MICROVITEC cub COLOUR DISPLAYS

Low Complexity Colour Display

SERVICE MANUAL

LIST OF CONTENTS

This service manual contains full information on the LCCD Main Chassis Assembly. Details of other Panels, Control Units, etc are published separately in the form of an information sheet for each model.

Section 1

GENERAL SPECIFICATION

1 LCCD Technical Specifications: Models 1431, 1432

System	:	1: 625 Lines, 50 Fields Interlaced Or 624/626 Lines, 50 Fields Non-Interlaced. 2: 525 Lines, 60 Fields Interlaced, or 524/526 Lines, 60 Fields Non-Interlaced. Other Non-Standard Systems May Be Suitable (Consult Microvitec Limited).
Supply	:	Nominal 180-265V, 48-64 Hz
Timebase	:	Pull In Range ± 500Hz Hold In Range ± 700Hz
Positional Error	:	± 2%
Convergence	:	Centre 0.3mm
Error (max.)	:	Edge 1.6mm
EHT	:	23KV Approx.
Degaussing	:	Automatic At Switch On
Bandwidth	:	7MHz
Resolution (625 lines)	:	452 (H) x 585 (V) Elements
Phosphor Pitch	:	0.62mm
CRT	:	Rectangular 335.4mm (Screen Diagonal) 90° Deflection. Precision In-Line Gun. Vertical Stripe Screen. High Voltage Focus.
Inputs	:	1431: TTL Compatible; 1500 ohm R, G and B Inputs. Link-selectable positive Or Negative Video. 1432: Linear; 0 to 4V with 1500 ohm R, G, and B Inputs. Positive Video. Composite, or separate line and field synchronisation, each link-selectable positive or negative.
Input Connector	:	10 Pin In-line 'System 25' Pressac
Operating Temperature Range	:	0-70°C
Power Consumption	:	65 Watts Approx.

2 LCCD Technical Specification : Model 2031, 2032

As models 1431 and 1432 except;

Convergence Error (max.)	:	Centre 0.3mm Edge 1.8mm
Resolution (625 Lines)	:	505(H) x 585 (V) Elements, 80 Characters On 6 Dot Wide Matrix.
Phosphor Pitch	:	0.8mm
CRT	:	Rectangular 480.0mm (Screen Diagonal) 90° Deflection Precision In Line Gun Vertical Stripe Screen High Voltage Focus
Power Consumption	:	72 Watts Approx

Section 2

CUSTOMER SAFETY, SPECIFICATIONS AND INSTALLATION GUIDELINES

1. **WARNING: THIS APPARATUS MUST BE EARTHED**

IMPORTANT: The wires in this mains lead are coloured in accordance with the following code:

Green and Yellow : Earth
Blue : Neutral
Brown : Live

As the colours of the wires in the mains lead of this apparatus may not correspond with the coloured markings identifying the terminals in your plug, proceed as follows:

The wire which is coloured green and yellow must be connected to the terminal in the plug which is marked by the letter E or by the safety earth symbol ⚠ or coloured green or green and yellow.

The wire which is coloured blue must be connected to the terminal which is marked with the letter N or coloured black.

The wire which is coloured brown must be connected to the terminal which is marked with the letter L or coloured red.

If a 13A plug is used, fit a 5A fuse. For any other plug or connector protect with a 5A fuse or fuse wire on a distribution board. Components marked ⚠ on the parts list or circuit diagram are safety approved types and should only be replaced by components supplied or approved by our service department.

2. **CUSTOMER SPECIFICATIONS**

For customer applications not covered by the specification listed in Section 1, it may be necessary to specify certain other parameters:

2.1 **Timing Details**

- Line and field frequencies.
- Duration and sense of line and field sync pulses.
- Timing of video information with respect to sync pulses.
- Position of active display with respect to edge of screen.
- Maximum allowable blanking (flyback) periods.

2.2 **Linearity**

Vertical or horizontal linearity can be specified as follows:

Use a test signal consisting of clearly defined lines (or characters) regularly spaced in time:

$$\text{Linearity} = \frac{\text{Maximum variation in distance between lines measured across the screen}}{\text{Screen centre measurement of the distance between lines}}$$

The distance between lines should not be less than 3% of the screen diagonal measurement.

2.3 **Convergence**

The maximum positional difference between any two primary colours (in mm). This should be specified in the centre of the screen and at a distance of Xmm from the edge of the screen where X is the nominal tube size in inches.

2.4 Colour Purity/Brightness Variation

Should be specified as a maximum change in relative brightness of one gun to another over the entire screen.

2.5 General

When evaluating monitors against the above specifications, the tests must be done under the following conditions:–

- Set warmed up for at least 15 minutes.
- Low ambient light.
- Correctly focussed picture.

3. O.E.M. USER GUIDELINES

3.1 The LCCD should have a clear air flow and be operated within a 0 to 50°C ambient temperature range.

3.2 There must be a barrier of 6mm (minimum) clearance between isolated wiring/metalwork and the non-isolated circuit.

3.3 The tripler and associated wiring must have 20mm clearance to any metalwork.

3.4 The tube Dag coating and associated wiring must have 4mm clearance to any metalwork.

3.5 The P Band (around tube screen) must be grounded to main panel.

3.6 All tubes should have 50mm clearance between scan coils and ferrous or non-ferrous metalwork.

3.7 High and medium resolution tubes do not have integral magnetic screens and are therefore very sensitive to external magnetic fields. They must be mounted with the EHT cavity connector uppermost. A 50mm clearance should be maintained between the tube funnel, scan coils, tube neck and O.E.M. ferrous or non-ferrous metalwork.

3.8 All O.E.M. inductors (main transformers, fans, motors, etc.) and magnets (loudspeakers, etc.) should be mounted as far away from the tube as possible.

3.9 If the tube and tube base panel have to be separated prior to assembly, it is imperative that:

(A) The 'Tube Dag Earth Wire' is securely replaced on the tube base panel using the pin provided.

(B) The metal frame of any substitute metalwork used in the assembly should be earthed back to the LCCD main panel using the Earth Pin provided.

(C) The CRT 'P Band' (to which tube mounting lugs are attached) should be earthed back to the main panel using the Earth Pin provided.

When securing the CRT and/or frame into a cabinet, ensure that the double-insulation of the degaussing coil is undamaged.

MICROVITEC

All units are made in Great Britain by Microvitec Ltd. The Microvitec policy is one of continual improvement and development and the company, therefore, reserves the right to alter descriptions and specifications without prior notice.

LCCD and CUB are registered trade marks.

WARRANTY

For warranty information please refer to the 'Conditions of Sale'.

Section 3

INPUT CONNECTION DETAILS

Video and synchronising information is fed into the LCCD via plug PL101, a 10 pin 'System 25 Pressac Connector' situated at the rear of the main circuit board. Connections to PL101 are summarised in figure 3.1.

1. **'T.T.L. Compatible'/'Linear' Input Selection**

   T.T.L. compatible or linear (0 to 4V, 1500 ohms) input level options can be selected by moving 3 links; TL103 R, G and B, located on the main circuit board: position '2' corresponds with T.T.L. levels, position '1' with linear levels. Contrast control VR111 is inoperative when position '1' is selected.

2. **Synchronisation Input Options**

   The sync input(s) should be T.T.L. compatible. The timing of sync pulses should approximately correspond with those used for broadcast purposes. Options available are summarised in figure 3.2.

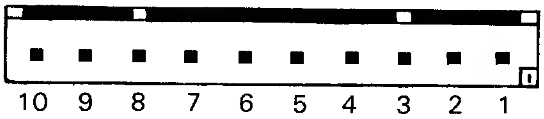
3. **Inverse Video**

   There is the facility for inverting the T.T.L. compatible video input signal by either moving link TL101, located on the main circuit board, to position '1', or removing TL101 and feeding a positive T.T.L. level into pin 9 of PL101.

NOTE
LCCD's are normally despatched from the factory wired in the composite/separate negative going syncs mode, with TL102 not fitted, and TL106 selected to position 'A'.

SIGNAL INPUT PIN CONNECTION DIAGRAM

FIGURE 3.1



PL101

10 PIN SYSTEM '25' IN LINE CONNECTOR

PIN CONNECTIONS:

1. +12V
2. No Connection
3. Sync 3; Positive Field Sync
4. Red Video
5. Sync 2; Negative Field Sync
6. Green Video
7. Sync 1; Composite Sync or Line Sync
8. Blue Video
9. Normal/Inverse TTL Video
10. Ground

FIGURE 3.2 **SYNCHRONISATION OPTIONS**

SYNC OPTIONS	INPUTS (PL101)	LINK POSITION
MIXED		
–ve going	Pin 7	TL102 not fitted TL106 in position 1
+ve going	Pin 7	TL102 fitted TL106 in position 1
SEPARATE		
–ve line –ve field	Pin 7 Pin 5	TL102 not fitted TL106 in position 1
+ve line +ve field	Pin 7 Pin 3	TL102 fitted TL106 in position 2
–ve line +ve field	Pin 7 Pin 3	TL102 not fitted TL106 in position 1

Section 4

CUSTOMER CONTROLS

CONTRAST ADJUSTMENT

Contrast of the display is controlled with the customer preset VR111, mounted at the rear of the main printed circuit board. This control is only active in the TTL mode of operation (Normal/Inverse) and allows the video gain of red, green and blue channels to be varied from a maximum to minimum at black level.

Turning VR111 clockwise will increase the contrast or intensity of the display.

BRIGHTNESS ADJUSTMENT

Brightness of the display is controlled with the customer preset VR134, mounted at the rear of the main printed circuit board adjacent to VR111. This control is active in TTL (Normal/Inverse) and Linear modes of operation and allows the brightness or operating point of the display to be varied above or below cut off. This feature is very useful to help compensate for differing ambient lighting conditions.

Turning VR134 Clockwise will increase the brightness or raise the 'black level' of the display.

In the majority of LCCD applications no further adjustment of controls will be required. However, some specific applications may require minor adjustments to the factory preset controls, in particular where the application requires reduced picture scan amplitude, or 525 line 60 Hz field standards.

Section 5

FACTORY PRESET ADJUSTMENTS

For the position of all presets on printed panels see 'Section 16' - Printed Circuit Panels.

All controls are positioned for accessibility, the majority towards the rear of the main panel, with the exception of VR4, VR328, VR321 and L202, each of which can be adjusted from above or below the main panel.

The following adjustments are best made on a static display, such as a Microvitec Test Card:-

(Details of test equipment are available on application to Microvitec Limited).

1. **Set HT VR4**

   This control is accurately preset at the factory to give 124V at black level on link 5 and should not be re-adjusted. This is a critical safety adjustment, and failure to comply with the above may invalidate the warranty.

2. **Line Frequency VR218**

   In order to achieve effective line lock, it is necessary to set the free running oscillator frequency to very nearly the frequency of the incoming line syncs, and in any event well within the pull in range of the phase locked loop. To adjust VR218, feed the LCCD with R, G, B video and interrupt the mixed sync information to the line oscillator by removing sync information on PL101 (Sync 1, 2, or 3 etc.) VR218 is then adjusted so that the picture almost stabilizes. Syncs are then re-connected via PL101 as required, resulting in a stable picture lock.

3. **Field Frequency VR307**

   VR307 controls the free running field oscillator frequency and is adjusted to give a stable picture lock on the screen (no field roll). For most effective lock, VR307 should be set to the centre of the 'locked picture' range.

4. **Line Phase VR220**

   VR220 controls positioning of the video information relative to the raster in the line scan direction

   A. The line frequency has been set using VR218.
   B. The width of the picture has been set using L202.
   C. The LCCD is positioned in its place of use.

   VR220 allows for display tube tolerances and will shift the picture relative to the raster to the right or left as may be required.

5. **Width L202**

   Picture width can be adjusted using width coil L202. Care should be taken when adjusting this component due to its proximity to the EHT section of the LCCD, in particular the tripler and the line output transformer overwind. Adjustment should be made using a non-metallic trimming tool.

   Maximum picture width occurs when the core is screwed out (upwards or downwards) from the coil.

6. **Height VR306**

   Picture height can be adjusted using VR306, and will provide for raster under-scan or over-scan if required.

7. **Field Linearity VR312**

   The field linearity is controlled using VR312, and should be adjusted to give a linear picture in the vertical direction. It is best set using a cross hatch type grid, or Microvitec test generator.

8. **Field Shift VR321**

VR321 controls positioning of the raster in the field scan direction.

9. **East – West CorrectionVR328**

VR328 is used to achieve straight verticals on the left and right hand sides of the picture.

Some variations of the LCCD will not require this adjustment, since East–West correction is integral to certain types of CRT.

10. **Focus**

The focus control is located on the end of the tripler module. Adjustment should be made at 'average picture brightness' and adjusted to give a compromise between optimum focus of horizontals and verticals over the screen area.

TUBE BASE PANEL ADJUSTMENTS

Tube base panel controls are factory preset and further adjustment should not be required. If adjustments are found necessary, an AVO 8 multimeter and/or CRO will be required. Note: For best accuracy, a CRO should be used.

COLOUR BACKGROUND CONTROLS (VR906, 914, 921) – For location see section 11, figures 11.1, 11.2

Colour background controls (black level) are adjusted with the customer contrast control VR111, the customer brightness control VR134 and the A1 control VR932 turned fully anti-clockwise. R, G, B and sync inputs should be disconnected. All measurements are made with respect to chassis. See figure 13.1

11. **Red Background VR906**
Adjust VR906 for red cathode blacklevel volts at R926 of:
A. 150V — 14" LCCD (TTL or Linear)
B. 155V — 20" LCCD (TTL or Linear)
C. 140V — 12"/14" LCCD (High or Medium Resolution)
12. **Green Background VR914**
Adjust VR914 for green cathode black level volts at R925 as above.

13. **Blue Background VR921**
Adjust VR921 for blue cathode black level volts at R924 as above.

The A1 voltage should then be increased using VR932 until a raster is just visible, the colour of which may be neutral or more likely shaded towards red, green, blue or combination of any two colours:

Red and Green	—	Yellow
Red and Blue	—	Magenta
Blue and Green	—	Cyan

depending on electrongun parameter spreads on a particular CRT. Having established the colour shading of the raster, it is then necessary to reduce the black level of the remaining one or two guns (using VR906, VR914, VR921 or combination) in order to achieve a neutral colour raster.

VR932 should then be re-adjusted so as to 'just' extinguish the raster.

Clockwise adjustment of VR111 And the application of a signal (R,G,B and Sync) should now produce a picture with correct white balance.

14. **Colour Gain Controls (VR903, VR910, VR916)**
Any adjustments to video output gain settings should only be made using a DC coupled CRO.

Prior to any adjustments, it is necessary to provide a test pattern with peak white and black level information on red, green and blue and dis-able the beam current limit circuit. This may be achieved by removing TL901 in series with the CRT heaters on the tube base panel. VR111 should be turned fully clockwise to provide maximum drive voltages to the video output stages.

15. **Red Gain VR903**

    Adjust VR903 for red peak — peak drive volts at R926 of:-

    A. 85V p-p on 14" LCCD — TTL Mode.
    B. 95V p-p on 20" LCCD — TTL Mode.
    C. 65V p-p on 14"/20" LCCD — Linear Mode.
    D. 60V p-p on 12"/14" LCCD — Medium and High Resolution

    In the case of option 'C' VR111 Is in-operative.

    Green Gain VR910

    Adjust VR910 for green p-p volts at R925 as above

    Blue Gain VR916

    Adjust VR916 for blue p-p volts at R924 as above. Finally re-fit TL901.

16. **A1 Volts VR932**

    VR932 sets the operating point of the electron guns, in particular it controls the tube cut off point. This adjustment is normally made on a blank raster after the adjustment of red, green, and blue background controls as detailed in 11, 12, and 13. With VR134 turned fully anticlockwise, VR932 should be adjusted so as to just extinguish the screen, under conditions of no cathode drive (VR111 set to minimum).

ADDITIONAL OPERATING INSTRUCTION FOR LINEAR INPUT MODE OPERATION

The LCCD operates in a linear video input mode when test links TL103, R, G and B are connected in their '1' positions. The main differences on the Linear LCCD arise in the adjustment of the 'Contrast' and 'Brightness' of the display. In the case of the TTL LCCD, brightness is adjusted using VR134, while VR111 allows the contrast or drive of the red, green and blue signals to be adjusted simultaneously.

In the case of the Linear LCCD, it may be necessary to adjust the contrast or video drives using the preset controls on the tube base panel (VR903, VR910, VR916).

The amount of R, G, and B CRT drives required and the adjustment of the gain controls will be dependant to a large extent on the following factors:-

A. The individual user.
B. The level of R,G,B video feeds at the input to the Linear Interface.
C. The ambient lighting conditions in which the LCCD is to operate, and
D. The Type of information (Text or graphics etc.) to be displayed.

Experience has shown that for 3.5V p-p video inputs at the interface, and using the LCCD in normal daylight then video drives of 65V p-p are required, while under subdued lighting conditions 40-50V p-p is likely to be adequate.

The brightness of the display is controlled using preset VR134 and will increase the black level by about 30V. When adjusting the gain controls VR903, VR910 and VR916 it is important that the beam limiter circuit be disabled, this is most easily done by removing TL901.

Adjustment of the gain controls should then be made as detailed under the main LCCD operating instructions. It is particularly important that having chosen a suitable CRT drive voltage that all three drives be set for the same p-p voltage, this will ensure that peak white will be displayed correctly.

CRT BEAM CURRENT LIMITING

It should be noted that at high CRT electron beam currents, a limiter circuit comes into action which holds the maximum mean beam current to about 700uA. This is necessary to prevent severe defocusing of the display and maximise the life time of the CRT.

On the Linear LCCD, beam limiting action takes place as with the TTL LCCD on the brightness information.

Section 6

MECHANICAL DETAILS

MAIN PCB ASSEMBLY REMOVAL

Turn off, and remove the mains input connector PL3. Disconnect the EHT cavity connector. Connect this to the chassis metal work to ensure no charge remains on the tripler. (Under normal conditions this will have discharged automatically via the focus potential bleed chain). Discharge the final anode of the CRT by connecting it to the CRT dag. Disconnect PL201, PL1 and on cabinet versions PL2 if fitted.

Remove the tube base panel and the CRT earthing braid tag. Finally, remove the 'P' band earthing tag from the main PCB, located next to the tripler module. Release in turn, each of the six nylon self locking PCB support clips by lodging a screw driver between the clip and the edge of the PCB, lifting the panel slightly in each case, after which the main PCB may be removed by lifting the panel first upwards and then withdrawing to the rear.

PICTURE TUBE REMOVAL

Remove the main PCB assembly as described above, and with the CRT face down, position the metal cabinet/wire frame on two padded blocks. Remove the four nuts, and large washers and withdraw the picture tube assembly vertically from the cabinet front (first having removed the metal base/plinth unit from the front piece) or wire frame.

The degauss coil and earthing braid/scan coil lead assembly should then be transferred to the new CRT. Care should be taken when refitting to ensure no damage occurs to the degauss coil, particularly when tightening down the CRT lug nuts.

SAFETY CHECKS AFTER REPLACEMENT

Check the earthing braid has been refitted on the CRT correctly, replace the main PCB and refit all plugs and sockets. Check that the black lead from the CRT earth braid to tube base panel is connected, and that the 'P' band earth pin has been replaced on the main PCB.

LINE OUTPUT TRANSISTOR TR202 REMOVAL

Remove the two M3 screws securing the Line Output Transistor and Heatsink to the main PCB, taking care not to lose the nuts and lock washers. Unsolder the base and emitter connections on the main PCB and withdraw vertically the complete heatsink-transistor assembly.

The transistor can now be removed from the heatsink taking care not to lose the insulating bushes or damage the insulating mica washer.

REPLACEMENT

The underside of the transistor should be coated with a thermally conductive heatsink compound, and the transistor/heatsink assembly replaced in reverse order.

Ensure that two screws are tightened down correctly since they are used to form electrical connections to other parts of the circuit.

