VIDEO/AUDIO LASER DISC TECHNOLOGY

CD VIDEO

The CDV475

Circuit Description

725 17722

PHILIPS

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1. OPERATING SUMMARY

TRANSIT SCREWS

A transit screw is inserted through the top of the player at the centre rear during production. The screw head is in a red plastic cup with a warning label under it. Red inserts are fitted each side of the drawer behind the front flap.

Once the screw is removed and the black plastic insert provided has been inserted, the player can be powered and the tray opened.

When the tray is open a red rectangular piece of plastic can be seen in the centre of the drawer, this is also part of the transit system; it can be removed by gently compressing the moulded clip on the left side while lifting and withdrawing it to the left of the player.

Before the player is transported it is important that transit parts are refitted and the player is placed in the transport position. First refit the red rectangular piece of plastic in the centre of the drawer and then put the player in the transport position before refitting the transport screw.

TRANSPORT POSITION

Hold "STOP OPEN/CLOSE" **pressed**, and while the drawer is closing press "STANDBY" as well, and hold the tray flap open to allow the red inserts to be refitted once the drawer is in.

Immediately after "TRANSPORT" appears on the screen, disconnect the player from the mains supply. The transport position places the tray in the down position

MAINS INSERTION

The player assumes the "stand-by" mode at mains insertion; this is identified by a red illuminated spot on the left side of the display.

The aerial loop through is then powered.

Before any player function can be used the "on" state must be raised by pressing the "standby" button.

The display then shows

CDV

CD TRACK INDEX min sec ◄ TIME

and a red dot is illuminated above the "stop open/close" button.

The "standby" function is also available from the handset.

GENERAL FUNCTIONS

The "stop open/close" button is pressed to open the drawer, which, once the red transit plate is removed will allow one of the three disc sizes to be inserted.

The drawer can be closed either by pressing the "stop open/close" button in which case the player will go to the "stop" position with the drawer closed; or by manually pushing the drawer part of the way in after which the player will automatically complete the closure and enter the "play" mode.

Pressing "pause" during play holds the disc in the present position.

If the player is left in the "pause" mode it will remain in pause until cleared.

From the three sizes of disc, five types can be identified, they are:-

1. CD audio disc.
2. CD Video single.
3. CD Video extended play.
4. CD Video long play.
5. LaserVision.

All except the LaserVision disc have digital sound.

When the "on" state is first raised the display background will be red and the Philips name and model number is shown in white letters within blue rectangles.

The red background remains until a disc is inserted but the captions name the functions as they happen after which the display returns to the original caption.

THE TELEVISION DISPLAYS DURING THE LOAD/UNLOAD SEQUENCE

The disc is loaded with the label of the required side uppermost.

When one of the three disc sizes is loaded the television display background colour will now depend on the type of disc being loaded.

When a CD audio disc is recognized the television display background is blank.

When a CD Video Single or Extended Play disc is used the television display background colour is blue.

When a CD Video Long Play or a LaserVision disc is used the television display background colour is green.

The background colour changes once a disc type has been identified.

When a CD Video single is inserted the sequence is:- the drawer closes, the caption on the screen is "DISC READ IN"; whenever this caption is used it flashes.

Once the disc is identified and the track located "SEARCH" is displayed and the screen background is made blue.

When a CDV Extended Play is loaded the disc size is recognised almost immediately it is on the turntable; at that moment the background colour changes to green and the caption "DISC READ IN" appears.

Once the track is found the caption again changes to "SEARCH".

When a CD disc is inserted the caption goes to "DISC READ IN", the screen background goes dark a short time after "DISC READ IN" but before "SEARCH" appears.

When a CD Video Long Play is inserted the captions "CD VIDEO" and "DISC READ IN" are displayed on screen followed by the addition of the word "SEARCH" just before the start of video information.

When a LaserVision disc is inserted the sequence and captions are as for CDV Long Play.

If "stop" is used while a disc is playing the appropriate background colour display is put up together with one of the following captions:-

"CD VIDEO SINGLE"	
"CD VIDEO"	When any type of video disc except CDV single is loaded.
"COMPACT DISC"	When CD audio only discs are in use.

During the stop function the caption "STOP" remains until the disc is stationary.

Captions displayed during playing of the disc depends on the type of disc in use.

Compact Disc (CD)

During play the TV display will normally show

The track no.	The index no.	The elapsed playing time (Minutes and Seconds).

By using the "display" button on the handset the playing time remaining is displayed; the word "REMAIN" is shown to the left of the hours and minutes.

By operating the "display" button again the total number of tracks on the disc is displayed as a one or two digit number between the word "TOTAL" and the total playing time in minutes and seconds.

Once a disc is playing a number of control features can be obtained via the handset. If during handset operation entries are made in error they can be removed by using the clear button. The features are:-

a) Selection of a specific track.
b) Selection of a specific time within a track.
c) Selection of a specific part of the disc and repetition of that part.
d) Select the next or previous track.
e) Repeat the complete disc.
f) Pause the disc at any time including at the point of selection of features a, b and c.
g) Scan forward and reverse.
h) Programming of the player to play selected tracks.

a) To select a specific track press "Track/Chapter". The television will now display "TRACK" and a space where the selected track number will appear when entered by the handset. If "play" is now pressed the word "SEARCH" is displayed until the new position is found when the display will revert to normal.

b) To select a specific time within a track press "frame/time"; the word "TIME" will appear between the track number and the space where the selected time will be displayed when entered.

If "play" is now pressed the word "SEARCH" is displayed until the position is found and the display will revert to normal.

c) To select and repeat a specific part of the disc press "A/B repeat"; at the start of the selected part; the display will now also show A-REP. At the end of the selected passage press "A/B repeat" again the display will show "REPEAT"; and "SEARCH" until the start point is found when the display will revert to normal but suffixed by a flashing "R". To stop the cycle press "clear".

d) To go to the next or previous track press "prev" or "next" as required. The word "TRACK" and the required number will appear together with the word "SEARCH" until the new track is found when the display will revert to normal.

e) To repeat a complete disc press "cont repeat"; the display will show "REPEAT" for a few seconds and the normal display will be suffixed by a flashing "R".

f) Press "pause" to stop the disc playing at a precise point.

When functions a or b are used it is possible to control the moment play starts using the "pause" button; after selection of a specific point on the disc as in a and b, press "pause" instead of "play"; the search will then take place after which either "pause" or "play" is pressed again to start the play at the point selected.

g) To fast scan the disc in either direction use the scan buttons; the action is slow for the first six seconds after which it speeds up.

h) Programming the player to play selected tracks.Press the "prog" button.

The display will have four blue blocks across the top. The first has the letters "PMG",the second a flashing white rectangle. The last two are blank.

Now press the number of the first required track; the number will appear in the block in place of the white rectangle. Press "memo" to enter. The white rectangle will now appear in the next blue block to the right, proceed as previously to enter the next wanted track. When the third block is reached enter track numbers as before but now each time "memo" is pressed the previously entered numbers are moved one position to the left leaving the right square clear for further entries.

The maximum number of tracks that can be selected is twenty.

By pressing "clear" all stored tracks are removed from memory.

CDV GOLDEN DISC.

The CDV single disc is in two parts:- video with audio and audio only.

The video section is on the outer part of the disc but is normally played first.

The track, index and elapsed time can be displayed by pressing "display" on the handset and can by further presses of the display button be sequenced through time remaining and total time.

The following functions operate as CD audio:-

a) Selection of a specific track.
b) Selection of a specific time within a track.
c) Selection of a specific time and repeat it only within either the video or audio sections, not across both.
d) Select the next or previous track.
e) Repeat the complete disc.
f) Pause the disc at any point including at the selection of features a, b, and c.
g) Scan forward or reverse (only within either the audio or video parts).
h) Programme to play selected tracks.

LINEAR PLAY FORMAT

When "display" is pressed the header is overlaid on the picture.

The header may consist of hours and minutes or minutes and seconds.

A 12 in. disc may have hours and minutes or chapter and minutes.

The linear play discs will normally carry out the following functions.

a) Select a specific track.
b) Select a specific time within that track.
c) Select a specific part of the disc and repeat it.
d) Select the previous or next track.
e) Repeat the complete disc.
f) Pause the disc at a specific point. The player can also be paused before the start of features (a) and (b) by pressing "pause" after inputing the time/track position.
g) Scan forward or reverse.
h) Programme the player to play selected tracks.

OPERATION OF THE ACTIVE PLAY DISCS

The active play disc allows the selection of still picture at a specific frame number, single frame advances and playback at other than normal speed.

It is also possible to carry out some of the features used on CLV discs. This is dependent on the information that is coded on the disc.

When the "display" button is pressed the chapter number is shown at the top right of the screen and the frame number at the top left.

To obtain a specific frame press "frame/time", the word "FRAME" will appear on the screen together with an area to the left of it containing one nought.

This area will show the wanted frame number as it is selected on the handset.

When either "play" or "pause" is pressed the player will search to the required position and enter the mode requested.

Playback speed

The playback speed can be varied in either direction when playing CAV discs. The possible speeds are two, four, eight and sixteen times normal speed forward and reverse at half, quarter, eighth and sixteenth speed; one or three frames per second can also be selected in either direction.

The speed is selected by repeatedly pressing either the plus or minus speed key; causing the speed to be incremented or decremented through the range. The selected speed ratio is displayed on the screen.

The selected speed is bought into operation when the direction of movement is selected using the reverse or forward buttons.

Sound selection

The audio on the disc may be stereo sound, or each channel can contain independent information, i.e. two languages.

The selection of stereo or one of the two channels is carried out by the button marked "sound".

The first press of the button sets the player into the stereo mode and the word "STEREO" is displayed on the screen. Successive button presses invoke first the left channel only then the right channel only. The screen shows 1-L-CH or 1-R-CH respectively.

When either the left or right information is selected the sound is fed to both channels.

2. INTRODUCTION TO THE DISCS

1. The audio Compact Disc (CD).
   The CD audio disc has digital sound and a maximum playing time in excess of.60 minutes.
2. The CD Video "Golden Disc" (CDV Single) 5 inch.
   The CDV Single contains up to 6 minutes of video with digital sound and up to 20 minutes of digital sound only.
3. The CD Video Extended Play (CDVEP) 8 inch.
   The CDVEP has up to 20 minutes of video on a side with digital sound.
4. The CD Video Long Play (CDVLP) 12 inch.
   The CDVLP has up to 60 minutes of video on a side with digital sound.
5. The LaserVision discs 12 inch CAV (Constant Angular Velocity) and 12 inch CLV (Constant Linear Velocity).
   The LaserVision CAV has up to approximately 30 minutes of video on a side.
   The LaserVision CLV has up to approximately 60 minutes of video on a side.
   Both discs use analogue sound tracks.

For purposes of understanding the operations of the player the discs can be divided into two main groups, those above 5" and 5" discs.

On all discs of both groups the information is implanted on the disc as pits on the disc surface. The modulation frequencies are contained in the length of pits and the distance between them. The 5" (12cm) discs can be CD or CDV single discs.

Both have CD format table of contents and the specification for the start and finish position of the lead-in area is the same for both, (20mm radius start and 23mm radius finish).

The video track on the CDV single is at the outer edge to lessen the pit density/relative rotational speed of the disc.

A video lead-in starts at 37.5mm radius and finishes where the video information starts at 39mm.

Although the video track is always on the outer edge of the disc and in the table of contents is allocated the highest track number, it is always automatically played first.

The discs above 5 inches diameter are 8 and 12 inches, (20 and 30cms) diameter, and are all CDV or LaserVision discs, which implies that all parts of the disc carry a video signal.

The start position of the lead-in for both discs is at 53.5mms radius.

The start position of the video information is at 55mm radius for both discs.

These specifications are also applicable to LaserVision discs.

The CDV disc has sound information in the standard CD format and the vision information as an FM modulated CVBS signal, giving a frequency spectrum as in Fig. 1, with the FM vision carrier centred on 7.5MHz.

The LaserVision disc has the same vision modulation (FM modulated on 7.5MHz carrier) but the sound information is a two channel FM modulated carrier system with the left channel carrier centred on on 684kHz and the right channel carrier centred on 1066kHz, see Fig. 1.

The lead-in code information and data indicating the type of disc, i.e. CDV or LaserVision together with other information regarding tracks is presented in a code referred to as the "Manchester code". The "Manchester code" is inserted in the video signal during the field blanking interval on lines 17, 18, 330 and 331.

One important difference in the video information obtained from the discs compared with the standard video is the inclusion of a signal in the bottom of each line sync. period.

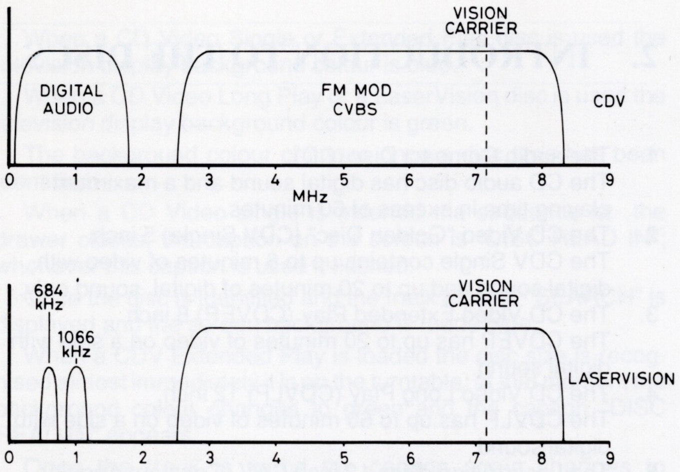


Fig.1 Signal spectrum of discs

The signal is used to ensure accurate phase lock of information obtained from the disc to provide the stability required for chroma decoding. The signal consists of a short burst of 3.75MHz. and is refered to as the special burst.

To provide background information for an understanding of the player requirements the approximate rotational speed of discs is quoted below, where discs are not constant angular velocity the inner and outer figures are quoted in revolutions per minute.

R.P.M. at -	Inner diameter		Outer diameter
CD disc	600		180
CDV single(audio)	600	-	400
CDV single(video)*			
CDV(CAV)		1500	
CDV(CLV)	1500	-	570

*maximum speed at start of video track 2250.

3. INTRODUCTION TO THE PLAYER

The CDV player plays optically read, video and audio discs.

A summary of the type and size of discs used together with the type of signals obtained from them is quoted in Section 2

From section 2 it can be seen that the player is required to play discs varying in size from 5 to 12 inch diameter with rotational speed requirements of between 2250rpm for the start tracks of the video on a CDV single to approximately 200rpm for the outer tracks of a CD audio disc.

The disc data may contain vision information as well as sound. The sound information may be analogue or digital.

From the previous assessment and an understanding of operator requirements, most of the basic circuit operations can be identified; these are now listed.

A control system to accept operator commands and pass them to the required circuits, and provide a response to the operator through the front panel displays and/or the television screen (On Screen Display, OSD).

A mechanical control system to load the disc.

An Optical Pick-up system to read the disc.

A number of Servo systems to ensure the disc rotational speed is correct, the optical pick-up system stays in focus, on track, and strikes the disc at right angles to the plane of the disc.

An internal control system which accepts information from the user processor as well as internally generated signals to control the player operating sequence, the selection of disc speed and the correct signal processing circuits.

A video system for processing the video signal from the disc.

A digital audio processing system (CD format).

An analogue audio processing system to process the sound from laservision disc.

A signal output selection system

An overall block diagram of the player identifying these areas is shown in fig. 2.

The large shaded area on the right of the diagram represents the plastic frame in which the optical pick-up unit is moved across the underside of the disc on a threaded spindle drive.

THE FRAME

The frame is pivoted at the centre to allow four degrees of tilt movement. A very small amount of tilt correction is applied to the frame to ensure that the laser light is always at right angles to the plane of the disc. Errors might otherwise occur when 12 inch discs are played due to edge droop.

THE OPTICAL PICK-UP UNIT (OPU)

The optical pick-up unit contains the complete laser optical system, the laser source and photo diode sensor assembly.

From the photo diode sensor assembly all signal information and the error signals required to maintain correct focus and tracking of the disc by the laser light is obtained.

Maintaining the laser light on the track of the disc is referred to as radial tracking.

The function of maintaining precise radial tracking and focus, is carried out by part of the OPU assembly referred to as the two dimensional actuator (2D actuator).

The 2D actuator is the final stage of the optical system before the light reaches (and is returned from) the disc, it supports the objective lens.

The two dimensional movement of the lens provides radial tracking (horizontal movement at right angles to the tracks on the disc) and focus (vertical movement).

The amount of radial movement possible by the 2D actuator is only approximately 100 microns. To follow the track over the radius of a complete disc the 2D actuator follows the track over its full range of radial movement after which it is returned to its rest position at the same time as the OPU is moved forward on a threaded spindle. The complete cycle is then repeated.

The x detector

The x (across) detector is used to measure the amount of radial movement of the 2D actuator. The measurement is required to determine when the end of the correction range of the 2D actuator is reached and therefore the point at which it is returned to the start position and the OPU moved by the spindle motor.

The x detector signal is also used to correct positional errors of the laser beam on the photo diode assembly due to the beam being offset by the radial movement of the 2D actuator (objective lens).

The tilt detector

The tilt detector unit is mounted on the top left hand side of the OPU and consists of one LED and a sensor assembly adjacent to it, both facing up. The LED output is reflected by the disc onto the sensor assembly.

The tilt detector has two functions -

1. During play to sense if the optical pick-up system laser output is at right angles to the plane of the disc.
2. During load/start to sense the presence of a disc and identify if it is 5 inches or greater.

The carriage reference detector

The carriage reference detector is mounted on the underside of the OPU and senses the presence of a raised edge of plastic forming part of the frame. The reference detector senses the start of the edge at which point the position of the OPU is such that the tilt detector on the OPU is just outside the radius of a 5 inch disc.

The pulse detector

The pulse detector is mounted on the end of the frame adjacent to, and partly either side of the pulley wheel used to rotate the threaded spindle. The pulse detector measures small steps of rotational movement of the pulley and therefore the threaded spindle as a means of moving the OPU a precise distance (50 microns) along the threaded spindle.

BRIEF OPERATIONAL DESCRIPTION (see Fig. 2)

Loading and unloading

When a disc is loaded either by manually pushing the tray or by using a front control button a signal is sent to the user micro processor system.

The user micro processor system then outputs control information to the tilt motor.

The processor also outputs information to control the front panel display and the characters displayed on the television screen (OSD).

Some of the OSD information concerns player status, for example when the player is finding the start of the disc the word "SEARCHING" is displayed, this status information comes to the user processor from the servo processor.

Returning to the tilt motor; the mechanical coupling from the motor is through a gear unit having two outputs, for reasons described in the section "Tray Tilt drive" The tray will be driven at this moment.

Once the tray is taken into the player it moves in a downward direction leaving the disc supported at the centre by a small turntable. During the dowward movement of the tray a locking arm is also brought down, but on the top of the disc centre.

Once the tray is down, the difference switch is operated by the gear unit and the micro processor stops the tilt motor.

To ensure the locking arm is in the fully locked down position, a micro switch, referred to as the hold down switch, is operated only when the final point of movement is reached. Both the hold down switch and the difference switch outputs are passed to the user processor system as control signals.

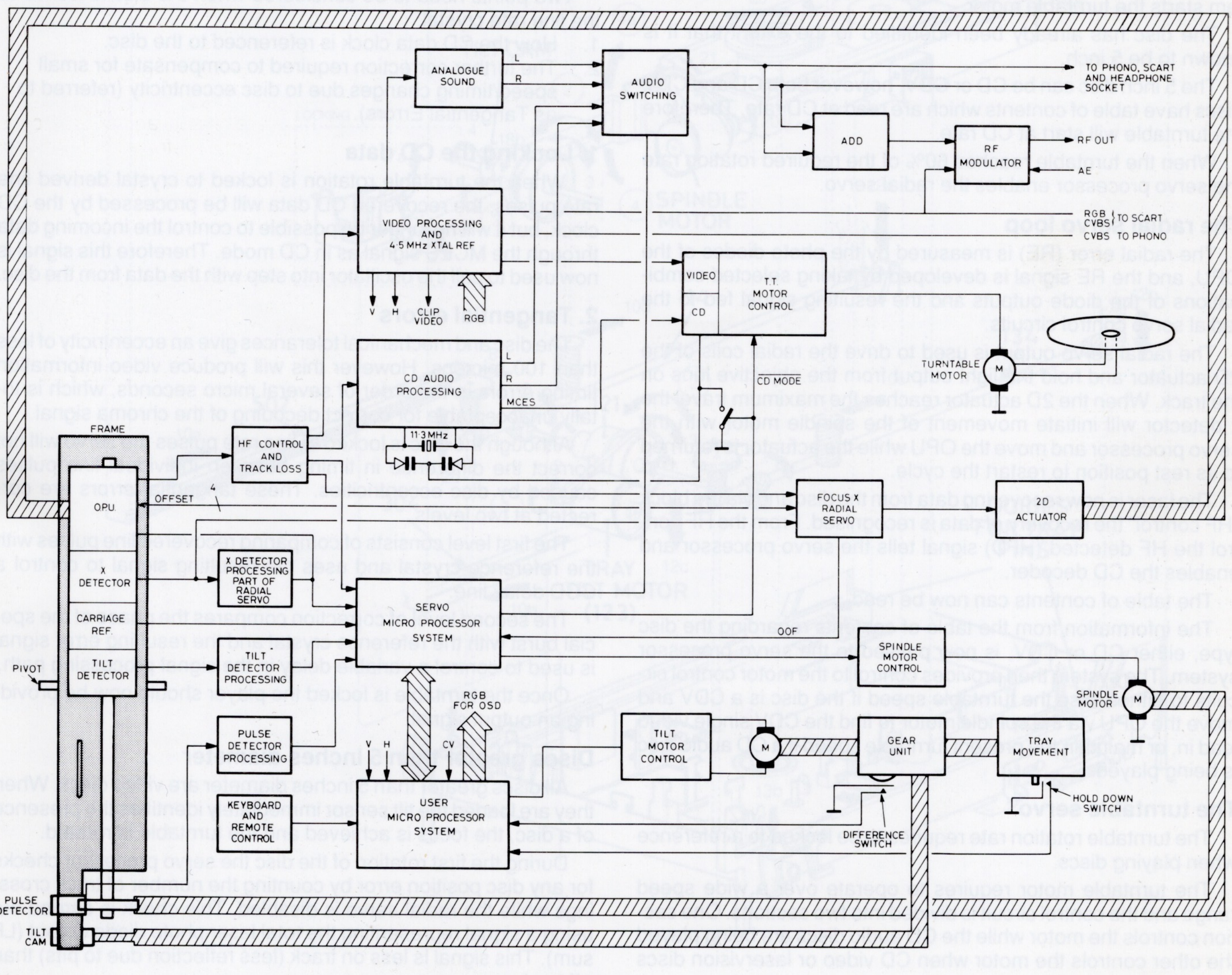


Fig.2 Block diagram of the player

Identify disc size

The size of the inserted disc now has to be established. This operation is carried out by the tilt detector in conjunction with the servo processor system controlling the spindle motor.

Once the tray is in the down position the tilt sensor will either find a reflective surface above it, indicating the disc size is greater than 5 inches and therefore a video disc, or if no reflection is present, the disc is 5 inches, or the tray contains no disc.

Tray loaded with 5 inch or no disc

When no reflection is obtained the OPU is moved to the start of the disc by the spindle motor under the control of the servo processor, if the tilt detector does not receive a signal then a no disc situation is implemented by the servo processor.

Tray loaded with 5 inch disc

If a reflection is obtained by the tilt detector the servo processor starts the focus procedure.

Focus

The focus servo control loop consists of the focus error signal output from the OPU being fed to the focus servo control circuits which provide an output to drive the focus actuator (part of the 2D actuator system) on the OPU.

The loop condition is indicated to the servo processor system by a status line, once the loop is locked the servo processor system starts the turntable motor.

The disc has already been identified to the extent that it is known to be 5 inch.

The 5 inch disc can be CD or CDV, however both CD and CDV discs have table of contents which are read at CD rate. Therefore the turntable will start at CD rate.

When the turntable reaches 60% of the required rotation rate the servo processor enables the radial servo.

The radial servo loop

The radial error (RE) is measured by the photo diodes of the OPU, and the RE signal is developed by taking selected combinations of the diode outputs and the resulting signal fed to the radial servo control circuits.

The radial servo output is used to drive the radial coils of the 2D actuator and hold the light output from the objective lens on the track. When the 2D actuator reaches the maximum travel the x detector will initiate movement of the spindle motor with the servo processor and move the OPU while the actuator is returned to its rest position to restart the cycle.

The laser is now recovering data from the disc and via the block "HF control" the recovery of data is recognised. From the HF control the HF detected (HFD) signal tells the servo processor and enables the CD decoder.

The table of contents can now be read.

The information from the table of contents regarding the disc type, either CD or CDV, is now passed to the servo processor system. The system then provides control to the motor control circuits to either raise the turntable speed if the disc is a CDV and move the OPU via the spindle motor to find the CDV single video lead in, or maintain the present turntable speed if a CD audio disc is being played.

The turntable servo

The turntable rotation rate requires to be locked to a reference when playing discs.

The turntable motor requires to operate over a wide speed range and the control circuit is divided into two sections. One section controls the motor while the CD audio discs are being played the other controls the motor when CD video or laservision discs are played.

CD Audio

When CD audio discs are played the turntable servo follows the normal CD convention. The data recorded from the disc is decoded and clocked out of the IC under the control of the crystal clock.

A motor error signal is developed as a result of the difference in time of data from the disc relative to the clock. It is this motor error signal (MCES) which is processed to control the turntable speed and hence the data in from the disc.

CD Video

When a CDV disc is played it is identified to the servo processor as being a video disc either because its diameter was greater than 5 inches or because the table of contents identified a CDV single.

The servo processor system brings the player into the video mode and selects the video section of the turntable motor control circuits.

The turntable servo locks the turntable motor by taking syncs from the recovered video information and comparing them with line rate pulses obtained by dividing down from a 4.5MHz crystal oscillator.

The comparison is carried out in the motor control servo, and the derived error signal, after further processing, drives the turntable motor.

Two points need to be considered when the disc is locked to the line rate crystal.

1. How the CD data clock is referenced to the disc.
2. The further correction required to compensate for small speed/timing changes due to disc eccentricity (referred to as Tangential Errors).

1. Locking the CD data

When the turntable rotation is locked to crystal derived line rate pulses, the recovered CD data will be processed by the CD clock, but it will no longer be possible to control the incoming data through the MCES signal as in CD mode. Therefore this signal is now used to pull the oscillator into step with the data from the disc.

2. Tangential errors

The disc and mechanical tolerances give an eccentricity of less than 100 microns. However this will produce video information timing errors in the order of several micro seconds, which is totally unacceptable for correct decoding of the chroma signal.

Although the disc is locked to line rate pulses the servo will not correct the difference in timing between individual line pulses caused by disc eccentricities. These tangential errors are corrected at two levels.

The first level consists of comparing recovered line pulses with the reference crystal and uses the resulting signal to control a CCD delay line.

The second level of correction compares the phase of the special burst with the reference crystal and the resulting error signal is used to control a variable delay in the signal processing path.

Once the turntable is locked the player should now be providing an output signal.

Discs greater than 5 inches diameter

All discs greater than 5 inches diameter are video discs. When they are loaded the tilt sensor immediately identifies the presence of a disc, the focus is achieved and the turntable is rotated.

During the first rotation of the disc the servo processor checks for any disc position error by counting the number of track crossings while the radial servo is disabled. This check is carried out using a signal representing the total laser photo diode output (LF sum). This signal is less on track (less reflection due to pits) than off track.

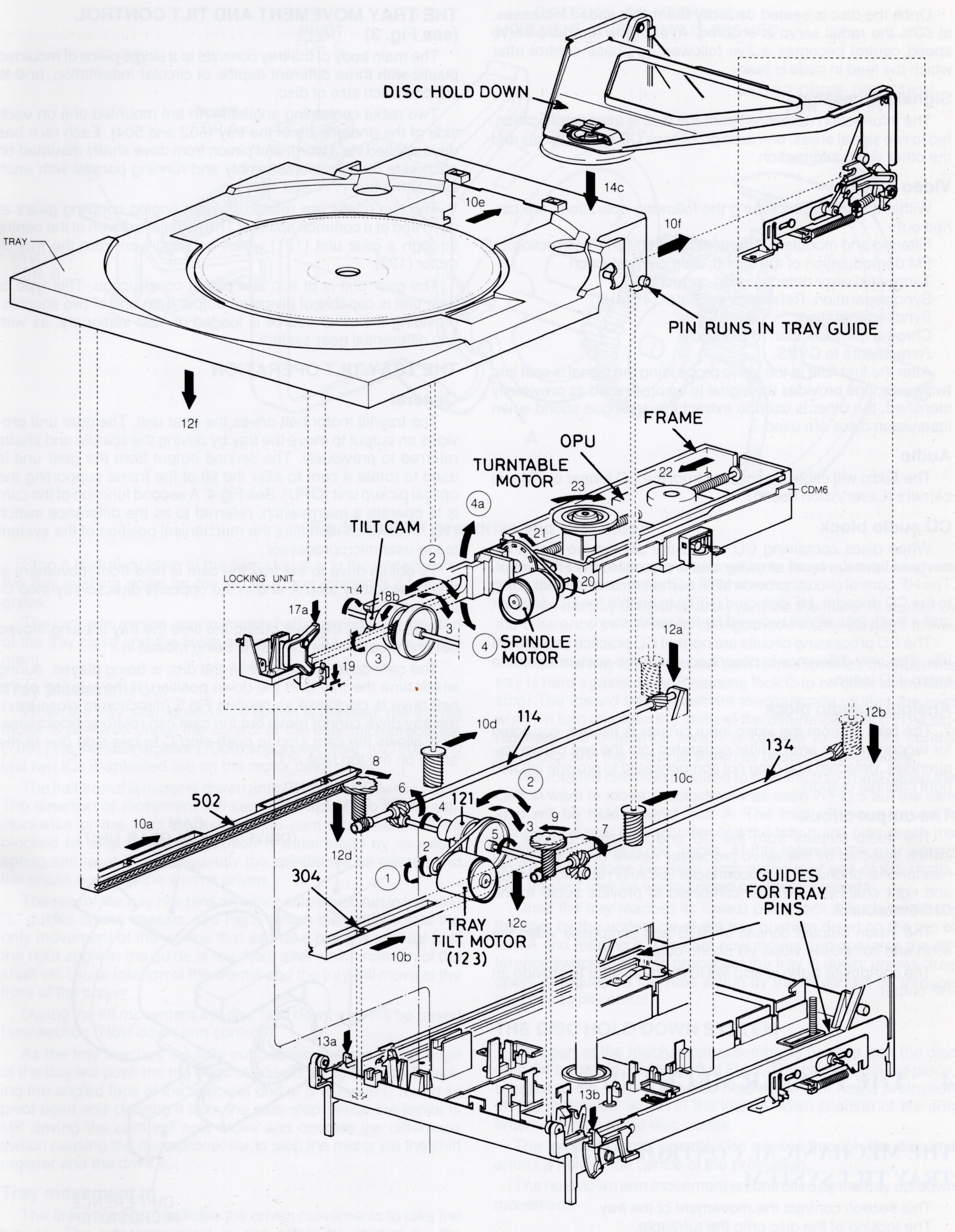


Fig.3 Tray and tilt movement

Once the disc is seated correctly the motor speed increases, at 60% the radial servo is enabled. At 80% the turntable servo speed control becomes active followed by phase control after which the lead in code is read.

Signal processing

The information recovered from the disc is after amplification, fed to two signal areas, one area processes CD audio signals and the other video information.

Video block

Within the video processing the following operations are carried out:-

Filtering and modulation transfer function (MTF) correction.
FM demodulation of the signal, drop out protection.
Tangential error detection and correction.
Sync separation. Reference oscillator (4.5MHz).
Sync regeneration.
Chroma demodulation to RG and B.
Remodulate to CVBS.

After the first filter in the video processing the signal is split into two feeds, one provides the signal to be processed as previously identified, the other is used to extract the analogue sound when laservision discs are used.

Audio

The audio will either be sourced from the CD format or FM sub carriers (LaserVision sound).

CD audio block

When discs containing CD sound are played the signal recovered from the head amplifier unit is passed to the HF control. The HF control circuits provide MTF correction to the signal going to the CD decoder, HF detected (HFD) to enable the CD decoder and a track loss signal required by the radial servo.

The CD processing circuits are normal CD practice using three ICs. The only difference is described under the section turntable servo, CD video.

Analogue audio block

The take off from the video input circuits is filtered, corrected for tangential time errors, filter separated into the two carrier frequencies, detected and drop out compensated to provide left and right channel outputs.

