SECTION 4

VERTICAL APERTURE CORRECTOR EP1/504

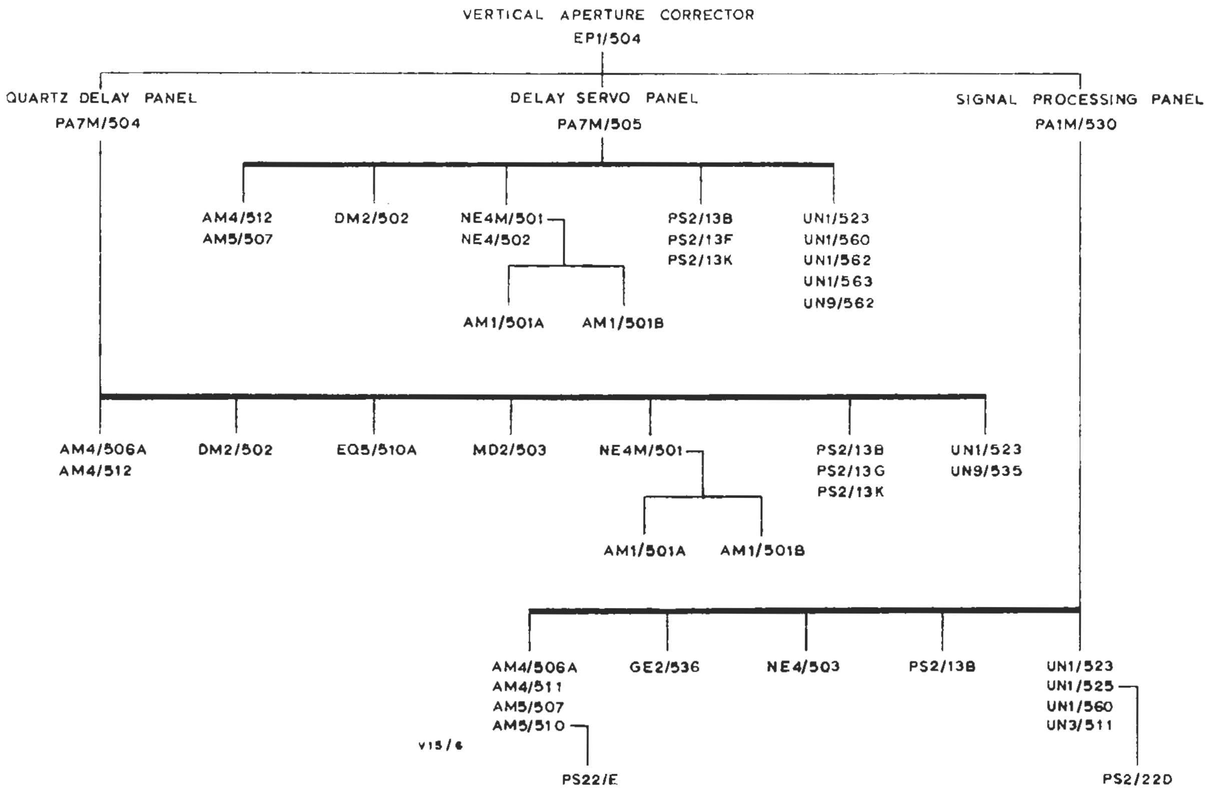

Fig. 4.1 EP1/504 Family Tree

Introduction

The EP1/504 is a vertical aperture-corrector which provides up to 6 dB of vertical aperture-correction. It is intended for use with film recorders and optical standards convertors to improve the vertical resolution which is degraded by the inclusion of an additional scanning process in the system.

The EP1/504 comprises three units mounted on a total of seven panels PN3/23. These units, described in Instruction V.13, are:

Quartz Delay Panel	PA7M/504
Delay Servo Panel	PA7M/505
Signal Processing Panel	PA1M/530

Fig. 4.1 shows the family tree of the EP1/504.

Vertical Aperture Distortion

Aperture distortion is a loss in resolution caused by the use of a scanning beam of finite size[1,2,3]. This loss in resolution appears as a reduction in the amount of fine detail visible in a picture and is most noticeable on a resolution wedge of converging black and white lines. Horizontal resolution is the ability of the system to reproduce vertical transitions in the picture and vertical resolution is the ability to reproduce horizontal transitions.

Correction of aperture distortion in both the horizontal and vertical directions can be effected by the addition of a signal derived from the distorted signal[6]. This correction signal enhances transitions in the picture but has an average value of zero so that it does not change the background tone.

