102	0.51
2N2217	0.36
2N2218	0.60
2N2219	0.50
2N2221A	0.41
2N2222A	0.50
2N2270	0.41
2N2369A	0.42
2N2401	0.60
2N2484	0.41
2N2570	0.18
2N2646	0.53
2N2712	0.12
2N2894	0.77
2N2904	0.22
2N2904A	0.26
2N2905	0.26
2N2905A	0.28
2N2926G	0.13
2N2926Y	0.12
2N2926O	0.12
2N2955	1.12
2N3012	0.91
2N3019	0.75
2N3053	0.21
2N3054	0.55
2N3055	0.60

Type	Price (£)
2N3133	0.54
2N3134	0.60
2N3232	1.32
2N3235	1.10
2N3250	1.02
2N3254	0.28
2N3323	0.48
2N3391A	0.23
2N3501	6.99
2N3702	0.13
2N3703	0.15
2N3704	0.15
2N3705	0.11
2N3706	0.10
2N3707	0.13
2N3715	2.30
2N3724	0.72
2N3739	1.18
2N3766	0.99
2N3771	1.70
2N3772	1.90
2N3773	2.90
2N3790	4.15
2N3794	0.20
2N3819	0.35
2N3820	0.49
2N3823	1.45
2N3866	1.70
2N3877	0.25
2N3904	0.16
2N3905	0.18
2N3906	0.15
2N4032	0.43
2N4033	0.54
2N4036	0.52
2N4046	0.35
2N4058	0.17
2N4123	0.13
2N4124	0.15
2N4126	0.20
2N4236	1.90
2N4248	0.12
2N4284	0.19
2N4286	0.19
2N4288	0.13
2N4289	0.20
2N4290	0.14
2N4291	0.18
2N4292	0.20
2N4392	2.84
2N4871	0.24
2N4902	1.30
2N5042	1.05
2N5060	0.32
2N5061	0.35
2N5064	0.45
2N5087	0.32
2N5294	0.35
2N5296	0.57
2N5298	0.58
2N5322	0.85
2N5449	1.90
2N5457	0.30
2N5458	0.35
2N5494	0.85
2N5496	1.05
2N6027	0.65
2N6178	0.71
2N6180	0.92
2SC643A	1.36
2SC1172Y	2.80
3N140	1.21
40250	0.60
40327	0.67
40361	0.48
40362	0.50
40429	0.80
40439	2.67

MATCHED PAIRS

Type	Price (£)
AC128/AC176	0.52
AC141K/AC142K	0.56
AC187/AC188	0.60
AC187K/AC188K	0.61
AC193K/AC194K	0.71
AD161/AD162	0.95
BC142/BC143	0.70
TIS90M/TIS91M	0.50

Any other transistors can be matched at a supplement of 20p per pair.

DIODES

Type	Price (£)
AA113	0.15
AA119	0.09
AA129	0.20
AA143	0.10
AAZ13	0.30
AAZ17	0.12
BA100	0.15
BA102	0.25
BA110U	0.30
BA115	0.12
BA141	0.17
BA145	0.17
BA148	0.17
BA154	0.13
BA155	0.16
BA156	0.15
BA157	0.25
BAX13	0.06
BAX16	0.07
BAY72	0.11
BB104	0.52
BB105B	0.52
BB105G	0.45
BB110B	0.45
BR100	0.50
BY100	0.22
BY103	0.22
BY126	0.16
BY127	0.17
BY133	0.23
BY140	1.40
BY164	0.55
BY176	1.68
BY179	0.70
BY206	0.31
BYX10	0.15
BYZ12	0.30
FSY11A	0.45
FSY41A	0.40
OA10	0.20
OA47	0.07
OA81	0.12
OA90	0.08
OA91	0.07
OA95	0.07
OA200	0.10
OA202	0.10
OA210	0.29
OAZ237	0.78
S2M1	0.22
TV20	1.85
IN914	0.07
IN914E	0.06
IN916	0.10
IN1184	0.92
IN1185	1.10
IN4001	0.05
IN4002	0.06
IN4003	0.07
IN4004	0.08
IN4005	0.09
IN4006	0.11
IN4007	0.14
IN4148	0.05
IN4448	0.10
IN5400	0.15
IN5401	0.17
IN5402	0.20
IN5403	0.22
IN5404	0.25
IN5405	0.27
IN5406	0.30
IN5407	0.34
IS44	0.07
IS310	0.45
IS920	0.07

Diodes can be supplied balanced at a supplement of **5p** per device – e.g. four balanced OA91 would be **£0.48** per set.

Variable capacitance diodes can be supplied matched at a supplement of **3p** per device.