The output circuit

The audio outputs from the CD and analogue circuits are switch selected by the servo processor before being fed to the headphone, phono and Euroconnector (SCART) outputs. The left and right channels are also combined to provide audio to the CH36 modulator.

The vision outputs consist of RGB and composite video via scart and composite video via phono output.

The composite video is also fed to the modulator to provide an RF output.

4. THE PLAYER MECHANICS

THE MECHANICAL CONTROL OF THE TRAY TILT SYSTEM

This section controls the movement of the tray.
The locking of the disc onto the turntable.
The control of the tilt for the optical pickup unit while the disc is being played.

THE TRAY MOVEMENT AND TILT CONTROL (see Fig. 3)

The main body of the tray consists of a single piece of moulded plastic with three different depths of circular indentation, one to support each size of disc.

Two racks containing angled teeth are mounted one on each side of the underneath of the tray (502 and 504). Each rack has drive applied via a worm and pinion from drive shafts mounted on each side of the base assembly and running parallel with each side of the tray (114 and 134).

The two shafts are rotated by right angled coupling gears at each end of a common spindle. The spindle is driven at the centre through a gear unit (121) which is belt driven from the tray/tilt motor (123).

The gear unit is of sun and planet construction. This type of gear unit is capable of giving an output from one of two sources, providing the other source is loaded or held stationary, as with any differential gear system.

THE TRAY/TILT OPERATION

General

The tray/tilt motor belt drives the gear unit. The gear unit provides an output to move the tray by driving the spindle and shafts referred to previously. The second output from the gear unit is used to rotate a cam to alter the tilt of the frame supporting the optical pickup unit (OPU). See Fig.4. A second function of the cam is to operate a microswitch, referred to as the difference switch (19), this switch identifies the mechanical position of the system to the user microprocessor.

To obtain drive to the tray the cam is held from movement in one direction by stop A and in the opposite direction by stop C, shown in Fig.5.

Stop C holds the cam during the time the tray is being moved out and stop A while the tray is being moved in.

The cam drive is active while the disc is being played, during which time the tray is in the down position. If the rotation of the belt drive is clockwise as seen in Fig.5 (direction to close tray). the tray drive cannot move but the cam can rotate anticlockwise. This allows the cam stop to push stop C to one side due to the angle on the top face of C.

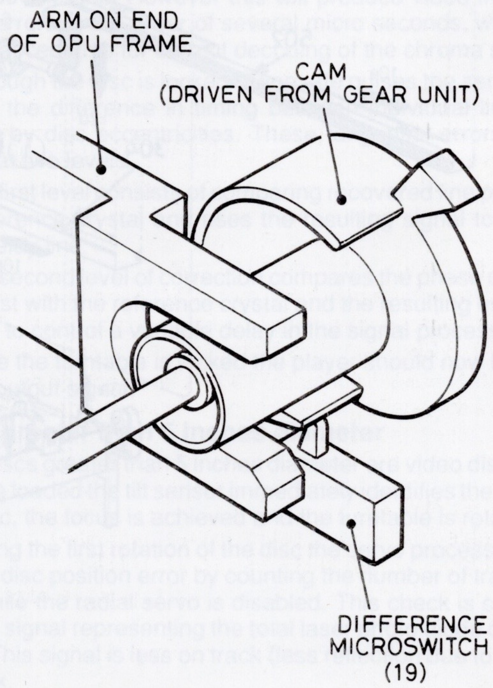


Fig.4 Cam and difference switch

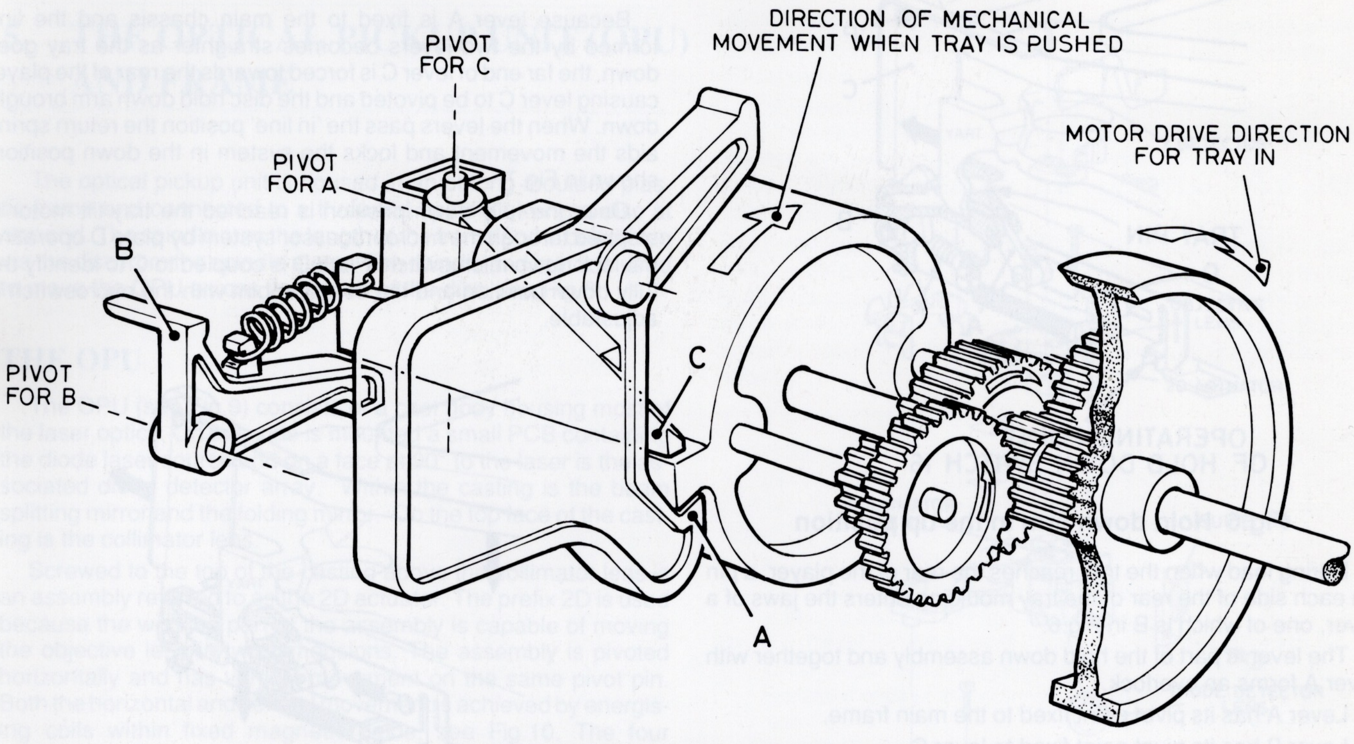


Fig.5 Tray/tilt gear drive and cam stops

Stop A is already clear of the cam stop due to the underside of the tray pushing down on the top of A and rotating it a few degrees.

The cam also moves approximately half a revolution at the start of the tray close and the finish of the tray open, see Tray Movement.

Tray Movement out

When the tray stop, open/close button is pressed, the tray/tilt motor is powered under the control of the user microprocessor (7001) via the shift register (7009) and motor drive IC(7008), the last two ICs mentioned are on the motor drive panel.

The belt from the motor is driven anticlockwise as seen in Fig.5. The direction of movement will cause the spindle to rotate anticlockwise or the cam clockwise. The cam movement will be blocked by stop C whose position is determined by its return spring and lever B, consequently the spindle will be rotated and the shafts coupling the worms driven.

The rear of the tray has pins on either side which run in inverted "L" guides on the chassis, see Fig.3. When the shafts rotate the only movement of the worms that can take place is vertical until the right angle in the guide is reached, after which rotation of the shaft will cause rotation of the worms and the tray will move to the front of the player.

During the lift movement the disc hold down arm will be raised (see section "Hold down arm control").

As the tray reaches the fully out position the lower rear edge of the tray will push the top edge of lever B in Fig.5 forward causing the angled face of the opposite end of B to move C round its pivot point and clearing it from the cam stop. Since the motor is still driving the cam will now move and operate the difference switch causing the microprocessor to stop the motor via the shift register and the drive IC.

Tray movement in

The arrows in Fig. 5 indicate the driven movements to take the tray in. The tray movement in can either be started by the stop/close button or by pushing the tray. When the stop/close button is used a direct command is given to the processor which via the expander and drive IC runs the motor.

When the tray is mechanically pushed the motor is started by the difference switch being changed due to the carriage movement.

When the tray is fully out the cam is free to rotate because the tray is hard against lever B causing lock C to be clear of the cam stop. The inward tray movement mechanically rotates the cam which in turn changes the state of the difference switch. The signal from the difference switch is passed to the front control processor and the motor is driven as described previously.

The rotation direction required to take the tray in will cause the cam to want to move anticlockwise as seen in Fig.5 but the cam stop will be held against lock A. The tray will move in until it reaches the rear spring buffer and the tray guide pins reach the vertical part of the guide tracks. At this moment the rear worms on the tray engage the drive cogs at the rear end of the shafts. The tray will now be wound down on the four worms.

Once the tray reaches its lowest point, lock A is cleared from the cam by the underside of the tray pushing down on the top of arm A and rotating it. The cam now moves and operates the difference switch to tell the processor the tray is down; unless "tray open" is requested the next action by the motor will be through the cam as tilt control.

THE DISC HOLD DOWN SYSTEM

This part of the mechanical assembly is used to lock the disc onto the turntable, see top left of Fig.3. The circular locking piece, situated at the front of the disc hold down arm has a protrusion on the underside, which in the locked down position of the arm enters the hole in the disc centre.

The turntable motor spindle also passes through the disc and enters a hole in the centre of the protrusion.

The hold down arm movement is controlled by the tray up/down movement.

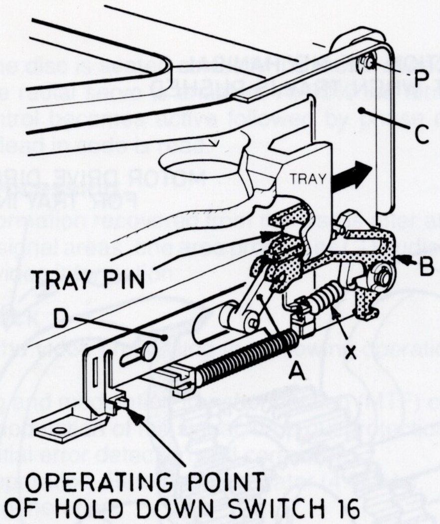


Fig.6 Hold down arm in the up position

During load when the tray reaches the rear of the player, a pin on each side of the rear of the tray moulding enters the jaws of a lever, one of which is B in Fig.6.

The lever is part of the hold down assembly and together with lever A forms an overlock.

Lever A has its pivot point fixed to the main frame.

Lever B has its pivot point fixed to lever C.

Lever C is pivoted at the upper rear corner and is part of the disc hold down frame.

When the pins are in the jaws, the tray's downward movement starts. The junction of levers A and B is forced down against the force of return spring x.

Because lever A is fixed to the main chassis and the line formed by the two levers becomes straighter as the tray goes down, the far end of lever C is forced towards the rear of the player causing lever C to be pivoted and the disc hold down arm brought down. When the levers pass the 'in line' position the return spring aids the movement and locks the system in the down position, shown in Fig.7.

Once the fully down position is reached the tray/tilt motor is stopped through the microprocessor system by plate D operating the lock down microswitch. Plate D is coupled to C to identify the fully down position and the contact point with the microswitch is adjustable.

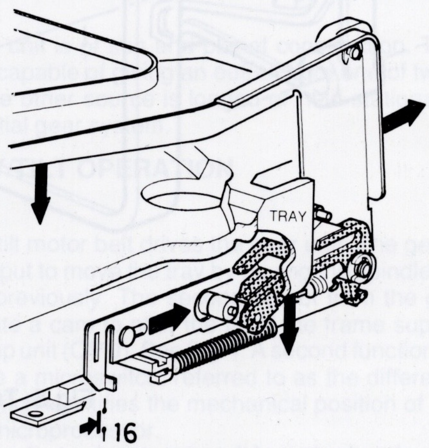


Fig.7 Hold down arm in the locked position

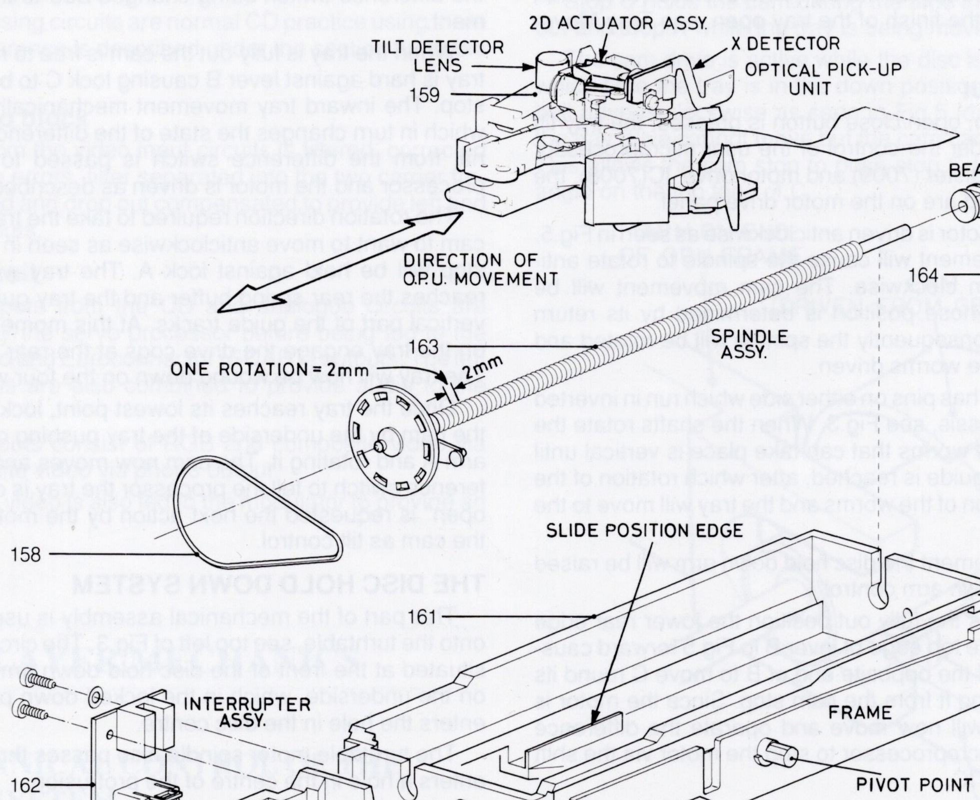


Fig.8 Optical pickup unit and frame

5. THE OPTICAL PICKUP UNIT (OPU) AND FRAME

The optical pickup unit is housed in an oblong moulded plastic frame and connected to a threaded spindle having a disc at one end. The spindle runs the length of the frame and is belt driven via the disc from the spindle motor. The spindle and motor is used to move the OPU across the radius of the disc, see Fig.8.

THE OPU

The OPU (see Fig.9) consists of a cast body housing most of the laser optics. On one side is mounted a small PCB containing the diode laser source and on a face at 90° to the laser is the associated diode detector array. Within the casting is the beam splitting mirror and the folding mirror. On the top face of the casting is the collimator lens.

Screwed to the top of the casting above the collimator lens is an assembly referred to as the 2D actuator. The prefix 2D is used because the working part of the assembly is capable of moving the objective lens in two dimensions. The assembly is pivoted horizontally and has vertical movement on the same pivot pin. Both the horizontal and vertical movement is achieved by energising coils within fixed magnetic fields, see Fig.10. The four connecting wires to the coils also form the means to establish and return the assembly to the mechanical zero position, it is therefore most important that the connecting wires are not disturbed or deformed.

Focus

The vertical movement of the objective or focus lens is used to achieve focus.

Radial control

The horizontal movement of the 2D assembly moves the objective lens radially with respect to the disc and is used to maintain fine radial tracking.

Coarse radial movement is achieved by rotating the spindle assembly to move the complete OPU within the frame.

THE LASER LIGHT PATH

The complete light path for the laser light is shown in Fig.11. From the laser source the beam first strikes the beam splitting mirror where it is deflected towards the folding mirror.

The folding mirror deflects the beam in a vertical direction to the collimator lens where it is made into a parallel beam. At this point the beam leaves the lower section of the OPU and enters the objective lens mounted on the 2D actuator assembly.

The objective lens is capable of vertical movement to focus the beam to a spot on the disc surface. The 2D actuator assembly is

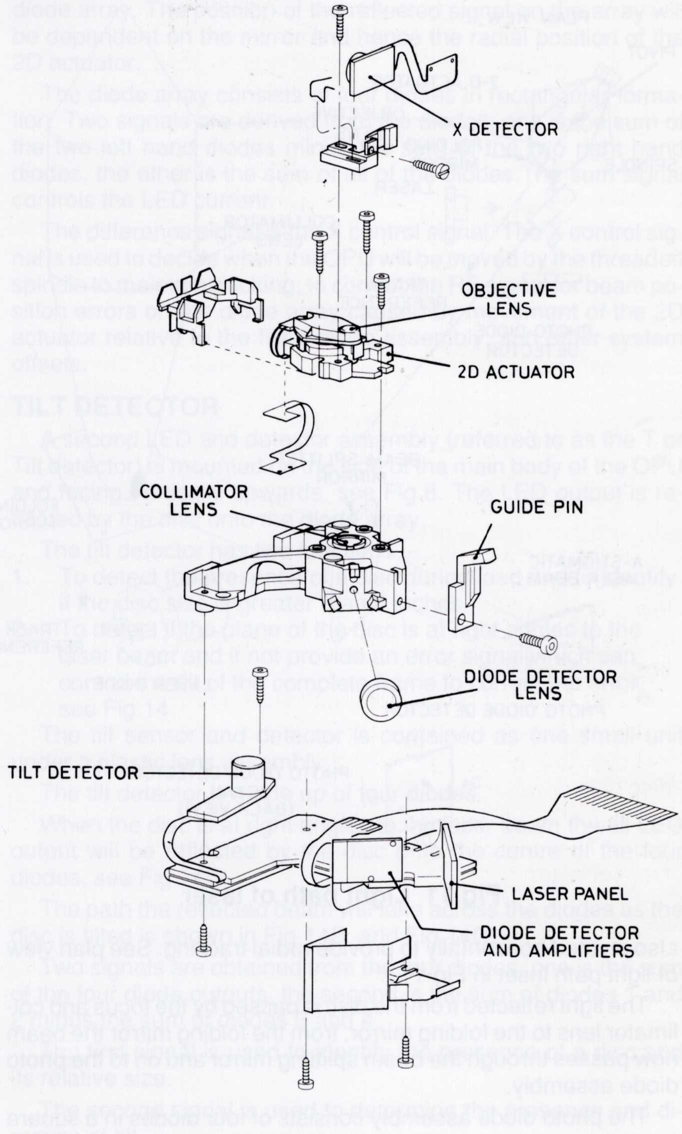


Fig.9 Optical pickup unit

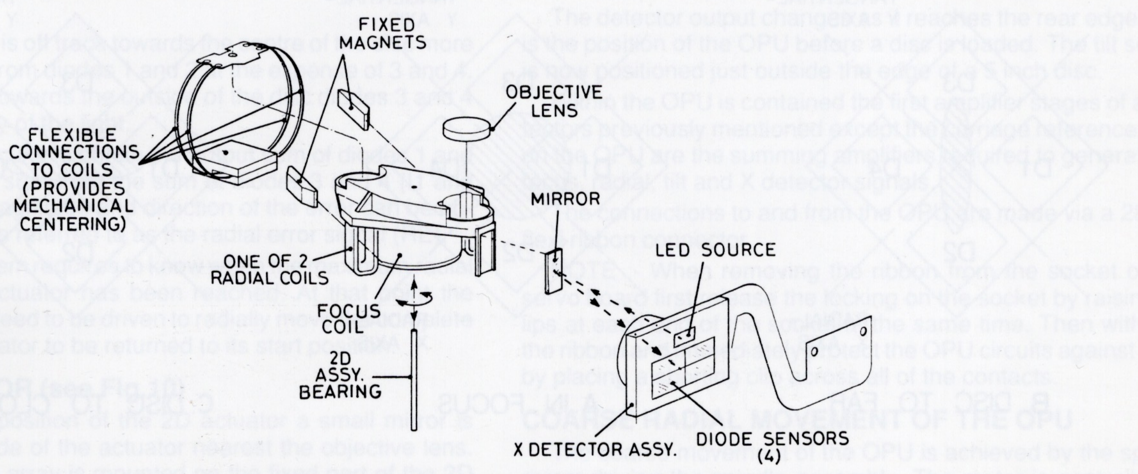


Fig.10 2D actuator and X detector

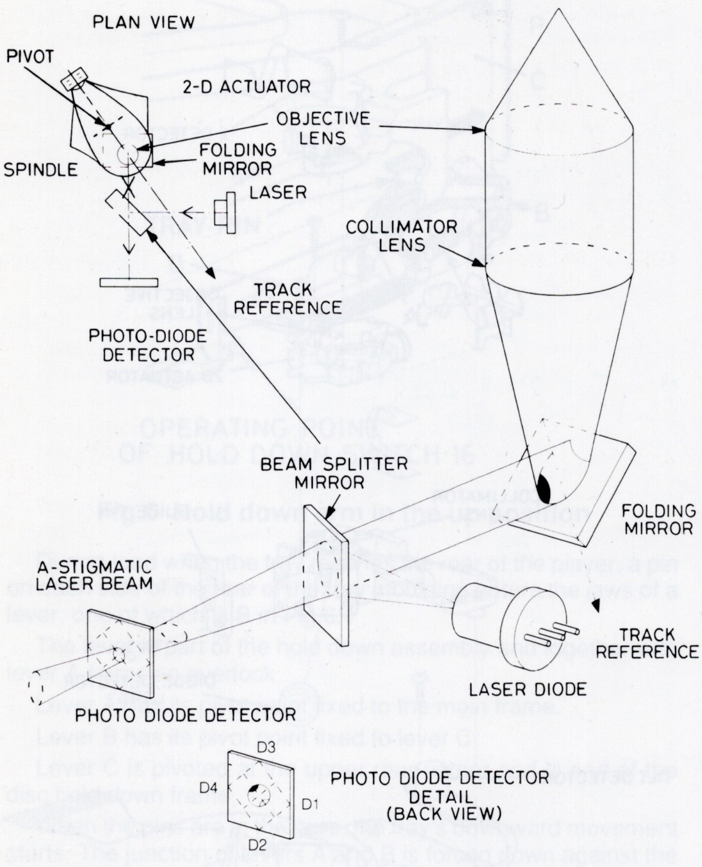


Fig.11 Light path of laser

also pivoted horizontally to provide radial tracking. See plan view of light path inset in Fig.11.

The light reflected from the disc is passed by the focus and collimator lens to the folding mirror, from the folding mirror the beam now passes through the beam splitting mirror and on to the photo diode assembly.

The photo diode assembly consists of four diodes in a square formation.

THE SIGNAL OUTPUTS

The OPU provides 5 outputs.

These consist of one output from each of the four photo diodes that make up the assembly and one output from the diodes substrate.

Once focus is achieved light is always reflected from the disc and passed to the diode array via the light path excepting when drop-out is present. When the system is reading a track the reflected light intensity varies due to the reduction of reflected light in the period of a pit.

Relating this to the current in the diodes it means there will be a DC component with high frequency variations on it.

Each of the four outputs contains this signal, but since the total current of the four diodes is present in the substrate it is used to recover the data from the disc.

The four individual diode outputs are used to identify focus and radial errors and therefore also have low frequency variation present. The LF variations are the result of one diode conduction increasing at the expense of one of the others as focus or radial errors occur and are corrected, see Focus and radial errors.

Each of the five signals is amplified before leaving the OPU assembly. The substrate signal is then refered to as the HF signal since as soon as it enters the servo panel it is capacitively coupled and therefore looses its DC component. The four individual diode outputs are given the designates E1, E2, E3 and E4.

The HF information is processed and decoded to provide the vision and sound information and to sense signal amplitude.

FOCUS ERROR DETECTION

Errors of focus are detected by a combination of using an astigmatic focus system and the resulting beam landing pattern produced on the four diodes. With astigmatic focus systems the beam becomes elliptical either side of the correct focus point. The resulting ellipses created in front of the focal point are at 90° with respect to the ellipses made when the beam landing is behind the focal point.

The correct focus condition shown in Fig.12A produces equal output from all four diodes. When the disc is too far from the objective diodes 2 and 3 are favoured at the expense of 1 and 4, when the disc is too close diodes 1 and 4 have the greater output.

By arranging circuits that obtain the sum of the outputs of diodes 1 and 4 and subtract the sum of the outputs from diodes

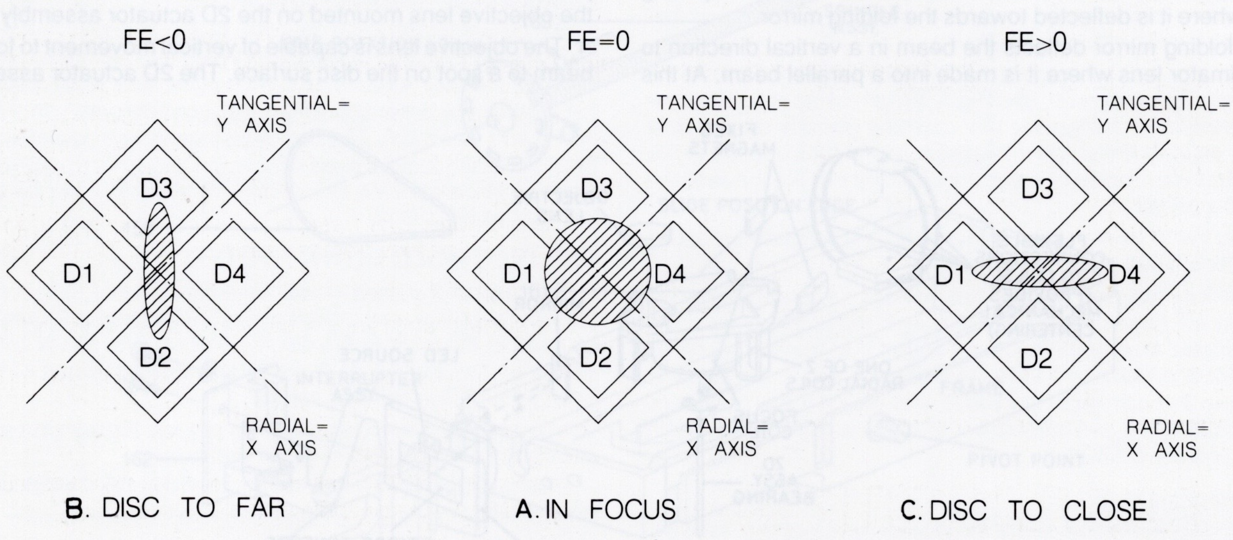


Fig.12 Focussing

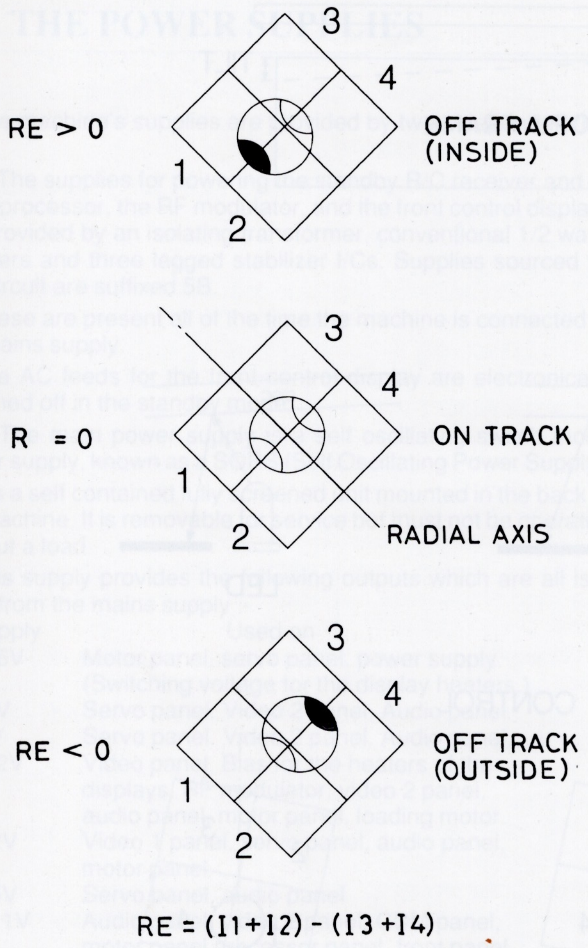


Fig.13 Radial errors

2 and 3 from 1 and 4 (I1 +I4) - (I2 + I3) the out of focus condition when the focal point is above or below the disc can be obtained. The resulting signal is referred to as the focus error signal (FE).

RADIAL ERROR DETECTION

To obtain a measure of the position of the beam relative to the track (radial error) use is also made of the beam landing on the four diodes, see Fig.13.

Fig.13 shows the beam off-centre due to radial errors, it is shown this way for clarity, in practice only the light intensity changes.

When the beam is off track towards the centre of the disc more signal is obtained from diodes 1 and 2 at the expense of 3 and 4. When the error is towards the outside of the disc diodes 3 and 4 receive the majority of the light.

By arranging circuits to obtain the output sum of diodes 1 and 2 and subtract the sum from the sum of diodes 3 and 4 (I1 and I2) - (I3 + I4) the magnitude and direction of the error can be obtained. The result is referred to as the radial error signal (RE).

The control system requires to know when the maximum radial travel of the 2D actuator has been reached. At that point the spindle motor will need to be driven to radially move the complete OPU, and the actuator to be returned to its start position.

THE X DETECTOR (see Fig.10)

To identify the position of the 2D actuator a small mirror is mounted on the side of the actuator nearest the objective lens. An LED and diode array is mounted on the fixed part of the 2D assembly. The LED output is reflected by the mirror onto the diode array. The position of the reflected signal on the array will be dependent on the mirror and hence the radial position of the 2D actuator.

The diode array consists of four diodes in rectangular formation. Two signals are derived from the diodes, one is the sum of the two left hand diodes minus the sum of the two right hand diodes, the other is the sum of all of the diodes.The sum signal controls the LED current.

The difference signal is the X control signal. The X control signal is used to decide when the OPU will be moved by the threaded spindle to maintain tracking; to correct the RE signal for beam position errors on the diode array caused by movement of the 2D actuator relative to the fixed diode assembly, and other system offsets.

TILT DETECTOR

A second LED and detector assembly (referred to as the T or Tilt detector) is mounted on the side of the main body of the OPU and facing vertically upwards, see Fig.8. The LED output is reflected by the disc onto the diode array.

The tilt detector has two functions :-

1. To detect the presence of a disc during load and to identify if the disc size is greater than 5 inches.
2. To detect if the plane of the disc is at right angles to the laser beam and if not provide an error signal which can control the tilt of the complete frame to correct the error, see Fig.14.

The tilt sensor and detector is contained as one small unit under a plastic lens assembly.

The tilt detector is made up of four diodes.

When the disc is at right angles to the laser beam the tilt LED output will be reflected by the disc onto the centre of the four diodes, see Fig.14B.

The path the reflected beam will take across the diodes as the disc is tilted is shown in Fig.14B. and Fig.14C.

Two signals are obtained from the four diodes, one is the sum of the four diode outputs, the second is the sum of diodes 1 and 2 minus the sum of diodes 3 and 4.

The first signal is used to identify the presence of a disc and its relative size.

The second signal is used to determine the presence and direction of tilt.

CARRIAGE REFERENCE DETECTOR

This detector consists of an LED and diode pickup mounted on the underside of the OPU. In the bottom of the frame is an edge of plastic referred to as the slide position edge, see Fig.8. When the OPU is moved to that part of the frame the slide position edge comes between the LED and the diode pickup.

The detector output changes as it reaches the rear edge. This is the position of the OPU before a disc is loaded. The tilt sensor is now positioned just outside the edge of a 5 inch disc.

Within the OPU is contained the first amplifier stages of all detectors previously mentioned except the carriage reference. Also on the OPU are the summing amplifiers required to generate the focus, radial, tilt and X detector signals.

The connections to and from the OPU are made via a 28 way flexi ribbon connector.

NOTE :- When removing the ribbon from the socket on the servo board first release the locking on the socket by raising the lips at each end of the socket at the same time. Then withdraw the ribbon and immediately protect the OPU circuits against static by placing a shorting clip across all of the contacts.