Horizontal aperture correction takes the form of a high-frequency lift[4]. However, vertical aperture correction is approximated by taking difference signals between successive lines [2,5] in the television waveform. In Fig. 4.2(a) the brightness (dotted line) of a thin vertical strip in a television picture in the region of a horizontal transition is shown in terms of the brightness of corresponding points in successive lines. Fig. 4.2(b) and 4.2(c) show the same waveform advanced and delayed respectively by one line duration. The correction signal, Fig. 4.2(d), is obtained by adding these three components in the proportions 1 : —1/2 : —1/2. These proportions ensure that there is no correction signal except in the region of a horizontal transition. Fig. 4.2(e) shows the corrected waveform formed by adding a variable amount of the correction signal to the original waveform. This gives both a faster transition and overshoots both of which increase subjective picture sharpness.

Fig. 4.3 shows the basic block diagram of a vertical aperture corrector operating in the manner described above. The main signal is the input signal delayed by one line (1H). The correction signal is formed by adding the components 0H, 1H and 2H in the proportions —1/2 : 1 : —1/2. The amount of correction is given by the ratio of the 1H signal component at the output of the corrector with correction to the amount of 1H signal component without correction.

General Specification

Input	1 volt p-p composite video signal.
Input Impedance	75 ohms ±1% in parallel with the input impedance of an AM4/512.
Output	1 volt p-p composite video signal.
Number of Outputs	3.
Output Impedance	
Return loss figure (with respect to 75 ohms)	40 dB from 10 kHz to 3 MHz.