SMPSU OUTPUT TRANSISTOR TR 2

Removal and replacement operations are as for 'Line Output Transistor TR202' as described above

TRIPLER - FOCUS MODULE REMOVAL

Discharge the final anode of the CRT to the earth braid. Disconnect the EHT lead from the CRT, unsolder the lead from the LOPT overwind, the focus lead to the tube base panel at the tripler module end, the earth return from the focus potentiometer and the clamp diode earth return lead. (The latter two connections are to the main PCB).

Loosen the two securing screws, but do not remove them and then carefully withdraw the tripler module from the main PCB.

REPLACEMENT

Ensure all soldered connections are smooth and that all connecting wires are kept as short as possible in order to guarantee adequate voltage clearances, particularly around the line output overwind tube lead. Re-connect the focus lead from the CRT tube base panel and secure to the tripler, after soldering, with a small tiewrap.

Finally re-connect the CRT cavity connector, turn on, and adjust the focus control for optimum setting

Section 7

CIRCUIT DESCRIPTION

LINE TIMEBASE FIGURE 7.1

The line oscillator function is based on the TDA1180P integrated circuit (IC201) and provides three outputs;

1. Horizontal drive pulses for control of the line output stage.
2. Vertical sync pulses compatible with the synchronisation requirements of the TDA1170S field output integrated circuit.
3. A sandcastle pulse providing burst gate and clamping information.
   This facility is only used in conjunction with the TDA3300 integrated circuit currently required by '1 volt 75ohm Linear Input LCCD's'.

SYNC SEPARATOR

The TDA118OP incorporates separate noise gated sync separators for line and field syncs, and as such accepts positive going sync pulses (or negative going composite video) on pins 8 and 9. The respective biasing networks have been designed for optimum line and field sync performance.

This facility has enabled various sync options; in particular composite syncs or separate line and field syncs as required.

The output pulses from the line sync separator are used in conjunction with a 'sync gate' to synchronise the line oscillator in a phase locked loop circuit.

LINE OSCILLATOR AND PHASE DETECTORS

The line oscillator is precisely timed by R215, 216, 217, VR218 and C210 on pins 14 and 15 of IC201, and is used to derive a pulse of suitable mark space ratio for driving the line output stage (via the line driver stages).

IC201 contains two basic control loops, each containing a phase detector. The first phase detector compares the output of the line oscillator with the incoming line sync pulse information. The output from the phase detector on pin 13 is filtered by C208, and R211, C207 in series with R212, C206, and fed to the voltage control input of the oscillator at pin 15 via R213. The second phase detector is used to compensate for the delays introduced by the line output stage (transistor storage time variations with CRT beam current), and compares line flyback pulses at pin 6 with the oscillator output. The output of the phase detector consists of a bidirectional current source and is used to charge and discharge a filter capacitor C213 on pin 5. The voltage derived by C213 is used to control a phase shifter which adequately regulates the phase of the output pulses available on pin 3. Pin 5 also provides for a 'Line Shift' function by offsetting the voltage developed across C213 via charge from VR220, R221 and R222, so allowing a phase shift of $\pm$ 1uS, between line scan and video information to be achieved.

From the line oscillator, a 7uS gate pulse is derived, whose phase position is centred around the horizontal sync pulse. The gate pulse is used to control the arrival of sync pulses at the sync phase detector for a duration of 7uS and therefore allows latching and de-latching of the line oscillator. This function is obtained by means of a coincidence detector which compares the phase of the gate pulse with that of the incoming syncs.

When the two signals are not accurately aligned, synchronism has not occurred and the coincidence detector is used to switch the p.l.l. filter into a short time constant mode effectively presenting a high input impedance at pin 12, resulting in increased sensitivity and loop gain of the line oscillator. In this condition the phase locked loop has a low noise immunity, but does have a very wide capture range. Upon achieving synchronisation, the coincidence detector activates the time constant switch and causes a low impedance to be present at pin 12, resulting in a lower sensitivity and loop gain but providing a high degree of noise immunity. During the 'locked' condition the p.l.l. operates with a long time constant.

If required, a short time constant mode can be achieved manually by connecting the output of the coincidence detector on pin 11 to ground. This allows the oscillator to follow rapid fluctuations in the line period which may occur on some non-standard signals.

LINE DRIVER STAGE

Horizontal drive pulses from pin 3 of IC201 are dc coupled to TR201 and used to control the driver transformer T201, which in turn provides the impedance conversion necessary to provide 600mA of forward base current required to guarantee saturation of the line output transistor TR202. R225 and C214 are used to damp out ringing occurring at turn off of TR201 and so limit its Vce to a safe value. The HT supply to the line driver stage is derived from the main HT supply rail prior to R231 and the HT scan interlock (PL201 pins 5 and 6) thus allowing its operation to be checked independently of the line output stage.

VERTICAL SYNC PULSE OUTPUT

The output of the field sync separator is used to drive the vertical sync output stage directly and is available on pin 10 of IC201.

In addition, this pulse is used internally to inhibit the first phase detector during the field sync period thus preventing 'top flutter' as a result of equalising pulses, etc.

SANDCASTLE PULSE

The sandcastle pulse is available on pin 7 of IC201 and is only used on models incorporating the linear interface PCB assembly. It consists of two sections:

1. An upper portion suitable for burst gate and clamping operations derived via the horizontal oscillator thus ensuring an accurate phase relationship between itself and the video information.

2. A Lower portion derived via a line flyback 'slice' used for line blanking operations.

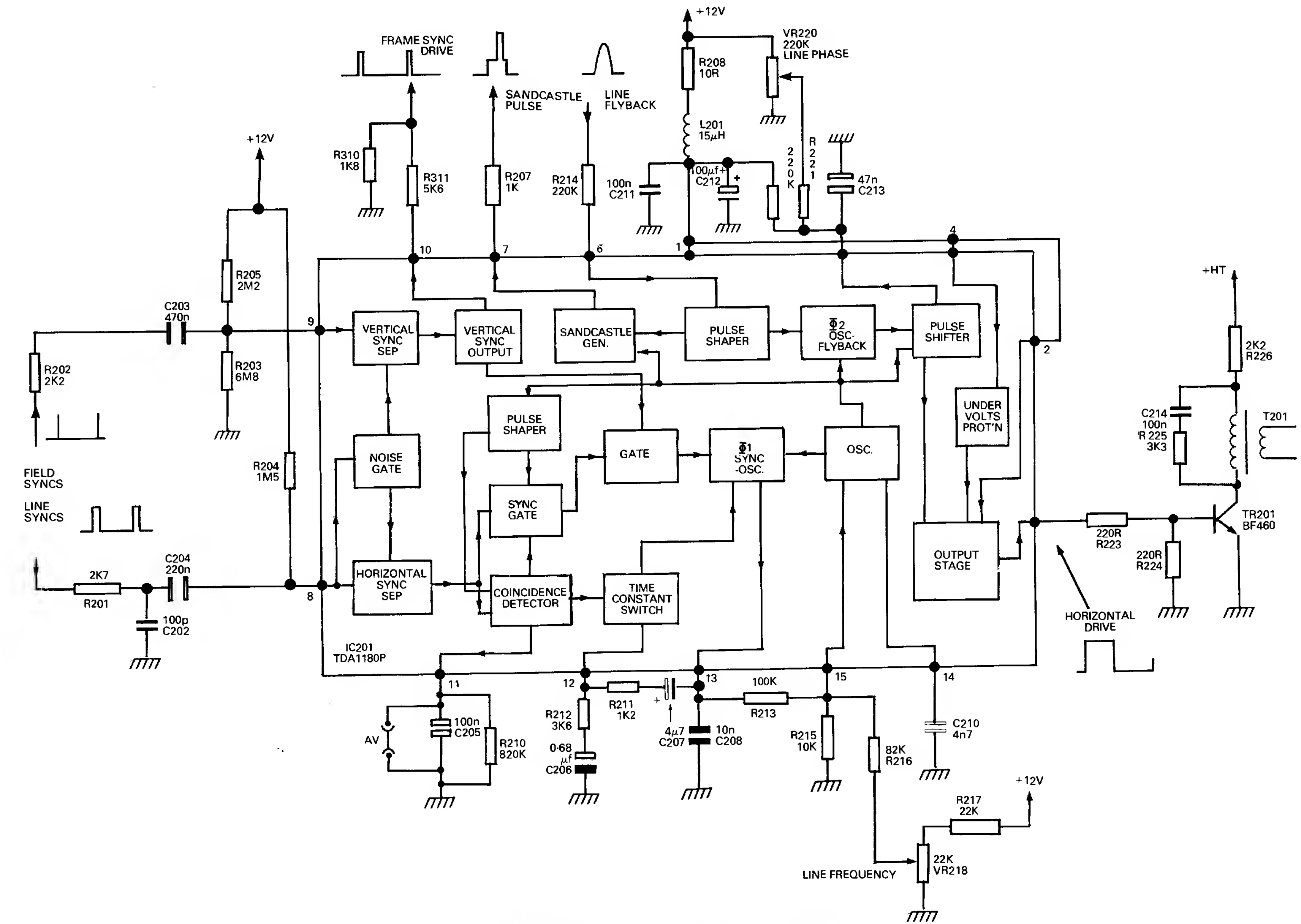


FIGURE 7.1 **LINE TIMEBASE : SIMPLIFIED CIRCUIT DIAGRAM.**

Section 8

FIELD TIMEBASE FIGURE 8.1

The complete field time-base function is carried out by IC301 (TDA1170S). The oscillator frequency is determined by VR307, R308 and C303 and its output, a 100uS pulse, appears at pin 12. The field sawtooth is derived from the potential appearing across C305 and C306 as they charge towards the +25V supply via R304, R305,VR306, and R301. At the end of the field scan the 100uS pulse discharges C305 and C306 ready for the charging cycle to start again.

Linearity is achieved by feedback of the sawtooth output on pin 1 of IC301 via R313 and the field linearity control VR312.

1. **Field Output** – See waveform 13.26

   The sawtooth output on pin 1 is applied to the output stage contained within IC301 and the scan output is available from pin 4 to the field deflection coils. The current in the coils is sampled by R323 and this sample is fed back via R317 to the virtual earth input at pin 10 of IC 301. The gain of the output amplifier is set by the ratio of resistors R314 and R317 and the dc operating point by R318 and R316.

2. **Field Flyback** – See waveform 13.25

   In order to achieve a short field flyback time, a supply voltage larger than that required during scan must be applied to the field deflection coils during the flyback period. This is made possible by the use of a separate field flyback generator within IC301. The main HT supply for IC301 is supplied to pin 5 via D302. During flyback the generator doubles the supply on pin 5, the potential on pin 3 is switched from OV during scan to +25V during flyback. The change in voltage occurs on pin 5 via C304 causing its potential to double during flyback.

   D302 isolates pin 5 from the +25 V supply during this period. When the deflection coil field has collapsed and potential across the field scan coils fall below +25V, pin 3 is switched back to OV and the scan cycle resumed.

   Synchronisation of IC301 is achieved by feeding a positive going field sync pulse on pin 8.

3. **HT Supply For IC301**

   The HT supply for IC301 is derived as a scan rectified rail from the line output stage. C305, C306, are fed via the height control VR306 from the scan rectified supply and from the 12V rail. The proportions of current and associated time constant R303, C301, D301 are chosen so as to minimise 'picture bounce' and maintain accurate tracking of the field scan amplitude with line scan amplitude during CRT beam current variations, thus reducing picture breathing effects to a minimum.

4. **Picture Geometry** – See waveform 13.29

   CRT E-W pincushion distortion is corrected by modulation of the line deflection current in the transductor T202. The transductor is actively driven by TR301 which in turn is fed from the parabolic waveform at the top of the S correction capacitor C311. The ac gain of the amplifying driver stage is controlled by VR328 which in turn is used to control the amount of correction applied to the CRT.

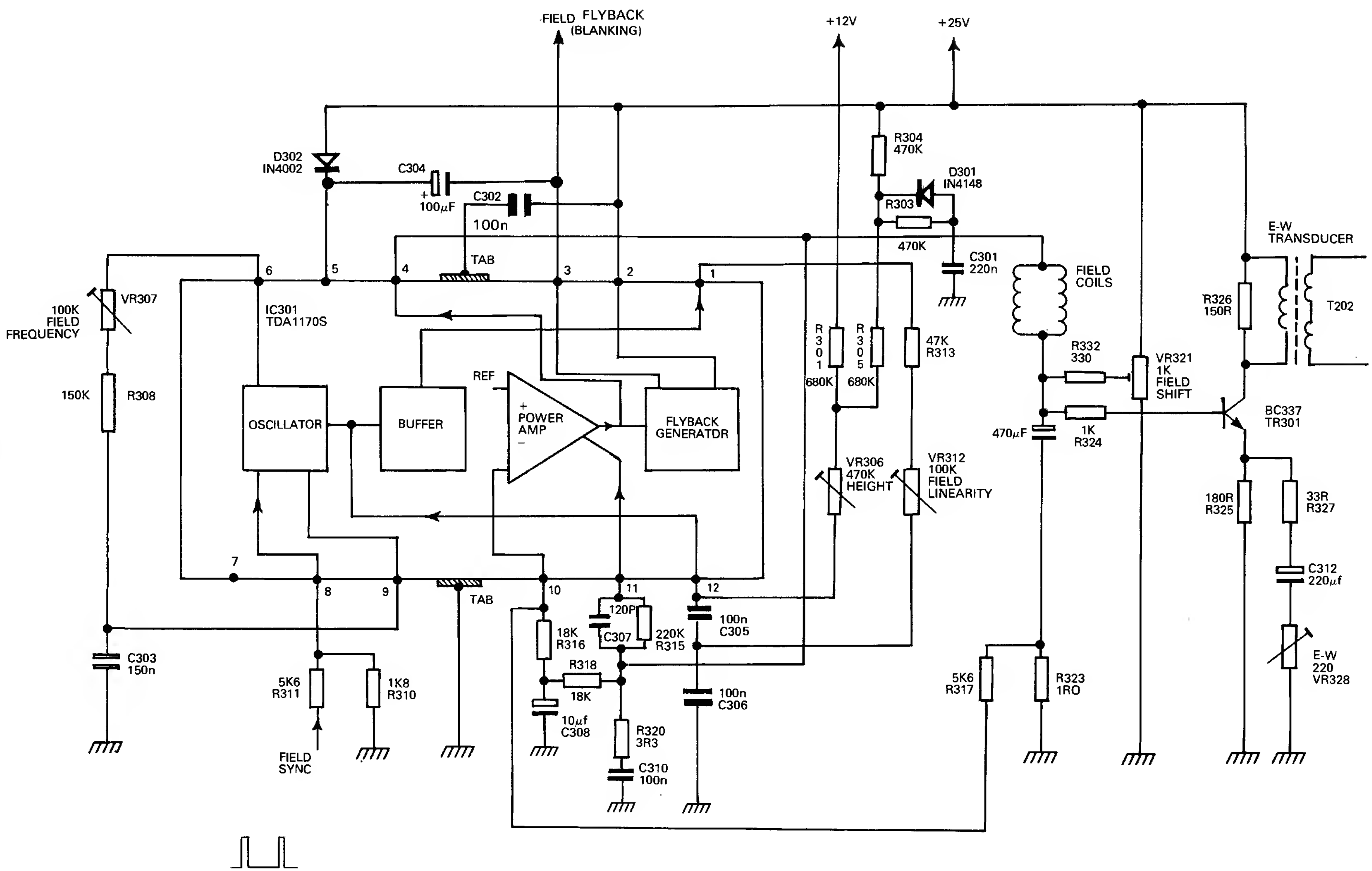


FIGURE 8.1 **FIELD TIMEBASE : SIMPLIFIED CIRCUIT DIAGRAM**

Section 9

VIDEO INPUT INTERFACE CIRCUIT

CIRCUIT DESCRIPTION (See Main Circuit Diagram)

The video input circuit of the LCCD has been designed for maximum flexibility while at the same time maintaining a wide bandwidth with excellent signal to noise ratio especially when operated in the 'TTL' mode.

All input connections are made via PL101, and include; red, green and blue video, sync options 1, 2, and 3 and TTL video normal/invert, all inputs are flashover protected by resistors R102, R103, R104, R105, R106, R107 and Diodes D101, D102, D103, D104, D105 and D106. R, G and B drives are split in two ways:

1. To test selectable links TL103, R, G and B
2. To IC101.

When TL103, R, G and B are in the select '1' position, the input stage acts in a straight forward 'Linear' mode and the video is buffered and level shifted by emitter output stages. These provide temparature tracking with TR103, 104 and 105 thus produce a stable black level. In the linear mode, only brightness variations of the video information are possible, using VR134. Adjustment of contrast is preset by R, G and B gain controls on the tube base panel.

When TL 103 R, G, B in the select '2' position, the bases of TR103, 104 and 105 are driven by IC101, a quad two input open collector exclusive OR package. This option is used when driving from TTL video sources offering primary colour, secondary colour and black and white drives. In the TTL input mode, the signal to noise immunity of the system is excellent. IC101 can also be used with negative TTL level video drives (R, G, and B) and will perform an inversion of the video simply by toggling the video polarity select line available at PL101 pin 2 or TL101;

+5V – Inverse video
OV – Normal video

In TTL mode the contrast of the video information is tracked by varying the potential available across the open collector load resistors R114, 115 and 116 which in turn are supplied by an emitter follower transistor TR101 from +12V, the base of which is driven from the contrast control slider VR111. R112, C101 form a low pass filter and ensure smooth operation of the contrast control.

Beam current information from the CRT panel is fed to diodes D117, and 118, which are fed from a constant current source derived from the 131V main HT rail. As the CRT beam current increases, the junction of D117, 118 tends more negative, causing D117 to conduct more heavily, causing the signal voltage to TR106 base to decrease. This signal (proportional to beam current) is filtered by R136, C105. The derived voltage is emitter followed, and used to source the emitters of TR103, 104 and 105 directly. Hence increases in beam current above a preset limit result in an automatic reduction in picture brightness.

The time constant of R136, C105 is chosen to give a mean acting beam current limit over the active field period.

Beam limiting is preset depending on the LCCD model;

400uA – High and medium resolution
700uA – 14" Standard Resolution TTL/Linear
900uA – 20" Standard Resolution TTL/Linear

The brightness of the display in all modes is adjusted using VR134 and enables the parallel adjustment of R, G, and B black levels within a ±20V range from nominal.

TR102 is a fast switching transistor and is used to derive mixed blanking pulses required for flyback blanking of the video information. The base of TR102 is driven from a resistive potential divider/mixing network from a line flyback pulse and a frame flyback pulse, the line flyback being advanced in phase by C225 in order to allow for transistor switching delays. D107 acts as a speed up diode at turn off by holding TR102 in semi-saturation only.

The remainder of IC101 is used to provide the various sync input options:-
1. Composite negative sync.
2. Composite positive sync.
3. Separate negative line and field syncs.
4. Separate positive line and field syncs.

1. **Composite Negative Syncs**

Composite negative sync is fed in on PL101 pin 7, while TL102 should be positioned in its non-active position, thus allowing pin 2 of IC101 to be pulled high, where upon IC101 performs a sync inversion and so provides an attenuated positive composite sync waveform for driving the sync separators of IC201, via R201 and TL106.

2. **Composite Positive Sync**

Composite sync is fed in on PL101 pin 7 with TL102 in its grounded position, IC101 now provides an output in phase with the input and of a suitable amplitude for driving IC201 directly via R201 and TL106.

3. **Separate Negative Line and Field Syncs**

For operation using separate negative line/field syncs TL102 is placed in its non-active position. Line syncs are fed in on PL101 pin 7 and field syncs on PL101 pin 5. IC101 performs an exclusive OR function and an inverted composite sync waveform is available at the output.

4. **Separate Positive Line and Field Syncs**

Line syncs are fed in via PL101 pin 7 with TL102 in its grounded position, while TL106 is switched over to the inverse field option. In this mode of operation IC101 provides an attenuated and buffered line sync feed for IC201 via R201. Positive field sync information is fed directly at PL101 pin 3 the 'Sync 3' input via TL106 (B) and R202.