COARSE RADIAL MOVEMENT OF THE OPU

The coarse movement of the OPU is achieved by the spindle motor driving the spindle assembly. The motor is controlled by

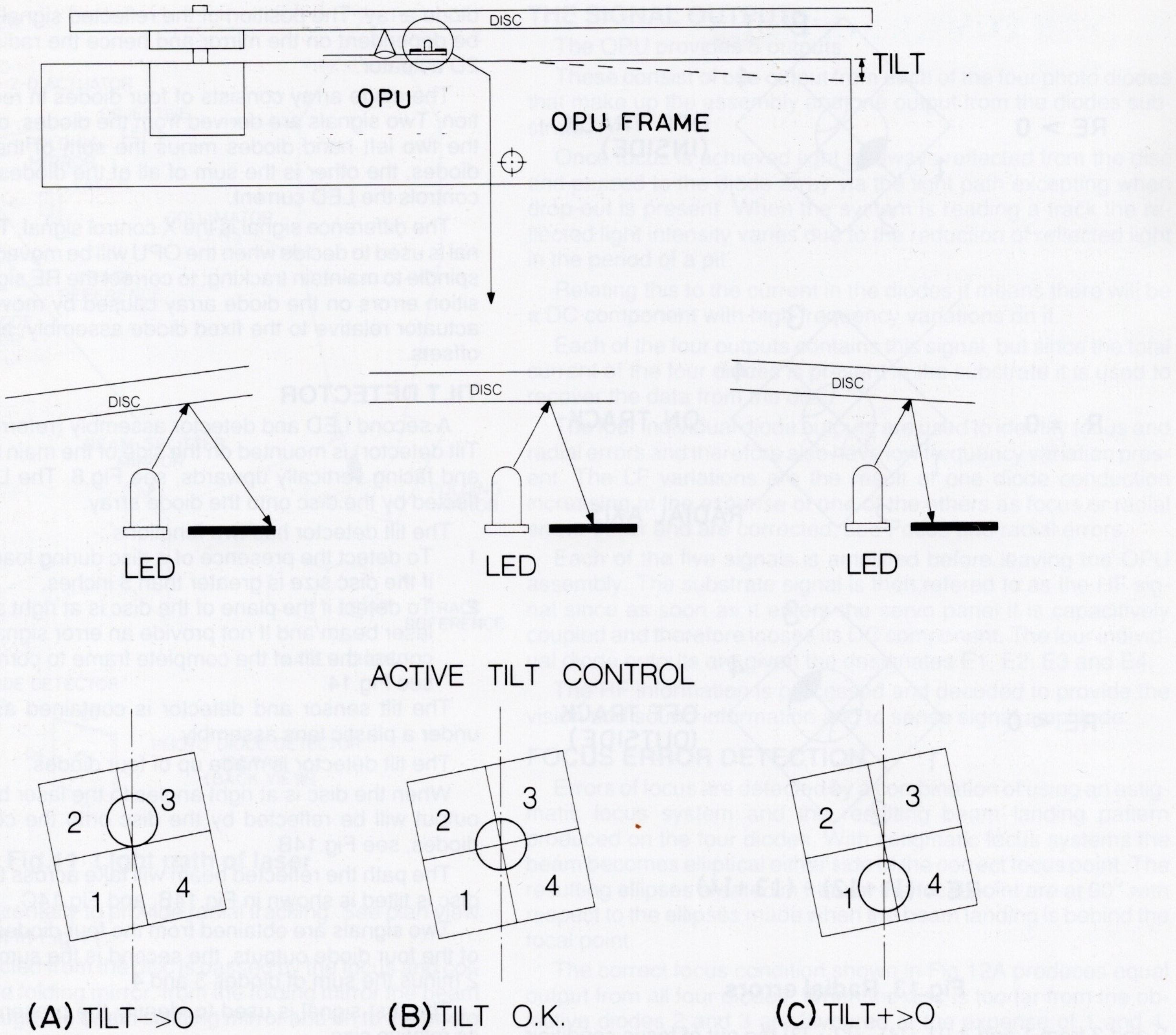


Fig.14 Tilt sensor operation

the servo microprocessor via a shift register, supplying information to the control and motor drive circuits.

The OPU coarse radial movement is limited to steps of 50 microns to ensure it stays within the range of the optical radial tracking unit (2D actuator) on the OPU.

This movement is achieved by measuring the rotation of the spindle. Each full rotation of the spindle corresponds to an OPU movement of 2mm.

Refer to Fig.8

The end of the spindle is fitted with a disc containing 10 cut-outs round its circumference. The distance between the cut-outs is the same as their width.

An LED sensor unit is fitted with the radiator and sensor either side of the disc to read the change as each cut-out is reached. A second sensor within the same unit, but displaced half a cut-out length from the first, also provides a change as each cut-out is reached.

Therefore the combination of the two sensors produces pulses at every half cut-out distance.

Since each revolution of the spindle corresponds to 2mm of OPU movement, the length of, and distance between, each cut-out corresponds to 100 microns of movement (10 cut-outs, and 10 spaces). Therefore the combined output of the sensors produces pulses after 50 microns of OPU movement, allowing the spindle motor to be stopped after that distance. The two sensor outputs are given the designates CARMV0 and CARMV1 and are shown in Fig.15.

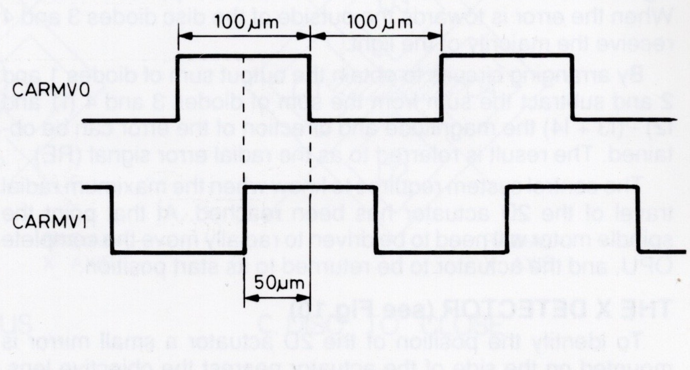


Fig.15 Control of the step movement

6. THE POWER SUPPLIES

The machine's supplies are provided by two independent circuits.

1. The supplies for powering the standby R/C receiver and its microprocessor, the RF modulator, and the front control displays are provided by an isolating transformer, conventional 1/2 wave rectifiers and three legged stabilizer I/Cs. Supplies sourced by this circuit are suffixed 5B.

These are present all of the time the machine is connected to the mains supply.

The AC feeds for the front control display are electronically switched off in the standby mode.

2. The main power supply is a self oscillating switch mode power supply, known as a SOPS (Self Oscillating Power Supply).

It is a self contained fully screened unit mounted in the back of the machine. It is removable for service but must not be operated without a load.

This supply provides the following outputs which are all isolated from the mains supply :-

Supply	Used on
+36V	Motor panel, servo panel, power supply. (Switching voltage for the display heaters.)
+7V	Servo panel. Video 2 panel. Audio panel.
-7V	Servo panel. Video 2 panel. Audio panel.
+12V	Video panel. Bias for the heaters of the displays. RF modulator, video 2 panel, audio panel, motor panel, loading motor.
-12V	Video 1 panel, servo panel, audio panel, motor panel.
-15V	Servo panel, audio panel
+5.1V	Audio panel, video 2 panel, CDM panel, motor panel processor panel, front panel, Video 1 panel.

THE BLOCKING OSCILLATOR ACTION (see Fig.16)

On mains insertion the base of T7002 is connected to the +300V supply via the high value R3002, causing T7002 to go into conduction and pin 6 of L5002 to be grounded.

The linearly increasing current in winding 5-6 of L5002 causes a build up of magnetic energy within the core, at the same time that this energy is building, a voltage is generated across winding 2-4-3 such that pin 2 goes positive and pin 3 is driven negative, charging C2009 and C2010.

When sufficient energy (to meet the needs of the loads plus some excess) has been built up in the core of L5002, the combination of T7001 and T7004 is turned on by the positive charge on C2009, the base of T7002 is connected to the negative charge on C2010, this rapidly turns off T7002.

The energy stored in the core of L5002 is now transferred to the loads, and the decaying energy results in reverse polarity voltages across the windings 5-6 and 2-3 which discharge the capacitors C2007, C2009 and C2010.

When the charge on C2007 decays sufficiently the winding 5-6 and C2007 go into a self oscillation which reverses the decaying voltage and T7002 switches on, starting once again the cycle just described.

The O/P voltages are stabilized against load variations and mains supply volts variations.

Stabilization against load variations is provided by feeding back the voltage changes through an opto coupler (6017). The use of an opto coupler ensures complete isolation between the secondary and the mains derived primary circuit.

When the voltage across the LED 6017-2A increases the increased light output turns the transistor 6017-2B harder on which then passes more current into C2009 which in turn switches T7001/7004 on sooner switching T7002 off sooner and the reduced on time means the output voltages fall.

When an increase of load produces a longer on time the frequency of the blocking oscillator is slower such that if the output is short circuit the frequency falls to about 1.3kHz, the frequency with a normal load is approximately 40kHz.

Stabilization against mains volts variation is produced as a result of the slope of the current changing with HT voltage as the 300V HT voltage rises the slope becomes steeper the increased slope is fed to the transistor 7001 via winding 2-3 diode D6006 and resistor 3006 to switch it on sooner resulting in a shorter on time for T7002 and a higher frequency. A corresponding reduction in mains volts will result in a lowering of the frequency.

The components D6007 and R3005 are to ensure that the maximum power available remains constant with these mains volts variations.

A second opto coupler 6026 is used to provide the current to switch off the SOPS when stand-by is selected:-

When the diode 6026-2A is powered the photo transistor 6026-2B passes base current into T7004 turning it hard on which in turn holds T7002 off.

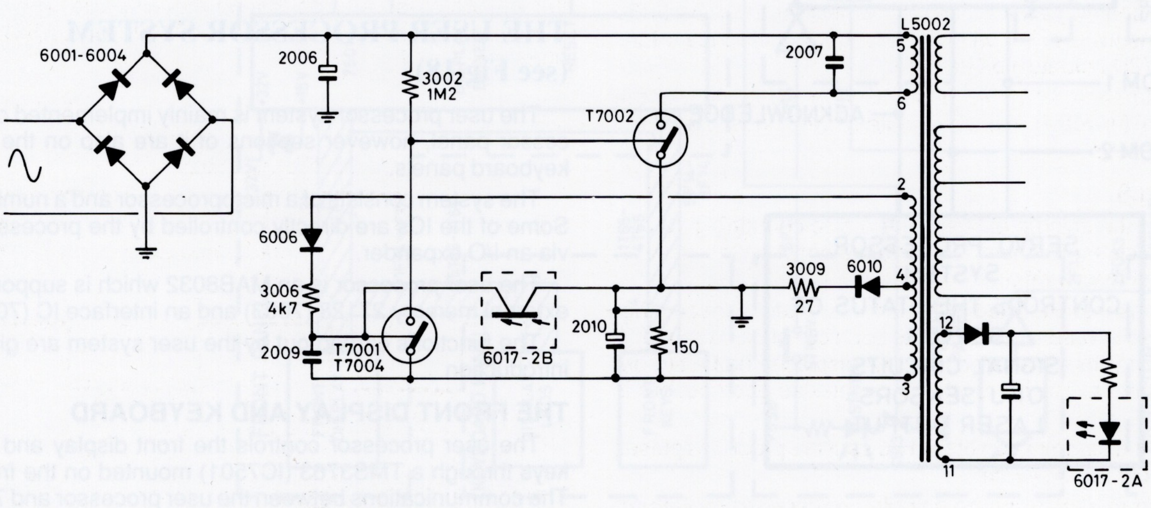


Fig.16 Basic SOPS circuit

7. THE CONTROL SYSTEM

INTRODUCTION (see Fig.17)

The following description of the control system is divided into two main sections and a subsidiary section.

The main sections are a user processor system and a servo processor system. The third section is the tray/tilt motor control which is a subsidiary of the user processor system.

The user processor system runs the customer key operations and the RC5 infra red input. It decodes the Manchester code obtained from video discs and from the decoded information provides data for, and controls the front panel display, and the on screen display, OSD.

The user system has a three line communications system between it and the servo processor system. It also has communications between it and the tray/tilt motor control in the form of two data lines, one for each direction of transfer and an enable line.

The servo processor system controls the internal circuits of the player.

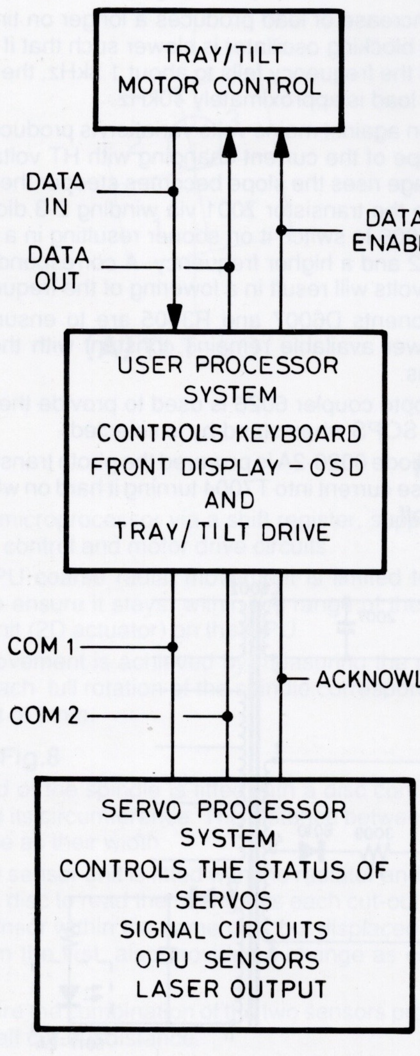


Fig.17 Outline of the control system

It controls the operations of, and monitors the responses from all of the servos and a number of other functions. From this data it controls the sequence of events leading to the playing of a disc.

The servo processor monitors all servos during play and provides all control signals necessary to carry out feature modes of play and stopping the disc.

SEQUENCE OF OPERATIONS RUN BY THE CONTROL SYSTEM

At mains insertion

The OPU is moved slightly in both directions (inwards first) to establish the carriage reference position.

The 2D actuator is momentarily energised.

The tray is moved down and the returned to its original position and then the player is returned to standby.

If the player is raised to the on state and no function is in progress for 3 minutes the player returns to standby.

Sequence to play a disc

Tray is moved out and disc inserted.

The tray moves in either started by physical movement or by operation of the close button and lowers the disc onto the turntable.

During this action the difference and hold down switches are operated.

The presence of a disc is confirmed and if it is a 5" disc; see Chapter 5 for detail.

The OPU is moved to the lead-in area of the disc, this is a function of the servo processor controlling the spindle motor.

The focus servo tries to find focus, when focus is found FOCRDY goes high.

The servo processor starts the turntable servo. From the on state the radial servo is held non operative by the servo processor.

At the first revolutions of the turntable the position of the disc is checked by counting track crossings; this only applies to 8 and 12 inch discs, see The Radial Servo Chapter 8 for detail.

When the turntable reaches 60% of normal speed the radial servo is active.

When the turntable servo phase lock is achieved (video disc only) PLOCK line goes high.

Table of contents are read.

For detail of the separate operations see the appropriate chapter.

THE USER PROCESSOR SYSTEM (see Fig.18)

The user processor system is mainly implemented on the processor panel, however sections of it are also on the front and keyboard panels.

The system consists of a microprocessor and a number of ICs. Some of the ICs are directly controlled by the processor, others via an I/O expander.

The user processor is an MAB8032 which is supported by an external memory 27128 (7003) and an interface IC (7002).

The functions carried out by the user system are given in the introduction.

THE FRONT DISPLAY AND KEYBOARD

The user processor controls the front display and customer keys through a TMS3763 (IC7501) mounted on the front panel. The communications between the user processor and 7501 is via an IIC Bus. The IIC Bus consists of a bidirectional serial data line and a clock line. All IIC Bus connections are run in open collec-

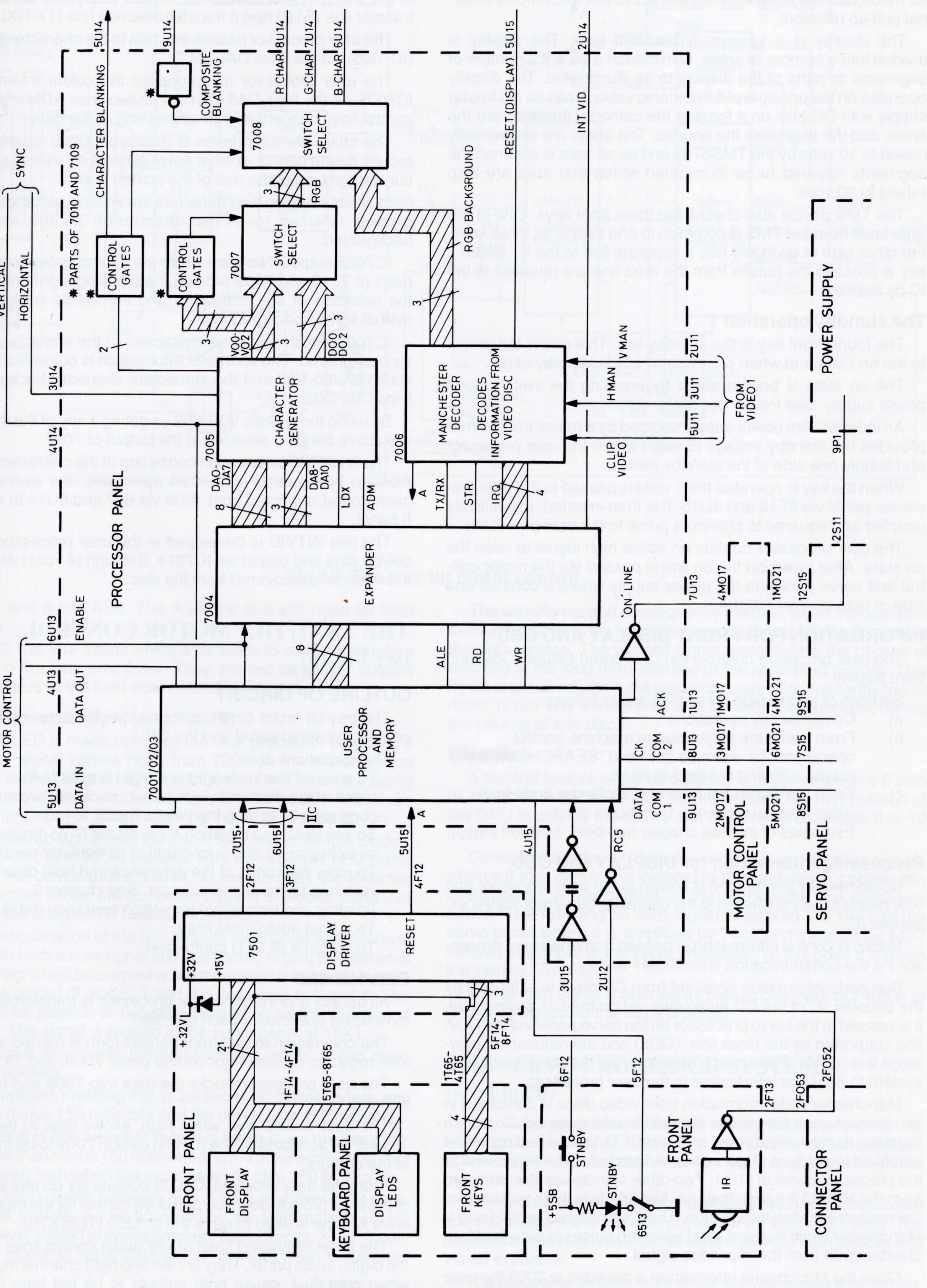


Fig.18 The user processor system

tor mode and therefore the lines are active low and employ external pull-up resistors.

The display is a vacuum fluorescent type. The display is divided into a number of areas, within each area are a number of segments or parts of the display to be illuminated. The display operates on the principle of a thermonic valve. It has an AC heater supply with DC bias on it forming the cathode, the grids are the areas and the segments the anodes. The areas are sequentially raised to 30 volts by the TMS3763 and as an area is scanned the segments required to be illuminated within that area are also raised to 30 volts.

The TMS device also checks the three front keys. One of the area lines from the TMS is common to one side of all three keys, the other side of each key has a separate line to the IC. When a key is pressed the pulses from the area line are returned to the IC by the key.

The standby operation

The fourth front key is the standby key. This raises the player to the on state and when on returns it to the standby state.

The on state is bought about by enabling the switch mode power supply. See Power Supply for detail.

An independent power supply sourced by a mains transformer provides the standby voltage (5 volts) to run the user processor and supply one side of the standby switch.

When the key is operated the 5 volts is passed to the user processor panel via 6F12 and 3U15. It is then inverted, capacitively coupled and squared to provide a pulse to the user processor.

The user processor outputs an active high signal to raise the on state. After inversion the on line is passed via the motor control and servo panels to the power supply where it controls one side of opto coupler 6026-A.

INFORMATION FOR FRONT DISPLAY AND OSD

The user processor controls the On Screen Display OSD and front display.

Sources of information for display are as follows:-

a) Customer key operations
b) From within the player due to machine control operations, for example the word "SEARCH" while the player is finding the lead-in track.
c) From the disc in the form of Manchester code from video discs or sub code from audio discs. Examples of this are chapter numbers, time left etc.

Processing information for DISPLAY and OSD

Customer key information is known to the user processor and only needs to be transferred to the character generator via the expander IC.

Machine control information is passed from the servo processor via the communication lines COM1 and 2.

Sub code information obtained from CD discs is extracted by the decoder IC of the CD audio chip set on the CD audio panel. It is passed to the servo processor on the servo panel via the QDA line supported by the clock line, (QCL) and the request acknowledge line (QRA). The servo processor uses the communications system to pass the information to the user processor.

Manchester code information from video discs is contained in two lines of each field within the field blanking period. To obtain the data, demodulated video on the VIDEO 1 panel is clipped and amplified to produce clean vertical edges before being passed to the processor panel at 5U11. Two other signals are also obtained from the VIDEO 1 panel, they are line and field sync pulses from the recovered video information. They are referred to as H and V Manchester since they are used as timing pulses to gate the Manchester code from the clip video signal.

Once the Manchester information is decoded in 7006 the user processor reads the data via the expander. Seven lines are used in the transfer, four data lines, a data ready line (IRQ), a data transfer line (STB) and a transfer direction line (TX/RX).

The user processor passes the data to the character generator (IC7005) via the lines DA0-DA7.

The user processor also supplies the colour information to IC7005 via the lines DA8-DA10. The two lines ADM and LDI are control lines concerned with addressing of the data.

The character information is displayed either inserted in the picture during play or at other times against an overall single colour background of the rest of the screen area.

In either situation the characters are within a rectangular background referred to in the description as the immediate background.

IC7005 outputs two lines which via control gates consisting of parts of 7010 and 7109 provide the blanking signal required for the selection of the characters and immediate background or overall screen background.

IC7007 switch selcts the characters or the immediate character background. The character information is output from IC7005 via lines V00-V02 and the immediate character background by lines D00-D02.

By using the signals V00-V02 as gating if any of the three lines are active they are selected at the output of 7007.

The final RGB information consisting of the characters, the immediate background and when applicable, the overall screen background is passed from 7008 via 6, 7 and 8U14 to the Video II panel.

The line INTVID is developed in the user processor from received data and output via IC7014. It is high (4 volts) when video information is recovered from the disc.

THE TRAY/TILT MOTOR CONTROL. (see Fig.19)

OUTLINE OF CIRCUIT

The tray/tilt motor control circuit is divided between the motor control, the servo panel and the OPU.

The operations are:-

- To sense if the laser light is at right angles to the plane of the disc and via the user processor provide correction by driving the tray/tilt motor.
- To sense at disc insertion if the disc is 5" or greater, see chapters 3 and 5 for detail of tilt detector sensing.
- To pass the status of the difference and hold down switches to the user processor. See chapter 3 (loading and unloading) for switch operation detail.
- To output audio mute lines.
- To output a tilt LED control line.

Data transfer

All data to and from the user processor is transferred in serial form using one line for each direction.

The conversion to and from parallel form is carried out by two shift registers on the motor control panel 7009, and 7010.

The user processor clocks the data into 7009 and from 7010 with line CLK.

The data enable line, when high, allows data at the input of 7010 to be accepted by the IC, and data in 7009 to be transferred to the outputs.

From the data received IC7009 outputs six control lines. Two of the lines provide direction and drive control for the tray/tilt motor drive IC, one is used to drive the tilt LED (TLEDON).

The three remaining lines are all audio control lines and go to the digital audio panel. They are left and right channel mute, which when operative, cause both outputs to be fed from the active

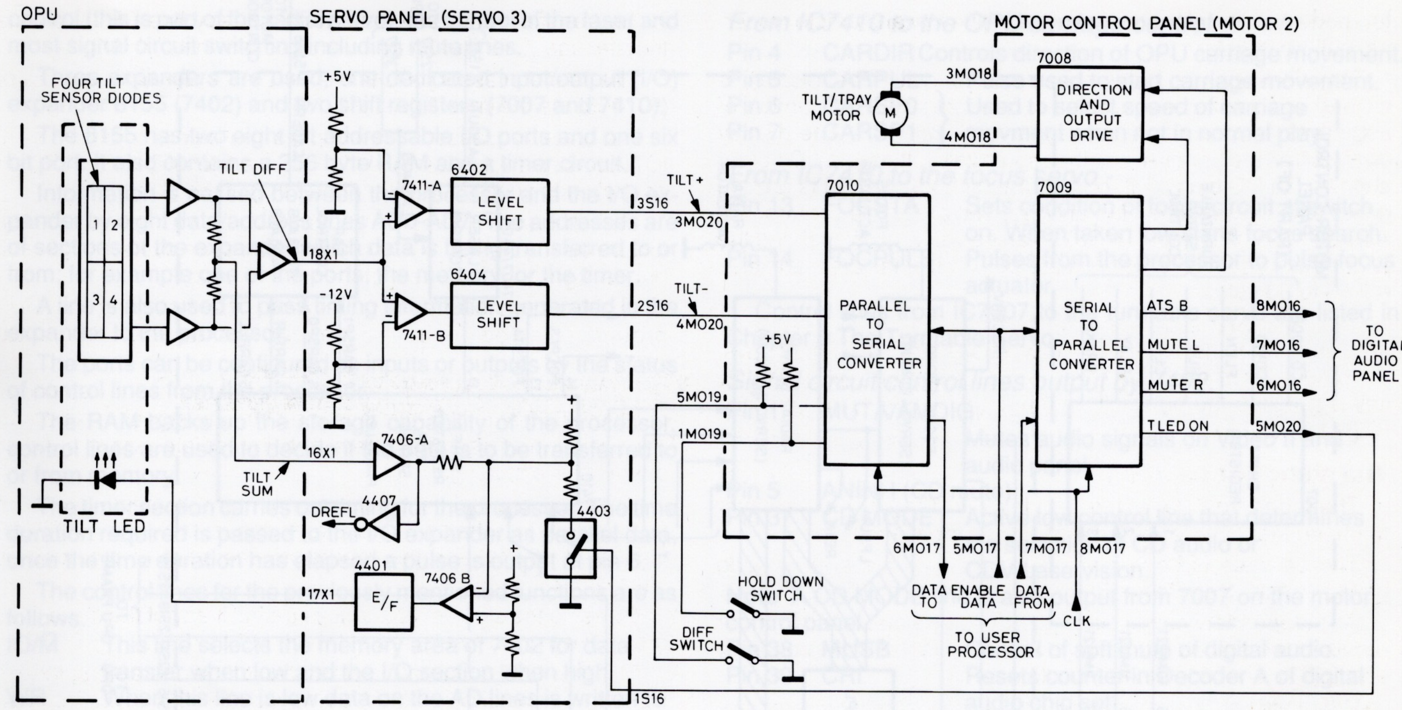


Fig.19 The tray/tilt motor control

channel, and a line ASB. The ASB line is a soft mute for both channels.

IC7010 has four inputs which it transfers to serial form before passing to the user processor. They are two tilt sensor outputs and the status of the hold down and difference switches.

Tilt sensor operation, (see Fig.19)

The tilt LED is made active by the user processor outputing a TLED ON signal (active high) from 7009 on the motor control panel. The line controls a transistor switch (4403) on the servo panel. The switch when closed removes the positive bias from the inverting input of 7406B allowing the tilt LED to be driven.

The reflected signal from the disc is returned to the four diodes. When the disc is at 90° to the laser light the reflected LED signal will fill in the centre of the diodes, as the disc tilts the reflected light will either favour the combined outputs of diodes 1 and 2 or 3 and 4 (see chapter Tilt Detector for detail).

After amplification of the two outputs the signals are resistively added to form a sum signal and subtracted to give tilt difference signal. A signal will be present at the difference output if tilt is present ie. the output of diodes 1 and 2 is not equal to 3 and 4. This signal will be positive or negative depending on the direction of the error. The signal is passed to the servo panel at 18X1.

The signal then feeds the non inverting inputs of two operational amplifiers.

The amplifiers inverting inputs are tied to resistive dividers, one providing minus 150 millivolts and the other, plus 150 millivolts.

The result is one amplifier output is taken low if the input signal is lower than minus 150 millivolts and the other amplifier output will be driven high when the input exceeds plus 150 millivolts.

The outputs swing between plus 5 volts and minus 12 volts. Before the signals can be accepted by the shift register (7010) they are level shifted to swing between 0 and 5 volts. IC7010 converts the inputs to serial data before passing them to the user processor.

The waveforms and consequently the data fed to the user processor changes every few milli-seconds due to minor changes at the disc surface. The wanted signal representing the degree of disc sag is the long term average of the recovered signals. This figure is obtained within the user processor. Consequently the tilt motor is run very infrequently and for very short periods, during the playing of any disc.

Disc size

A second feature of the tilt detector is to sense when a 5 inch as opposed to a 8 or 12 inch disc is loaded. The rest position of the OPU is outside the radius of a 5 inch disc but inside 8 or 12 inch.

Consequently the tilt detector receives no reflected signals when a 5 inch disc is first lowered to the turntable. To obtain this information the two outputs of the tilt detector are resistively added. The resulting tilt sum signal is passed via 16X1 to the servo panel where it is amplified by 7406 and inverted by 4407 before being input to the servo processor. At this point it is given the identity DREFL.

The tilt sum signal is also fed as bias to one input of 7406-B to form loop control of the tilt LED output.

THE SERVO PROCESSOR SYSTEM (see Fig.20)

The servo processor system is mainly implemented on the servo processor panel, servo 3 in the service documentation, however one shift register used for output expansion is on the motor control panel.

The system consists of a processor (IC7401) which has serial communications with the user processor via the COM's lines. The processor also receives internal control signals both directly and via an expander.

The processor outputs lines direct and via expanders, to control the focus, radial and turntable servos, the OPU carriage

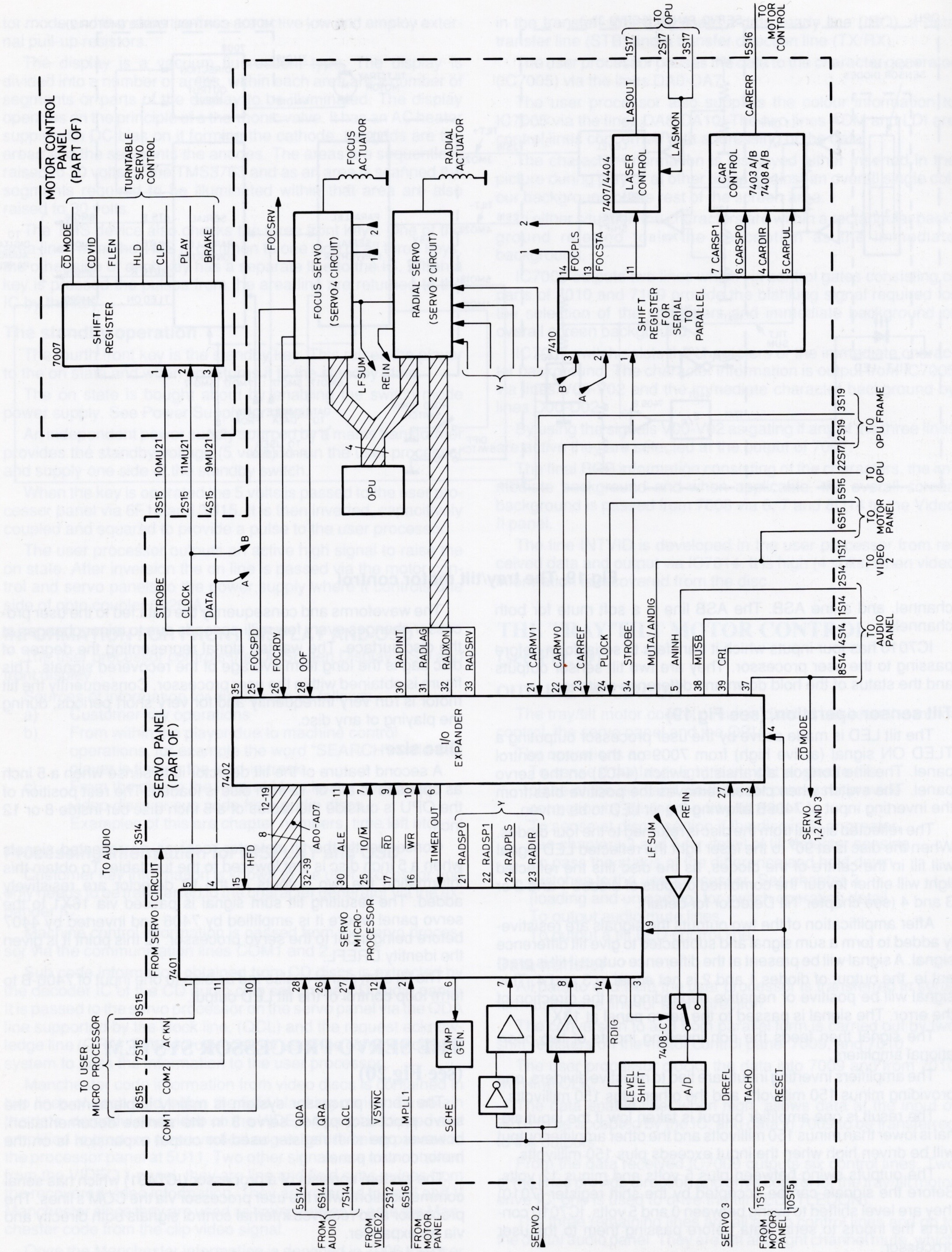


Fig.20 The servo processor system

control (this is part of the radial servo), the control of the laser and most signal circuit switching including mute lines.