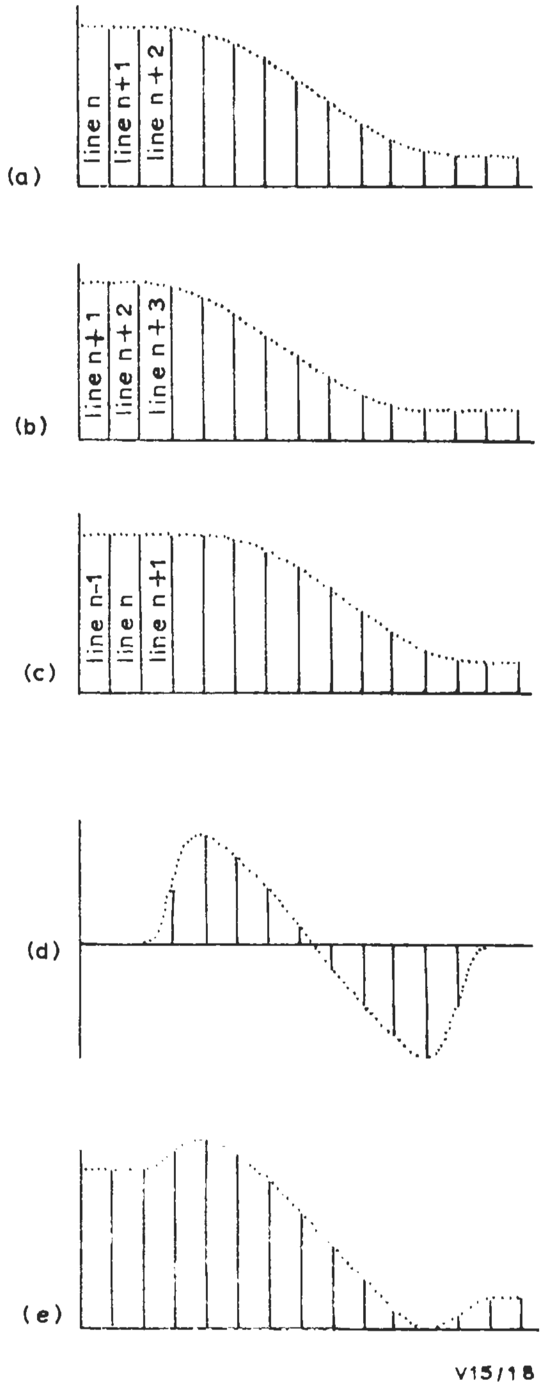

Fig. 4.2 Illustrating the Principle of Vertical Aperture Correction

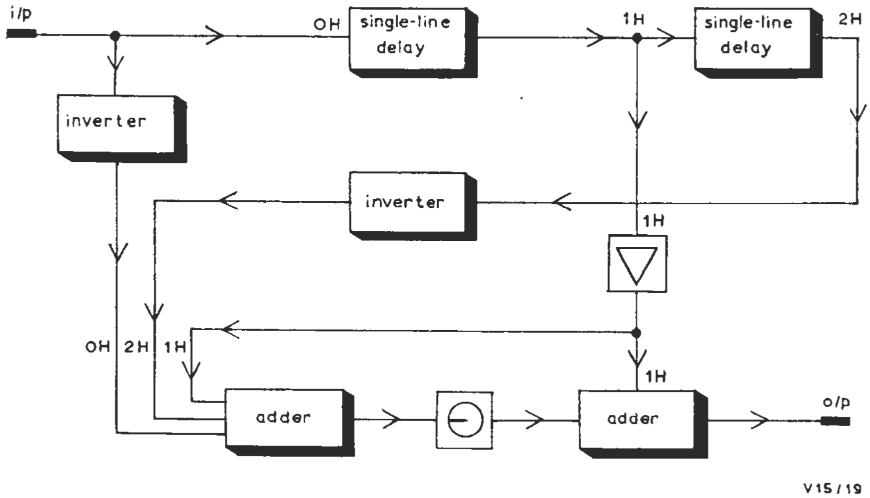

Fig. 4.3 Basic Block Diagram of a Vertical Aperture Corrector using Two Single-line Delays

Line Standards	405, 525 and 625.
Operating Field-frequency Ranges;	
(a) 405-line	50 Hz, +0.4 Hz, −0·6 Hz.
(b) 525-line	60 Hz, +0·45 Hz, −1·35 Hz.
(c) 625-line	50 Hz, ±0·75 Hz.
(outside these ranges the correction signal is removed automatically)	
Amount of Correction	0 to 6 dB continuously variable.
Pulse and Bar Response (625-lines)	
(a) k_{PB}	less than 0·5% uncorrected. less than 1·5% with maximum correction.
(b) k_{2T}	less than 1% uncorrected. 1% (approx.) with maximum correction.
Non-linearity Distortion	
(with clipping circuits correctly set up)	less than 4%.
50-Hz Square Wave Response	less than 5% sag on a symmetrical 50-Hz square wave.
Line Tilt	less than 1% on a 405 white-level line bar.
Noise	
Generated noise with 5-MHz bandwidth (no correction, no weighting)	less than −50 dB r.m.s. noise with respect to 0·7 volts p-p.
Signal/noise Ratio Degradation	
(with maximum correction and input ratio less than 50 dB)	
405-line, 3·2-MHz bandwidth	5 dB unweighted. 6 dB weighted.
525-line and 625-line, 5-MHz bandwidth	4 dB unweighted. 6 dB weighted.
Variations in Gain	
Up to one hour after being switched on	within ±0·5 dB of the gain measured 15 minutes after switch-on.
After one hour from switch-on	within ±0·3 dB of the gain measured at 1 hour after switch-on.
Overall Delay:	
(a) 405	100·5 μs (approx.).
(b 525 and 625	65·5 μs (approx.).

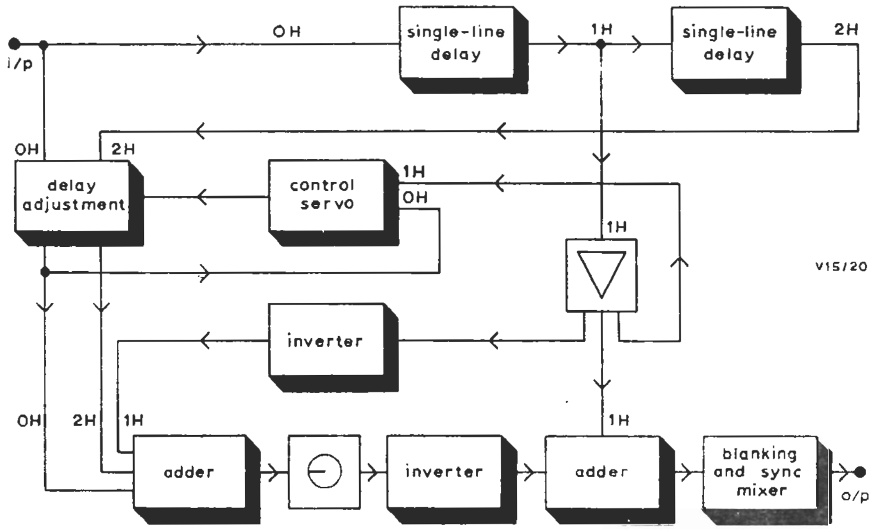

Fig. 4.4 Simple Block Diagram of the EP1/504

Variation in Delay:

(a) 405	—7·5 μs per °C. (approx.).
(b) 525 and 625	—5 μs per °C. (approx.).
Power Requirements	240 volts, 50 Hz at 1 amp.