On models incorporating a '1 Volt 75ohm Linear Video Input Interface Panel' all sections described above, with the exception of TR102 are deleted. Further details are available in the '1 Volt 75ohm Linear Video Interface Service Supplement.'

Section 10

LINE OUTPUT STAGE FIGURE 10.1

The line output stage operation is based upon the conventional energy recovery principle.

The line deflection coils and associated inductances (L202, 203 and T202 primary) are tuned during the flyback period by capacitor C222. This lasts for a nominal 11.8/11.1 uS on 14/20 inch LCCD's respectively. See waveform 13.20
The line output transistor (TR202) is driven directly from T201's secondary winding, the 'on' current being controlled by R227 while turn off dissipation is minimised using L204 to optimise the storage time.

Line linearity correction is provided by using a fixed 'saturable' inductor L203 which is damped by C216/R228 and adjustment of width is effected by L202, also damped by C217, R230.'S' correction is provided by C218.

The +25V supply for the field timebase (IC301) is achieved by rectifying a negative going flyback voltage obtained from a secondary winding on the line output transformer. R235 is a 10R metal film fusible type in order to provide protection to the CRT under possible fault conditions.

A further winding on T203 provides 6.3V at 0.6A for the CRT heaters.

EHT GENERATION

The EHT supply, nominally 23.5KV for the CRT is generated by means of a tripler module driven from a 7.5KV overwind on T203. The leakage inductance of the transformer, between primary and overwind, is tuned to the 7th harmonic of the flyback frequency by the input capacitance of the tripler and the distributed self capacitance of the overwind. This results in a much improved EHT regulation over the more conventional designs.

The 'breathing' performance of the display is further improved by deriving the high voltage focus potential via a resistive thick film/substrate potential divider chain from the EHT. This gives rise to a constant bleed current from the EHT thus lowering the output impedance of the EHT circuit.

An extra input diode within the tripler has its anode connected to the tube base ground and via a beam current sensing circuit to OV. C223 and the network R236, R933, R934 and VR932 provide a load for the diode and effectively damp out ringing which may occur during scan. The resulting 1000V which occurs across C223 is used to generate the A1 potential required for the CRT. Adjustment of the A1's is made on the tube base panel by means of VR932.

HT SUPPLY

The HT supply for the line output stage is from the main secondary winding of the switch mode power supply, via R231. R231 is chosen to optimise the picture breathing performance and offer protection to the line output transistor during CRT flashover as well as providing a renewable fusible link for operation under possible fault conditions.

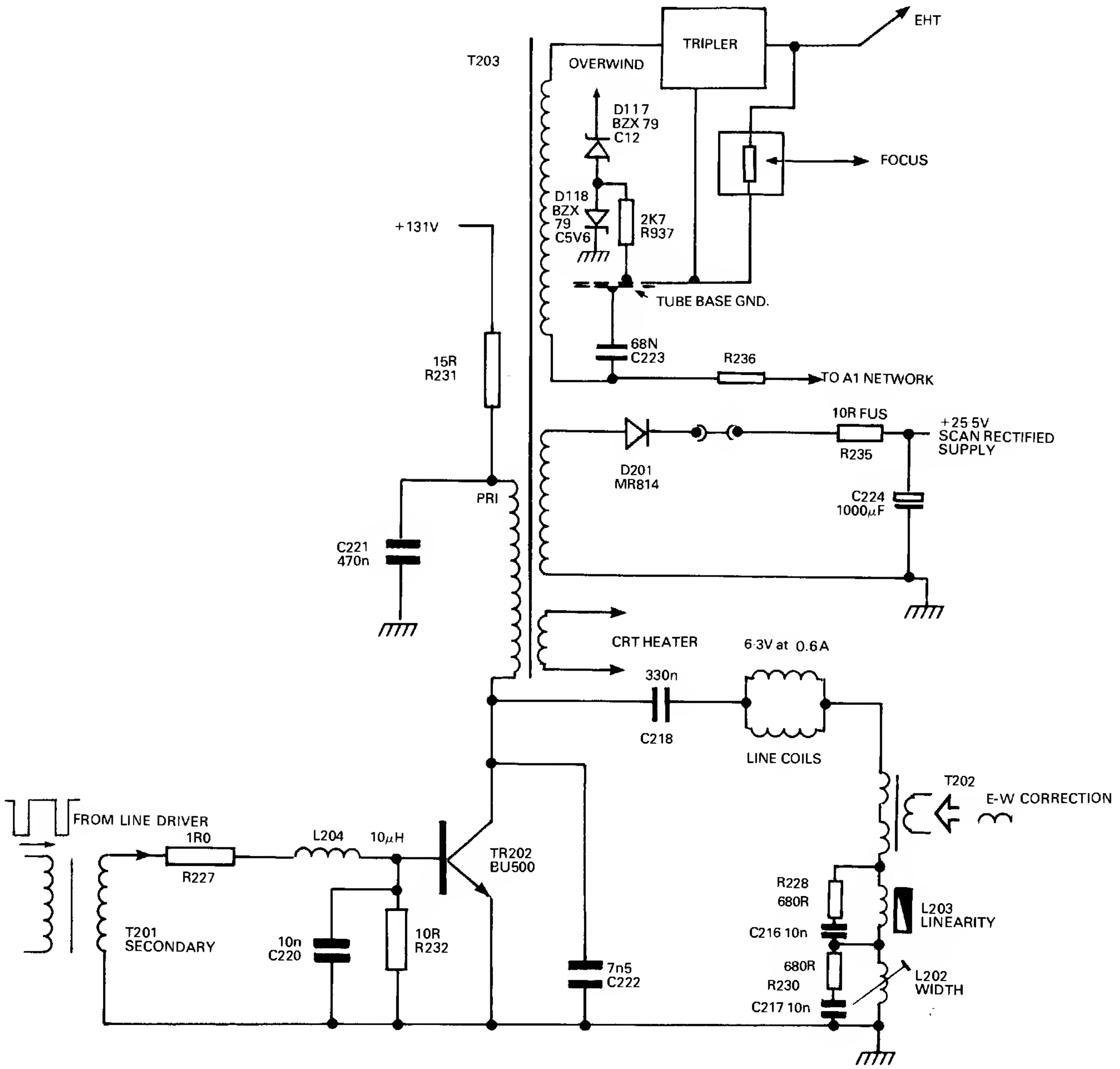


FIGURE 10.1 **LINE OUTPUT STAGE : SIMPLIFIED CIRCUIT DIAGRAM**

Section 11

CRT TUBE BASE PANEL

For preset control locations see figures 11.2 and 11.3

CIRCUIT DESCRIPTION FIGURE 11.1 (TB3 ISSUES 1 TO 4)

The CRT base panel contains special spark gaps, capacitors and carbon composition stand off resistors required to enhance the LCCD's flashover performance.

All CRT electrodes are protected by a resistor, a capacitor and a spark gap. The spark gaps on all electrodes except focus are formed by means of a 1 – 2KV ring trap gap situated within the CRT base socket assembly, while the high voltage focus has a separate 10KV spark chamber also integral to the tube base socket.

CRT cathodes are stood off from the video outputs by 1K protection resistors, the grid by a 100K resistor and the A1's by an 82OK resistor, Decoupling of the grid and A1's is achieved by capacitors C910, C911.

The focus electrode potential is provided from a thick film substrate potential divider module located within the tripler and provides an adjustable voltage of 5 – 8KV.

The A1 potential is adjusted using VR932 and has a range of 350 – 820 volts.

The CRT heaters are driven from the line output transformer T203 and may be disconnected by removing TL901 for purposes of video output adjustments.

The CRT cathodes are driven directly from the video output stages mounted on the CRT base panel, this improves product reliability, maximises the video bandwidth and minimises RF radiation.

VIDEO OUTPUT STAGES CIRCUIT DESCRIPTION

The video output stages are essentially class A type with active loads. red, green and blue video outputs are identical in terms of their circuit and great care was taken during the layout to ensure similarity in terms of stray capacitance. The circuit description will therefore relate to the red output stage only.

TR902 forms the basic Class A amplifier whose AC gain is determined by the ratio R935 to R902, VR903 and DC gain or operating point by a DC off-set current via R905 and VR906, R904 forms the video output load and TR902 represents a low impedance drive source to the CRT input cathode capacitance during its conduction, in particular its ability to sink current on negative going edges of video by discharging the cathode capacitance.

During the turn off of TR902, ie:- a transition from peak white to black level, the source impedance of the load R904 is considerably reduced using an emitter follower (TR901) as an impedance converter, thus ensuring good 'pull up' performance even at high frequencies by rapidly sourcing current to re-charge the cathode input capacitance.

Video compensation is achieved by capacitors C902, 903. Split capacitances in this way help to maintain a reasonably constant amplifier response curve over the entire range of VR903.

The emitters of TR902 TR904, 906 are connected together and sit on a DC reference of about 7.5V, this is used to set the video black level voltage and may be considered to operate as the positive input of a virtual earth amplifier system.

Line and field blanking of the video information is achieved using transistor TR907.

TR907 is driven with negative going mixed blanking pulses derived from TR102. During the active line, TR907 conducts providing a 7.5V black level reference, however during line and field flyback TR907 is turned off forcing the video outputs off. CRT beam current information is also sensed on the tube base panel resistively across the line output ground to OV line by means of R937, and D117, 118 on the main PCB.

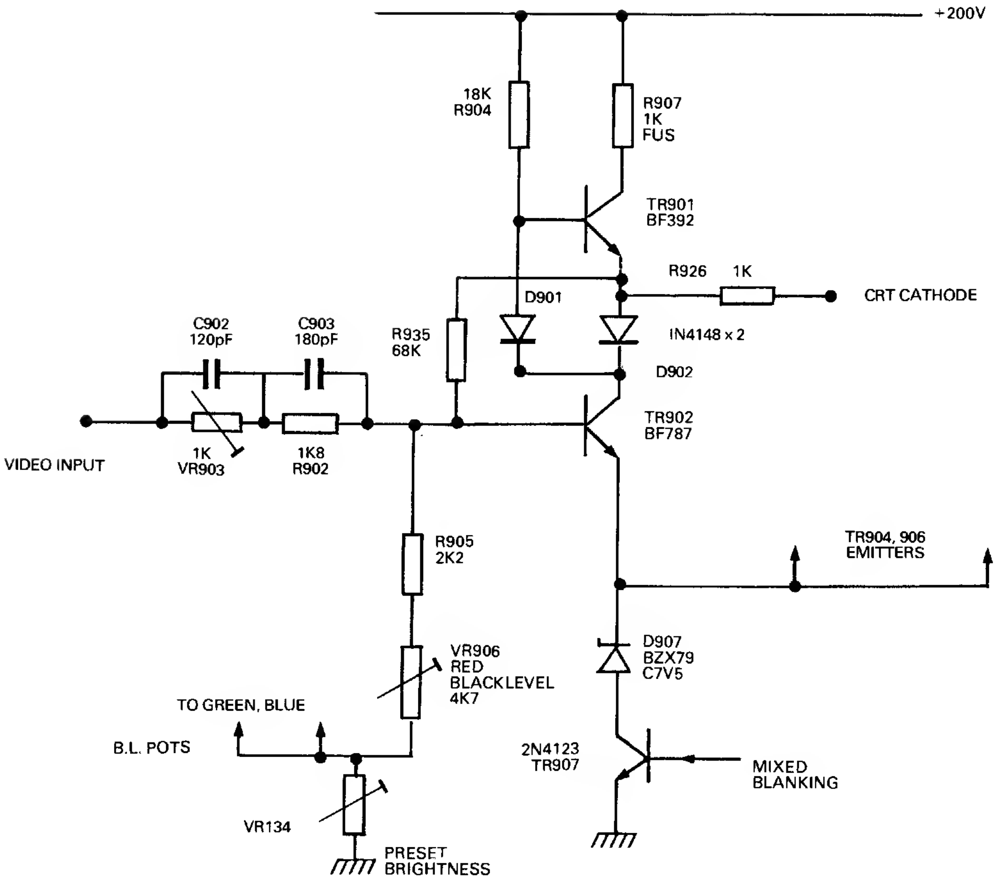


FIGURE 11.1 **FIG 1 : RED VIDEO OUTPUT STAGE : SIMPLIFIED CIRCUIT DIAGRAM**

CRITICAL
SAFETY CONNECTION

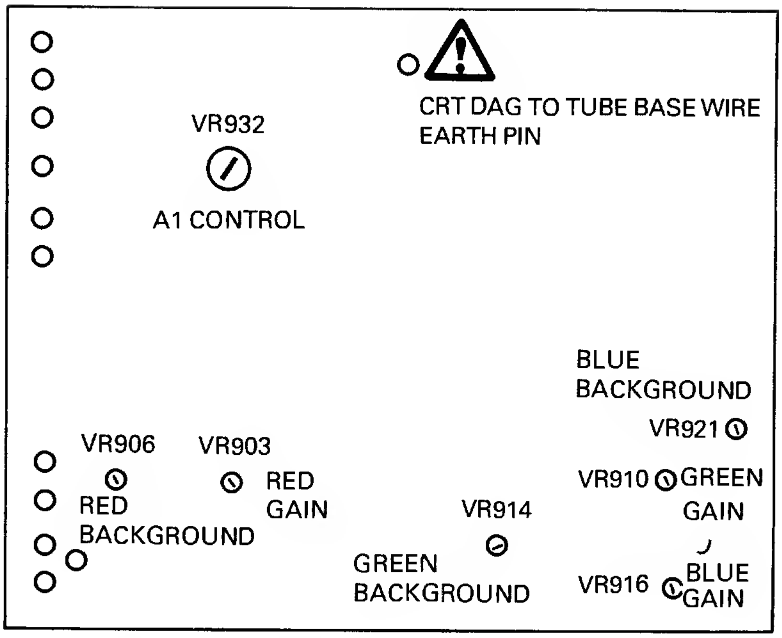


FIGURE 11.2 TRACK SIDE

LCCD: TUBE BASE PANEL – PRESET CONTROL LOCATIONS

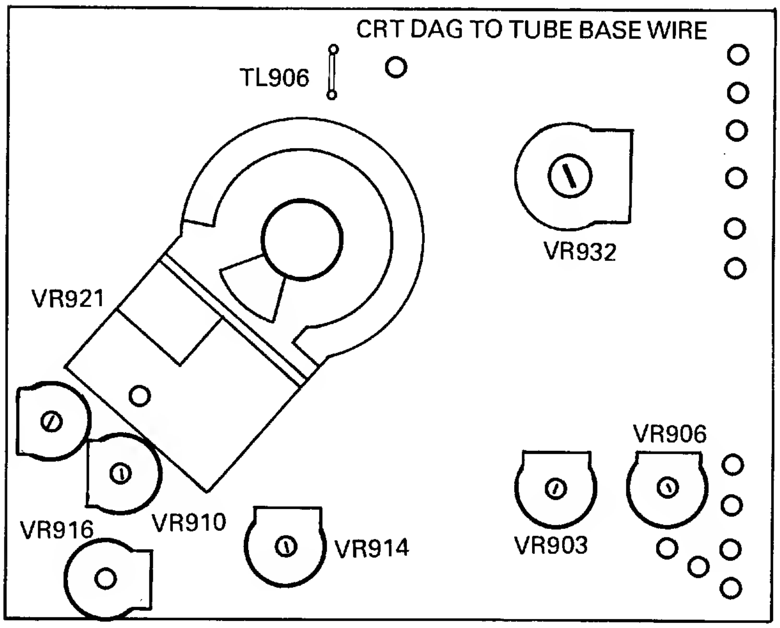


FIGURE 11.3 COMPONENT SIDE

CIRCUIT DESCRIPTION SUPPLEMENT – TB3 ISSUE 5

The following changes to TB3, Issues 1 to 4, are made to TB3 Issue 5 to increase the video bandwidth from 7 MHz to approximately 15 MHz (depending on the video gain setting and tube used).

The changes to the red channel only are described:

R904 is changed from 18K resistor to 15K
R935 is changed from 68K resistor to 47K
R907 is changed from 1K resistor to 100R
R926 is changed from 1K resistor to 220R
R902 is changed from 1K8 resistor to 2K2
C902 is changed from 75pF capacitor to 27pF

On the main panel resistors R131, 132 and 133 are changed from 470R to 100R, and resistor R138 is not fitted. R137 is fitted and is 180K.

Section 12

SWITCHED MODE POWER SUPPLY FIGURE 12.1

The power supply is a variable frequency, self oscillating, switching flyback converter type providing mains isolation.

The design features a simple discrete control circuit, a high voltage switching transistor, a direct mains derived low power start up circuit and a high overall conversion efficiency.

The power supply is used to provide three stabilised voltages, 18 volts, 124 volts and 200 volts.

CIRCUIT DESCRIPTION

1. CONTROL CIRCUIT

Initially we will consider the power supply to be operating normally in the steady state. As TR2 turns on a step voltage whose amplitude depends upon the instantaneous value of the rectified mains is applied across the primary of T2. The current in the winding and TR2's collector increases linearly from zero during which time energy is stored as flux in the transformer. During this period the output diodes D22, 23, 24 are reverse biased and any energy supplied to the load is via C27, 28, 31 and 26 from the previous cycle of operation. TR1 forms the error amplifier or control function, and is supplied with power from a reference winding on the transformer (nominally +30V). During the on time of TR2, the emitter of TR1 is held at a constant potential W.R.T. the reference rail via D18. However, since TR1's base is fed directly from the reference rail, via R3, VR4 and R5, then any change of voltage on the reference rail arising from a change of voltage at the main output (via D23) will vary the base-emitter voltage and hence the current. In turn TR1's collector current will vary, causing the constant current source, used to charge C16 via R10, to vary in sympathy.

C16 charges up at a rate depending upon the amount of current available via R10, and the voltage across C16 exponentially increases until it reaches the gate-trigger voltage of the 'turn off device TY1, where-upon TY1 conducts and 'crow-bars' the base drive to TR2. TR2 ceases conduction and its collector voltage becomes positive very rapidly. The dV/dT at TR2's collector is limited to a safe value by C17, R12 and D17. As this occurs, D22, 23, 24 and 21 become forward biased and stored energy within the transformer is transferred into the output capacitors and their respective loads.

During the 'off' period the base drive winding goes negative thus ensuring TR2 remains off until the next conduction period. D8, D10, D11 limit the negative off drive and so protect TY1.

Eventually, depending upon the load, the energy in the transformer is exhausted and the voltages on D6, 21, 22, 23 and 24 anodes collapses as does the collector-emitter voltage of TR2, during which time the base drive winding tends more positive, TY1 is forced off prior to this stage by negative volts on its anode therefore allowing TR2 to turn on. Full base drive is then sustained via R16.

HT stabilisation is achieved by controlling the duty cycle of the switching transistor. Increasing load increases the duty cycle and the peak collector current, while increasing supply mains increases the overall operating frequency. HT adjustment is performed via VR4.

Extra damping in the form of C14, R6 and D7 is provided in order to limit the maximum Vce of TR2 to a safe value, even under fault conditions. D15, 16 provide negative off drive and base current tracking while L2 optimises the storage time of TR2 for minimum switching losses.

The maximum available power is determined by measuring the peak collector current of TR2 and is sensed by R15. If the voltage across R15 at any time exceeds the voltage across TY1 gate-cathode plus three diode drops D12, 13, 14, then TY1 is immediately brought into conduction thus turning TR2 off. This sequence of events happens during the start up sequence at low mains and under fault conditions.

2. **Start up Procedure** – See waveform 13.2

Start up power for the SMPSU is derived from a half wave rectified positive going differentiated pulse from the mains supply. The current required at start up is small compared with the base drive current under normal operating conditions because of the self oscillating nature of the design. Once turn on of TR2 has been achieved in this manner (once every 20 ms) the oscillation becomes self-sustaining. R8 continues to supply current even under normal operation but is swamped by the forward base drive via R16.

During the start up period the peak collector current is limited by R15. C21, R18 and 20 provide active feed forward so as to provide excellent ripple rejection over the mains range 180-265 volts or 90-130 volts depending upon the model of LCCD.