Three expanders are used, one dedicated input/output (I/O) expander 8155 (7402) and two shift registers (7007 and 7410).

The 8155 has two eight bit addressable I/O ports and one six bit port. It also contains a 256 byte RAM and a timer circuit.

Information is passed between the processor and the I/O expander by eight data/address lines AD0-AD7. The addresses are of sections of the expander which data is being transferred to or from; for example one of the ports, the memory, or the timer.

A line is also used to pass timing information generated in the expander to the processor.

The ports can be configured as inputs or outputs by the status of control lines from the processor.

The RAM backs up the storage capability of the processor, control lines are used to decide if the data is to be transferred to or from memory.

The timer section carries out timing for the processor. The time duration required is passed to the I/O expander as parallel data, once the time duration has elapsed a pulse is output at pin 6.

The control lines for the previously mentioned functions are as follows.

IO/$\overline{M}$	This line selects the memory area of 7402 for data transfer when low and the I/O section when high.
WR	When this line is low data on the AD lines is written to RAM or the I/O ports depending on the state of line IO/$\overline{M}$.
RD	A low on this line enables AD0-AD7 buffers. If IO/$\overline{M}$ is low the RAM content will be read out to the AD lines. If IO/$\overline{M}$ is high the contents of the selected I/O port will be read to the AD lines.
ALE	On the falling edge of ALE the following inputs are latched, ADO-AD7, the chip enable and the IO/$\overline{M}$ status.

The WR and RD lines require the chip enable to be active (LOW) however on the CD475 the chip enable line of 7402 is taken to chassis and is therefore always active.

The two shift registers are supplied with serial data supported by a clock line. Which IC is to accept the data is decided by two strobe lines.

The radial servo is controlled by 8 lines, four direct from the processor and four via the output expander. Four more lines are used to control the OPU carriage movements, these are output via shift register 7410. IC7410 also outputs two lines to control the focus servo and one line to control the laser. The second shift register, 7007 is used to provide all output control to the turntable servo.

A summary of the output lines is given below - for detail of their application refer to the appropriate section of Chapter 8.

From IC7401 to the radial servo -

Pin 21	RADSP0	Low speed } Movement of radial
Pin 22	RADSP1	Medium speed } actuator for track
Pin 24	RADPLS	High speed } crossing/jumping.
Pin 23	RADDIR	Determines direction of radial actuator movement during RAD SP-- and RADPLS.

From IC7402 to the radial servo -

Pin 30	RADINT	Changes bandwidth of servo between startup and normal running.
Pin 31	RADLAG	Alters bandwidth of servo once tracking is found.
Pin 32	RADXON	Switches between servo control of the radial actuator during play and control by the X detector prior to play.
Pin 33	RADSRV	Switches between servo control of the radial actuator or processor control during SCAN etc. by RADSP0 etc.

From IC7410 to the OPU carriage control -

Pin 4	CARDIR	Controls direction of OPU carriage movement.
Pin 5	CARPUL	Pulse used to start carriage movement.
Pin 6	CARSP0	} Used to select speed of carriage
Pin 7	CARSP1	} movment when not in normal play.

From IC7410 to the focus servo -

Pin 13	FOCSTA	Sets condition of focus circuit at switch on. When taken low starts focus search.
Pin 14	FOCPULS	Pulses from the processor to pulse focus actuator.

Control lines from IC7007 to the turntable servo are listed in Chapter 8 The Turntable Servo.

Signal circuit control lines output by 7402.

Pin 1	MUTA/AMDIG	Mutes audio signals on Video II and audio panel.
Pin 5	ANINH (CD mute)	
Pin 37	CD MODE	Active low control line that determines the selection of CD audio or CDV/Laservision.

Note A CD MODE line is also output from 7007 on the motor control panel.

Pin 38	MUSB	Control of soft mute of digital audio.
Pin 39	CRI	Resets counter in Decoder A of digital audio chip set.

A number of control lines are returned from the servos to inform the processor of the servo status. Control lines also come from other areas of the player to provide information required by the processor.

From the radial servo to 7401 -

Pin 7 and 8		Have time related measurement of SCHE signal.
Pin 14	RDIG	The digitalised version of LF SUM or RE.

Other lines to 7401 -

Pin 1	ACKN	Acknowledge for data line at pin 10.
Pin 10	COMS1	Data communications between the user and servo processor.
Pin 11	COMS2	Clock line for pin 10.
Pin 2	MPLLI	Indicates when recovered line pulses are within 0.7% of REF H.
Pin 12	VSYNC	Vertical sync, locked to displayed raster.
Pin 15	HFD	High frequency detected. Used by the processor to identify when track information is present.
Pin 26,27,28	QRA,QLC and QDA	Acknowledge, clock and data lines for Q channel sub code.

Control lines returned via 7402 to the processor from the focus servo -

Pin 25	FOCSPD	Indicates focus actuator speed.
Pin 26	FOCRDY	Indicates focus found (high)
Pin 28	OOF	Goes high when focus is lost.

Control lines from OPU assembly returned via 7402 to the processor -

Pin 21,22	CARMV0 and CARMV1	From sensors on OPU frame. Measures rotation of spindle
Pin 23	CARREF	Used to find OPU carriage reference position.
Pin 27	DREFL	Sum of outputs from tilt sensor diodes, used to sense disc size/presence.

Control from turntable servo returned via 7402

Pin 3 TACHO Tacho pulses from turntable motor.
Pin 24 PLOCK Indicates when phase lock is achieved.

For the operation of the circuit measuring the SCHE signal amplitude refer to Chapter 8 (radial servo).

The processing of the carriage control signals (CAR---) from 7410 refer to the radial servo, OPU carriage movement.

The laser on circuit is controlled from 7410. It consists of an operational amplifier driving an emitter follower.

The operational amplifier has its non inverting input tied to a reference potential. The inverting input is raised high by pin 11 of 7410 when the laser is off. Once pin 11 is low the laser is on, a diode sensor in the laser assembly is then used to monitor output and pass this information to the laser control circuit (LASMON) where it forms feedback control to the inverting input of the amplifier.

8. THE SERVOS

The following sections are covered in this chapter.

8.1 HF Processing and track loss detector. Servo 1 circuit in the service documentation.

8.2 The Focus Servo. Servo 4 circuit in the service documentation.

8.3 The Radial Servo. Servo 2 circuit in the service documentation. Section 3 also mentions associated control circuits from servo 3 and the CDM unit.

8.4 The Turntable Servo. Mainly on motor control 2 circuit in the service documentation.

8.1 THE SERVO 1 CIRCUITS

The servo 1 circuits process two signals, the LF SUM and HF. From these it derives High Frequency Detected (HFD) and a track loss signal (TL).

The HFD signal is used by the servo processor to establish the presence of a minimum level of recovered track information, 55% of normal. This signal is used by the CD audio processing as an enable signal. It is also used by the servo processor at startup, for track counting and during features.

The track loss signal is used by the radial servo (servo 2) to operate solid state switching allowing the last radial actuator position to be held when track loss occurs.

Servo 1 also provides two HF outputs, one which amplifies the HF before it is passed to the Video 1 panel, and a feed from the HF via a low pass filter and frequency correction to the digital audio panel. The frequency correction is switch selected to give HF lift (MTF correction) when CD audio discs are played and extra amplification (EFM correction) when CDV discs are played. For an explanation of MTF and EFM correction see Chapter 9 Signal Processing "The Servo Panel".

The HF signal

The HF signal is obtained from the optical pickup unit and is sourced by the photo diode substrate. It enters the servo panel at 6S17 and is then capacitivity coupled to the first amplifier (4001).

The LF SUM signal

The LF SUM signal is made up on the servo panel (servo 2) by combining the four individual diode signals E1, E2, E3 and E4.

The resulting signal contains the DC and HF components of the original signals.

For detail of the HF and E1-E4 signals refer to Chapter 5 "The signal outputs".

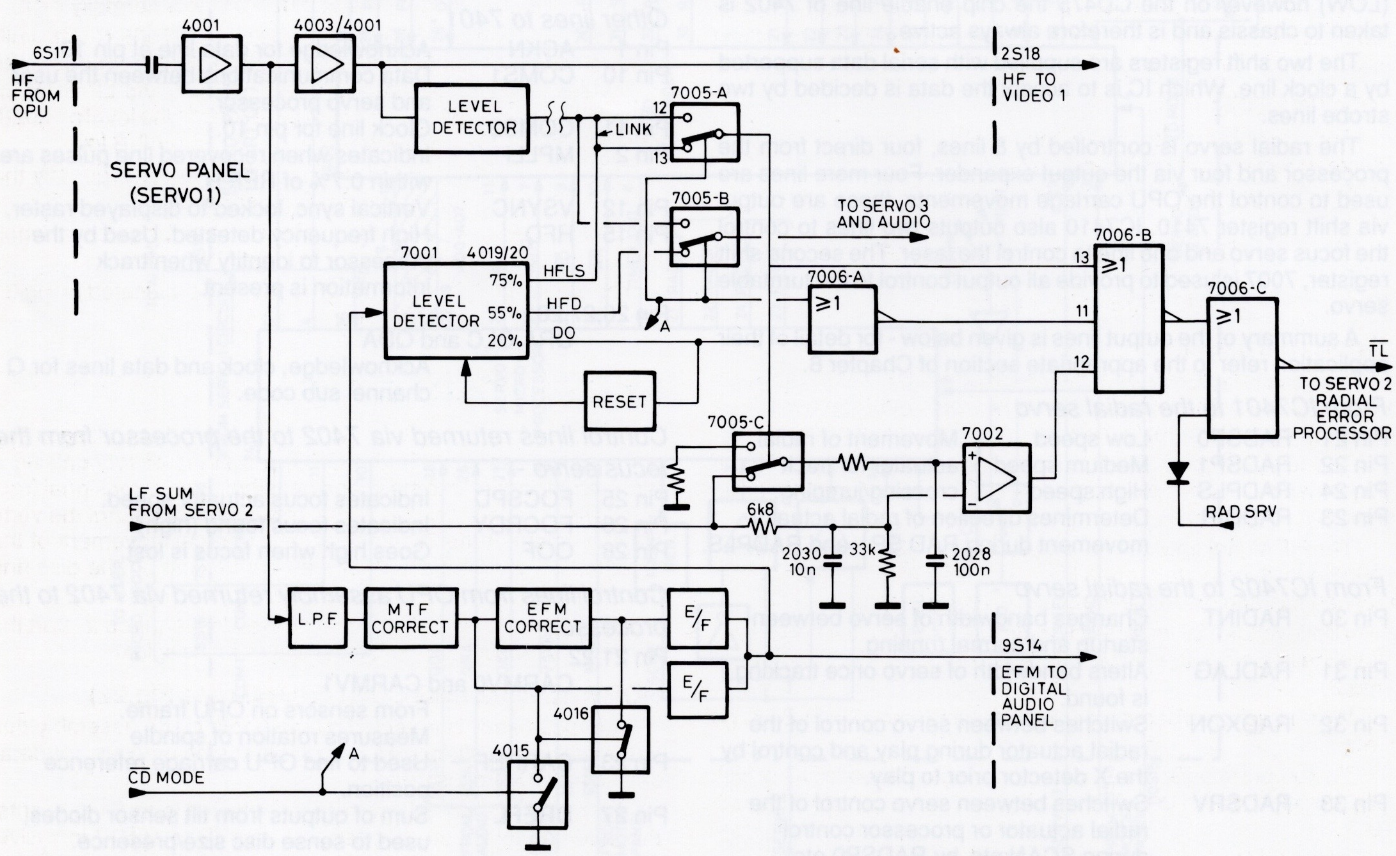


Fig.21 The HF processing and track loss detector

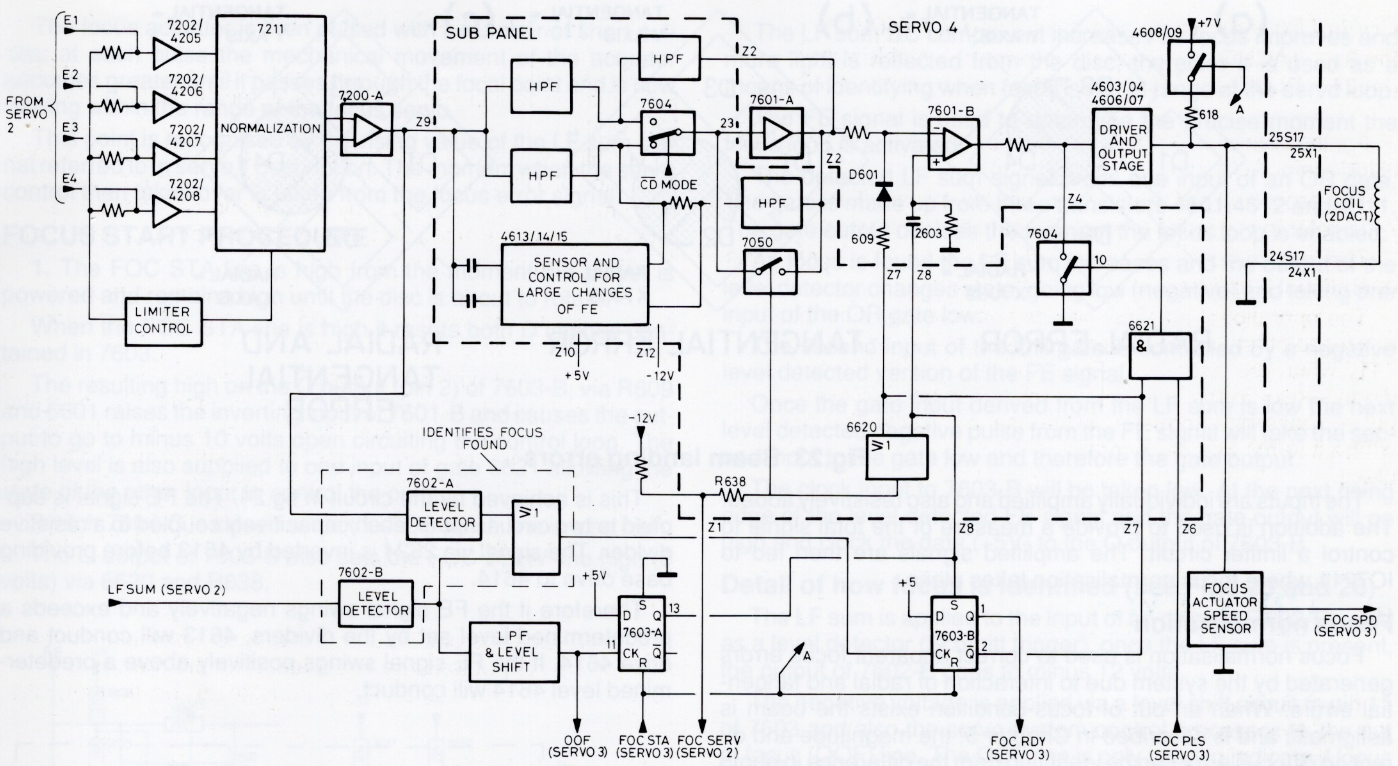


Fig.22 The focus servo

Although the two signals originate from the photo diode array they have different characteristics.

The LF SUM increases in amplitude if the laser beam goes off track; this is because the reflected light from the pits of the track is less than the surrounding area.

The HF signal will decrease in amplitude if the laser goes off track since the HF only consists of the changes in reflected light level caused by the track information.

TRACK LOSS

Track loss is the situation when the OPU photo diodes still receive reflected light but the beam is not on track.

In terms of signals this is defined when the following conditions exist.

The HF is less than 75% of normal output but more than 20%.
The LF SUM is increasing.

Operation (see Fig.21)

To detect the levels of signal required for HFD and track loss a detector with three output levels is employed together with a sensing circuit to identify the LF SUM rising above normal.

The level detector is fed from the digital audio output. When laser vision discs are played the FM sound envelope will be present.

The HF signal entering the servo panel at 6S17 is amplified by 4001 before being fed to the low pass filter. After frequency correction it is applied to the input of the level detector.

The level detectors three outputs will each go low if the input level falls below the values specified against each output in Fig.21.

When track loss occurs, the level detector output HFLS will go low.

The output DO (Dropout) will remain high. Because DO is high the output of gate 7006-A will be low and therefore pin 11 7006-B.

With HFLS low via 7005-A pin 13 of 7006-B will be low. The state of 7006 pin 12 will depend on the circuit comprising 7002, 7005-C, 2028, 2030 and associated components. This circuit detects when LF sum rises above its normal level.

Switch 7005-C is normally as shown and therefore the DC component of the LF SUM charges both 2028 and 2030. Due to the resistive divider feeding 2030 it has a very slightly lower voltage across it, this ensures the output of 7002 is normally high.

When HFLS goes low it changes the state of 7005-C. The voltage across 2028 remains almost constant short term due to its high value and high resistance discharge path. As LF SUM increases the rising voltage across 2030 exceeds the level on 2028. The output of 7002 goes low taking pin 12 of 7006-B low.

The output of 7006-B will now go high and consequently the output of 7006-C goes low indicating track loss.

The RADSRV signal is used to block the track loss signal when the radial servo is not controlling the radial actuator.

The video level detector is not used and as indicated in Fig.21 the pins 13 and 12 of 7005-A are joined.

8.2 THE FOCUS SERVO

The focus loop consists of the reflected laser light falling on the photo diode assembly in the OPU, a method of recognising a focus error on the assembly, and developing an error signal from it, followed by amplification of the error signal to control the vertical movement of the 2D actuator. The vertical movement of the actuator will alter the shape of the beam falling on the disc and therefore also on the diode assembly.

Apart from the servo loop, circuits are also required to start the system, find focus, and recognise when focus is lost.

NORMAL RUNNING CONDITIONS (see Fig.22)

The focus error is detected by the photo diode assembly due to the astigmatic shape of the spot either side of focus, for detail see Chapter 5 'Focus error'.

The amplified photo diode outputs, referred to as E1 to 4, enter the servo panel via the flex cable at pins 12 to 15S17 inclusive, these connections are shown on the servo 2 diagram Fig.30 and in Fig.44.

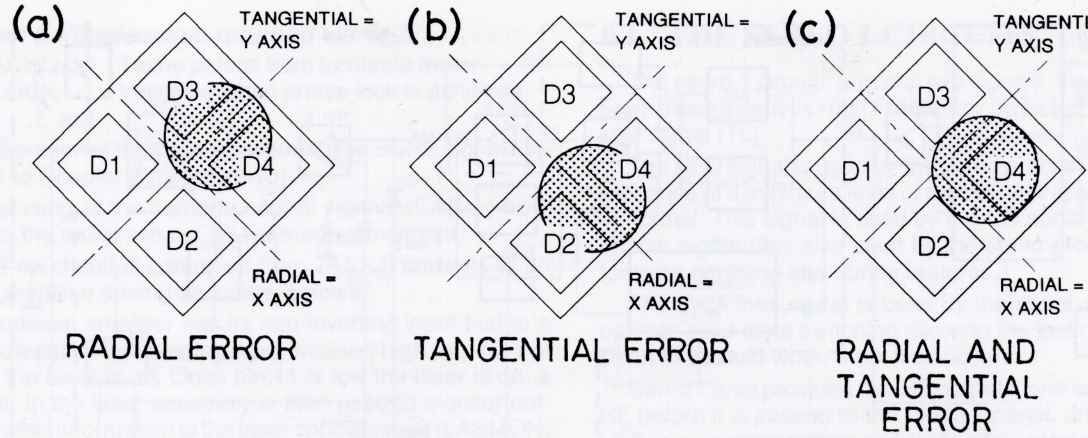


Fig.23 Beam landing errors

The inputs are individually amplified and also resistively added. The addition is used to provide a measure of the total signal to control a limiter circuit. The amplified signals are then fed to IC7211 where focus normalisation takes place.

Focus normalisation

Focus normalisation is used to correct apparent focus errors generated by the system due to interaction of radial and tangential errors. When an out of focus condition exists the beam is astigmatic and is described in Chapter 5, the magnitude and direction of focus error can be identified from the difference in photo diode currents using the following formula :-

Focus error (FE) = (I1 + I4) - (I2 + I3)

Chapter 5 also identifies radial errors and how they are detected. Fig.23a shows the apparent beam landing on the photo diodes when a radial error is present. When the reflected beam is returned to the photo diodes on the radial axis but not in the centre of the four diodes it represents a tangential error (see Fig.23b).

If both tangential and radial errors occur, as in Fig.23c, a focus error is generated since the area of D1 and D4 covered by the spot does not equal the areas of D2 and D3 covered by the spot.

To eliminate the error caused by the tangential error component and therefore the apparent focus error, the formula to identify focus errors becomes

$$\frac{I1-I2}{I1+I2} \quad \frac{I3-I4}{I3+I4}$$

The left and right halves of the formula are resolved in IC7211 and the final subtraction by 7200. See Fig.22. The limiter circuit restricts the signal components amplitude during focus start.

The single focus error signal FE appears for the first time at the output of 7200A. It is then fed to the main control circuits via Z9 and to 7602A for use during focus start. The next section of the main control circuit is constructed on a sub panel indicated by the dashed box in Fig.22. The connections to the sub panel are all prefixed Z.

The signal entering the sub panel at Z9 is offered to two inputs of the block "sensor and control circuit for large charges of FE" and also two high pass filters.

Each of the filters feeds one input to switch 7604. The switch changes between CD and video modes, controlled by the CD mode line. The filters are part of the frequency selection circuits that define the servo bandwidth. The switch selection is necessary because the bandwidth or reponse time of the servo is changed between video and audio discs.

Sensor and control circuit for large charges of FE (see Fig.24)

Distortion of the disc causing need for fairly large changes in focus will require a change in the gain of the control amplifier.

This is achieved by the circuit in fig.24. The FE signal is supplied to two circuit inputs, each capacitively coupled to a resistive divider. The signal via 2624 is inverted by 4613 before providing base drive to 4614.

Therefore if the FE signal swings negatively and exceeds a predetermined level set by the dividers, 4613 will conduct and drive 4614. If the FE signal swings positively above a predetermined level 4614 will conduct.

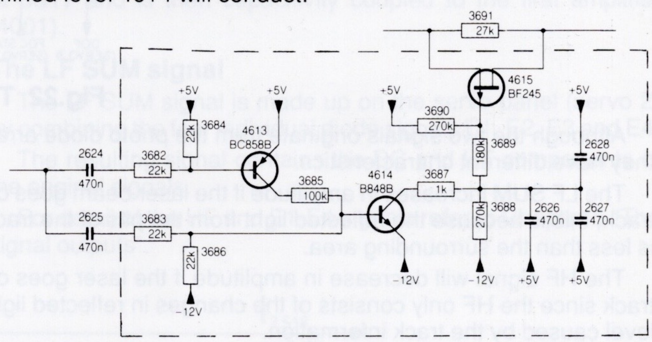


Fig.24 Circuit of sensor and control for large changes of FE

When 4614 conducts it causes 2626/7/8 connected in parallel to charge towards minus 12 volts and take the gate of 4615 negative reducing its conduction. This increases the resistance in parallel with 3691. The resistor 3691 is in series with the negative feedback path of 7601-A. Therefore as the resistance is increased the gain of the stage increases allowing it to provide larger changes of focus. This circuit is only operational during the playing of video discs.

Playing (refer to Fig.22)

The selected signal at the switch output leaves the sub panel at Z3 before it is amplified by 7601-A. Two negative feedback lines are taken from the output of 7601-A via high pass filters, each feed one input of the CD mode switch. This frequency selective feed back partly defines the servo bandwidth. The bandwidth is approximately 1kHz in the CD mode and 1.6kHz in the video mode.

The signal output of 7601-A is passed to 7601-B whose output provides the signal input to the driver and output stages.

The complementary push/pull output stage is used to energise the coil of the 2D actuator and alter focus.

FINDING FOCUS

OUTLINE OF OPERATIONS

Before the start of finding focus the servo loop is disabled and the focus actuator taken to its lowest point.

The focus actuator is then pulsed with a number of short pulses; at each pulse the mechanical movement of the actuator becomes greater until it passes through the focal point and is now moving within the range of the focus servo.

This point is recognised by the rising value of the LF sum signal referred to in servo 1 description. The moment when the servo control then takes over is taken from the focus error signal.

FOCUS START PROCEDURE

1. The FOC STA line is high from the moment the player is powered and remains high until the disc is about to rotate.

When the FOC STA line is high it resets both D latches contained in 7603.

The resulting high on the Q output (pin 2) of 7603-B, via R609 and 6601 raises the inverting input of 7601-B and causes the output to go to minus 10 volts open circuiting the control loop. The high level is also supplied to one input of gate 6621 allowing the state of the other input to control the output.

Switch 7604-C is closed since the FOC pulse line is also high. The Q output of 7603-B also sets the FOC SERV line high (0 volts) via 6620 and R638.

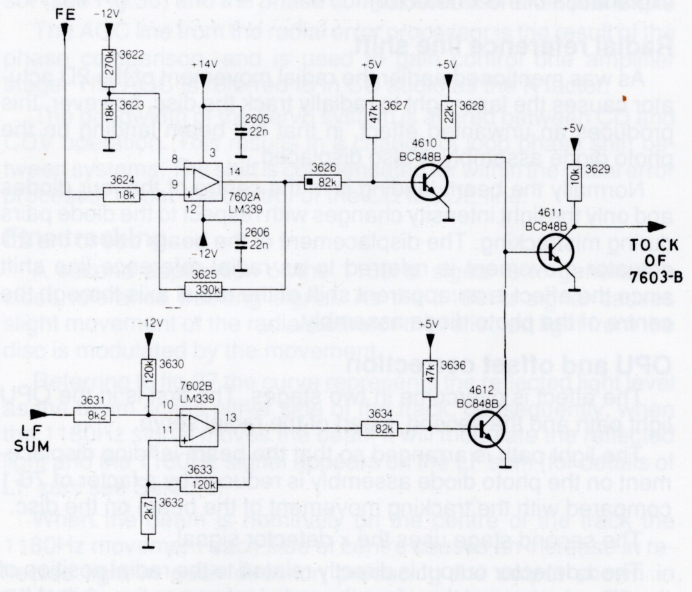


Fig.25 Focus identification circuit

The FCO STA line when high bottoms 4609 and consequently 4608, closing the switch and feeding the focus coil from +7 volts via 560 ohms (R618).

This drives the focus coil to its lowest position. When the lead in area of the disc is reached, defined by software in the servo processor, the FOC STA line goes low and the FOCPLS line is made active from the servo processor via 7410.

2. The FOCPLS line is normally high but provides a train of negative going pulses for approximately 100mS. The pulses drive 7604 via 6621 causing 7604 to take the input of the driver stage to earth each time FOCPLS goes high closing contacts 1 and 15 of 7604. When FOCPLS is low the switch is open and the driver stage input goes to minus 4 volts.

This voltage swing is applied to the focus actuator driver stage causing the actuator to be pulsed. Each time the actuator is pulsed it travels slightly higher and therefore nearer focus.

As focus is passed through, signals are recovered by the pick up diodes in the optical pick up unit.

After amplification the four diode outputs are summed (shown on the servo 2 circuit) to create a signal referred to as the LF sum.

The LF sum DC component increases as focus improves and more light is reflected from the disc, therefore it is used as a means of identifying when focus is within range of the servo loop.

The FE signal is used to determine the precise moment the focus loop is activated.

The detected LF sum signal feeds one input of an OR gate. The gate is made up from three transistors 4601,4612 and 4611. The gate output decides the moment the focus loop is enabled.

As focus is found the LF sum increases and the output of the level detector changes state, going low (negative) and taking one input of the OR gate low.

The second input of the OR gate is controlled by a negative level detected version of the FE signal.

Once the gate input derived from the LF sum is low the next level detected negative pulse from the FE signal will take the second input to the gate low and therefore the gate output.

The clock input to 7603-B will be taken low. At the next rising edge of the level detected FE signal and the gate output will go high and clock the data (+5V) to the Q output of 7603-B.

Detail of how focus is identified (see Figs.25 and 26)

The LF sum is applied to the input of an op amp (7602-B) used as a level detector (Schmitt trigger), once the LF sum is present, the output of 7602-B goes to minus 12 volts.

The negative voltage is applied via a level shift circuit to pin 11 of 7603 and also the servo system control processor as the out of focus (OOF) line. The OOF line is only used to indicate if focus is lost during normal play and start the refocussing sequence via 7603A.

The detected LF sum from pin 13 7602B controls the base divider for 4612. When pin 13 goes to minus 12 volts (LF sum present) 4612 is cut off.

The collector load of 4612 is shared by 4610.

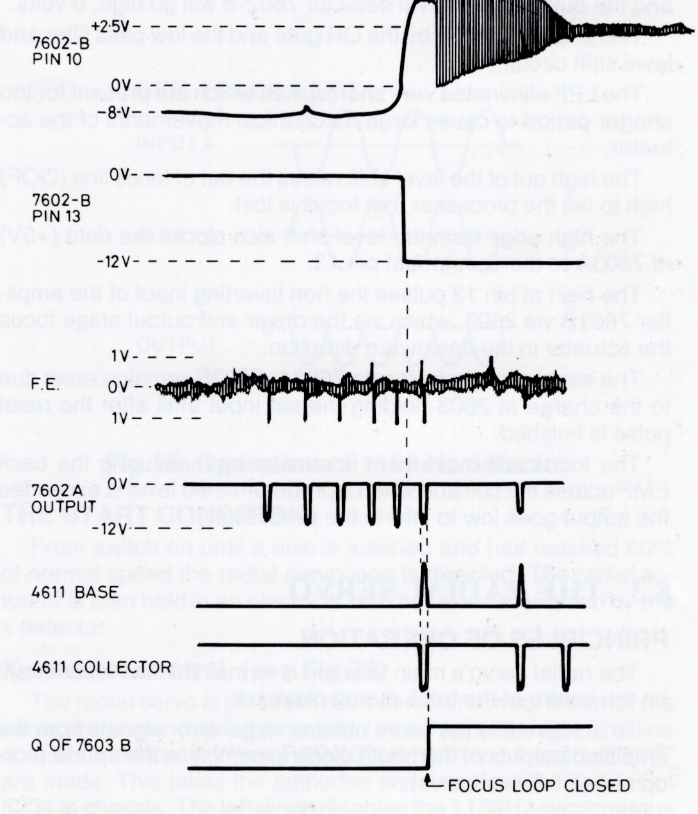


Fig.26 Focus identification circuit waveforms

The base of 4610 is controlled by a negative going level detected version of the focus error signal (FE). The FE signal will be pulsing due to the focus coil being pulsed.

The first negative FE signal after 4612 is driven off will cause 4610 to be cut off, the base of 4611 is driven on causing the collector and hence the clock input of 7603-B to go low.

The next rising edge of the FE signal will cause the collector of 4611 to go high and allow the data input to 7603 to be clocked to the output at pin 1.

Refer to Fig.22

Pin 1 high provides the FOCRDY signal for the servo processor system. Pin 2 going low allows the focus loop to become operational by clearing the positive voltage to the inverting input of 7601-B and via 6621 taking pin 10 of 7604 low and opening the switch.