General Description

The EP1/504 is a vertical aperture corrector of the type described above which uses two single-line delays. Fig. 4.4 shows a simplified block diagram of the EP1/504. This differs from the basic block diagram, shown in Fig. 1.3, in the following three points:

(a) Inversion is carried out in the path of the 1H component of the correction signal and in the correction signal path. In the basic block diagram, inversion is carried out in the 0H and 2H component paths of the correction signal.

(b) Two sets of single-line delays suitable for 405-lines, 525-lines and 625-lines standards are incorporated in the EP1/504.

(c) Additional automatically-adjusted delay is added to accommodate changes in the line duration.

Fig. 4.5 shows a full block diagram of the EP1/504.

Control Servo

The adjustment in delay to accommodate changes in line duration is achieved by exchanging incremental delay networks between the signal paths of the 0H and the 2H components. Fig. 4.6 illustrates how the exchange of delay gives the correct relative delay in the signal paths. Let D_1 and D_2 be the delays in the two single-line delay units. Let the total delay through the delay adjustment be T and let t be a variable fraction of T. The delays of the three components with respect to the input signal are given by:

$$\text{delay 0H} = T - t$$
$$\text{delay 1H} = D_1$$
$$\text{delay 2H} = D_1 + D_2 + t$$

This gives the relative delays of the components with respect to each other as:

$$\text{delay 1H} - \text{0H} = D_1 - T + t$$
$$\text{delay 2H} - \text{1H} = D_2 + t$$

These relative delays are equal if:

$$D_1 = D_2 + T$$

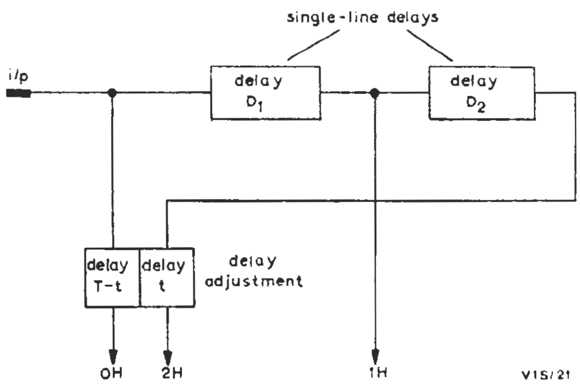

Fig. 4.6 Illustrating the Use of Delay Adjustment

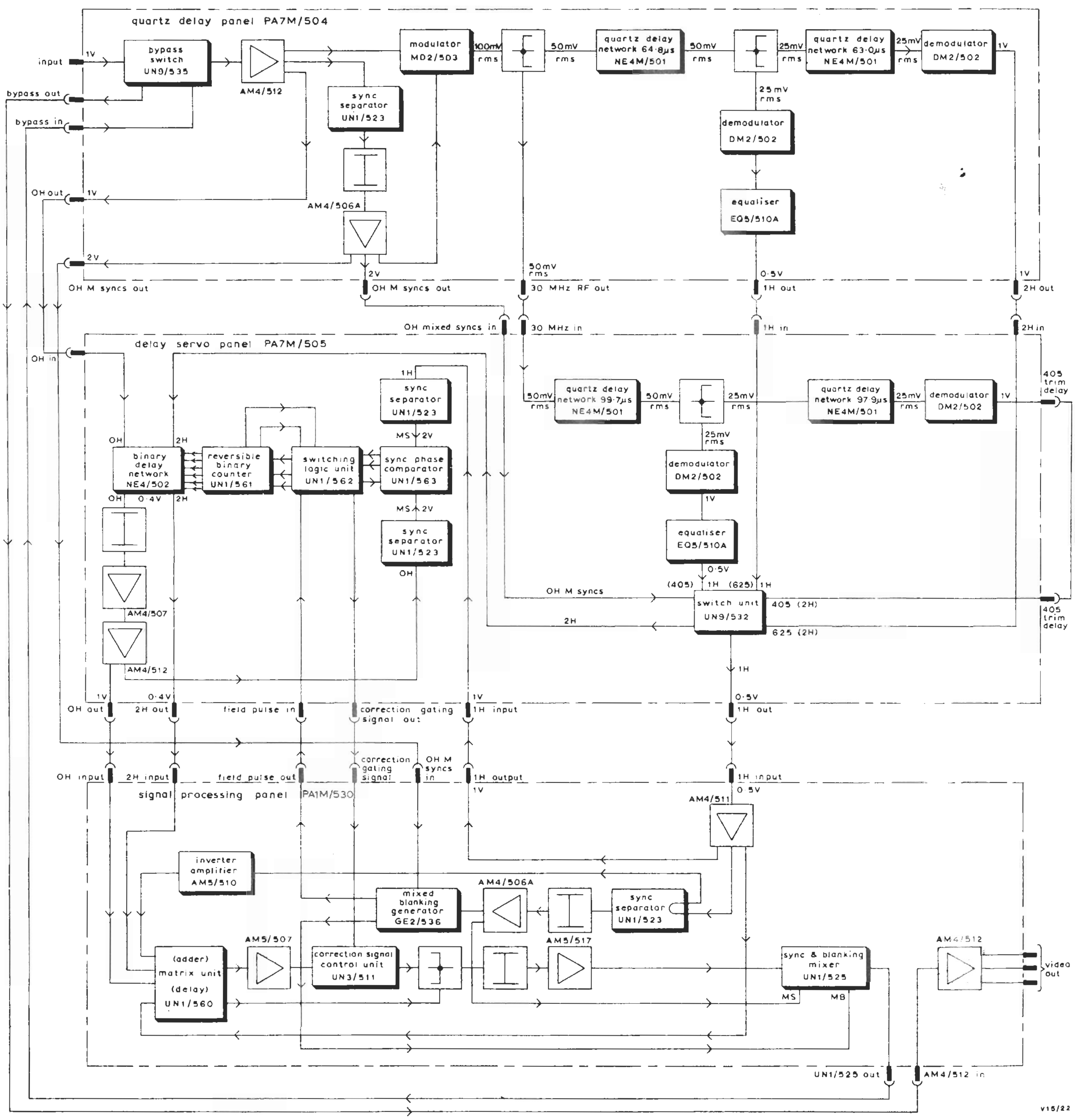

Fig. 4.5 Block Diagram of the EPI/504

Fig. 4.7 shows a block diagram of the control servo and the delay adjustment. The delay adjustment occurs in a Binary Delay Network NE4/502 in which a total of about 2 μs delay is shared automatically between two video paths.

Video signals 0H and 1H are fed to a Sync Phase Comparator UN1/563 via two Sync Separators UN1/523. The UN1/563 has two outputs. Either of these outputs, but not both simultaneously, can feed a field-frequency error pulse to a Switching Logic Unit UN1/562. The outputs of the UN1/563 correspond to the sense of the error between the two sets of sync pulses. There is no output if the error is less than 25 ns.

Test Schedule

Apparatus Required

Sync pulse-generator for both 405-line and 625-line standards with manual control of line frequency over a range approximately ±2 per cent. from normal.

405-line and 625-line pulse and bar generators.

Field Pulse Inserter UN1/505.

Variable Line Equaliser EQ1/505 or EQ5/501.

Tektronix oscilloscope Type 545 with Type H plug-in unit.

Non-linearity Test Signal Generator GE4/505 together with Filter FL1/509B and Amplifier AM1/505.

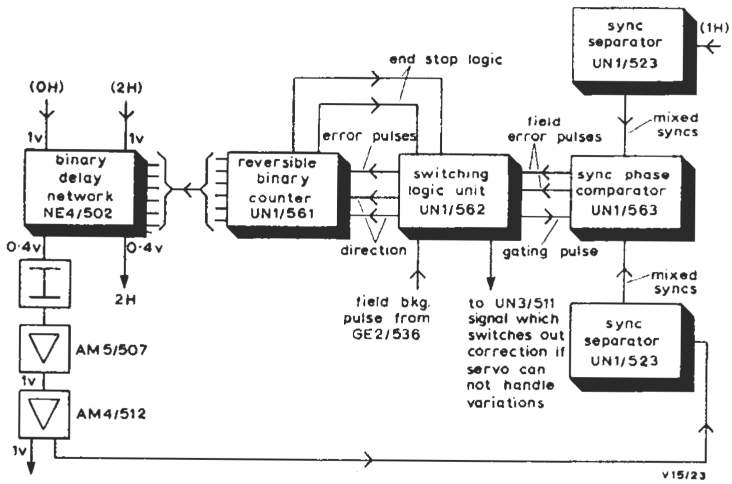

Fig. 4.7 Block Diagram of the Control Servo in the EP1/504

The UN1/562 combines the error pulses into a single feed of error pulses and two d.c. direction signals. These three signals are fed to a Reversible Binary Counter UN1/561 which has a counting range of 63 input pulses. At either end of the counting range a d.c. voltage (*End Stop Logic*) is fed to the UN1/562 which inhibits further error pulses until the direction of counting is changed. At the same time the UN1/562 also feeds a signal to a Correction Signal Control Unit UN3/511 which switches out the correction signal.

The output states of the bistable circuits in the UN1/561 control the distribution of the delay between the two video paths in the NE4/502.

Field blanking pulses from a Mixed Blanking Generator GE2/536 ensure that the UN1/562 and UN1/563 operate only during the middle of each field.