3. **Over Voltage Protection** – See waveform 13.10

Over voltage protection and hence the maximum permissible EHT is controlled by a second feedback loop attached to TY1. This consists of a zener diode reference which senses the reference rail voltage, and hence proportionally the HT voltage. If this reference exceeds the zener voltage, D20 conducts, fires TY1 and terminates the drive to TR2, during which time sufficient volts are developed across TY2 gate-cathode to cause it to enter conduction and latch on. Drive to TR2 is now terminated until all the energy from C23 has been removed (10ms). The power supply is held off during this period and remains so until the presence of the next mains start up pulse, after which conduction of TR2 will again occur.

Energy again flows into and out of the transformer T2 and into the secondary circuits until the over voltage condition is again reached, after which the whole cycle of events is repeated.

4. **Short Circuit Protection** – See waveform 13.10

Short circuit or over current on any output rail represents an increase in stored energy required from the transformer T2, and therefore an increase in collector current through TR2, again this is detected by R15 and above a preset load, TY1 is fired and TR2 turned off. The supply now operates in 'Burst Mode'. This means that the power supply is initiated as under normal start up conditions once every mains cycle, but only operates for a few switching cycles during which time the over current protection again comes into operation thus terminating the drive to TR2.

5. **Mains Input Circuit**

This consists of a diode bridge preceeded by a surge limiting thermistor and optional mains filter network. Degaussing is automatic at switch on and employs a dual PTC thermistor. The mains filter networks, when fitted, provides suitable suppression of the symmetric and assymetric radiation developed within the SMPSU concept.

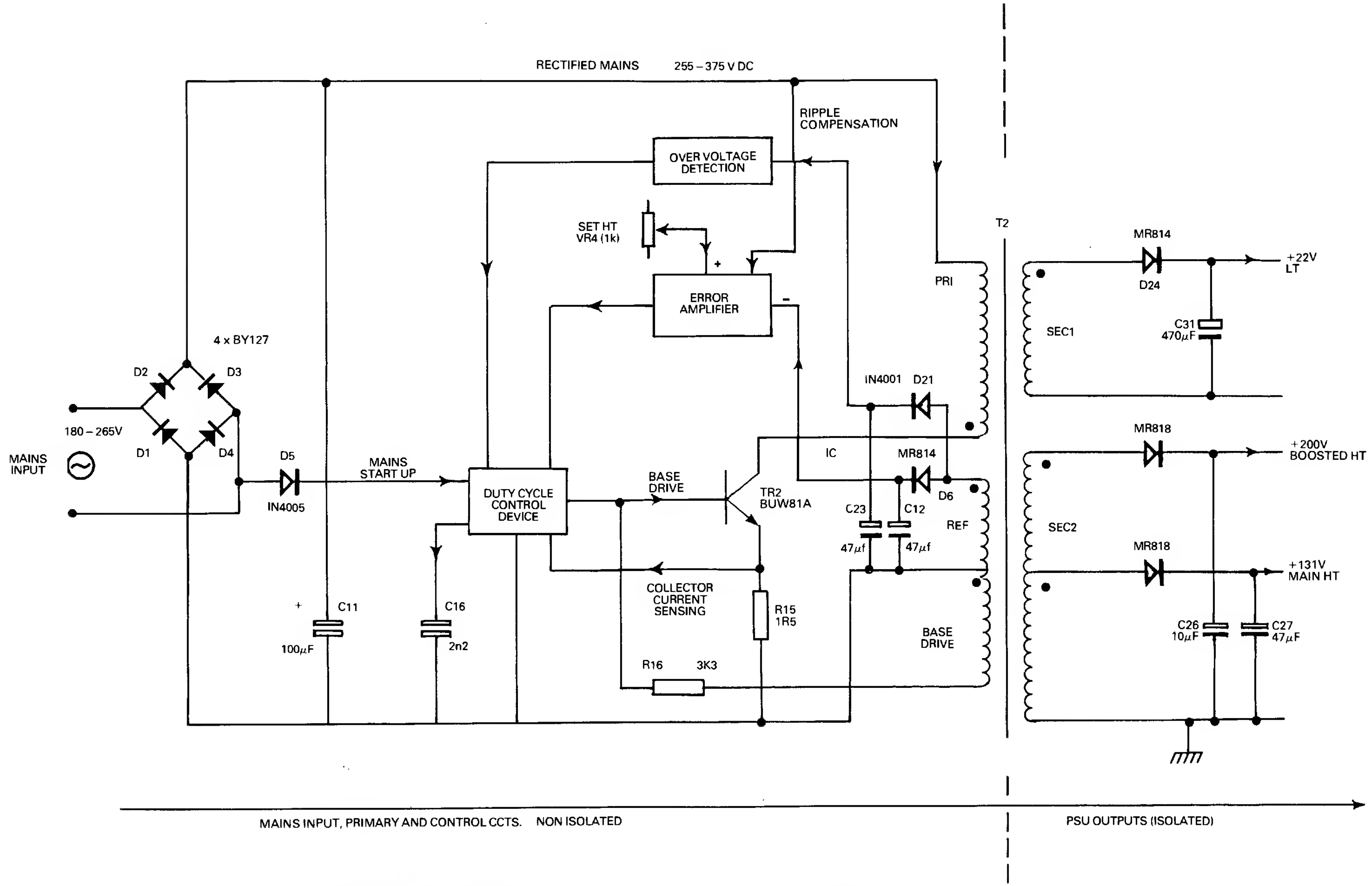
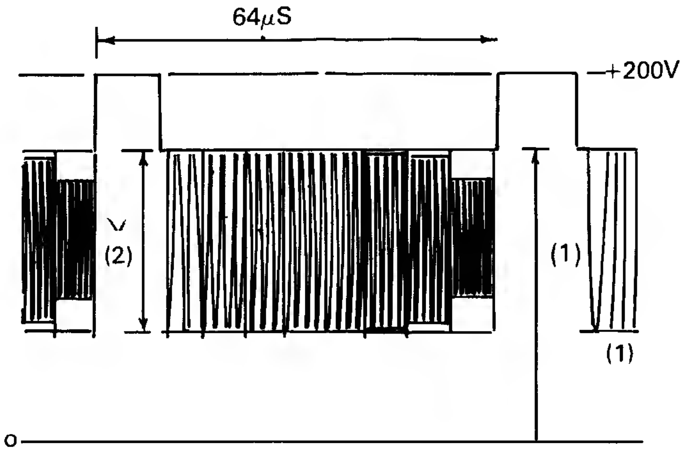
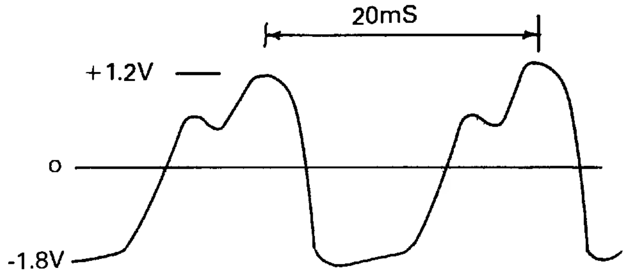
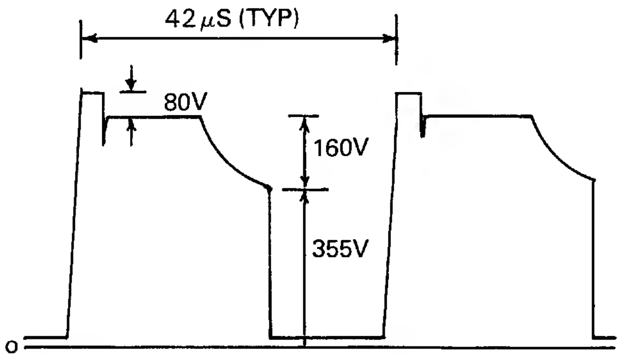
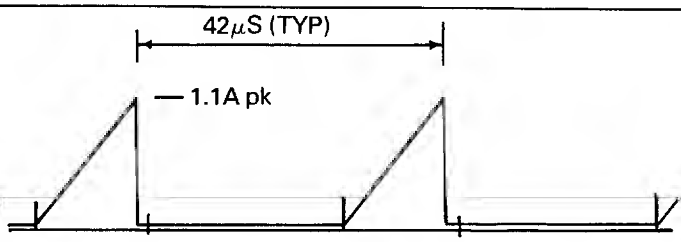
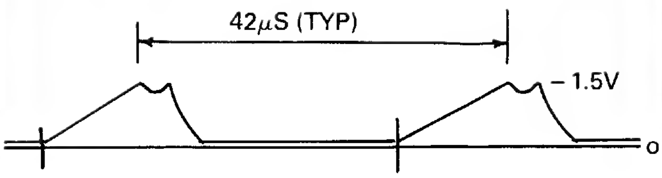
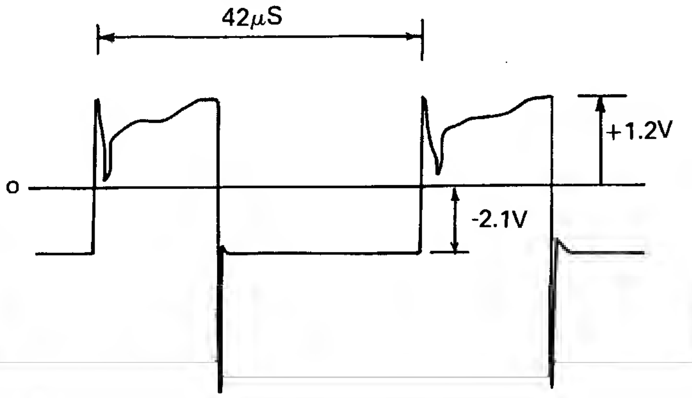
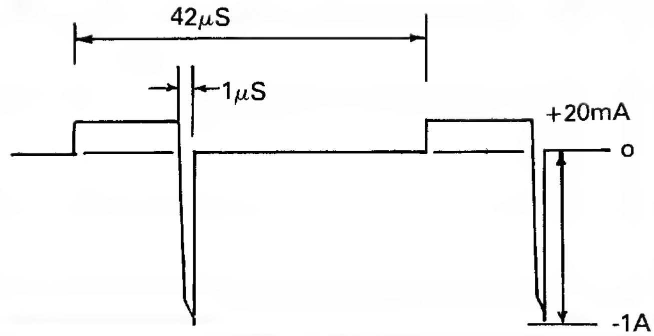
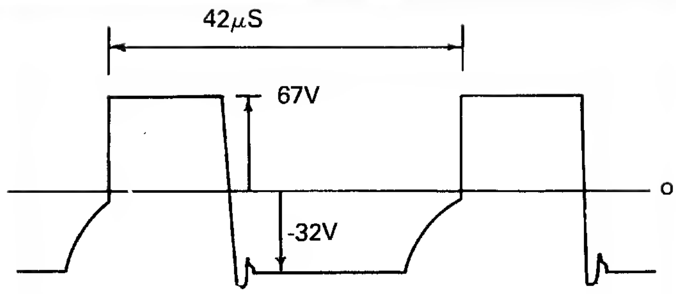
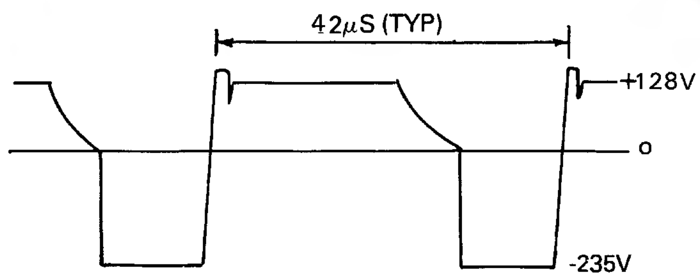
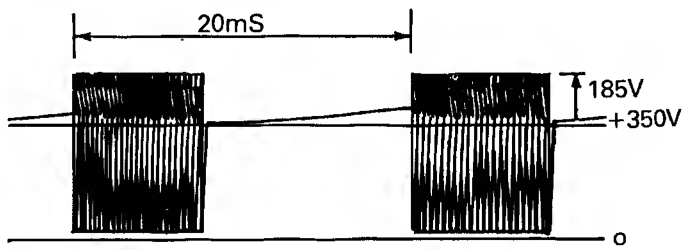
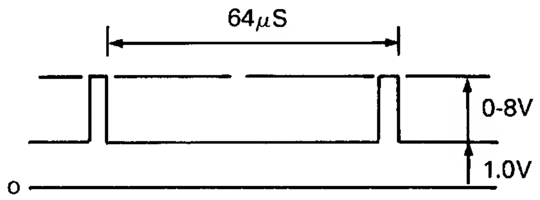
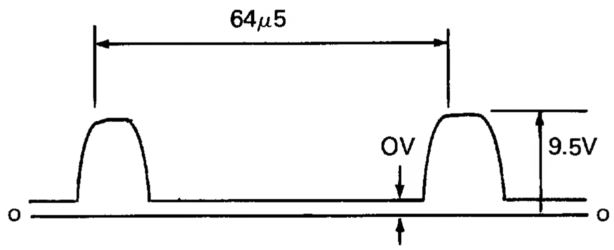
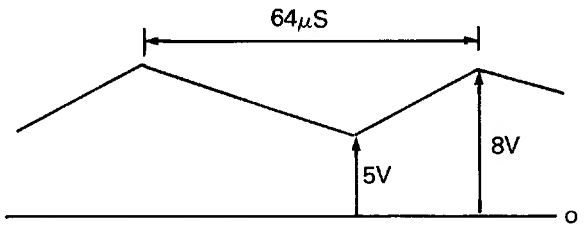
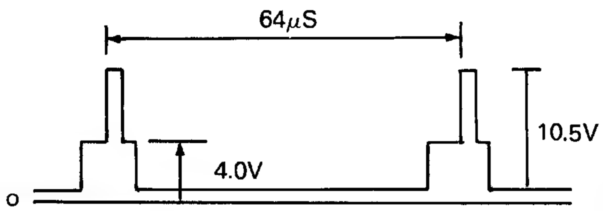
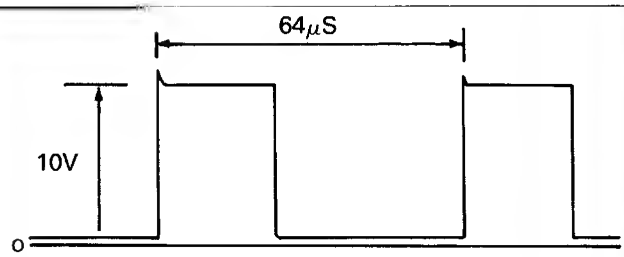
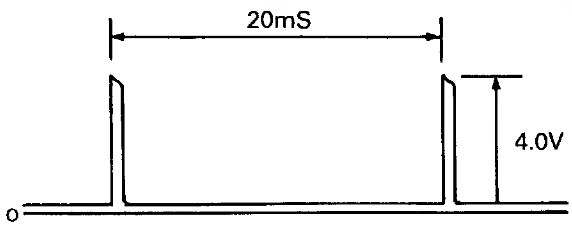


FIGURE 12.1 **SWITCHED MODE POWER SUPPLY CONCEPT : SIMPLIFIED CIRCUIT DIAGRAM**

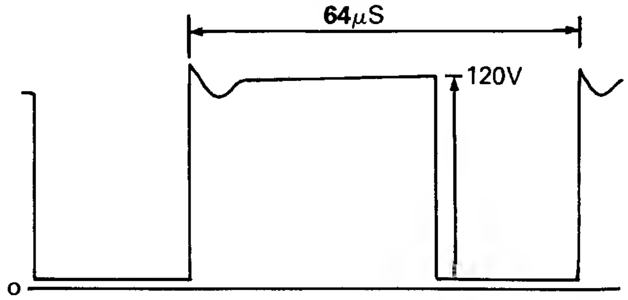
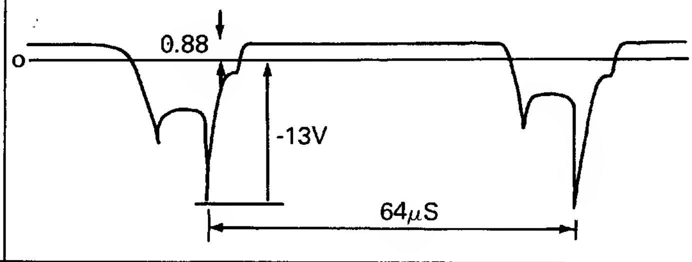
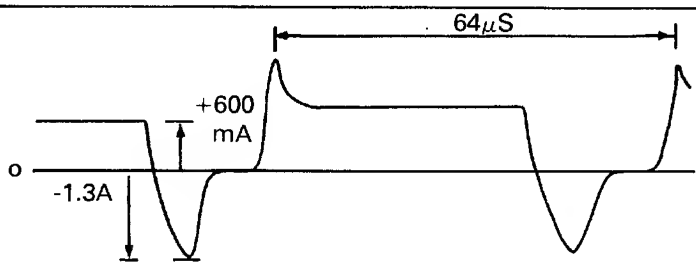
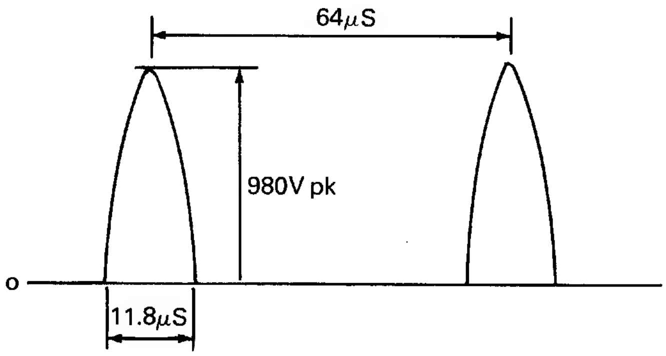
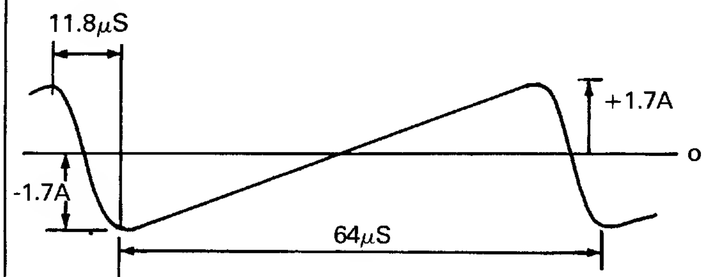
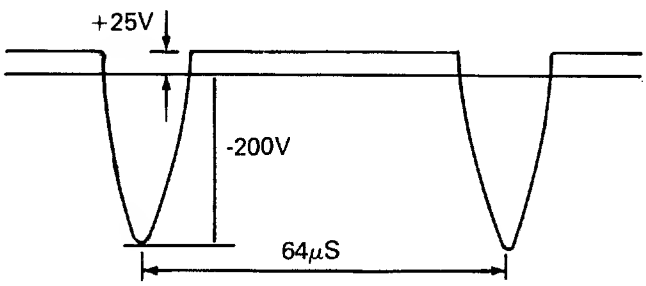
W/F No.	TEST POINT	WAVEFORM	DESCRIPTION
1	TR901, 903, 905 EMITTERS.		VIDEO OUTPUT WAVEFORM RED, GREEN, AND BLUE. (1) BLACK LEVEL 150V – 14" Standard LCCD 150V – 14" Linear LCCD 155V – 20" Standard LCCD 155V – 20" Linear LCCD 140V – 14" High Res LCCD (2) GAIN. 85Vp-p – 14" Standard LCCD 60Vp-p – 14" Linear LCCD 95Vp-p – 20" Standard LCCD 60Vp-p – 14" High Res LCCD
2	TR2 BASE F3 NOT FITTED. W.R.T. NON-ISOLATED GROUND		TR2 BASE DRIVE VOLTAGE (F3 NOT FITTED) START UP WAVEFORM. 240V RMS MAINS INPUT
3	TR2 COLLECTOR W.R.T. NON—ISOLATED GROUND		TR2 COLLECTOR VOLTAGE WAVEFORM. 240V RMS MAINS INPUT 400μA AVERAGE CRT BEAM CURRENT
4	TR2 COLLECTOR		TR2 COLLECTOR CURRENT WAVEFORM. 240V RMS MAINS INPUT. (400μA BEAM CURRENT)
5	R15 W.R.T. NON--ISOLATED GROUND		TR2 EMITTER CURRENT SENSED AS A VOLTAGE ACROSS R15. 240V RMS MAINS INPUT (400μA BEAM CURRENT)