The low from pin 2 of 7603 takes the other input of 6620 low resulting in the switch 7050-B going open and the FOC SERV line going negative.

The FOC SERV line is used as control to the radial servo.

When the player is in the focussed condition 7603-A is in the reset condition and 7603-B is set.

The clock input of 7603-A is low.

FOCUS ACTUATOR PROTECTION

A major disturbance is reflected light from the disc surface could be accompanied by a very large swing in the focus error signal. Without suitable protection the actuator could be driven up to the surface of the disc.

To protect the 2D actuator when a large movement starts to lose focus the actuator is pulsed in a downward direction.

The method of creating the pulse

When a disturbance of focus occurs it must first be decided if normal actuator movement will compensate for the disturbance or if protection is required. If focus is lost the LF sum will decrease and the output of the level detector 7602-B will go high, 0 volts.

This change is seen by the OR gate and the low pass filter and level shift circuit.

The LPF eliminates very short spikes which are present for too shorter period to cause large mechanical movements of the actuator.

The high out of the level shift raises the out of focus line (OOF) high to tell the processor that focus is lost.

The high edge from the level shift also clocks the data (+5V) of 7603A to the Q output at pin 13.

The high at pin 13 pulses the non inverting input of the amplifier 7601B via 2603, which via the driver and output stage focus the actuator in the downward direction.

The servo processor resets 7603A, 7603B remains reset due to the charge at 2603 holding the set input until after the reset pulse is finished.

The focus coil movement is sensed by measuring the back EMF across the coil and when a predetermined level is exceeded the output goes low to inform the processor.

8.3 THE RADIAL SERVO

PRINCIPLES OF OPERATION

The radial servo's main function is to maintain the laser beam on the centre of the track during playback.

To achieve this the servo obtains radial error signals from the amplified outputs of the photo diode assembly in the optical pick-up unit (E1-E4 inclusive).

The final error signal is derived by carrying out the following mathematical operation on the four signals to create a single radial error signal RE. RE = (I1+I2) - (I3+I4)

The radial error signal is amplified before it is used to control the radial movement of the 2D actuator.

The 2D actuator supports the objective lens and radial movement of the 2D actuator causes the beam to move radially across the disc.

The normal maximum distance moved by the actuator as it follows the track is 50 microns.

To obtain radial tracking across the complete disc a further operation is required.

The second operation is to move the complete optical pick-up unit (OPU) each time the actuator reaches a position approximately 25 microns from the centre position. The OPU movement is carried out by running the spindle motor under the control of the servo processor. As the OPU is moved the actuator is returned to its start position and the cycle is repeated.

To determine when the actuator reaches its maximum point of movement the servo processor system measures the amplified x detector signal. This signal is a measure of the radial displacement of the 2D actuator. (Refer to Chapter 5 for diagram and explanation of the x detector).

Radial reference line shift

As was mentioned earlier the radial movement of the 2D actuator causes the laser light to radially track the disc, however, this produces an unwanted effect, in that the beam landing on the photo diode assembly is also displaced.

Normally the beam landing is in the centre of the four diodes and only the light intensity changes with respect to the diode pairs during mistracking. The displacement of the beam due to the 2D actuator movement is referred to as radial reference line shift since the effect is an apparent shift of the radial axis through the centre of the photo diode assembly.

OPU and offset correction

The effect is overcome in two stages. The first is in the OPU light path and the second is part of the radial servo.

The light path is arranged so that the beam landing displacement on the photo diode assembly is reduced by a factor of 70-1 compared with the tracking movement of the beam on the disc.

The second stage uses the x detector signal.

The x detector output is directly related to the radial position of the 2D actuator and therefore the radial reference line shift. After amplification, the x detector voltage is applied as compensating bias to the E1-E2 and E3-E4 amplifiers.The bias is referred to as the offset voltage.

The 1180Hz signal

When the servo is in lock a frequency of 1180Hz is introduced to the radial servo control loop.

The signal is used for two operations, one is to maintain servo loop gain, the other is to obtain a fine degree of radial error correction.

Gain control

Reflected light intensity on to the photo diodes will vary with disc reflectivity. This calls for a wide operating gain requirement in the servo system.

To meet the requirement and maintain stability, one stage of the radial servo is gain controlled.

The loop phase shift is proportional to gain, by measuring the phase shift of the 1180Hz signal the gain can be assessed. The signal causes a very small movement of the actuator, approximately 0.05 microns of beam displacement, but since the movement is equal each side of the track the beam remains following the track. A 1180Hz error signal is now present in the servo

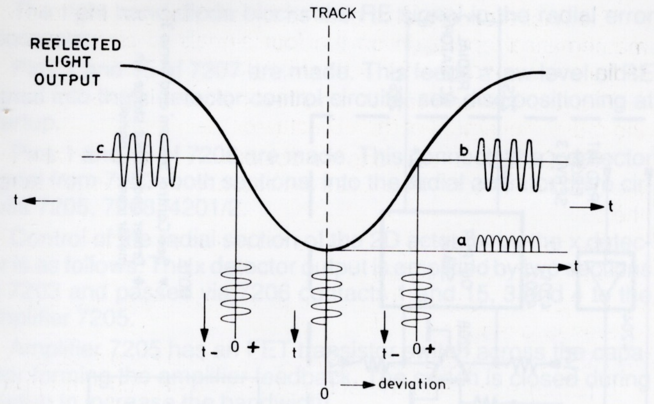


Fig.27 Relative phase of 1180Hz signal to track position

RE signal. The error signal phase is compared with each original 1180Hz to provide a gain control signal.

The 1180Hz signal was generated in the radial error processor (see Fig.30) and the phase comparison also takes place in it.

The AGC line from the radial error processor is the result of the phase comparison, and is used to gain control one amplifier stage. The AGC is referred to in CD audio as the K factor.

The bandwidth of the servo system is altered between CD and CDV operation. This results in a change of loop phase shift between systems. The shift is compensated for within the radial error processor under the control of the CD MODE line.

Fine tracking

A second application of the 1180Hz signal is to generate a close tolerance tracking signal. As the 1180Hz signal causes slight movement of the radial actuator the reflected light from the disc is modulated by the movement.

Referring to fig.27 the curve represents the reflected light level as the beam scans either side of the track, consequently, when the 1180Hz signal moves the beam it will modulate the reflected light and the 1180Hz signal appears on the LF sum (for details of LF sum see Servo 1).

When the beam is nominally on the centre of the track the 1180Hz movement each side of centre causes an increase in reflected light in each direction producing the output shown in Fig.27(a).

When the beam is off centre to the left the 1180Hz signal on the LF sum will be inverted compared to the drive as in Fig.27c. When the beam is off centre to the right the 1180Hz signal will be in phase with the drive signal.

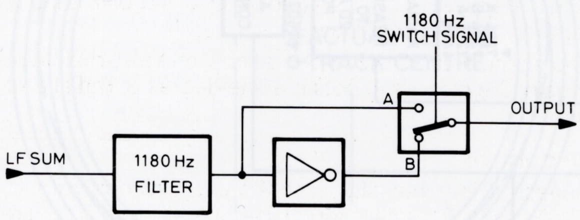


Fig.28 The 1180Hz synchronous detector

To obtain a radial error signal from the returned 1180Hz signal it is filtered from the LF sum and then synchronously detected using a switch as in Fig.28.

The circuit filters the 1180Hz from the LF sum and then offers an inverted and normal version of it to the switch inputs A and B. The switch is driven from the original 1180Hz signal, the outputs after filtering will be zero on track, positive off track right and negative off track left.

The switching signal and unfiltered outputs are shown in Fig.29.

The resulting control voltage is added to the x detector signal in the offset channel. By altering the offset voltage, correction is applied in the same way as if radial actuator movement had taken place.

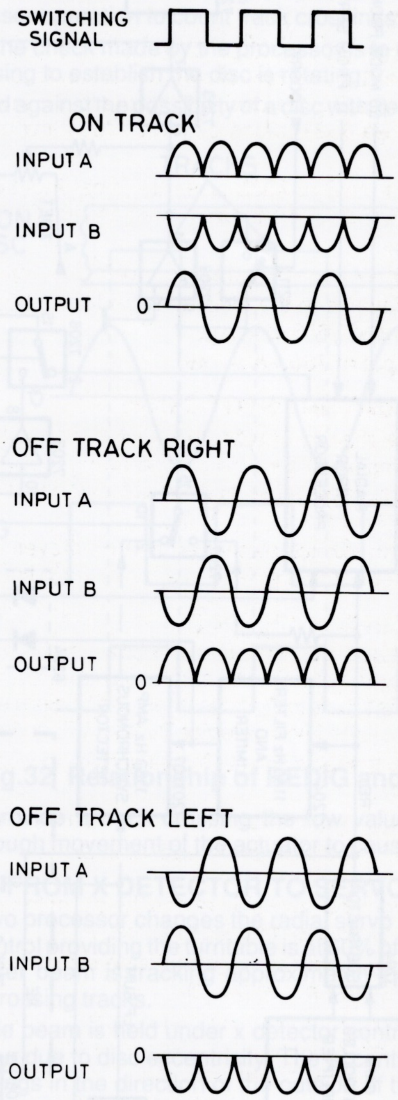


Fig.29 Operation of 1180 Hz detector

THE START CONDITION

From switch on until a disc is inserted and has reached 60% of normal speed the radial servo loop is disabled. The radial actuator is then held in an electrical zero position determined by the x detector.

X detector control, (see Fig.30)

The radial servo is placed in the x detector control mode by the servo processor making the control line RADXON high. The line controls 3 switches. When RADXON is high pins 4 and 3 of 7207 are made. This takes the cathodes and therefore the anodes of 6204 to chassis. The left diode disables the 1180Hz synchronous detector by taking the switching input to chassis.

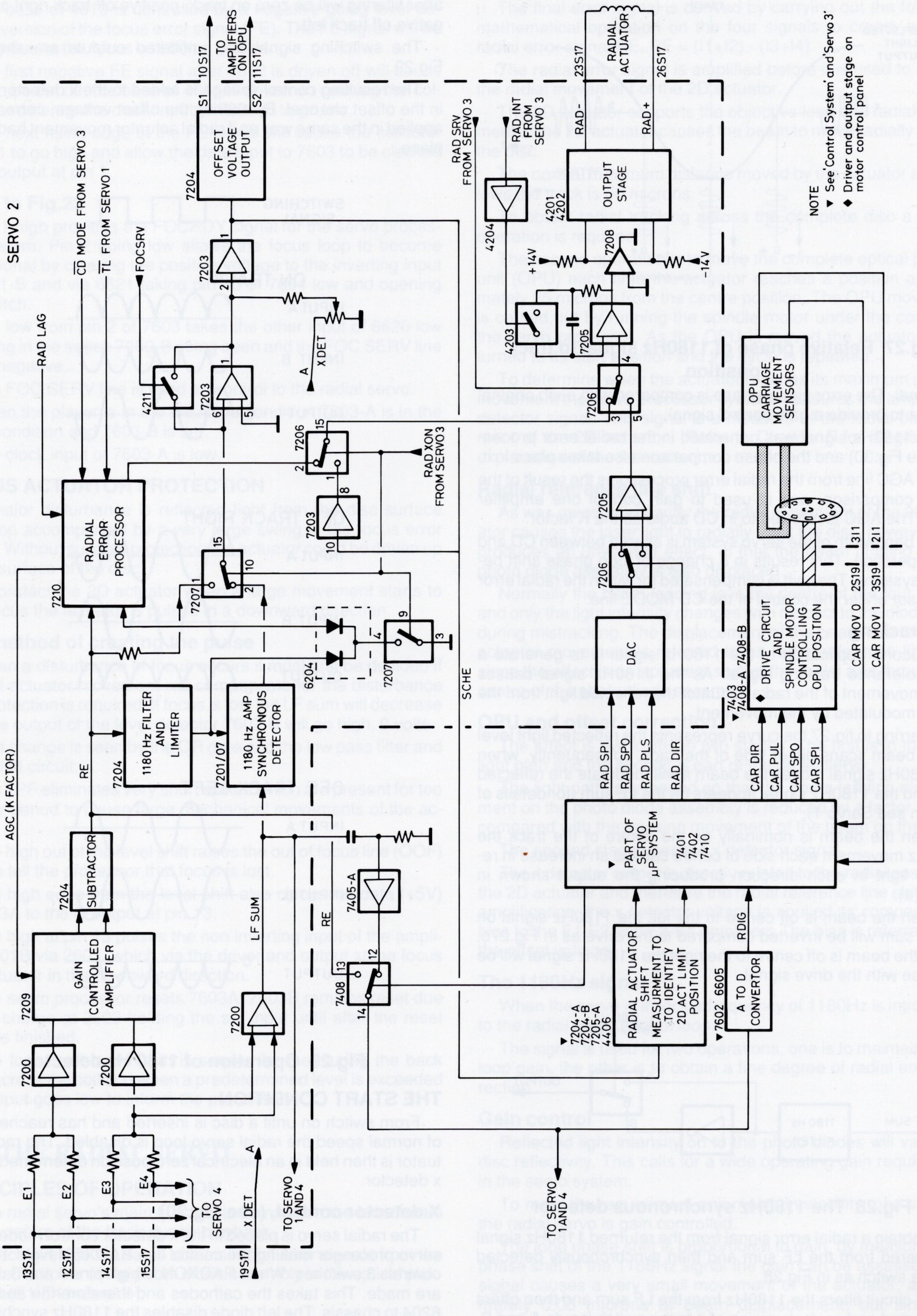


Fig.30 The radial servo

The right hand diode blocks the RE signal in the radial error processor.

Pins 1 and 15 of 7207 are made. This feeds a low level of RE signal into the x detector control circuits, see disc positioning at startup.

Pins 1 and 15 of 7206 are made. This connects the x detector signal from 7203, both sections, into the radial actuator drive circuits 7205, 7208, 4201/2.

Control of the radial section of the 2D actuator by the x detector is as follows: The x detector output is amplified by two sections of 7203 and passed via 7206 contacts 1 and 15, 3 and 4 to the amplifier 7205.

Amplifier 7205 has an FET transistor switch across the capacitor forming the amplifier feedback. The switch is closed during startup to increase the bandwidth.

The output of 7205 controls the radial actuator via 7208, 4201/2.

The loop is completed by the radial actuator position determining the voltage output of the x detector. The overall phasing of the loop is such that the radial actuator is driven into a position which causes least output from the x detector (electrical centre). The final x detector position is determined by adjustment to give zero volts on the SCHE line, which gives zero offset voltage and centres the radial reference line.

DISC POSITIONING AT STARTUP

The x detector control of the radial actuator holds the actuator in an electrical zero condition with zero offset until the radial actuator becomes operational. This allows the servo processor to count track crossings by the laser beam as the disc starts to rotate. If too many track crossings are found per revolution the processor stops the rotation, returns the OPU to its reference position and opens the disc hold down lever on the assumption the disc is not held centrally on the turntable.

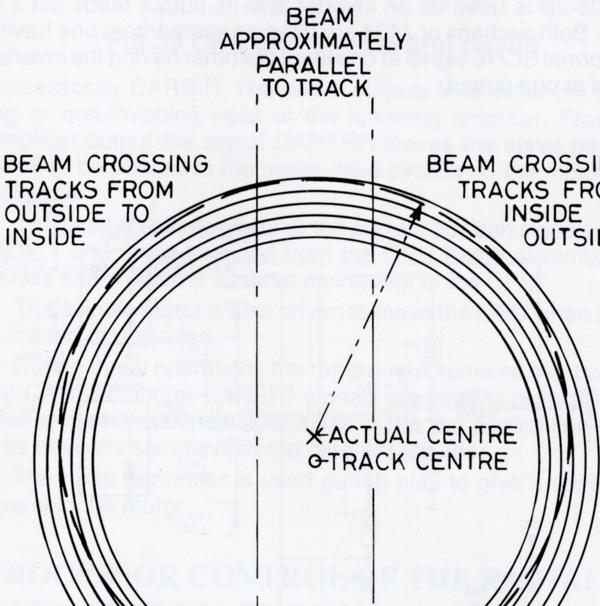


Fig.31 Identifying the moment to enable the radial servo

To carry out this operation the RE signal is passed via pins 13 and 14 of 7408 to an analogue to digital converter. The RE signal will be sinusoidal as tracks are crossed due to disc eccentricity and the A/D converter squares them to provide transitions to be counted by the processor. The switch 7408 is normally in the RE position. The LF sum is selected during still picture at CAV features.

In the description of x detector control, reference was made to switch 7207 pins 1 and 15 feeding a small amount of RE signal into the x detector control. This signal is used in conjunction with the processor operation to count track crossings.

Part of the check made by the processor is to find at least one track crossing to establish the disc is rotating.

To guard against the possibility of a disc with zero eccentricities

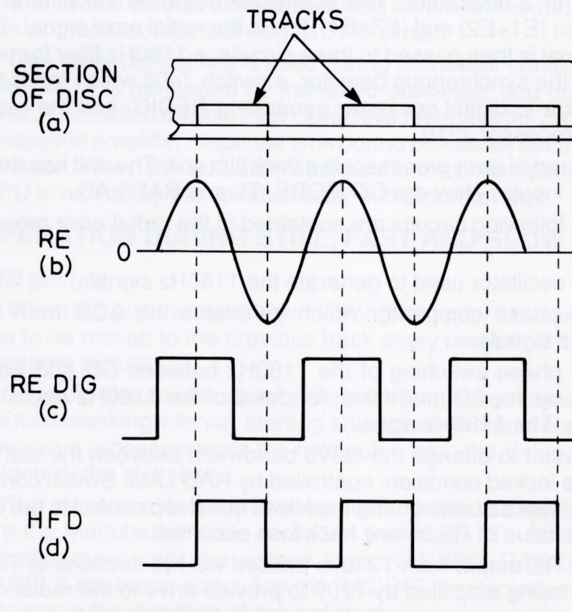


Fig.32 Relationship of REDIG and HFD

failing to provide a track crossing the low value of RE signal causes enough movement of the actuator to cause one to occur.

CHANGE FROM X DETECTOR TO SERVO CONTROL

The servo processor changes the radial servo from x detector to servo control providing the turntable is at 60% of nominal speed and the laser beam is tracking approximately parallel to or on track, not crossing tracks.

When the beam is held under x detector control, track crossing will occur due to disc eccentricity. The eccentricity will cause track crossings in the direction of the outside of the disc for part of the rotation and on the opposite part of the rotation the track crossing will be in the direction of the disc centre. See fig.31.

Between these two periods the beam will be approximately parallel to the tracks. This is the optimum period for tranfer of control to occur, and is identified as being between the last track crossing in the outward direction and the first track crossing in the inward direction.

The track crossing direction is found by using the RE and HFD signals.

Fig.32(a) shows a cross section of part of the disc with tracks indicated.

The RE signal resulting from track crossing is shown in (b); note the polarity of the error signal is different each side of the track.

REDIG. that is RE after being squared by a Schmitt trigger is shown in (c).

The high frequency detected (HFD) is shown in (d).

When the laser crosses tracks in one direction HFD is preceded by a low level of RE,DIG.

When track crossings occur in the other direction HFD is preceded by a high level of REDIG.

From this the processor identifies the time between the last track crossing in one direction and the first in the other direction. This will occur at the same time of each revolution. At this point RADXON is taken low to enable the servo.

OPERATION DURING NORMAL PLAY (see Fig.30)

The four OPU photo diode outputs enter the servo panel at connectors 12-15S17 after which E1 and E2 are resistively added, also E3 and E4. Two feeds are then taken from each of the combined signals. One pair is fed to 7200 where the LF SUM is developed. The second pair is passed via gain controlled amplifiers to a subtractor. The subtractor output is the difference between (E1+E2) and (E3+E4), this is the radial error signal. The RE signal is then passed to three circuits; a 1180Hz filter forming part of the synchronous detector, a switch 7408 which feeds the analogue to digital converter generating REDIG, and the radial error processor 7210.

The radial error processor is a thick film unit. The unit has three control inputs. They are CD MODE, TL and RAD LAG.

The following circuits are contained in the radial error processor.

The oscillator used to generate the 1180Hz signal.

The phase comparitor which generates the AGC from the 1180Hz signals.

The phase switching of the 1180Hz between CD and video modes by the CD mode line; for detail of the 1180Hz operation refer to 'The 1180Hz signal'.

A circuit to change the servo bandwidth between the startup and the locked condition, controlled by RAD LAG. Switch control of the radial actuator during track loss from loop control to the last correct value of RE before track loss occurred.

The RE output from 7210 is passed via two sections of 7206 before being amplified by 7205 to provide drive to the radial output circuits.

The drive amplifier 7208 is arranged as a phase splitter with the load resistors in the IC's supply and return feeds to provide opposite half cycles of drive to the complimentary output stage.

As the radial actuator is moved to follow the track two other actions take place in the radial servo.

The radial reference line shift increases.

The x detector output will increase.

A signal will need to be developed to inform the servo when the OPU is to be moved by the spindle motor.

Radial reference line shift.

The radial reference line shift was described earlier. The methods of correction were also mentioned, one of which was the x detector output being used as compensating bias. Refering to Fig.30 the x detector output enters the servo panel at 19S/7. It is amplified by 7203 and the output at pin 1 is fed to the two circuits: one is a voltage output stage which provides push pull signals S1 and S2. These are fed via 10 and 11S17 bias to the OPU amplifiers. Within the OPU S1 is used to provide corrective bias to the E1 and E2 amplifiers and S2 is used to provide corrective bias to E3 and E4 amplifiers.

Radial actuator shift measurement

The second feed from pin 1 of 7203 is referred to as the SCHE signal, and is fed to the radial actuator shift measurement circuit in Fig.30. The SCHE signal is shown in Fig.33.

The SCHE signal consists of a ramp containing a relatively large proportion of sine wave.

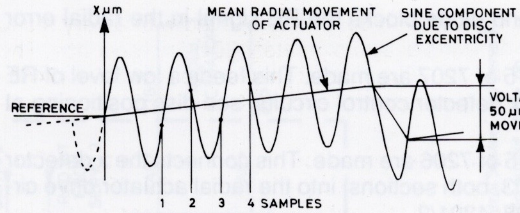


Fig.33 The SCHE signal

The sine wave content is the result of disc eccentricity and therefore its repetition rate is the same as the disc rotation.

The ramp represents the radial displacement of the 2D actuator and its repetition rate is in the region of 0.8 seconds, but depends on the disc rotation rate.

The function of the circuit is to identify when the maximum deviation of the radial actuator has been reached, this maximum of plus or minus 25 microns from the centre reference excludes movement due to disc eccentricity.

The reason for the requirement is to generate a signal in the processor at the moment of maximum deviation to start the spindle motor and move the OPU.

To find the mean or ramp value of the waveform the processor samples the waveform twice per disc rotation. By sampling twice per rotation and calculating the average value of consecutive samples the mean value is arrived at.

To establish the ramp amplitude, the reference level must also be known. It can be found by taking samples from an inverted version of the same waveform and calculating the difference between a sample from the inverted and normal versions of the waveform.

The operation of the circuit (see Fig.34)

The SCHE signal is passed to pin 6 of 7404 and pin 2 of 7405. IC7405-2B is used as an inverter and its output feeds pin 2 of 7404. Both sections of 7404 are used as comparitors one having the normal SCHE signal at one input the other having the inverted signal at one output.

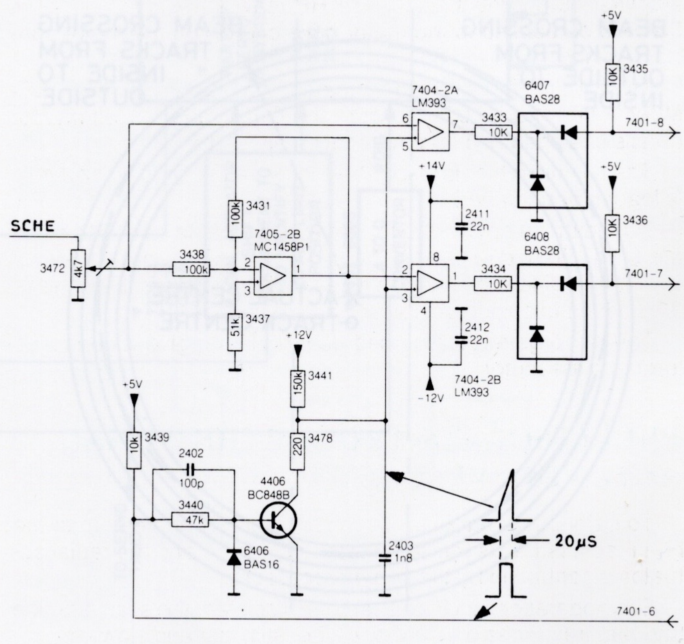


Fig.34 Measurement of SCHE signal

The second input of both comparitors is fed with a very steep ramp having a duration of approximately 20 micro seconds. The ramp is derived from a pulse output by the servo processor (7401) at pin 6. The ramp generator consists of 4406, 2403, and associated components.

When the ramp value exceeds the value of the incoming SCHE waveforms the output of each comparitor goes high. The processor translates the time displacement into a value and carries out the previously described processes on the samples to obtain the final amplitude.

OPU carriage movement (see Fig.30)

The circuit to provide OPU carriage movement consists of a control section, a driver and output circuit to power the spindle motor.

The control circuit is on the servo panel and is shown in servo 3 circuit. The drive and output stage to power the motor are on the motor control panel.

In normal play mode the servo processor identifies when the radial actuator has reached maximum movement from information supplied by the radial actuator shift measurement circuit.

It then makes the CARPULS line active which enables the ramp generator. See Fig.35.

The ramp generator output is passed through 7408-B, the direction switch. The switch is controlled via 7410 from the servo processor by CARDIR. The switch outputs feed either the inverting or non-inverting input of the following amplifier. From the amplifier output the signal CARERR leaves the servo panel at 5S16 to be passed to the motor drive circuits on the motor control panel.

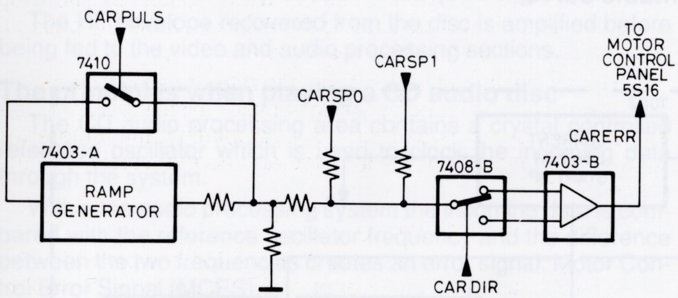


Fig.35 OPU carriage control circuit

To stop the spindle motor at the correct position signals CARMOV 1 and 0 are obtained from the OPU frame assembly, for details see chapter 5 "Course movement of the OPU".

The spindle motor is also driven to move the OPU when a disc is loaded or unloaded.

During these operations the ramp circuit remains inactive and the CARSP0 and/or CARSP1 signals are used to provide drive. Due to the different resistor values in the two control line feeds they drive the spindle motor at different speeds.

The ramp generator is used during play to give a controlled torque to the motor.

PROCESSOR CONTROL OF THE RADIAL ACTUATOR VIA THE DAC

To carry out operations which require rapid movement of the beam across tracks the servo loop is disabled and the radial actuator is controlled by the servo processor.

Such operations include search at disc start, the scan function and feature modes on CAV discs, i.e. still, fast and slow play.

These operations require different speeds of radial actuator movement. To provide a number of different drive conditions the processor outputs three control lines which are fed to a digital to analogue converter (DAC) before becoming actuator drive. See fig.30.

The three lines are RADSP0, RADSP1, and RADPLS.

At the input of the DAC the three lines feed potential dividers, the outputs of which are combined to form a single control line. By the processor outputing a high level to one or more lines a number of voltage combinations is achieved on a single output line.

A fourth line (RADDIR) is used to switch the control voltage between the inverting and non-inverting inputs of the next amplifier (7205). This selects direction of actuator movement.

After the direction switch the signal is passed to pin 5 of 7206. Switch 7206 is controlled by the line RADSRV which is sourced from the processor and passed via IC7402.

The switch selects either servo loop control of the radial actuator or processor control via the DAC circuit.

One other control line is used during processor control, this is RADINT. It is generated by the servo processor and output via 7402. The switch disables the capacitive feedback on 7205 to decrease the amplifier response time during processor control of the actuator. When the actuator reaches the maximum position the OPU is moved by the spindle motor in the normal way.

OPERATION DURING STILL, FAST AND SLOW PLAY

Still picture.

When still pictures are shown (CAV discs only) the laser beam has to be moved to the previous track every revolution to repeat the same picture.

To avoid picture disturbance the track jump takes place during the field blanking interval, starting after the sixth line of each field. The servo processor uses the field pulse from the Video II panel to identify the sixth line.

The movement is completed by the tenth line to allow time before the Manchester code is read at line fifteen. To achieve the actuator movement the control lines RADSP0, RADSP1 and RADPLS are made active and the RADDIR is selected move the actuator in the direction of the last track.

RADSRV is taken low to disconnect the servo and apply the direction controlled output of the DAC to the actuator via the driver and output stages.

The actuator movement accelerates towards the previous track due to the drive, after 100 microseconds RADPLS is taken low to reduce the drive and therefore the movement of the actuator.

The approaching of the wanted track is recognised by the processor checking the state of RDIG and HFD.

The source of RDIG is now a differentiated and squared version of LF sum due to the processor control of switch 7408. One edge of the differentiated LF sum will occur just before the track while HFD is still low. At this point RADPLS is again made active and the drive direction reversed by RADDIR. This applies braking force to the actuator. After 100 microseconds RADPLS and RADSP are switched off and RADDIR is again reversed to allow the actuator to reach the track under the control of RADSP1. Once HFD goes high (track found) the radial control is once again applied by RADSRV.

Slow and fast play

The playing of active play discs at other than normal speed follows the same principles as for still picture, except the direction and frequency of track changes depend on the speed and direction of play selected.

Search and scanning

During scanning and search the actuator movement is controlled via the DAC from the processor as described previously.