Test Procedure

In the following test the oscilloscope input must be terminated in 75 ohms when fed from the musa plugs at the rear of the EP1/504 and must be connected via a probe or short open lead when fed from front panel test points. Any unplugging necessary for a given test must be restored immediately after the test except where stated.

Quartz Delay Panel PA7M/504

1. Check that the serial numbers on units EQ5/510A, NE4M/501 and UN1/523 agree with those signwritten on the PN3/23 panels. Set the switch on the UN9/535 to *Corrector In.* Feed the 405-line pulse and bar waveform to the *Input* plug and switch to a 1T pulse. This is a 6-MHz bandwidth pulse as opposed to the 5-MHz bandwidth of the 2T 625-line pulse.

Switch on the mains and check that all star indicators in all the Power Suppliers turn on (including those in the UN1/525 and the AM5/510).

2. Check with the oscilloscope that the pulse and bar waveform is present at *0H Out*.
3. Check with oscilloscope that 2 volts p-p of mixed sync pulses are present at both the *0H M.Syncs Out* plugs.
4. Check with oscilloscope triggered from the *0H M. Syncs Out* that a modulated waveform is present at *30 Mc/s RF Out*.
   Adjust the *Set Modulation* control on the front panel of the MD2/503 so that the carrier level during a sync pulse is one quarter of the carrier level during the remainder of the blanking period.
5. Check with the oscilloscope that the pulse and bar waveform is present at *1H Out*.
   Adjust the *Video Gain* of the DM2/502 in the upper PN3/23 to give a 0·5-volt p-p signal. There may be slight overshoots and reflections, but they should have an amplitude less than 10 mV p-p. If the amplitude is greater than 10 mV p-p or there is any asymmetry in the overshoots, check the response of the EQ5/510A against that of a Variable Line Equaliser. The total basic loss in the equaliser should be 6 dB.
6. Check with the oscilloscope that the pulse and bar waveform is present at *2H Out*.
   Adjust the *Video Gain* of the DM2/502 in the lower PN3/23 to give an output level of 1 volt p-p. The pulse to bar ratio of this output should be 1·0 ±0·1.
7. Reconnect the output of the GE4/504 to *Bypass In* and check with the oscilloscope that the pulse and bar waveform is present at *Bypass Out*.
   Set the switch on the UN9/535 to *Corrector Out* and check that the waveform disappears.
   Reset the switch to *Corrector In*.
   Connect pins 1 and 2 of the 4-pin *Bypass Control* socket and check that the waveform disappears.
   Remove the connection from the *Bypass Control* socket and reconnect the GE4/504 to the *Input*.

Delay Servo Panel PA7M/505

8. Check with oscilloscope that the pulse and bar waveform is present at *1H Out*.
   Adjust the *Video Gain* of the left-hand DM2/502 to give a level of 0·5 volts p-p.
   Check that unplugging the *30 Mc/s RF In* cable makes the signal disappear. Do not replug.
   Check that unplugging the *0H Mixed Syncs In* cable makes the signal reappear. Do not replug.
   Check that unplugging the *1H In* (not the *1H Input*) cable makes the signal disappear.
   Replug the three cables.
   Check the EQ5/510A as in test 5.
9. Check with the oscilloscope that the pulse and bar waveform is present at the right-hand *Trim Delay*.
   Adjust the *Video Gain* of the right-hand DM2/502 to give a level of 1 volt p-p.
   Check with the oscilloscope that the waveform is present at *2H Out* and that the level is approximately 0·4 volts p-p.
10. Disconnect the GE4/504 from the *Input* on the PA7M/504 and replace it with a feed from a Nonlinearity Test Signal Generator GE4/505. Using the ancillary equipment, FL1/509B and AM1/505, check that the nonlinearity at *1H Out* is less than 3 per cent.
    Remove the cable from *0H Mixed Syncs In* and check that the nonlinearity is less than 3 per cent.
11. Unplug *0H Out* and *1H Input* (not *1H In*) and join these plugs with a 2-foot cable.
    Disconnect the GE4/505 from the *Input* on the PA7M/504 and replace it with a feed from the GE4/504.
    Check the presence of two mixed sync pulse waveforms at the output monitor sockets of the two UN1/523 units using the oscilloscope.
    Remove the UN1/563 and replace it using the extender board.
    Observe the signal at the monitor socket of the UN1/563.
    Adjust resistor RV1 to balance out the sync pulse component of the waveform.
    Observe the spike corresponding to the leading edge of line sync pulses. If it is positive-going with an amplitude greater than 0·1 volts interchange the two UN1/523 units, and readjust resistor RV1 on the UN1/563. Measure the amplitude of the spike (negative-going) and check that the length of the cable normally used between *0H Out* on the PA7M/505 and *0H Input* on the PA1M/530 is given by: length in feet = 16 −8 × spike amplitude in volts.