WAVEFORMS

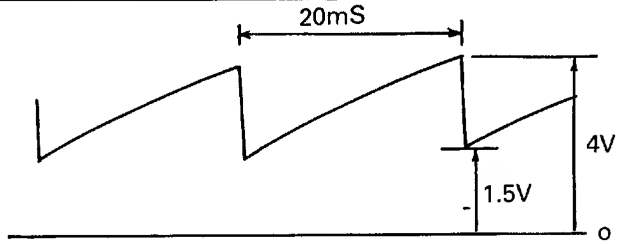
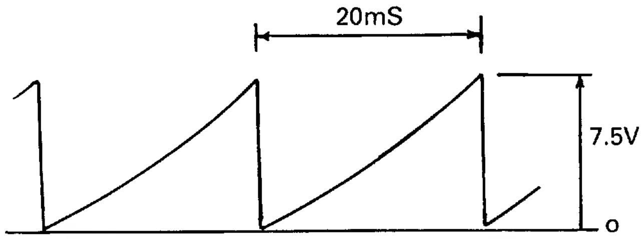
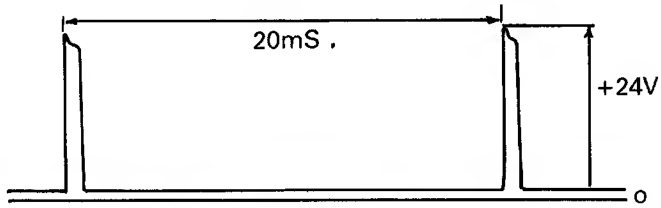
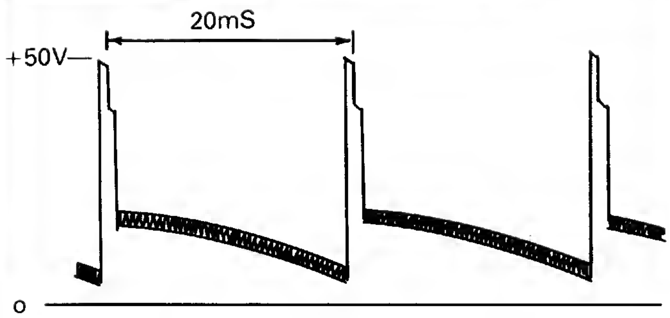
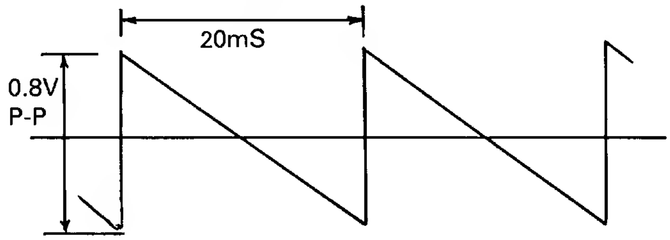
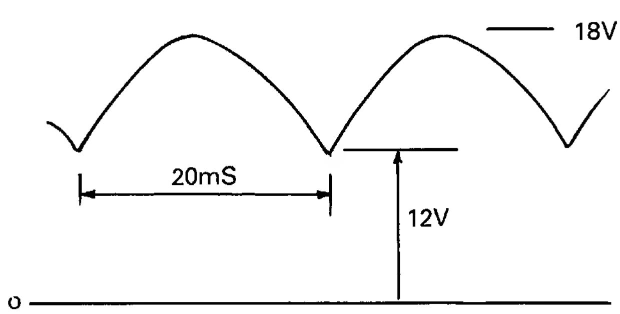
W/F No.	TEST POINT	WAVEFORM	DESCRIPTION
6	TR2 BASE W.R.T. EMITTER		TR2 BASE DRIVE VOLTAGE WAVEFORM WRT EMITTER
7	TR2 BASE CURRENT		TR2 BASE DRIVE CURRENT WAVEFORM.
8	T2 PIN (4) W.R.T. NON—ISOLATED GROUND.		BASE DRIVE WINDING DRIVE VOLTAGE (PIN 4)
9	D23 ANODE		ISOLATED SECONDARY VOLTAGE DRIVE WINDING (D23 ANODE)
10	TR2 COLLECTOR		TR2 COLLECTOR VOLTAGE ENVELOPE, UNDER 'OVER VOLTAGE' FAULT CONDITION. 'EXTENDED BURST MODE'

W/F No.	TEST POINT	WAVEFORM	DESCRIPTION
11	IC201 pins 8 and 9.		Mixed Sync Pulses at Line rate
12	IC201 pin 6		Line Flyback p.1.1. Ref Pulse input
13	IC201 pin 14		Line oscillator
14	IC201 pin 7		Sandcastle Pulse
15	IC201 pin 3		Line Drive Information
16	IC201 pin 10		Field Sync Output

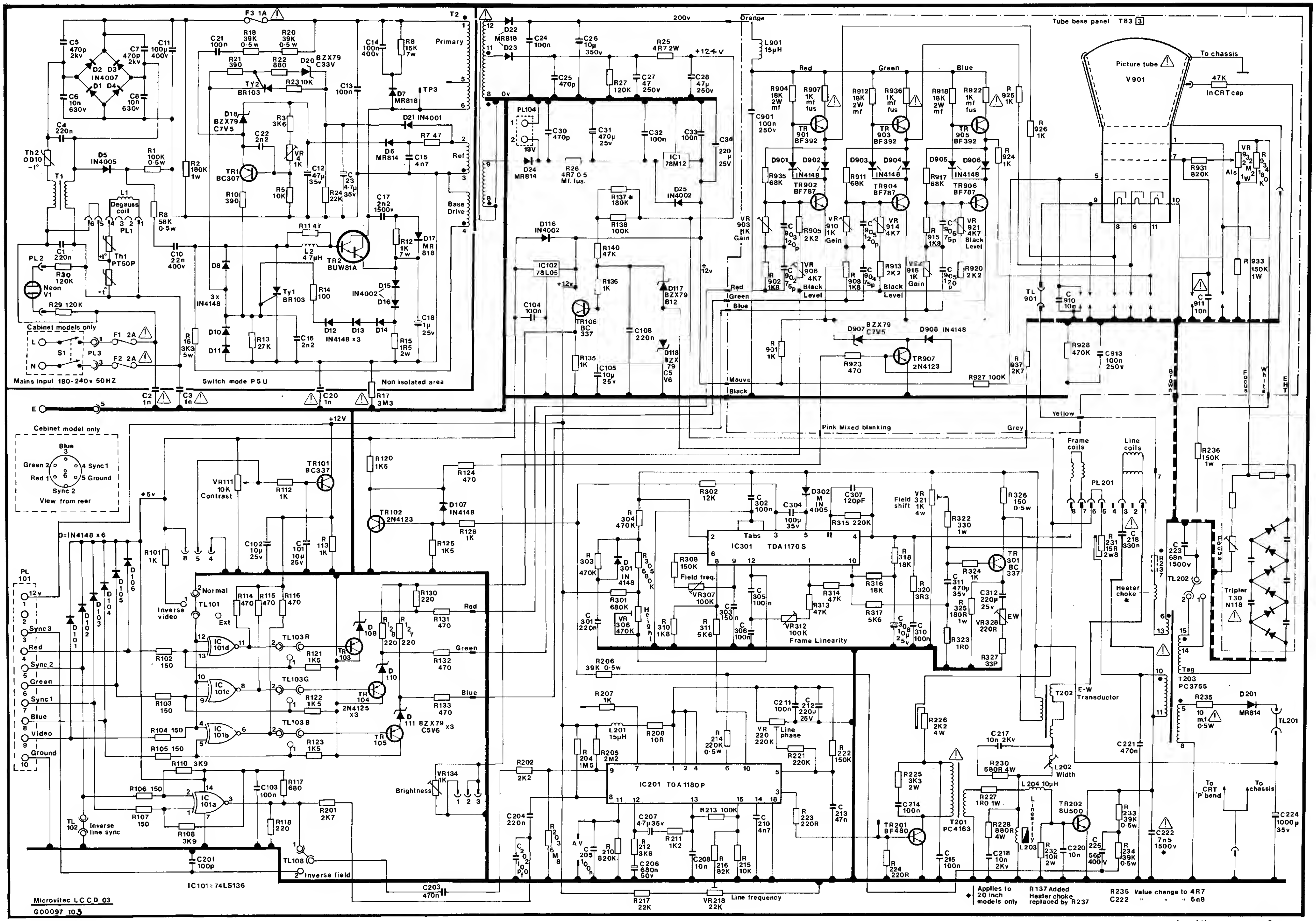
WAVEFORMS

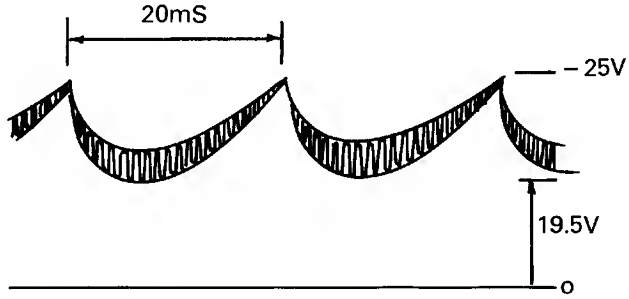
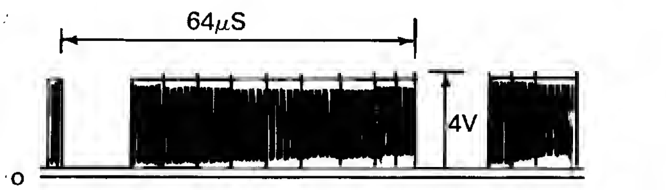
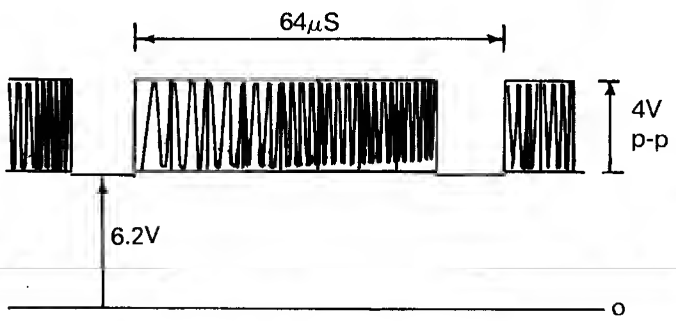
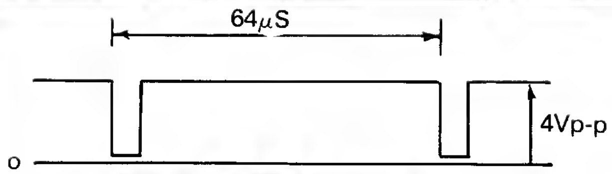
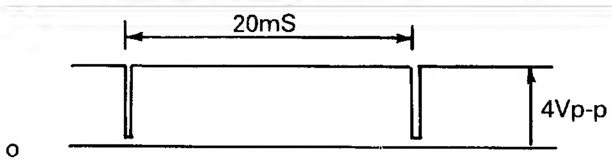
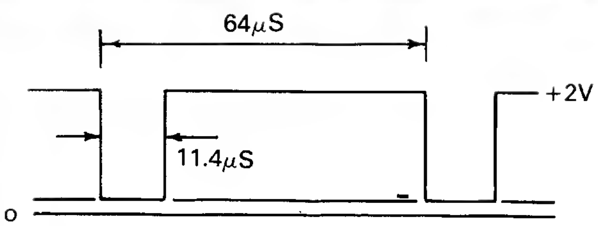
W/F No.	TEST POINT	WAVEFORM	DESCRIPTION
17	**TR201 COLLECTOR**		LINE DRIVER PRIMARY WAVEFORM
18	TR202 BASE		LINE OUTPUT TRANSISTOR BASE DRIVE VOLTAGE
19	TR202 BASE		LINE OUTPUT TRANSISTOR BASE DRIVE CURRENT.
20	TR202 COLLECTOR		LINE OUTPUT TRANSFORMER COLLECTOR – EMITTER VOLTAGE
21	LINE SCAN COILS		LINE SCAN DEFLECTION CURRENT
22	LINE OUTPUT FRAME HT SUPPLY (D201 ANODE)		SCAN RECTIFIED SUPPLY WAVEFORM.

WAVEFORMS

W/F No.	TEST POINT	WAVEFORM	DESCRIPTION
23	IC301 PIN 9		FIELD OSCILLATOR WAVEFORM.
24	IC301 PIN 12		RAMP GENERATOR.
25	IC301 PIN 3		FIELD FLYBACK GENERATOR
26	IC301 PIN 4		FIELD OUTPUT WAVEFORM
27	R323		FIELD COILS (SAWTOOTH CURRENT).
28	TR301 BASE DRIVE		FIELD PARABOLA WAVEFORM

Section 14 CIRCUIT DIAGRAM: MODELS 1431, 1432, 2031, 2032.



W/F No.	TEST POINT	WAVEFORM	DESCRIPTION
29	TR301 COLLECTOR		E—W TRANSDUCTOR DRIVE WAVEFORM
30	PL101 PINS 4,6,8		VIDEO INPUTS (RED, GREEN AND BLUE)
31	R,G,B DRIVE TO TUBE BASE		CONTRAST CONTROLLED VIDEO DRIVES. (RED, GREEN AND BLUE)
32	IC101 PINS 2,1	 	SEPARATE NEGATIVE SYNC INPUTS LINE SYNCS FIELD SYNCS
33	IC101 PIN 3		COMPOSITE SYNC OUTPUT (LINE AND FIELD)
34	TR102 COLLECTOR		MIXED BLANKING PULSE TRAIN. (LINE AND FIELD).

Section 15

FAULT FINDING

A logical approach to fault finding the LCCD should be adopted, in common with other electronic equipment.

The following guide lines may prove useful:

1. Isolate the section of the circuit within which the fault exists.

2. If the fault is visible on the display, determine whether it is timebase (line or field), video or power supply orientated.

3. If no picture is present on the CRT, check all CRT base voltages, and the stabilised power supply output rails (200V, 124V 18V)
   If the power supply is suspected, the fault charts at the end of this section should help.

4. Use should be made of the oscilloscope waveforms, in association with the circuit descriptions, and circuit diagrams as well as voltage measurements to help find the fault.

5. There are a couple of test links in the LCCD, included to facilitate fault finding, particularly useful for video output faults;

   A. TL901 removes the CRT heater voltage, preventing excessive beam current.

   B. TL201 allows the frame timebase section to be isolated from the line output stage.

6. In addition to (5), a link at PL201 (5, 6) enables the 124 volts to the line output stage to be disconnected when this plug is removed. Under these conditions, HT still remains connected to the Line Driver Transformer (TL201) enabling the Line Output Transistor base drive conditions to be checked independently.

7. Fusible resistors are fitted in the HT supply to the line Output stage, LT supply to the 12V regulator and the scan rectified supply to IC301. Failure of one of these components automatically directs attention to the part of the circuit in which the fault may be found.

8. If the fault is located within the line output stage it may be useful to remove the tripler to overwind connection thus preventing the generation of EHT under adverse conditions.

9. Fusible resistors are also fitted on the tube base panel, (R907, R936, R922) and are used to protect the video output transistors from faults in the output stages.

POWER SUPPLY

Since the Power Supply has a number of built in protection and overload circuits, many faults will cause the power supply to enter 'Burst Mode'. An overload on TR2, or any of the supply rails (124 volts, 200 volts or 18 volts) causes the PSU to enter Burst Mode (ie. The supply operates normally for only a few operating cycles per mains cycle and makes a distinctive 'buzzing' noise). This cycle of events is continuous and no harm will occur to the LCCD under prolonged operation in Burst Mode.

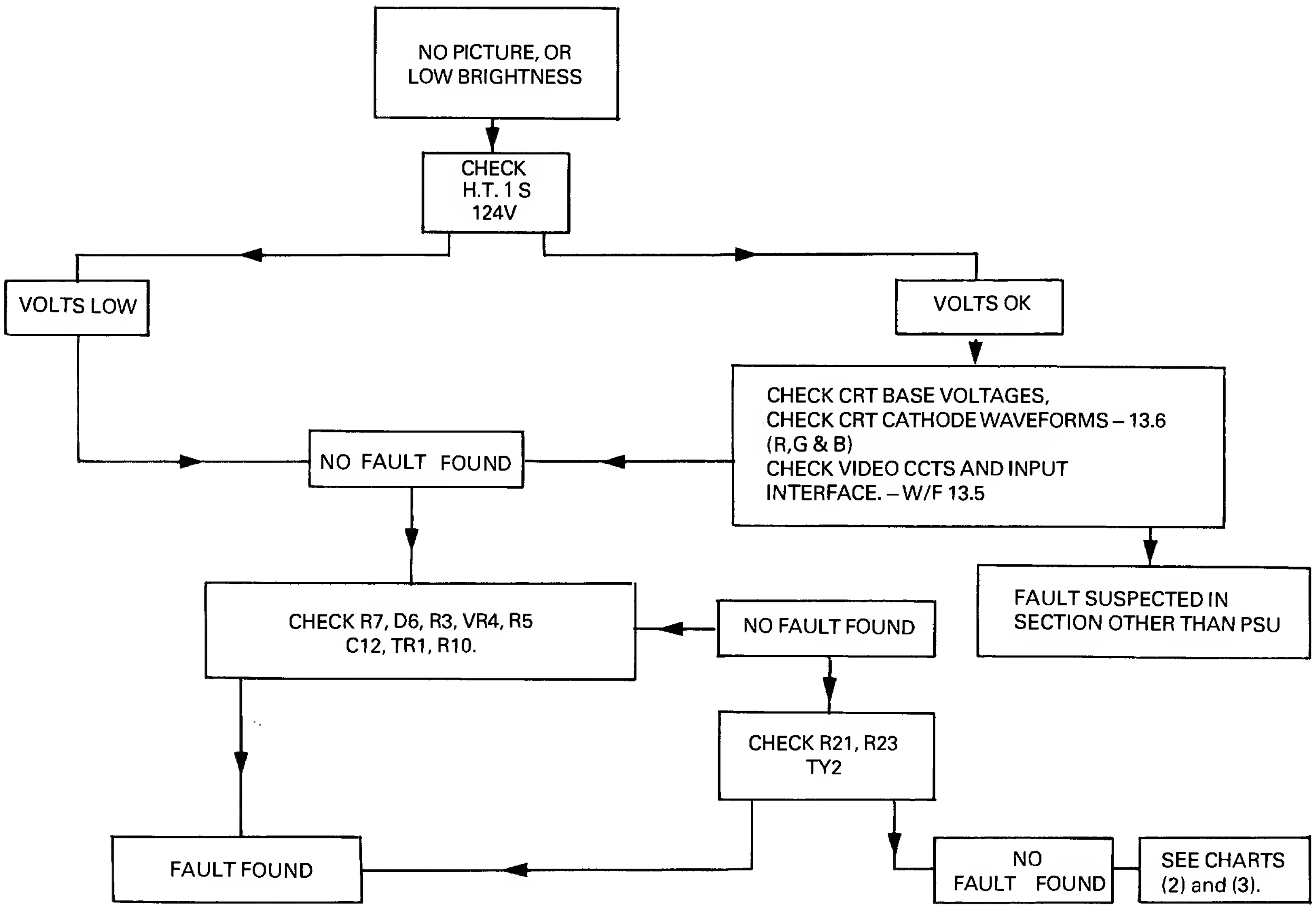
If the reference rail should go high for any reason,(representing an overvoltage condition on the supply rails, hence possibly the EHT), D20 fires TY2 and a similar sequence of the events above occurs, except that the conduction period over a mains cycle is longer and may reach 50%.