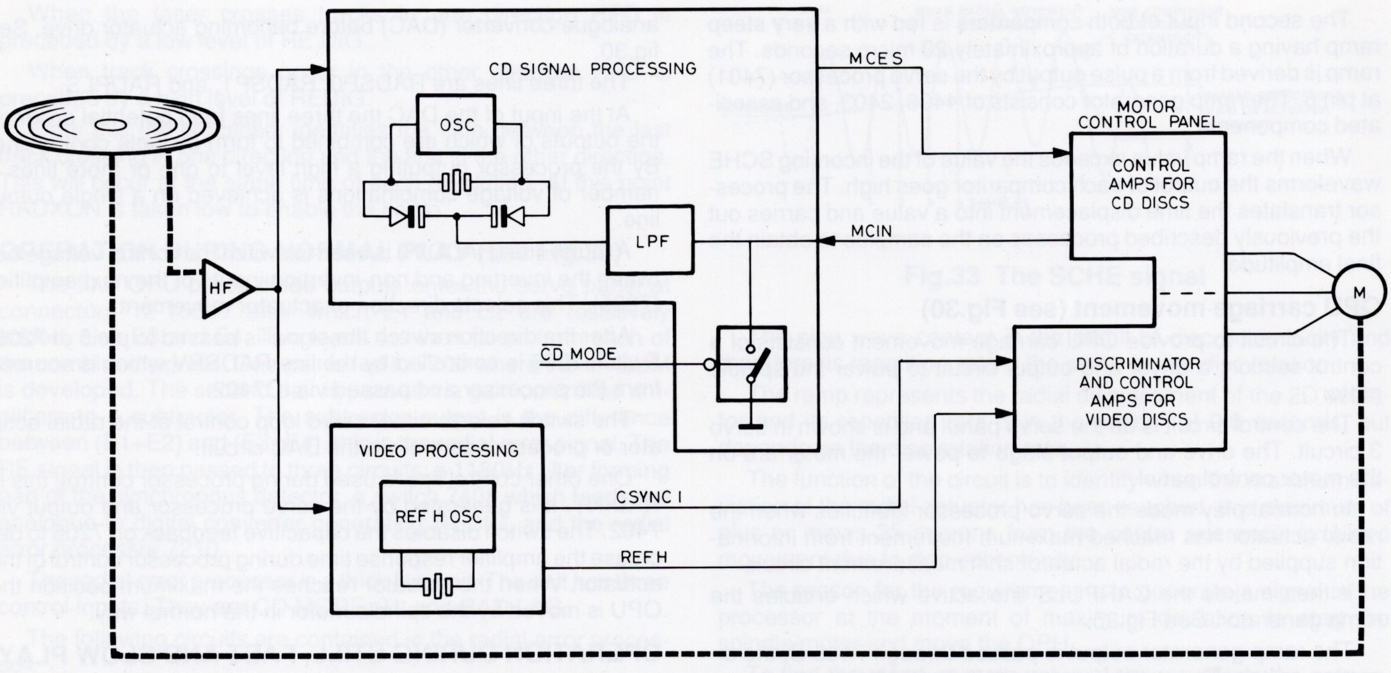


Fig.36 The turntable servo

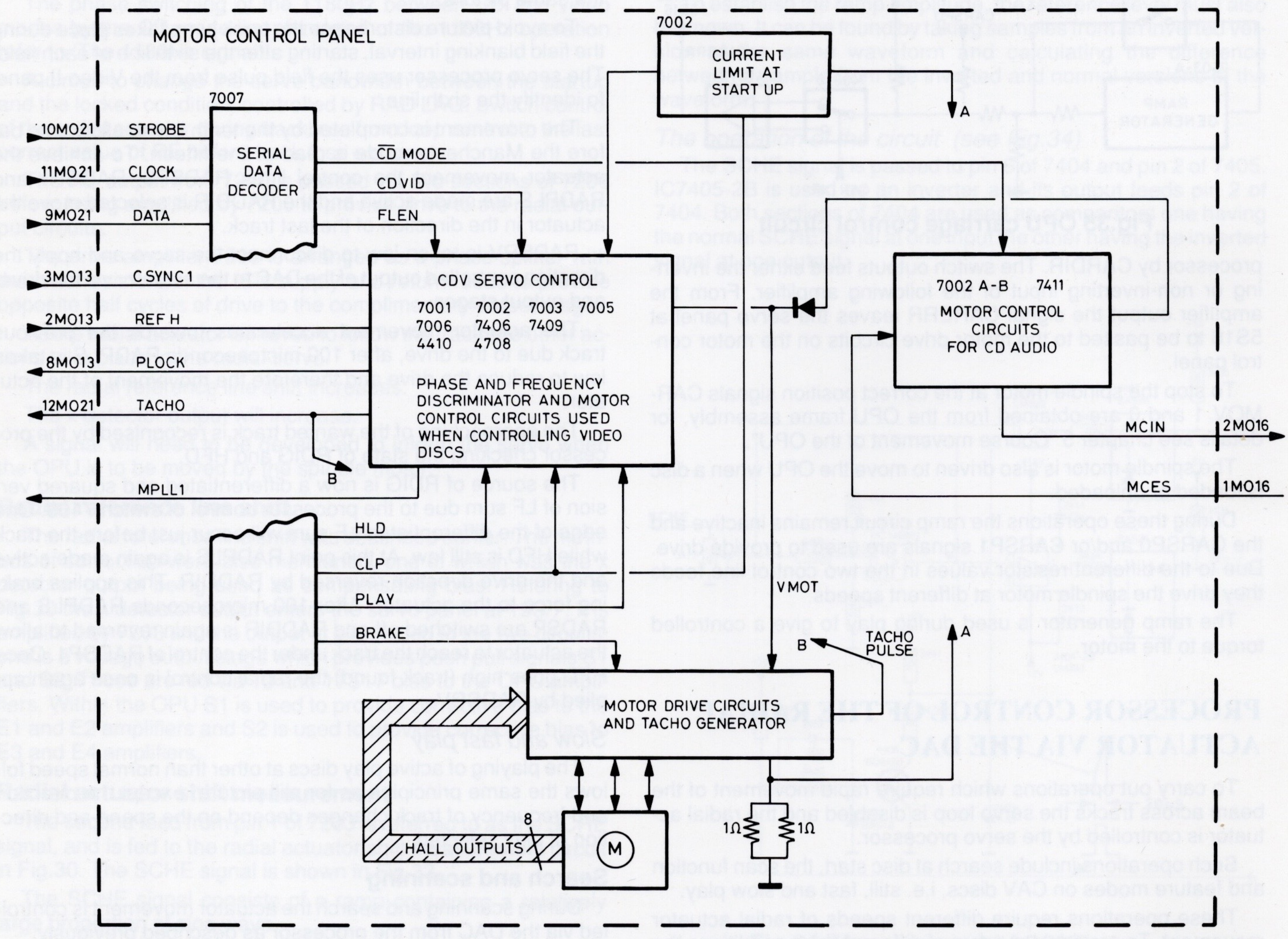


Fig.37 Turntable motor control

The RADSP0 and 1 pulses are in groups, during the pulses the servo is disabled by RADSRV.

After each group of pulses RADSRV returns the actuator to loop control for track reading.

8.4 THE TURNTABLE SERVO

The turntable motor is required to operate over a wide speed range with a variation of disc sizes.

The change in disc size implies a change of mass and hence the amount of control power required.

To ensure the video disc reading speed is correct the disc rotation rate is locked with reference to a crystal oscillator.

This operation is achieved by comparing line sync pulses recovered from the disc with the crystal oscillator.

To ensure the correct reading speed of a CD audio disc, the rotation rate is locked to a second crystal oscillator by comparing the recovered bit rate with the oscillator output.

Because of the different speed, power and references required between disc types and sizes, the turntable servo system becomes two servos driving a single motor. One servo is used when video is being played and one when CD audio only discs are played.

TURNTABLE SERVO PRINCIPLES (see Fig.36)

The HF envelope recovered from the disc is amplified before being fed to the video and audio processing sections.

The principles when playing a CD audio disc

The CD audio processing area contains a crystal controlled reference oscillator which is used to clock the incoming data through the system.

Within the audio processing system the incoming data is compared with the reference oscillator frequency and the difference between the two frequencies creates an error signal; Motor Control Error Signal (MCES).

The MCES signal is then integrated and amplified on the motor control panel before being used to control the motor.

The principles when playing video discs

When playing a video disc the signal is fed to both the CD and video processing areas since the video disc may also have CD sound.

Within the video processing area line sync pulses are obtained from the incoming video via a sync separator circuit and are offered to the motor control panel as C SYNC 1.

Also within the video processing a crystal oscillator is divided down to produce line rate reference pulses (REF H). For detail of REF H and C SYNC sources see Chapter 9.

The REF H and C SYNC are frequency and phase compared on the motor control panel and an error signal is obtained. The error signal, after suitable processing, becomes control for the motor.

CD data control during video playback

When video discs containing CD audio tracks are played, the CD data processing rate is still controlled by the CD reference oscillator, but the disc and hence the CD data rate from it is now locked to REF H by recovered line sync pulses.

To ensure CD data processing is in step with the data rate from the disc the CD oscillator needs to be controlled by REF H. This is carried out by using the CD error signal (MCES) which after integration and amplification on the motor control board becomes a DC control voltage. The MCES signal is returned to the CD processing as MCIN.

The MCIN line is passed via a LPF to the junction of two capacity diodes. The diodes are across the crystal of the CD reference oscillator. Therefore a frequency difference between the CD data from the disc and the CD reference crystal is seen as a MCES signal which after processing is used to pull the CD crystal to match the incoming data rate.

The MCIN line is blocked during the CD audio function by a two transistor switch. The transistors are on the audio processing panel and are controlled by the CD MODE line.

THE SERVO OPERATIONS ON THE MOTOR CONTROL PANEL (see Fig.37)

The operations on the motor control panel can be divided into four main areas which are :-

i) Control data processing
ii) The complete CDV Servo Control
iii) The CD audio control circuits
iv) Motor drive circuit and motor

Control data processing

The motor control panel receives serial data from the servo processor at 9M21 to control the servo modes.

From the serial data entering the panel at 9M21, IC7007 provides the following servo control signals :-

CD MODE(active low)	Which allows the CD only motor control circuits to function.
CDVID(active high)	This signal allows the video servo system to function.
FLEN	This signal enables the phase lock circuits of the video servo to function.
HLD	This is a hold signal which, when active, holds the mark space ratio of the MFE constant.
CLP	The CLP line is low for CDV 5" discs and when low alters the servo loop gain, the current limit circuit condition and switches from power to time error control within the circuit IC.
PLAY	Goes high from the moment the motor states to rotate and remains high until the motor reaches 80% of normal speed. It disables the servo loop and provides drive during start up.

Control signals returned to the servo processor system are :-

1) Tacho pulses leaving the panel at 12M021.
The processor uses the tacho pulses during the disc braking operation, to identify when the motor is stationary.
2) A signal referred to as MPLL1.
This signal goes high when C SYNC 1 is within 0.7% of the frequency REF H.
3) A signal referred to as P LOCK.
This line is high when C SYNC 1 is locked to REF H and tells the processor system when phase lock is achieved.

CDV SERVO CONTROL

The complete servo for use during the playing of video discs is contained on the panel. The sample rate of rotation enters the panel at 3MO13 as C SYNC 1 and the reference enters at 2MO13 as REF H.

When a disc is inserted, the size and type are determined, these operations are described in the section "an introduction to the player".

If a 5" disc is identified and focus achieved, the CD mode line will go low and the motor starts under the control of the CD motor control circuit.

The table of contents are read and if they indicate it is a video disc the CD mode line will go high and the CDVID line will also go high placing the motor under the control of the video motor control circuits. The CLP line will go low to set the loop gain and other circuits of the servo to suit the small disc.

When a video only disc, 8 or 12 inches is loaded and focus is achieved, the CDVID line will go high, the CD MODE and the CLP line will remain high.

In either of the video situations as the motor starts the play line becomes active high. The play line is only active at the motor start and is used to reduce the control and increase the rate of motor speed up.

Once the motor reaches 80% of nominal speed the play signal goes low and the control circuit has greater influence as frequency lock is approached.

The processor then outputs a signal FLEN which enables the phase lock circuits in the system.

When the frequency of the recovered line syncs is within (plus or minus) 0.7% of REF H the system raises MPLL1 high to inform the processor system.

Once phase lock is achieved the line PLOCK goes high to inform the servo processor the servo is locked.

When the stop command is implemented the servo processor outputs a brake signal via IC7007. This signal applies reverse control to the motor drive IC.

The video motor control circuit provides an output control voltage (V MOT) which powers the motor through the motor drive circuit.

Detail of the CDV Servo Control Section (see Fig.38)

The control sequence from the start of turntable rotation until the moment phase lock is achieved has been described previously.

The CDV control circuits use an IC to compare frequency and phase of the recovered syncs (C SYNC 1) with REF H. The resulting outputs are integrated, combined and amplified before being converted to a switch mode signal whose mark space ratio determines motor drive. The switch motor signal is amplified before being applied to the motor via an integrator.

Under normal running conditions C SYNC 1 is compared with REF H in the frequency and phase discriminator (IC 7005). Once frequency and phase lock is achieved MPLL1 and PLOCK will be high. The FLOCKIN signal will be low (active), the FLEN signal will be high and the play signal low.

Two active outputs are provided by the discriminator, both are variable duty cycle waveforms. One is output from the phase error control section of the IC (MPE). The other output is from the frequency error control circuit (MFE).

Each waveform is then separately integrated to provide a DC level relative to the duty cycle.The integrated MPE signal is amplified by 7001-A and AC feedback is provided to control the loop time constants.

The motor control sync protection

Within the IC two levels of sync protection are carried out.

Both levels use a "window" technique to limit the period that pulses can be accepted for use in the IC.

The window times are defined by counting pulses obtained by dividing down the crystal oscillator (5002).

The first level of protection is to use the count pulses to measure a time period of just over half a line starting at each sync pulse. During this time period no further pulses are allowed to enter the comparator circuit. This ensures spurious and half line pulses are not seen by the comparator. Once the servo is locked the second level of protection is implimented. A second window is formed by the counter which only allows sync pulses to enter between approximately 62 and 67 microseconds after the last pulse.

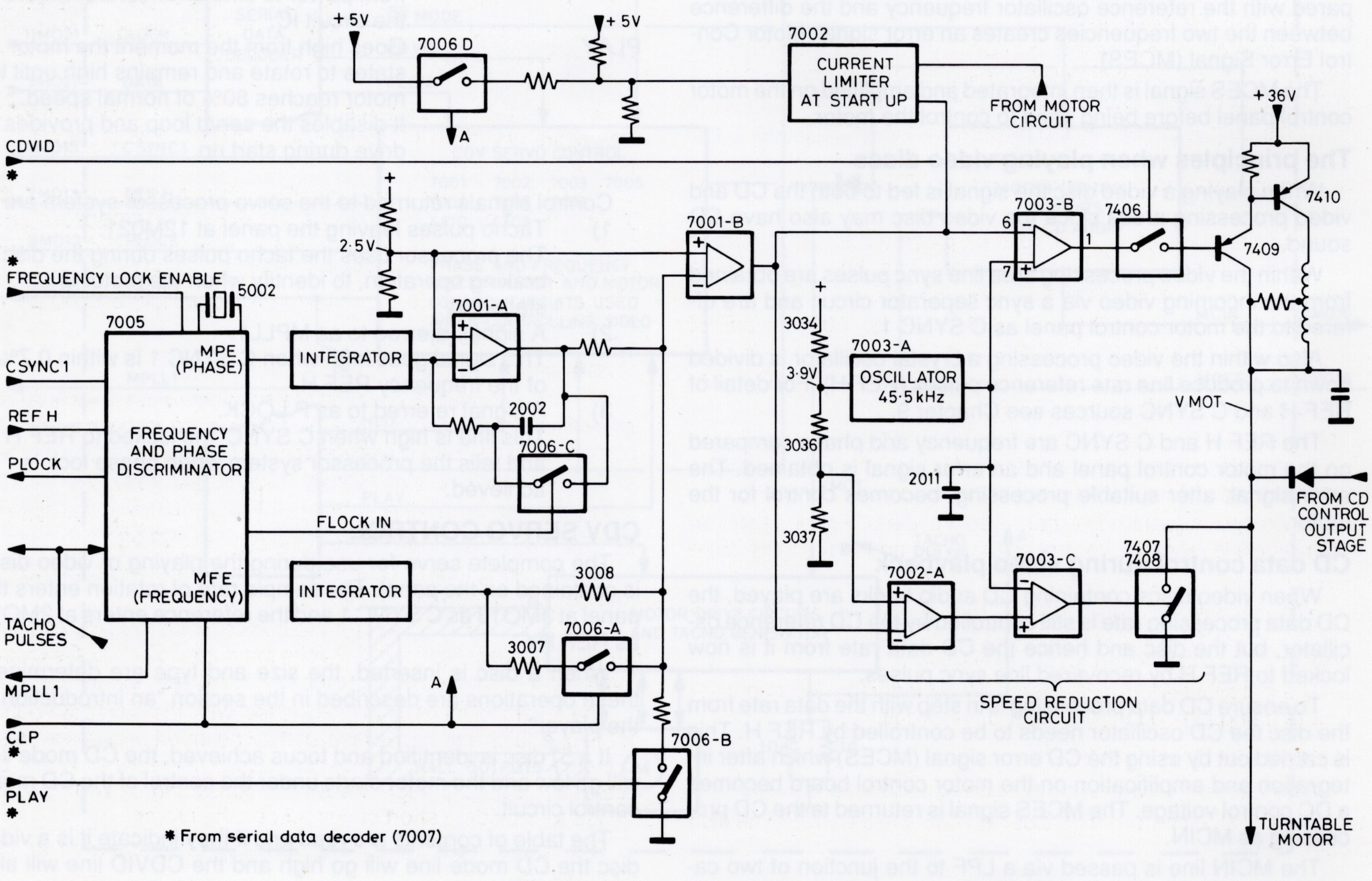


Fig.38 Detail of CDV control system

Power time error correction

The IC also takes steps to compensate for problems caused by disc eccentricity.

This takes two forms, one is a power compensation circuit to lessen the excessive power disipation caused by eccentricity of large discs, the other is to reduce the time error caused by eccentricity of 5" discs.

The power compensation takes the form of adding an anti phase signal of the eccentricity component to the MFE signal and adjusting the amplitude of the component for optimum performance.

The time error reduction system adds a signal in phase with the eccentricity components. The amplitude of the added signal is adjusted in the IC for minimum time error.

The switching between power and time error correction is carried out by the CLP line.

NORMAL RUNNING CONDITIONS

Under normal running conditions 7006-C is open leaving 2002 in the feedback path.

The integrated MFE signal is resistively added to the MPE signal at the output of 7001-A.

The value of the resistor in the MFE path is switch selected by 7006-A.

The switch 7006-A is controlled by the CLP signal.

The CLP signal is high for 8 or 12 inch discs and low for 5 inch discs. When high the switch is closed placing 3008 and 7 in parallel to lower the resistor value and increase the loop sensitivity.

The switch 7006-B is only closed during the start sequence (see section on starting up).

The now combined signal at the input to 7001-B is the total DC control voltage, it is amplified by 7001-B before being converted to a switch mode signal whose control level is determined by the duty cycle of the waveform.

The reference level of the DC control voltage is mainly determined by the divider which provides the common bias point of 7001-A and B. The potential at this point is 2.5 volts.

At the output of 7001-B the reference level is 6 volts and the control swings above and below this figure. To convert the voltage swing to a variable duty cycle signal an RC oscillator (7003-A) is used.

A sawtooth waveform of 4 volts pk-pk on a 3.9 volt reference is formed across the oscillator capacitor. The 3.9 volt reference being decided by the potential divider 3034,36, and 37.

The oscillator output is fed to 7003-C and B, 7003-C is part of a speed reduction circuit to be described later.

The conversion of the control voltage to a variable duty cycle waveform is carried out by 7003-B.

The control voltage now on a reference of 6 volts is applied to one input of the operational amplifier 7003-B. The 4 volt sawtooth waveform on a 4 volt reference is applied to the other input.

The output square wave has a duty cycle which depends on the precise level of the control voltage and any movement. (See fig.39).

The variable duty cycle waveform at the output of 7003-B is passed via 7046 to the output driver transistor 7409 which in turn provides drive for the output stage (7410).

The output waveform is filtered by an inductor and capacitor before being applied to the motor drive circuit.

START UP-CONDITIONS

When an 8 or 12 inch disc is inserted and focus is found

The CDVID line goes high closing 7406 and the PLAY line also goes high.

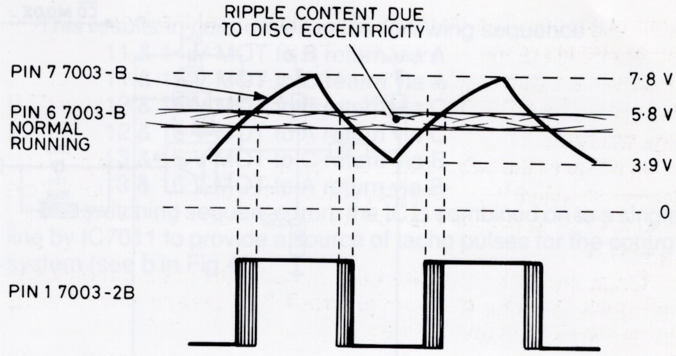


Fig.39 Conversion of control signal to switch mode

The CDVID line goes high closing 7406 and the PLAY line also goes high.

With the play line high 7006-B is closed taking the inverting input of 7001-B to 1.75 volts and causing the output and therefore the inverting input of 7003 to go to plus 12 volts.

This results in the output stages being on at maximum current. The only limitation being the current limiter circuit operating on the input to 7003-B which allows a maximum current of 1 amp. When the motor reaches approximately 80% of nominal speed, measured by the IC counting tacho pulses, the play signal goes low allowing 7006-B to open and the discriminator outputs to control the servo.

When C SYNC 1 is within plus or minus 0.7% of REF H MPLL1 goes high to inform the servo processor.

Once phase lock is achieved the PLOCK line goes high to inform the servo processor phase lock is achieved.

When a 5 inch CDV disc is inserted the sequence is as described except the CLP line will be low and the start sequence will begin after focus is achieved by turning on the CD control circuit with the CD mode line.

Once the table of contents has been read the CD mode will go non active and the CDVID line made active, this is followed by the normal start sequence.

The CLP line, apart from controlling 7006-A also controls 7006-D. The CLP line is low for 5 inch CDV discs, and when low opens 7006-D effectively raising the value of resistance in the top end of the divider used for reference. This allows current limiting to start at a lower level, (0.3 amp) since it requires less motor power to rotate a 5 inch disc.

Speed reduction system

If the speed starts to exceed the nominal value during control for example overshoot during the final run up to phase lock of a 12 inch disc, a speed reduction circuit is used.

The circuit consists of 7002-A, 7003-C and 7407/08.

The operational amplifier 7002-A at the circuit input is tied to a 3.9 volt reference obtained from the divider 3036/37.

The inverting input of the amplifier is supplied with the control voltage from the output of 7001-B.

If the disc speed is too fast the control voltage falls, when the control voltage is less than 3.9 volts the output of 7002-A exceeds 4 volts and the non inverting input to 7003-C also exceeds 4 volts.

The inverting input to 7003-C is fed with the sawtooth output of the oscillator and as the level of the non inverting input to 7003-C increases, the time the output is high increases. When the output of 7003-C is high the switch consisting of 7407/7408 is closed to provide a short circuit across the motor.

The speed reduction circuit normally only operates in very short bursts.

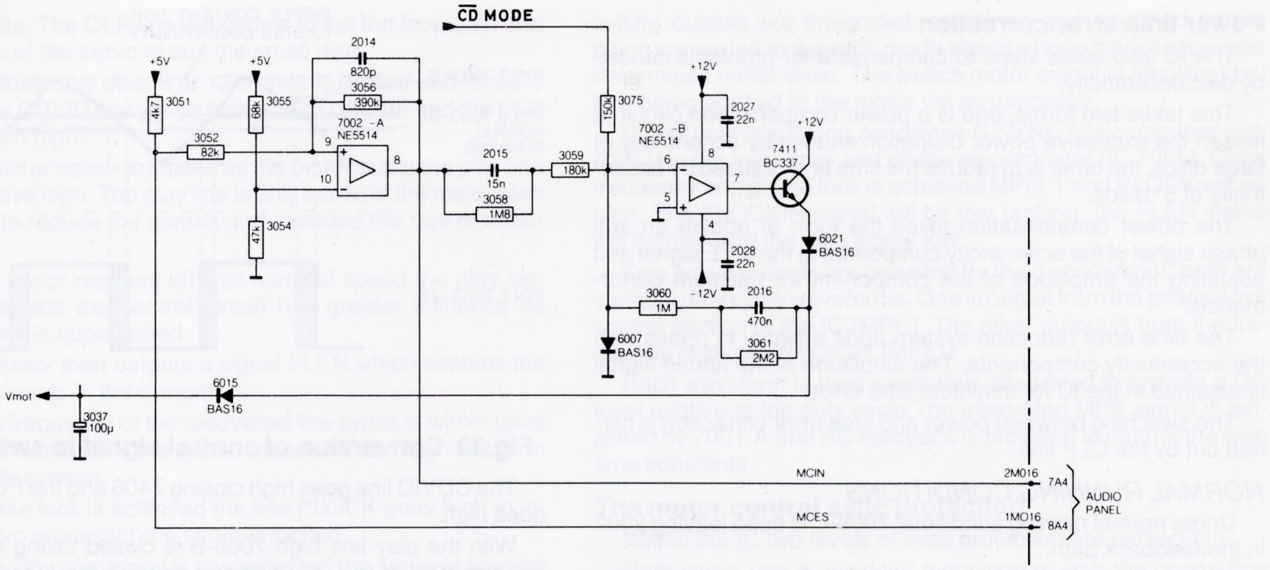


Fig.40 Detail of CD audio control

The circuit action can best be examined using a DC coupled oscilloscope to measure points in the circuit while the player is in the transition period between the finish of the video track and the start of the 1st audio track on CDV discs.

Because the speed reduction circuit only operates when the control voltage at the output of 7001-B falls below 3.9 volts the output stage providing the motor current will be cut off since the output of 7003-B will be high. (See fig.39).

CD AUDIO CONTROL (see Fig.40)

When a CD disc is inserted and identified by the procedure previously mentioned in "introduction to the disc". The focus is found and then the servo processor outputs via 7007 an active low signal line (CD MODE). This line enables the CD audio motor control circuit.

The comparison of data rate from the disc with a master crystal to generate the motor control signal MCES is carried out on the audio CD processing board.

The resulting error control signal MCES enters the motor control panel at 1M016.

The MCES signal is a variable duty cycle waveform which is first amplified and filtered by 7002-A and its associated circuit. The IC is powered between the plus 12 volt and minus 12 volt lines and therefore the output can be negative. The output of 7002-A at pin 8 provides DC control with a nominal voltage of minus 6.4 volts.

The control voltage is passed via an RC network to pin 6 of 7002 to provide drive for the output stage 7411. During the playing of a CD disc the voltage at pin 7 is nominally 6 volts.

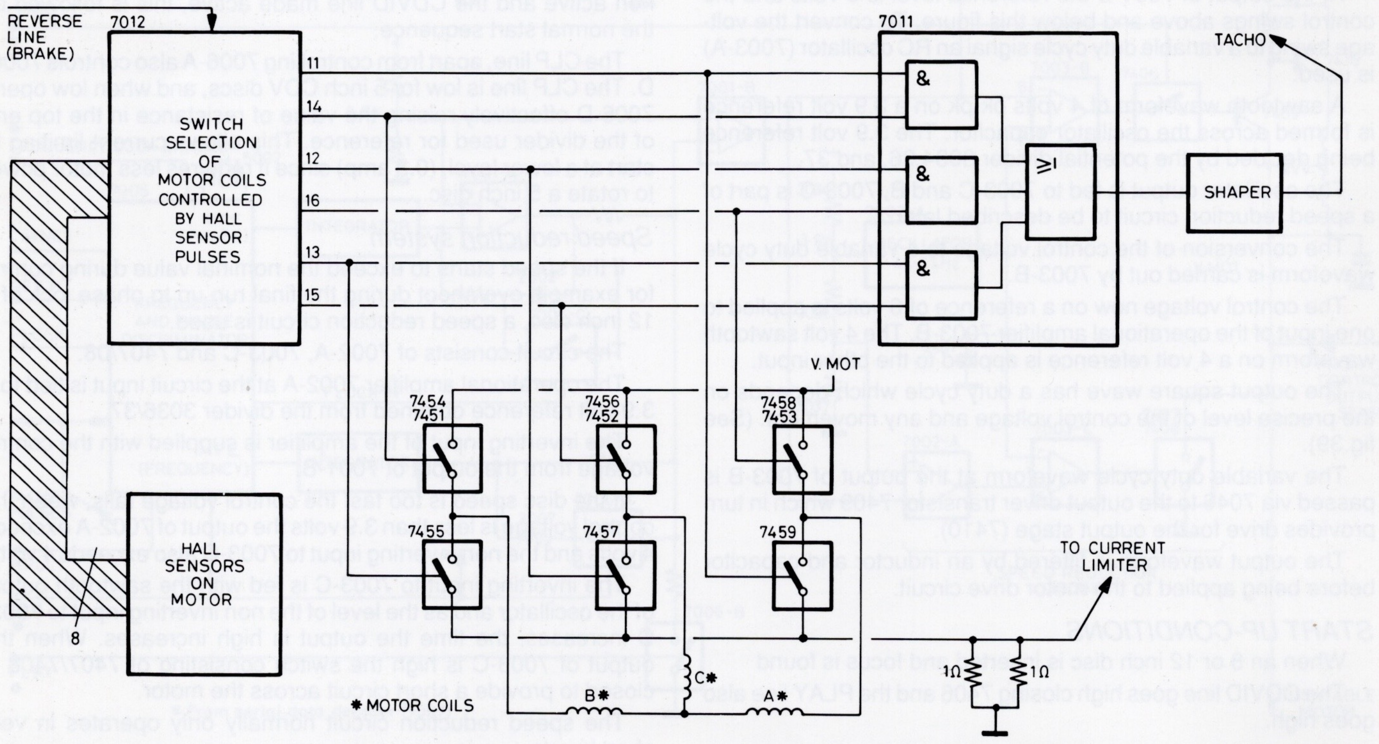


Fig.41 Motor drive circuit

When a CDV disc is being played the CD MODE line will be high and drive the inverting input to the amplifier at pin 6. This results in pin 7 going to minus 12 volts and the motor current being cut off.

The first stage of the CD control circuit is operational during the CDV mode to allow the output control from pin 8 (MCIN) to be used on the CD audio panel; (see "CD data control during video playback").

The motor drive circuit and motor (see Fig.37)

The line, V MOT feeds the motor drive circuit.

The circuit consists of a dedicated IC used to control the switching sequence of the coils in a hall motor, a number of transistor switches, and a second IC used to generate tacho pulses.

Detail see fig.41

The motor uses three groups of coils.

The particular group of coils to be energised is decided by the hall sensors within the motor. The hall outputs are fed to an IC.

The IC uses the hall sensor pulses to provide the correct sequence on six outputs which are used to switch select current to the motor coils and also control the direction of current through the coils.

The source of current for the coils is the output of either the CDV or CD control circuit, the common line is given the ref V MOT.

The six transistors forming the upper three switches in Fig.41 provide the switching of the power to each of the three coils.

The lower three switches in the diagram switch the return of the three coils via two 1 ohm resistors in parallel to chassis.

The voltage across the two resistors is used as motor current indication to the current limiter circuit.

The switch control sequence is shown in Fig.42.

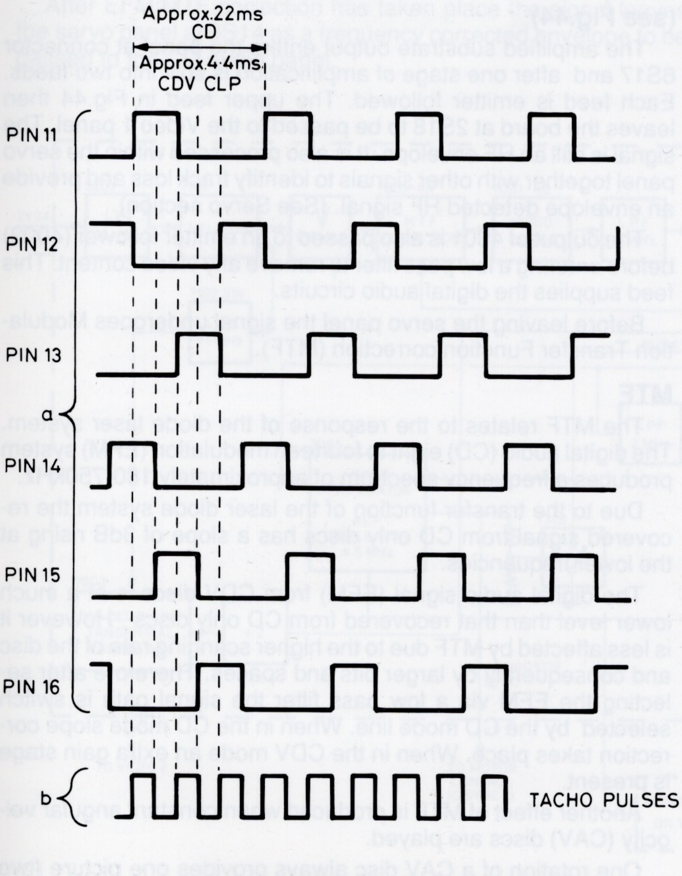


Fig.42 Motor switch control sequence

This results in coils driven in the following sequence :-

11 & 14 V MOT to B return via A
11 & 15 V MOT to C return via A
12 & 15 V MOT to B return via C
12 & 16 V MOT to A return via C
13 & 15 V MOT to C return via B
13 & 16 V MOT to A return via B

The switching sequence from the IC is combined on to a single line by IC7011 to provide a source of tacho pulses for the control system (see b in Fig.42).

9. SIGNAL PROCESSING

INTRODUCTION (see Fig.43)

The signal processing is mainly carried out in five areas of the player.

The five areas are :-

1. The Optical Pick-up Unit
2. The Servo Panel
3. The Video 1 panel
4. The Video 2 panel
5. The Digital Audio panel

There is also a small PCB used to support the output sockets referred to as the connector panel and in some players a panel physically between Video 2 and the audio panel, referred to as Video 3, later changed to a thick film unit on Video 1 panel.

1. The optical pick-up unit

The unit recovers the full frequency spectrum from disc via the substrate of the four diode sensors.

The four diode outputs are also individually recovered to measure the landing position of the reflected beam on the diodes, this gives focus and radial error signals. See section on the OPU for detail of error signals and total signal make-up.

Within the OPU all of the recovered signals are amplified before being passed via 5 connections of the 28 way flex cable to the servo panel.

2. The servo panel

The radial and focus error signals are passed to the appropriate servo within the servo panel.

The signal recovered in the OPU from the diode substrate is amplified and split into two signals, one is to be used only to recover digitally coded audio information, this signal is passed from the servo panel to the digital audio processing panel. The second signal is to be used to recover video information and analogue FM modulated audio signals. Both signals, if examined using an oscilloscope, are envelopes containing a band of frequencies.

The envelope to be used to recover the video and the analogue audio is passed from the servo panel to the Video 1 panel.