Remove the 2-foot cable and replace the UN1/563.

Signal Processing Panel PA1M/530

12. Unplug *0H Input*, *2H Input* and *Correction Gating Signal* and terminate each of these plugs with a 75-ohm Musa socket.
    Turn the *Correction Gain* control on the UN3/511 to zero.
    Check that the level of the signal at the output monitor socket of the right-hand AM5/507 is 1 volt p-p using the oscilloscope.
    Turn the *Correction Gain* control on the UN3/511 to maximum and check that the level has risen to 2 volts p-p.
    Remove the termination from the *Correction Gating Signal* plug and check that the level is reduced to 1 volt p-p.
13. Check the presence of a 2-volt p-p mixed blanking waveform at the *Non Mix Supp* socket on the UN1/525 (unit 2) using the oscilloscope.
    Check the presence of a 2-volt p-p mixed sync waveform at the *MON. M.S.* socket on the UN1/525 (unit 4) using the oscilloscope.
14. Replug the UN1/525 (unit 2) using the extender board.
    Set the *Black Clip* switch to *Int* and turn R46 fully anticlockwise.
    Check with the oscilloscope that a signal is present at *UN1/525 Out*.
    Set the *Black Clip* control to give a minimum amount of pedestal.
    Adjust the *Sync Gain* on unit 4 and the *Output Gain* on unit 3 to give a 1-volt p-p signal with the correct picture-sync ratio.
    Turn R46 in unit 2 clockwise and check that white clipping occurs.
    Turn control R46 fully anticlockwise.
15. Disconnect the GE4/504 from the *Input* on the PA7M/504 and replace it with a feed, via a 16-dB attenuator, of mixed sync pulses from the sync pulse generator set to crystal control and the 625-line standard.
    Check with the oscilloscope and the use of the extender that the signal at the collector of transistor TR11 of the UN1/563 consists of a 4-ms group of narrow pulses either positive or negative going.
    Check that the *Correction Off* star indicator in the UN1/562 is off and note the condition of the star indicators in the NE4/502. The delay indicated should total about 30 units.
    Switch the sync pulse generator to manual control of M.O. frequency and adjust to the same frequency as for crystal control. This can be achieved by triggering the oscilloscope from mains frequency and ensuring that the display of the field signal from the sync pulse generator drifts at the same rate for both manual and crystal control.
    Slowly increase the frequency of the sync pulse generator M.O. At the same time note the state of the star indicators on the NE4/502. When these are all on, the star indicator in the UN1/562 should be on also. Also check for hunting of the control servo. This takes the form of an oscillation of the control servo at some frequency of the master Oscillator. Such an oscillation suggests a fault in the NE4/502.
    Slowly decrease the frequency of the sync pulse generator M.O. When all the indicators on the NE4/502 are off the indicator in the UN1/562 should be on.
16. For the remaining tests the EP1/504 should have been switched on continuously for at least one hour.
    Disconnect the sync pulse generator from the *Input* on the PA7M/504 and replace it with a feed from the GE4/504.
    Check the waveform at the input monitor socket on the UN3/511 using the oscilloscope triggered from line sync pulses.
    Vary the M.O. frequency of the sync pulse-generator until the bar portion of the waveform splits as shown in Fig. 4.8.

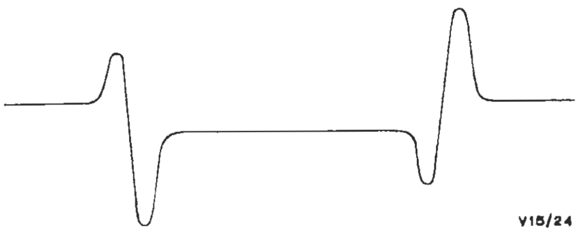

Fig. 4.8 Bar Waveform Not Cancelled

Adjust the *Video Gain* of the DM2/503 in the upper PN3/23 of the PA7M/504 so that the level corresponding to the centre of the bar is equal to the black level of the waveform.
Adjust the *Video Gain* of the DM2/503 in the lower PN3/23 of the PA7M/504 so that the amplitude of the two positive-going pulses at the ends of the bar are equal.
Repeat these adjustments as necessary.