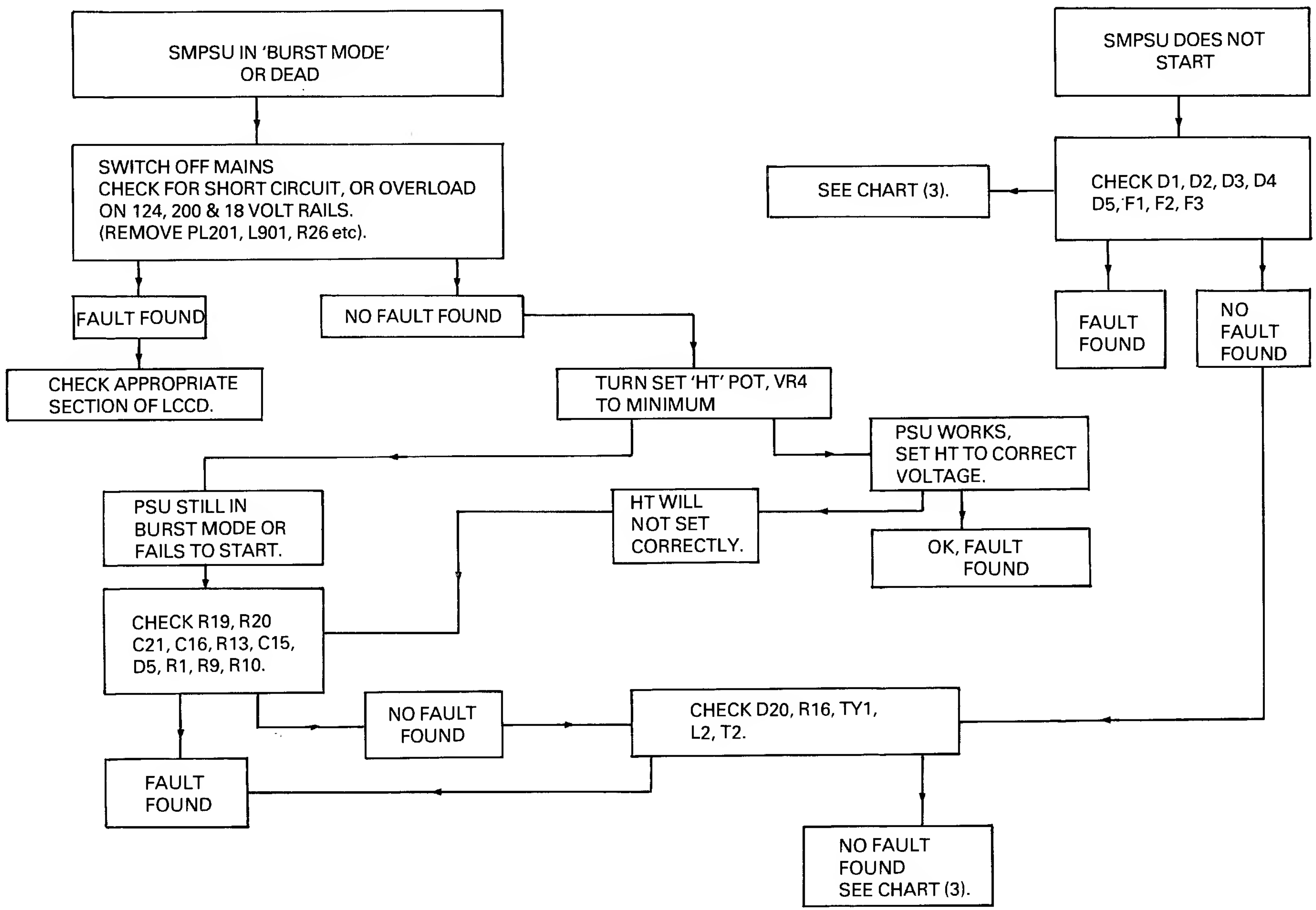
Under these conditions the main HT will be held at 124 volts, and the line output will continue to operate in safety. Over voltage faults can usually be seen visibly, the picture displayed becomes intermittant, flashes on the screen and, associated with this, a quiet 'ticking' noise.

If the 12V supply fails or goes low, the line output and field output stages shut down due to lack of line drive from IC201.

If the main reference rail within the power supply control circuit becomes open circuit, the power supply enters Burst Mode. The power supply will also continue to operate safely without loads on the main HT or boosted HT rails, a useful feature during fault finding operations.

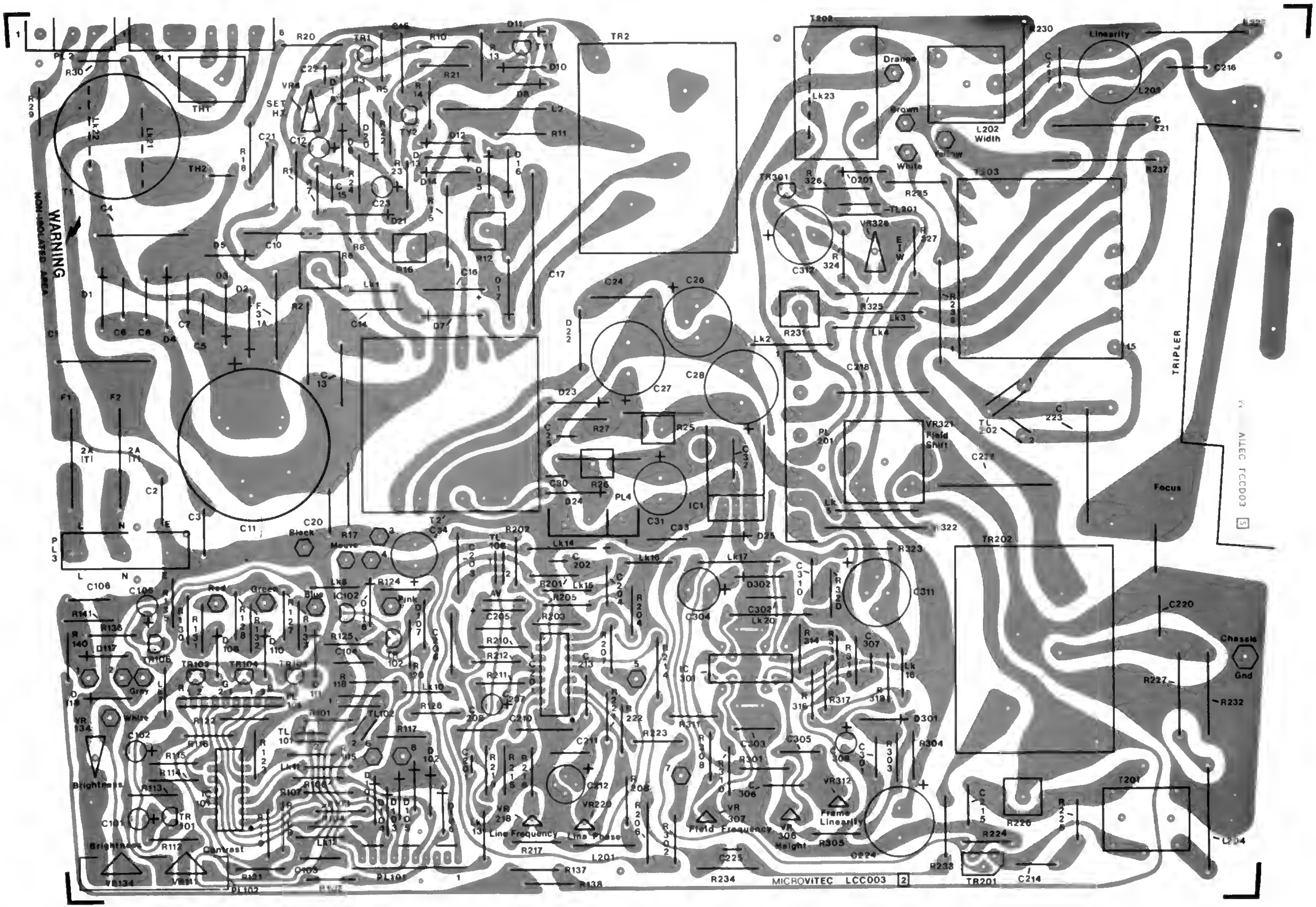
SECTION 15: FAULT FINDING CHART : No 1



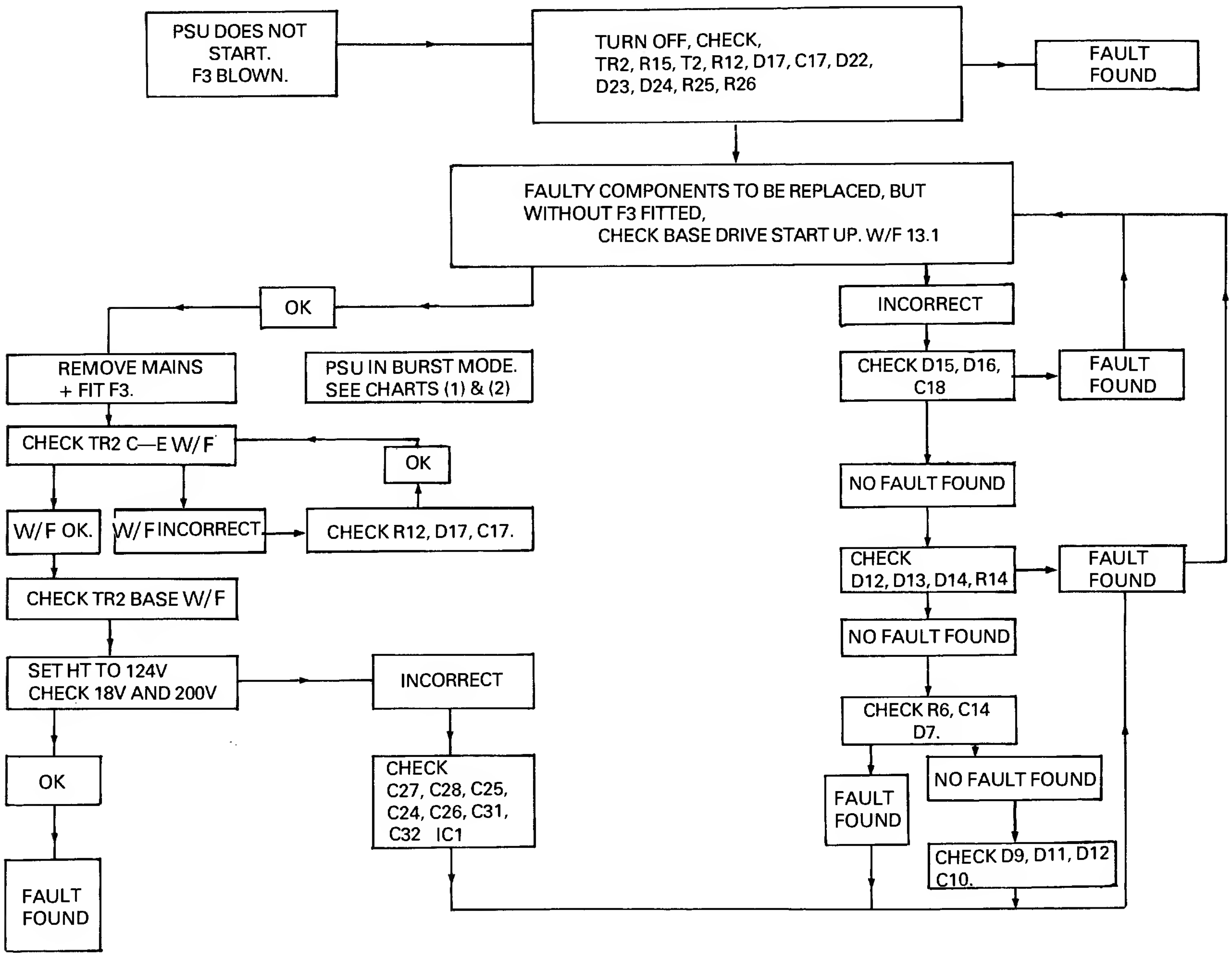

SMPSU IN 'BURST MODE' OR DEAD
SWITCH OFF MAINS CHECK FOR SHORT CIRCUIT, OR OVERLOAD ON 124, 200 & 18 VOLT RAILS. (REMOVE PL201, L901, R26 etc).
FAULT FOUND
CHECK APPROPRIATE SECTION OF LCCD.
NO FAULT FOUND
TURN SET 'HT' POT, VR4 TO MINIMUM
PSU WORKS, SET HT TO CORRECT VOLTAGE.
OK, FAULT FOUND
HT WILL NOT SET CORRECTLY.
PSU STILL IN BURST MODE OR FAILS TO START.
CHECK R19, R20 C21, C16, R13, C15, D5, R1, R9, R10.
FAULT FOUND
NO FAULT FOUND
CHECK D20, R16, TY1, L2, T2.
NO FAULT FOUND SEE CHART (3).
SMPSU DOES NOT START
CHECK D1, D2, D3, D4 D5, F1, F2, F3
SEE CHART (3).
FAULT FOUND
NO FAULT FOUND

Section 16

'MAIN PRINTED CIRCUIT BOARD: COMPONENT IDENT AND TRACK LAYOUT'



SECTION 15 FAULT FINDING CHART : No 3



Section 17

COMPONENT REFERENCE	PART NO.	DESCRIPTION
R1	RK105GK1	100K Carbon Comp. Resistor 10% 0. 5W Axial
R2	RF185JJ1	180K Carbon Film Resistor 5% 1W Axial
R3	RF363DJ1	3K6 Carbon Film Resistor 5% 0. 25W Axial
VR4	RQ103AL2	1K Preset Pot Carb. Min. H Mntg 20% 0.1W Axial
R5	RF104DJ1	10K Carbon Film Resistor 5% 0.25W Axial
R6	RW154VJ7	15K WW Resistor 5% 7W Radial
R7	RF471DJ1	47R Carbon Film Resistor 5% 0.25W Axial
R8	RF564GJ1	56K Carbon Film Resistor 5% 0.5W Axial
R9		
R10	RF392DJ1	390R Carbon Film Resistor 5% 0.25W Axial
R11	RF471DJ1	47R Carbon Film Resistor 5% 0.25W Axial
R12	RW103VJ7	1K WW Resistor 5% 7W Radial
R13	RF274DJ1	27K Carbon Film Resistor 5% 0.25W Axial
R14	RF102DJ1	100R Carbon Film Resistor 5% 0.25W Axial
R15	RO150LJ1	1R5 Metal Oxide Resistor 5% 2W Axial
R16	RW333RJ7	3K3 Resistor 5% 5W Radial
R17	RG336GJ1	⚠ 3M3 Metal Glaze Resistor VDE/BS415 approved 5% 0.5W Axial
R18/20	RF394GJ0	39K Carbon Film Resistor 5% 0.5W Axial
R21	RF392DJ1	390R Carbon Film Resistor 5% 0.25W Axial
R22	RF682DJ1	680R Carbon Film Resistor 5% 0.25W Axial
R23	RF104DJ1	10K Carbon Film Resistor 5% 0.25W Axial
R24	RF224DJ1	22K Carbon Film Resistor 5% 0.25W Axial
R25	R0470LJ1	4R7 Metal Oxide Resistor 5% 2W Axial
R26	RL470GJ1	⚠ 4R7 Fusible Metal Resistor 5% 0.5W Axial
R27/29/30	RF125DJ1	120K Carbon Film Resistor 5% 0.25W Axial
R101	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R102/3/4/5/6/7	RF152DJ1	150R Carbon Film Resistor 5% 0.25W Axial
R108	RF393DJ1	3K9 Carbon Film Resistor 5% 0.25W Axial
R109		
R110	RF393DJ1	3K9 Carbon Film Resistor 5% 0.25W Axial
R111		
R112/113	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R114/115/116	RF472DJ1	470R Carbon Film Resistor 5% 0.25W Axial
R117	RF682DJ1	680R Carbon Film Resistor 5% 0.25W Axial
R118	RF222DJ1	220R Carbon Film Resistor 5% 0.25W Axial
R119		
R120/121/122/123	RF153DJ1	1K5 Carbon Film Resistor 5% 0 25W Axial
R124	RF472DJ1	470R Carbon Film Resistor 5% 0.25W Axial
R125	RF153DJ1	1K5 Carbon Film Resistor 5% 0.25W Axial
R126	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R127/128	RF222DJ1	220R Carbon Film Resistor 5% 0.25W Axial
R129		
R130	RF222DJ1	220R Carbon Film Resistor 5% 0.25W Axial
R131/132/133	RF472DJ1	470R Carbon Film Resistor 5% 0.25W Axial
R134		
R135/136	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R137		
R138	RF105DJ1	100K Carbon Film Resistor 5% 0.25W Axial
R139		
R140	RF474DJ1	47K Carbon Film Resistor 5% 0.25W Axial

R201	RF273DJ1	2K7 Carbon Film Resistor 5% 0.25W Axial
R202	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
R203	RF686DJ1	6M8 Carbon Film Registor 5% 0.25W Axial
R204	RF156DJ1	1M5 Carbon Film Registor 5% 0.25W Axial
R205	RF226DJ1	2M2 Carbon Film Registor 5% 0.25W Axial
R206	RF3946J1	39K Carbon Film Registor 5% 0.5W Axial
R207	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R208	RF101DJ1	10R Carbon Film Resistor 5% 0.25W Axial
R210	RF825DJ1	820K Carbon Film Resistor 5% 0.25W Axial
R211	RF123DJ1	1K2 Carbon Film Resistor 5% 0.25W Axial
R212	RF363DJ1	3K6 Carbon Film Resistor 5% 0.25W Axial
R213	RF105DJ1	100K Carbon Film Resistor 5% 0.25W Axial
R214		
R215	RF104DJ1	10K Carbon Film Resistor 5% 0.25W Axial
R216	RF824DJ1	82K Carbon Film Resistor 5% 0.25W Axial
R217	RF224DJ1	22K Carbon Film Resistor 5% 0.25W Axial
VR218	RQ224AL1	22K Preset Pot Carbon min 20% 0.1WV Mntg
R218	RQ224AL1	22K Preset Pot Carbon min 20% 0.1WV Mntg
R223/224	RF222DJ1	220R Preset Pot Carbon min 20% 0.1WV Mntg
R225	RW333LJ5	3K3 WW Resistor 5% 2W (Plug)
R226	RX223PJ7	⚠ 2K2 Fusible WW Resistor 5% 4W Radial
R227		
R228	RW682PJ1	680R WW Resistor 5% 4W Axial
R230	RW682PJ1	680R WW Resistor 5% 4W Axial
R231	RX1518J7	⚠ 15R Fusible WW Resistor 5% 2W8 Radial
R232	R0101LJ1	10R Metal Oxide Resistor 5% 2W Axial
R233/R234	RF394GJ1	39K Carbon Film Resistor 5% 0.5W Axial
R235	RL101GJ1	⚠ 10R Fusible Metal Resistor 5% 0.5W Axial
R236	RF155JJ1	150K Carbon Film Resistor 5% 1W Axial
R301	RF685DJ1	680K Carbon Film Resistor 5% 0.25W Axial
R302	RF124DJ1	12K Carbon Film Resistor 5% 0.25W Axial
R303/304	RF475DJ1	470K Carbon Film Resistor 5% 0.25W Axial
R305	RF685DJ1	680K Carbon Film Resistor 5% 0.25W Axial
VR306	RQ475AL2	470K Preset Pot Carbon min 20% 0.1W V.Mtng
VR307	RQ105AL2	100K Preset Pot Carbon min 20% 0.1W V.Mtng
R308	RF155DJ1	150K Carbon Film Resistor 5% 0.25W Axial
R310	RF183DJ1	1K8 Carbon Film Resistor 5% 0.25W Axial
R311	RF563DJ1	5K6 Carbon Film Resistor 5% 0.25W Axial
R312	RQ105AL2	100K Preset Pot. Carbon min 20% 0.1W V.Mtng
R313/314	RF474DJ1	47K Carbon Film Resistor 5% 0.25W Axial
R315	RF225DJ1	22OK Carbon Film Resistor 5% 0.25W Axial
R316	RF184DJ1	18K Carbon Film Resistor 5% 0.25W Axial
R317	RF563DJ1	5K6 Carbon Film Resistor 5% 0.25W Axial
R318	RF184DJ1	18K Carbon Film Resistor 5% 0.25W Axial
R319 missing		
R320	RF330DJ1	3R3 Carbon Film Resistor 5% 0.25W Axial
R321	RS103PL2	1K Preset Pot WW H Mtg 20% 4W
R322	RF332JJ1	330R Carbon Film Resistor 5% 1W Axial
R323	RF100DJ1	1RO Carbon Film Resistor 5% 0.25W Axial
R324	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R325	RF182JJ1	180R Carbon Film Resistor 5% 1W Axial
R326	RF152GJ1	150R Carbon Film Resistor 5% 0.5W Axial
R327	RF331DJ1	33R Carbon Film Resistor 5% 0.25W Axial
VR328	RQ222AL2	220R Preset Pot Carb Min Hmtg 20% 0.1W Axial
R801	RO154PJO	15K Metal Oxide Resistor 5% 2W Axial
R802	RL102DJ1	⚠ 100R Fusible Metal Film Resistor 5% 0.25W Axial
R803	RF224GJ0	22K Carbon Film Resistor 5% 0.5W Axial
R804	RF224GJ0	22K Carbon Film Resistor 5% 0.5W Axial
R805	RF183DJ1	1K8 Carbon Film Resistor 5% 0.25W Axial
VR806	RQ103AL2	1K Preset Pot Carb min H Mntg 20% 0.1W
R807	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
VR808	RQ473AL2	4K7 Preset Pot Carb min H Mntg 20% 0.1W
R809	RF331DJ1	33R Carbon Film Resistor 5% 0.25W Axial