3. The video 1 panel

The signal is amplified on the Video 1 panel and then split into two feeds.

One feed is to be used to recover the FM audio signal, the other is used to recover the video information.

The video processing

The envelope signal undergoes a number of processes before a CVBS signal suitable to drive a television receiver is obtained.

After some processing the envelope is demodulated and the resulting signal is corrected for drop-out.

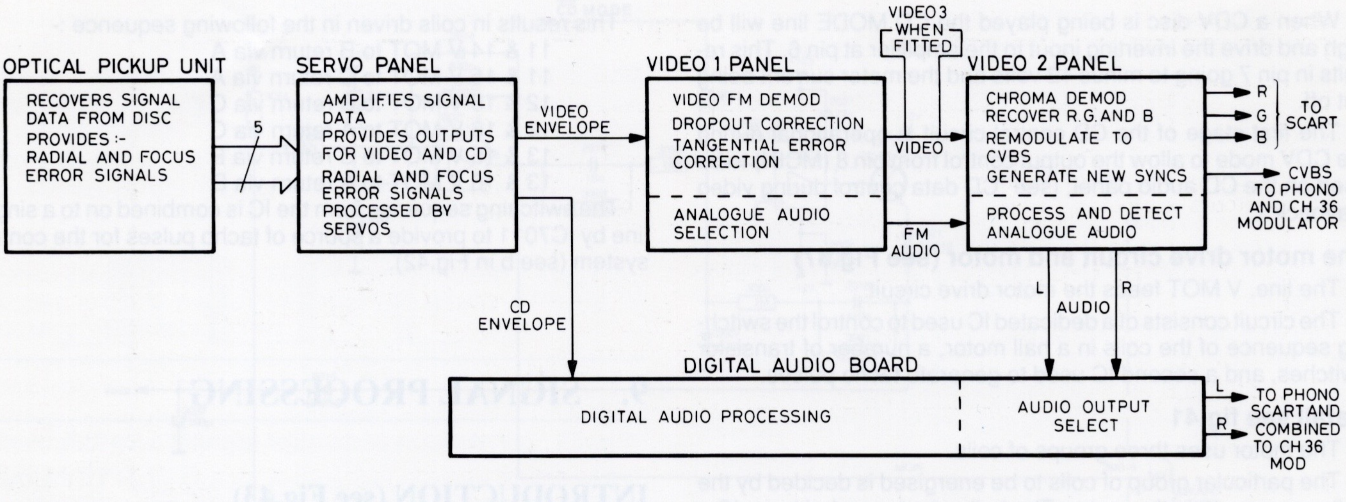


Fig.43 Block diagram of the signal processing

The next process the signal undergoes is tangential error correction, this is also referred to as Time Base Correction (TBC).

The tangential errors originate due to disc eccentricity and cause timing errors of line periods within the frame period, see "The CDV Player an introduction".

The tangential or time base correction applied to the video signal is also applied to the FM audio signal.

The Demodulated TBC video signal and the FM audio signal are passed to the Vide 2 panel.

4. The video 2 panel

The CVBS video signal from Video 1 is chroma demodulated to provide R,G and B signals. New syncs are generated and the R,G and B signals are remodulated to provide a CVBS output.

The FM audio signal is processed and demodulated to provide Left and Right channel audio signals.

The processed video signals are supplied to the connector panel containing the output sockets and via the connector panel to the RF modulator.

The left and right audio signals are fed to the digital audio panel, which contains the audio output switching.

5. The digital audio panel

The signal from the OPU was split into two feeds on the servo panel. One feed went to Video 1 panel, the second went to the digital audio panel.

Within the digital audio panel the 2nd generation chip set is used for CD processing. The publication under code number 725 21918 gives a full description of the signal processing.

The outputs are passed to the switch selection which provide either audio from the CD channel or from the analogue audio processing on the Video 2 panel. The switch output is fed to the connector panel and the RF modulator.

SIGNAL PROCESSING DESCRIPTION

THE OPTICAL PICK-UP UNIT (see Fig.44)

The optical pick-up unit contains the laser diode, the optical pick-up diodes together with the pre-amps for each of the diodes and an amplifier for the substrate output.

The signal and other circuits, are built on, and connected to, the servo panel by a foil print. The connector is a 28 way, 5 of which are used for signal connections.

The complete unit is a service item (refer to service documentation) however some information is given to provide an understanding of the system.

The four optical pick-up unit photo diode outputs are individually amplified before being passed to the servo panel.

Two signals are each applied to a pair of the diode amplifier inputs (S1 and S2), these two signals are a form of dynamic correction to the radial and focus servo signals and are discussed in the section dealing with the servos.

The optical pick-up diode output used to recover the signal information from the disc is taken from the substrate of the four diodes.

The substrate output is amplified in a three stage amplifier before being passed from the OPU to the servo panel at connector 6x1.

SIGNAL PROCESSING ON THE SERVO PANEL (see Fig.44)

The amplified substrate output enters the panel at connector 6S17 and after one stage of amplification is split into two feeds. Each feed is emitter followed. The upper feed in Fig.44 then leaves the board at 2S18 to be passed to the Video 1 panel. The signal is still an HF envelope. It is also processed within the servo panel together with other signals to identify track loss and provide an envelope detected HF signal. (See Servo section).

The output of 4001 is also passed to an emitter follower (4002) before entering a low pass filter to remove any video content. This feed supplies the digital audio circuits.

Before leaving the servo panel the signal undergoes Modulation Transfer Function correction (MTF).

MTF

The MTF relates to the response of the diode laser system. The digital audio (CD) eight to fourteen modulation (EFM) system produces a frequency spectrum of approximately 180-750kHz.

Due to the transfer function of the laser diode system the recovered signal from CD only discs has a slope of 3dB rising at the lower frequencies.

The digital audio signal (EFM) from CDV discs is at a much lower level than that recovered from CD only discs . However it is less affected by MTF due to the higher scanning rate of the disc and consequently by larger pits and spaces. Therefore after selecting the EFM via a low pass filter the signal path is switch selected by the CD mode line. When in the CD mode slope correction takes place. When in the CDV mode an extra gain stage is present.

Another effect of MTF is produced when constant angular velocity (CAV) discs are played.

One rotation of a CAV disc always provides one picture (two fields).

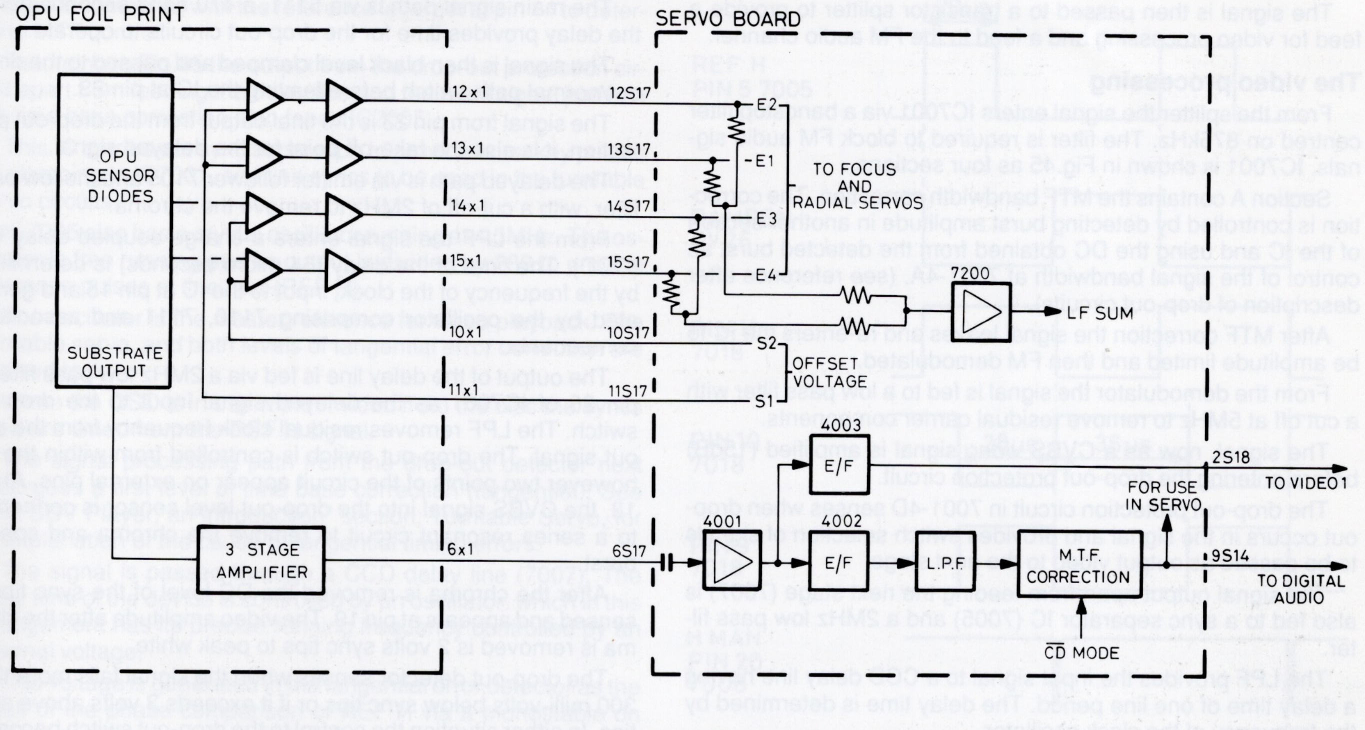


Fig.44 Signal path of OPU and servo panel

This means the pit density is much less at the outer diameter of the disc than the centre, causing an increase in recovered bandwidth towards the outside of the disc.

The correction for the video bandwidth takes place on the Video 1 panel before demodulation.

After EFM/MTF correction has taken place the signal leaves the servo panel at 9S14 as a frequency corrected envelope to be passed to the CD audio panel.

It is also used in the servo board to provide an envelope detected HF signal and as one of the signals required to identify track loss.

THE VIDEO 1 PANEL (see Fig.45)

The envelope from 2S18 on the servo panel enters Video 1 at 2V24 and is passed to a low pass filter with a cut off frequency of 15MHz.

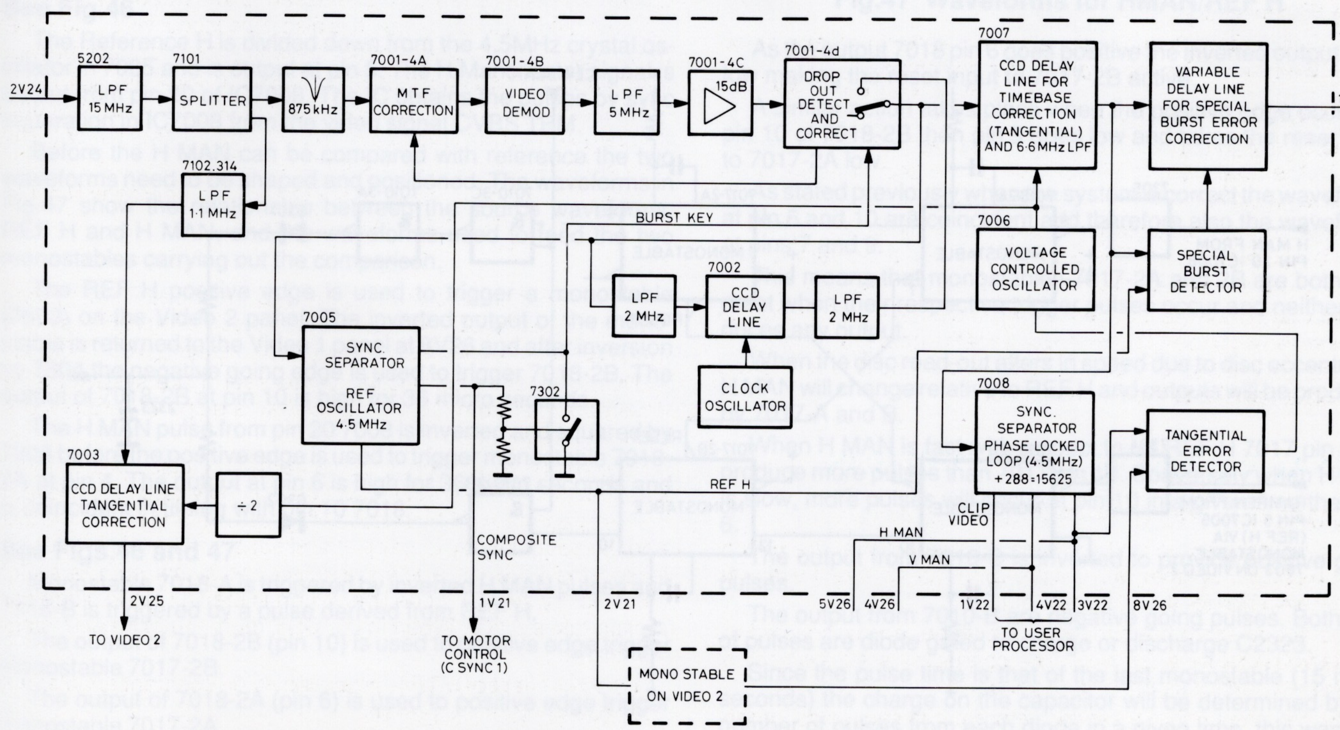


Fig.45 Signal processing on Video 1

The signal is then passed to a transistor splitter to provide a feed for video processing and a feed to the FM audio channel.

The video processing

From the splitter the signal enters IC7001 via a bandstop filter centred on 875kHz. The filter is required to block FM audio signals. IC7001 is shown in Fig.45 as four sections.

Section A contains the MTF bandwidth correction. The correction is controlled by detecting burst amplitude in another section of the IC and using the DC obtained from the detected burst as control of the signal bandwidth at 7001-4A. (see reference after description of drop-out circuits).

After MTF correction the signal leaves and re-enters the IC to be amplitude limited and then FM demodulated.

From the demodulator the signal is fed to a low pass filter with a cut off at 5MHz to remove residual carrier components.

The signal, now as a CVBS video signal is amplified (15dB) before entering the drop-out protection circuit.

The drop-out protection circuit in 7001-4D senses when drop-out occurs in the signal and provides switch selection of signals to be passed as output video to the next stage.

The signal output apart from feeding the next stage (7007) is also fed to a sync separator IC (7005) and a 2MHz low pass filter.

The LPF provides the input signal to a CCD delay line having a delay time of one line period. The delay time is determined by the frequency of the clock oscillator.

The delay line output is passed via an LPF of 2MHz to remove clock oscillator components before being used as video signal when drop-out occurs. When the drop-out circuit is in use the delayed signal is applied to the signal output circuits (7007) and fed back to the delay line input and recirculated.

The drop-out protection, detail (see Video 1 circuit diagram in service documentation)

The signal enters the IC at pin 20 where a stage of amplification with external feed back is used. The feedback consisting of R3151, 3150 and C2143 provides de-emphasis.

The main signal path is via 5111, a 470 nano seconds delay, the delay provides time for the drop-out circuits to operate.

The signal is then black level clamped and passed to the drop-out/normal path switch before leaving the IC at pin 23.

The signal from pin 23 is the final output from the drop-out protection, it is also the take-off point for the delayed signal.

The delayed path is via emitter follower 7105 and the low pass filter, with a cut-off of 2MHz to remove the chroma.

From the LPF the signal enters a charge coupled delay line (CCD). The time of the delay (64 micro seconds) is determined by the frequency of the clock, input to the IC at pin 15 and generated by the oscillator comprising 7110, 7111 and associated components.

The output of the delay line is fed via a 2MHz low pass filter to pin 26 of IC7001 as the delayed signal input to the drop-out switch. The LPF removes residual clock frequency from the output signal. The drop-out switch is controlled from within the IC, however two points of the circuit appear on external pins. At pin 18, the CVBS signal into the drop-out level sensor is connected to a series resonant circuit to remove the chroma and special burst.

After the chroma is removed the DC level of the sync tips is sensed and appears at pin 19. The video amplitude after the chroma is removed is 2 volts sync tips to peak white.

The drop-out detector senses when the signal falls more than 300 milli-volts below sync tips or if it exceeds 3 volts above sync tips. In either situation the control to the drop-out switch becomes active.

At pin 15 the control to the drop-out switch is brought out to a 47pF capacitor.

When the drop-out circuit is active the video signal at the delay line output is passed via the drop-out switch within the IC and output at pin 23 where it becomes the video output. It is also recirculated through the delay line.

Within the IC the video signal after the chroma trap is compared in a differential amplifier with the full CVBS signal. The amplifier output is gated by burst key pulses. The resulting voltage appears at pin 2 and is a measure of burst amplitude. The

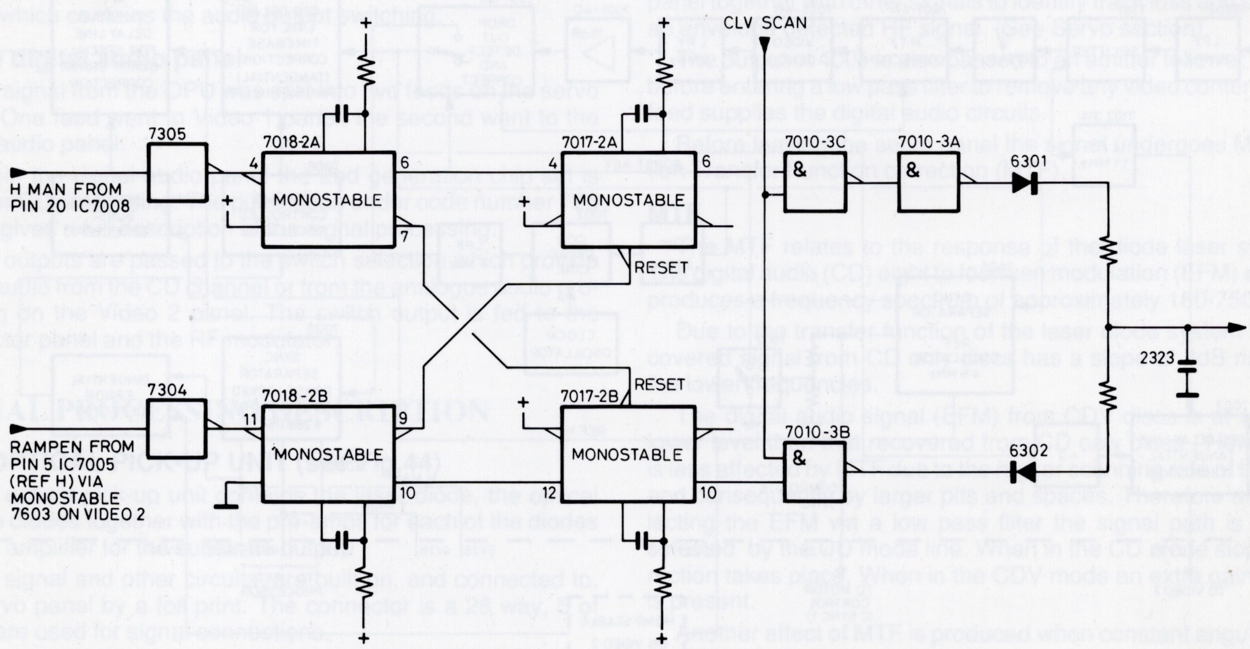


Fig.46 Comparing the timing of HMAN and REF H

voltage is compared with the reference level set at pin 14 to determine MTF control.

Returning to Fig.45 the output from the drop-out protection circuit apart from feeding the delay line and the main signal path via the time base correction also feeds IC7005.

This IC carries out sync separation to provide burst key pulses for clamping in IC7001, and line syncs to be used in the turntable servo circuits.

IC7005 also has a crystal oscillator running at 4.5MHz. The oscillator is free running and its output is divided by 288 to provide reference pulses at line rate (REF H).

The oscillator is the master reference for video playback. The turntable servo, and both levels of tangential error correction are referred to it.

When the OSD is in use without video from the disc the syncs used are timed from the REF H signal.

The signal processing path from the drop-out detector next undergoes a first level of time base correction (tangential). See "The CDV Player, an introduction" section; Turntable Servo, for an explanation of the cause of tangential timing errors.

The signal is passed through a CCD delay line (7007). The delay time of the device is controlled by an oscillator, which in this arrangement has its precise running frequency controlled by an external voltage.

This voltage is generated in the tangential error detector as the result of the phase comparison of REF H via a monostable on Video 2 panel and a signal, H MAN.

H MAN consists of line rate pulses derived from a phase locked loop in IC7008. The loop is locked to line syncs extracted from the playback video via a sync separator in 7008 and consequently represents disc timing.

Therefore the comparison is between present timing of line pulses and absolute timing from REF H.

Since the video for the sync separator is taken at the delay line output, each correction is reflected at the input to the error detector reducing the loop error to a minumum.

TANGENTIAL ERROR CORRECTION (detail)

See Fig.46

The Reference H is divided down from the 4.5MHz crystal oscillator in 7005 and is output at pin 5. The H Manchester signal is output from pin 20 of IC7008. The IC obtains the pulses by sync separation in IC7008 from the video signal CVBS TBM.

Before the H MAN can be compared with reference the two waveforms need to be shaped and positioned. The waveforms in Fig.47 show the relationship between the source waveforms, REF H and H MAN, and the waveforms used to feed the two monostables carrying out the comparison.

The REF H positive edge is used to trigger a monostable (7603) on the Video 2 panel. The inverted output of the monostable is returned to the Video 1 panel at 8V26 and after inversion by 7304 the negative going edge is used to trigger 7018-2B. The output of 7018-2B at pin 10 is high for 36 micro seconds.

The H MAN pulse from pin 20 7008 is inverted and squared by 7305 before the positive edge is used to trigger monostable 7018-2A at pin 4. The output at pin 6 is high for 36 micro seconds and is coincident in timing with pin 10 7018.

See Figs.46 and 47

Monostable 7018-A is triggered by inverted H MAN pulses and 7018-B is triggered by a pulse derived from REF H.

The output of 7018-2B (pin 10) is used to positive edge trigger monostable 7017-2B.

The output of 7018-2A (pin 6) is used to positive edge trigger monostable 7017-2A.

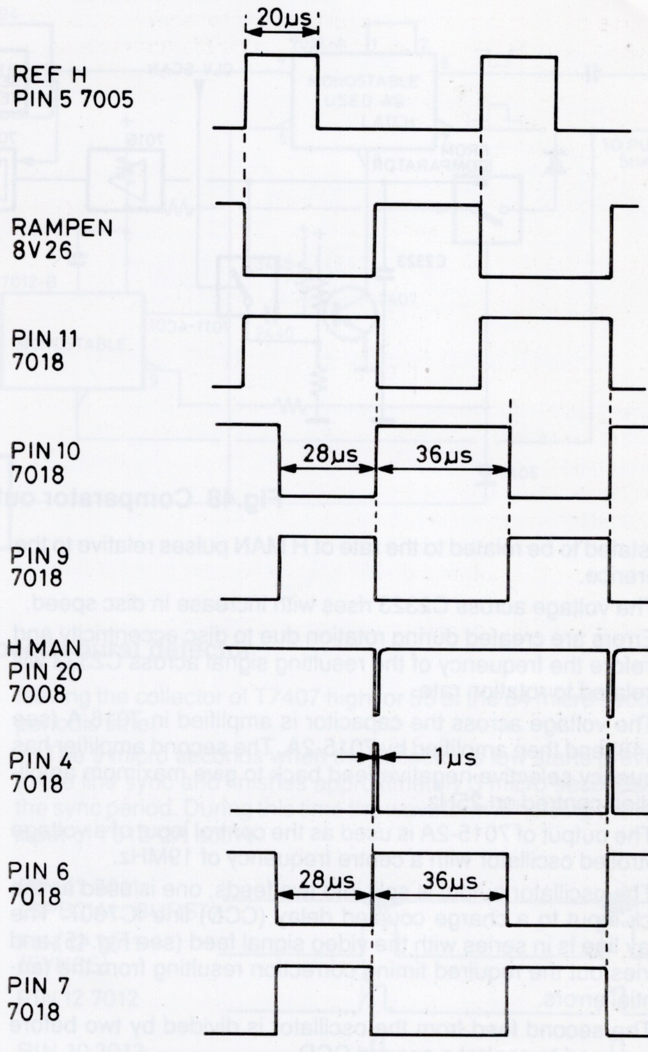


Fig.47 Waveforms for HMAN/REF H

As the output 7018 pin 6 goes positive the inverted output goes low making the reset input to 7017-2B active.

A similar action takes place when the positive edge occurs at pin 10 of 7018-2B then pin 9 goes low and takes the reset input to 7017-2A low.

As stated previously when the system is correct the waveforms at pin 6 and 10 are coincident and therefore also the waveforms at pins 7 and 9.

This means that monostables 7017-2A and 2B are both held reset when their respective trigger pulses occur and neither produces any output.

When the disc read-out alters in speed due to disc eccentricity, H MAN will change relative to REF H and outputs will be produced by 7017-A and B.

When H MAN is fast with respect to ref REF H 7017 pin 6 will produce more pulses than 7017 pin 10. Conversely when H MAN is slow, more pulses will occur at pin 10 in a given time than pin 6.

The output from 7010-C is inverted to provide positive going pulses.

The output from 7010-B are negative going pulses. Both sets of pulses are diode gated to charge or discharge C2323.

Since the pulse time is that of the last monostable (15 micro seconds) the charge on the capacitor will be determined by the number of pulses from each diode in a given time, this was ear-

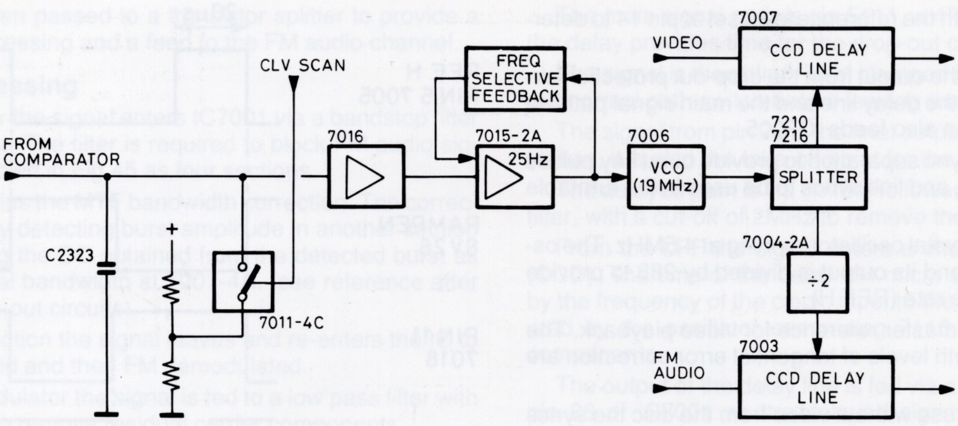


Fig.48 Comparator output control of delay line

lier stated to be related to the rate of H MAN pulses relative to the reference.

The voltage across C2323 rises with increase in disc speed.

Errors are created during rotation due to disc eccentricity and therefore the frequency of the resulting signal across C2323 will be related to rotation rate.

The voltage across the capacitor is amplified in 7016-A (see Fig.48) and then amplified by 7015-2A. The second amplifier has frequency selective negative feed back to give maximum amplification centred on 25Hz.

The output of 7015-2A is used as the control input of a voltage controlled oscillator with a centre frequency of 19MHz.

The oscillator output is split into two feeds, one is used as the clock input to a charge coupled delay (CCD) line IC7007. The delay line is in series with the video signal feed (see Fig.45) and carries out the required timing correction resulting from the tangential errors.

The second feed from the oscillator is divided by two before being used to control a second CCD.

The second delay line is in series with the FM audio signal prior to demodulation.

The two nand gates 7010-B and C in Fig.46 together with 7011-4C in Fig.48 are controlled from CLV SCAN. This control line is generated by the user processor system and enters the Video 2 panel at 2V22 as an active low signal CVL SCAN, it is inverted by 7010-D.

The line is active when "scan" is operated from the handset and a video disc is being played.

When the line is "active" the gates 7010-B and C are closed blocking the tangential error correction signal and the capacitor 2323 is connected to a reference voltage by 7011-4C.

SPECIAL BURST ERROR CORRECTION

Returning to Fig.45. The now TB corrected video information is passed to a variable delay line comprising of series inductors and varicap diodes to provide the variable capacitance.

The delay line is controlled by a signal derived from a comparison of timing between the REF H signal and a particular cycle of the special burst. The resulting alteration in the delay time of the line makes very small corrections to the timing of the video signal (in the order of less than 0.2 micro seconds) to ensure that the recovered chroma signal is correct.

The special burst is extracted from the TB corrected video. For an explanation of the special burst refer to "An introduction to the discs" Chapter 1.

Special Burst Correction (Detail, see Fig.49)

The circuit operation can be divided into three sections;

All three sections are shown in Fig.45 as the block special burst detector. The seperate sections are shown in Fig.49.

Section 1 separates the burst and provides a pulse, time related to the rising edge of the fourth cycle of special burst.

Section 2 compares the timing of the pulse with the REF H pulse and generates a control voltage related to that difference.

Section 3 blocks the system when special burst is not present.

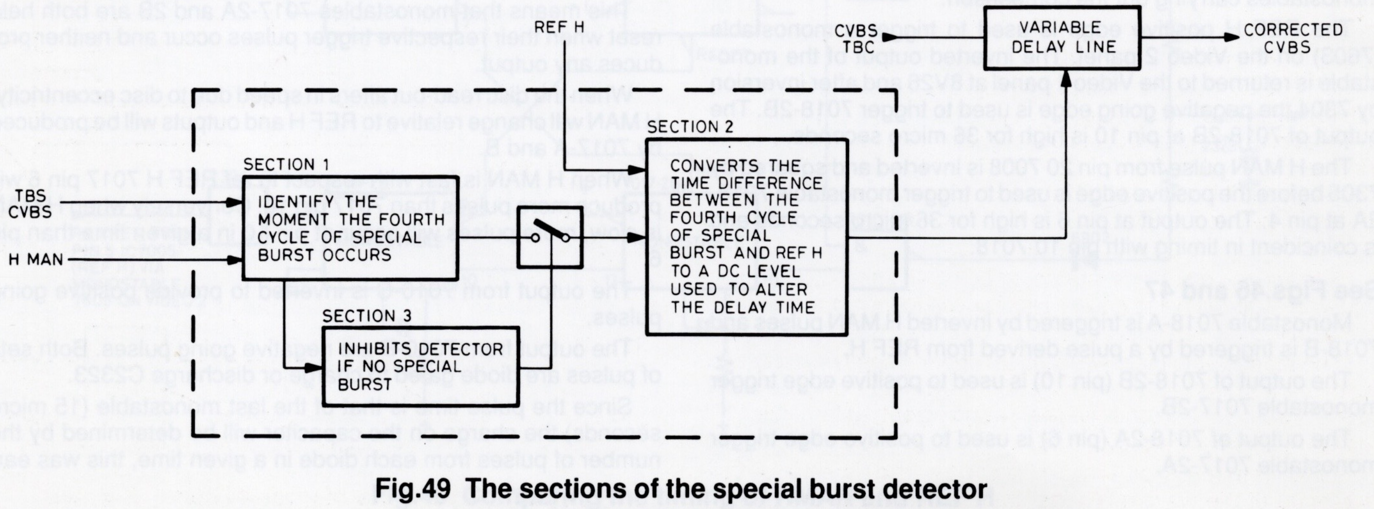


Fig.49 The sections of the special burst detector

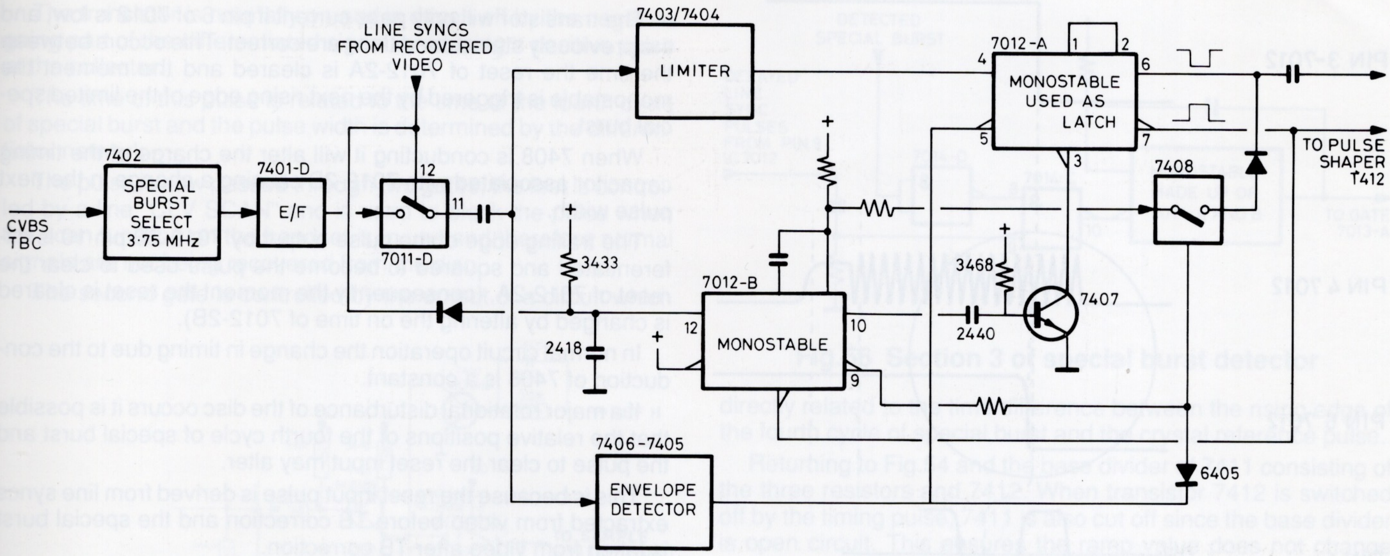


Fig.50 Section 1 of special burst detector

Section 1 (see Figs.50 and 51)

The TB corrected signal, apart from being fed to the variable delay line is also passed to the input of an amplifier tuned to 3.75MHz, the frequency of the special burst.