17. Insert the UN1/505 between the output of the GE4/504 and the *Input* of the PA7M/504.
Switch the sync pulse generator to crystal control and check that there is a 1-volt p-p waveform at the *Input* of the PA7M/504.
Switch the GE4/504 to a 2T pulse.
The spikes corresponding to the pulse waveform at the input monitor socket of the UN3/511 should now have an amplitude less than 30 mV p-p. If their amplitude exceeds this voltage, vary the length of the cable between *2H Out* on the PA7M/504 and *2H In* on the PA7M/705.
18. Repeat steps 16 and 17 on the 405-line standard adjusting the *Video Gain* controls on the DM2/502 units on the PA7M/505. The spikes corresponding to the pulse waveform should have an amplitude less than 40 mV p-p. If their amplitude exceeds this amount vary the length of the cable joining the *405 Trim Delay* plugs.
19. Check that the signal at the input monitor socket of the UN1/525 (unit 1) is a 405-line 2T-pulse and bar waveform with picture and sync pulse amplitudes respectively of 0·7 volts p-p and 0·3 volts p-p.
Set the *Correction Gain* on the UN3/511 to zero.
Check that the *Black Clip* control on the UN1/525 (unit 2) is set to give a small pedestal on the *Video Out* waveform of the PA1M/530.
Adjust the *Output Gain* on the UN1/525 (unit 3) to give 0·7 volts of picture information.
Adjust the *Sync Gain* control on the UN1/525 (unit 4) to give 0·3 volts of sync pulses.
Use the extender board and adjust control R46 on the UN1/525 (unit 2) so that white clipping does not quite occur.
Use the extender board and adjust control RV1 on the GE2/536 to give 16·5 μs of line blanking.
Trigger the oscilloscope from the field-blanking monitor socket on the GE2/536.
Adjust the control RV3 on the GE2/536 to give 12½ lines of field blanking from the trailing edge of the last broad pulse.
20. Change the input standard to 625 lines.
Adjust RV4 on the GE2/536 to give 18½ lines of field blanking from the trailing edge of the last broad pulse.
Set the switch on the GE2/536 to *Broad*. The position of the end of field blanking should be changed by approximately 2¾ lines.
Return the switch to *Equalising*.
Adjust the RV2 on the GE2/536 to give 10·5 μs of line blanking.
Replug the GE2/536 into the PA1M/530.
21. Reduce the input pulse and bar waveform amplitude to 0·6 volts p-p.
Increase the *Correction Gain* on the UN3/511 to maximum and check that there is no change in bar amplitude.
Return the *Correction Gain* to zero.
22. Check with the oscilloscope the overall k_{2T} and k_{PB} ratings of the EP1/504 on 625 lines are less than 2 per cent.

Fault Finding

In the event of a fault occurring in the EP1/504 the first step is to determine whether the fault is in the main signal path or in the correction signal circuits. This can be checked by turning the *Correction Gain* on the UN3/511 to zero. If the fault persists then it is probably in the main signal path.

The fault area can be narrowed down still further by feeding a video signal of the other line standard to the EP1/504, so that the signal passes through the other set of quartz delay lines.

Signal levels at various points in the EP1/504 are shown in Fig. 4.5 and these can help in tracing a fault in the main signal path. The depth of modulation of the 30-MHz carrier signal can be checked by using a wideband oscilloscope connected to *30 Mc/s RF Out*. The waveform at this point should be a modulated waveform in which the level of the carrier at the tips of sync pulses equals one-quarter of the carrier level during the remainder of the blanking period.

A fault in the correction-signal circuits is indicated if the fault condition appears only when the *Correction Gain* is faded up. Table 1 is a guide to some of the faults that can occur.

Correct operation of the control servo is indicated if the residual spike corresponding to a 652-line 2T pulse at the input of the UN3/511 is less than 30 mV p-p. This measurement should be made using a probe.

TABLE 1

Large change of output level as the *Correction Gain* is turned up	Check the signal levels at the inputs to the matrix section of the UN1/560 and the output monitor point of the AM5/510.
Large change of output level with widely spaced reflections (about 30μs apart)	Probably due to the UN9/532 not having changed to the appropriate delay lines for the standard in use. Check that sync pulses are reaching the UN9/532. Also check for possible faults in the UN9/532.
Reflections on the output signal spaced up to about 2μs apart	Probably due to wrong operation of the control servo. Check the following points: (a) That field pulses are reaching the UN1/562. (b) That a field-frequency pulse is leaving the UN1/562. (c) That two sets of synchronising pulses are reaching the UN1/563 from the two adjacent UN1/523 units. (d) That error pulses are leaving the UN1/563. (e) If error pulses are leaving the UN1/563 and reaching the UN1/562, but trigger pulses are not reaching the UN1/561 suspect the UN1/562. (f) If trigger pulses are reaching the UN1/561, check the UN1/561 and the NE4/502.

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