R810	RF103DJ1	1K Carbon Film Resistor 5% 0.25W Axial
R811	RF472DJ1	470R Carbon Film Resistor 5% 0.25W Axial
R812	RO154PJO	15K Metal Oxide Resistor 5% 2W Axial
R813	RL102DJ1	⚠ 100R Fusible Metal Film Resistor 5% 0.25W Axial
R814	RF224GJO	22K Carbon Film Resistor 5% 0.5W Axial
R815	RF224GJO	22K Carbon Film Resistor 5% 0.5W Axial
R816	RF183DJ1	1K8 Carbon Film Resistor 5% 0.25W Axial
VR817	RQ103AL2	1K Preset Pot Carb min H Mntg 20% 0.1W
R818	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
R819	RF331DJ1	33R Carbon Film Resistor 5% 0.25W Axial
VR820	RQ473AL2	4K7 Preset Pot Carb min H Mntg 20% 0.1W
R821	RO154PJO	15K Metal Oxide Resistor 5% 2W Axial
R822	RL103GJ1	⚠ 1K Fusible Metal Film Resistor 5% 0.25W Axial
R823	RF224GJO	22K Carbon Film Resistor 5% 0.5W Axial
R824	RF224GJO	22K Carbon Film Resistor 5% 0.5W Axial
R825	RF183DJ1	1K8 Carbon Film Resistor 5% 0.5W Axial
VR826	RQ103AL2	1K Preset Pot Carb Min H Mntg 20% 0.1W
R827	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
VR828	RQ473AL2	4K7 Preset Pot Carb Min H Mntg 20% 0.1W
R829	RF331DJ1	33R Carbon Film Resistor 5% 0.25W Axial
R830	RK222GJ1	220R Carbon Comp Resistor 10% 0.5W Axial
R831	RK222GJ1	220R Carbon Comp Resistor 10% 0.5W Axial
R832	RK222GJ1	220R Carbon Comp Resistor 10% 0.5W Axial
R833	RK105GK1	220R Carbon Comp Resistor 10% 0.5W Axial
R834	RF273DJ1	2K7 Carbon Film Resistor 5% 0.25W Axial
R835	RF475DJ1	470K Carbon Film Resistor 5% 0.25W Axial
R836	RK825GK1	820K Carbon Comp Resistor 10% 0.5W Axial
VR837	RQ226CL2	2M2 Preset Pot Carb H Mntg 20% 0.15W
R838	RF185JJ1	180K Carbon Film Resistor 5% 1W Axial
R840	RF155JJ1	150K Carbon Film Resistor 5% 1W Axial
R901	RF103DJ1	1K Preset Pot Carb Min Hmtg 20% 0.1W Axial
R902	RF183DJ1	1K8 Preset Pot Carb Min Hmtg 20% 0.1W Axial
VR903	RQ103AL2	1K Preset Pot Carb Min H Mtg 20% 0.1W
R904	RO184LJ1	18K Metal Oxide Resistor 5% 2W Axial
R905	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
VR906	RQ473AL2	4K7 Preset Pot Carb Min H Mtg 20% 0.1W
R907	RL103GJ1	⚠ 1K Fusible Metal Film Resistor 5% 0.5W Axial
R908	RF183DJ1	1K8 Carbon Film Resistor 5% 0.25W Axial
VR910	RQ103AL2	1K Preset Pot Carb Min H Mtg 20% 0.1W
R911	RF684JJ1	68K Carbon Film Resistor 5% 1W Axial
R912	RO184LJ1	18K Metal Oxide Resistor 5% 2W Axial
R913	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
VR914	RQ473AL2	4K7 Preset Pot Carb Min H Mtg 20% 0.1W
R915	RF183DJ1	1K8 Carbon Film Resistor 5% 0.25W Axial
VR916	RQ103AL2	1K Preset Pot Carb Min H Mtg 20% 0.1W
R917	RF684JJ1	68K Carbon Film Resistor 5% 1W Axial
R918	RO184LJ1	18K Metal Oxide Resistor 5% 2W Axial
R920	RF223DJ1	2K2 Carbon Film Resistor 5% 0.25W Axial
VR921	RQ473AL2	4K7 Preset Pot Carb Min H Mtg 20% 0.1W
R922	RL103GJ1	⚠ 1K Fusible Metal Film Resistor 5% 0.5W Axial
R923	RF472DJ1	470R Carbon Film Resistor 5% 0.25W Axial
R924	RK103GK1	1K Carbon Comp Resistor 10% 0.5W Axial
R925	RK103GK1	1K Carbon Comp Resistor 10% 0.5W Axial
R926	RK103GK1	1K Carbon Comp Resistor 10% 0.5W Axial
R927	RK105GK1	100K Carb Comp Resistor 10% 0.5W Axial
R928	RF475DJ1	470K Carbon Film Resistor 5% 0.25W Axial
R931	RK825GK1	820K Carbon Comp Resistor 10% 0.5W Axial
VR932	RQ226CL2	2M2 Preset Pot Carbon H Mtg 20% 0.15W
R933	RF155JJ1	150K Carbon Film Resistor 5% 1W Axial

R934	RF185JJ1	180K Carbon Film Resistor 5% 1W Axial
R935	RF684JJ1	68K Carbon Film Resistor 5% 1W Axial
R936	RL103GJ1	⚠ 1K Fusible Metal Film Resistor 5% 0.5W Axial
R937	RF273DJ1	2K7 Carbon Film Resistor 5% 0.25W Axial
C1	CX225NL6	⚠ 220nF 250v AC Met Poly Class X Cap 20% Radial
C2	CY103NL7	⚠ 1000pf 250v AC Ceramic Disc Capacitor Class 'Y' 20% Radial
C3	CY103NL7	⚠ 1000pf 250v AC Ceramic Disc Capacitor Class 'Y' 20% Radial
C4	CX225NL6	⚠ 220nF 250v AC Met. Poly Class X Cap 20% Radial
C5	CD472YL7	470pf 2Kv Ceramic Capacitor 20% Radial
C6	CM104TL6	10nf 630v Met Poly Capacitor 20% Radial
C7	CD472YL7	470pf 2Kv Ceramic Capacitor 20% Radial
C8	CM104TL6	10nF 630v Met Poly Capacitor 20% Radial
C10	CM225RL6	22nF 400v Met Poly Capacitor 20% Radial
C11	CA108RM7	100uF 400v Alum Elect Capacitor -20 + 5% Rad
C12	CA476HM7	4·7uF 35v Alum Elect Capacitor - 20 + 5% Rad
C13	CM105RL6	100nF 400v Met Poly Capacitor 20% Radial
C14	CM105RL6	100nF 400v Met Poly Capacitor 20% Radial
C15	CD473JL7	4700pf 50v Ceramic Capacitor 20% Radial
C16	CP223GG1	2200pf 30v Polystyrene Capacitor 2.5% Axial
C17	CL223XJ7	⚠2200pf 1500v Polypropylene Capacitor 5% Radial
C18	CA106JL1	1uF 50v Alum Elect Capacitor 20% Axial
C20	CY103NL7	⚠1000pf 250v AC Ceramic Disc Capacitor Class 'Y' 20% Radial
C21	CM105RL6	100nF 400v Met Poly Capacitor 20% Radial
C22	CD223FL7	2200pf 25v Ceramic Capacitor 20% Radial
C23	CA476HM7	4.7uF 35v Alum Elect Capacitor - 20 + 50% Rad
C24	CM105NL6	100nF 250v Met Poly Capacitor 20% Radial
C25	CD472RL7	470pf 400v Ceramic Capacitor 20% Radial
C26	CA107PM7	10uF 350v Alum Elect Capacitor - 20 + 50% Rad
C27	CA477NM7	47uF 250v Alum Elect Capacitor - 20 + 50% Rad
C28	CA477NM7	47uF 250v Alum Elect Capacitor - 20 + 50% Rad
C30	CD472RL7	470pf 400v Ceramic Capacitor 20% Radial
C31	CA478EM7	470uF 25v Alum Elect Cap - 20 + 50% Radial
C32	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C33	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C101	CA107EM7	10uF 25v Alum Elect Cap - 2 + 50% Radial
C102	CA107EM7	10uF 25v Alum Elect Cap - 2 + 50% Radial
C103	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C104	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C105	CA107EM7	10uF 25v Alum Elect Cap - 20 + 50% Radial
C106	CM225KL6	220nF 100v Met Poly Capacitor 20% Radial
C201	CD102FL7	100pf 25v Ceramic Capacitor 20% Radial
C202	CD102FL7	100pf 25v Ceramic Capacitor 20% Radial
C203	CM475KL6	470nF 100v Met Poly Capacitor 20% Radial
C204	CM225KL6	220nF 100v Met Poly Capacitor 20% Radial
C205	CM105ML6	100nF 160v Met Poly Capacitor 20% Radial
C206	CA685JL1	680nF 50v Alum Elect Capacitor 20% Axial
C207	CA476HM7	4.7uF 35v Alum Elect Capacitor - 20 + 50% Rad
C208	CM104KL6	10uF 100v Met Poly Capacitor 20% Radial
C210	CP473GG1	4700pf 30v Polystyrene Capacitor 2.5% Axial
C211	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C212	CA108EM7	100uF 16v Alum Elect Cap - 20 + 50% Radial
C213	CM474NL6	47nF 250v Met Poly Capacitor 20% Radial
C214	CM105NL6	100nF 250v Met Poly Capacitor 20% Radial
C215	CM105NL6	100nF 250v Met Poly Capacitor 20% Radial
C216	CD104YL7	10nF 2Kv Ceramic Capacitor 20% Radial
C217	CD104YL7	10nF 2Kv Ceramic Capacitor 20% Radial
C218	CL335NK7	⚠0.33uf 250v Polypropylene Cap 10% Radial

C220	CM104KL6	10uF 100v Met Poly Capacitor 20% Radial
C221	CM475RL6	470nF 400v Met Poly Capacitor 20% Radial
C222	CL753XJ7	⚠7500pf 1500v Polypropylene Cap 5% Radial
C223	CM684XK6	68nF 1500v Met Poly Capacitor 20% Radial
C224	CA109HM7	1000uF 35v Alum Elect Capacitor - 20 + 50% Rad
C225	CD561RL6	56pF 400v Ceramic Capacitor 20% Radial
C301	CM22KL6	220nF 100v Met Poly Capacitor 20% Radial
C302	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C303	CM155ML6	150nF 160v Met Poly Capacitor 20% Radial
C304	CA108HM7	100uF 35v Alum Elect Capacitor - 20 + 50% Radial
C305	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C306	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C307	CD122FL7	120pf 25v Ceramic Capacitor 20% Radial
C308	CA107EM7	10uF 25v Alum Elect Cap - 20 + 50% Radial
C310	CM105ML6	100nF 160v Poly Capacitor 20% Radial
C311	CA478HM7	470uF 35v Alum Elect Cap - 20 + 50% Rad
C312	CA228EM7	220uF 25v Alum Elect Cap - 20 + 50% Rad
C801	CM105NL7	100nF 250v Metal Polyester Capacitor 20% Radial
C802	CC391KJ6	27pF 30v Polystyrene Capacitor Axial
C803	CP561GGO	56pF 30v Polystyrene Capacitor 2.5% Axial
C804	CC391KJ6	27pF 30v Polystyrene Capacitor Axial
C805	CP561GGO	56pF 30v Polystyrene Capacitor 2.5% Axial
C806	CC391KJ6	27pF 30v Polystyrene Capacitor Axial
C807	CP561GGO	56pF 30v Polystyrene Capacitor 2.5% Axial
C808	CD104YL7	10nF 2Kv Ceramic Capacitor 20% Radial
C810	CM105NL7	100nF 250v Metal Polyester Capacitor 20% Radial
C811	CD104YL7	10nF 1-2Kv Ceramic Capacitor 20% Radial
C901	CM105NL7	100nF 250v Metal Polyester Capacitor 20% Radial
C902	CP751GG1	75pf 30v Polystyrene Capacitor 2.5% Axial
C903	CP122GG1	120pf 30v Polystyrene Capacitor 2.5% Axial
C904	CP751GG1	75pf 30v Polystyrene Capacitor 2.5% Axial
C905	CP122GG1	120pf 30v Polystyrene Capacitor 2.5% Axial
C906	CP751GG1	75pf 30v Polystyrene Capacitor 2.5% Axial
C907	CP122GG1	120pf 30v Polystyrene Capacitor 2.5% Axial
C910	CD104YL7	10nF 2Kv Ceramic Capacitor 20% Radial
C911	CD104YL7	10nF 2Kv Ceramic Capacitor 20% Radial
IC1	IV7812MM3	Voltage Regulator 1C 78M12
IC101	IT74136MM2	Or/TTL Type Logic IC74LS136N
IC102	IV7805LXO	Voltage Regulator IC ⚠ 78L05
IC201	IL118OP52	Linear Bi-polar IC TDA 1180P Plastic DIL S.G.S.
IC301	IL117OPSS2	Linear Bi-polar IC TDA 1170S Plastic DIL S.G.S.
IC301 HEATSINK	HHOOO1HCO	Heatsink Staver V8-800
IC1 HEATSINK	HHOOO3HAO	Heatsink 1 Staver Type V6-2L
T2	T10004102	Transformer - Switch Mode Isolating PC3769
T201	T10009101	Transformer - Liner Driver PC4163
T202	T10003101	⚠Transductor - East-West PC3396
T203	T10007101	Transformer - Line Output 14" PC3755
L2	LW473UA6	Choke-Wire ended 4.7uH PC3774
L201	LW154UA5	Choke-Wire ended 15uH PC3391
L202	LV001UA5	Coil-Width PC3398
L203	LN001UA5	Coil-Line Linearity PC3392
L204	LW104UA6	Choke-Wire ended 10uH PC2677
L901	LW154UA5	Choke-Wire ended 15uH PC3391
FH1 A/B	KS0001Y01	Fuse Clip - PCB Mntg 5mm
F1	KA2001BQ0	⚠ Fuse T2A 2A 20mm Time Delay
F2	KA1001BQ0	⚠ Fuse F1A 1A 20mm Fast blow
PL1	KP0220D06	6 Pin In-Line Plug PCB Mntg Shrouded Pressac 220/1546
	or KP0300D06	6 Pin In-Line Plug PCB Mntg Shrouded Lockable, Pressac 320/3766
PL3	KP0220D05	5-2 Pin In Line Plug Mntg Shrouded Pressac 220/2145 -2,4
	or KP0300D05	5-2 Pin In Line Plug Mntg Shrouded Lockable, Pressac 320/3765

PL101	KP0026A10	10 Pin In-Line Plug PCB Mntg Shrouded Pressac 20/3450
PL103	KP0025A10	10 Pin In Line Plug PCB Mntg Unshrouded Pressac 20/3430
PL201	KP0222D08	8 Pin In-Line Plug PCB Mntg Unshrouded Pressac 220/1138
	OR KP0300D08	8 Pin In-Line Plug PCB Mntg Unshrouded Lockable, Pressac 320/3768
L801	LW154VA5	Choke-Wire ended 15vH PC3391
L802	LW104VA4	Choke-Wire ended 10vH PC2677
L803/L804	LW104VA4	Choke-Wire ended 10vH PC2677
D1	DP4007UM1	Power Rectifier Diode IN4007 Motorola Axial
D2	DP4007UM1	Power Rectifier Diode IN4007 Motorola Axial
D3	DP4007UM1	Power Rectifier Diode IN4007 Motorola Axial
D4	DP4007UM1	Power Rectifier Diode IN4007 Motorola Axial
D5	DP4005UM1	Power Rectifier Diode IN4005 Motorola Axial
D6	DF0814UM1	Fast Recovery Diode MR814 Motorola Axial
D7	DF0818UM1	Fast Recovery Diode MR818 Motorola Axial
D8	DS4148UT1	Small Signal Diode IN4148 Thompson Axial
D10-D14	DS4148UT1	Small Signal Diode IN4148 Thompson Axial
D15-15	DP4002UM1	Power Rectifier Diode IN4002 Motorola Axial
D17	DF0818UM1	Fast Recovery Diode MR814 Motorola Axial
D18	DZ7950FC1	Zener Diode BZX79C7V5 400mw 5% Axial
D20	DZ79331FC1	Zener Diode BZX79C33V 400mw 5% Axial
D21	DP4002UM1	Power Recifier Diode IN4002 Motorola Axial
D22-23	DF0818UM1	Fast Recovery Diode MR818 Motorola Axial
D24	DF0814UM1	Fast Recovery Diode MR814 Motorola Axial
D25	DP4002UM1	Power Rectifier Diode IN4002 Motorola Axial
D101-107	DS4148UT1	Small Signal Diode IN4148 Thompson Axial
D108	DZ79560FC1	Zener Diode BZX79C5V6 400mw 5% Axial
D110	DZ79560FC1	Zener Diode BZX79C5V6 400mw 5% Axial
D111	DZ79560FC1	Zener Diode BZX79C5V6 400mw 5% Axial
D117	DZ79121FB1	Zener Diode BZX79B12 400mw 5% Axial
D118	DZ79560FC1	Zener Diode BZX795V6 400mw 5% Axial
D201	DF0814UM1	Fast Recovery Diode MR814 Motorola Axial
D302	DP4005UM1	Power Rectifier Diode IN4005 Motorola Axial
D801	DS4148UT1	Small Signal Diode IN4148 Thompson Axial
D804	DZ79750FC1	Zener Diode BZX79C7VS 400mw 5% Axial
D805-808	DS4148 UT1	Small Signal Diode IN4148 Thompson Axial
D901-906	DS4148UT1	Small Signal Diode IN4148 Thompson Axial
D907	DZ79750FC1	Zener Diode BZX79C7V5 400mw 5% Axial
D908	DS4148UT1	Small Signal Diode IN4148 Thompson Axial