The amplifier output is gated in 7011-D by line sync pulses and at the output the special burst is passed to a limiter and also an envelope detector circuit.

The limiter is used to provide sharper edges to each cycle for accurate triggering of the next stage. The detector circuit amplitude detects the special burst, producing a positive going output pulse to gate the next stage, ensuring that it can only be triggered during the special burst period.

The limiter and the detector outputs both control trigger inputs of a monostable multivibrator (7012-2A).

The monostable has its timing pins joined and consequently once triggered remains in the active state until forced into the non-active state by the reset input. It therefore provides an action similar to a latch.

The HEF4528 bistable (7012) has an active high edge triggered input and an active low edge triggered input. A reset input is also provided which is active low and over-rides conditions at both other inputs. Assuming the reset is not active, then the device is triggered if one input is made active while the other input is in the non-active state.

Returning to Fig.50 and reference made as necessary to Fig.51 (waveform timing diagram).

IC7012-2A has the positive going edges of each cycle of limited special burst to trigger it at pin 4 while pin 5 is held high, (non-active) by the detected burst signal. However the device will not be triggered to the on state until after the completion of the fourth cycle of burst, as until then the reset input is held low by a pulse related to, but delayed from, the leading edge of the line sync pulse.

The line sync pulse is integrated by R3433 and C2418 causing a delay to the rising edge which is used to trigger monostable 7012-2B.

The monostable therefore triggers approximately 1 micro second late with respect to the start of line sync. The on time is just over 1 micro second and the positive going output from pin 10 is differentiated by 2440 and 3468.

T7407 is normally on and is driven off by the differentiated trailing edge of the waveform. The time constant is relatively long leaving the collector of T7407 high for 55 of the 64 micro seconds periodic time.

The 9 micro seconds when the collector is low starts previous to the line sync and finishes approximately 3 micro seconds into the sync period. During this time the waveform is holding the reset input of 7012-2A active.

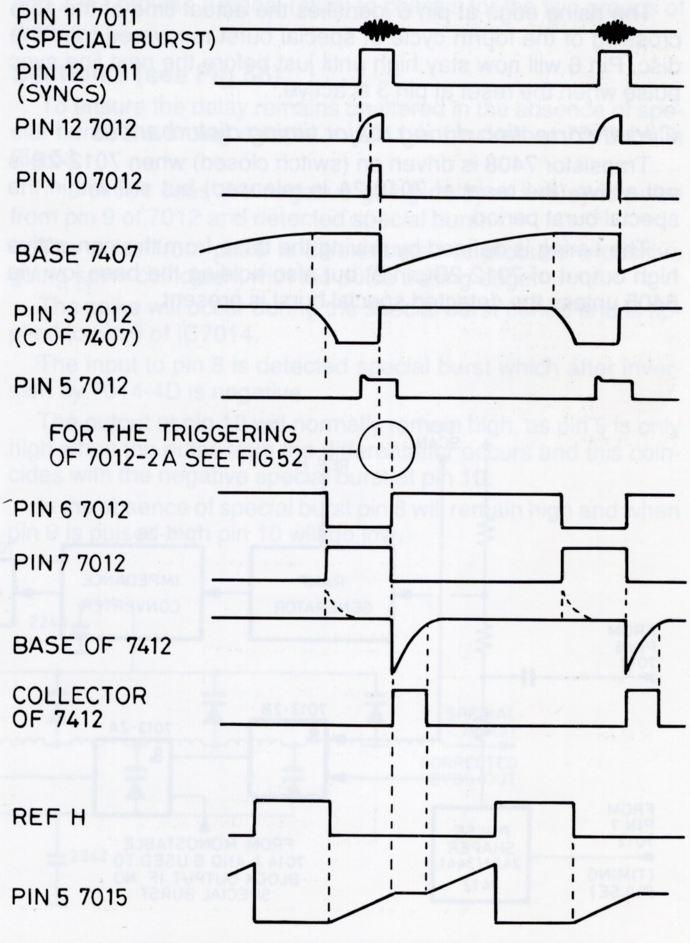


Fig.51 Waveforms of special burst detector

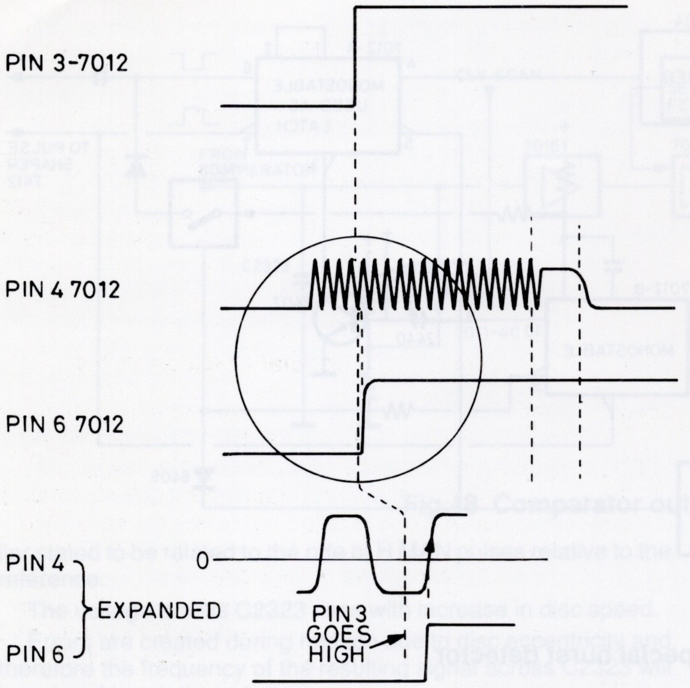


Fig.52 Waveforms associated with the triggering of 7012-2A

The fourth cycle of special burst is about to start when the reset input is released and consequently the rising edge of the fourth cycle triggers 7012-2A and pin 6 goes high. See Figs.50 and 52.

The rising edge at pin 6 identifies the actual time of the zero crossing of the fourth cycle of special burst recovered from the disc. Pin 6 will now stay high until just before the next line sync pulse when the reset at pin 3 is active.

Circuit correction during major timing disturbances

Transistor 7408 is driven on (switch closed) when 7012-2B is not active (the reset of 7012-2A is released) but still within the special burst period.

The timing is defined by driving the base from the non-active high output of 7012-2B(pin 9) but also holding the base low via 6405 unless the detected special burst is present.

The transistor will only pass current if pin 6 of 7012 is low, and the previously stated conditions are correct. This occurs between the time the reset of 7012-2A is cleared and the moment the monostable is triggered by the next rising edge of the limited special burst.

When 7408 is conducting it will alter the charge of the timing capacitor associated with 7012-2B causing a change in the next pulse width.

The trailing edge of the pulse output by 7012-2B pin 10 is differentiated and squared to become the pulse used to clear the reset of 7012-2A, (consequently the moment the reset is cleared is changed by altering the on time of 7012-2B).

In normal circuit operation the change in timing due to the conduction of 7408 is a constant.

If a major rotational disturbance of the disc occurs it is possible that the relative positions of the fourth cycle of special burst and the pulse to clear the reset input may alter.

This is because the reset input pulse is derived from line syncs extracted from video before TB correction and the special burst is taken from video after TB correction.

During extreme conditions the TB correction of the video may not be complete.

For example if the rising edge of the fourth cycle of special burst occurs at virtually the same time as the clearing of the reset input (pin 3 of 7012) the device will not be triggered until the following cycle.

The longer the time period between the reset clearing and pin 6 (the output) going high, the longer 7408 will conduct and the greater the corrective action that will be applied to the on time of 7012-2B, this will bring the time difference between the next clearing of the reset and the triggering of 7012-2A by the special burst to normal.

Section 2 (see Figs.53 and 51)

The time of the rising edge of pin 6 IC7012-2A now has to be compared with the time of the REF H pulse.

To carry out this operation the inverted output of 7012-2A at pin 7 is used.

The identified timing point corresponds to the negative going edge of the waveform at pin 7.

The waveform is then differentiated by 3441 and 2421 before being applied to the base of 7412.

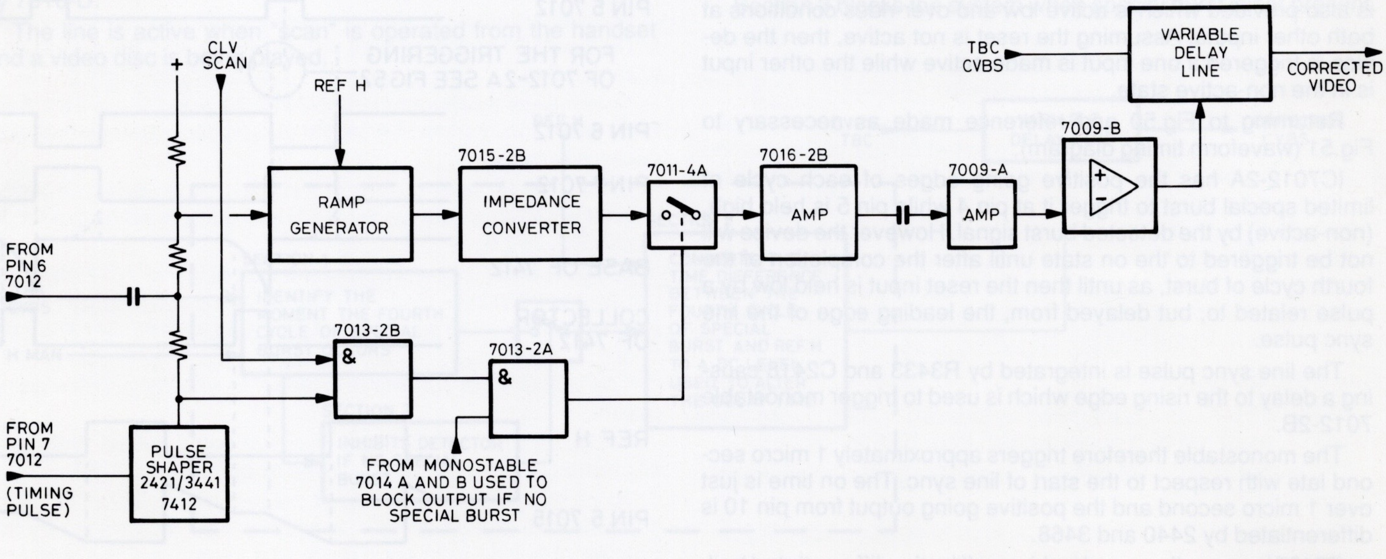


Fig.53 Section 2 of special burst detector

The transistor is normally on and is driven off by the negative going part of the differentiated signal, producing a positive pulse at the collector.

The time of this pulse is related to the time of the fourth cycle of special burst and the pulse width is determined by the differentiator network.

The pulse is now passed through two gates; the first is controlled by a line "CLV SCAN" and is used to block the pulse when the scan function on the handset is in use and therefore normal signals are not being recovered from the disc.

The second gate is controlled by the output of a circuit which

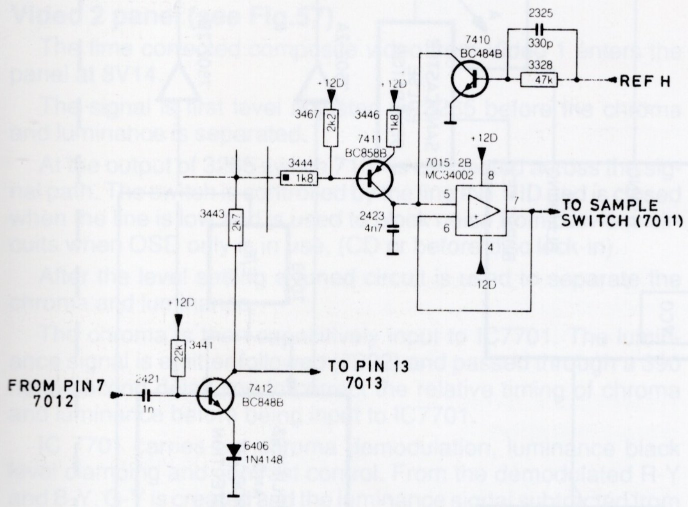


Fig.54 The ramp generator

will block the gate when the special burst is missing. At the output of the second gate the pulse is now ready to be compared with the reference.

The comparison is carried out by creating a ramp timed by REF H and then sampling the ramp using the pulse timed from the special burst.

The ramp generator (see Fig.54)

The REF H pulse, crystal derived in 7005 is used to create a ramp in the circuit consisting of 7411,7410 and 2423.

Transistor 7411 is normally on via 3467, 3444, 3443 and 7412 which is conducting except during the timing pulse.

The transistor 7411 forms a constant current source to linearly charge 2423. The positive going REF H pulse is applied to the base of transistor 7410 driving it on to discharge 2423 and complete the ramp cycle.

The ramp output from the capacitor is impedance converted before being applied to a switch (7011-4A). (see Fig.53)

The switch is closed by the timing pulse to sample the amplitude of the ramp. Therefore the voltage at the switch output is

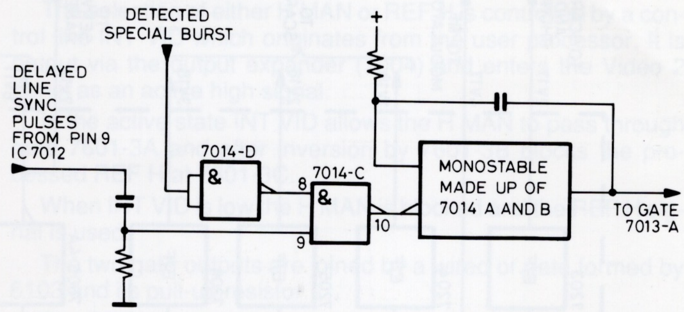


Fig.56 Section 3 of special burst detector

directly related to the time difference between the rising edge of the fourth cycle of special burst and the crystal reference pulse.

Returning to Fig.54 and the base divider of 7411 consisting of the three resistors and 7412. When transistor 7412 is switched off by the timing pulse, 7411 is also cut off since the base divider is open circuit. This ensures the ramp value does not change while it is being sampled by the timing pulse.

The control voltage obtained from the switch sampling of the ramp undergoes three stages of amplification (7016,7009A and B) before the control signal is applied across the capacity diodes which form part of the delay line, see Fig.53.

The input level to the second stage 7009 is adjustable to set the correct nominal delay.

The six diodes forming the distributed capacitance of the line are controlled as a series/parallel network (see Fig.55) allowing the final amplifier output to be applied to the diodes without the DC component being present on the delay line. Capacitors 2249 and 2242 provide a signal return to chassis for the two groups of diodes.

Section 3 (see Fig.56)

To ensure the delay remains unaltered in the absence of special burst, the timing sample to 7011 is blocked at 7013-2A in Fig.53.

The circuit uses the negative going delayed line sync pulse from pin 9 of 7012 and detected special burst.

The pulse from pin 9 is differentiated to produce a positive going spike coincident with the pulse trailing edge.

The spike will occur during the special burst period and is applied to pin 9 of IC7014.

The input to pin 8 is detected special burst which after inversion by 7014-4D is negative.

The output at pin 10 will normally remain high, as pin 9 is only high when the pulse from the differentiator occurs and this coincides with the negative special burst at pin 10.

In the absence of special burst pin 8 will remain high and when pin 9 is pulsed high pin 10 will go low.

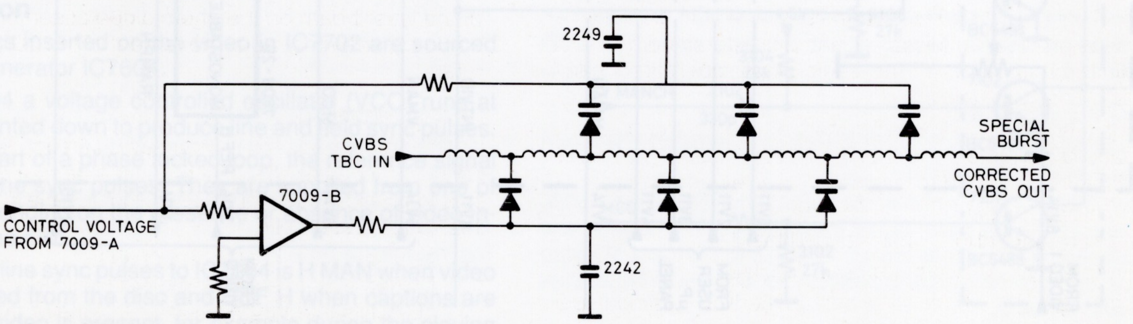


Fig.55 Variable delay line

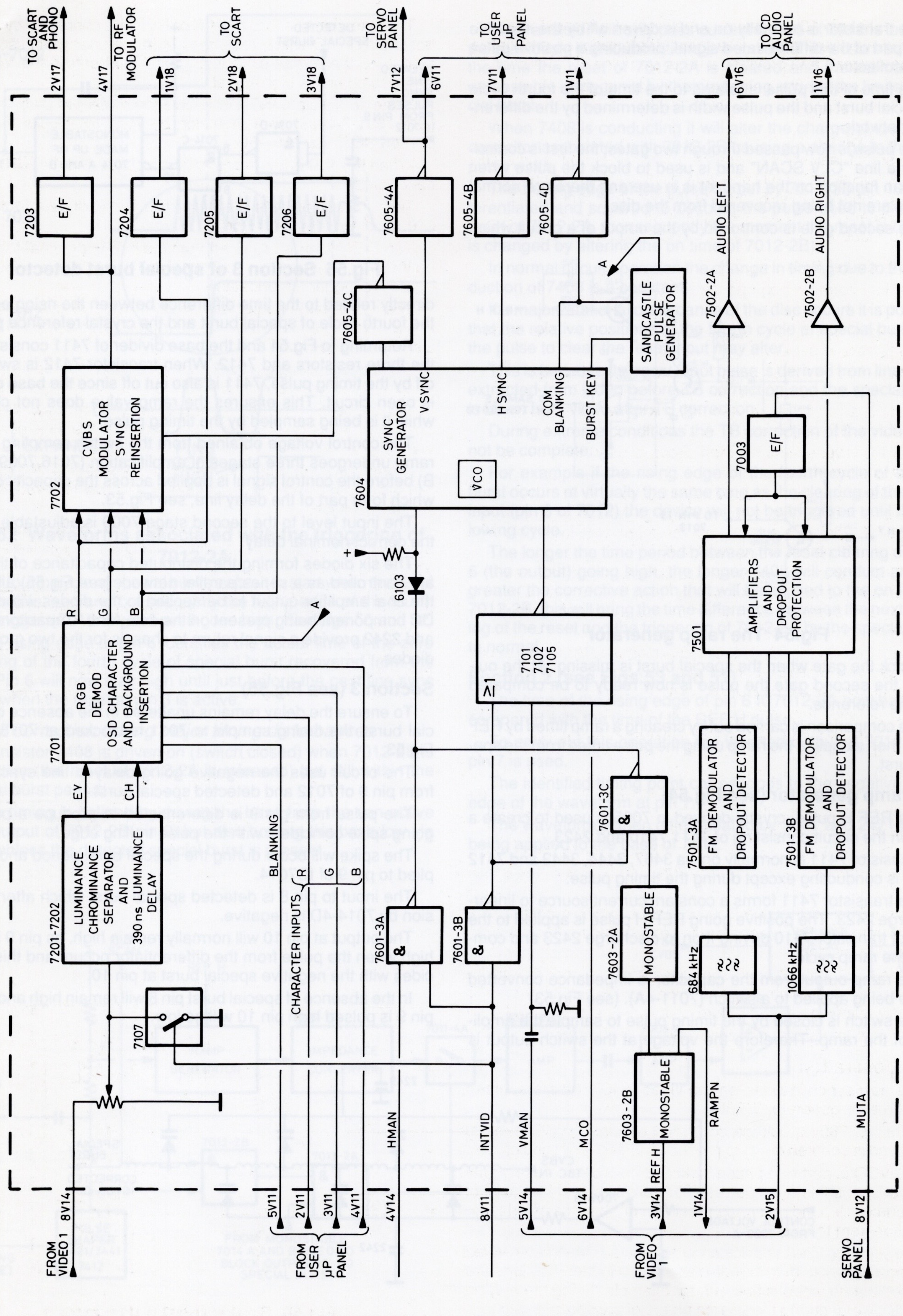


Fig.57 Signal processing and Video 2

The low at pin 10 is passed to the input of a monostable consisting of two nand gates. The monostable requires a negative pulse to trigger it and provides a negative pulse at the output.

When triggered the negative going output pulse is used to block the sample pulse through 7013-2A.

Refer to Fig.45.

The signal leaving the variable delay line is now a time corrected CVBS signal and is passed via a thick film noise reduction circuit to connector 1V26 to go to the Video 2 panel. If no thick film is present on Video 1 the signal from 1V26 goes via Video 3 panel to Video 2. A description of Video 3 follows Video 2.

Video 2 panel (see Fig.57)

The time corrected composite video from Video 1 enters the panel at 8V14.

The signal is first level adjusted by 3265 before the chroma and luminance is separated.

At the output of 3265 switch 7107 is connected across the signal path. The switch is controlled by the line INT VID and is closed when the line is low and is used to block noise from previous circuits when OSD only is in use, (CD or before disc lock-in).

After the level setting a tuned circuit is used to separate the chroma and luminance.

The chroma is then capacitively input to IC7701. The luminance signal is emitter followed (7202) and passed through a 390 nano-second delay line to correct the relative timing of chroma and luminance before being input to IC7701.

IC 7701 carries out chroma demodulation, luminance black level clamping and contrast control. From the demodulated R-Y and B-Y, G-Y is created and the luminance signal subtracted from each to produce R, G and B.

Before leaving the IC, R, G and B are passed through a circuit to add captions when present or when CD discs are being played the caption and background are inserted.

The operation requires four signals to be input to the IC; they are the R, G and B signals representing the characters in the caption and the blanking signal for character insertion.

The four signals are supplied to the Video 2 panel from the microprocessor panel where they are sourced by the character generator under the control of the user processor. They enter the Video 2 panel at connectors 2 to 5V11 inclusive.

The R, G and B signals from the IC are fed to the SCART socket via emitter followers 7204, 7205, 7206. The R, G and B are also fed to IC7702, a CVBS modulator.

The CVBS modulator derives luminance and colour difference signals from the RGB signals and remodulates the colour difference signals onto 4.43MHz.

New sync signals from the sync generator are inserted into the video before it leaves the IC. The CVBS signal output from the IC is emitter followed in 7203 before supplying the phono socket.

The IC output also feeds the CH36 RF modulator.

Sync generation

The new syncs inserted on the video in IC7702 are sourced from the sync generator IC7604.

Within IC 7604 a voltage controlled oscillator (VCO) runs at 5MHz and is counted down to produce line and field sync pulses.

The VCO is part of a phase locked loop, the reference signal into the loop is line sync pulses. They are supplied from one of two sources depending on the presence or absence of video information from the disc.

The source of line sync pulses to IC7604 is H MAN when video is being recovered from the disc and REF H when captions are required but no video is present, for example during the playing of a CD disc or during the search phase of a video disc, etc.

The selection of either H MAN or REF H is controlled by a control line INT VID which originates from the user processor. It is output via the output expander (7004) and enters the Video 2 panel as an active high signal.

In the active state INT VID allows the H MAN to pass through gate 7601-3A and after inversion by 7601-3B blocks the processed REF H at 7601-3C.

When INT VID is low the H MAN is blocked and the REF H signal is used.

The two gate outputs are joined by a wired or gate formed by 6103 and its pull-up resistor.

The REF H signal (sourced from the 4.5MHz crystal oscillator on Video 1) enters the Video 2 panel at 3V14 and its leading edge is used to trigger a monostable.

The monostable output has an on time of 34 micro seconds and the trailing edge of the non inverting output is used to trigger a second monostable.

The second monostable has an on time of 15 micro seconds and the inverted output is used to feed the input of gate 7601-C.

The purpose of the two monostables was to time position the pulse and set its on time before passing it to the sync generator via the gate.

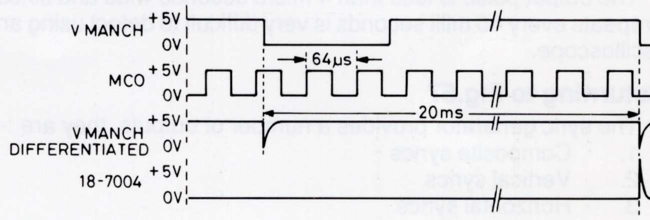
When video information is being recovered from the disc the reinserted syncs from the sync generator are required to have correct interlace.

To enable the sync generator to start the odd field at the correct time, a reset pulse, derived from the original syncs is input to IC7604 every 40 milli seconds.

The pulse is created by gating two signals, both obtained from the incoming video by the sync separator (IC7008) on the Video 1 panel.

They are V MANCH (field syncs) which enter Video 2 at 5V14 and the signal MCO which enters Video 2 at 6V14.

The MCO is a line rate waveform having an equal mark space ratio.



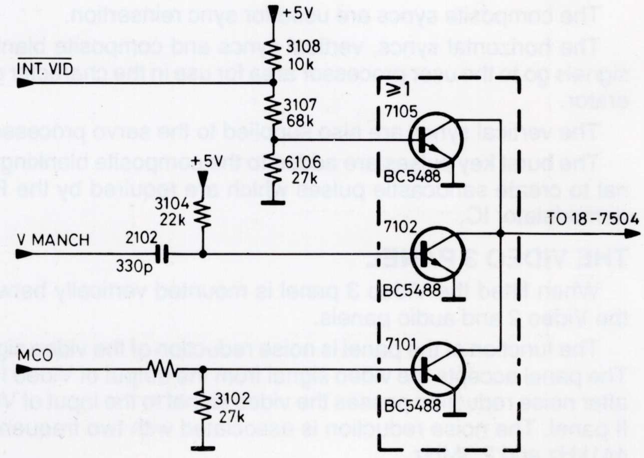


Fig.58 Raster reset pulse former

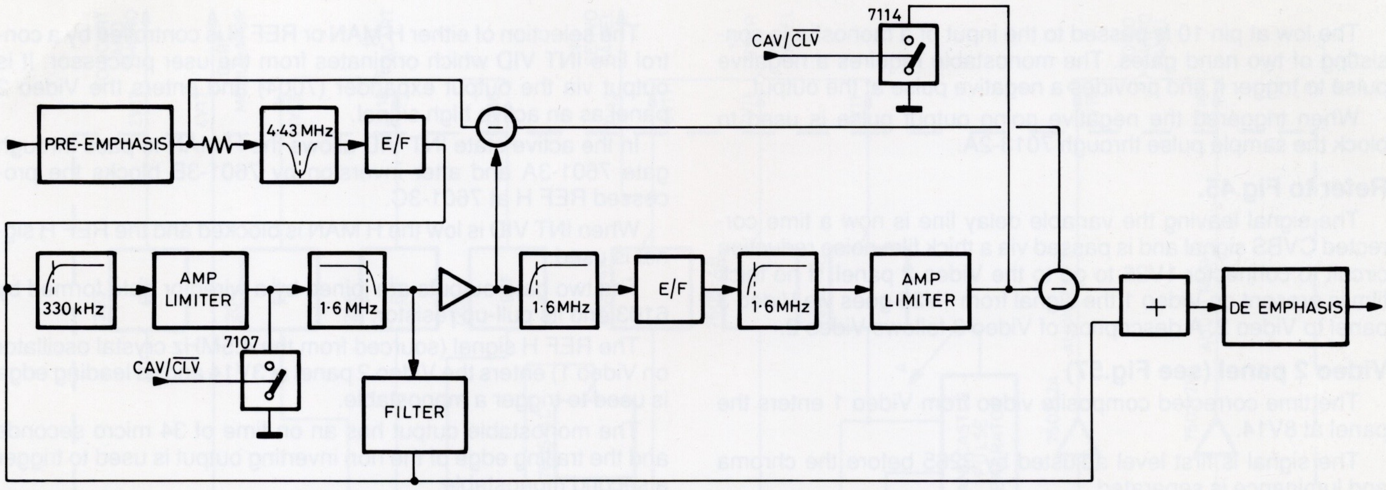


Fig.59 Video 3 block diagram

It is obtained from a voltage controlled oscillator locked to Line sync pulses recovered from the disc.

See Fig.58

The V MANCH is first differentiated to produce a very narrow pulse before being input to the gate.

The gate consists of three discrete transistors 7105, 7102 and 7101.

The MCO is fed to the second input.

The third input is connected to INT VID to ensure the gate is blocked unless video is being recovered from the disc.

Referring to the waveforms in Fig.58 and assuming INT VID is low then the gate will output a pulse if V MANCH goes low and MCO is low.

The output pulse is less than 4 micro seconds wide and since it repeats every 40 milli seconds is very difficult to detect using an oscilloscope.

Returning to Fig.57

The sync generator provides a number of outputs, they are :-

1. Composite syncs
2. Vertical syncs
3. Horizontal syncs
4. Composite blanking
5. Burst key pulses

The composite syncs are used for sync reinsertion.

The horizontal syncs, vertical syncs and composite blanking signals go to the user processor area for use in the character generator.

The vertical syncs are also supplied to the servo processor.

The burst key pulses are added to the composite blanking signal to create sandcastle pulses which are required by the RGB demodulator IC.

THE VIDEO 3 PANEL

When fitted the Video 3 panel is mounted vertically between the Video 2 and audio panels.

The function of the panel is noise reduction of the video signal. The panel accepts the video signal from the output of Video I and after noise reduction passes the video signal to the input of Video II panel. The noise reduction is associated with two frequencies 441kHz and 2.3MHz.

The circuits operate on the principle of selecting the frequencies to be attenuated and after amplification and limiting add them into the normal signal in anti-phase causing cancellation.

The frequency selection is carried out using resistor capacitor combinations forming low and high pass filters to set the limits each side of the frequencies to be attenuated. A block diagram of Video 3 is shown in Fig.59.

Refer to the circuit of Video 3 in the service documentation.

The video signal entering the panel first undergoes pre-emphasis and is then emitter followed. The normal signal from which the unwanted frequencies will be cancelled is taken via 2004 from the emitter follower output.

The signal from which the frequencies used for cancillation are selected, is taken from the emitter follower via resistor 3106.

Selecting the frequencies for cancellation

From 3106 the chroma signal is removed by the series resonant circuit 2003 and the 34 micro-henry inductor. The signal is then emitter followed before feeding a high pass filter (2005/3110) having a 6dB point at 330kHz. A second feed from the emitter follower going to the output circuit at 7117 will be mentioned later.

The output of the HPF is amplified and limited before being passed to a low pass filter with a 6dB point at 1.6MHz. The resulting signal from the two filters peaks at approximately 440kHz. After buffering by 7108, 7109 the filtered signal is subtracted from the main signal at R3124. The filter signal is also passed to an HPF with a 6dB frequency of 1.6MHz (2012/3126) it is then amplified and emitter followed before being passed via a second HPF of the same frequency (2014,3180) to an amplifier and limiter. The two high pass filters and amplifier acting on the side of peak of the previous filter output produces peak at 2.3MHz. This signal is subtracted from the main signal at 3136/37.

The now filtered signal has a second signal added to it to correct overall phase and relative frequency levels. The correction signal is made up from the signal after chroma rejection and selected frequencies from the output of the first filter section. It is input to the base of 7117. The main signal is fed to the base of 7115. The corrected signal is taken from the collector of 7117 and undergoes de-emphasis before being emitter followed and leaving Video 3.

The noise cancellation is not required during the playing of CAV discs and consequently it is disabled by 7107/7114 controlled by line CAV/$\overline{CLV}$.

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