LINEAR INTEGRATED CIRCUITS

Type	Price (£)
CA3045	1.35
CA3046	0.70
CA3065	1.90
MC1307P	1.19
MC1310P	2.94
MC 1327PQ	1.01
MC1330P	0.76
MC1351P	0.75
MC1352P	0.82
MC 1358PQ	1.85
MC1496L	0.87
MC3051P	0.58
MFC 4000B	0.43
MFC 4060A	0.70
MFC6040	0.91
NE555	0.72
NE556	1.34
SL414A	1.91
SL901B	3.84
SL917B	5.12
SN 76001N	1.45
SN 76003N	2.92
SN 76013N	1.95
SN76013 ND	1.72
SN 76023N	1.95
SN76023 ND	1.72
SN 76033N	2.92
SN 76227N	1.46
SN 76530P	1.05
SN 76533N	1.20
SN 76666N	0.90
TAA300	1.76
TAA320	0.94
TAA350A	2.02
TAA435	0.85
TAA450	2.70
TAA550	0.55
TAA570	2.02
TAA611A	1.70
TAA611B	1.85
TAA630Q	4.18
TAA630S	4.18
TAA661B	1.32
TAA700	4.18
TAA840	2.02
TAA861A	0.49
TAD100	2.66
TBA120S	0.99
TBA240A	2.97
TBA281	2.28
TBA480Q	1.90
TBA500	1.99
TBA500Q	2.00
TBA510	1.99
TBA520Q	3.34
TBA530	2.71
TBA530Q	2.71
TBA540	3.21
TBA540Q	3.21
TBA550Q	4.10
TBA560C	4.09
TBA 560CQ	4.10
TBA570	1.17
TBA641	2.30
TBA673	2.28
TBA700	2.59
TBA720Q	2.45
TBA750Q	2.33
TBA800	1.75
TBA 810AS	1.75
TBA920Q	4.23
TBA990	4.10
TBA990Q	4.10
TCA270Q	4.18
ZN414	1.25

Please enquire for linear op. amps, 709, 710, etc.

DIGITAL INTEGRATED CIRCUITS

Type	Price (£)
7400	0.20
7401	0.20
7402	0.20
7404	0.24
7406	0.45
7408	0.25
7410	0.20
7411	0.25
7412	0.28
7413	0.50
7416	0.45
7417	0.30
7420	0.20
7425	0.37
7430	0.20
7440	0.20
7441	0.85
7445	1.95
7447	1.30
7450	0.20
7451	0.20
7454	0.20
7460	0.20
7470	0.33
7472	0.38
7473	0.44
7474	0.48
7475	0.59
7489	4.32
7490	0.65
7491	1.10
7492	0.75
7493	0.65
7494	0.85
7495	0.85
7496	1.00
74100	2.16
74121	0.60
74122	0.80
74150	1.44
74151	1.15
74154	1.66
74164	2.01
74192	2.05
74193	2.30

HARDWARE BASES

Type	Price (£)
DIL8	0.16
DIL14	0.16
DIL16	0.18

MOUNTING KITS

TO-3	0.06
TO-66	0.06

VALVES

Type	Price (£)
DY87	0.39
EB91	0.30
ECC82	0.41
EF80	0.41
EF183	0.53
EF184	0.53
EH90	0.55
PC86	0.67
PC88	0.76
PCC89	0.58
PCF80	0.47
PCF86	0.58
PCF801	0.58
PCF802	0.63
PCL82	0.50
PCL84	0.54
PCL805/85	0.58
PCL86	0.58
PFL200	0.74
PL36	0.80
PL84	0.61
PL504	0.80
PL508	0.95
PL509	1.44
PY81/800	0.46
PY88	0.52

ZENER DIODES

400mW 3.0-33V **12p each**
1.3W 3.3-100V **18p each**

VDR'S, PTC & NTC RESISTORS

Type	Price (£)	Type	Price (£)
E295ZZ/01	14	E299DD/P116-P354	all 8
E295ZZ/02	14	VA1015	50
E298CD/A258	7	VA1026	41
E298ED/A258	6	VA1033	8
/A260	6	VA1034	8
/A262	6	VA1040	8
/A265	6	VA1053	8
/P268	6	VA1055S	10
E298ZZ/05	7	VA1077	12
/06	6	VA1104	35
		VA8650	110

RESISTORS

Carbon Film (5%)	ea
¼W 5.6 Ω-330k Ω (E12)	1.5p
½W 10 Ω-10M Ω (E24)	1.5p
1W 10 Ω-19M Ω (E12)	3p
2W 10 Ω-10M Ω (E6)	5p

WIREWOUND (5%)

2½W	0.22 Ω-270 Ω	15p ea
5W	1 0 Ω-8.2k Ω	13p ea
10W	1 0 Ω-25k Ω	18p ea

CAPACITORS

Full range of C280, C296, tubular ceramic, pin-up ceramic, miniature electrolytics, mica, mixed dielectric and TV electrolytics stocked. – Please see catalogue.

MASTHEAD AMPLIFIERS

Labgear uhf group amplifier complete with mains power unit CM6001/PU. Groups A, B, or C/D please specify **£12.65**

Labgear CM6030 WB vhf/uhf ultra wideband amplifier (channels 1-68). Complete with mains power unit CM6001/PU **£18.95**

Labgear CM6019 WB uhf wideband amplifier (channels 21-68). Complete with mains power unit CM6020/PU **£9.85**

PATTERN GENERATORS

Labgear CM6004/PG giving crosshatch dots, greyscale and blank raster on 625-lines. Tuning can be preset for anywhere in Bands IV and V as well as Band III (for relays) **£58.80**

Labgear CM6038 DB Pocket size vhf/uhf generator. Outputs as CM6004 PG above but can be used either on mains or battery **£46.60**

COLOUR/BAR GENERATORS

Labgear CM6037/DB: Dual standard band generator gives standard 8 band colour bars + greyscale step wedge + red raster + centre cross + centre dot + crosshatch + dot pattern + blank raster. Sync output also provided **£125.15**

VHF/UHF CONVERTERS

Labgear "Televertas" for DX-ing or single-standard receiver use on relay systems. Type 6022/RA **£15.90**

OUR NEW CATALOGUE IS AVAILABLE AT 30p (refundable).

P. & P.: UK £0.12 per order.
Overseas: At cost.
Please add VAT at 25% on all items except test generators which are at 8%.
All prices subject to availability.
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CALLINGTON - CORNWALL

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