TY1	QY0103UM7	Thyristor BR 103 Motorola Radial
TY2	QY0103UM7	Thyristor BR 103 Motorola Radial
TR1	QS0307UM6	PNP Silicon Transistor BC307-5 Motorola
TR2	A00007102	LCCD Heat Sink (SMPSU) Assembly
TR2	QD008AX0	NPN Darlington Transistor TEXAS BUW81A
TR16	QS0500UM0	NPN Silicon Power Transistor Motorola BU500
	or QS0500VX0	NPN Silicon Power Transistor TEXAS BU500
TR16	A00008102	LCCD Heatsink (LOPT) Assembly
TR101	QS033YUM1	NPN Silicon Transistor BC337-5 Motorola
TR102	QS4123UM0	NPN Silicon Transistor 2N4123 Motorola
TR103	QS4125UM6	PNP Silicon Transistor 2N4125 Motorola
TR104	QS4125UM6	PNP Silicon Transistor 2N4125 Motorola
TR105	QS4125UM6	PNP Silicon Transistor 2N4125 Motorola
TR106	QS0337UM1	NPN Silicon Transistor BC337-5 Motorola
TR201	QS0460UM1	NPN Silicon Transistor BF460-5 Motorola
TR301	QS0337UM1	NPN Silicon Transistor BC337-5 Motorola
TR801	QS0392UM1	NPN Silicon Transistor BF 392 Motorola
TR802	QS0787UM1	NPN Silicon Transistor BF787-5 Motorola
TR803	QS4123UM0	NPN Silicon Transistor 2N4123 Motorola
TR804	QS0392UM1	NPN Silicon Transistor BF392 Motorola
TR805	QS787UM1	NPN Silicon Transistor BF787-5 Motorola
TR806	QS0392UM1	NPN Silicon Transistor BF392 Motorola
TR807	QS0787UM1	NPN Silicon Transistor BF787-5 Motorola
TR901	QS0392UM1	NPN Silicon Transistor BF392 Motorola
TR902	QS0787UM1	NPN Silicon Transistor BF787-5 Motorola
TR903	QS0392UM1	NPN Silicon Transistor BF392 Motorola
TR904	QS0787UM1	NPN Silicon Transistor BF787-5 Motorola
TR905	QS0392UM1	NPN Silicon Transistor BF392 Motorola
TR906	QS0787UM1	NPN Silicon Transistor BF787-5 Motorola
TR907	QS4123UM1	NPN Silicon Transistor 2N4123 Motorola
TH1	RT001QN0	Dual PTC Thermistor ITT PT50P 250v
TH2	RT001NN0	Single NTC Thermistor ITT 0010 250v

MECHANICAL PARTS

TL101	KP0024A03	3 Pin In-Line Plug PCB Mntg Unshrouded Pressac 20/3423
TL101	KS7859102	2 Pin Shorting Socket Molex 7859-02
TL102	KL4838202	Links-Push on Test Points Pressac 10/4838
TL103	KS7859102	2 Pin Shorting Socket Molex 7859-02
TL104	KS7859102	2 Pin Shorting Socket Molex 7859-02
TL105	KS7859102	2 Pin Shorting Socket Molex 7859-02
TL106	KP0024A03	3 Pin In Line Plug PCB Mntg unshrouded Pressac 20/3423
TL201	KL4838Z02	Links-Push on Test Points Pressac 10/4838
TL901	KM3070Y01	Test Pins 10mm long PCB Mntg Pressac 10/3070
TL901	KL4838Z02	Link push on Test Points Pressac 10/4838
TL102 A/B	KM3070Y01	Test Pins 10mm long PCB Mntg Pressac 10/3070
TL201 A/B	KM3070Y01	Test Pins 10mm long PCB Mntg Pressac 10/3070
TL205 A/B	KM3070Y01	Test Pins 10mm long PCB Mntg Pressac 10/3070

	HS0312AAO	Screw M3 x 12mm Pozi Pan Hd Plated
	HS0310AA0	Screw M3 x 10mm Pozi Pan Hd Plated
	HN0310HA0	Nut M3 Full Hexagon Plated
	HW3000BA0	Washer M3 Internal Shakeproof
	HW4104CA1	Washer M4 Plain Plated
	FT0002AA0	150mm Tiewrap - RICHO WIT18L
	KF4106Z01	Crimp Tag Female 11/4106
FRAME ASSEMBLY		
	MD0020102	Support Frame - Nickel Plated to Microvitec Dwg
	M00020	Issue 2
	FM0006AA0	12·7mm Support Pillar Nylon with clip RICHO TEH - CBS-8N
	FM0009AA0	6·35 Support Pillar Nylon with clip RICHO TEH - CBS - 4N
	HT0606AA3	Screw 6·32 x ¼" Long Taptite Supa Pan BZP
	HT0608AA3	Screw 6·32 x 5/16" Long Taptite Supa Pan BZP
	HS0520BA0	Screw M5 x 20 Hex Hd Mild Steel BZP
	HN0510HAO	Nut M5 Full Hexagon Mild Steel BZP
	HW5257AA1	Washer 2BA - 1" x 1·4mm Repair Mild Steel MZP
	FT0002AA0	150mm Tiewrap - RICHO WIT18L
	A00097I01	LCCD Chassis Earth Lead Assy Type 1
	A00002I03	14" Tube Assembly
	A00139I01	14" Combined LCCD Main 03 TB03 Assy
	A00005102	LCCD Mains Lead Assy
	HS0535BD0	Screw M5 x 35mm Hex Hd Black
		(Free Issue Music Hire)
TUBE ASSEMBLY		
	VC0001NC0	14" CR Tube-Mitsubishi 370GUB22-TC01
	LD001VA5	14" Degaussing Coil - Weyrad PC3395
	FT0002AA0	150mm Tiewrap - RICHO WIT 18L
	FT0001AA0	190mm Tiewrap RICHO WIT 30L
	GL0003BW0	White Label - Self adhesive - Blank 22·5mm x 16mm
	VS201AE0	20SWG Solder - Multicore 60/40 Alloy 362 Flux
	A00012I02	14" Scan Coil Lead Assembly
	A00091I01	14" Dag Wire Assembly
14" SCAN COIL LEAD ASSEMBLY		
	KH0212L08	Housing - 8 way in-line Floating Pressac SE212/3558P5-6
		16/0.2 Stranded Wire with 0.3mm PVC Insulation
		Colour as below:-
	WD1620PG0	Green
	WD1620PL0	Blue
	WD1620P00	Orange
	WD1620PRO	Red
	WD1620PY0	Yellow
	KF4106Z01	Crimp Tag Female - Pressac 11/4106
	WS0600PB0	PVC Sleeving 6mm Bore
14" DAG WIRE ASSEMBLY	A00091I01	
	WB6410VV0	Braid - Flat Tinned Copper - 16 x 4/0·1mm 10 Amp
	WZ4040BV0	Brass Strip - Cold Drawn - 4 x 0·4mm PRESSAC 616c
	HP5050AS5	Spring - Tension - Stainless Steel 50mm x 5mm
	KF3575Z01	Crimp Tag Female - PRESSAC 11/3575
	WD2420PB0	24/0 Stranded Wire with 0.45mm PVC Insulation - Black
	WS0400PB0	PVC Sleeving 4mm Bore Black
	FT0002AA0	150mm Tiewrap RICHO WIT 18L

HEATSINK (SMPSU) ASSEMBLY

TR2	QD008AX0	NPN Darlington Transistor TEXAS BUW81A
	HH0002HA0	Heatsink - Staver V10T03
	YM0001WV0	Washer - Mica Insulating TEXAS 00280414
	YN0001BV0	Bush - Nylon Insulating TEXAS 00380364
	VC0001UV0	Compound Silicon R5 S54-311
TRIPLER		
	ET001RA2	EHT Tripler - REMO T30-N118
	HN031HA0	Nut M3 Full Hexagon Plated
	HW4104CA1	Washer M4 Plain Plated
	HW3000BA0	Washer M3 Internal Shakeproof
	WR0480SZ0	Sleeving 4mm Heat Shrink

HEATSINK (LOPT) ASSEMBLY A00008I02

TR16		
	QS0500VM0	NPN Silicon Power Transistor Motorola BU500
	OR	
	QS0500UX0	NPN Silicon Power Transistor TEXAS BU500
	HH0002HA0	Heatsink - STAVER V10T03
	YM0001WV0	Washer - Mica Insulating TEXAS 002 80414
	YN0001BV0	Bush Nylon Insulating TEXAS 003 80364
	VC0001VV0	Compound Silicon R5 S54-311

FA0001AA0	Cabinet Feet Black Plastic 37mm OD x 12mm
FA0002AA0	Foot Stick-on Plastic Grey 543-327
FG003AA0	Grommet - Strain Relief
FM0006AA0	12·7mm Support Pillar-Nylon with Clip RICHO TEH CBS 8N
FM0009AA0	6·35mm Support Pillar-Nylon with Clip RICHO TEH CBS 8N
FM0012AA0	6·35mm Support Pillar-Nylon with Clip RICHO TEH CBS 4N
FR0002AA0	Rivet-Plastic FASTEX 201-05-0043
FT0002AA0	Tie Wrap 150mm RICHO WIT 18L

High Resolution LCCD

Service Information Supplement

Issue 1

LIST OF CONTENTS

Section 1

GENERAL SPECIFICATION

LCCD Technical Specification
Model No: 1441 and 1442 — **14" High Resolution**

System	1:	625 Lines, 50 Fields Interlaced Or 624/626 Lines, 50 Fields Non-interlaced
	2:	525 Lines, 60 Fields Interlaced or 524/526 Lines, 60 Fields Non-interlaced
		Other Non-standard systems may be suitable. (Consult Microvitec Ltd.)
Supply	:	180-265 V.A.C., 48-64 Hz.
Timebase	:	Pull-in Range ± 500 Hz Lock-in Range ± 700 Hz.
Positional Error	:	± 2%
Convergence Error (Max)	:	0.6mm Within 90mm of Screen Centre. 0.8mm Within 15mm of Screen Edge.
E.H.T.	:	Approximately 24KV.
Bandwidth	:	15MHz.
Resolution (625 Lines)	:	895 (H) x 585 (V) Elements
C.R.T.	:	Rectangular 333mm (Screen Diagonal). Automatic Degaussing At Switch-on. High Focus Voltage Precision In-Line Gun. 90° Diagonal Deflection. 0.31mm Dot Pitch Black Matrix Screen With Pigmented Phosphors.
Inputs	:	i) TTL Compatible; 1500 ohm R,G & B Inputs. Link Selectable Positive Negative Video. ii) Linear; 0-4V, 1500 ohm R, G & B Inputs Positive Video. Composite Or Separate Line and Field Sync, Each Link Selectable Positive Or Negative.
Operating Temperature Range	:	0 – 50°C Ambient.
Power Consumption	:	Approximately 65W.
Weight	:	8.7Kg.

Supplement Section 2

CIRCUIT DESCRIPTION

The majority of circuitry employed in the high resolution LCCD is similar to that in standard LCCD's and therefore details can be found in the main LCCD service manual. The main difference is found in the video output stages which have been re-designed to give an improved bandwidth.

HIGH RESOLUTION VIDEO OUTPUT CIRCUIT DIAGRAM

The video output states are again based upon the class A type with active load. The circuit description in section 11 of the main service manual is therefore relevant.

The following description will supplement the information in the main service manual and give a detailed description of the changes made.

1. Video load resistors R801, 812, 821 have been reduced in value to 15k ohm resulting in an increased video bandwidth with little increase in 'active' power dissipation.

   In conjunction with the above change, flashover protection resistors R830, 831, 832 have been reduced to 220ohm thus increasing the low-pass break frequency formed by the resistors themselves, the video output source impedance and the CRT cathode capacitance. Adequate flashover protection to the video output devices and surrounding components is still guaranteed.

2. High resolution tubes used with the LCCD operate at a much lower beam current than conventional CRT's, typically 350uA. This means that the maximum peak to peak drive voltage may be limited to 60 volts (approx.), restricting considerably the gain requirements placed on the video output stage. For this reason the overall AC feed-back has been increased. Since the gain bandwidth product for the stage is constant a further increase in bandwidth results.

   Split feedback resistors (R803+R804, R814+R815, R823+R824) have been used to minimise the distributed self capacitance across the feed-back resistor, to reduce Miller feed-back.

3. Split compensation capacitors have been used to ensure a high degree of frequency response – gain tracking over the range of VR806, 817, 826. The values of capacitors chosen provide correct compensation of the video under the new feedback conditions.

4. Peaking chokes (L802, 803, 804) have been placed in series with each video output drive, resulting in additional lift around the mid to high frequencies. Damping is ensured by the series flashover protection resistors R830, 831, 832 respectively.

5. Care has also been taken in laying out the PCB so as to provide a high degree of symmetry particularly around the collector base regions of TR802, 805, 807 in an effort to maintain identical response curves for the red, green and blue channels.

   Cross talk between output stages has also been reduced.

6. The CRT beam limit circuit has been modified to provide limiting at 450 – 500 uA maximum.

Supplement Section 3

HIGH RESOLUTION VIDEO OUTPUT ALIGNMENT PROCEDURE

Tube base panel controls are factory preset and further adjustment should not be required. If adjustments are necessary, a quality CRO will be required with bandwidth in excess of 25MHz. See figures S5.1 and S5.2.

INITIAL CONDITIONS

A. TL801 removed.

B. VR111 turned fully clockwise providing maximum video drives from the input interface circuit.

C. VR134 turned fully anti-clockwise.

D. TTL compatible R, G, and B video source providing peak R, G, and B drive and black level information.

1. **Red Output**

   Monitor the red video output using CRO, (after RF peaking choke L802). Set black level using VR808 to 140V, and adjust the gain using VR806 for 60V p-p drive. If necessary re-adjust the black level, using VR808, to 140V.

2. **Green Output**

   Repeat test (1) for the green video stage, monitoring at the output side of L803, using VR802 to set the black level and VR817 to set the gain.

3. **Blue Output**

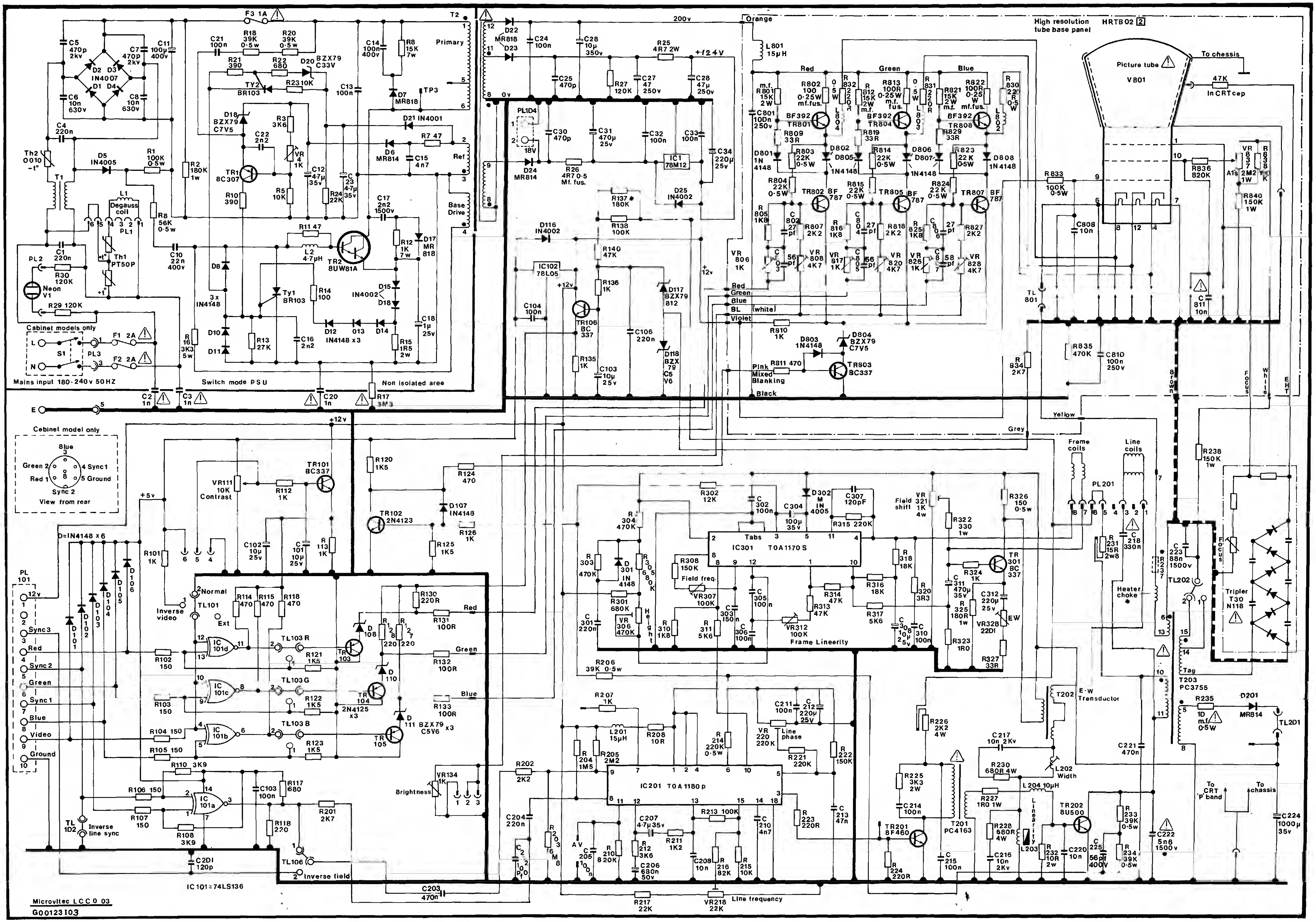
   Repeat test (1) for the blue video stage, monitoring at the output side of L804, using VR828 to set the black level and VR826 to set the gain.

   See 'Supplementary waveforms sheet (1)' Figure (1).

   TL801 may now be refitted and the black levels, A1's and 'grey scale' adjusted in the normal manner.

Supplement Section 4

CIRCUIT DIAGRAM: MODLES 1441, 1442.



Supplement Section 5

HIGH RESOLUTION TUBE BASE PANELS : PRESET LOCATIONS

CRITICAL
SAFETY CONNECTION

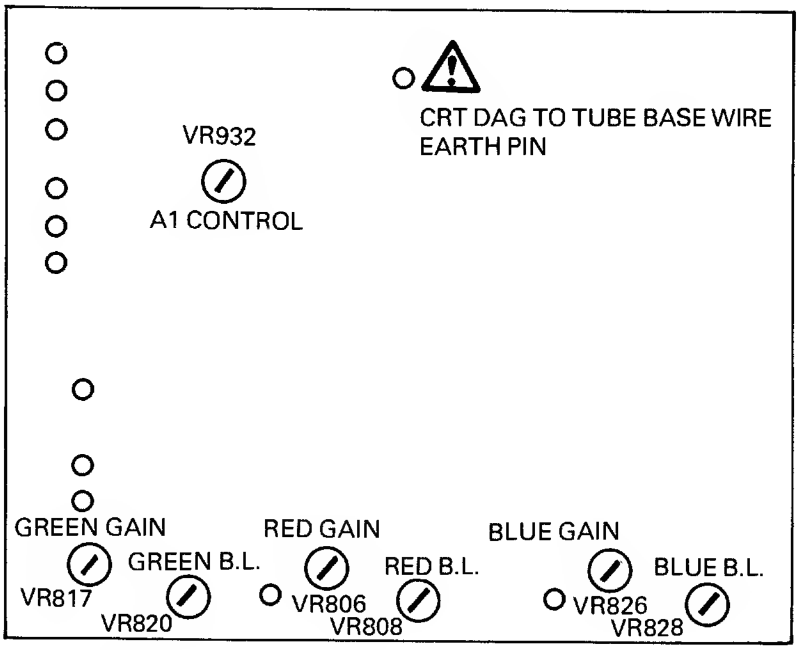


FIGURE S5.1 HRTB 01 (Track Side)

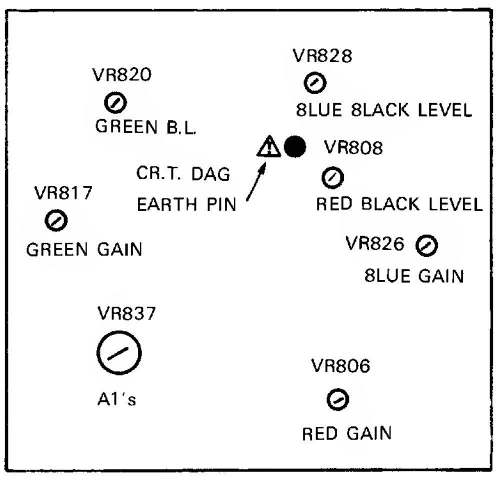


FIGURE S5.2 HRTB 02 (Track Side)

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